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Research Article

Zooplankton Community Structure in Akassa Creek, Delta State, Nigeria

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ABSTRACT
Zooplankton are key indicators of aquatic ecosystem health and productivity. This study investigated the taxonomic composition, abundance, and spatial-temporal distribution of zooplankton in Akassa creek, a brackish water system in the Niger Delta, Nigeria. Monthly samples were collected between the months of October-December, 2024 from 2 stations (Akassa 1 and Akassa 2) using a 55 µm plankton net. A total of 4 taxa were recorded, dominated by *Lecane closterocerca; Acartia metanauplius* and *Arcella vulgaris.* Akassa 1 recorded a higher diversity index (H' = 1.312), lower dominance D (0.2861), higher richness S (4) taxa and a higher evenness J' (0.9284) reflecting a more balanced community. On the other hand, Akassa 2 had a lower diversity H' (0.8379), higher dominance D (0.4631), lower richness S (3 taxa), lower evenness J' (0.7705) indicating a skewed community. The differences between the composition and abundance of zooplanktons in Akassa 1 and Akassa 2 suggests that spatial monitoring of diversity indices is critical for fisheries management. The findings provide unique data for conservation and fisheries management in Akassa creek.

Keywords: Akassa Creeks; Aquatic Ecosystems health; Ecological indices; Water Intergrity; Zooplanktons

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INTRODUCTION

Zooplankton are a productively diverse set of macroscopic and microscopic drifting animals that occupy a position of critical importance in aquatic food webs (Vereshchaka, 2024). As primary consumers, they feed directly on phytoplankton, detritus, and bacteria, transferring nutrients and energy from the base of production to higher trophic levels. This feeding pressure control phytoplankton community structure and biomass, thereby influencing dissolved oxygen dynamics, water clarity, and overall ecosystem productivity (Molline *et al.,* 2019; Li *et al.,* 2025). Globally, zooplankton mitigate carbon flux through the process of "biological pump" by undergoing diel vertical migration and generating fecal pellets and critically important to oceanic carbon sequestration.

Zooplankton make up the major first food for most freshwater and marine fish larvae during their most vulnerable period when survival distinguish year-class strength (China & Holzman, 2014). Copepods, rotifers and cladocerans, provide proteins and essential fatty acids required for larval development and growth (Bell *et al.,* 2003).

Zooplankton communities serve as bioindicators of environmental change as a result of their rapid life cycles and quick responses to physicochemical changes such as salinity shifts and nutrient concentrations (Kuczyńska-Kippen *et al*., 2020; Li and Chen, 2020; Yuezhao *et al*., 2021). Outside their sensitivity, zooplankton plays a pivotal role in aquatic food webs, transferring energy from phytoplankton to higher trophic levels, although their community structure differs considerably, under degraded conditions (Chiba *et al*., 2018; Makwinja *et al*., 2021). Their short life span, combined with a capacity to swiftly recolonize substrates and microhabitats, make them particularly important for monitoring (Bonecker *et al*., 2013; Yuezhao *et al*., 2021). Consequently, zooplankton are widely employed as ecological indicators of change in aquatic ecosystems (Li & Chen, 2020).

In Nigerian waters, previous studies have discussed the link between fish recruitment and zooplankton abundance. For example, Ogidiaka-Obende *et al*. (2025) documented the seasonal changes in the abundance of clupeidae, sciaenidae, and mugilidae commercially important fish families in Forcados River estuary and related this interaction to environmental drivers and plankton availability highlighting zooplankton role as prey base for estuarine fisheries. Ogidiaka and Ikomi (2021) also assessed the fish fauna composition and distribution in same estuary, emphasizing that zooplankton-rich periods co-occurred with higher juvenile fish abundance.

Beyond bioindication and energy transfer, zooplankton add to nutrient cycling by supporting planktivorous invertebrates, excreting nitrogen and phosphorus, and jellyfish, and are food for economically important species from shrimp to sardines (Chetram, 2025).

