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Diversity, abundance and distribution of fish community in the Mangroves of the MPA of Niamone-Kalounayes (Casamance, Senegal)

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Abstract

The composition and distribution of the fish community in the Marine Protected Area (MPA) of the Niamone-Kalounayes was studied using monthly experimental fisheries from July 2020 to June 2021. A total of 45 fish species from 22 families were captured in the MPA. September dominates the population in abundance (27.51%) and biomass (23.55%) while the specific richness is more important in December (27 species), September (26 species), July, October and February (25 species each) and in the confluence of the Tobor bolong (34 species). *Cichlidae* and *Mugilidae* dominate the community with 86.92% of the total abundance for a biomass of 65.64%. The ecological categories are largely dominated by species with a strong estuarine affinity. They represent about 98% of the total abundance and 97.79% of the total biomass. Herbivores (mainly predating phytoplankton or microphytophage) are the most represented in this study. Juveniles represented 70% of the captured individuals. Canonical Analysis of Correspondence of abiotic parameters showed that temperature and salinity might influence the distribution of fish assemblages in the MPA of Niamone-Kalounayes.

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Introduction

Mangrove ecosystems support a high number of species, either temporarily or permanently. They are the site of intense reproductive activity for many species. They ensure the renewal of fisheries resources (Albaret, 1999) and are critical habitats for juveniles of various marine species (Rubec *et al.*, 1999). Despite their importance, mangroves are subject to significant anthropogenic disturbances, which is one of the major causes of biodiversity erosion in these ecosystems. It is within this framework that the Government of Senegal, in a way of respecting the commitments relating to the Convention on Biological Diversity (CBD), that it created the MPA of Niamone-Kalounayes in 2015. Since the creation of this MPA, the ichthyological settlement in that mangrove ecosystems has not been the subject of an in-depth study. The few studies carried out on the ichthyological settlement in the MPA of Niamone-Kalounayes are incomplete or old. Albaret (1987) inventoried the ichthyological communities of the Casamance River from downstream to upstream in relation to environmental changes, including the MPA of Niamone-Kalounayes. The work of Kantoussan (2012) explored the effects of salinity on fish assemblages in the Casamance estuary. Finally, Diedhiou (2019) conducted a partial inventory of ichthyofauna in the MPA using two experimental fishing campaigns.

The purpose of this work is to study the specific composition, structure and distribution of the ichthyological community in the MPA of Niamone-Kalounayes. It aims specifically to dress a list of the fish species present in the MPA and to determine its fish community structure in terms of habitat needs and trophic position.

Materials and methods

Study Area Presentation

Created on November 4, 2015 by the decree no. 2015-1724, the MPA of Niamone-Kalounayes covers an area of 63,894 ha. It is located in the maritime, estuarine and also freshwater parts of the Ziguinchor region. It consists of a complex and diffuse system of channels (called bolongs) and mangroves, characteristic of brackish intertropical wetlands. It is delimited in the North by the village of Djiringoumane, going into the classified forest of Kalounayes, by the river of Soungrougrou within the limits of the commune of Ouonck in the East, and west by the Bignona marigot to the Affiniam Dam in the Manghagouleuck Commune and in the South by the Casamance River, borded by the communes of Coubalan and Niamone (Fig. 1). The main objectives of the creation of the MPA were the restoration of habitats and natural resources, the improvement of living conditions of animal populations and the establishment of an adapted governance system (DAMPC, 2015).

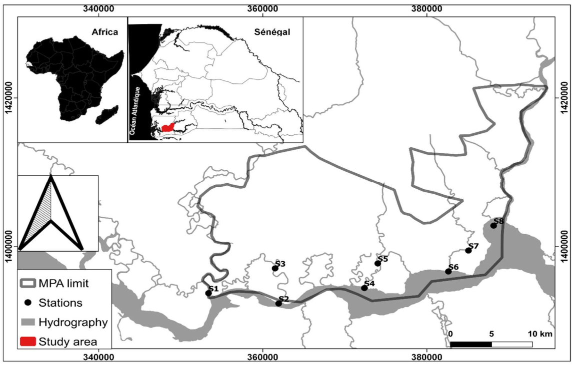

Fig. 1. Location of sampling stations: S1 bolong Affiniam, S2 confluent Tobor, S3 bolong Tobor, S4 confluent Coubalan, S5 bolong Coubalan, S6 confluent Hathioune, S7 bolong Hathioune, S8 Djiguipoune.

