


# Contribution to the Knowledge of Zooplankton in the Mellacore Estuary, Republic of Guinea

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## Abstract

This study aims to inventory the zooplankton stand in the Mellacorée River estuary, as well as its composition, abundance, and structure during the dry season. This river is located in Forécariah Prefecture, the southwestern Republic of Guinea. It is located about 30 kilometres from the border with Sierra Leone. Sampling work at the stations was carried out monthly from December 2019 to May 2020 using the plankton net “Djedi”, 55 µm mesh vacuum. For a total of 10 stations sampled, 21 species belonging to 12 families (Calanidae, Paracalanidae, Eucalanidae, Calocalanidae, Oithonidae, Medusae, Phaenidae, Mysidaceae, Sagittidae, Cladocère, and Euphausiacea) were identified. The density is dominated by the species *Paracalanus parvus* (41866.31 ind/m<sup>3</sup>) followed by *Calanus helgolandicus* (19277.49 ind/m<sup>3</sup>) and then *Eucalanus elongatus* (13221.98 ind/m<sup>3</sup>), *Lucifer sp* (66.65 ind/m<sup>3</sup>) and other organisms: nauplii larva (111.1 ind/m<sup>3</sup>). Analysis of the samples shows a high zooplankton diversity with the following relative frequencies: Calanidae (36.06%); Paracalanidae (34.66%); Eucalanidae (17.83%); Calocalanidae (0.84%); Oithonidae (1.17%); Medusae (0.23%); Temoridae (0.12%); and other larva organisms, nauplii (1.09%). Biomass ranged from 170.2758 mg/m<sup>3</sup> to 48.6824 mg/m<sup>3</sup>. However, the highest biomass was obtained in February and the lowest in March. Conclusion and application: The results of our investigation suggest that the zooplankton community of the Mellacore River estuary exhibits significant richness and diversity. This research can be a valuable biomonitoring tool to assess the ecological integrity of this aquatic system. Further study on the phytoplankton of the Mellacore River is essential to improve knowledge of the different plankton species.

## Keywords

Zooplankton, Diversity, Abundance, Mellacorée, Density, Biomass

## 1. Introduction

In Guinea, work on estuarine ecology has been carried out in the northern part of the coast, particularly in the Sangaréah Bay, notably in Sonfonia by [1], in Soumba by [2], and in Konkouré by [3], etc. In the Mellacorée River estuary, one of the main rivers in the southern part of the coast, no ecological study, primarily on zooplankton, has yet been conducted.

This estuary is located in the Konta district, in the Forécariah prefecture, approximately 86.9 km from the city of Conakry. Several small villages or districts surround this lotic ecosystem. It was once used for drinking water by the local population.

Indeed, in recent years, with population growth, this body of water has begun to suffer from bank degradation and a deterioration in water quality. Estuaries are places where large quantities of organic matter of continental and oceanic origin pass from upstream to downstream or from downstream to upstream, depending on the rhythms of the tides and seasonal fluctuations in river flows.

Zooplankton is an essential instrument for the management and monitoring of the environmental integrity of aquatic ecosystems, as well as for drawing conclusions concerning pollution charges [4]. In this context, there are correlations between the structural composition of zooplankton populations and various environmental variables. The dynamics of zooplanktonic communities are influenced by a multitude of ecological and abiotic factors, including temperature, water chemistry (such as pH and dissolved oxygen), transparency, nutrient concentrations, etc. [5] [6]. These factors exercise significant control over the diversity of species, the abundance of populations, and spatial distribution, thus structuring the zooplanktonic communities and influencing the seasonal phenology of these organisms [7]-[9].

Zooplankton plays an important ecological role in lakes and rivers, feeding on non-living organic matter, phytoplankton, and bacteria, and in turn being consumed by secondary consumers such as fish [10].

