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Zooplankton diversity and distribution in a Fresco Lagoon (West Africa, Côte d'Ivoire)

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Abstract

Our objective during this study was to determine Fresco lagoons zooplankton fauna composition, abundance and biomass spatial and temporal variation in relation to some environment parameters. Zooplankton organisms were collected monthly during an annual cycle (August 2013 to September 2014) in five sampling sites. This lagoonal ecosystem zooplankton community was composed of 54 taxa including Copepoda (42.59%), Cladoceran (14.81%) Rotifera (9.26%), and other zooplankton organisms (33.34%). Fresco lagoon zooplankton community diversity was mainly dominated by zooplankton marine taxa (54.72%), followed by freshwater and brackish taxa with 22.64% each. In Fresco lagoon, zooplankton abundance varied from 207 ind/l(mean) during the rainy season to 296 ind/l (mean) throughout *the dry season. During the rainy season, zooplankton abundance varied from 45 to 387 ind/l according to stations while it varied from 29 to 579 ind/l* throughout *the dry season. All these variation were statistically significant ($p < 0.01$). Fresco zooplankton community was mainly dominated by Copepoda taxa (main 98 % of total abundance), with Oithona brevicornis (56.11%) and Acartia clausi (33.26%) as main species. This study revealed also that, in Fresco lagoon, zooplankton taxa in stations far from of the channel were mainly influenced by pH, Salinity and conductivity while in stations near of the channel zooplankton composition and abundance variation were mainly under dissolved oxygen, phosphates and ammonium concentrations influence.*

Keywords: Zooplankton diversity, distribution, environmental parameters, Fresco lagoon.

Introduction

Fresco lagoon is an important ecosystem for socio-economic activity in Fresco city. Indeed, this aquatic ecosystem constitutes an important zone of commercial and subsistence fishing for riparian populations. Unfortunately, it receives forests rivers waters as Bolo, Niouniourou, Gnouand and Guitako. Indeed, it shelters on its basin pouring the agro-industrial plantations and farmers such as: culture of palm to oil, of darling, banana, pineapple, etc.) and could receive nourishing elements from the fertilizing agricultural and some of the pesticides drained by the courses of waters and rains[1]. These different situations constitute as many factors, of which could alter its working and return urgent the necessity of the hold of measures for it preservation and management.

Zooplankton is tiny drifting organisms living in the water and drifting at the mercy of currents. They are vital component of aquatic ecosystem, forming the base of most aquatic food web. Indeed, zooplankton associated to phytoplankton constitutes the principal diet of the early life stage of fish, mainly for almost all fish larvae[2]. In addition, zooplankton community reacts quickly to changes in water environmental characteristics[3]. So, zooplankton can be used as bioindicators of water pollution[4,5], water quality[6], and eutrophication[7,8]. Collect of informations on zooplankton community can help for monitoring of aquatics ecosystems[9]. In Fresco lagoon, several studies have been realized. But they are mainly focus on Teredinidae (Mollusca lamellibranch)[10], physic-chemical parameters[11], heavy metals in the sediments[12], phytoplankton[13], sedimentology and bathymetry[18]. Surveys on Fresco lagoon zooplankton are inexistent. Our objective during this study was to determine Fresco lagoons zooplankton fauna composition, abundance and biomass variation in relation with environment parameters.

Materials and methods

Our survey environment (Fresco lagoon, Figure-1) is a minor lagoon, with a basin of 6 km long and stretches on a larger of 2 to 4 Km^2 between 5°40' and 5°70'N and between 5°32 and 5°38' W, with a total area varying from 17 to 29 km^2. It communicates with the Atlantic Ocean through a channel which was open during our data collection. The mean water depth of the Fresco lagoon is low (<4m). The Fresco lagoon undergoes the influence of 4 small forests rivers: Bolo (84km), Niouniourou (140km), Gnou (12km) and Guitako (5km). However, the Bolo

and Nioumouzou, which are the two main rivers discharge their waters mainly in the Atlantic ocean through a pass. The lagoon shores are marshy in places, particularly along the estuaries, and there are areas subject to seasonal inundation immediately behind the marshes. There are small mangrove stands inside the lagoon mouth, and some swamp forest occurs at the river mouths. In Fresco lagoon localization zone rainy season lasts from April to July and October to November while the dry season lasts from December to March and August-September.

During this study, data collection lasted in five stations (Figure-1) from August 2013 to July 2014. For zooplankton sampling, a plankton net of 64µm of mesh opening size was used, then samples collected were conserved in formalin (5%). Zooplankton was identified to species, genus and /or family on the base of taxonomical key of following authors[14-22] under a dissecting microscope. Moreover, taxa were counted and result was expressed in density (zooplankton organisms numbers per liter of water filtered (ind/l). Density (D) was obtained according to the equation: D=N/(n.o.a.*d), with N = zooplankton organisms number of estimated in the different samples, n.o.a. = the net opening area (0.071m^2) and d = station depth. Zooplankton biomass (B, in µgC.l^{-1}) was estimated according to the equation: B = D*DW, with D = taxa density and DW = Individual taxa dry weight (in µg). The individual weights were obtained according the length-weight relationship proposed by Literature and converted into carbon (C) using the equation proposed by Pagano and Saint-Jean[23]: DW = C/0.045. Water environment parameters as Temperature, salinity, conductivity, dissolved oxygen, and pH were measured with a scientific multi-parameter. Water transparency was estimated with a Secchi disk. Mineral salts as phosphate, nitrite and ammonium were analyzed according to protocols described by Strickland[24].

Relationship between zooplankton composition and distribution, and environmental parameters were studied using a ReDundancy Analysis (RDA). Analyses of variance (ANOVAs) test were used for comparison between sampling sites and seasons of zooplankton density, species richness, Shannon's and regularity diversity index. All these statistically analysis were carried out with Statistica 7.1.