Sampling stations

The sampling stations were chosen by their hydromorphological characteristics and the possibility of fishing with the different nets used. Indeed, the MPA of Niamone-Kalounayes presents a rather important hydrographic network with several interconnected bolongs, bordered by mangroves and in communication with the main bed of the Casamance River. Thus, experimental fisheries were carried out at eight (8) stations located in mangrove zones, four (4) in bolongs bordered by mangroves (S1, S3, S5, S7) and four (4) at areas of confluence between bolongs and the main bed of the Casamance River (S2, S4, S6, S8).

Sampling Strategy

Fishing techniques

Monthly sampling was conducted from July 2020 to June 2021 by experimental fisheries using a beach seine, a surface drift gillnet and a bottom gillnet, the dimensions of which are presented in Table 1.

Table 1. Characteristics of the fishing nets used.

Type of net	Characteristics		
	Length (m)	Height (m)	Side mesh (mm)
Beach seine	200	7	25
Surface drift gillnet	150	2	25
Bottom gillnet	150	10	80, 40, 36, 30

Biological parameters measured

All fish caught were identified to the species level using different identification keys (Belleman *et al.*, 1988; Schneider, 1992; Seret and Opic, 2011; Paugy *et al.*, 2003). Individuals of each species were counted, and the total weight determined.

For each species, thirty individuals (or all if the number was less than 30) were weighed and measured individually (fork length and total length). The fish were measured with an ichthyometer of 1mm precision and weighed with a balance at a precision of 0.1g.

Environmental parameters measured

At each fishing station, temperature (°C) and salinity (‰) were recorded using a multiparameter (AQUAREAD, AP-5000) probe during fishing operations.

Data processing and analysis

The data was processed using R (R core Team, 2018). Two biological indicators were calculated: relative abundance (% N) and relative biomass (% B), calculated according to the formulas below:

$$\% \text{ N} = \frac{\text{total number of individuals of a given species}}{\text{total number of individuals of all species}} \text{ x } 100$$

$$\% \text{ B} = \frac{\text{total weight of individuals of a given species}}{\text{total weight of individuals of all species}} \text{ x } 100$$

Furthermore, different synthetic biological indices were calculated from the abundance numbers. The calculation of synthetic indices allows the estimation of the degree of organization of the communities, and the quality of this organization (Legendre *et al.*, 1998). Shannon-Weiner's Diversity Index (H') was calculated using this formula (Shannon, 1948):

$$H' = - \sum Pi * \ln * Pi$$

where Pi = the relative abundance of species i in the sample and ln = natural log.

The Pielou (1966) or Equitability (E) evenness index is defined as the ratio between the observed and maximum diversity in a determined spatial range. It was calculated using this formula:

$$E = H'/\log 2S$$

where E = the Evenness score (between 0 and 1); H' = Shannon-Weiner's Diversity Index; log2 = logarithme in base 2; S = species richness. Moreover, all species captured have been classified by ecological category, according to Albaret (1999). Classification is based on four criteria: abundance, degree of euryhalinity, spatial and temporal distribution, and breeding location. A total of six (6) groups were identified: estuarine species of continental origin (Ec), strict estuarine species (Es), estuarine species of marine origin (Em), marine estuarine species (ME), marine incidental species in estuary (Ma), and occasional marine species in estuaries (Mo).

Depending on the diet, species were also grouped into 6 trophic categories: detritivorous or grazing herbivores (he-de), herbivores with predominant phytoplankton or microphytophage (he-ph), top-level predators with predominant benthophage (p1-bt), generalist first-level predators: crustaceans, insects (p1-mc), generalist second-level predators: fish and other prey (p2-ge) and piscivorous second-level predators (p2-pi) (Froese *et al.*, 2011; Elliott *et al.*, 2007). In addition to the ecological and trophic categories, the spatial and temporal distribution of the fish community was also determined. A Common Factor Analysis (CFA) was conducted to group the most abundant species by months of sampling. Additionally, a Canonical Correspondence Analysis (CCA) was performed to assess the relative importance of the environmental parameters in the distribution of each species.

