SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 7 | Issue: 2 | February 2022 - Peer Reviewed Journal

BIODIVERSITY AND DISTRIBUTION OF CRUSTACEANS AS BIOINDICATORS OF HUMAN IMPACT IN THE RIVER NUN ESTUARY AROUND AKASSA, NIGER DELTA, NIGERIA

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ABSTRACT

A Research on the biodiversity and distribution of crustaceans in the River Nun estuary, Niger Delta, Nigeria was conducted from November, 2020 to April, 2021. This was done to impliedly monitor certain aspects of the environment, such as eutrophication, pollution warning trends and long-term changes which are signs of human induced environmental disturbance. Crustacean communities seem to be particularly useful for the evaluation of ecosystem status due to the presence of indicator taxa. Water Samples were collected from three sampling stations with collection bottles and taken to the laboratory for analysis. Crustacean samples were collected from four sampling stations. Different sampling techniques were employed in the collection of the crustaceans. Sampling was done with a quadrat of size 0.25m² at the ebb of the spring tide in each of the stations. Pole seine nets, beach seine nets, visual counts, collections, and burrow counts techniques were also employed. The mean values of physico- chemical parameters ranged from 6.13 to 6.34 for pH, 3.70 to 5.57‰ for salinity, 31.07 NTU to 37.92 NTU for turbidity, 3.57mg/L to 3.84mg/L for Total Dissolved Solids (TDS), 3.47mg/L to 3.79mg/L for Total Suspended Solids (TSS), 6.50mg/L to 23.04mg/L for HCO_3, 5.66mg/l to 6.33mg/l for Dissolved Oxygen (DO), 0.90mg/L to 1.55mg/L for Total Hydrocarbon Content (THC), 44.41mg/L to 72.07mg/L for Biochemical Oxygen Demand (BOD), 139.70mg/L to 169.45mg/L for Chemical Oxygen Demand (COD), and 0.58mg/L to 1.81mg/L for Total Organic Carbon (TOC) respectively. 27 species of crustaceans belonging to 4 orders, 15 families, and 18 genera were encountered during this study. Among these, the decapods crustaceans were the most abundant, having 24 species out of the 26 species of crustaceans that were identified. Also, the family Graspsidae had the highest numbers of species (7 species), followed by the families Panaeidae (4 species), Portunidae (3 species), and Ocypodae (3 species), respectively. Most of the crustaceans, except Parapenaeus longirotius, Penaeus monodon, and Penaeus satiferus, are usually found either close to or around the fringes of the estuary or around mudflats. The abundance and preponderance of indicator crustaceans such as Decapods, Isopods, and copepods which are known to be negatively correlated to the density of solid waste, which in turn is affected by the presence of human activity reveal an unpolluted environment. It can be concluded that the fishery and environment is not under threat. However, environmental sustainability should be ensured or indeed improved upon.

KEY WORDS: *biodiversity, distribution, crustaceans, River Nun, Akassa, Niger Delta*

1.0 INTRODUCTION

Crustaceans are members of the sub-phylum crustacea. They are a group of invertebrate animals consisting of some 45,000 species distributed worldwide. They constitute one of the most morphologically diverse taxonomic groups on the planet [1]. They form a large diverse arthropod taxon which includes such animals as crab, lobsters, Crayfish, Shrimp, prawn, kill, Woodlice, and barnacles.

They constitute one of the most priced delicacies that are eaten worldwide for their high nutrient value and low cholesterol content. Apart from their role as priced protein sources, crustaceans play an important role in ecosystem stability. They are also converters of biomass and organic matter in the biogeochemical cycles [2]. Also, they can directly consume organic matter as deposit

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feeders or feed on dead organisms like scavengers which in turn are transformed to higher trophic levels via their directions by the other higher animals and man [3, 4].

However, despite their seeming toughness and importance as environmental sanitizers, crustaceans are often affected by adverse environmental inputs such as heavy metals, petroleum and its bi-products and other anthropogenic inputs. Heavy metals for instance can affect molting and limb regeneration in crustaceans. Furthermore, certain crustaceans may totally disappear or leave environments that are far from ideal. These crustaceans are termed indicator species or taxa. They provide information about the state of the environment and its effects over time.

Therefore, there is an acute need to study crustaceans' diversity in order to determine the ecological health status of water bodies. As River Nun at Akassa axis provides a veritable ground for the growth, survival and harvest of crustaceans, there is a need to study crustacean biodiversity and distribution in the river in order to determine its pollution status. This will provide information for assessing the status of crustaceans and diversity, water quality and ecological health of the water. The protection of our fishery and sustenance of the environment is sacrosanct.

2.0 MATERIALS AND METHODS

2.1 Description of Study Area

The study area is the River Nun estuary in Akassa kingdom in Brass Local Government Area in Bayelsa State situated in the Niger Delta Region of Nigeria. Akassa kingdom occupies an area of 120km^2 and is situated on both sides of the River Nun estuary. Akassa kingdom has a population of over 280,000 people who are inhabitants of 21 major towns and several fishing settlements that make up the kingdom. The mother tongue of the Akassa people is the Izon (Ijaw) language. The estuary is located on latitude of 4^0: 20" E and 4^0: 17" N longitude of 6^0: 49" and 4^0:55" E [5]. The wet season spans from April to November, while the short dry season spans from December to March.

