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Short Communication

Assessment of the physico-chemical water quality, distribution and abundance of *Macrobrachium* species in Okwagbe River, Delta State, Nigeria

Jerimoth Kesena Ekelemu¹, Alice Olok Ekwu², Patrick Adarighofua² and Arnold Ebuka Irabor^{3,4*} 

¹ Department of Fisheries and Aquaculture, Delta State University, Abraka, Nigeria

² Department of Fisheries and Aquaculture, University of Uyo, Akwa Ibom State, Nigeria

³ Department of Fisheries and Aquaculture, Dennis Osadebay University, Asaba, Nigeria

⁴ Department of Applied Animal Science and Welfare, Swedish University of Agricultural Sciences, Uppsala, Sweden

* Correspondence: arnold.ebuka.irabor@slu.se, iraborarnold@gmail.com

Okwagbe community, situated along the Okwagbe River, a tributary of River Forcados, is a notable commercial hub recognised for its shrimp harvesting and trade. A study was therefore conducted on this river to determine its water quality, and distribution and abundance of *Macrobrachium* species. Water samples were collected fortnightly for three months (December 2024 to February 2025) from three sites along the river. Samples of crustaceans were collected with the help of local fishermen, and later identified. The water quality of the river was within acceptable ranges for fish production, and the values were generally not significantly different ($p > 0.05$) between sampling points. Three hundred and eight (308) *Macrobrachium* species were identified, primarily consisting of four species: *Macrobrachium macrobranchion*, *M. vollenhoveni*, *M. felicinum* and *M. rosenbergii*. *Macrobrachium vollenhoveni* was the most dominant, while *M. felicinum* the least dominant. *Macrobrachium rosenbergii* is rarely found in Nigerian rivers. This study also showed that the Okwagbe River has good quality water, suitable for aquaculture.

Keywords: crustaceans, dominant, quality, river, sampling, water

Naturally occurring bodies of water contain organic and inorganic components. The quality of that water is measured by the levels of these components or water quality parameters, grouped into physical, chemical and biological components, with temperature, pH, turbidity, nitrates, ammonia, hardness, alkalinity and dissolved oxygen usually measured. Water quality parameters play a vital role in the growth of living organisms in the aquatic ecosystem (Ekelemu and Okoro 2018; Ekelemu et al. 2022). Water quality is usually impacted by seasonal changes (Irabor et al. 2024), with rising temperatures reducing dissolved oxygen levels, with pollutants less diluted during low rainfall or vice versa, and sedimentation increasing with surface rain runoff (Marale et al. 2012). Additionally, the surrounding geology and soil condition, physical structure of the channel and the riparian zone plus channel management (e.g. physical structures, macrophytes cutting and dredging) all affect river ecosystem health; as do anthropogenic such as method of fishing, and animal activities (Dhawde et al. 2018; Acreman and Dunbar 2004; Nwabueze and Ekelemu 2021).

In Nigeria, approximately 70% of surface water resources and groundwater reserves have been contaminated by biological, organic and inorganic wastes, largely from urbanisation, industrialisation and the discharge of wastes, agricultural fertilizer use, and generally increasing human activities (Adu and Oyeniyi 2019). A major source of water

pollution is oil prospecting and drilling (Akporido and Ayodele 2014), with the effects of an oil spillage on the ecosystem in the Niger Delta severe, resulting in damage to and complete loss of biodiversity and reduction of arable land (Akporido and Ayodele 2014). The presence of heavy metals in oil also affects the biodegradation of spilled oil, and thus environmental recovery (Almeida et al. 2013). The nature of the waterbed can also be altered for aquatic organisms by changing their habitat structure, water quality and biotic interaction (Irabor et al. 2024).

The availability of sufficient good quality freshwater for aquaculture purposes in most developing countries of the world, like Nigeria, is a concern for fishers (Adu and Oyeniyi 2019; Nwabueze and Ekelemu 2021). Furthermore, aquaculture yields from most water bodies are no longer sustainable due to over-exploitation of fishing and the use of obnoxious fishing methods (Akindele et al. 2015). This has further led to the extinction of many species, including shellfish and finfish.

The aquatic invertebrate community structures effectively reflect their prevailing environmental conditions (Arimoro and Ikomi 2008; Payakka and Prommi 2014; Prommi and Payakka 2015). Aquatic invertebrates including insects, annelids (leeches), oligochaetes (worms), crustaceans (crayfish and shrimp) are important ecosystem indicators because they exhibit different tolerances and ranges of tolerance to changes in their environmental conditions

(Odume et al. 2012; Prommi and Payakka 2015; Adu et al. 2016).