Results and discussion

Environmental parameters: Spatial variations of environmental parameters measured in Fresco lagoon are provided below (Figure-2). Water temperature varied from 26.54 to 31.30°C depending on the sampling sites and periods. Highest values were always recorded during the wet season (29.25-31.30°C) versus 26.54 to 28.54°C during the dry season (Figure-2A). Similar seasonal variation was also obtained for nitrites (Figure-2B) and ammonium (Figure-2C), with respectively 0.36-0.64µmol/l and 0.03-0.06µmol/l obtained during the wet season, versus respectively 0.27-0.37µmol/l and ≈ 0.03-0.05µmol/l during the dry season. In contrast, salinity (Figure-2D), conductivity (Figure-2E), dissolved oxygen (Figure-2F), transparency (Figure-2G), pH (Figure-2H), and phosphates concentration (Figure-2I) present spatio-temporal variation characterized by highest values obtained during the dry season (respectively 16.88-20.18, 20.55-27.78µS/cm, 5.01-6.12mg/l, 0.60-0.87m, 7.96-8.49, 0.72µmol/l) (Figure-2), with statistically meaningful seasonal difference ($p<0.05$).

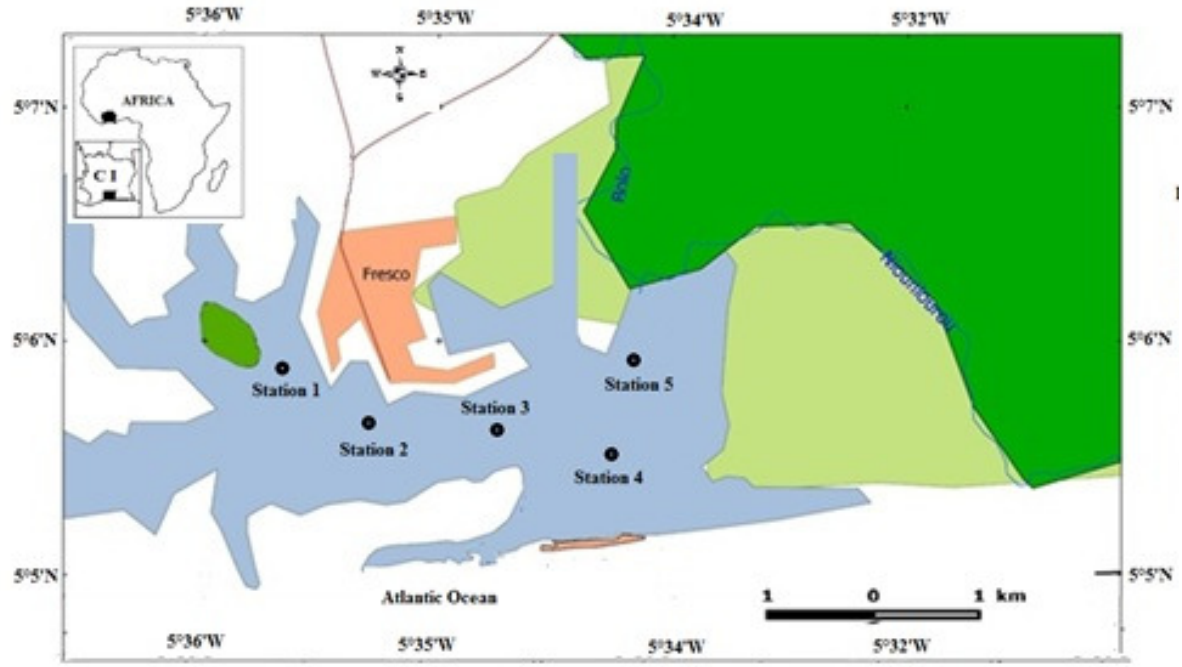
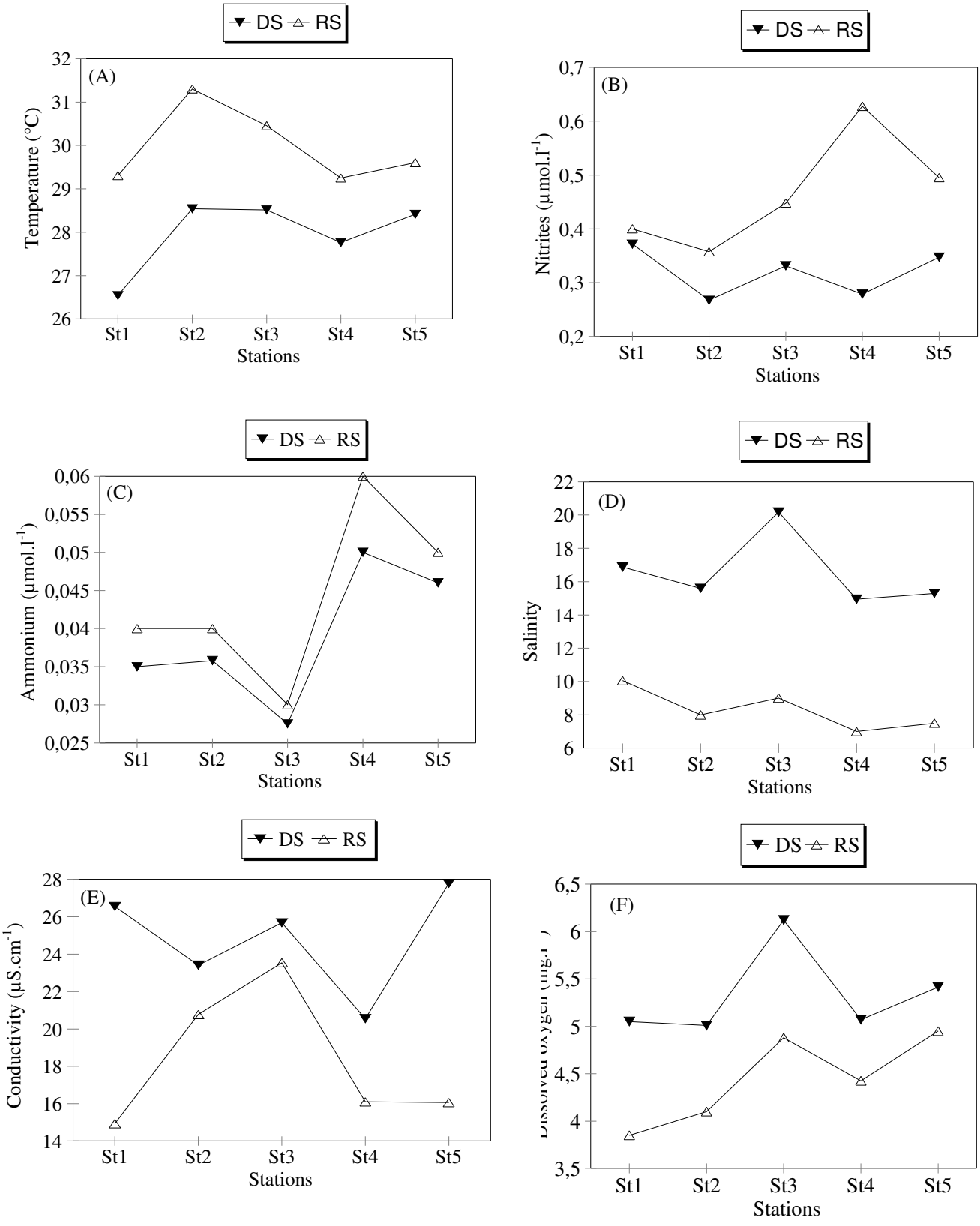
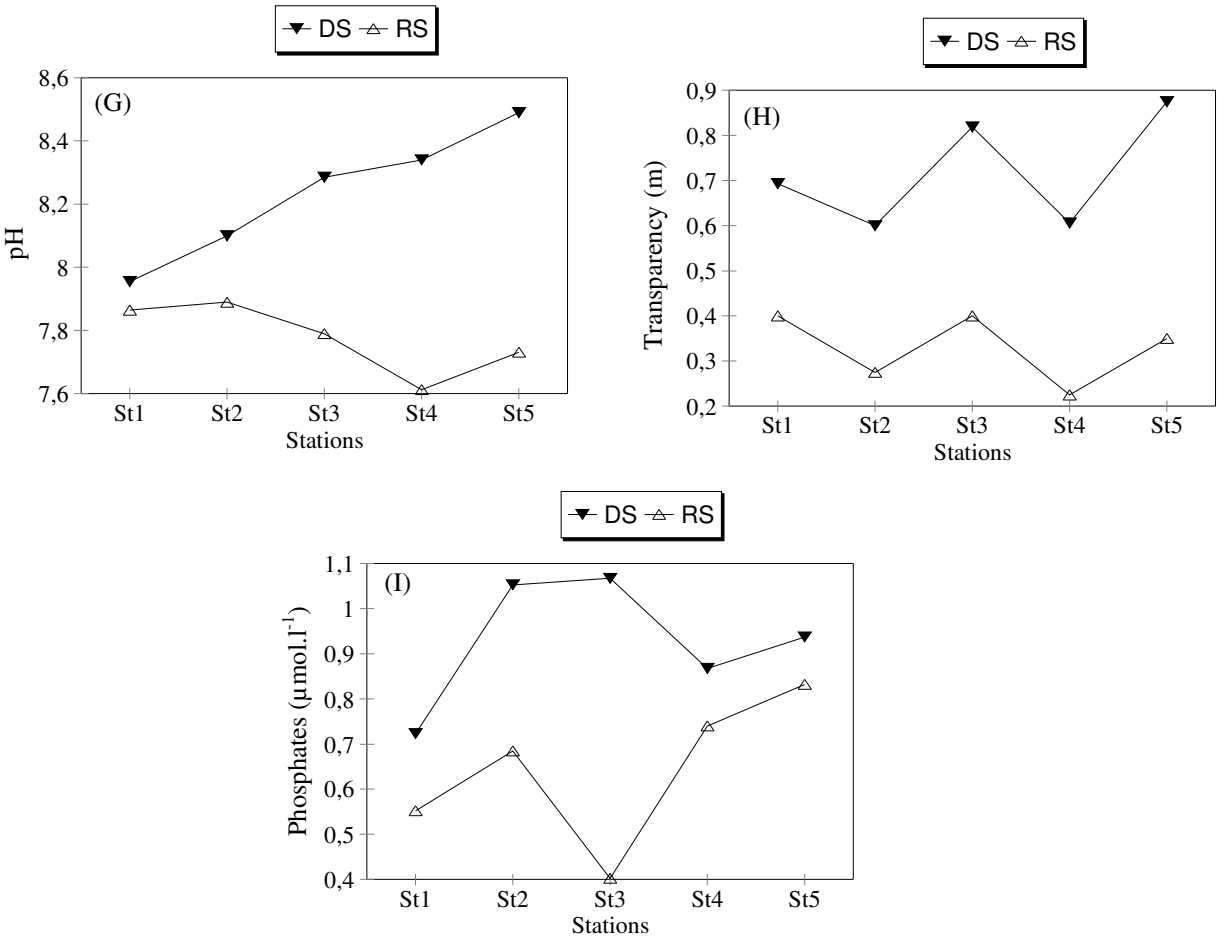


Figure-1: Sampling stations localization in the Fresco lagoon (Côte d'Ivoire).



DS = Dry season, RS = Rainy season

Figure-2: Spatial variation of physico-chemical parameters during dry and rainy seasons in Fresco lagoon.



DS = Dry season, RS = Rainy season

Figure-2: Spatial variation of physico-chemical parameters during dry and rainy seasons in Fresco lagoon.