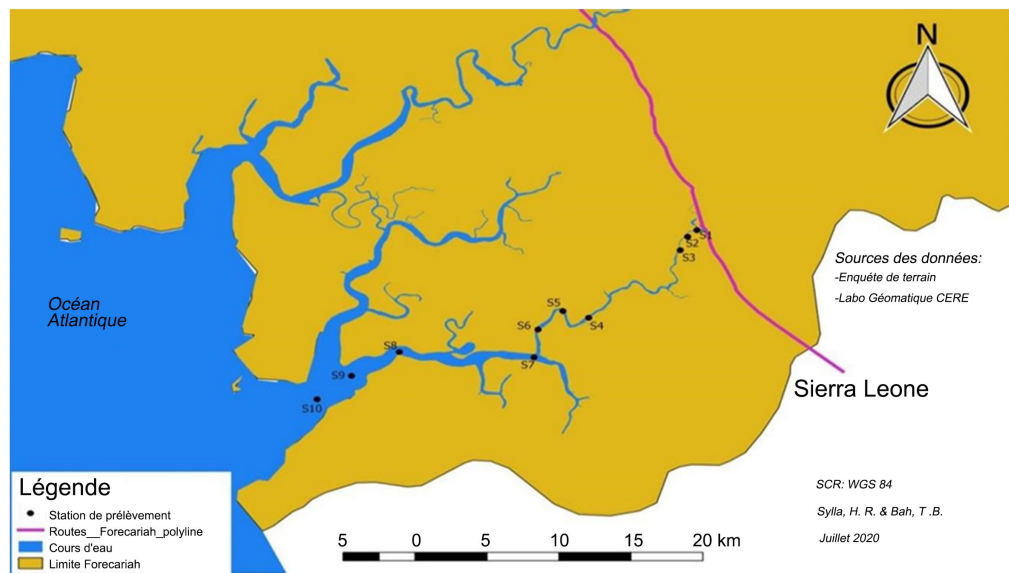
According to [11], estuaries are nonetheless ecological borders, in the sense that they have biotic compositions, ecosystem functions, and distinct temporal dynamics from adjacent ecosystems; that they are open to flows coming from these adjacent systems, and that they have the emerging property—the ability to control these flows [12].

To date, no study has been carried out to inventory zooplanktonic species and the parameters that influence their distribution in this river. It is therefore important to make an inventory of zooplanktonic species in order to characterize the structure of their assembly in such a context of environmental and societal transfer. However, our knowledge is still limited, because for this first phase, our study will be presented without environmental parameters.

The purpose of this study is to investigate the structure of the zooplanktonic population in the Mellacorée river estuary, which remains an important area for artisanal fishing.

## 2. Materials and Methods

**STUDY AREA:** The Mellacorée estuary is located between 9°43' North latitude and 13°10' West longitude. It is a low-lying coastal area characterized by mangroves and rice paddies crossed by small coastal streams. As a result, this estuary receives rainwater and household waste through diffuse runoff; the average depth is 4.84 m. Stations 1, 2, and 3 (**Figure 1**), located upstream of the river source, contain non-salty water compared to station 10 of the channel. The climate has two seasons: the dry season (December to May) and the rainy season (June to November).



**Figure 1.** Location of the Mellacorée River with study stations.

**Table 1** shows the geographical coordinates of the selected sites by sector. The geographical location of the river and study stations is shown in **Figure 1**.

**Table 1.** Zooplankton sampling sites in the Mellacorée River.

Site	Stations	Latitude	Longitude	Average Depth (m)
Estuary of the Mellacorée River	S1	9.271608°	-13.031747°	7 m 75
	S2	9.266517°	-13.037645°	6 m 15
	S3	9.255991°	-13.042353°	6 m
	S4	9.203428°	-13.100581°	6 m 50
	S5	9.208762°	-13.116810°	7 m
	S6	9.194376°	-13.132620°	4 m 50
	S7	9.172707°	-13.135277°	4 m 25
	S8	9.177319°	-13.220418°	2 m 50
	S9	9.158760°	-13.250746°	1 m 75
	S10	9.140533°	-13.272614°	2 m

## 2.1. Methodology

Sample collection was carried out from December 2019 to May 2020, a period that covers the entire dry season. Due to the shallow depth of the study area, zooplankton samples were collected conventionally from the bottom to the surface using the 55  $\mu\text{m}$  Djedi plankton net; opening diameter 70 cm; then condensed and fixed in 5% formalin for laboratory analysis. The features are created by putting the speed of the boat in slow motion, where the net is unrolled vertically to the bottom and remains there for three minutes before being raised. Zooplanktonic organisms have been listed in the Bogorov cell and identified under a microscope or binocular magnifying glass with a magnification of 40x and 100x. For a homogenized sample, place three one-milliliter (1 ml) drops onto the cell using a Pasteur pipette.