Results

Environmental Parameters

The surface water temperature at the MPA of Niamone-Kalounayes between July 2020 and June 2021 ranged from 20°C to 33.50°C with an average of 27.39 ± 3.15°C. Salinity ranged from 21‰ to 51.60 ‰ with an average of 34.76 ± 9.48 (Table 2).

Table 2. Statistical parameters of the environmental variables studied.

Parameters	Temperature (°C)	Salinity (‰)
Minimum	20.00	21.00
Minimum	33.50	51.60
Mean	27.39	34.76
Standard deviation	3.15	9.48

Specific composition and structure of the community

A total of 45 species from 22 families were sampled in this study (Table 3). The most represented families are *Mugilidae* (6 species), *Haemulidae* (4 species), and *Sciaenidae* (4 species). The other families are represented by one to three species each. Of the 45 species captured, only eight (8) were captured during all monthly sampling. These are *Carlarius latiscutatus*, *Coptodon guineensis*, *Elops lacerta*, *Ethmalosa fimbriata*, *Neonchelon falcipinnis*, *Parachelon grandisquamis*, *Sarotherodon melanotheron* and *Sphyraena afra*. *Sarotherodon melanotheron* largely dominates the community in terms of population (72.24%). Then come *Coptodon guineensis* (5.81%), *Parachelon grandisquamis* (4.97%) and *Ethmalosa fimbriata* (3.46%). The biomass is dominated by *Sarotherodon melanotheron* and *Carlarius latiscutatus* with respectively 48% and 11.80% of the total weight. They are followed by *Coptodon guineensis* (5.72%), *Parachelon grandisquamis* (5.56%), *Ethmalosa fimbriata* (3.47%), *Polydactylus quadrifilis* (3.37%) and *Elops lacerta* (3.22%).

Table 3. Fish species and structure of the ichthyological community in the MPA of Niamone-Kalounayes.

Family	Species	Code	Ecological category	Trophic category	Abundance (%)	Biomass (%)
Ariidae	*Carlarius heudeloti*	CHE	Ma	p2-ge	0.14	0.34
	Carlarius latiscutatus	CLA	ME	p2-ge	2.64	11.8
	Carlarius parkii	CPA	ME	p2-ge	0.23	0.85
Batrachoididae	*Batrachoides liberiensis*	BLI	Ma	p2-ge	0.01	0.01
Belonidae	*Strongylura senegalensis*	SSE	Em	p2-pi	0.01	0.01
	Tylosurus crocodilus	TCR	Mo	p2-pi	0.01	0.01
Bothidae	*Citharichthys stampflii*	CST	Em	p2-ge	0.82	0.67
Carangidae	*Caranx hyppos*	CHI	ME	p2-ge	0.01	0.01
	Caranx senegallus	CSE	ME	p2-ge	0.05	0.36
	Trachinotus teraia	TTE	Em	p1-bt	0.03	0.02
Cichlidae	*Coptodon guineensis*	CGU	Es	he-de	5.81	5.72
	Hemichromis fasciatus	HFA	Ec	p2-ge	0.51	0.51
	Sarotherodon melanotheron	SME	Es	he-ph	72.24	48
Clupeidae	*Ethmalosa fimbriata*	EFI	Em	he-ph	3.46	3.47
Cynoglossidae	*Cynoglossus senegalensis*	CYS	Em	p1-bt	0.29	0.77
Dasyatidae	*Fontetrigon margarita*	FMA	Em	p1-bt	0.18	1.5
Drepanidae	*Drepane africana*	DAF	ME	p1-mc	0.04	0.04
Elopidae	*Elops lacerta*	ELA	ME	p2-pi	1.9	3.22
	Elops senegalensis	ESE	Ma	p2-pi	0.88	0.97
Ephippidae	*Chaetodipterus lippei*	CLI	Ma	p1-mc	0.06	0.12
	Ephippus goreensis	EGO	Mo	p1-mc	0.02	0.1
Gerreidae	*Eucinostomus melanopterus*	EME	ME	p1-mc	0.13	0.05
	Gerres nigri	GNI	Es	p1-mc	0.13	0.09
Haemulidae	*Plectorhynchus macrolepis*	PMA	Em	p2-ge	0.03	0.04
	Pomadasys incisus	PIN	Em	p1-bt	0.01	0.01
	Pomadasys jubelini	PJU	Em	p1-bt	0.06	0.16
	Pomadasys perotaei	PPE	Em	p1-bt	0.01	0.03
Monodactylidae	*Monodactylus sebae*	MSE	Es	p2-ge	0.38	0.15
Mugilidae	*Chelon dumerili*	CDU	Em	he-de	0.95	1.08
	Mugil bananensis	MBA	ME	he-de	0.32	0.53
	Mugil cephalus	MCE	ME	he-de	0.23	1.66
	Mugil curema	MCU	Em	he-de	0.06	0.11
	Néonchelon falcipinnis	LFA	Em	he-de	1.86	2.49
	Parachelon grandisquamis	PGR	Em	he-de	4.97	5.56
Polynemidae	*Galeoides decadactylus*	GDE	ME	p2-ge	0.09	1
	Polydactylus quadrifilis	PQU	ME	p2-pi	0.19	3.37
Sciaenidae	*Pseudotolithus elongatus*	PEL	Em	p2-ge	0.57	1.42
	Pseudotolithus senegalensis	PSE	Ma	p2-ge	0.04	0.08
	Pseudotolithus senegallus	PBR	ME	p2-ge	0.4	2.17
	Pseudotolithus typus	PTY	ME	p2-ge	0.01	0.04
Soleidae	*Synaptura cadenati*	SCA	Mo	p1-bt	0.01	0
	Synaptura lusitanica	SLU	Ma	p1-bt	0.01	0.03
Sphyraenidae	*Sphyraena afra*	SAF	ME	p2-pi	0.21	1.4
Tetradontidae	*Ephippion guttifer*	EGU	ME	p1-bt	0.01	0.01
Torpedinidae	*Torpedo atlanticus*	TAT	Mo	p2-ge	0.01	0.03