The Okwagbe community, located along Okwagbe River, is a commercial centre renowned for shrimp harvesting and trade. This study seeks to assess the physico-chemical quality of Okwagbe River, a tributary of River Forcados, as well as the abundance and distribution of crustaceans (shrimps) in the *Macrobrachium* genus.

This study was conducted on the Okwagbe River, a channel of the Forcados River in the Niger Delta, Nigeria. Okwagbe is located at latitude 5°21'–5°38' N and longitude 5°47'–5°79' E of the equator. The river is an important channel for small boats and ships that berth at Okwagbe, bringing their wares for sale through the Forcados River and the River Nun. In addition to being a centre of commerce, Okwagbe is also a fishing community, known for the harvest and sale of shrimps.

For this study, the river was delineated into three sampling sites (1, 2 and 3) 500 m apart from each other. Sampling site 1 was upstream, site 2 was Okwagbe market jetty, and site 3 was downstream (Figure 1).

Water samples were collected fortnightly for three months, from December 2024 to February 2025, between 7:00 am and 10:30 am on sampling days, from the three sites using 1 000 ml plastic sampling bottles. Water was sampled at the same location along the river as the shrimp sampling to ensure that the physio-chemical variables shrimp were exposed to were consistent with measured parameters. Temperature, pH, conductivity, total dissolved solids (TDS), dissolved oxygen and transparency were electronically measured in situ. Other parameters (total hardness, salinity, alkalinity, nitrate and phosphate) were determined in the laboratory using standard methods (APHA 2010).

The sampling method used for the shrimp collection was via conventional methods using locally fabricated traps and nets (cast net) to ensure the bentic and palegic zones were covered. Shrimp were sampled between 6:30 am and 8:30 am (2 hrs) from the three sites and with the help of local fishermen. Samples collected were stored in the ice chest and taken to the laboratory for identification.

Shrimp were identified to species level using Powell (1983).

Correlation, Analysis of Variance (ANOVA) and New Duncan Multiple Range Test (NDMRT) were used to analyse data collected (SPSS; IBM Corp. 2023). Correlation analysis was employed to analyse the relationship between species richness and water quality parameters. ANOVA was used to evaluate differences in diversity across various sites, followed by the NDMRT to pinpoint specific site-level variations in diversity metrics.

Results of the eleven physicochemical water parameters determined in Okwagbe River are presented in Table 1. Sites 2 and 3 had the same temperature of 29.17 °C; site 1 was lower at 28.17 °C. The highest mean value for transparency was recorded for site 3 (32.33 mg l⁻¹), while site 2 had the lowest mean value (29.52 mg l⁻¹). The mean value for total hardness at site 1 was 83.50 mg l⁻¹, compared to site 2 and 3 (79.67 mg l⁻¹ and 78.17 mg l⁻¹, respectively). The highest mean value for nitrate was recorded for site 1 and 2 (0.05 mg l⁻¹), while site 3 recorded 0.03 mg l⁻¹.

Apart from water temperature, transparency, total hardness and nitrate, which showed significant differences between sample sites ($p < 0.05$), all other water parameters were not significantly different among the sample sites ($p > 0.05$).

A total of three hundred and eight (308) individuals, made up of four *Macrobrachium* species, were recorded in the study



Figure 1: Map showing the stretch of the Okwagbe River, Nigeria, where the sample sites were located

area. The four species were *Macrobrachium rosenbergii*, *M. macrobrachion*, *M. felicinum* and *M. vollenhovenii*. Species abundance is presented in Figure 2. From the results, the order of the relative abundance was *M. vollenhovenii* ($n = 114$, 37%), *M. macrobrachion* ($n = 105$, 34%), *M. rosenbergii* ($n = 78$, 25%), and *M. felicinum* ($n = 11$, 4%).

