

Seasonal Occurrence of the Polychaete Worm *Namalycastis indica* and its Ability to Accumulate Heavy Metals in the Shatt Al-Basrah Canal

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Abstract

The worm *Namalycastis indica* is a Polychaete that lives in the intertidal zone under rocks and is tolerant of fluctuating conditions, especially temperature, salinity, and exposure to pollutants, and contributes to the balance of the aquatic ecosystem. This research aims to study the seasonal presence and density of *N. indica* in the Shatt al-Basra Regulator habitat, calculate the concentrations of heavy metals in their bodies and in the intertidal zone sediments, determine the bioaccumulation factor (BAF) of the worms and the sediments and the relationship between BAF and the environmental factors, and their relationship to the distribution of the worms. The total density (individual/m²) of individuals was identified collected using a 0.25m x 0.25m square frame for quantitative sampling. The highest average density of the species was recorded at 112 individuals per square meter during the spring season, and the lowest average density was 32 during the summer season. The results showed variation in environmental factors between seasons, water temperature ranged between 15.2-33.1 °C. Higher value of salinity recorded in summer season was 43.7‰. Dissolved oxygen ranged between 5.8-8.7 mg/l, and pH between 7.3-7.6. The results also showed that worm length average ranged between 4.7-7.16 cm. four were measured, heavy metals: Cobalt, nickel, cadmium, copper, The results of heavy metals for worms bodies showed arrangements from high to low concentrations during all study periods as follow: Co > Ni > Cd > Cu for *N. indica* tissues and Ni > Co > Cu > Cd in sediment.

Keywords: polychaete worms, Environmental factors, Heavy metals, BAF.



Introduction

Generally inhabiting mangrove and estuarine regions *N. indica* is a species of brackish water polychaete worm related to the Nereididae family. It is known to be a beneficial ecological indicator due to its resilience to changes salinity and contaminant levels. Annelida has traditionally included Polychaeta, Oligochaeta and Hirudinea, it's found living in terrestrial, freshwater, from the sediments of rivers & lakes to moist soils. Polychaete worms constitute about 80 % of the total macro-benthic community, its characterized by several morphological characteristics include segmentation via a pre-pygidial growth zone, a dorsal brain and ventral nerve cord, nuchal organs, longitudinal muscle bands and the structural composition of the capillary chaetae as well as separate sexes (Purschke, 2002; Purschke *et al.*, 2014).

Polychaete is usually the most abundant taxon in benthos and have been most often utilized as an indicator species of environmental characteristics (Dean, 2008). Most of marine annelids confront the threat of seasonal or chronic hypoxia and often diverse and highly abundant, especially in areas of anthropogenic stress (Ogino, 2019; Gray and Elliott, 2009). *N. indica* is a very common inhabitant of the mud, silt, and sand substrates of An aquatic environment with a wide variety of salinity changes, also widespread in brackish waters of South and Southeast Asia (Glasby, 1999). Use the worm *N. indica* to accumulate some heavy metals in its tissues and appears that the increasing effect of heavy metals on worms growth, with concentration increasing and the maximum effect on weight loss Ca followed by Ni, Cu and Co, when worms grown in media containing (250 ppm) of the metals (Akbar *et al.*, 2011).

According to the length of the worm, *N. indica* has recorded the least appearance rates for the size range 40-50 mm in most of the study stations, and it has recorded the highest rates of density in four stations (Abed *et al.*, 2022). The density of the *N. indica* community typically varies in response to seasonal changes in water temperature, salinity, dissolved oxygen, and organic matter availability. Abundance usually increases during the moderate in temperature months (spring/autumn), possibly due to increased food availability and reproduction. Therefore, this type survives in areas with varying environmental conditions, particularly salinity, due to its resilience to contaminants and fluctuations in salinity levels. As a result, it can be found in downstream settings like the Shatt al-Arab, the Faw region's sea coastlines, and in canals that are exposed to contaminated water from many sources, chiefly untreated sewage and oil. As a result, it was studied in these areas and selected for found as a practical environmental indicator.

