IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402, p- ISSN: 2319-2399.Volume 18, Issue 12 Ser. 2 (December 2024), PP 01-06
www.iosrjournals.org

Evaluation Of Water Quality Parameters And Heavy Metal Concentrations In *Perinella Cingulatus* And *Nerita Oryzarum* From Karanja Creek, Raigad District, Maharashtra, India.

Snehal B. Punde[1] , Aparna A. Ghadi[2] And Manisha N. Kulkarni[3]
Department Of Zoology, Dr. Homi Bhabha State University, The Institute Of Science, Churchgate, Mumbai - 400032, Maharashtra, India.
Department Of Zoology, Ghanshyamdas Jalan College Of Science And Commerce, Malad East, Mumbai - 400097, Maharashtra, India.
Department Of Zoology, Dr. Homi Bhabha State University, The Institute Of Science, Churchgate, Mumbai - 400032, Maharashtra, India.

Abstract

Karanja Creek is situated 30 km away from Mumbai and 10 km from the Jawaharlal Nehru Port Trust (JNPT), receives substantial inputs of domestic and industrial effluents. It serves as a vital habitat for diverse marine species. Monitoring of chemical and physical water parameters is crucial for assessing marine pollution and regulating its impact.

The water quality parameters showed significant deterioration, with low dissolved oxygen (DO) concentrations, elevated pH, total dissolved solids (TDS), total suspended solids (TSS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and high concentrations of heavy metals such as cadmium (Cd), chromium (Cr), copper (Cu), zinc (Zn), lead (Pb), and arsenic (As) in the shells of aquatic organisms. These results indicate a substantial decline in water quality due to human-induced pollution sources.

The results of the study indicated that the overall pollution levels in both the water and shells exceeded safe limits, based on the physicochemical properties of the water. The findings reveal a deterioration in surface water quality and the bioaccumulation of heavy metals, such as cadmium, chromium, copper, zinc, lead, and arsenic, in the species Potamides cingulatus and Nerita oryzarum which are collected from Karanja Creek, Uran, Mumbai.

Keywords: *Bioaccumulation, Concentration, Heavy Metals, Karanja creek, Nerita oryzarum, Perinella cingulatus , Water Parameters,.*

Date of Submission: 04-12-2024 Date of Acceptance: 14-12-2024

I. Introduction

Karanja Creek (Lat. 18 0 50' 15" N and Long. 72 0 57' 15" E), situated along the eastern shore of Mumbai harbour opposite Colaba, encompasses the village of Karanja. It forms a continuous waterway with Dharamtar and Pen-Khopoli creeks, ultimately joining the Arabian Sea near Uran on the west coast of India. Recent years have witnessed substantial urbanization and industrialization along the entire coastal belt of Uran, fueled by the establishment of numerous industries along its coastline (Abdul-Wahab & Maikar, 2011). Effluent discharge from these industries, particularly those around Rasayani and Nagothane, contributes to pollution in the region. The effluents are channeled into the Patalganga and Amba estuaries, both of which feed into Dharamtar Creek, serving as the inlet of Thane Creek and Karanja Creek. Moreover, Karanja Creek receives a significant influx of wastewater from industries in the Thane-Belapur belt, as well as domestic and industrial waste from sources along the Ulhas River, Nhava-Seva Creek, Panvel Creek, and various point discharges along its course. The proximity of the Jawaharlal Nehru Port Trust (JNPT), one of the busiest international ports in India, further intensifies maritime activities along the Uran shore and Karanja Creek, leading to the establishment of numerous Container Freight Stations.

The coastal areas surrounding this creek receives substantial untreated liquid effluent and solid waste which is leading to degradation of the coastal ecosystem.

Despite its ecological importance and proximity to Mumbai, the business capital of India, Karanja Creek remains understudied in terms of its water quality status. This knowledge gap underscores the urgency of conducting comprehensive monitoring of the physical and chemical variables of Karanja Creek's water over two consecutive years. Heavy metal pollution poses a significant environmental challenge due to the non-degradable nature of these substances. Their propensity to bioaccumulate in organisms across food webs raises concerns about ecosystem integrity and public health (Agbelusi, E. A. & Adeparusi, E. O., 1999). The bioaccumulation of heavy metals has been observed in various compartments of ecosystems, leading to detrimental effects on biodiversity and ecosystem functionality.