## 2.2. Data Processing and Statistical Analysis

The density of zooplankton was calculated from the arithmetic average of the number of individuals observed in a portion of 100 ml, then reported to the total volume of the sample to be analyzed. Its formula is as follows:  $D = n/V$ , where  $n$  = number of individuals sampled and  $V$  = volume of filtered water expressed in liters.

The data are expressed in the number of individuals per unit of volume. The biomass is calculated from the formulas: ( $W = 1/6 \pi lT^2 + 1/4 \pi lT^2$ ), where  $l$  and  $t$  represent, respectively, the length and width of the anterior body, and  $l$  and  $t$  are the length and width of the posterior body for calanoids; and  $W = 1/4 \pi lT + 1/12 \pi l(T^2 + Tt + T^2)$  for harpacticoids, and the tables of [13] [14].

The geographical coordinates of the sampling stations were determined using GPS.

The planktonology manuals by [15]-[17], among others, were key to identifying zooplankton species.

The tables by [13] [14] were used to determine biomass based on the average individual weight of organisms.

## 2.3. Data Analysis

Data were analyzed using Microsoft Office Excel 2013. Taxonomic composition, relative frequency, and biomass were used to explain the state of the zooplankton community.

## 3. Results

Analysis of samples collected from the Mellacorée River estuary revealed that the taxonomic composition of the zooplankton population is quite diverse. A total of 21 taxa were recorded during the dry season.

This study identified species divided into four groups (Copepods, Cladocera, Arthropods, and Other organisms) (**Table 2**).

**Table 2.** List of zooplankton taxa collected in the Mellacorée River.

Families	Species	Total relative frequency (fr %)	
Calanidae	<i>Calanus helgolandicus</i> (Claus, 1863)	13.61	36.06
	<i>Calanus minor</i> (Claus, 1863)	10.85	
	<i>Calanus gracillus</i> (Dana, 1849)	9.56	
	<i>Nannocalanus minor</i> (Claus, 1863)	2.04	
Paracalanidae	<i>Paracalanus parvus</i> (Claus, 1863)	30.58	34.66
	<i>Paracalanus scotti</i>	3.76	
	<i>Paracalanus aculeatus</i>	0.32	
Eucalanidae	<i>Eucalanus minor</i> (Claus, 1863)	7.4	17.83
	<i>Eucalanus elongatus</i> (Dana, 1849)	9.52	
	<i>Eucalanus pileatus</i> (Giesbrecht, 1892)	0.91	
Calocalanidae	<i>Calocalanus pavo</i> (Dana, 1849)	0.84	0.84
Temoridae	<i>Temora longicornis</i>	0.12	0.12
Oithonidae	<i>Oithona nana</i> (Giesbrecht, 1892)	1.17	1.17
	<i>Larve nauplii</i>	1.09	1.09
Phaenidae	<i>Xanthocalanus greeni</i> (Farran, 1905)	1.33	1.33
Mysidaceae (Arthropode)	<i>Lucifer faxoni</i> (Nobili, 1901)	2.87	2.89
	<i>Lucifer sp</i>	0.02	
Cladocère	<i>Penilia avirostris</i>	0.20	0.20
Autres	<i>Sagitta hispida</i> (Conant, 1895)	2.88	3.06
	<i>Sagitta minima</i> (Grassi, 1881)	0.18	
	<i>Hydromeduse</i>	0.23	0.23
	<i>Larve euphausiacé</i>	0.29	0.29

Twenty (20) species belonging to twelve (12) genera were distributed among these taxa. The Calanidae family (36.06%) is represented by four species distributed among two genera, followed by Paracalanidae (three species) and Eucalanidae (three species), while the other families are monospecific. The abundance of nauplii in the samples proves that the dry season corresponds to the reproductive period of copepods.