The study aimed to focus on studying the presence of this type of worm in the region, calculating its seasonal distribution and its relationship to some environmental factors and trace elements, calculating the bioaccumulation factor and its relationship to the distribution of the worms, identifying the trace elements that accumulate most and least in the worm tissues, and considering them as an important tool as indicators of pollution in the Shatt al-Basra Canal regulator area.

Materials And Methods

Study sites description

The study area is located in the Shatt al-Basra Canal (near the Regulator) with Longitude $30^{\circ}24'23.90''$ N. and Latitude $47^{\circ}46'33.99''$ E. A site was chosen before the regulator towards the sea outlet (Fig. 1), (Picture 1), where the water is affected by tidal processes coming from the Arabian Gulf, causing fluctuations in water salinity and differences in physical and chemical properties depending on the seasons and climatic conditions. The importance of this site lies in the limited number of studies conducted there and in its status as a transitional zone where pollution sources affect the physical and chemical properties of the canal water, most notably pollution from petroleum hydrocarbons and untreated sewage. Furthermore, stagnant water, weakened currents, and increased sedimentation of organic matter and other elements from adjacent sediments have contributed to creating a suitable environment for the adaptation and survival of benthic worms in the intertidal zone.



Figure 1. Map of Shatt Al-Basrah chanal showing study area.

Samples collection

Samples of worms and sediment were collected seasonally from the area during daylight hours. The area was marked using a wooden corer with sides measuring 25 cm. A sediment sample was collected to a depth of 5 cm and placed in plastic bags. Samples of Indian ringworm were also collected from the same area using tweezers. The samples were placed in plastic containers with a quantity of river water and transported to the laboratory.



Picture 1. Study area

Samples isolation and preservation

In the laboratory, samples were initially washed with water and cleaned of mud and other materials. A sieve with an opening diameters of 2000 micrometers was used to isolate worms larger than 2 mm. The specimens were collected alive using forceps and placed in bottles. Small individuals were collected using dissecting forceps, and a dissecting microscope was used to confirm the species. They were preserved by freezing without the addition of any preservatives. The ruler was used to measure the length after gently fixing the worm on a moist surface such as a wet filter paper so that it would not slip or dry out. This prevents excessive movement without harming its body (Picture 2)

Picture 2. The worm *Namalycastis indica*

and they were preserved for measuring trace element concentrations in their bodies. The sediment sample was sieved to remove gravel and impurities, then dried and ground for analysis.

Environmental factors

Water quality parameters such as water temperature (°C), pH, salinity (‰), and dissolved oxygen (mg/L) and pH were measured seasonally using a digital multimeter (YSI-multimeter).

Heavy metals

The method mentioned in ROPME (1982) was adopted to digest worm samples. 0.5 g of dried and ground worms were taken and digested in 3 ml of a mixture of central perchloric acid HClO₄ and nitric acid HNO₃ in a ratio of 1:1 in glass tubes after shaking well. Then, they were left for 12 hours to complete the primary digestion process after being placed in a high-efficiency vacuum. Then, the tubes were placed in a German-made Memmert water bath at a temperature of 70 °C for 30 minutes and then transferred to a German-made Ritesch heating plate to complete the digestion process (until the mixture becomes clear). Then, the filtrate was taken and the volume was completed with deionized distilled water to 25 ml. The samples were kept in tightly sealed glass bottles until they were examined using a Flame Atomic Absorption Spectrophotometer (F.A.A.S). The sediment samples were digested based on (ROPME, 1987)

Bioaccumulation factor (BAF): The bioaccumulation factor of the measured elements, from worms to sediments, was calculated using the equation given by Wilson and Pyatt (2007).

$$BAF(\%) = \frac{C(N.indica\ tissues)}{C\ sediment} \times 100$$

$C(N.indica\ tissues)$: the concentration of elements in *N. indica tissues*

$C\ sediment$: the concentration of elements in sediment.