Gastropods are one of the most important taxonomic groups which are potential biomonitors of heavy metal pollution and there are several important features or characteristics of the gastropods which supports *Nerita* used as a biomonitor of heavy metal pollution (AbdAllah & Moustafa 2002; Bu-Olayan & Subrahmanyam 1997; Yap & Cheng 2008). The use of molluscs as biomonitors for heavy metals is beneficial, as they are the indicators of the bioavailability and contamination of heavy metals in intertidal zones (Yap et al., 2006a, b).

Furthermore, the consumption of organisms contaminated with heavy metals can have severe implications for human health (Anathan, 2006). Recognizing these risks, this study aims to assess the concentrations of heavy metals, including Cadmium (Cd), Chromium (Cr), Copper (Cu), Zinc (Zn), and Arsenic (As), in both water samples and snail shells collected from Karanja Creek (Amin et al., 2008). By elucidating the extent of heavy metal pollution in the creek, this research seeks to inform environmental monitoring efforts and guide policy interventions aimed at safeguarding both environmental quality and public health in this vital coastal ecosystem (Catsiki, et al., 1994).

II. Methods And Materials

Study area

Karanja creek (Lat. 18 0 50' 15'' N and Long. 72 0 57' 15'' E) located along the eastern shore of Mumbai harbour (Fig. 1). The creek is continuous with Dharamtar and Pen-Khopoli creek joining Arabian Sea near Uran on west coast of India. Following map show area of sampling site.

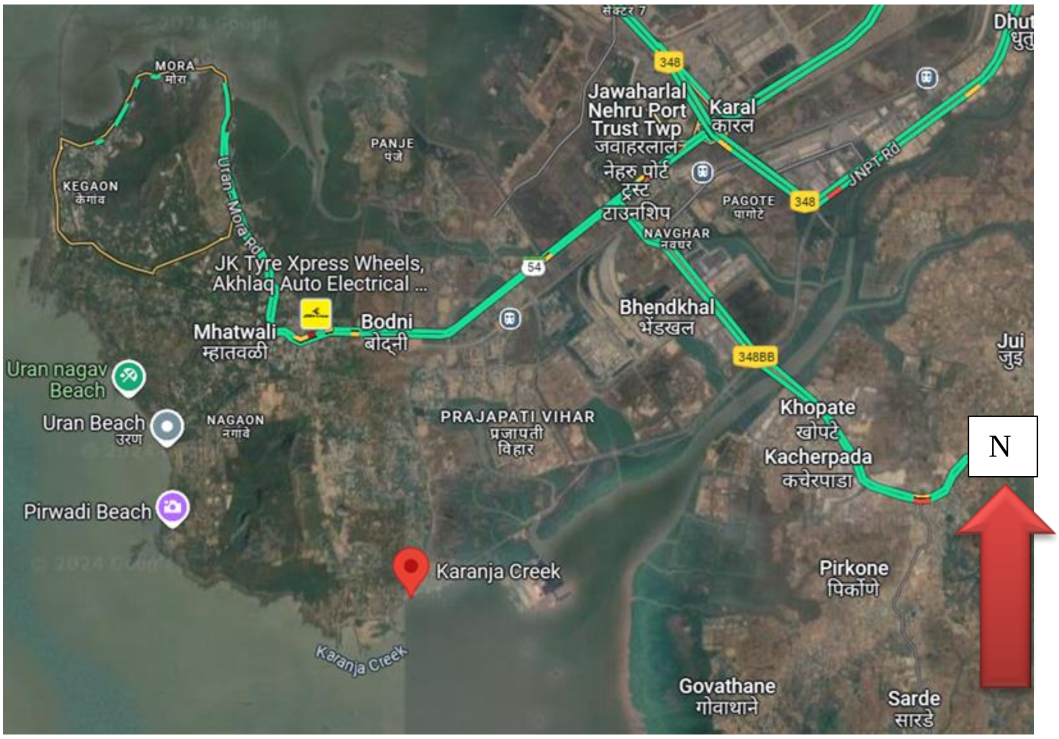


Fig 1: Map showing the study area, Karanja Creek, Raigad District, Maharashtra, India (Lat. 18 0 50' 15'' N and Long. 72 0 57' 15'' E) created from Google Earth.