The correlation matrix between the shrimp species and the physico-chemical parameters is presented in Table 2. Significantly high positive correlations ($p < 0.05$) were observed between *M. rosenbergii* and pH (0.651) and turbidity (0.536); and *M. felicinum* and dissolved oxygen (0.659). Significantly moderate positive correlations ($p < 0.05$) were observed between *M. rosenbergii* and temperature (0.403) and alkalinity (0.403); *M. vollenhovenii* and pH (0.457); *M. macrobrachion* and turbidity (0.481) and alkalinity (0.309); and between *M. felicinum* and temperature (0.408), turbidity (0.454) and alkalinity (0.424). Significantly low positive correlations ($p < 0.05$) were observed between *M. macrobrachion* and pH (0.223) and DO (0.208). There was a non-significant low positive correlation ($p < 0.05$) between *M. vollenhovenii* and temperature (0.042), conductivity (0.009), salinity (0.058) and TDS (0.042). A non-significant moderate positive correlation ($p < 0.05$) was observed between *M. rosenbergii* and alkalinity (0.403).

Significantly high negative correlations ($p < 0.05$) were observed between *M. rosenbergii* and conductivity (-0.526), TDS (-0.511); *M. macrobrachion* and conductivity (-0.541), TDS (-0.527), hardness (-0.543) and salinity (-0.557); and between *M. felicinum* and hardness (-0.501) and salinity (-0.514). Significantly moderate negative correlations ($p < 0.05$) were observed between *M. rosenbergii* and hardness (-0.475) and salinity (-0.491); and *M. felicinum* and TDS (-0.472). There was a non-significant difference ($p < 0.05$) between *M. vollenhovenii* and DO (-0.317). Significantly low negative correlation ($p < 0.05$) was observed between *M. rosenbergii* and DO (-0.052) while a non-significant low negative correlation ($p < 0.05$) was observed between *M. macrobrachion* and nitrate (-0.232), temperature; *M. vollenhovenii* and turbidity (-0.024), hardness (-0.010), alkalinity (-0.246) and nitrate (-0.058); and between *M. felicinum* and pH (-0.129).

Physical and chemical parameters of water contribute to the abundance and well-being of aquatic life (Arimoro

et al. 2007). Although differences in the mean values of the physicochemical parameters determined were noticed, these differences appeared to have a minimal effect on the abundance and distribution of the prawn species in the river. In most of the water parameters examined, site 3 had higher values compared to other sites. The pH, DO and temperature ranges (6.47–6.52; 5.01–5.07 mg l⁻¹; and 25–32 °C, respectively) recorded were within the recommended values for freshwater fish culture (Umehai and Ekelemu 2023).

Of the four species recorded, *M. felicinum*, *M. macrobrachion* and *M. vollenhovenii* were reported by Kingdom et al. (2013) in lower Taylor Creek, Niger Delta. The *Macrobrachium* species reported by Ibim (2018) in some creeks in Rivers State were *M. macrobrachion*, *M. vollenhovenii*, *M. equidens*, *M. dux* and *M. felicinum*, with *M. equidens* and *M. felicinum* being the most abundant

