Original Research Article

Diversity and Structure of Planktonic Fauna in Gold-Mining Areas of the Cavally River (Côte d'Ivoire)

ABSTRACT

In a context where artisanal gold mining durably alters river ecosystems, this study analyzes the effect of gold panning on the diversity and structure of the planktonic fauna of the Cavally River. Zooplankton was sampled monthly from January to May 2025 using a plankton net with a 55 µm mesh size. The inventory of the zooplankton community identified a total of 40 taxa, distributed as follows: Rotifers (34 taxa), Copepods (2 taxa), Cladocerans (1 taxa) and other groups of organisms (3 taxa). The community was largely dominated by Rotifers, which represented 85% of the total density. Zooplankton diversity and abundance were higher at Niampleu, a station not affected by illegal gold-mining activity. The environmental variables that most strongly influenced taxonomic diversity and abundance were temperature, dissolved oxygen, transparency, and pH.

Keywords: Zooplankton, diversity, structure, illegal gold mining, Cavally River.

1. INTRODUCTION

In Côte d'Ivoire, the Cavally River, stretching over 700 km, constitutes a vital resource for local communities. It provides water for domestic and agricultural use and serves as an important source for artisanal fishing (Kouassi et al., 2017). In recent years, however, the expansion of mining activities, particularly artisanal gold-mining, has raised serious environmental concerns **(Doffou, 2000) (absent from the reference list)**. Although this activity contributes significantly to local and regional economies, it also produces numerous negative environmental impacts, including chemical pollution caused by the use of mercury and cyanide, degradation of aquatic habitats, and high sedimentation rates in river systems (Doffou, 2020). Such disturbances alter water quality and directly influence the structure and diversity of aquatic communities, particularly those of zooplankton. Zooplankton play a key role in aquatic food webs, serving as a major food source for many fish and invertebrate

species (Ferdrous and Muktardir, 2009). Moreover, they are excellent indicators of the ecological quality of aquatic environments, as their diversity and community composition directly reflect environmental conditions and human-induced disturbances (Medeiros and Arthington, 2008; Aka et al., 2010). Therefore, studying zooplankton is an effective approach to assessing the ecological health of freshwater ecosystems.

Despite the ecological importance of the Cavally River, research on zooplankton diversity—especially in areas affected by gold-mining remains limited. A better understanding of zooplankton diversity and community structure in such environments is essential for evaluating the ecological impacts of mining activities and for developing sustainable management strategies. This study aims to inventory the zooplankton diversity of the Cavally River and to analyze their spatial distribution in relation to environmental variables, in order to assess the influence of artisanal gold-mining on the ecological integrity of this important river system.

2. MATERIALS AND METHODS

2.1. Study Area

The Cavally River originates in Guinea, north of Mount Nimba, at an altitude of approximately 1,000 meters. It flows through western Côte d'Ivoire and empties into the Gulf of Guinea in the southern part of the country, at sea level. This transboundary river is about 700 km long and drains a catchment area of 30,600 km² (Girard et al., 1971; **et al., 2017(absent from the reference list)**, of which roughly 15,000 km² are located within Côte d'Ivoire. The river crosses the Zouan-Hounien Department, situated between 6°40′–7°40′ N latitude and 7°40′–8°20′ W longitude, covering a surface area of 12,284 km². The study region lies within a mountain climate characterized by two distinct seasons: a dry season (November to February) and a rainy season (March to October) (Doffou, 2020). Four sampling stations were selected around the Ity mining area located along the Cavally River: Niampleu (a station unaffected by gold-mining activities) and three stations, Bakatouo, Daapleu, and Floleu, exposed to the effects of artisanal gold mining (Figure 1).