In quantitative analysis of the sampled zooplankton population, the species *Paracalanus parvus* presents numerical dominance (30.58% of the total abundance), followed by *Calanus helgolandicus* (13.61%), *Calanus minor* (10.85%), and *Lucifer sp.* (0.02%). For the monthly evolution of the density (Figure 2), the abundance varies between 34676.8 ind/m<sup>3</sup> (February) and 8044.2 ind/m<sup>3</sup> (March).

During this sampling period, we noted a steady water level during the first three months (December to February), as well as a considerable decrease in the water level during the last three months (March to May), which negatively impacts the count and therefore the zooplankton density despite the upwelling of seawater.

Relative frequency of species (Fr%) allowed us to distinguish between “perennial” (constant) species, whose presence is observed at all stations, “frequent” species, whose frequency is between 0.64% and 34.77%, and “episodic” (rare) species, whose frequency is less than 0.88%. Only ten (10) species are episodic; all the others (12) are perennial, mostly copepods (Table 2).

Among the species encountered (*Calanus helgolandicus*, *Calanus minor*, *Calanus gracillus*, *Paracalanus scotti*, *Eucalanus minor*, *Eucalanus elongatus*, *Oithona nana*, *Lucifer faxoni*, *Sagitta hispida*, *Xanthocalanus greeni* and *Larva nauplii*), *Paracalanus parvus* could be considered constant since it was encountered at all stations during the month of February.

The figure below compares the variation in zooplankton density by month during the dry season. It can be seen that the species *Paracalanus parvus* is found at all times and in all places.

Furthermore, the composition and abundance of zooplankton showed strong temporal variability of species; *Paracalanus parvu* and *Calanus helgolandicus* were recorded in January and February with much greater specificity in number and density (Figure 3). The species *Sagitta minima* was present only in March, unlike *Penilia avirostris* (cladoceran), which appeared monthly during this period of the dry season, even in lower numbers.

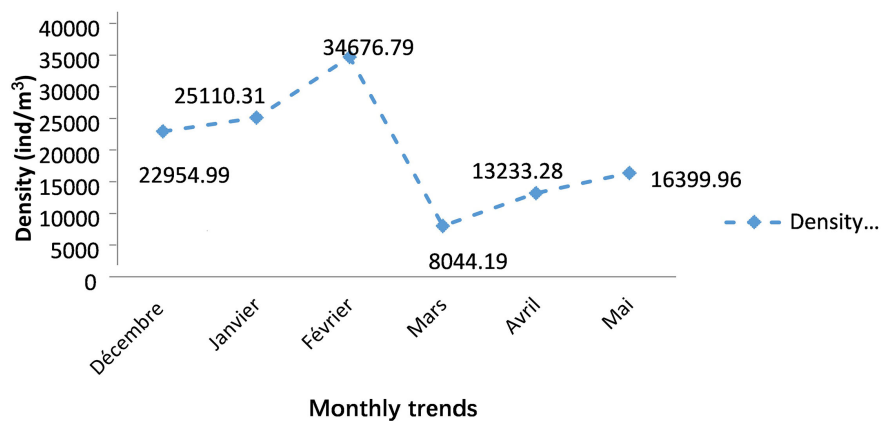


Figure 2. Monthly variation in zooplankton density from December 2019 to May 2020.