Statistical analysis: Use SPSS program to calculate means, minimum and maximum limits, standard deviation, and other equations used.

Results and Discussion

Understanding the productivity of organisms is essential for assessing their efficiency in different environments, as well as for understanding the impact of external factors on their growth patterns and, consequently, their role in the food chain. The results indicate that the suitability of shared environmental conditions such as moderate temperature and adequate dissolved oxygen levels reflecting the availability of suitable food to meet the needs of benthic organisms in the intertidal zone affected the population structure of the studied species (Mahmoud *et al.*, 2022). The population density of worms recorded a higher value in spring season (112 Ind./ m²), and a lower value in the summer season (32 Ind./m²), (Fig. 2), this may be due to the association of benthic invertebrates with multiple environmental factors, such as the Water temperature, Abundance of vegetation plants and algae.

Aquatic plants provide a haven for them. The nature of the soil and the speed of the current also affect their distribution and preference for wet areas near water (Buffagni and

Comin, 2000), These results are consistent with a study by Sultan *et al.* (2017); Al-Baghdadi *et al.* (2021) in the tidal zone of the Shatt al-Arab and A study by Okash and Al-Abbad (2025) on two locations, one of which was the Shatt al-Basra canal, when they recorded the lowest densities during the summer months and the highest densities during the spring and autumn months. They did not agree with a study Glasby *et al.* (2021) which mentioned that many polychaetes living in extreme habitats, in particular elevated temperatures, occur in high abundances, have high growth rates, and may be numerically dominant.

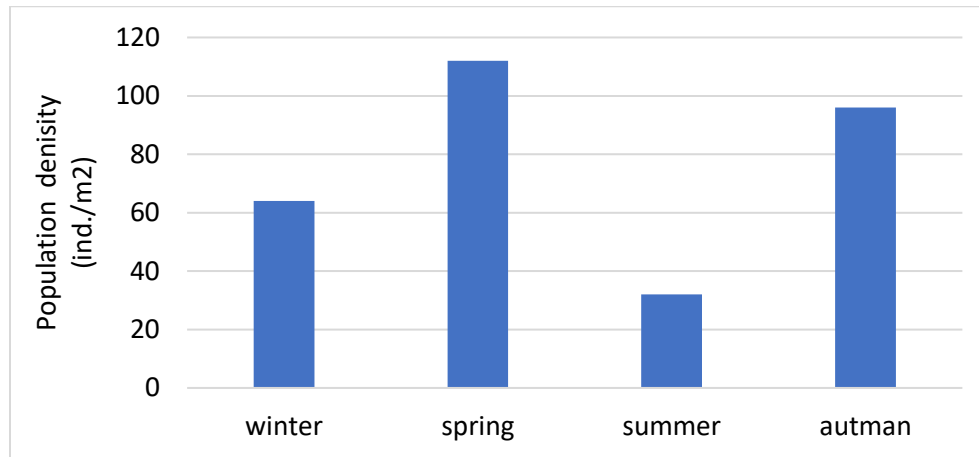


Figure 2. The population density of worms.

In other words, temperature stability allows organisms to grow, but pollution prevents them from reaching their maximum potential length (Fan *et al.*, 2015). The results showed that Average length value of worm length was recorded in the autumn at 7.16 cm, while Average length lowest was recorded in the winter was 4.7 cm at Study station (Fig. 3).

