

INFLUENCE OF SEDIMENT COMPOSITION ON POPULATION DYNAMICS OF *Pachymelania aurita* IN EPE LAGOON

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ABSTRACT

Sediment composition is the most important factor that influences the benthic fauna. The sediment characteristics of Epe lagoon was studied alongside the population dynamics of *Pachymelania aurita* between November, 2024 and March, 2025. Six study stations were selected along the northern axis of the Lagoon. The aim was to investigate the impacts of the sediment on *P. aurita* abundance. Benthic samples were collected monthly at each study station using Van-veen grab. Sediment samples were collected in polyethylene bags for sediment analysis. Sieving and fixing of benthic samples were done *in situ* following standard procedures. Sorting for *P. aurita* was conducted in the laboratory and its abundance in relation to other benthic macrofauna was recorded. Particle size analysis indicated that the sediment was dominated by fine sand ranging between about 78.5% and 81%. The percentage TOC is low (<10%) and ranged between 1.02% and 7.41%. The nutrient loads in the sediment were relatively low, Nitrate (0.3-3.6mg/kg), and Phosphate (0.60-3.01mg/kg). Study stations with higher fine sand-sized sediment composition recorded relatively higher abundance of *P. aurita*. This sediment particle size was likely a preference for *P. aurita* in Epe lagoon resulting to the relatively high density of this species in the study area. It is necessary to monitor the sediment composition of the study area to regulate the influx of high organic matter, which could result in muddier sediments and a decline in the abundance of *P. aurita*.

Keywords: Epe Lagoon, *Pachymelania aurita*, Sediment, Organic content, Benthic, Macroinvertebrates.

INTRODUCTION

Sediment and its constituents are the most important environmental metrics that impact the benthic organisms as they play the role of habitat to these benthic fauna (Haue *et al.*, 2018, Bianchi *et al.*, 2021). It provides the physical substrates for attachment, burrow, and direct habitation. According to Wiesebron *et al.* (2021) and Taborte *et al.* (2022), composition of the ambient sediment influences the benthic macroinvertebrates in their environment. These organisms conversely modify the sediment properties through bioturbation activities which enhances sediment permeability, nutrient cycling, and aeration (Chakraborty *et al.*, 2022). This improves habitat quality and support ecosystem functions.

According to Adepitan *et al.* (2025) and Ogunleye (2024) the sediments of Epe lagoon composed mainly of fine sand, and the colour ranging from light to dark gray. Most lagoon sediment contain organic debris and some fossil shells (Boutoumit, 2021). The decayed plant and animal materials transported from the nearby rivers and creeks contribute to the organic matter content in the sediment of Epe lagoon and may accumulate heavy metals and hydrocarbons from urban and agricultural runoff.

Pachymelania aurita is moderately tolerant but shows population decline under severe contamination. The sediment characteristics of Epe lagoon play a critical role in determining the health of its benthic ecosystem, the abundance of organisms like *Pachymelania aurita*, and the lagoon's overall ecological function (Adepitan, 2025). In Epe lagoon, the grain size of the sediment is influenced by the river discharges especially from the Ogun River and tidal flows, as well as human activities like dredging (Ogunleye, *et al.*, 2024). The organic matter content could be high especially where there is high primary productivity as a result of high domestic waste input (Zhou, *et al.*, 2022). Although organic matter provides the benthic fauna with detritus, excessive accumulation may result to low dissolved oxygen and formation of toxic gas like hydrogen sulphide, as well as very fine sediment particles. Moderate organic matter in sediments supports a greater abundance of *P. aurita* by enhancing food availability. However, excessive organic content can lead to a hypoxic condition which negatively impact populations through habitat degradation (Manam, 2025).

The genus *Pachymelania aurita* a bulk-feeding benthic macroinvertebrates is one of the most common gastropod molluscs in the south-western lagoon systems of Nigeria (Koudenoukpo *et al.*, 2020;

Oyenekan, 1987). It is endemic to West Africa (Brown, 2000; Oyenekan, 1987), and is harvested by natives of coastal towns and villages in Nigeria as a staple source of protein. The species has received a lot of research attention due to its economic and aquaculture potentials. The shell characteristics, classification and geographical distribution of the genus have been reported by earlier researchers (Buchanan, 1954; Ajao and Fagade, 1991; Brown and Oyenekan, 1998). The ecology of the genus in relation to changes in temperature, salinity and survival out of water under experimental conditions have been documented (Oyenekan, 1988) while Uwadiae, *et al.* (2009) reported the ecology and natural food items of the organism.