Diversity index

The results obtained showed a small monthly variation in the values of the Shannon-Weiner's Diversity Index as well as Pielou Equitability (Fig. 2). The stock of fish reached a greater degree of organization during the months of July (3.49), October (3.49), and December (3.34). On the other hand, the Equitability index values obtained in July (0.75), October (0.75), August (0.71), April (0.71), May (0.71), December (0.70) and March (0.70) reflect a greater distribution of the fish community (Fig. 2).

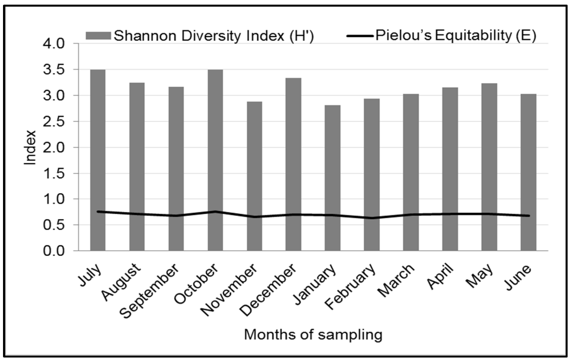

Fig. 2. Monthly changes in Shannon-Weiner's Diversity Index and Pielou's Equitability.

Spatio-temporal variations in abundance, biomass, and specific richness

The spatial variation of the fish community shows greater species richness in the confluence of the Tobor bolong and river (34 species), followed by only the Tobor bolong (30 species) and the Affiniam bolong (29 species). The lowest number of species was recorded in the Coubalan bolong. In contrast, the Hathioune bolong dominates in abundance (25%) and biomass (21%) (Fig. 3).

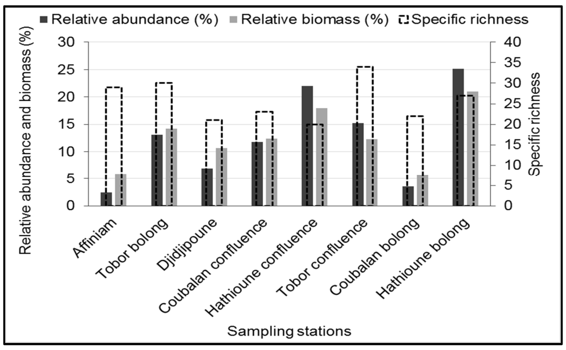

Fig. 3. Spatial variability of abundance, biomass and specific richness.