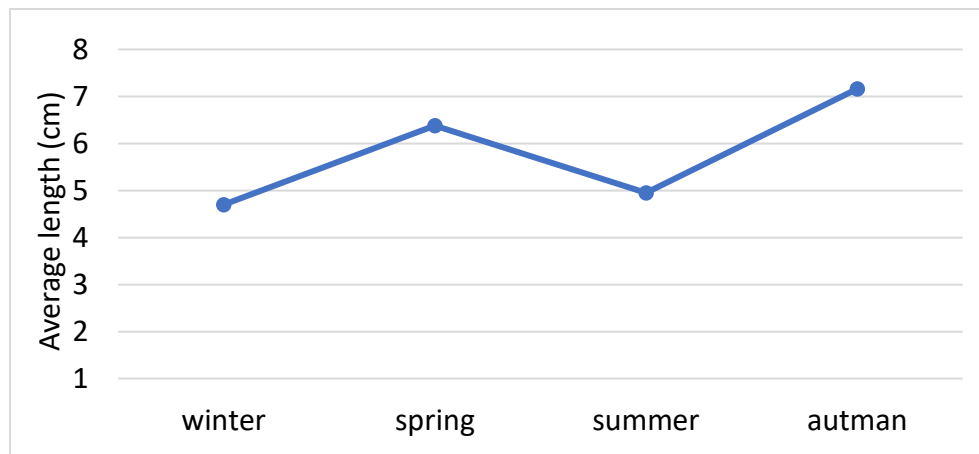


Figure 3. Average length and weight of worms in study sites during seasons.

The results of the study show that the average length values were highest during the autumn season due to the availability of conditions, especially temperature and food abundance. In general, the presence and quality of food are the main factors determining

the spread and distribution of these species (Al-Abbad *et al.*, 2015), this is consistent with study (Abdul-Latif, 2020).

The environmental factors play an essential role in the biomass and productivity of benthic fauna, including polychaete worms. The results showed variation in environmental factors between seasons, water temperature ranging between 15.2-33.1 °C. A higher value of salinity was recorded in the summer season was 43.7‰. Dissolved oxygen ranged between 5.8 -8.7 mg/l, and pH between 7.3-7.6 (Fig. 4). Fluctuations in salinity and pollution act as forces that compel organisms to divert their energy away from growth. Although the relationship between worm length and temperature stability is positive, the final length the worms will reach will be less than what they could achieve in a stable, unpolluted salinity environment, even at moderate temperatures (Fan *et al.*, 2015; Pires *et al.*, 2015).

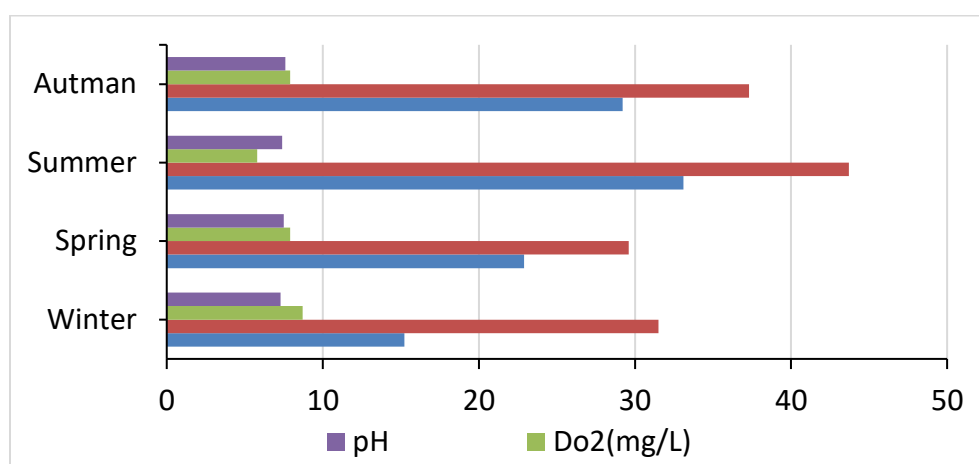


Figure 4. The environmental factors measured during study periods.