The genus, *P. aurita* exhibit very poor mobility and is sensitive to changes in its environment. They however, link the primary producers and other fauna at the higher level in the marine food chain. (Nkwoji *et al.*, 2024). Anthropogenic activities may have negative impacts on the species composition and general community structure of benthic macroinvertebrates. Marine benthic macroinvertebrates are therefore, widely used as ecological indicators. These group of marine fauna constitutes the key components of aquatic feeding relationship in Epe lagoon and hence, link organic matter and nutrient resources with higher trophic level like the fish (Ovioma *et al.*, 2025).

Although *Pachymelania* species adapt to freshwater, they prefer brackish water of higher salinity and often extremely abundant in mangrove swamps and on mud-flats within the reach of the tide in the lagoons and river estuaries (Egonmwan, 2007). Of the four species, only *P. bryoensis* inhabits fresh water, others including *P. aurita* and *P. fusca* are characteristics of brackish tidal water and mangrove swamps along the West African Coast (Oyenekan, 1988; Egonmwan, 2007). According to Uwadiae (2009, 2020), *P. aurita* populations are most abundant in sediments with moderate total organic carbon (TOC) levels, typically between 3.63% and 4.14%. High TOC concentrations (greater than 10%) are associated with lower *P. aurita* densities, likely due to sediment conditions unfavorable to their survival, such as oxygen depletion and smothering effects. Organic matter in sediments serves as a potential food source for deposit feeders; however, excessive organic content may negatively impact filter feeders like *P.*

aurita. Peaks in *P. aurita* population densities correlate with sites having relatively higher salinity (>1.77‰), low to moderate TOC (<10%), and high sand content (>60%). Sediments with favourable mixtures of sand and organic matter support higher biomass of *P. aurita*, with biomass observed to increase in stations presenting these conditions. *P.aurita* favours habitats where sediment is sandy with moderate organic carbon. Excessive organic carbon or muddy conditions can reduce their abundance due to physiological stress and habitat unsuitability. This species thrives in environments balancing sediment grain size and organic content to optimize feeding and survival

Sediments in aquatic environments act as both a sink and a potential source of pollutants. They accumulate contaminants, including the microplastics and may also release them back into the water, influencing water quality and ecosystem health (Chiaia-Hernández, *et al.*, 2022). In Epe Lagoon sediment composition tilts toward finer grain sizes, higher mud, elevated TOC, and polluted sediments are likely to negatively impact *Pachymelania aurita* populations by degrading their habitat quality and influencing their survival, distribution, and abundance. Understanding these roles in relation to the population dynamics of *P. aurita* is crucial for effective environmental management and remediation strategies. The characteristics of the sediment of Epe lagoon therefore, is a good indicator of the health of that water body.

MATERIALS AND METHODS

Description of the Study Area

The study area (Figure 1) is part of the Lagos Lagoon complex, and situated between latitudes 06°31'89' N and 06°33'70' N and longitudes 003°31'91'E and 004°03'71'E. The lagoon is sand-witched between the Lekki and Lagos Lagoons, and connected to the Atlantic Ocean through the Lagos Lagoon. The Epe lagoon is shallow with most part measuring less than 3.0 meters deep. It also features fringing wetlands with diverse riparian vegetation and is a source of livelihood and recreation for the surrounding communities. The lagoon is basically fresh in most parts of the year with very minimal tidal influence but more influenced by freshwater inflow from Ogun River and surrounding creeks.

