

Ichthyoplankton Population in the Estuaries and Mangroves of Sangaréah Bay

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How to cite this paper: Sangaré, O., Oueda, A., Sawadogo, Y.M.-F., Guissé, A. and Touré, F. (2024) Ichthyoplankton Population in the Estuaries and Mangroves of Sangaréah Bay. *Open Journal of Ecology*, 14, 879-890. <https://doi.org/10.4236/oje.2024.1411051>

Received: September 27, 2024

Accepted: November 26, 2024

Published: November 29, 2024

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Abstract

This study concerns the density and biomass of the ichthyoplankton population in the estuaries and mangroves of Sangaréah Bay. The study resulted in the inventory of 5938 individuals divided into 20 families and 30 species, more dominated by the Carangidae, Clupeidae and Sciaenidae, which each account for 10% of the species total population. A high concentration of planktonic ichthyoplankton organisms was observed in the Sonfonia, Samatran, Soumba and Arabanty areas. In short, the constant presence of eggs and larvae of ontogenetic stages make these estuary and mangrove zones environments of advection, migration, ontogenetic development and feeding. Ichthyoplankton is one of the modern tools used in the bio-indication and bio-monitoring of aquatic ecosystems. A diverse population dominated by fish eggs and larvae is a sign that the ecosystems surveyed are functioning properly.

Keywords

Estuaries, Mangroves, Sangaréah Bay, Ichthyoplankton Species

1. Introduction

Coastal environments consisting of mangroves and estuaries are places with significant natural and economic potential, which have long played and continue to play an important role for mankind [1]. From a socio-economic point of view, these ecosystems are privileged areas for the development of numerous activities, sources of employment such as port and industrial activities, rapid urbanisation

and tourism, which provide a wide range of goods and services [2]. Fishing, fish smoking, wood cutting, salt farming and rice growing are also the main activities in mangroves. Today, the trend is reversed in some coastal areas, particularly in mangrove and estuarine zones, because of the decline that this ecosystem is undergoing [3]. This is why it is necessary to strengthen coastal management, which aims to strike a balance between protecting the quality of the environment and meeting social and economic needs. Then through its Intergovernmental Oceanographic Commission (IOC), Guinea has the objective of promoting and facilitating international marine and coastal research, in order to improve knowledge of critical global, regional and national issues relating to the oceans, seas and coastal zones [4]. One of the big issues is the sustainable management of natural resources. This management requires solid knowledge about spatial and temporal distribution of these natural resources and also techniques for analyzing, modeling and monitoring of these resources.

When it came to ichthyoplankton, many authors have worked on these organisms in the Republic of Guinea [5]-[11] but very little information is available concerning Sangaréah Bay. This lack of information may lead to irreversible upheaval in the renewal processes of exploited stocks, then affect fish production in the long term and the regional economy. This study aims to give some light on the diversity and the distribution of the ichthyoplankton in the Sangaréah Bay to serve as background information for improving management.