Taxonomic composition spatio-temporal pattern: This work allowed identifying fifty-four (54) zooplankton taxa in the Fresco lagoon (Table-1). Zooplankton community belonging to for (4) main groups: Rotifers (5 taxa, 9.26%), Cladocerans (8 taxa, 14.81%), Copepods (23 taxa, 42.59%) and other zooplankton organisms (18 taxa, 33.34%) (Table-1). So, copepods were the most diversified group in Fresco lagoon. These 23 taxa were belonging to thirteen families and fifteen genus plus unidentified harpacticoids and copepod nauplii. Six taxa (*Acartia clausi*, *Paracalanus parvus*, *Oithona brevicornis*, *Euterpina acutifrons*, and unidentified *copepods nauplii*) were obtained with highest occurrence (>50%). Temoridae and Oithonidae presented the highest diversity (3 taxa each) followed by Paraclanidae, Euclanidae and cyclopidae with two species each. All other families were monospecific. In Fresco lagoon, Rotifera were represented by Brachionidae, with five species belonging to two genuses: *Brachionus* (*B. caudatus, B. plicatilis, B angularis* and *B. falcatus*) and *Platyas* (*P. quadricornis*). Rotifera community was observed in Fresco lagoon with lowest occurrence (< 5%). Cladocera taxa (seven) were belonging to four families and eight genuses. The other zooplankton group contains various taxa, Sagitidae (sagittal spp.), Euphausidae (*Euphausia* sp.), Balanidae (*Balanus* spp. Nauplii), Mysidae (*Mesopodopsis tropicalis* and *Rhopalophthalmus africana*), Oikopleuridae (*Oikopleura* sp), Luciferidae (*Lucifer faxonii*), plus several benthic organism larvae.

Fresco lagoon zooplankton taxa might be separated in freshwater (22.64%), brackish (22.64%), and marine (54.72%) origin (Table-1). Freshwater taxa were obtained in stations 4 and 5, mainly during the wet season while marine and brackish origin taxa were observed in all stations, excepted at station 4, according the seasons.

This study reveals that Fresco lagoon zooplankton taxonomic richness fluctuates depending on seasons and stations. During the dry season, total zooplankton richness was 42 taxa versus 28 taxa obtained during the wet season, with a statistically meaningful seasonal difference ($p<0.01$). During the rainy season, lowest richness (8-11 taxa) were obtained in stations (St 1-3) relatively far from of the channel while highest values (17-21) were recorded in zone near of the Fresco channel and the mouth of the Bolo-Niourouniourou rivers (stations 4 and 5).

During the dry season, the same richness taxonomical spatial tendency was observed in Fresco lagoon, with lowest values obtained in stations distant of the channel (stations 1-3) (23-27 taxa) while highest values (28-38 taxa) were recorded in stations 4 and 5 close to the Fresco channel and the mouth of the Bolo-Niourouniourou rivers. Thus, during the two major climatic seasons of our study area, zooplankton richness spatial variation was meaningfully different ($p<0.01$), with lowest values in stations far from of the Fresco channel and highest richness in stations near of the Fresco channel and the mouth of the Bolo-Niourouniourou rivers. Ecological index (Shannon and equitability) estimated during this study were relatively low, with respectively from 1.07 to 1.87bit/ind and 0.33 to 0.55.

Community structure, abundance and biomass spatio-temporal variation: In Fresco lagoon, copepods constituted the most important group (mean and relative abundance: 271ind/l; 98.20%), followed by others organisms zooplanktonic group (4 ind/l; 1.47%). Rotifers and Cladocerans were rare (mean percentage =0.01% and 0.32% respectively) (Figure-3). Copepods comprised 55% (96ind/l) of nauplii stages and 45% (79ind/l) for the other stages (copepodid and adult forms). These other stages of copepods were mainly represented by *Acartia clausi* and *Oithona brevicornis* which constitute, respectively, 33.26% (28ind/l) and 56.11% (47 ind/l) of total abundance, and represent the main zooplankton species of Fresco lagoon. *Platiyas quadricornis* constitutes the most abundant rotifers (< 0.023ind/l; 87.94%), following to *Brachionus plicatilis* (0.003 ind/l; 11.55%). Cladocerans were rare (<1ind/l, mean percentage = 0.32%). This group was mainly dominated by *Penilia avirostris* (0.86ind/l; 97%) which was most abundant at stations 3–5 (1–2ind/l) during the dry seasons (mainly in February) (Figure-3). The most abundant other zooplankton taxa (mean 4ind.l^{-1}) were (mean; relative abundance): Tintinnid (1.50 ind.l^{-1}; 36%); Polychaete larvae (1.19ind/l; 29%), and gastropods larvae (0.86ind/l ; 21%).

The zooplankton community abundance has a significant spatial and seasonal variation (Figure-3). In all sampling sites, except in station 5 where wet season abundance is more important (107 ind/l) than in the dry season (30ind/l), in the other stations, highest zooplankton abundance were obtained the dry season (70 to 579ind/l) against 45 to 387ind/l throughout the wet season (Figure-3A).

Throughout the two seasons, highest total zooplankton abundances were always recorded in stations far from of the opening of the lagoon on the ocean (Fresco channel) and the mouth of Bolo-Niourouniourou rivers (stations 1, 2 and 3) (142 to 579ind.l^{-1}) while lowest abundances (30 to 107ind.l^{-1}) were obtained in stations near this zone (stations 4 and 5). The same tendencies have been observed with the total zooplankton biomass (Figure-3B), and with the main zooplankton species of Fresco lagoon (*O. brevicornis* and *A. clausi*). Concerning the other zooplankton organisms group, throughout the dry season, abundance decreases progressively from station far from Fresco channel (station 1:11ind.$^{-1}$) to station near of the channel (station 5:<1ind.$^{-1}$). Throughout the wet season, highest abundance was recorded at station 4 (6-11ind.l^{-1}), against ≤ 1ind/l in the other sampling sites. During the dry season, the main taxa of this group: Tintinnids (39%), Polychaete larvae (30%), and gastropods larvae (16%) were observed in all stations. however, Tintinnids have been observed with the highest abundances in stations 1 to 3 (2-6ind/l), while Gastropods and Polychaeta larvae were sampled with highest abundances in stations 1 and 2 (respectively ≈ 2ind/l and 2-4ind/l). Throughout the wet season, other zooplankton group was, on average, mainly represented by Gastropods larvae (83%), followed by Polychaete larvae (15%). Gastropods larvae were sampled with highest abundance in station 4 (5ind.l^{-1}; ≈ 90%) while Polychaete larvae were observed all stations with <1ind/l. However, Polychaete larvae represent 75 to 95% of total abundance of this group in stations 1, 2 and 3.