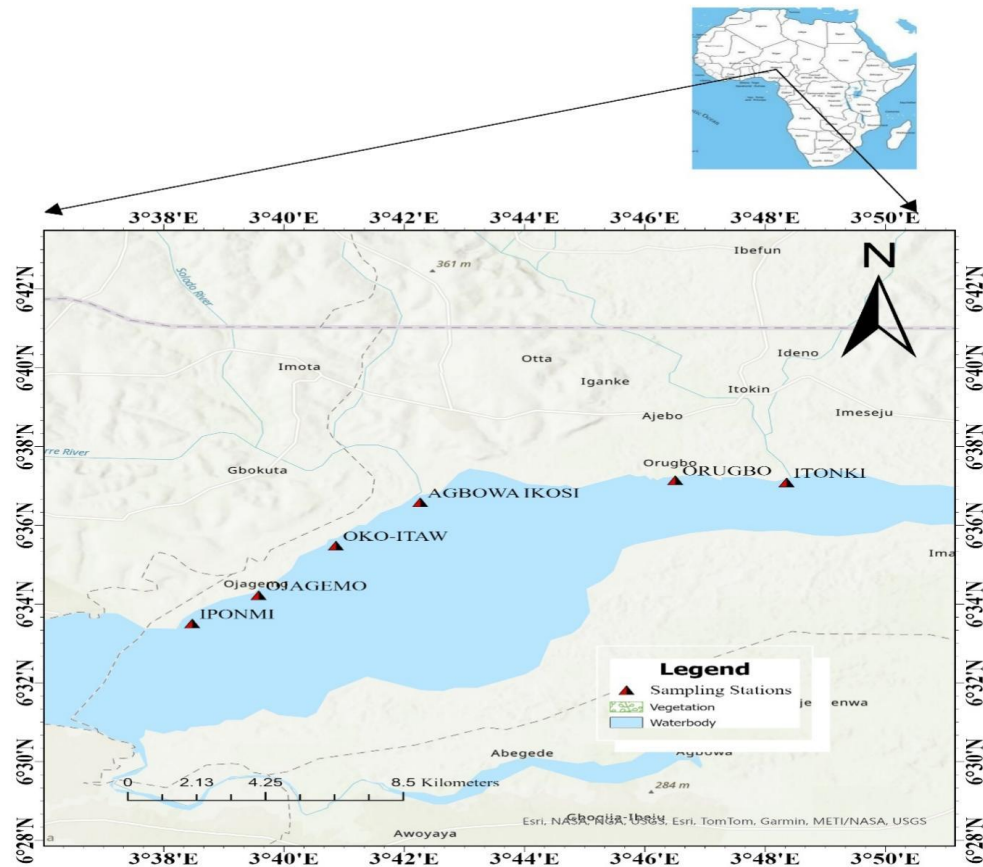


Figure 1: Study Area showing the Sampling Stations

Table 1: Sampling Stations and Coordinates

Station Name	Latitude	Longitude
IPONMI	6.558641N	3.641219E
OJAGEMO	6.570606N	3.659619E
OKO-ITAW	6.591593N	3.681033E
AGBOWA		
IKOSI	6.609914N	3.704396E
ORUGBO	6.619280N	3.775072E
ITONKI	6.618319N	3.805912E

Sample Collection

Three composite grab hauls of benthic samples were collected at each station with the use of a Van-veen (0.1m²) deployed from a boat with an out-board engine. The sediment samples collected at each station were placed in labeled polyethylene bags for grain size and total organic content analysis in the laboratory according to procedures described in APHA (1998). The remaining part of the sample was emptied into an open plastic basin. Sieving and fixing of samples were conducted on the field with 0.5mm mesh sieve size and 10% formalin respectively. Treatment and sorting of

pure samples were conducted in the laboratory and each micro benthic fauna was identified to species level where possible and recorded using the relevant texts (Schilling, *et al.*, 2006; Tagliapietra and Sigovini, 2010; Yankson and Kendall, 2001). Abundance of *P. aurita* in relation to other benthic macroinvertebrates was recorded

Sediment Characterization

The air-dried sediment sub-samples collected from each sampling site were first oven-dried for 72 hours at 50°C to remove every moisture in the sediment. A weighed portion of each oven-dried

sediment is crushed with a pestle in a laboratory mortar and then sieved using a mechanical sieving machine to determine the percentage of coarse ($x > 63 \mu\text{m}$) and fine ($x < 63 \mu\text{m}$) grain size sediment fractions. The sieving machine was equipped with stainless steel sieves with a stainless collection tray at the base. After each 5-minute sieving session,

the sieve retention was inspected, and a brush was used if necessary to help break up clumps in the sample. The retained particles were weighed and recorded as sand while the sieved particles were weighed and recorded as mud. The percentage sand/mud are calculated as follows:

$$\% \text{ Sand} = \frac{\text{Wt. of Sand}}{\text{Wt. of sediment}} \times 100 \quad \% \text{ Mud} = \frac{\text{Wt. of Mud}}{\text{Wt. of sediment}} \times 100$$