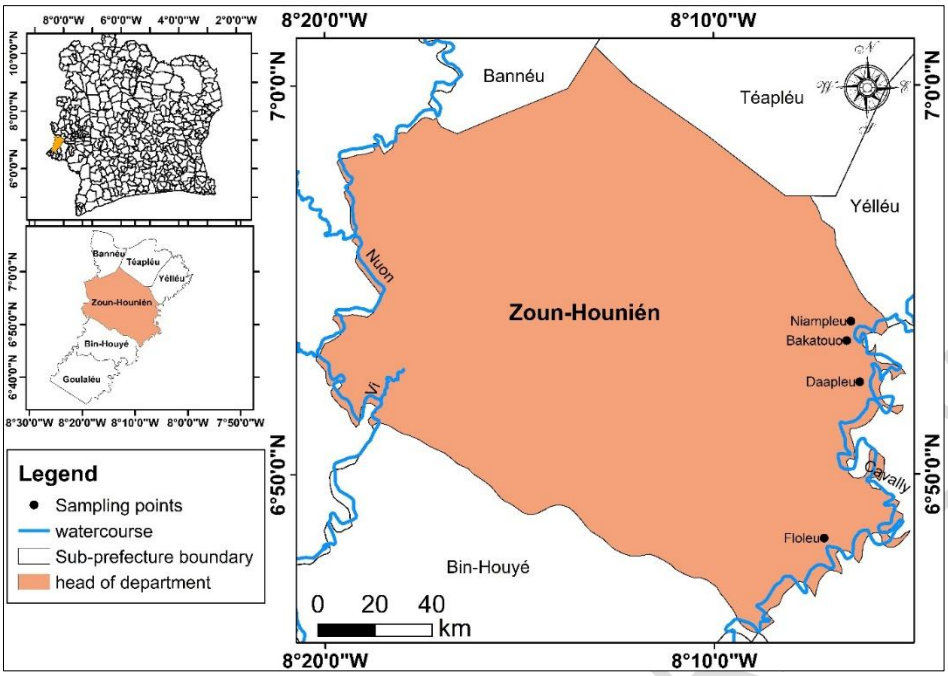


Fig 1: Study Area

2.2. Sampling and Identification of Zooplankton Organisms

At each station, zooplankton samples were collected by taking six buckets of water (15 liters each) from different points within the sampled habitat. These water samples were then filtered through a plankton net with a 55 µm mesh size. The collected material was preserved in a 5% formaldehyde solution (Haney and Hall, 1973). In the laboratory, each zooplankton sample was concentrated to a final volume of 50 mL. Taxonomic identification was performed under a Leica WILD M3c stereomicroscope based on morphological characteristics. Identification of taxa followed the determination keys proposed by Mannuel (2000), Dussart and Defaye (2001), Sharma (2010), and Kotov et al. (2012).

2.3. Measurement of Environmental Parameters

Physico-chemical parameters, including temperature, dissolved oxygen, conductivity, and pH, were measured *in situ* at each sampling station using a portable multiparameter probe (HACH HQ30d model). The probe was immersed within the top 30 cm of the water column, and after stabilization, readings were directly recorded from the display screen. Water transparency was determined using a Secchi disk, which was lowered into the water until it disappeared from

view and then raised until it reappeared; the corresponding depth represented the water transparency. Depth was measured by immersing a weighted cord until the weight reached the bottom, and the immersed length of the cord was recorded as the water depth.

2.4. Data Analysis

Zooplankton community diversity and structure were characterized using the Shannon diversity index, **Pielou's evenness index (not mentioned in the result section!!)**, and species richness. The Kruskal–Wallis test was applied to compare the values of environmental parameters, diversity indices, and zooplankton densities among stations. A redundancy analysis (RDA) was performed to examine the relationships between environmental variables and zooplankton taxa across the different sampling stations.

3. RESULTS AND DISCUSSION

3.1. Qualitative Analysis of the Zooplankton Community

A total of 40 taxa were collected across the four sampling stations (Table I). These taxa were grouped into four major zooplanktonic groups: 34 Rotifera, 2 Copepoda, 1 Cladocera, and 3 taxa classified as other organisms, distributed across 16 families.