Collection of samples:

For the study, water samples were systematically collected during the morning hours in pre-rinsed polythene bottles. The shells were gently cracked with a clean knife to avoid causing damage to the meat then they were gently peeled away from the tissue (Arivoli, 2016). All collected samples were then transported to the Zoology Department at the institute of Science in Mumbai for further analysis.

Pre- Analysis procedure:

The shells were labelled and placed in an oven for approximately 48 hours to remove water and lipid content. Once the snail samples became relatively dry, they were broken apart using a piston to separate the snail tissue, digestive tract, and other contents from the shells. The shells were then returned to the oven for an additional 36 hours of drying. The shells were kept separate from the contents, labelled, covered with foil paper and tape, and reintroduced to the oven with forceps to ensure complete removal of lipid content. After drying for about 28 hours at approximately 150°C, the dried tissue was carefully grinded using a ceramic mortar and pestle. Conical flasks used for sample digestion were washed with soapy water, rinsed with tap water, and soaked in 10% nitric acid. The flasks were then rinsed with distilled water and oven-dried prior to use (Jatto, 2016).

Analysis of water quality

The pH was measured with digital pH meter. Temperature of surface water was measured by using a thermometer. Total Dissolved solids (TDS) were determined by weighing the residue left after evaporation of 100 ml unfiltered and filtered water samples respectively. Total suspended solids (TSS) were calculated by subtracting value of TDS from TS. Winkler's Iodometric method was adopted for high precision dissolved oxygen (DO) estimation. Biochemical oxygen demand (BOD) was determined by Wrinkler's iodometric method. Total hardness was determined by EDTA Titrimetric method. Chemical oxygen demand (COD) was estimated by Potassium dichromate method. Salinity and chloride was estimated by argentometric method. Total alkalinity measure by titrimetric method. Phosphate was determined by ascorbic acid method whereas, for estimation of ammonia, Nesslerization method was adopted. The nitrite was determined through the formation of a reddish purple azo-dye produced at pH 2.0 – 2.5 by coupling deoxidized sulfanilamide with N – (1 – napthyl) ethylenediamine dihydrochloride (NED). Nitrate was estimated by cadmium-reduction metho. All colorimetric measurements were done on ERMA INC (AE 11D) colorimeter (Khan & Murgesan , 2005, Subrahmanyam, 1949 and Prabhakar & Balasaheb, 2009)

Heavy metals analysis from water and shells:

The shells were dried crushed to fine powder and sieved with 2 mm mesh sieve to achieve particle size. Homogeneity was done and the sample was labelled in polythene bags prior to analysis. The shell and water sample was digested with a mixture of HNO_3 and HCl with the addition of H_2O_2, so that approximately 10 ml water sample and 4g of shell sample is poured with 10 mL HNO3 (1:1) in a glass partially covered and heated at 95-100°C for 10-15 minutes. To the cooled sample 5 mL of concentrated HNO_3 was added, cover and heat for 30 min at the same temperature. After cooling, 2 mL of deionized water and 3 mL of 30 % H_2O2 was added and slight heated. After the sample was cooled 7 mL of 30 % H_2O_2 was added. Then 5 mL of concentrated HCl and 10 mL of deionized water were added, covered, and heated for 15 minutes. After cooling, the samples were transferred to a flask of 50 mL and completed to the volume with deionized water for analysis (AOAC, 1997). The following metals were analysed from the samples for both water and shells by Atomic absorption spectrophotometric Method: cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), zinc (Zn) and Arsenic (As).