The total organic carbon of the sediment was estimated by loss of weight on ignition in muffle furnace at 550°C for 4 hours as employed Bensharada *et al.* (2022). Nitrate concentration in the sediment samples was determined using Cadmium Reduction Colorimetric Method 4500D (APHA, 1998) while Phosphate was determined using the Molybdenum Blue Method where the sediment extract was reacted with ammonium molybdate in an acidic medium to produce a blue-colored complex called molybdenum blue. The colour intensity is measured spectrophotometrically. Sulphur in the sediment was determined using the Turbidimetric Method 4500 E (APHA, 1998). 10ml of the sample was mixed with 10 drops of already prepared conditioning reagent and then mixed. A pinch of Barium chloride (BaCl_2) salt was added and the solution left standing for 5min. A colorimeter, previously calibrated with sulphate standards was used to read the sulphate concentration in each sample and the readings expressed in mg/L.

RESULTS AND DISCUSSION

The spatial variation in percentage particles sizes of sediment during the period of study is illustrated in Figure 2. The result shows predominance of sand-sized particles in the sediment composition of the study area especially in Ojagemo and Ipomi study stations. The anthropogenic activities leading to increased sedimentation and organic pollution have altered sediment composition of some of the study stations, and adversely affected the abundance of *P. aurita* in such stations (Figure 6).

Figure 3 shows the spatio-temporal variation in the percentage of total organic carbon (TOC) composition in sediment of the study area. *Pachymelania aurita* is sediment sensitive and

abundant in sediments with specific features as TOC between approximately 3.63% and 4.14%, and sand content between about 78.5% and 81% (Uwadiae *et al.*, 2020). These sediment compositions favour higher densities of the species. Higher densities of *P. aurita* are found at stations with relatively higher salinity ($>1.77\text{‰}$), low TOC ($<10\%$), high sand content ($>60\%$), and low mud content ($<30\%$). Conversely, sediments with high percentages of mud and higher TOC tend to have lower densities of the mollusc. Muddy sediments, although rich in organic matter (food source for deposit feeders), can limit the abundance of *P. aurita*, which is more of a filter feeder. High organic matter and mud can smother benthic molluscs and reduce water clarity, thereby decreasing water pumping efficiency and food intake mechanisms.

The nitrate level (0.3-3.6mg/kg) recorded in the sediment of the study area during the period of study (Figure 4) was lower compared to 10.6-25.4 mg/kg recorded by Fabunmi *et al.* (2018) in some part of Epe lagoon. Although the nitrate levels did not follow any particular spatial pattern in their study, it reflected a higher anthropogenic input such as agricultural runoff and sewage disposal that translated to higher TOC and consequently, higher nitrate concentration.

The highest level of phosphate in the sediment of the study area is 3.01mg/kg. This level is also low compared to some recorded levels in the lagoon. Fabunmi *et al.* (2018) recorded as high as 85.9 mg/kg in a station with high anthropogenic activities. According to House and Denison (2000), high phosphate level in sediment could be as a result of agricultural and urban runoff from fertilizers, animal waste, and leaky septic systems, as well as industrial and municipal wastewater.

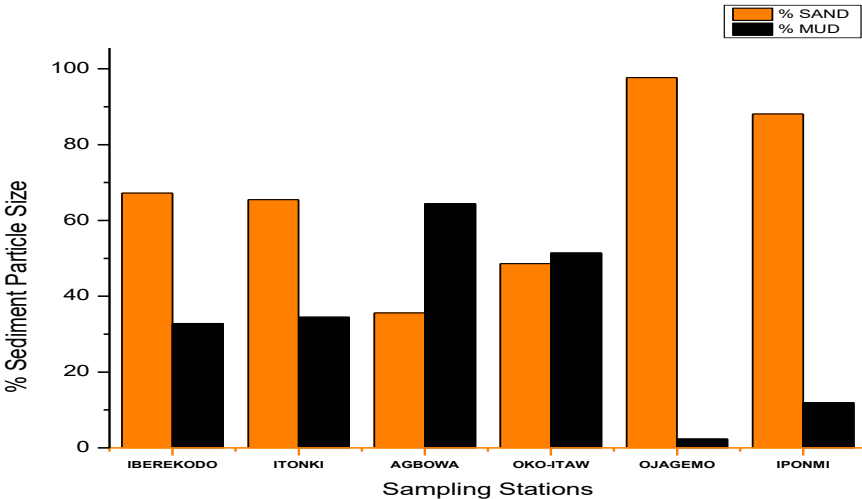


Figure 2: Spatial Variation in Percentage Particles sizes of Sediment during the Period of Study