Rotifers, comprising 34 taxa, formed the most diverse group (85%). They were distributed among 16 genera and 13 families. The Brachionidae family (10 species) was the most diversified, followed by Lecanidae (4 species) and Synchaetidae (4 taxa). Other families included Trichocercidae (3 species), Arcellidae (2 species), Asplanchnidae (2 species), Epiphanidae (2 species), Filiniidae (2 species), Euglyphidae (1 species), Mytilinidae (1 species), Notommatidae (1 species), Testudinellidae (1 species), and Trichotriidae (1 species).

Copepods accounted for 5% of the total diversity and included two taxa belonging to a single family, Cyclopidae, represented by one species, *Thermocyclops decipiens*. Cladocerans represented 2.5% of total diversity and were composed solely of the family Chydoridae, represented by a single species, *Alona guttata*. Finally, the group of "other organisms" accounted for 7.5% of the total zooplankton diversity.

The lowest values of taxonomic richness (4 to 16 taxa) were recorded at the stations affected by illegal gold-mining activities (Bakatouo, Daapleu, and Floleu), while the highest richness

(31 taxa) was observed at Niampleu (the unimpacted station). Significant differences in taxonomic richness were observed between Niampleu and Daapleu, and between Niampleu and Floleu (Kruskal–Wallis test, $P < 0.05$).

Table 1. Zooplankton Species List and Distribution of Taxa Collected at Different Stations of the Cavally River

Groups	Families	Taxa	Codes	Niampleu	Bakatouo	Daapleu	Floleu
Rotifera	Arcellidae	*Arcella catinus*	Aca	-	+	+	-
		Arcella conica	Aco	+	-	+	-
	Asplanchnidae	*Asplanchna sielboldii*	Asi	+	-	-	-
		Asplanchna sp.	Asp	-	+	+	-
	Brachionidae	*Anuraeopsis fissa*	Afi	-	+	+	-
		Anuraeopsis navicula	Ana	+	-	+	-
		Brachionus angularis	Ban	+	+	-	+
		Brachionus calyciflorus	Bcal	+	-	-	-
		Brachionus caudatus	Bca	+	+	-	-
		Keratella cochlearis	Kco	+	-	-	-
		Keratella santa	Ksa	-	-	+	-
		Keratella tropica	Ktr	+	-	-	-
		Keratella quadrata	Kqu	-	+	-	-
		Platyias quadricornis	Pqu	+	+	-	-
	Epiphanidae	*Epiphanes clavulata*	Ecl	+	+	+	-
		Epiphanes senta	Ese	+	-	-	-
	Euglyphidae	*Euglypha acanthophora*	Eac	+	-	-	-
	Filiniidae	*Filinia opoliensis*	Fop	+	-	-	-
		Filinia terminalis	Fte	-	+	-	-
	Lecanidae	*Lecane bulla*	Lbu	+	+	+	+
		Lecane elasma	Lel	+	-	-	-
		Lecane lunaris	Llu	+	-	-	-
		Lecane quadridentata	Lqu	+	-	-	-
	Mytilinidae	*Mytilina* sp.	Msp	+	+	-	-
	Notommatidae	*Cephalodella gibba*	Csp	+	-	-	-

		Ploesoma truncatum	Ptr	-	+	-	-
	Synchaetidae	*Polyarthra* sp.	Psp	+	-	-	-
		Polyarthra vulgaris	Pvu	+	+	-	-
		Synchaeta pectinata	Spe	+	-	+	-
	Testudinellidae	*Pompholyx* sp.	Psp	+	-	-	-
		Trichocerca cylindrica	Tcy	+	-	-	-
	Trichocercidae	*Trichocerca pocillum*	Tpo	-	+	-	-
		Trichocerca rousseleti	Tro	+	-	-	+
	Trichotriidae	*Macrochaetus sericus*	Mse	+	+	-	-
Cladocera	Chydoridae	*Alona guttata*	Aug	+	-	-	-
Copepoda	Cyclopidae	*Thermocyclops decipiens*	Tsp	+	-	-	-
	Undeterminate	Nauplii	Nco	+	-	-	+
other organisms	Chaoboridae	Chaoborus larvae	Lch	+	-	-	-
	Undeterminate	Other insect larvae	Adi	+	-	-	-
	Undeterminate	Ostracodes	Os	-	+	-	-
		Lecane lunaris	Llu	+	-	-	-
		Lecane quadridentata	Lqu	+	-	-	-
	Mytilinidae	*Mytilina* sp.	Msp	+	+	-	-
	Notommatidae	*Cephalodella gibba*	Csp	+	-	-	-
Total	16	40		31	1 6	9	4

+ : presence ; – : absence.