Environmental parameters influence on zooplankton composition and distribution: ReDundancy Analysis (RDA) applied to environmental variables and zooplankton abundance reveal two main zones, distinguished according to sampling sites localization related to the Fresco channel: stations 1-3 (far from to the channel, zone 1) and stations 4 and 5 (near of the channel, zone 2) (Figure-4).

The first zone was influenced positively by environmental parameters as pH, salinity and conductivity while the second zone was correlated to dissolved oxygen, phosphates and ammonium concentration. Zooplankton taxa sampled in this first zone (stations 1-3) were mainly marine origin (*Centropages furcatus*, *Temora stylifera*, *T. longicoris*, *Eucalanus attenuatus*, *E. elongatus*, *Oncea* sp., *Corycoeus* sp., Mysidacea, Euphausiacea, Tintinnids and Decapoda zoe) and brackish origin (Gastropods larvae, Fish larvae, Polychaeta larvae, *Acartia clausi*, *Oithana brevicornis*, *Pseudodiaptomus hessei* and *Brachionus plicatilis*).

The second group of stations (stations 4 and 5) were mainly associated to marine (*Calocalanus parvus*, *Paracalanus parvus*, *Oithona plumifera*, *Euterpina acutifrons*, *Microsetella rosea*, *Evadne* sp., *Penilia avirostris,* Amphipods, Larvacae, medusea, *Lucifer faxonii*, Thaliacea (Dolioles), Chaetognatha (*Sagitta* sp.) and Freshwater origin taxa (*Diaphanosoma excisum*, *Platyas quadricornis*, *Mesocyclops* sp., *Brachionus caudatus*, etc.).

Discussion: Our study permitted to inventory in the Fresco lagoon, for the first time, 54 zooplankton taxa grouped in Rotifers (5taxa, 9.26%), Cladocerans (8taxa, 14.81%), Copepods (23taxa, 42.59%) and other zooplankton organisms (18taxa, 33.34%). This zooplankton population richness (54) inventoried in Fresco lagoon is weak in comparison with zooplankton richness obtained in other lagoons of Côte d'Ivoire: Ebrié lagoon[25] (66taxa), Grand-Lahou lagoon[9] (65taxa). It is in contrast compared to the zooplankton diversity in Aby (53 taxa)[26], in Ebrié lagoon (59taxa)[27].

Table-1: Composition and distribution of different taxa collected in the Fresco lagoon (St: Stations)

Groupes	Famillies	Taxons	Origin	St1	St2	St3	St4	St5
Rotifers	Brachionidae	*Brachionus caudatus* Barrois and Daday, 1894	F				+	+
	"	*Brachionus plicatilis* O.F. Müller, 1786	FB		+	+		
	"	*Brachionus angularis* Gosse, 1852	F				+	
	"	*Brachionus falcatus* Zcharias, 1898	F				+	+
	"	*Platyias quadricornis* Ehrenberg, 1832	F				+	
Cladocerans	Chydoridae	*Chydorus* sp. Leach, 1843	F				+	
	"	*Camptocercus* sp. Baird 1843	F				+	
	Sididae	*Diaphanosoma excisum* G.O. Sars 1885	F				+	
	"	*Penilia avirostris* Dana, 1849	M	+	+	+	+	+
	Daphniidae	*Ceriodaphnia cornuta* Sars 1885	F				+	
	"	*Moina micrura* Kurz, 1874	F				+	
	Podonidae	*Evadne* sp. Lovén, 1836	M		+	+	+	+
	"	*Podon* sp. Lilljeborg, 1853	M			+		+
Copepods	Unidentified	Copepoda nauplii		+	+	+	+	+
	Acartiidae	*Acartia clausi* Giesbrecht, 1849	B	+	+	+	+	+
	Paracalanidae	*Calocalanus pavo* Dana, 1852	M			+	+	
	"	*Paracalanus parvus* Claus, 1863	M	+	+	+	+	+
	Centropagidae	*Centropages furcatus* Dana, 1849	M	+	+	+	+	+
	Eucalanidae	*Eucalanus attenuatus* Dana, 1849	M		+	+		+
	"	*Eucalanus elongatus*	M			+		+
	Pseeudodiaptomidae	*Pseudodiaptomus hessei*	B	+	+	+	+	+
	"	*P. serricaudatus* Scott, 1894	B			+	+	+
	Temoridae	*Temora stylifera* Dana, 1849	M		+	+		+
	"	*Temora longicornis* Dana, 1849	M	+	+	+	+	
	"	*Temora* sp. Baird, 1850	M			+	+	
	Corycaeidae	*Corycaeus* spp. Dana, 1849	M	+	+	+	+	+
	Oncaeidae	*Oncaea* spp. Phylipi, 1843	M	+		+	+	+