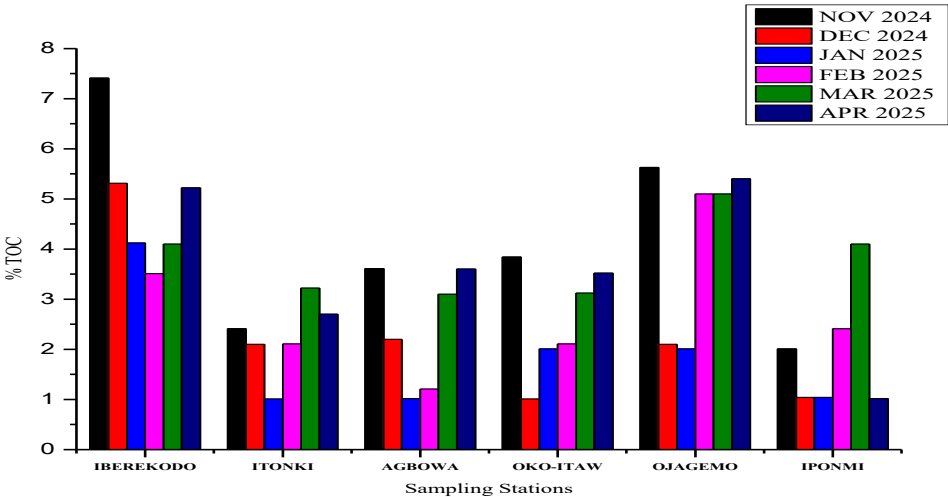


Figure 3: Spatiotemporal Variation in Percentage Total Organic Content of Sediment during the Period of Study

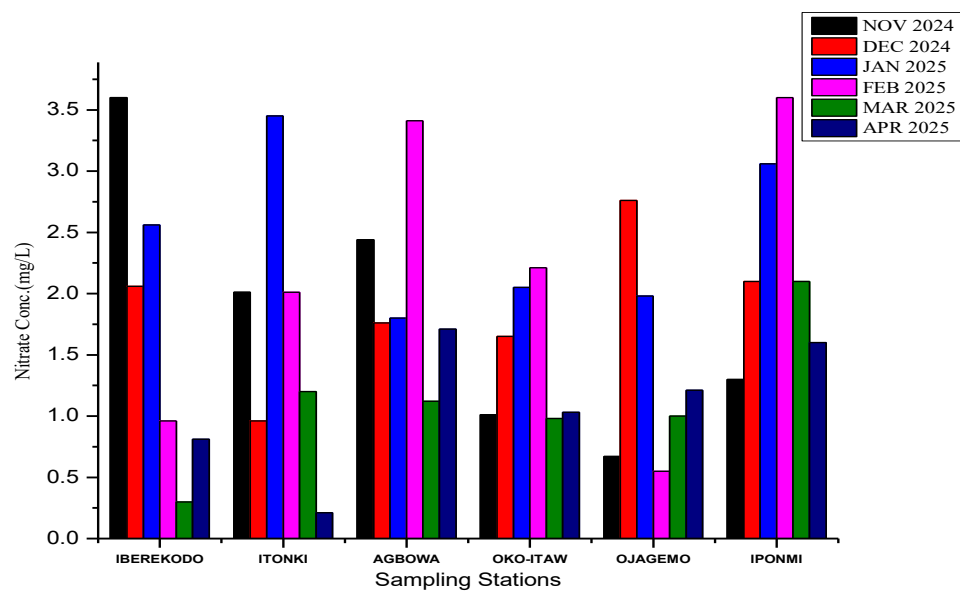


Figure 4: Spatiotemporal Variation in Concentration of Nitrate in Sediment during the Period of Study