Coastal and estuary ecosystems are part of the most biologically productive aquatic ecosystems in the world, but they are also highly susceptible to anthropogenic pollution due to their closeness to human settlements, agricultural catchments, industrial activities, and transport corridors (Mitra and Zaman, 2016; Kennish, 2023). Rapid industrialisation, urbanisation, agricultural runoff, and ineffective waste management attitudes have transformed the properties of the physical and chemical parameters of many water bodies, resulting in habitat degradation, poor water quality and loss of ecosystem services (Ogidi and Akpan, 2022; Okafor *et al*., 2023; Albou *et al*., 2024).

Akassa creek, a tidal brackish creek in the Niger Delta zone of Nigeria, is covered extensively with mangrove and occupied by active artisanal fisheries. This region is among the most stressed coastal regions globally because of urbanization, intensive oil extraction and coastal development (Zabbey *et al*., 2019; Sunday *et al*., 2024). Aquatic ecosystems plagued by anthropogenic factors, including domestic waste discharge, hydrocarbon pollution, nutrient pollution, land-use changes and siltation. All these factors can impair water quality, biological diversity, aquatic habitats, and fisheries that support people in the zone (Nduka and Orisakwe, 2011; Okoyen *et al*., 2020; Igbani *et al*., 2024). Previous research works in Niger Delta estuaries and creek sexposed water physicochemical changes associated with human activities (Abowei and George, 2009; Makinde *et al*., 2015).

Despite Akassa creeks economic and ecological importance, data on zooplankton assemblages remain scare.

Available literature on the water quality and zooplankton of rivers and creeks in Nigeria includes works by Abowei and George, (2009) who studied the physicochemical properties of Okpoka creek in the Niger Delta region of Nigeria; Deekae *et al. (*2010) documented the water quality parameters of Luubara creek in Ogoni land; Ibanga *et al. (*2019) determined the concentration of physicochemical concentrations in Woji creeks; Chukwujindu*, et al.,* (2023) assessed some physicochemical properties of Bomadi creek; Ogidìaka-Obende *et al.,* (2025) reported on the Water Quality Index of Akassa creek.

Furthermore, Edegbene *et al*. (2022) assessed zooplankton as indicators species in Afrotropical ephemeral streams and noted that pollution gradients significantly changed abundance, zooplankton diversity, and functional traits. Kaine and Ogidiaka (2022) used zooplankton community metrics assessing water quality of Ogbese River, Ekiti State, and related high nutrient loads to abundance of pollution-tolerant zooplankton taxa. These studies confirm that zooplankton community indices be used as cost-effective tools for monitoring stress in tropical waters. The aim of this study is to document zooplankton taxonomic composition of these important aquatic ecosystems in Delta State, Nigeria.

MATERIALS AND METHODS

Study Area

Akassa creek (4°22'N, 6°05'E) is a tidal creek at Burutu region in Burutu Local Government Area of Delta State, Southern Nigeria linked to the Atlantic Ocean (Figure 1). The water body receives freshwater input from inland tributaries and is bordered by mangrove vegetation. Two sampling stations were selected downstream (5˚0ˊ.0ˊˊˊN, 5˚30.5.4ˊE) and upstream (5˚20ˊ.35.88ˊN, 5˚20ˊ35.88ˊE).

Zooplankton sample collection and analyses-

Between the months of October-December, 2024, the modified hand trawling technique was employed to collect zooplankton samples at the shore using a 55-µm mesh size plankton net in a horizontal way for 20 minutes (Yagit, 2006). The well labeled samples were preserved in 4% formalin solution and taken to the laboratory for analysis. In the laboratory, 1 ml of each sample per station was poured out in a different container, shaken properly to ensure fair distribution, placed into a glass slide covered with a cover slip,

identified and enumeration using a digital microscope at magnification of × 10 and confirmed at × 40 by counting manually (Suthers *et al*., 2009).
This was repeated thrice for each of the 1 ml per plastic container. Counting of zooplankton was done manually. Zooplankton identification was done using guides by Harris *et al*. (2000); and Yamaguchi and Bell (2007).