3.2. Quantitative Analysis of the Zooplankton Community

The composition of the zooplankton revealed that Rotifers constituted the dominant group, representing 88% of the total zooplankton abundance, followed by other organisms (3%), Copepods (7%), and Cladocerans (2%) (Figure 2). The structure of the main zooplanktonic groups at the sampling stations showed that Rotifers were primarily dominated by *Macrochaetus sericus* (20.08%), followed by *Polyarthra vulgaris* (19.44%) and *Lecane bulla* (17.53%) (Figure 3A). Copepods were dominated by nauplii, which represented 70.3% of all

Copepods collected from the Cavally River, followed by *Thermocyclops decipiens* (39.7%) (Figure 3B).

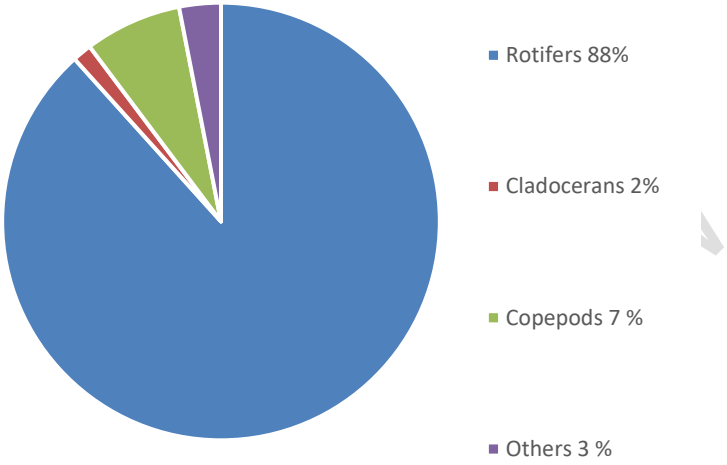
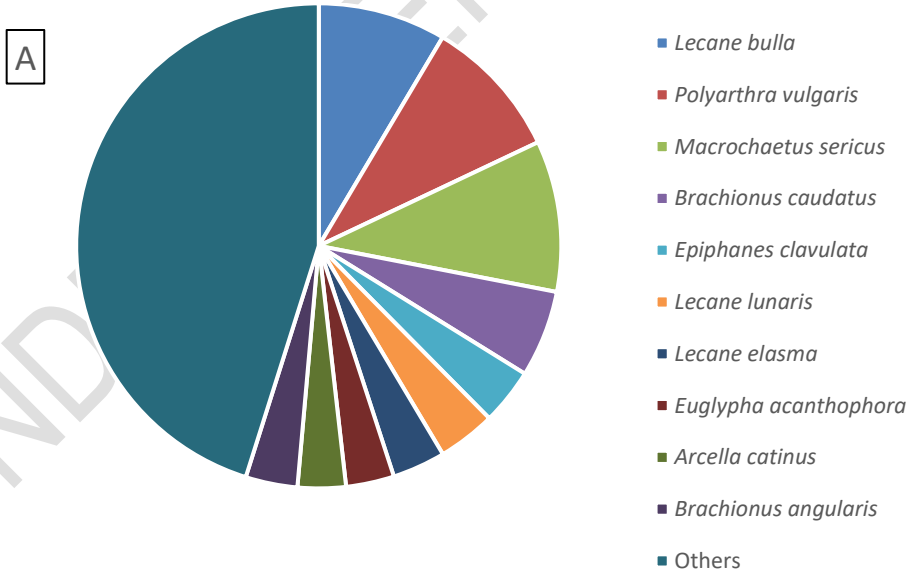


Figure 2. Structure of the zooplankton community collected from the Cavally River**.**