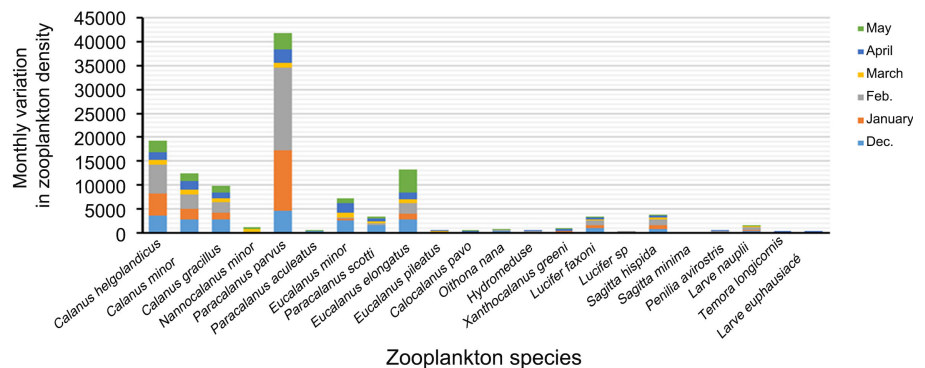
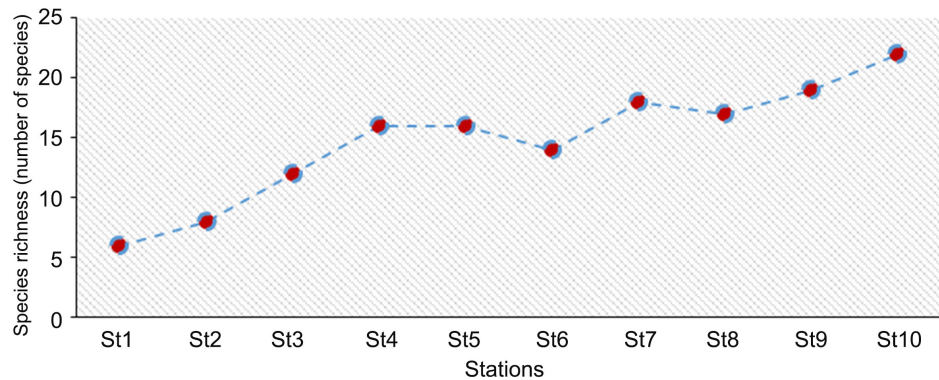


Figure 3. Variation in density by zooplankton species in the Mellacorée estuary during the dry season.

## Species Richness

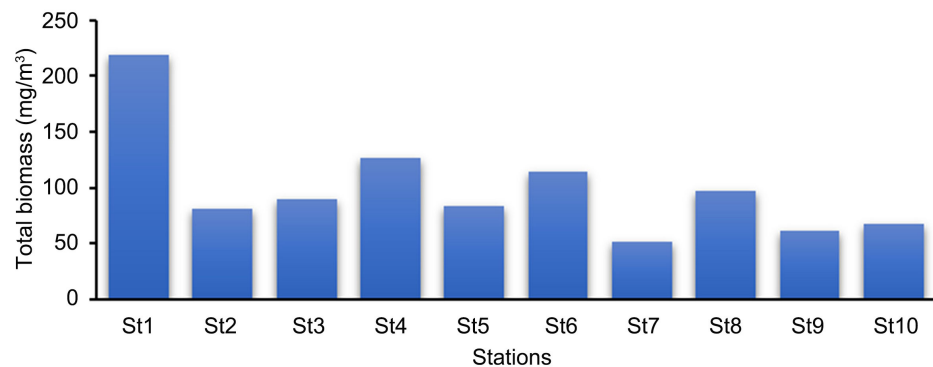
Species richness varied between 6 (Station 1) and 22 (Station 10) in Mellacorea. See **Figure 4**. The Mellacorea estuary is characterized by a numerical dominance of Calanidae (36.06%), followed by Paracalanidae (34.66%), and Eucalanidae (17.83%). Temoridae (0.12%) are less present during this sampling period. The species richness of copepods is significantly higher than the species richness of the other identified taxa.



**Figure 4.** Evolution of the specific richness of zooplankton in the Mellacorée estuary during the dry season (2019-2020).

The abundance could be explained by a low average depth value (4.84 m), and especially by the contribution of solar rays, which promote the phenomenon of photosynthesis.