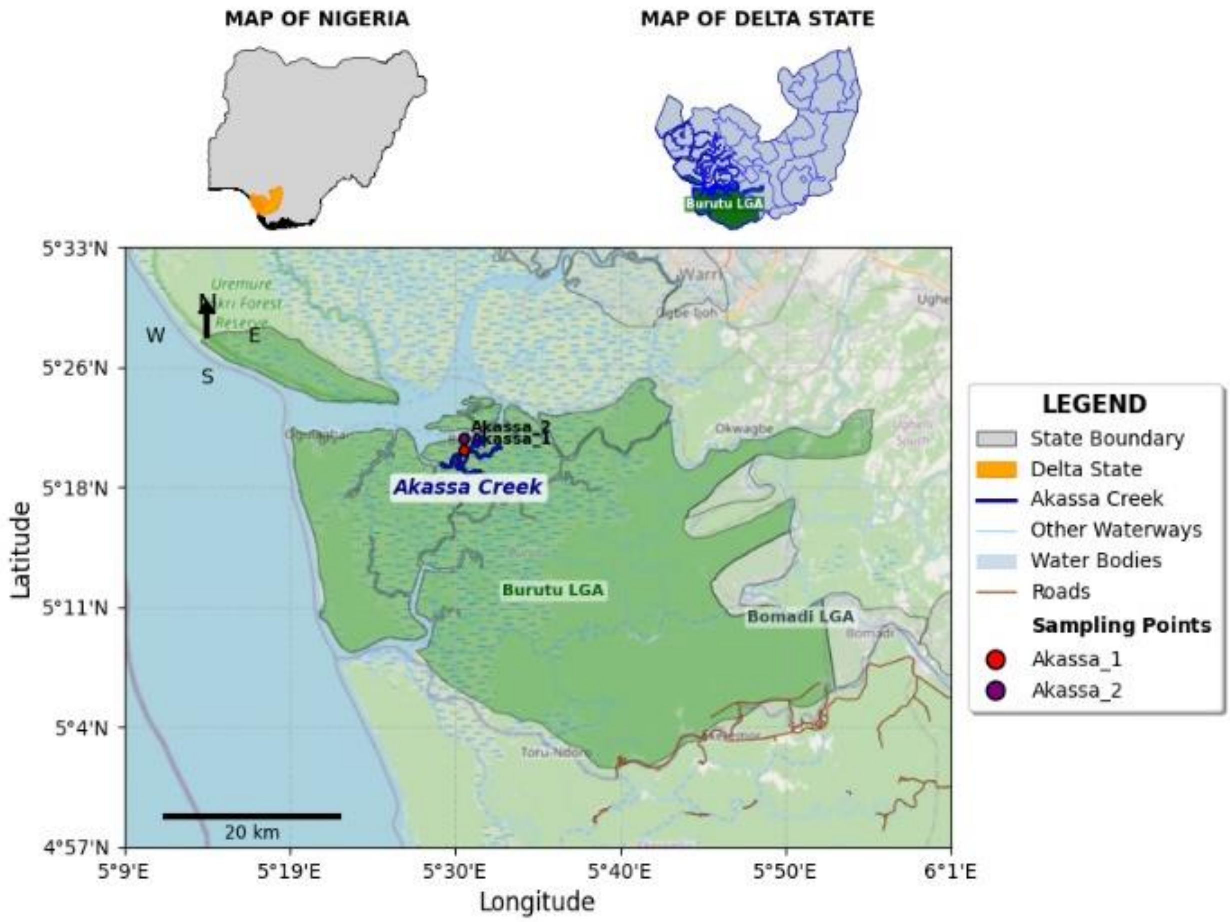

Figure 1: Map of study area showing sampling locations

Statistical Analysis
Statistical analysis was performed using Python 3 and the scipy.stats and pandas' libraries for data manipulation and hypothesis testing.
The formulae used are shown below:

Species diversity Index (H,)
Shannon-Wiener Index

$$H = \frac{N\log N - \sum f_i \log f_i}{N}$$

Where H = index of species diversity/degree of uncertainty
N = total number of individuals
f_1 = proportion of total sample belonging to ith species

Taxa richness: The maximum possible diversity for a given set of data consisting of K category is given as H_{max} = LogK,
Where K = number of categories

The Evenness or Homogenity
Expressed as equitability index, E

$$\text{Evenness (E)} = \frac{H}{H_{max}}$$

Richness Indices: Focusing on the number of species in relation to the number of individuals was used (Margalef, 1958).