III. Results And Discussions:

Sr. No.	**Parameters**	**Method Used**	**Values Obtained in three different seasons**		
			Summer	Monsoon	Winter
1	pH	Digital pH meter	7.3	6.9	7.6
2	Temperature (^{0}C)	Thermometer	30^0C	27^0C	25.4^0C
3	TDS (ppm)	Evaporation	1439.72	1258.14	1293.25
4	TSS (ppm)	Evaporation	1023.31	968.22	1001.54
5	DO (mg/L)	Wrinkler's Iodometric	1.22	1.47	1.38
6	COD (mg/L)	Potassium dichromate	56.55	36.15	36.45
7	BOD (mg/L)	Wrinkler's iodometric	3.10	2.7	2.25
8	Total hardness (mg/L)	EDTA titrimetric method	17.23	19.3	18.93
9	Alkalinity (mg/L)	Titration method	120	131	120
10	Salinity (mg/L)	Argentometric method	125	125.4	115.8
11	Chloride (mg/L)	Argentometric method	8.21	6.74	6.92
12	Phosphate (mg/L)	Ascorbic acid method	6.89	7.141	7.18
13	Phosphorous (mg/L)	Molybdate method	3.34	4.15	4.16
14	Ammonia (mg/L)	Nesslerization method	1.2	0.88	0.92
15	Nitrite (mg/L)	Colorimetric method	5.26	6.08	6.15
16	Nitrate (mg/L)	Colorimetric method	6.23	7.10	7.3

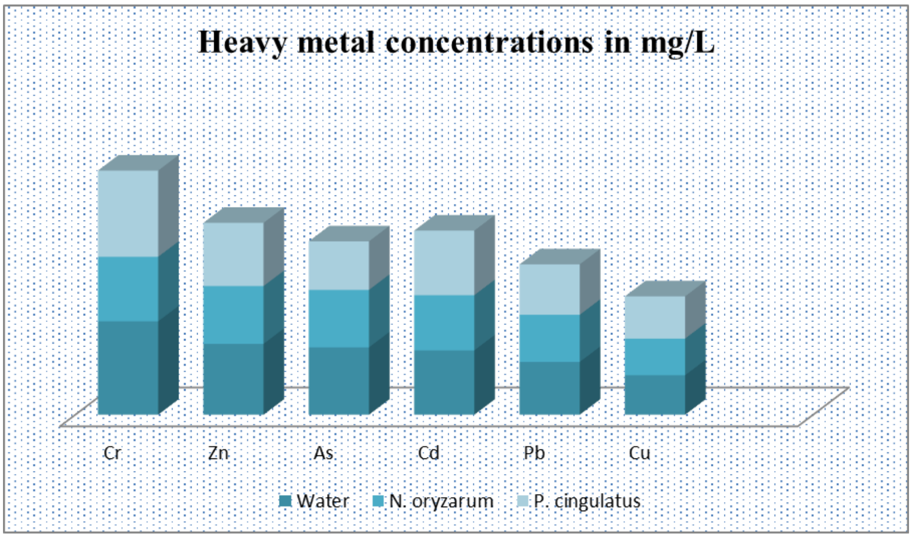
Table 1: Results of seasonal variations in physical and chemical parameters of water of Karanja Creek, Raigad District, Maharashtra, India.

Heavy metal analysis of water and shells of Karanja Creek, Raigad District, Maharashtra, India are as follows :-

Sr. No.	**Element**	**Water (mg/L)**	***Nerita oryzarum* (mg/L)**	***Pirenella cingulate* (mg/L)**
1	Cd	5.439	4.666	5.452
2	Cr	7.889	5.459	7.286

3	Cu	3.334	3.101	3.567
4	Zn	5.987	4.885	5.342
5	Pb	4.456	3.988	4.201
6	As	5.689	4.861	4.101

Table 2: Results of heavy metal concentrations in water, *Nerita oryzarum* (mg/L) and *Pirenella cingulate* (mg/L) of Karanja Creek, Raigad District, Maharashtra, India.