Results from the monthly variation showed that the species richness is higher in December (27 species) and September (26 species), which when combined, would group about 19% of the species inventoried. Next, July, October and February showed high species diversity, with 25 species, or 9% of the total specific richness. The lowest specific richness was recorded in January, with 17 species representing only 6% of the species caught. September dominates in abundance (27.51%) and biomass (23.55%). The lowest values were recorded in February with 4.75% for abundance and 4.15% for biomass (Fig. 4).

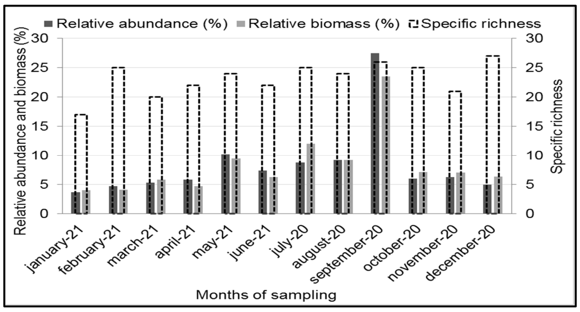

Fig. 4. Monthly variability in abundance, biomass and specific richness.

Community variation by ecological and trophic categories

Strict estuarine species (Es) dominate the community in terms of abundance (78.56%) and biomass (53.95%). On the other hand, the greatest species richness is recorded in marine species with an estuarine affinity (ME) and estuarine of marine origin (Em), which respectively held 15 and 14 species (Fig. 5).

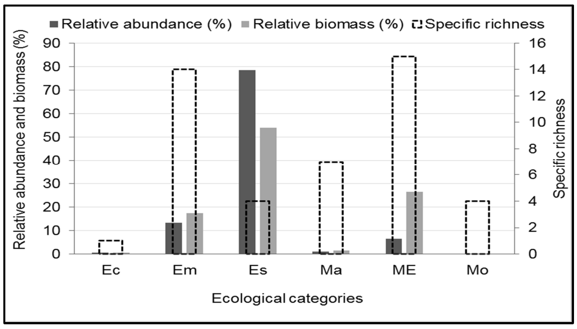

Fig. 5. Species richness, abundance and relative biomass presented by ecological category. Estuarine of continental origin (Ec), strict estuarine (Es), estuarine of marine origin (Em), marine-estuarine (ME), marine accessories (Ma), occasional marine (Mo) (Albaret *et al.*, 1999).

Depending on the trophic categories, herbivores predominating phytoplankton or microphytophage (he-ph) dominate in abundance (75.70%) and biomass (51.47%). However, the greatest species richness is observed in general second-level predators p2-ge with 16 species or 15.21% of the total species richness. Top-level predators predominantly benthophagus (p1-bt) and generalist top-level predators: crustaceans, insects (p1-mc) are poorly represented in terms of abundance and biomass (Fig. 6).

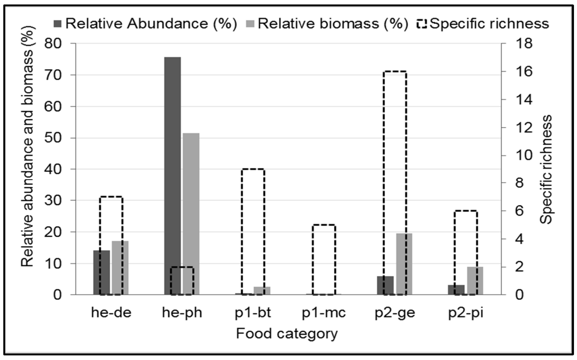

Fig. 6. Species richness, abundance and relative biomass presented by trophic category. he-de = herbivores detritivores, he-ph = herbivores with a phytoplanktonophage dominance, p1-bt = first-level benthophage predators, p1-mc = first-level general predators, p2-ge = second-level general predators; p2 = second-level predators that are predominantly piscivorous (Froese et al., 2011; Elliott et al., 2007).