Increased water temperature was found to have negative effects on the distribution and abundance of the studied species, while it had a negative effect on the community density of the polychaete, emphasizing the potential of using the study of the structural composition of worm societies of polychaete as bioindicators (Dekaeva and Dvoretzky, 2024). A significant negative relationship was found between salinity and worm density, and a positive relationship with the cobalt and nickel concentration of the worm body due to increased density. A positive relationship was also found between temperature and copper concentration in the worms. The results of heavy metals for worms bodies showed arrangements from high to low concentrations during all study periods as follows: Co > Ni > Cd > Cu for *N. indica* tissues (Figure 5) and Ni > Co > Cu > Cd in sediment (Figure 6).

The accumulation of heavy metals is evident in polychaete worms, which are characterized by their ability to concentrate heavy metals in their bodies at higher concentrations, which are directly proportional to the concentration of metals in their environment (Bat 1998; Akbar *et al.*, 2011). Heavy metal pollution was monitored by Said *et al.* (2017) the worm *Nereis succinea* as a control species. The heavy metal concentration

of the worms in the study area varies with the seasons. The average concentrations of four heavy metals: cadmium, copper, nickel, and cobalt were 5.4575, 4.7425, 22.48, and 26.5175 $\mu\text{g/g}$ (dry weight), respectively. The worms recorded the highest concentrations of cadmium, nickel, and cobalt during the autumn, while the lowest concentrations were recorded for cadmium during the spring and for copper during the winter.

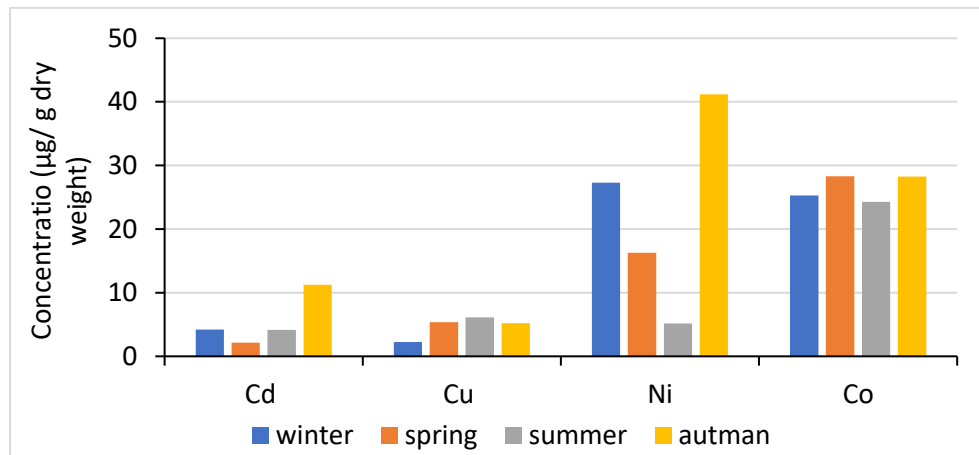


Figure 5. The concentration of heavy metals measured for *N. indica*.

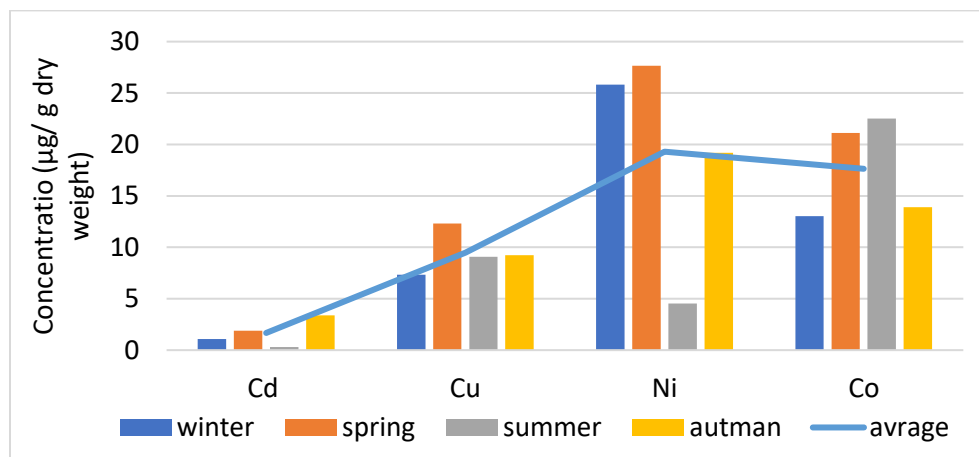


Figure 6. The concentration of heavy metals measured in sediment.