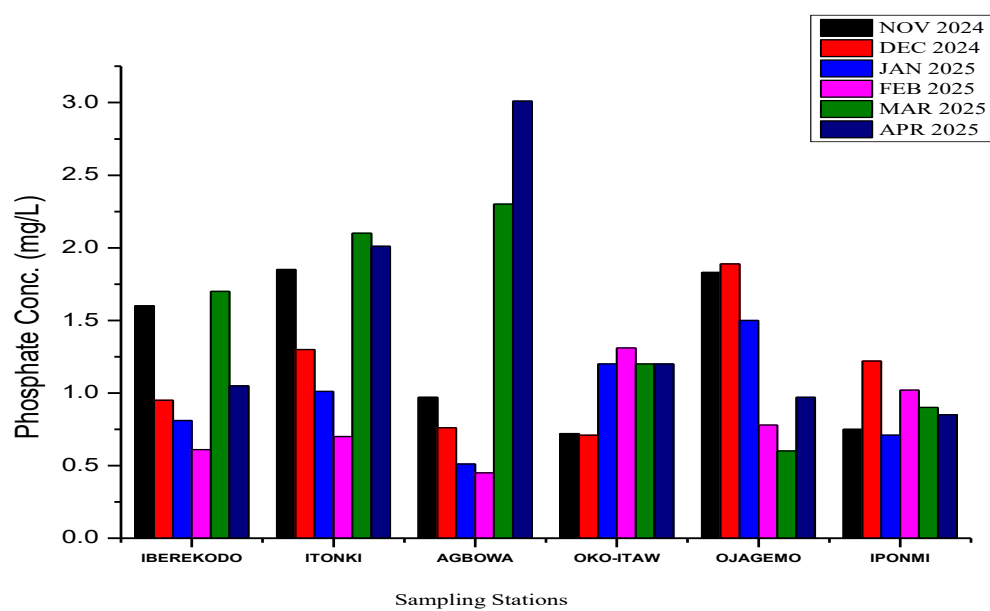


Figure 5: Spatiotemporal Variation in Concentration of Phosphates in Sediment during the Period of Study

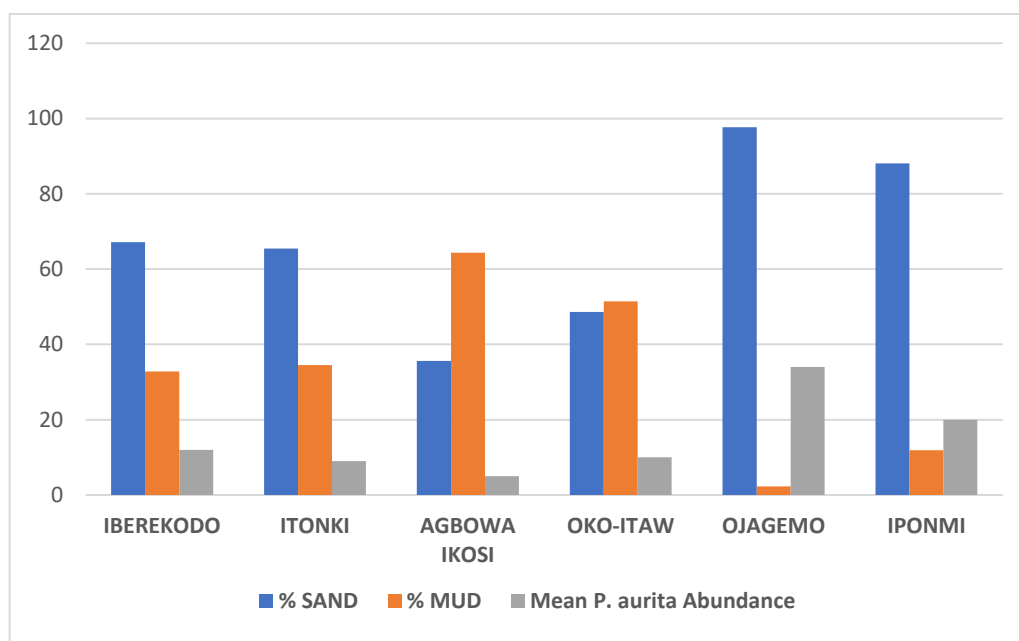


Figure 6: *Pachymelania aurita* abundance in relation to sediment composition

CONCLUSION

Sediment characterization plays a critical role in shaping the population, distribution and density of *Pachymelania aurita* in Epe Lagoon. The population dynamics and health of these organisms in the study area are closely linked to the ambient sediment composition as the organism prefers sandy-mud sediment, with moderate organic content and brackish water salinity conditions. Anthropogenic disturbances leading to high pollution load and sediment destabilization, can alter these sediment characteristics and tend to reduce the mollusc population. Monitoring these sediment characteristics can inform sustainable management of the *T. fuscatus* populations and lagoon health.

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CONFLICTS OF INTEREST

No conflict of interest.

AUTHORS' CONTRIBUTIONS

This paper has sole authorship

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