Size structure

The size structure of the MPA of Niamone-Kalounayes has a unimodal variation. Individuals smaller than 20cm are largely dominant with 70% of the community. The largest sizes were measured in *Carlarius latiscutatus* (50cm), *Sphyraena afra* (68cm) and *Pseudotolithus senegallus* (89cm). Smaller individuals are represented by *Monodactylus sebae*, *Coptodon guineensis*, *Sarotherodon melanoteron* and *Hemichromis fasciatus* (Fig. 7). Three characteristic groups are highlighted. The first group, projected positively on the first axis, highlights the most abundant species in May, June and July. These include *Ethmalosa fimbriata*, *Chelon dumerili*, *Elops lacerta*, *Neonchelon falcipinnis*, *Citharichthys stampflii*, *Monodactylus sebae*, *Fontitrygon margarita* and *Pseudotolithus elongatus*.

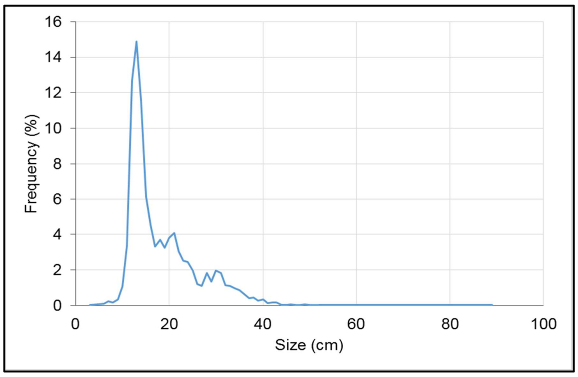

Fig. 7. Size structure of the fish community of the MPA of Niamone-Kalounayes

Multivariate analyses

Temporal distribution of fish community

The distribution of variances evaluated by the CFA in the temporal distribution of fish species in the MPA of Niamone-Kalounayes suggests that the first two axes represent 52.4% of the total inertia (Fig. 8).

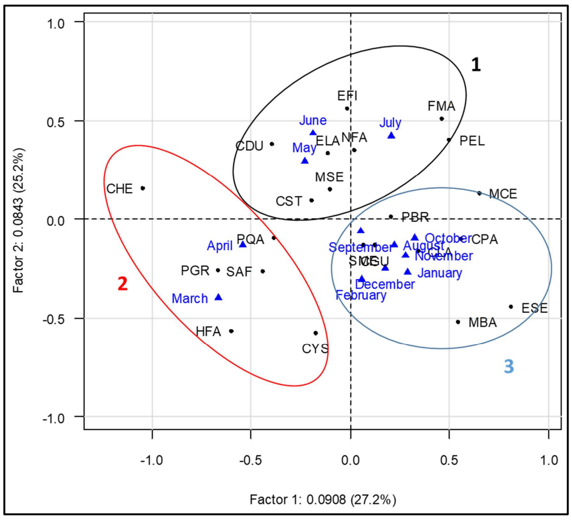

Fig. 8. Temporal distribution of the most abundant species by sampling months.

The second axis is an axis of opposition which opposes the most abundant species during the months of March and April (*Polydactylus quadrifilis*, *Parachelon grandisquamis*, *Sphyraena afra* and *Hemichromis fasciatus)* to the most abundant species in August, September, October, November, December, January and February (*Mugil bananensis*, *Elops senegalensis*, *Coptodon guineensis*, *Sarotherodon melanotheron*, *Carlarius latiscutatus*, *Carlarius parkii* and *Cynoglossus senegalensis)* Presented in the third group.

Canonical Analysis of Correspondence (CCA)

Fig. 9 shows the distribution of species according to temperature and salinity. Axis 1 (horizontal), concentrating 73.4% of the information, is a gradient axis for temperature and salinity. This axis isolates two (2) groups of species.

The first group consists of species most often encountered in environments with high temperature and salinity. These are *Monodactylus sebae*, *Polydactylus quadrifilis*, *Ethmalosa fimbriata*, *Chelon dumerili*, *Elops lacerta*, *Neochelon falcipinnis*, *Carlarius heudeloti*, *Parachelon grandisquamis*, *Cynoglossus senegalensis* and *Sphyraena afra*.