The highest concentrations of cobalt and nickel were recorded in *N. Indica* compared to cadmium and copper. All of these concentrations were higher than the concentrations of the metals in the sediments, except for copper, where the concentration in the sediments was higher than in the worms. This agrees with a study Al Qarooni (2011) The same type of worm was used as a biological indicator of the accumulation of heavy elements at the stations in the Shatt al-Arab and Shatt al-Basra canals. It also confirmed that these worms are capable of accumulating high concentrations of the metal and detoxifying it through specific mechanisms by binding the metal to a particular protein that induces its formation upon exposure to high concentrations of the metal (Suzuki *et al.*, 1980). For the sediments, the average concentrations of the four metals: cadmium,

copper, nickel, and cobalt: were 1.6725, 9.49, 19.3005, and 17.64, respectively. The highest concentrations were recorded for nickel and the lowest for cadmium. Concentrations also varied seasonally, with the highest concentrations for nickel during winter and spring, and the lowest for cadmium during summer. Due to the lower temperature, the metabolic rates of worms decrease compared to higher temperatures, where the metabolic rate increases and the release of toxins accumulated in the summer increases. The high concentration of cobalt and nickel in the worms may be attributed to their high presence in the sediments due to the region's exposure to petroleum products, particularly from transport and fishing vessels. This increase is directly proportional to the concentration in the worm tissues, as confirmed by Al Al Qarooni (2011) who found clear differences in the average concentrations of heavy metals in the worms and the sediments of the study area. This was confirmed by Said *et al.* (2017) when they calculated the worm density in Hurghada and the Red Sea in the tissues of marine *Neisseria succinate* worms and assessed the effects of various aquatic factors seawater temperature, pH, dissolved oxygen concentration, turbidity, conductivity, and salinity on the absorption and storage of four heavy metals manganese, lead, cadmium, and copper.

The bioaccumulation factor (BAF) is a very important indicator in ecology and environmental chemistry used to determine whether a chemical poses an environmental hazard, usually expressed as the ratio of the concentration of metals in a living organism to the concentration in the environment (water and sediment). BAF was calculated (Figure 7) and the results showed that the highest BAF values were recorded for cadmium at 3.26.

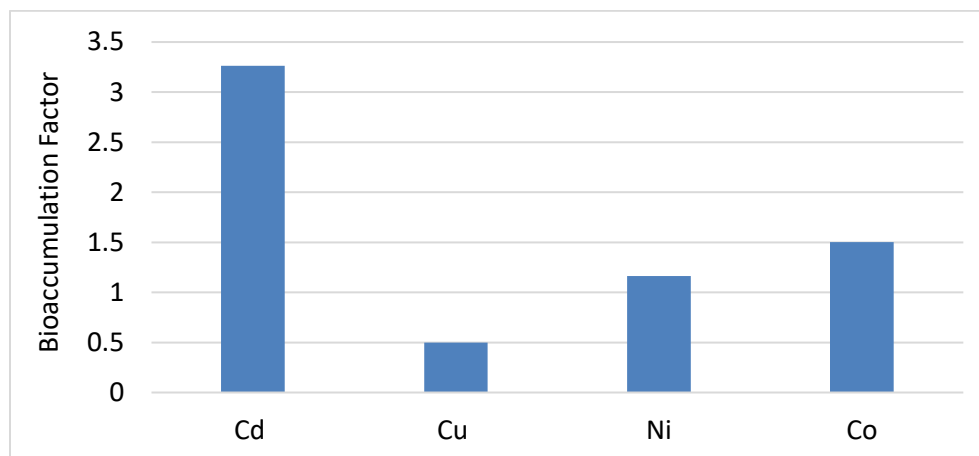


Figure 7. Bioaccumulation Factor (polychaete worms - sediment).