Graph 1: A graph depicting the concentrations of heavy metals in water, *N. oryzarum*, and *P. cingulatus* collected from Karanja Creek, Raigad District, Maharashtra, India.

pH: pH plays a crucial role in determining the corrosive nature of water, with lower pH values indicating higher corrosiveness. pH has been positively correlated with electrical conductivity and total alkalinity (Gupta, 2009). The reduced rate of photosynthetic activity, along with the assimilation of carbon dioxide and bicarbonates, contributes to an increase in pH. Additionally, low oxygen levels are often associated with high temperatures during the summer months.

The pH of the water in this study ranges from approximately 6.9 to 7.3. Similarly, Ahmed and Rehman (2000) reported that the pH of most raw water sources typically falls within the range of 6.5 to 8.5 (Table 1).

Temperature: Temperature can have significant effects on dissolved oxygen (DO) levels and biological oxygen demand (BOD). Variations in river water temperature are typically influenced by factors such as season, geographic location, sampling time, and the temperature of effluents entering the stream (Ahipathy, 2006). In the present study, the water temperature was recorded to range from ± 30°C to ± 25.4°C (Table 1).

Total Dissolved Solids (TDS): Total dissolved solids (TDS) represent the concentration of inorganic salts such as calcium, magnesium, and sodium, along with small amounts of organic matter present in the water. Elevated TDS values have been linked to an increased risk of acute myocardial infarction and ischemic heart diseases in some studies (Sneka Lata et al., 2015). In the present study, the TDS values ranged from ± 1258.14 ppm to ± 1439.72 ppm (Table 1).

Total Suspended Solids (TSS): The total suspended solid (TSS) content of water is influenced by the amount of suspended particles, soil, and silt, which are directly related to the water's turbidity. In the present study, the average TSS values ranged from ± 968.22 ppm to ± 1023.31 ppm (Table 1).

Hardness: Water hardness is a crucial factor in determining the suitability of water for both domestic and industrial uses. Hardness results from the presence of multivalent metallic cations, which, in combination with certain anions, can form scale. The primary cations responsible for hardness are divalent calcium, magnesium, strontium, ferrous iron, and manganous ions (Pawar & Kulkarni, 2009). In the present study, total hardness was recorded between 17.23 mg/L and 19.3 mg/L. The hardness levels were below the permissible limits (Table 1).

Chlorides: It occurs naturally in all types of waters. High concentration of chlorides is considered to be the indicators of pollution due to organic wastes of animal or industrial origin. Chlorides are troublesome in irrigation water and also harmful to aquatic life (Rajkumar, 2004). Concentration of salts is also affected by the excessive evaporation as observed by Bhatt et al. (1999). In present study concentration of chloride is 6.74 mg/ L to 8.21 mg/ L (Table 1).

Dissolved oxygen (DO): Dissolved oxygen (DO) content is a critical indicator of stream health, as its deficiency directly impacts the ecosystem through bioaccumulation and biomagnification (Abdel, 2018). The oxygen content in water samples is influenced by various physical, chemical, biological, and microbiological processes. DO values also exhibit lateral, spatial, and seasonal variations, which are affected by industrial, human, and thermal activities. In the present study, DO values ranged from 1.22 mg/L to 1.47 mg/L (Table 1).

Biological Oxygen Demand (BOD): Biochemical oxygen demand (BOD) measures the amount of oxygen required by aerobic organisms to degrade organic materials in water. The biodegradation of organic matter creates oxygen demand, leading to an increase in BOD (Abida, 2008). BOD reflects the oxygen consumed by living organisms involved in the breakdown or stabilization of organic substances in water (Hawkes, 1993). In the present study, BOD values ranged from 2.25 mg/L to 3.10 mg/L (Table 1).

Chemical Oxygen Demand (COD): COD is a measure of the oxidation of reduced chemicals in water. It is commonly used to indirectly measure the number of organic compounds in water. The measure of COD determines the quantities of organic matter found in water. This makes COD useful as an indicator of organic pollution in surface water (King et al., 2003 and Faith, 2006). The chemical oxygen demand (COD) in present study is ranging between ± 56.55 mg/L to ± 36.15 mg/L (Table 1).