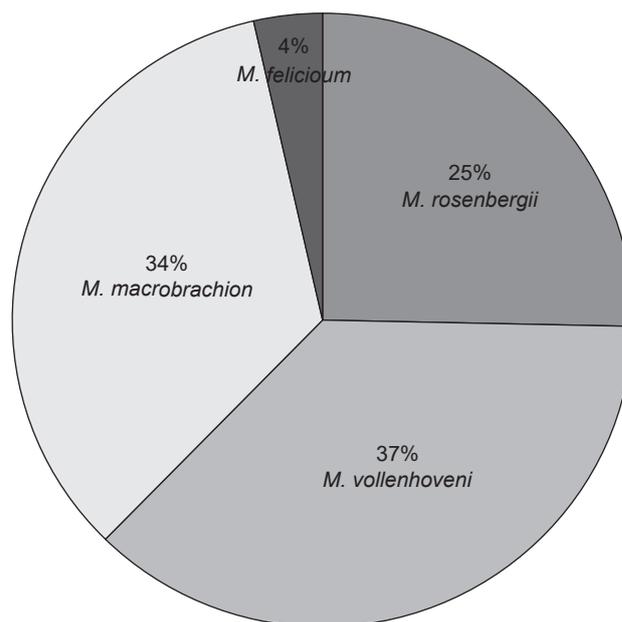


Figure 2: Abundance of *Macrobrachium* species in Okwagbe River

Table 1: Physico-chemical parameters of water obtained from sampling sites

Parameters	Site 1	Site 2	Site 3
pH	6.47 ± 0.12 ^a	6.47 ± 0.08 ^a	6.52 ± 0.16 ^a
Temperature (°C)	28.17 ± 2.64 ^a	29.17 ± 0.75 ^a	29.17 ± 0.75 ^a
Conductivity (µS cm ⁻¹)	168.33 ± 38.69 ^a	168.33 ± 38.69 ^a	168.33 ± 38.69 ^a
Dissolved oxygen (mg l ⁻¹)	5.01 ± 0.08 ^a	5.02 ± 0.04 ^a	5.07 ± 0.05 ^a
Total dissolved solids (TDS) (mg l ⁻¹)	91.70 ± 21.56 ^a	91.67 ± 21.54 ^a	91.67 ± 21.54 ^a
Turbidity (transparency) (NTU)	29.90 ± 7.04 ^b	29.52 ± 8.32 ^b	32.33 ± 7.81 ^a
Total hardness (mg l ⁻¹)	83.50 ± 23.77 ^a	79.67 ± 22.46 ^b	78.17 ± 22.36 ^c
Salinity (mg l ⁻¹)	25.13 ± 9.44 ^a	25.13 ± 9.44 ^a	25.13 ± 9.44 ^a
Alkalinity (mg l ⁻¹)	14.33 ± 1.86 ^b	13.67 ± 3.50 ^b	14.67 ± 3.67 ^a
Nitrate (mg l ⁻¹)	0.05 ± 0 ^a	0.05 ± 0.01 ^a	0.03 ± 0.01 ^b
Phosphate (mg l ⁻¹)	0.01 ± 0 ^a	0.01 ± 0 ^a	0.01 ± 0 ^a

Rows with the same letters as superscripts are not significantly different ($p > 0.05$)

Table 2: Correlation between physico-chemical parameters and shrimp species

Parameters	<i>M. rosenbergii</i>	<i>M. vollenhoveni</i>	<i>M. macrobrachion</i>	<i>M. felicinum</i>
pH	0.651*	0.457*	0.223	-0.129
Temperature	0.403*	0.042	-0.014	0.408*
Conductivity	-0.526*	0.009	-0.541*	-0.375
DO	-0.052	-0.317	0.208	0.659*
TDS	-0.511*	0.042	-0.527*	-0.472*
Turbidity	0.536*	-0.024	0.481*	0.454*
Total hardness	-0.475*	-0.010	-0.543*	-0.501*
Salinity	-0.491*	0.058	-0.557*	-0.514*
Alkalinity	0.403*	-0.246	0.309	0.424*
Nitrate	0.032	-0.058	-0.232	-0.383

Correlation is significant at one tailed level (0.05)

and least abundant species, respectively. Ekelemu (1998) and Ekelemu and Ekwu (2012) also reported the presence of *Macrobrachium felicinum*, *M. macrobrachion*, *M. vollenhovenii* and *Potamalpheops* species in Benin River and *M. felicinum*, *M. vollenhovenii* and *Atya gabonensis* in Ase Creek, respectively.

The most outstanding finding of this study is the record of *M. rosenbergii* in the Okwagbe River, a species not previously reported in Nigeria. Furthermore, this study showed *M. vollenhovenii* to be the most abundant and dominant, while *M. felicinum* was the least abundant. Ibim (2018) also reported that *M. felicinum* was the least abundant in some creeks in Rivers State.

The correlation analysis indicated that TDS, turbidity, total hardness and salinity were major determinant key factors influencing the distribution and abundance of *M. rosenbergii*, *M. macrobrachion* and *M. felicinum*; while pH, temperature, conductivity and alkalinity influenced the abundance of *M. rosenbergii*. This latter suggests that *M. rosenbergii* may require certain specific water quality levels to thrive, possibly explaining why it was not recorded by Kingdom (2013) and Ibim (2018). Unsurprisingly, there is a negative correlation between salinity and most of the species. It is well known that *Macrobrachium* species live in freshwater and low salinity waters not exceeding 10%, with their larval stages requiring brackish water conditions for their survival and optimum development (Lawal-Are and Owolabi 2012).

The water quality parameters showed that the Okwagbe River is good for aquaculture of the *Macrobrachium*, with its rich assemblage of *Macrobrachium* species. *Macrobrachium vollenhovenii* was the most dominant species. A striking feature of the river is the occurrence of *M. rosenbergii*, which had not been previously reported in Okwagbe rivers.

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Data availability statement — The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declaration of interest statement — The authors declare that they have no conflict of interest.

ORCID

Arnold Ebuka Irabor: <https://orcid.org/0000-0002-2276-6897>

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