Margalef (1958) $D = \frac{S-1}{\ln N}$

where S = number of species
N= number of individuals.

RESULT AND DISCUSSION

Akassa 1 recorded the overall highest abundance of zooplanktons during the study period with *Lecane closterocerca* recorded the highest abundance, followed by *Acartia metanauplii* was second, while *Arcella vulgaris* recorded the least abundant species. At Akassa 2, the species *Arcella vulgaris* was the most abundant while *Acartia metanauplius* was the least abundant species recorded (Table 1).

Many studies in Nigeria and elsewhere have reported similar dominance of rotifera within zooplankton communities. Akin-Oriola 2003 reported the dominance of rotifers (*Brachionus* and *Keratella* spp) in Lagos Lagoon, Nigeria and attributed the dominance to high nutrient loads and rapid population turnover. Imoobe (2011) recorded > 60% rotifera of the total zooplankton collected at Ikpoba River Reservoir, Benin City, Nigeria and linked their dominance to high temperature, shallow depth, and organic pollution. Furthermore, Abdul *et al.* (2016) attributed the dominance of rotifers all year round in Jabi Lake, Abuja, Nigeria to fast developmental rates under relatively stable, nutrient-rich conditions. This trend can be linked to their rapid developmental pace under great conditions Abdulwahab and Rabee (2015), while Neves *et al*. (2003) connected it to parthenogenetic reproduction strategy. High temperature and conductivity are known to alter zooplankton egg ratios by affecting egg production frequency and parthenogenetic egg hatch times (Sarma *et al*., 2005). This may also account for the overall low zooplankton abundance observed here, a pattern reported in another tropical systems (Smith *et al*., 2021). Edegbene *et al*. (2022) opined that alternatively, differences in sampling methodology and analysis could cause low species counts.

Summary of Diversity Indices

Akassa 1 recorded a higher diversity index (H' = 1.312), lower dominance D (0.2861), higher richness S (4) taxa and a higher evenness J' (0.9284) reflecting a more balanced community (table 2). On the other hand, Akassa 2 had a lower diversity H' (0.8379), higher dominance D (0.4631), lower richness S (3 taxa), lower evenness J' (0.7705) indicating a skewed community with *Lecane closterocerca* and *Arcella vulgaris* making up >95% of individuals (Table 2). This is the inverse pattern of what "total abundance" suggested. While Akassa 1 had more individuals, it is the healthier station ecologically because diversity and evenness are higher. Akassa 2 has fewer species and 2 taxa dominate >95% of the population. Overall, the ecological indices from this study indicated low taxonomic richness which has direct implications for fisheries productivity and sustainability.

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Zooplankton diversity and evenness are more important for fisheries than raw abundance alone. Fish larvae, especially sciaenids andclupeids common in the Niger Delta, require a range of prey sizes and species during ontogeny. A diverse zooplankton assemblage provides "size spectra" of rotifers, copepod nauplii, and cladocerans that match larval gape size and nutritional needs. When 2 taxa dominate >95% of the community as in Akassa 2, the food web becomes simplified and unstable. This reduces feeding efficiency for larval fish and increases risk of recruitment failure if the dominant prey crashes. Ogidiaka-Obende *et al*., 2025 reported seasonal fluctuations in sciaenidae, clupeidae, and mugilidae abundance in Forcados River Estuary adjacent to Akassa, and linked low zooplankton diversity periods to reduced juvenile fish catches. Similarly, Ogidiaka & Ikomi 2021 found that estuarine fish assemblages were richest when zooplankton diversity indices were high, because multiple fish species could partition prey resources.

High dominance by 1-2 taxa, as observed in Akassa 2, is a classic indicator of environmental stress and reduced ecosystem resilience. Edegbene *et al*., 2022 demonstrated in Afrotropical streams that dominance indices >0.8 coincided with low dissolved oxygen and high conductivity, conditions that suppress sensitive zooplankton and, by extension, planktivorous fish. For fisheries, this means Akassa 2 may support fewer fish species and lower nursery function compared to Akassa 1, even if total zooplankton numbers appear high. Tropical estuaries with low zooplankton evenness often show truncated fish food webs and reduced catches of high-value species Smith *et al*. (2021).