Phosphate and Phosphorous: Phosphate concentrations in aquatic systems are generally low due to active uptake by plants. However, elevated levels can signal pollution and are a major contributor to eutrophication (WHO, 1993). The current study reports phosphate concentrations ranging from ± 6.89 mg/L to ± 7.18 mg/L, while phosphorus concentrations vary between ± 3.34 mg/L and ± 4.16 mg/L (Table 1).

Alkalinity: The standard desirable limit for alkalinity in water is 220 mg/L, with a maximum permissible level of 600 mg/L. In the present study, alkalinity concentrations ranged from 120 mg/L to 131 mg/L (Table 1), which falls within the desirable limit. Alkalinity values in water indicate the presence of natural salts.

Nitrate and nitrite: Nitrates in freshwater are primarily introduced through sewage discharge, industrial waste, and runoff from agricultural fields. In the water of Karanja Creek, the recorded concentrations of nitrate and nitrite range from ± 6.23 mg/L to ± 7.10 mg/L and ± 5.26 mg/L to ± 6.15 mg/L, respectively (Table 1). Elevated nitrate-nitrogen concentrations are known to promote the formation of algal blooms (Anderson, 1998).

Ammonia: Ammonia is a significant industrial pollutant in aquatic environments, with concentrations in water typically ranging from ± 0.8 mg/L to ± 1.2 mg/L, as reported in the present study (Table 1). Although these concentrations are relatively low, ammonia remains a notable concern due to its potential toxicity to aquatic organisms.

Salinity: Salinity has a significant impact on the dissolved oxygen (DO) levels in water. As salinity increases, the solubility of oxygen in water decreases, which can lead to lower concentrations of dissolved oxygen available for aquatic organisms. According to the present study (Table 1), the salinity concentration in the water ranges from ± 115.8 mg/L to ± 125 mg/L.

Heavy Metals:

The concentrations of heavy metals—Cd, Cr, Cu, Zn, Pb, and As—in water samples from Karanja Creek were compared to the WHO standard values. The heavy metal accumulation in the water followed the order: Cr > Zn > As > Cd > Pb > Cu, with concentrations of 7.889, 5.987, 5.689, 5.439, 4.456, and 3.334 mg/L, respectively.

The elevated levels of cadmium (Cd) in the water can be attributed to industrial and agricultural discharges (Mason, 2002). Similarly, the high concentrations of lead (Pb) in the water have been linked to industrial and agricultural runoff, as well as the spillage of leaded gasoline from fishing boats (Saeed & Shaker, 2008). Chromium (Cr), copper (Cu), zinc (Zn), and arsenic (As) have also been found in high concentrations in aquatic ecosystems (Ikechukwu & Ajeh, 2011), further contributing to the pollution of the water body.

The order of heavy metal accumulation in the shells of *Nerita oryzarum* was found to be Cr > Zn > As > Cd > Pb > Cu, with concentrations of 5.459, 4.885, 4.861, 4.666, 3.988, and 3.101 mg/L, respectively. In contrast, the order of heavy metal accumulation in the shells of *Pirenella cingulate* was Cr > Cd > Zn > Pb > As > Cu, with concentrations of 7.286, 5.452, 4.861, 5.342, 4.261, 4.101, and 3.567 mg/L.

These findings are consistent with the study by Nwoko et al. (2014), who reported elevated chromium (Cr) concentrations in both the shells and tissues of snails. Higher levels of cadmium (Cd) and lead (Pb) in the shells were also observed by Yap et al. (2003b). It is generally recognized that molluscs accumulate higher concentrations of copper (Cu), zinc (Zn), and cadmium (Cd) in their soft tissues than in their shells, as reported by several studies (de Wolf et al., 2001; Fishelson et al., 1999; Giusti et al., 1999; Puente et al., 1996; Szefer & Szefer, 1985, 1990; Szefer et al., 2002; Yap et al., 2009).

IV. Conclusions:

The present study examined the variations in water quality and analysed heavy metals to assess the extent of water pollution in Karanja Creek. The findings revealed that the primary cause of water pollution was anthropogenic activities. The water quality parameters showed significant deterioration, with low dissolved oxygen (DO) concentrations, elevated pH, total dissolved solids (TDS), total suspended solids (TSS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and high concentrations of heavy metals such as cadmium (Cd), chromium (Cr), copper (Cu), zinc (Zn), lead (Pb), and arsenic (As) in the shells of aquatic organisms. These results indicate a substantial decline in water quality due to human-induced pollution sources.