Groupes	Famillies	Taxons	Origin	St1	St2	St3	St4	St5
	Oithonidae	*Oithona brevicornis* Giesbrecht, 1891	B	+	+	+	+	+
	"	*Oithona plumifera* Baird, 1843	M					+
	"	*Oithona* sp. Baird, 1843	M				+	
	Cyclopidae	*Thermocyclops neglectus* Sars G.O., 1909	F				+	
	"	*Mesocyclops* sp. Sars G.O., 1914	F				+	
	Euterpinidae	*Euterpina acutifrons* Dana, 1848	M	+	+	+	+	+
	Miraciinae	*Macrosetella gracilis* Dana, 1847	M				+	+
	Ectionosomatidae	*Microsetella rosea* Dana, 1847	M					+
	Unidentified	Harpacticoids undetermined		+	+	+	+	+
Other Zooplankton	Unidentified	Amphipods	M					+
	Sagittidae	Chaetognatha *Sagitta* spp.	M	+	+	+	+	+
	Euphausiidae	Euphausiacea *Euphausia* sp.	M	+	+	+		+
	Unidentified	Bivalves larvae	B	+		+	+	+
	Unidentified	Gastropods larvae	B	+	+	+	+	+
	Balanidae	Cirripedia nauplii *Balanus* spp.	B		+	+	+	+
	Unidentified	Polychaete larvae	B	+	+	+	+	+
	"	Fish larvae	B	+	+	+	+	+
	Unidentified	Medusea	M					+
	Mysidae	*Mesopodopsis tropicalis* Wittmann, 1992	B					+
	"	*Rhopalophthalmus africana* O. Tattersall, 1957	B			+		+
	Unidentified	Ostracoda	B M	+	+	+	+	+
	Oikopleuridae	Appendicularia *Oikopleura* sp.	M					+
	Unidentified	Thaliacea Dolioles	M					+
	"	Decapoda zoea	M	+	+	+	+	+
	Luciferidae	*Lucifer faxonii*	M					+
	Unidentified	Tintinnids	M	+	+	+		+
	"	Echinoderm larvea Pluteus	M			+		+
Taxonomic Richness		54		21	24	33	37	40

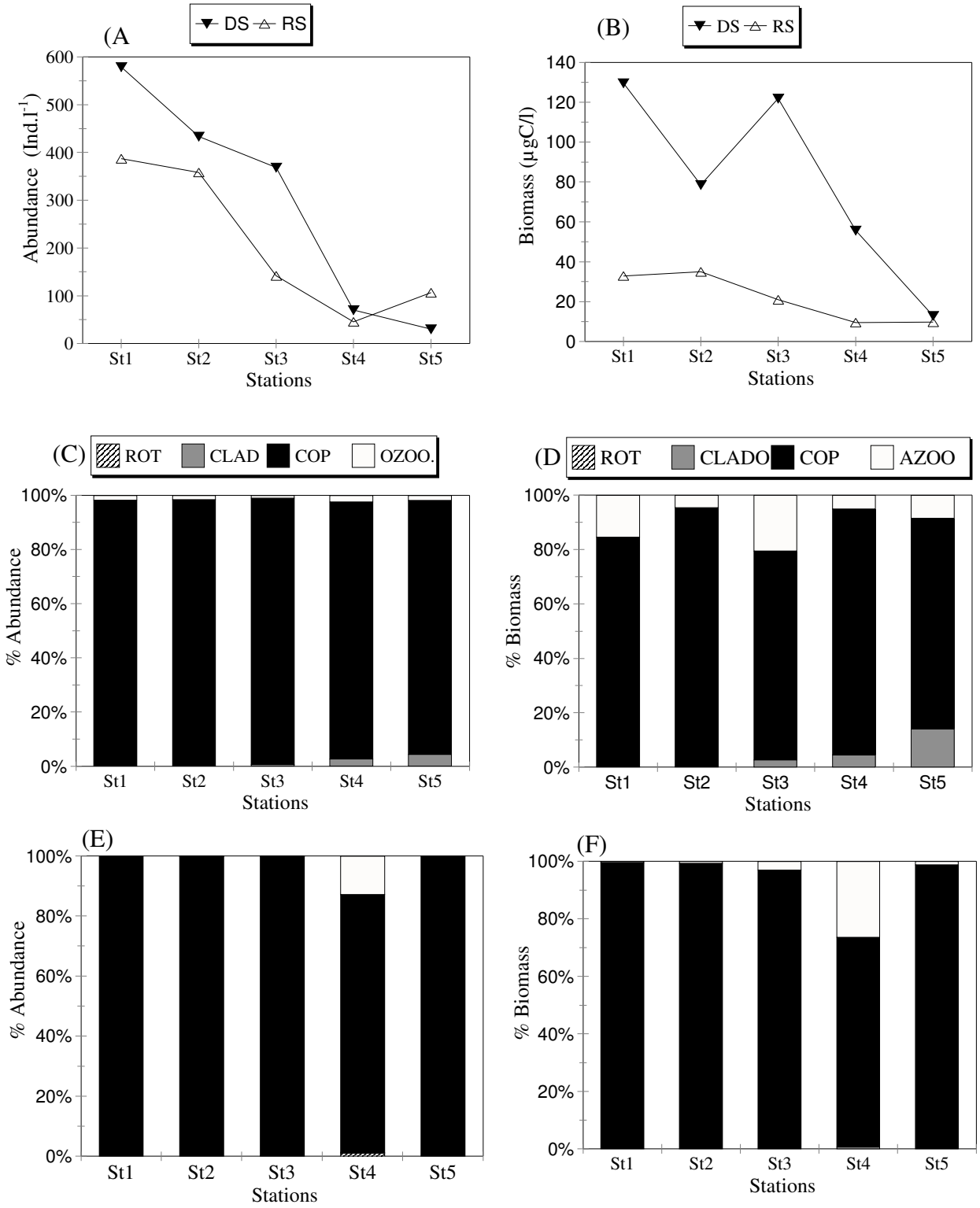


Figure-3: Spatio-temporal variations of the total zooplankton absolute abundance (A) and Biomass (B), and spatial variation of the relative abundance (C, E) and biomass (D, F) of the main zooplankton groups in the Fresco lagoon during the dry season (C, E) and the rainy season (D, F) (DS: Dry Season, RS: Rainy season, ROT: Rotifers, CLAD: Cladocerans, COP: Copepoda, and OZOO: Other zooplankton organisms).