2. Methodology

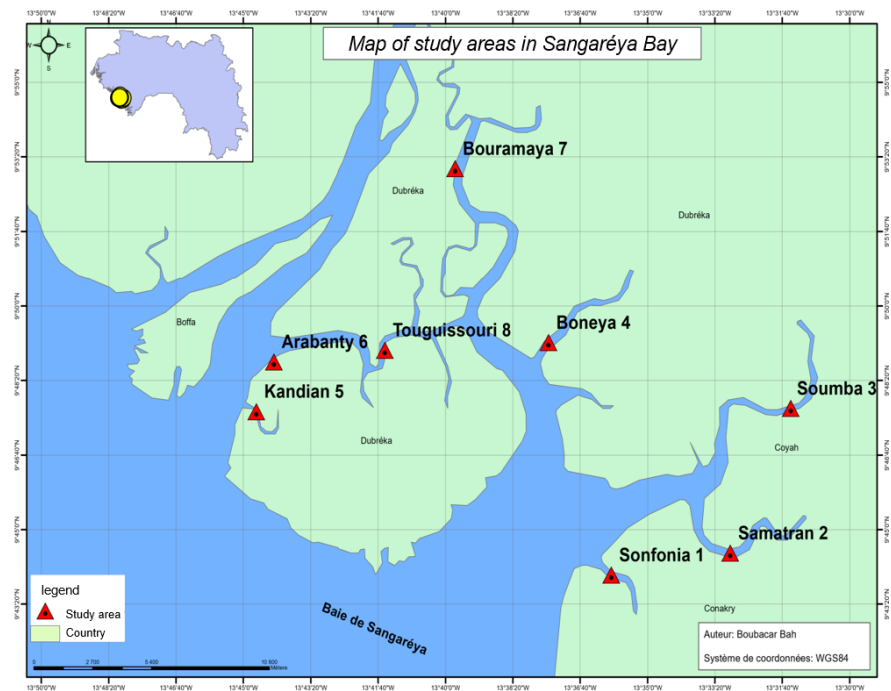
2.1. Study Area

Sangaréah Bay is one of the coastal ecosystems closest to Conakry, the capital city of the Republic of Guinea. The bay is located to the north-west of the city of Conakry between 9°11'N and 10°5'N in latitude and between 13°29'W and 13°45'W in longitude, it covers an area of 38,000 ha and was home to 49,318 inhabitants from 51 villages, including 6 mangrove villages, in 1999 [12]. The study area is bounded to the east by Mount Kakoulima and part of the coastal chain, to the west by the Konkouré river, to the north by the Kabitaye classified forest and the sub-prefectures of Wassou and Tanènè, and to the south by the Atlantic Ocean and the Kaloum peninsula. It is fed by the Konkouré River, the Soumba River and the Sonfonia River. Sangaréah Bay is characterised by alluvial hydro morphic soils of marine or continental origin [13]. It is a typical estuarine zone used by fish as a breeding ground, nursery, refuge or feeding ground. This ecosystem is also a transit area for juvenile fish before they migrate to deeper waters [14] (Figure 1).

Taking into account the habitat heterogeneity and the variety of activities in the Bay (wood cutting, salt farming, fish smoking, fisheries, domestic and agricultural wastewater), eight sampling point, distributed along the estuaries and mangroves in the bay, have been selected following a downstream-upstream gradient as in Table 1.

Table 1. Geographical coordinates of sampling points in the Sangaréah Bay.

Number	Names	Latitude (N)	Longitude (W)	Depth (m)
1	Sonfonia	9° 43' 59.73"	13° 35' 56.53"	3.5 - 7
2	Samatran	9° 44' 41.03"	13° 32' 30.99"	5.5 - 9
3	Soumba	9° 47' 54.00"	13° 32' 38.04"	6.5 - 9.9
4	Bonèya	9° 48' 59.83"	13° 37' 37.61"	8.6 - 9.89
5	Bouramaya	9° 53' 24.51"	13° 39' 35.85"	6.89 - 11.54
6	Touguissourie	9° 55' 37.32"	13° 39' 47.77"	5.7 - 12.54
7	Arabanty	9° 47' 46.38"	13° 44' 48.46"	4.7 - 6.82
8	Kandian	9° 55' 37.32"	13° 41' 37.53"	4.3 - 9.52

**Figure 1.** Map of the study area showing the sampling points in red triangles.

2.2. Sampling and Data Analysis

Ichthyoplankton in the Sangareah Bay was sampled monthly during two years from January 2022 to December 2023. Samples were taken in the first week of each month following the same methodology as Tamoïkine [6]. After sampling, all fish larvae were sorted, identified and counted. The taxonomic determination was made based on the guide in [6] [15]-[21].

Standard length and total length of larvae were measured under a microscope using an eyepiece micrometer. Weight of the larvae was also measured.

3. Results and Discussion

3.1. Species Inventory

In total 5938 ichthyoplankton specimen were sampled in this study. These specimens belong to 30 species divided into 20 families, dominated by the Carangidae, Clupeidae and Sciaenidae, which each account for 10%, and the Ariidae,

Cynoglossidae, Mugilidae and Polynemidae, which represent 7% (Figure 2). Table 2 shows the list of inventoried species.

Table 2. Inventory of ichthyoplankton populations.