Statistical Difference Between Stations

Chi-Square test of independence

The zooplankton community composition differed significantly between the two sampling stations as indicated by the Chi-square test ($\chi^2 = 19.8092$, p = 0.000186). Null hypothesis of no difference in species composition between stations was rejected (p-value < 0.05). The differences in the distribution and structure of zooplankton community between the two stations are statistically highly significant. *Tintinnopsis gracilis* and *Acartia metanauplius* are extremely dominant in Akassa 1 but totally or near-absent in Akassa 2. This indicates a significant

difference in the abundance distribution of zooplankton taxa between Akassa 1 and Akassa 2.
Variations in salinity, depth, nutrients, turbidity, or pollution can result to dis-uniformity between 2 stations in creeks that can cause major shifts in zooplankton compositions. Studies shows that differences in water depth, hydrology, and plant cover across short horizontal distances shape unique microhabitats directly affecting zooplankton community composition and alpha diversity (Olson *et al*., 2004; Rosas *et al*., 2024). Minor spatial changes in salinity reducing light entrance and turbidity have been documented to act as primary environmental filters that rapidly alter zooplankton biomass and taxa (Oliver *et al*., 2010; Sun *et al*., 2023). Furthermore, due to the fact that creeks receive localized inputs such as runoff or industrial/municipal discharge), stations separated by small distances can show different trophic states that drive major zooplankton shifts (Meremo *et al*., 2022; Zhang *et al*., 2022; Dorak *et al*., 2025).
Acartia spp. are known estuarine copepods that flourish in brackish, eutrophic conditions (Annabi-Trabelsi *et al*., 2019) while *Tintinnopsis* spp is a loricate ciliate predominant in turbid, nutrient-rich coastal waters (Bai *et al*., 2020). The species composition pattern implies that Akassa 1 favours eutrophic-tolerant taxa, while Akassa 2 has different hydrodynamics.

Table 1: Zooplankton Composition and Abundance recorded from Akassa creeks

Taxa	AKASSA 1	AKASSA 2
Lecane closterocerca	23	10
Tintinnopsis gracilis	11	0
Arcella vulgaris	9	12
Acartia metanauplius	21	1

Table 2: Diversity indices of Zooplankton community along Akassa creek, Delta State, Nigeria

Indices	AKASSA 1	AKASSA 2
Taxa	4	3
Individuals	64	23
Dominance D	0.2861	0.4631
Simpson_1-D	0.7139	0.5369
Shannon_H	1.312	0.8379
Evenness_e^H/S	0.9284	0.7705
Brillon	1.217	0.718

Table 3: Chi-Square Test of Independence (Community Composition)

Parameter	Value
Chi-square Statistic (χ^2)	19.8092
Degrees of Freedom (dof)	3
p-value	0.000186
Decision	Statistically Significant
Interpretation	Community composition differs significantly between Akassa 1 and Akassa 2

CONCLUSION

This study validates the effectiveness of zooplankton communities for Akassa Creek, ecological monitoring in Niger Delta system. The taxonomic inventory showed the presence of 4 taxa, with *Lecane closterocerca*, *Acartia metanauplius* and *Arcella vulgaris* as dominants species. Spatial variation was obvious: Akassa 1 favoured higher diversity H’ = 1.312, evenness J’ = 0.9284, richness S = 4, and lower dominance D = 0.2861, reflecting a more stable community. On the contrary, Akassa 2 had reduced diversity H’ = 0.8379, evenness J’ = 0.7705, richness S = 3, and elevated dominance D = 0.4631, suggesting that the community is skewed likely due to local stressors.
The contrast between Akassa 1 and Akassa 2 suggests that spatial monitoring of diversity indices is critical for fisheries management. Protecting Akassa 1 as a healthy station and determining stressors driving dominance in Akassa 2 such as conductivity, turbidity, and nutrient inputs will help restore and maintain the zooplankton base that supports artisanal fisheries in the area.

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