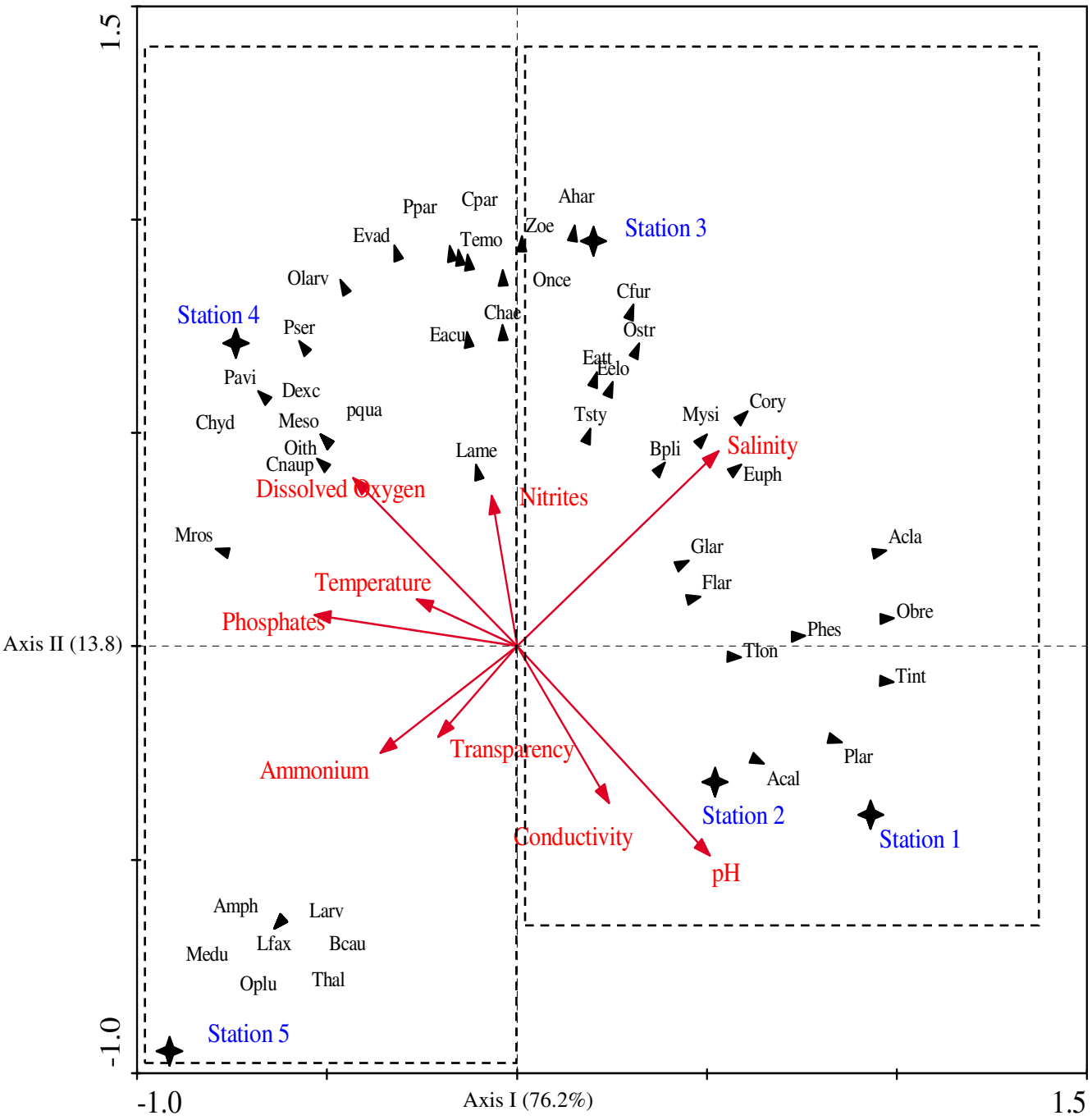


Figure-4: Triple projection graph (triplot) of ReDundancy Analysis (RDA) showing the two first axis (90% of the observed variance) of zooplankton taxa ordination, environmental variables (red arrow) and sampling stations (star), Zoe: Zoea of crab, Once: *onceae* spp., Cfur: *Centropages furcatus*, Ostr: Ostracoda, Eatt: *Eucalanus attenuates*, Tsty: *Temora stylifera*, Bpli: *Brachionus plicatilus*, Mysi: Mysidaceae, Cory: *Corycaeus* sp., Euph: *Euphausia* sp., Glar: Gastropods larvae, Flar: Fish larvae, Tlon: *Temora longicornis*, Phes: *Pseudodiaptomus hessei*, Acla: *Acartia clausi*, Obre: *Oithona brevicornis*, Oplu : *Oithona plumifera*, Tint: Tintinnids, Plar: Polychaete larvae, Amph: Amphipods, Larv: Larvacae, Bcaud: *Brachionus caudatus*, Medu: Medusea, Thal: Thaliaceae, Lfax : *Lucifer faxonii*, Mros: *Microsetella rosea*, Cnaup: Copepods nauplii, Oith: *Oithona* sp., Chyd: *Chydorus* sp., Meso: *Mesocyclops* sp., Pqua: *Platyas quadricornis*, Dexc: *Diaphanosoma excisum*, Palv: *Penilia avirostris*, Pser: *Pseudodiaptomus sericaudatus*, Olarv: Other larvae, Evad: *Evadne* sp., Ppar: *Paracalanus parvus*, Cpav: *Calocalanus* pavo, Temo : *Temora* sp., Chae: Chaetognatha (*Sagitta* sp.), Eacu: *Ecalanus aculeatus*,