Ordres	Family	Abundance	Genres	Species			
Albuliformes	Albulidae	3.76	<i>Albula</i>	<i>Albula vulpes</i>			
Siluriformes	Ariidae	3.33	<i>Carlarius</i>	<i>Arius latiscutatus</i> <i>Carlarius heudelotii</i>			
			<i>Ethmalosa</i>	<i>Ethmalosa fimbriata</i>			
Clupeiformes	Clupeidae	26.12	<i>Sardinella</i>	<i>Sardinella aurita</i> <i>Sardinella maderensis</i>			
			<i>Caranx</i>	<i>Caranx hippos</i> <i>Chloroscombrus chrysurus</i>			
Perciformes	Carangidae	6.53	<i>Trachurus</i>	<i>Trachurus lepturus</i>			
			Cynoglossidae	5.84	<i>Cynoglossus</i>	<i>Cynoglossus senegalensis</i> <i>Cynoglossus monodi</i>	
	Gobidea	2.76	<i>Periophthalmus</i>	<i>Periophthalmus barbarus</i>			
	Polynemidae	9.55	<i>Galeoides</i>	<i>Galeoides decadactylus</i>			
			<i>Pentanemu</i>	<i>Pentanemus quinquarius</i>			
	Pristigasteridae	4.45	<i>Ilisha</i>	<i>Ilisha africana</i> <i>Pseudotolithus elongatus</i>			
	Sciaenidae	9.75	<i>Pseudotolithus</i>	<i>Pseudotolithus epipercus</i> <i>Pseudotolithus typus</i>			
				Trichiuridae	0.64	<i>Trichiurus</i>	<i>Trichiurus lepturus</i>
				Sphyraenidae	2.75	<i>Sphyraena</i>	<i>Sphyraena barracuda</i>
	Sparidae	0.62	<i>Sparus</i>	<i>Sparus auratus</i>			
Pleuronectiformes	Cichlidae	1.20	<i>Sarotherodon</i>	<i>Sarotherodon melanotheron</i>			
Syngnathiformes	Syngnatidae	0.96	<i>Hipocampus</i>	<i>Hipocampus punctulatus</i>			
Tetraodontiformes	Tétradontidae	3.35	<i>Ephppion</i>	<i>Ephppion guttifererum</i>			
				Elopidae	1.21	<i>Elops</i>	<i>Elops senegalensis</i>
Beloniformes	Exocoetidae	2.31	<i>Cheilopogon</i>	<i>Cheilopogon cyanopterus</i>			
	Hemiramphidae	0.51	<i>Hemiramphus</i>	<i>Hemiramphus brasiliensis</i>			
Elopiformes	Drepanidae	4.72	<i>Drepane</i>	<i>Drepane africana</i>			
Mugiliformes	Mugilidae	9.40	<i>Liza</i>	<i>Liza falcipinnis</i> <i>Liza grandisquamis</i>			

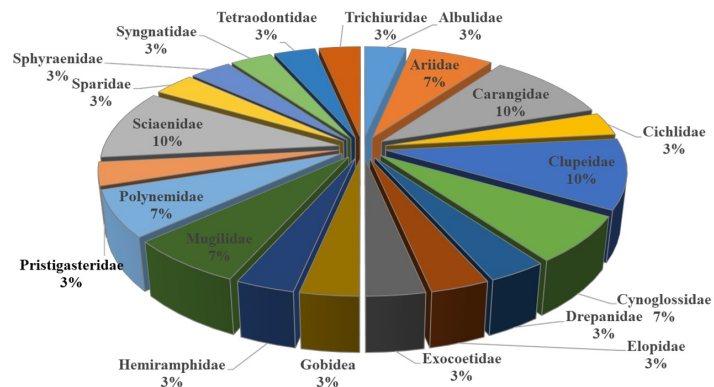


Figure 2. Proportion of families of fish larvae in the estuary and mangrove areas of Sangaréah Bay.

The dominant species were as follows: *Ethmalosa fimbriata* 9%, *Sardinella aurita* 8%, *Sardinella maderensis* 8% (Figure 3).