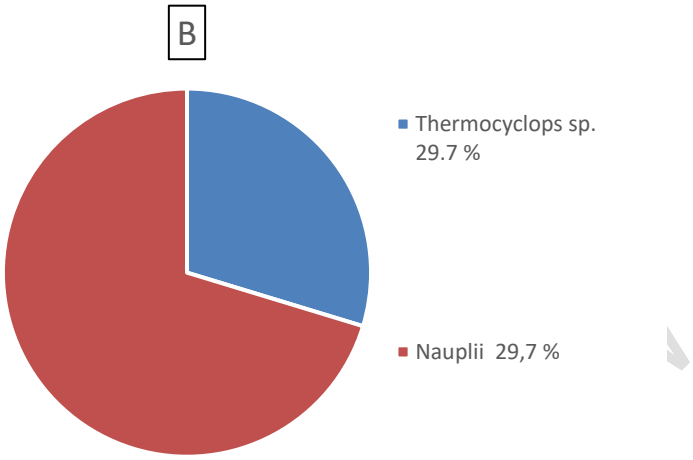


Figure 3. Structure of Rotifera and Copepoda collected from the Cavally River.
(A) Relative abundance of dominant Rotifera species; *(B)* Relative abundance of Copepoda species.

3.3 Spatial Variation in Zooplankton Density

The highest mean total zooplankton density (6,444.44 ind·m^{-3}) was recorded at Niampleu. Conversely, the lowest mean densities (125 to 2,383.33 ind·m^{-3}) were observed at the stations affected by illegal gold-mining activities. Significant differences in total zooplankton density were found between Niampleu and the impacted stations, according to the Kruskal–Wallis test ($p < 0.05$) (Figure 4).

Rotifers constituted the dominant group at all stations, accounting for 75% to 100% of total zooplankton density. Copepods ranked second, with proportions ranging from 9.46% to 25.42% at Niampleu and Floleu. The Shannon diversity index ranged from a minimum value of 1.38 bits·ind^{-1} at Floleu to a maximum of 3.16 bits·ind^{-1} at Niampleu. Significant differences in Shannon index values were also recorded between Niampleu and Floleu (Kruskal–Wallis test, $p < 0.05$).

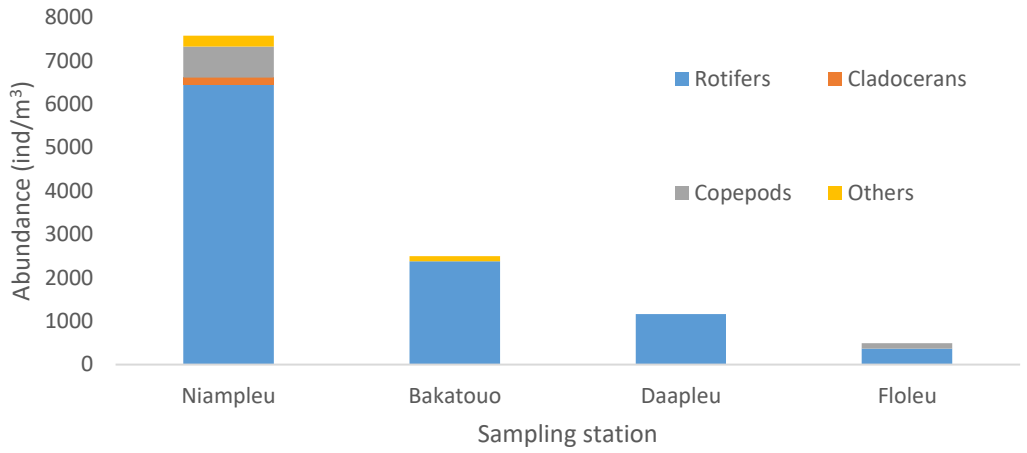


Figure 4. Spatial variation in the structure and mean total density of zooplankton collected at the sampling stations of the Cavally River.