The results of the study indicated that the overall pollution levels in both the water and shells exceeded safe limits, based on the physicochemical properties of the water. It was concluded that the water in Karanja Creek is unsuitable for drinking, irrigation, and sustaining aquatic life. To mitigate environmental degradation, it is essential to implement effective management of domestic and industrial waste, aiming to reduce the accumulation of pollutants in the creek and improve the overall water quality.

References:

[1] Abdul-Wahab, S. A., And Maikar, F. A. (2011). The Environmental Impact Of Gold Mines: Pollution By Heavy Metals. Central European Journal Of Engineering, 2 (2), 304-313.

[2] Agbelusi, E. A., And Adeparusi, E. O. (1999). Egg Incubation Period And Hatching Success Of The African Giant Land Snail (Archachatina Marginata) Swaison In Different Incubation Media. J. Appl. Anim. Res., 15, 57-62.

[3] Anathan, G. Et. Al., (2006). Distribution Of Heavy Metals In Velar Estuary, South East Coast Of India. J. Ecotoxicol. Environ. Monit., 16 (2), 185-191.

[4] Amin, B., Ismail, A. & Yap, C.K. 2008. Heavy Metal Concentrations In Sediments And Intertidal Gastropod Nerita Lineata From Two Opposing Sites In The Straits Of Malacca. Wetland Science 6(3), 411-421.

[5] Aoac, (1997), Official Methods Of Analysis Of Aoac International (16 Thed,), Association Of Official Analytical Chemists, Washington, Dc.

[6] Catsiki, V.A., Bei, F. & Nicolaidou, A. 1994. Size Dependent Metal Concentrations In Two Marine Gastropod Species. Netherlands Journal Of Aquatic Ecology 28(2), 157-165.

[7] Arivoli, Appovu Et. Al; (2016) Study Of Water Quality Parameters Of Cauvery River Water In Erode Region. Journal Of Global Biosciences, 5 (9), 4556-4567.

[8] O. E. Jatto Et. Al; (2016). Proximate And Mineral Composition Of Different Species Of Snail Shell. The Pacific Journal Of Science And Technology, 11(1), 416-419.

[9] Khan S. A. And Murgesan P.(2005). Polychaetes Diversity In Indian Estuaries. Indian Journal Mar. Science, 34 (1), 114-119.

[10] Subrahmanyam T. V. Et.Al; (1949). The Marine Pelecypoda Of Bombay, J. Univ. Of Bombay. 17, 50-81.

[11] Subrahmanyam T. V. Et.Al; (1952). Marine Gastropods, Part Ii. Of Bombay, J. Univ. Of Bombay. 21 (3), 26-73.

[12] Prabhakar R. Pawar And Balasaheb G. Kulkarni (2009). Popullation Density And Biomass Of Selected Macrobenthos In Karanja Creek. Research Gate, 9 (1-2), 78-86.

[13] Nwagu, Chima Vdu And Olujiwi Olanrewaju Olusoji (2022). Evaluation Of Heavy Metal Concentration Of Snails' Shell Samples Of Archachatina Marginata And Achatina Fulica International Network Organization For Scientific Research, 8(1), 44-58.

[14] Adebowale Et.Al; (2022). Analysis Of Heavy Metals In African Gaint Land Snail (Archachatina Marginata): Journal Of Research In Forestry, Wildlife And Environment. 14(1), 22-26.

[15] Soad S. Abdel (2018). Concentrations Of Heavy Metals In Water Sediment And Millusk Gastropod, Lanisetes Carinatus From Lake Monzala, Egypt. Egyption Journal Of Aquatic Research, 44(2), 77-82.

[16] Nguyen Thi Hang Nhung Et.Al; (2023). A Critical Review Of Snail Shell Material Modification For Applications In Wastewater Treatment. Materials. 16(3).