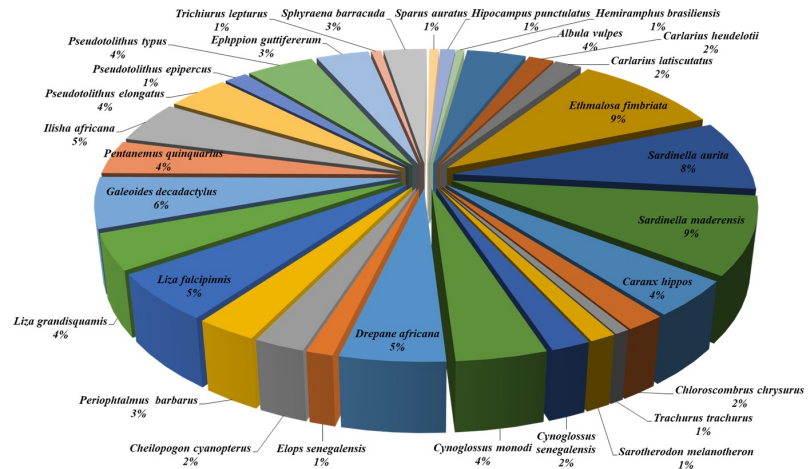


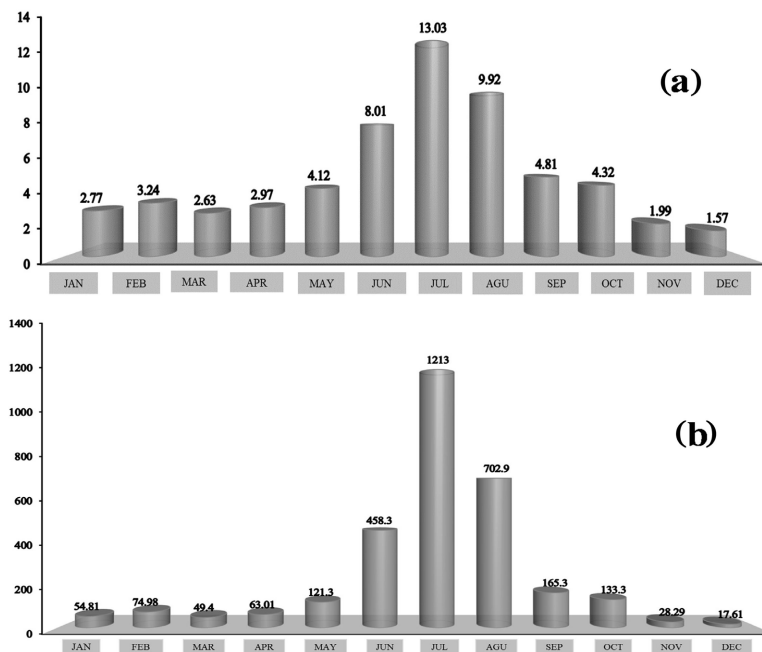
Figure 3. Proportion of larvae of fish species in the estuary and mangrove areas of Sangaré Bay.

The qualitative analysis shows that the study areas are rich in ichthyoplankton organisms.

Species of the Clupeidae family are widely represented Sangaré Bay, accounting for 26%, followed by 6% and *Trichurus lepturus* with 2% (Figure 3).

3.2. Quantitative Study

For the quantitative study of the ichthyoplankton population, the density, biomass and egg count were determined in time and space.



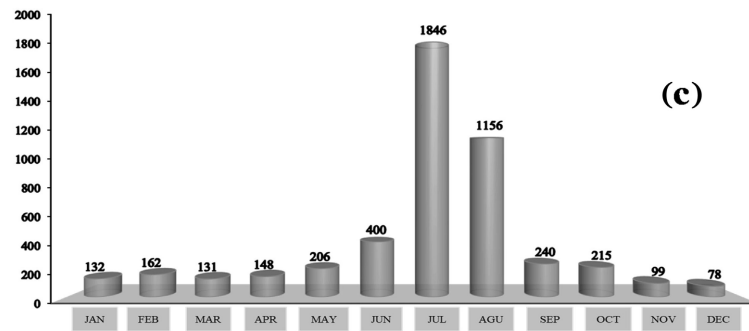


Figure 4. Monthly variation in ichthyoplankton species density (a), biomass (b) and number of eggs (c).