Beside, zooplankton community composition obtained in this study characterized by qualitative dominance of marine taxa (54.72%) is similar to zooplankton composition obtained in Grand-Lahou lagoon also marked by marine taxa diversity dominance (45% of total diversity)[9]. Beside, this result contrast with those obtained by others studies in some lagoons of Côte d'Ivoire, marked by freshwater taxa qualitative dominance in Aby lagoon (100%)[26], Ebrie lagoon, sector Aghien (100%)[27], Ebrie lagoon (53% of total diversity)[28]. The difference in zooplankton richness and community composition in this study (54 taxa, qualitative dominance of marine taxa: 54.72%) and previous studies in other lagoons of Côte d'Ivoire cited below (53 to 66 taxa, community mainly dominated by freshwater taxa diversity) could be explained by factors as lagoon physical and chemical parameters. Freshwater zooplankton population preponderance in Aby, and in sector Aghien of Ebrié lagoons can be linked to factors as sampling sites localization (remoteness of these lagoons with channel which connects to the Atlantic Ocean) and intrusion of water coming from Bia and Tanoe rivers concerning Aby lagoon system and from Djibi, Bété and Mé rivers concerning the sector Aghien of Ebrié lagoon. These two factors confer to these coastal lagoons a freshwater character, which promote freshwater zooplankton development. In contrast, zooplankton community composition obtained in the present study characterized by qualitative dominance of marine taxa (54.72%), could be linked to oceanic influence in Fresco lagoon, closely linked to water circulation and residence time regulated by factors as climate, geomorphology, tidal cycle, hydrology and topography of this ecosystem. Indeed, Fresco lagoon freshwater inflow comes mainly from the Bolo-Niourouniourou rivers of which the mouth is set over (Figure-1). In addition, marine water which inters in Fresco lagoon during the tidal cycle flows mainly from east to west and gives a major part of this lagoon a mesohaline to marine character, except in the Bolo-Niourouniourou rivers mouths sector where salinity decreases down to zero during the wet season.

In Fresco lagoon, quantitative analysis of zooplankton population shows that copepods constituted the most important group (mean and relative abundance: 271ind/l^{-1}; 98.20%) while rotifers and cladocerans were rare (mean percentage = 0.01% and 0.32% respectively). Besides, *Oithona brevicornis* and *Acartia clausi* constituted 56.11% (47ind/l) and 33.26% (28 ind/l) of abundance, respectively and represent the main zooplankton species of Fresco lagoon. *O. brevicornis* and *A. clausi* predominance in lagoon zooplankton community of Côte d'Ivoire is also reported by several previous studies in Grand-Lahou lagoon[9] and in Ebrié lagoon[29]. But this result contrast with those reported from Aby lagoon [26] and from Ebrié lagoon (sector Aghien)[27] where zooplankton community is numerically dominated by rotifers (respectively 51 and 83% of total zooplankton abundance) with *Lecane leontina* (67%) and *Brachionus plicatilis* (17%) as major species in Aby lagoon[26], and *Lecane* spp. (16 %) and *Mesocyclops* sp. (15%) as majors species in sector Aghien of Ebrié lagoon[27].

Coexistence and predominance of species of *Oithona* and *Acartia* species in lagoons as reported by different survey: e.g. in Discorevry bay (Jamaica)[30], Berre Lagoon (Mediterranean Sea, France)[31], Sontecomapan lagoon (Veracruz, Mexico)[32]. According to Arfi et al.[33], *Oithona brevicornis* and *Acartia clausi* predominance in lagoon of Côte d'Ivoire may be linked to their capacity of adaptation to a wide range of salinity (euryhaline spacies), with respectively 5 to 30 and 0 to 30 psu for *Oithona brevicornis* and *Acartia clausi* in Ebrié lagoon.

In the present study, zooplankton abundance varied significantly with time (seasons) and in space (sampling sites) ($p<0.05$). Dry season abundance (70 to 579ind/l) always higher than during the wet season (45 to 387ind/l) on the one hand, while highest abundances were always recorded in stations far from of the opening of the lagoon on the ocean (Fresco channel) and the mouth of Bolo-Niourouniourou rivers (142 to 579ind/l) against lowest abundances (30 to 107ind.l^{-1}) obtained in stations near this zone on the other hand. In Fresco lagoon, zooplankton abundance variation was mainly linked to *O. brevicornis* (56% total zooplankton abundance) and *A. clausi* (33%) population dynamic. *O. brevicornis* and *A. clausi* were perennial in the lagoons of Côte d'Ivoire (e.g., Grand-Lahou lagoon), with however an significant seasonal variation of abundance and biomass[34,35].

This seasonal fluctuation of *O. brevicornis* (main specie in Fresco lagoon) may be linked to the fact that it population increases quickly during the dry season where favorable conditions for its reproduction and development are found[34]. The same tendency was also obtained for abundance and biomass of *A. clausi* in Grand-Lahou lagoon[35]. This seasonal variation of *O. brevicornis* abundance, biomass and reproductive characteristics can be explained by the fact that all these parameters were positively influenced by water temperature, salinity and transparency increasing and by negative influence of turbidity increase as reported by Etile *et al.*[34].

Zooplankton density and biomass droop near the Fresco channel (station 5) and the mouth of Bolo-Niourouniourou rivers (station 4) (30 to 107in/l against 142-578 ind/l in zone far from the channel) could be linked to the fact that these two main zooplankton species of Fresco lagoon (*O. brevicornis* and *A. clausi*) can survive in any biotope, as all species, only if they are capable to adapt to environmental conditions and regulate it internal salt concentration concentrations with the wide range of salinity observed in fresco (Figure-2D).

In Ebrié lagoon, it reported by Arfi et al.[33] that range of salinity tolerated by *O. brevicornis* and *A. clausi* were respectively 5-30 and 0-30. So in this study, total zooplankton density are important in lagoon zone far from of the channel where conditions of adaptation (optimum's salinity) of these two species are met, but are low (or useless) when the salinity approaches or passes their limiting conditions of adaptation.

Conclusion

Fifty-four zooplankton taxa grouped in Rotifers (5taxa, 9.26%), Cladocerans (8taxa, 14.81%), Copepods (23taxa, 42.59%) and other zooplankton organisms (18taxa, 33.34%) were inventory, for the first time, in the Fresco lagoon. Quantitative analysis shows that Fresco lagoon zooplankton was dominated by copepod (mean: 98.20% of total abundance), with *Oithona brevicornis* (56.11%) and *Acartia clausi* (33.26%) as main species. Besides, in Fresco lagoon, zooplankton taxa distribution and abundance variation were linked to pH, Salinity, conductivity, dissolved oxygen, phosphates and ammonium concentrations fluctuation.

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