1.1. Correlation Between Environmental Variables and Zooplankton Distribution

The influence of environmental variables on zooplankton distribution was analyzed using Redundancy Analysis (RDA). The results revealed strong correlations between environmental factors and zooplankton taxa, mainly explained by the first two axes, which accounted for 88.75% and 7.86% of the total variance, respectively (Figure 5).

The RDA ordination along the first axis clearly separated Bakatouo, Daapleu, and Floleu (impacted by illegal gold-mining) from Niampleu (unimpacted). The first group of taxa—*Trichocerca rousseleti*, Copepod nauplii, *Brachionus angularis*, *Euglypha acanthophora*, *Keratella tropica*, *Lecane lunaris*, *Brachionus calyciflorus*, *Thermocyclops decipiens*, *Lecane bulla*, *Lecane elasma*, *Polyarthra vulgaris*, *Anuraeopsis navicula*, *Arcella conica*, *Macrochaetus sericus*, *Brachionus caudatus*, *Trichocerca cylindrica*, *Mytilina* sp., *Synchaeta pectinata*, and *Epiphanes clavulata*—was positively correlated with axis 1 and associated with Niampleu. This station was characterized by high values of transparency, pH, and dissolved oxygen.

The second group, composed of only two taxa (*Anuraeopsis fissa* and *Arcella catinus*), was associated with Bakatouo, Daapleu, and Floleu, characterized by higher values of water temperature, conductivity, and depth. Along the second RDA axis, taxa were further separated into two subgroups: the first, positively correlated with axis 2, was associated with Floleu and

characterized by high temperature, conductivity, and depth; the second subgroup, composed of *Anuraeopsis fissa* and *Arcella catinus*, was associated with Bakatouo and Daapleu, characterized by lower values of these parameters.