Evaluation of the variation in density and mean biomass (Figure 4) of the ichthyoplankton population reveals peaks during the months of June to September, corresponding to the rainy season in the study area. In June, which totals 8.01 ind/m^3 , 1.57% of which is represented by the clupeid family, which is the most diverse and abundant along the upstream-downstream gradient. Within this family, the genera *Sardinella* and *Ethmalosa* predominate, with biomasses of 58.29 and 65.56 g/m^3 respectively. In July, with a density close to 13.63 ind/m^3 , 26% of which belonged to the class Clupeiformes, the genera *Sardinella* and *Ethmalosa* also predominated, with a biomass of 12.72 g/m^3 and a density of 13.63 ind/m^3 respectively. August, with an average biomass of 10.9 g/m^3 and a density close to 9.72 ind/m^3 , of which 8.5% were clupeiformes; the genus *Sardinella* also recorded the highest density. Although less pronounced, in September, with 4.81 ind/m^3 of which 5% are represented by the family Clupeidae, the genera *Sardinella* and *Ethmalosa* predominate with densities of 5.8 and 2.9 ind/m^3 respectively and a biomass of 65.26 g/m^3 .

The monthly variation in the number of eggs (Figure 4) shows abundance during the months of June to August, with a total average of 1134 eggs, compared with an annual average of 156 eggs. At the height of the rainy season (July-August), this average rises to 1501 eggs.

Looking at the different values obtained (Figure 4), we can see that July has the highest concentration of ichthyoplankton in terms of density, biomass and number of eggs. These first two months justify the choice of the period for the introduction of biological rest in Guinea.

3.3. Ichthyoplankton Density by Zone

The high concentration of ichthyoplankton organisms is observed in the Sonfonia, Soumba, Arabanty and Samatran areas, where the density varies between 156.1 and 198.3 ind/100m^3 (Figure 5).

These areas are characterised by a massive presence of poison eggs. This suggests the hypothesis of ontogenetic development.

In short, the constant presence of eggs and larvae of ontogenetic stages make these estuary and mangrove zones environments of advection, migration, ontogenetic development and feeding.

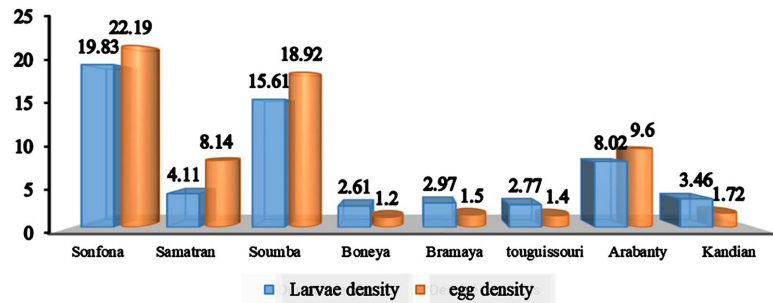


Figure 5. Ichthyoplankton density by zone.

Furthermore, the quantitative study of ichthyoplankton shows significant variations depending on the location of the estuary and mangrove areas in relation to communication with the sea. Remote areas, which receive little marine input, have very low and unstable abundances or specific richness.

It is worth noting the presence of various larval stages of meroplankton: molluscs, cephalopods (cuttlefish, squid), crustaceans, decapods (prawns, spiny lobsters, crabs, squid, etc.) and phytoplankton, which demonstrates the diversity of the planktonic ichthy net in hydrobiont sampling.

3.4. Assessment of Frequency of Occurrence

In order to get an idea of the organisation and structure of the various ichthyoplankton populations inventoried, we calculated the frequency of occurrence of the various families inventoried and the similarity between the structures of the ichthyoplankton populations.

The frequency of occurrence or constancy C in % provides information on the characteristic species of the zones. A total of 10 families (*i.e.* 72.16%) are considered constant, with a cosmopolitan distribution and a broad ecological spectrum, and are found in all the study areas. Also, 3 families (20.10%) are considered accidental and 7 families are accessory. In terms of frequency of occurrence, there is a relative numerical similarity between the groups of constant and accidental genera. The majority of species reported as constant tolerate the various abiotic parameters characterising their habitat.