The second group consists of species that do not support higher values of temperature and salinity. These are *Pseudotolithus elongatus*, *Elops senegalensis*, *Fontitrygon margarita*, *Carlarius margarita*, *Monodactylus sebae*, *Mugil bananensis*, *Coptodon guineensis*, *Parachelon grandisquamis*, *Sarotherodon melanotheron*, *Citharichthys stampflii* and *Hemichromis fasciatus*. Axis two (2), which concentrates 26.6% of the information, is an axis of opposition that divide the species that live in high temperature waters (*Monodactylus sebae*, *Polydactylus quadrifilis*, *Ethmalosa fimbriata*, *Elops lacerta* and *Chelon dumerili*) with species that live in waters with high salinity (*Carlarius heudeloti*, *Parachelon grandisquamis*, *Neonchelon falcipinnis*, *Cynoglossus senegalensis* and *Sphyraena afra*).

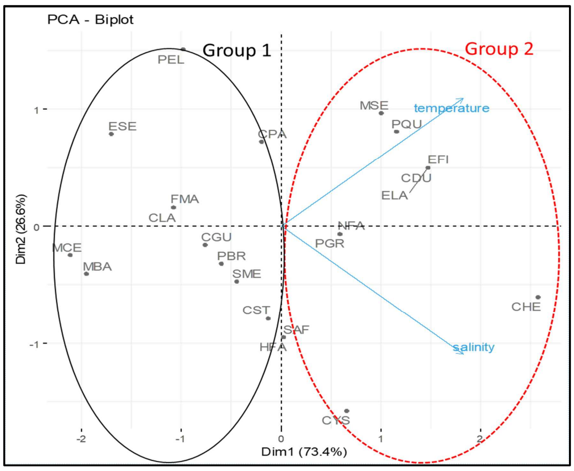

Fig. 9. Canonical analysis of the correspondences of the most abundant species with the abiotic factors.

Discussion

Community composition

The study identified 45 species of fish in 22 families. The number of species inventoried during the study is relatively high, compared to the results of previous studies in and around the MPA (Diedhiou, 2019; Nzalé, 2019). Diedhiou (2019) inventoried 28 species in 15 families in the MPA of Niamone-Kalouanyes. A total of 26 fish species have been identified in the MPA of Kassa-Balantacounda, adjacent to the MPA of Niamone-Kalounayes (Nzalé, 2019). This increase in the number of species recorded in this study is explained by the higher sampling effort. Indeed, Diedhiou and Nzalé each carried out only two experimental fishing events, contrary to the present study, in which 12 fishing events were conducted.

In contrast, the specific richness of the MPA of Niamone-Kalounayes is lower than that observed in the MPA of Sangomar (76 species), and that of the MPA of Bamboung (57 species) (Ngom, 2019; Ecoutin *et al.*, 2012).

This observed difference in the composition of fish communities can be explained by the management measures put in place, and by the influence of physicochemical factors which can play an important role in the composition and distribution of the species (Lae *et al.*, 2003; Kantoussan *et al.*, 2007). Sadio (2015) indicated that the increase in specific richness can be explained by a strong presence of species in the MPA through a phenomenon of attraction (massive arrival of species in the MPA).

The Mugilidae (*Chelon dumerili, Parachelon grandisquamis, Neonchelon falcipinnis, Mugil curema, Mugil banansis, and Mugil cephalus*) remain the most diverse family in the MPA. These results corroborate those obtained by Diankha (2018), Diedhiou (2019), Diallo (2018), Nzalé (2019) and Albaret (1987) in the different MPAs of the Saloum and Casamance deltas.

In terms of abundance and biomass, the greatest variations in the fish population of the MPA of Niamone-Kalounayes are recorded in species with a high estuarine affinity, corroborating the results of Kantoussan (2012). These species are represented by strict estuarine (Es), marine estuarine (Em) and estuarine marine (ME). They represent about 98% of the total abundance and 97.79% of the total biomass.