Overall, the total biomass was 993.276 mg/m<sup>3</sup>, dominated by station (1) with 218.822 mg/m<sup>3</sup>, followed by stations (4) and (6) with 126.798 mg/m<sup>3</sup> and 114.278 mg/m<sup>3</sup>. Station (7) has the lowest biomass, with 51.795 mg/m<sup>3</sup> (see **Figure 5**). At this level, we note that there is a numerical difference between station 1 and the other stations, but also a slightly larger size of the species encountered. In February, the maximum biomass was observed (170.2758 mg/m<sup>3</sup>), followed by the month of January (168.758 mg/m<sup>3</sup>), and the lowest was observed in March (48.682 mg/m<sup>3</sup>).



**Figure 5.** Total zooplankton biomass at stations.

## 4. Discussion

The present survey documented 21 distinct zooplankton taxa in the Mellacorée River ecosystem. The analytical results obtained made it possible to determine the density in number of individuals per cubic meter ( $\text{ind}/\text{m}^3$ ), the relative frequency (Fr%), and the biomass ( $\text{mg}/\text{m}^3$ ). The taxonomic diversity identified in this study is slightly more consistent with the results of [18], who reported 28 taxa distributed across four coastal rivers in southeastern Côte d'Ivoire, but it remains lower than the 56 species recorded by [19] in Kondi Stream, Cameroon, as well as the 68 taxa recorded by [20] in the Bia and Agnéby Rivers in Côte d'Ivoire. The discrepancies between the quantity of zooplankton species inventoried in the present study and those documented by the aforementioned authors may be attributable to the different intensities of the sampling methodologies used and the mesh sizes of the nets used for collecting the organisms. The species richness identified here is similar to that reported by [21] in Cameroon, where zooplankton density was more diverse and abundant during the dry season, with 37 and 41 species recorded in Lakes Ossa and Mwembè, respectively. Conversely, [22] postulates that the seasonal average zooplankton density was measured at  $8201.386 \text{ ind}/\text{m}^3$ .

The peak abundance of zooplankton recorded during the dry season coincides with the period of abundance of phytoplankton, which serve as primary producers since temperature and food availability are the most important factors controlling zooplankton abundance in the water [23].

The species richness achieved in the Mellacorée River is close to that documented for the Iiakwu and Ogba rivers in Nigeria, as reported by [24] and [25], which contained 25 and 27 species, respectively. It is more similar to the results from Lake Kaby in Côte d'Ivoire, as presented by [26]. The observed richness in the Okpara River, Benin, as noted by [27], was high during sampling, totaling 68 zooplankton species. These authors indicate that cladocerans constitute a less dominant community while rotifers are more dominant. Our results are consistent with those of this study, as we recorded a lower presence of cladocerans (1.3%).

## 5. Conclusions

This study provides the first information regarding the understanding of zooplankton diversity and structural composition in relation to calculated density and biomass indices. Data analysis indicates that the zooplankton community of the Mellacorée River estuary exhibits remarkable richness and diversity. A total of twenty (20) species, classified into twelve (12) genera, were documented. Among copepods, which constitute the most abundant group, the species *Paracalanus parvus* predominates, representing 30.58% of the total density, followed by *Calanus helgolandicus* at 13.61%, *Calanus minor* at 10.85%, and *Lucifer sp.* at 0.02%. Zooplankton density fluctuates between  $34676.8 \text{ ind}/\text{m}^3$  in February and  $8044.2 \text{ ind}/\text{m}^3$  in March. Consequently, the biomass ranges from  $218.822 \text{ mg}/\text{m}^3$  to  $51.795 \text{ mg}/\text{m}^3$ . This remarkable abundance of zooplankton organisms generally

occurs when phytoplankton has sufficient nutritional intake. The phytoplankton bloom phenomenon is primarily influenced by sunlight, which facilitates the photosynthesis process during the designated study period.

Therefore, it is imperative to continue this research to elucidate the distribution of zooplankton in conjunction with environmental variables, with the aim of bio-monitoring the ecological quality of the aquatic systems in this river.

### Author Contributions

All authors have contributed equally to this work.

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### Conflicts of Interest

We have no financial competitors, no competing interests related to this work, and no known conflicts of interest associated with this publication.

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