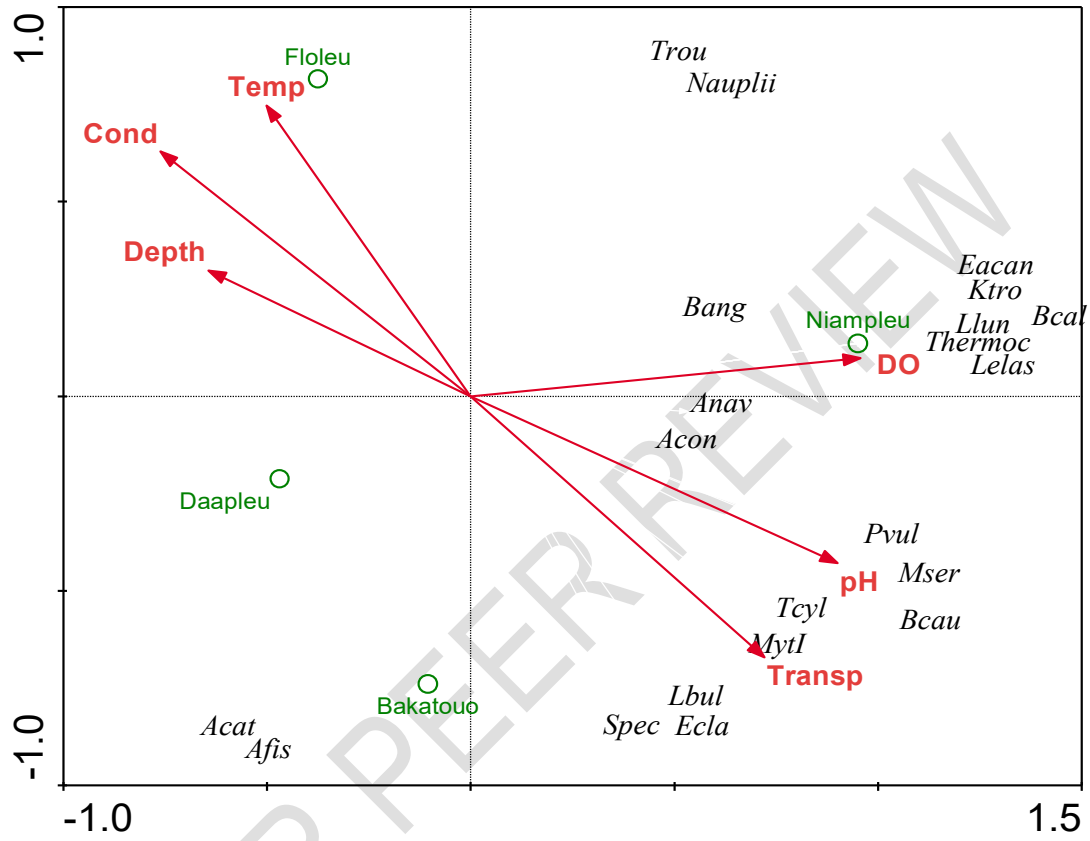


Figure 5. Redundancy Analysis (RDA) showing the relationships between environmental variables, sampling stations, and zooplankton taxa collected at the different stations of the Cavally River. No abbreviations explanations!!

4. DISCUSSION

A total of 40 zooplankton taxa were collected from the different sampling stations along the Cavally River. This relatively moderate taxonomic richness reflects an ecological selectivity influenced by physico-chemical conditions, particularly the reduced transparency and low dissolved oxygen concentrations recorded at stations affected by illegal gold-mining activities. The richness observed in the Cavally River is relatively low compared with that reported for

other Ivorian river systems, such as the Sassandra River (67 taxa, **Kouamé et al., 2018**) and the Bandama River (56 taxa, Soro et al., 2019).

The qualitative and quantitative dominance of Rotifers (85%) with Brachionidae as the most represented family—can be explained by their high adaptability, short life cycles, and ability to colonize unstable or disturbed environments (Onana et al., 2014). These organisms are often the first to develop in habitats subject to environmental fluctuations, as observed in gold-mining zones where conditions become more stressful. A similar dominance of Rotifers was also reported in the Sassandra River, which is heavily impacted by artisanal mining in its watershed (Soro et al., 2019).

The highest species richness and mean abundance recorded at Niampleu—the station not affected by illegal gold-mining—reflect the better environmental quality of this site. This finding is consistent with the RDA results, which clearly separated Niampleu (characterized by numerous taxa) from the impacted stations (Bakatouo, Daapleu, and Floleu, with fewer taxa). At Niampleu, higher values of key physico-chemical parameters such as water transparency and dissolved oxygen concentration provide more stable and favorable conditions for photosynthesis and phytoplankton growth, which form the primary food source for zooplankton. Such conditions support long-term establishment and effective reproduction of diverse zooplankton taxa.

In contrast, at stations affected by illegal gold-mining, dredging, sediment resuspension, and mercury use result in reduced transparency, chemical contamination, and decreased dissolved oxygen levels. These disturbances degrade aquatic habitats and generate ecological stress, reducing zooplankton survival, reproduction, and diversity. As a result, only tolerant taxa persist under these degraded environmental conditions. Similar observations were made by Doffou (2020), who reported reduced values of these same parameters associated with alterations in the ichthyofauna of the Cavally River in mining zones. According to Kouassi et al. (2019), the use of motorized pumps to excavate the riverbed disrupts hydrological conditions, affects aquatic biodiversity, and deteriorates overall water quality.

CONCLUSION

This study, which focused on the diversity and structure of planktonic fauna in gold-mining areas of the Cavally River, contributes to the identification of planktonic communities and the assessment of the trophic status of this river in zones under intense mining pressure. The zooplankton of the Cavally River comprised 40 species, including 34 Rotifera, 2 Copepoda,

and 1 Cladocera. This community was characterized by the clear dominance of Rotifers (85%), followed by Copepods (5%) and Cladocerans (2.5%). The study also revealed a marked spatial variability in taxonomic richness and abundance, with significantly higher values recorded at Niampleu—the station not affected by illegal gold-mining activity. These findings highlight the significant impact of artisanal gold-mining on aquatic ecosystems, notably through habitat degradation, water quality deterioration, and the decline of biological diversity. The results confirm the usefulness of zooplankton as a reliable bioindicator for assessing the ecological health of aquatic environments and underline the need for sustainable management strategies to protect the Cavally River against increasing mining pressures.

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