This suggests that they accumulate more inside the body than in the environment, indicating their potential use *N. indica* as an indicator of heavy metal (Cd, Ni, Co) pollution in this region. the lowest values were recorded for copper 0.49 , and BAF were Similar values for nickel and cobalt (1.16- 1.50) respectively. A copper BAF value below 1 indicates low accumulation of this element within the organism. This may be due to several factors, the most important of which is the body's ability to regulate copper

physiologically in tissues and its essential role in vital bodily functions. This was confirmed by (Al-Qassab, 1990; Altaee, 2009).

To understand the relationship more clearly, it is necessary to compare the density with the BAF of metals in the worms and between different seasonal environmental interaction was found during the spring and utamun wich stimulates an increase in worm population density. However, pollution with metals (Co, Ni) determines which species can thrive at this area at the individual worm level, there may be a dilution of metal concentration due to the rapid growth of new individuals. But at the community level, the worms that exhibit increased density in polluted environments are necessarily those with an innate ability to bioaccumulate these metals (Dange and Manoj, 2015; Mdaini *et al.*, 2020).

Conclusions

Calculating bioaccumulation factor and studying its relationship to seasonal worm density and linking it to environmental factors is an important tool for assessing heavy metal pollution in the Shatt al-Basra canal environment.

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التواجد الموسمي لدودة *Namalycastis indica* عديدة الاهلاب وقدرتها على تراكم العناصر الثقيلة في قناة شط البصرة

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المستخلص

دودة *Namalycastis indica* هي ديدان عديدة الاهلاب تعيش في منطقة المد والجزر تحت الصخور، وتتميز بتحملها للظروف المتقلبة، وخاصةً درجة الحرارة والملوحة والتعرض للملوثات، كما أنها تساهم في توازن النظام البيئي المائي. يهدف هذا البحث إلى دراسة التواجد الموسمي وكثافة دودة *N. indica* في بيئة ناظم شط البصرة، وحساب تراكيز المعادن الثقيلة في أجسامها وفي رواسب منطقة المد والجزر، وتحديد معامل التراكم الحيوي (BAF) للديدان والرواسب، ودراسة العلاقة بين BAF والعوامل البيئية، وعلاقتها بتوزيع الديدان. تم تحديد الكثافة الكلية (فرد/م²) للأفراد، وجمعت العينات باستخدام إطار مربع بمساحة 0.25 م × 0.25 م لأخذ العينات الكمية. سُجِّل أعلى معدل كثافة للنوع عند 112 فردًا لكل متر مربع خلال فصل الربيع، وأقل معدل كثافة كان 32 فردًا خلال فصل الصيف. أظهرت النتائج تباينًا في العوامل البيئية بين الفصول، حيث تراوحت درجة حرارة الماء بين 15.2-33.1 درجة مئوية. بلغت أعلى قيمة للملوحة المسجلة في فصل الصيف 43.7‰. تراوح الأكسجين المذاب بين 5.8-8.7 ملغم/لتر، ودرجة الاس الهيدروجيني بين 7.3-7.6. كما أظهرت النتائج أن معدل طول الديدان تراوح بين 4.7-7.16 سم. تم قياس طول الديدان، وأربعة معادن ثقيلة: الكوبالت، والنيكل، والكاديوم، والنحاس. أظهرت نتائج المعادن الثقيلة داخل جسم الديدان ترتيبات من التركيزات العالية إلى المنخفضة خلال جميع فترات الدراسة على النحو التالي Cu > Ni > Co > Cd: لأنسجة *N. indica* و Ni > Co > Cu > Cd في الرواسب. **الكلمات المفتاحية:** ديدان عديدة الاهلاب، عوامل بيئية، المعادن الثقيلة، عامل التراكم الحيوي.