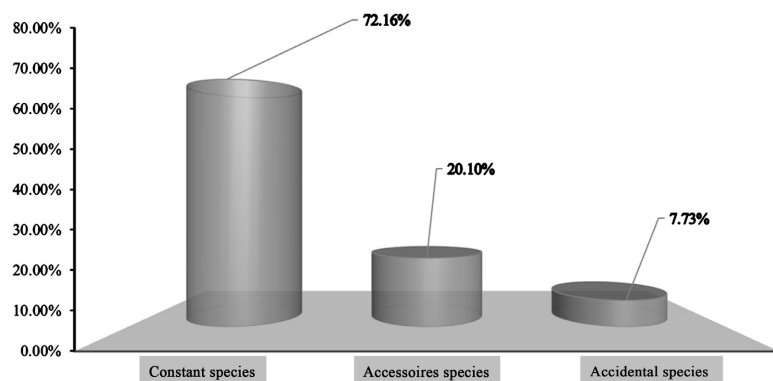


Figure 6. Frequency of occurrence (C in %) of different ichthyoplankton families.

The presence of 72% of ichthyoplankton families with a “constant” frequency of occurrence ($C > 50\%$) indicates that these species have a high ecological value and can withstand the conditions of different habitats (Figure 6). Accessory species, on the other hand, may develop in a particular type of biotope or at fairly limited periods of the year.

3.5. Similarities between the Structures of Ichthyoplankton Populations (Sorensen Similarity Index)

Based on the presence or absence of species in the areas studied, we compared the composition of ichthyoplankton populations taken in pairs, using Sorensen’s similarity index. This index is obtained from the common genera, taken in pairs (Table 3).

Table 3. Sorensen similarity index for the 8 areas sampled.

Zones	Sonfonia	Samatran	Soumba	Bouramaya	Touguissouri	Arabanty	Kandian	Bonèya
Sonfonia	70.79	55	62.65	51.06	62.65	58.62	58.25	100
Samatran	56.45	54	61.53	52.06	51.21	52.65	100	
Soumba	55.04	49.98	62.5	53.06	57.65	100		
Bouramaya	42.55	51.54	62.65	54.66	100			
Touguissouri	50.25	66.25	55.54	100				
Arabanty	55.05	58.56	100					
Kandian	58.45	100						
Bonèya	100							

The similarity index calculated is greater than 50% in most cases of comparisons between two zones taken in pairs. The highest rate of similarity was noted between the Sonfonia, Samatran, Bouramaya, Bonèya and Arabanty zones, where the similarity coefficient was 63.79%. The similarity between the zones taken in pairs can be explained by the fact that they generally offer the same ecological conditions to the ichthyoplankton population. It is certainly not accidental, as it reflects the action of situational ecological conditions, in particular the action of the physico-chemical properties of the water on the development of these ichthyoplankton populations.

The structure of the ichthyoplankton population is similar in the different areas studied, demonstrating the similarity of the environmental conditions, particularly the physico-chemical properties of the water.

The composition of the ichthyoplankton population in the Sonfonia area is closest to that in the Soumba and Samatran areas, where the values recorded are 63.79% and 62.65% respectively. This similarity represents the greatest resemblance between the estuary and mangrove zones studied and the physicochemical parameters of the environment that characterise them.

The grouping of the sampling zones by means of a dendrogram (Figure 7) using the simple link and for a minimum level of similarity makes it possible to distinguish 2 distinct homogeneous groups which are:

- The first group: includes the Sonfonia, Bonèya, Samatran, Arabanty and Bouramaya areas.
- The second group includes the areas of Kandian, Touguissouri and Soumba.

Furthermore, grouping the variables using the simple link gives a similarity rate of (63.79%), which is greater than 50%.

Our results show that there are significant differences between the 8 zones studied, which may be linked to seasonal differences. In addition, the differences depend on the diet of the ichthyoplankton population in each zone sampled, the physiological state of the individuals at the time of sampling and even the sampling period.