These species spend some or all of their life cycle in estuarine environments (Albaret *et al.*, 2005; Ecoutin *et al.*, 2005). The dominance of these ecological groups can be explained by the strong presence of *Cichlidae* and *Mugilidae*. These species constitute the base populations of estuaries in West Africa thanks to their high tolerance to fluctuations in environmental conditions in these ecosystems and especially to variations in salinity (Albaret *et al.*, 1989; Simier *et al.*, 2004; Whitfield *et al.*, 2005; Ecoutin *et al.*, 2014). The presence of species with marine and/or estuarine affinity would be related to the presence of the Casamance River favouring their recovery at a time of their life cycle. Indeed, migratory species from brackish habitats migrate upstream from rivers at the time of flooding for spawning (Lévêque and Paugy 1999).

The fish population of the MPA was largely dominated by herbivores with a predominance of phytoplanktonphage or microphytophage (he-ph). These species accounted for 89.89% and 68.62% of the total abundance and biomass respectively. Similar results were obtained in the same area by Diedhiou (2019) and Nzalé (2019). In contrast, studies conducted in the MPAs of Palmarin, Sangomar and the Somone reserve in Sénégal shown that second-level predators predominantly piscivorous (p2-pi) dominate the pool of species (Diankha, 2018, Ngom, 2019; Diallo, 2018). Catches over all fishing seasons show a dominance of small individuals. In this particular context, estuaries and mangroves still play their role as nurseries (Vidy, 2000).

Spatio-temporal distribution of fish community in MPA

Analysis of biological indicators showed that September was the most favourable month in terms of abundance and biomass. On the other hand, the greatest specific wealth was recorded in September and December in the confluence between the Tobor bolong and the bed of the Casamance river. The highest diversity index values were recorded in July (3.49), October (3.49) and December (3.34). On the other hand, the Equitability index values obtained in July (0.75), October (0.75), August (0.71), April (0.71) May (0.71), December (0.70) and March (0.70) reflect a greater distribution of the fish community. Shannon-Wiener diversity index between 3.38 and 3.49 were observed in the Casamance estuary (Kantoussan *et al.*, 2012).

The CCA of the seasonal abundance data shows that the two parameters studied (temperature and salinity) are among the main factors influencing the seasonal structure of fish in the MPA. The present study was able to show that temperature would be the main factor controlling the distribution of species such as *Monodactylus sebae, Polydactylus quadrifilis, Ethmalosa fimbriata, Chelon dumerili, Elops lacerta* and *Neochelon falcipinnis*. However, the distribution of *Carlarius heudeloti, Parachelon grandisquamis, Cynoglossus senegalensis* and *Sphyraena afra* is more related to salinity. The influence of environmental factors on the structure of fish assemblages in estuarine environments has been demonstrated by several authors (Diankha, 2018; Diallo, 2018; Albaret *et al.*, 2005; Akin *et al.*, 2005; Pérez-Ruzafa *et al.*, 2007; Maci *et al.*, 2009). Other factors such as aquatic vegetation (West and King 1996; Rozas and Minello 1998; Akin *et al.*, 2003), food availability (Rozas and Hackney, 1984; Barry *et al.* 1996; Kneib 1997), sediment type (Marchand, 1993), river mouth characteristics (Young *et al.*, 1997; Bell *et al.*, 2001), habitat quality and biological inter-relationships (Martino and Able, 2003) all play an important role in the spatial distribution of fish assemblages in several estuarine systems.

Conclusion

The present study has shown that the MPA of Niamone-Kalounayes has a rather important specific richness, with 45 species of fish distributed in 22 families. The families of *Mugilidae* and *Cichlidae* dominate the community with the greatest abundance and biomass recorded, and with species encompassing six ecological and trophic categories

(Albaret *et al.*, 1999; Froese *et al.*, 2011; Elliott *et al.*, 2007). The community is dominated by juveniles, with 70% of the individuals less than 20cm in size.

The temporal organization of most fish assemblages remains strongly influenced by temperature and salinity. The results of this study made it possible to have a clear idea of the spatial and temporal variation, but also of the structure of fish populations in the MPA.

However, in order to establish a better management plan, other environmental parameters such as conductivity, turbidity, dissolved oxygen and the nature of the substrate should be taken into account.

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