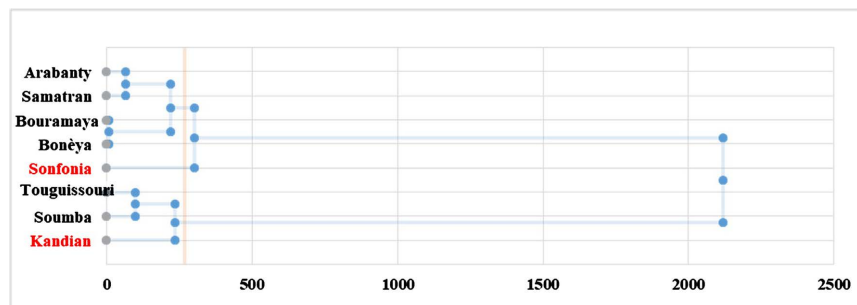


Figure 7. Dendrogram of aggregation in the 8 areas sampled.

4. Discussion

This study provides the results of the first inventory, which would currently be the most exhaustive of the areas surveyed, as all the species listed have already been described by [7].

Of these 27 ichthyoplankton families reported, 5 families, 5 species and 514 individuals are present in our samples and the 7 others are absent from the catches of [8].

The presence or absence of a species in our fisheries is probably due to the tolerance or otherwise of the species to the abiotic factors of the area (salinity, turbidity, temperature, tidal cycle, etc.), to the choice of stations, and to differences in sampling gear and techniques.

The drop in species density observed (**Figure 3**) from November to April, practically the dry season in the study areas, corroborates the hypothesis of a seasonal succession, under the influence of predation on fish fry, deteriorating water quality and competition between species [22]. It should be remembered that the dry season is characterised by low values for pH, dissolved oxygen, turbidity, conductivity and nutrients. On the other hand, the rainy seasons are characterised by high nutrient values (ortho-phosphates, nitrates and nitrites). This allows us to affirm with [23] that only the “season” factor influences the abundance and distribution of ichthyoplanktonic species. Also, the presence of eggs, larvae and juveniles of certain coastal and marine species in the study areas sufficiently demonstrates that estuaries and mangroves are breeding, migration, nursery and rearing grounds. This information is in line with the results obtained by [10], which states that in

estuary and mangrove areas, the peak in biomass and larval density is in July and August.

In short, the areas studied are characterised by a high concentration of planktonic organisms. Maximum values for density and biomass were obtained during the rainy season, while minimum values were observed during the dry season. Minimum values were observed during the dry season.

This could be explained by the contribution of nutrient-rich continental waters.

According to some specialists, such as [24], this period corresponds to a reduction in the input of coastal waters from the continent due to the weakening of the inter-trade current. During this period, the influence of the canary current does not reach the Guinean sector, which causes the upwellings to subside and consequently a drop in the quantity of plankton in the coastal zone.

5. Conclusions

The study enabled 5938 individuals to be inventoried, divided into 20 families and 30 species, dominated by the Clupeidae (26%). The Sonfonia, Samatran, Soumba and Arabanty areas show a high concentration of planktonic ichthyo-organisms.

One peculiarity of the zones (Sonfonia, Samatran, Soumba and Arabanty) is that the peak of eggs is higher than that of larvae, which suggests the hypothesis of an ontogenetic development of reproduction and feeding.

Ichthyoplankton is one of the modern tools used in bio-indication and bio-monitoring of aquatic ecosystems. A diverse population dominated by fish eggs and larvae is a sign that the ecosystems surveyed are functioning properly.

According to the classification of these zones, the data would correspond to the characteristics of a eutrophic zone.

The areas of high biomass and high concentration of larvae identified in this study could be essential reference indicators for (i) the creation of Marine Protected Areas (MPAs) or Protected Fishing Zones (PFZs) (ii) and the application of biological rest for the benefit of sustainable management and rational exploitation of fishery resources.

Given the scale of the anthropogenic pressures threatening these ecosystems, it is absolutely necessary to set up these environments as protected zones, with a ban on certain economic activities (fishing, cutting mangrove wood, etc.).

Carry out further research into the other links in the trophic chain and extend these studies to the entire coastal zone.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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