The estuary is interconnected with several creeks, inlets, and canals which serve as navigational routes and drainages in the area. It is also connected to other estuaries through these channels. The River Nun estuary is bordered to the east by the Brass River estuary and to the west by the Sangana River estuary. It opens up into the Atlantic Ocean at its southern part (Figure 1).

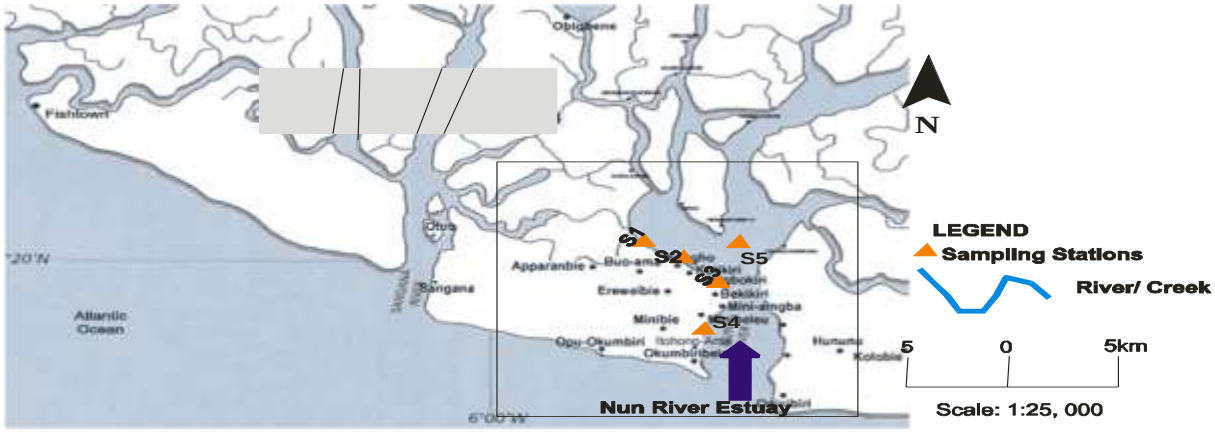

Figure 1: Map of the Nun River Estuary
Retrieved: http://www.pronatura-nigeria.org/OLD-WEBSITE/adf/akassa.html#amap

The River Nun estuary (Akassa kingdom) has been reported to have the highest rainfall per annum in the whole of West Africa, with an annual rain fall of between 2,000mm to 3, 000mm [5]. Rain occurs virtually every month of the year with heavy downpour. The climate is tropical. The wet season is not less than 340 days. The mean monthly atmospheric temperature is in the range of 25^{0}C to 31^{0}C.

2.2 Description of Sample Stations

2.2.1 Station 1 (Near Buo- ama Creek)

This station is around the Buo- ama Creek. It is located on a latitude of N4^{0}20'59.6472" and a longitude of E6^{0}2'48.3036". This station is characterized by the possession of mangrove vegetation and a relatively short intertidal zone. The vegetation consists mainly of red mangroves.

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2.2.2 Station 2 (Akahapolo)

This station is around Akahapolo community and is located on a latitude of N4^{0}20'40.8552" and a longitude of E6^{0}2'56.4396". In this station, the low intertidal zone is muddy, middle intertidal zone is a mixture of sand and clay and the high intertidal zone is purely sandy. This station does not have mangrove vegetation. The fringes of this station are dominated by grasses.

2.2.3 Station 3 (Ogbokiri)

The station is situated on a mud flat and its GPS coordinates are N4^{0}19'46.8048" and E6^{0}3'49.3596". It has vegetation that is dominated by the white mangroves. The low intertidal zone is a mixture of sand and clay, the mid intertidal zone is sandy and the high intertidal zone is clay.

2.2.4 Station 4 (Tobukiri)

This station is a sandy beach close to the mouth of the River Nun estuary at Tobukiri, Akassa, where this estuary opens into the Atlantic Ocean. It is situated on a latitude of N4^{0}18'12.0996" and longitude of E6^{0}3'58.518". It has vegetation that is dominated by grass and shrubs. It has a sandy soil.

2.3 Field Sampling

2.3.1 Collection of Water Samples

Water Samples were collected in triplicates from three sampling stations with collection bottles and taken to the laboratory for analysis. The samples for total hydrocarbon content (THC) analysis were placed in pre-labelled glass containers and sealed with aluminum foil.

2.3.2 Sampling of Crustaceans

Crustacean samples were collected from four sampling stations. Different sampling techniques were employed in the collection of the crustaceans. Sampling was done with a quadrat of size 0.25m^2 (50cm x 50cm) at the ebb of the spring tide in each of the stations. Pole seine nets, beach seine nets, Visual counts, collections and burrow counts techniques were also employed.

In quadrat sampling, the crustaceans covered by the quadrat were excavated with the aid of a spade to the depth of about 20cm. Prior to the excavation, all juvenile crabs crawling within the quadrat were hand- picked and put into a labeled wide mouthed bottle containing 10% formalin and 0.1% of the vital Rose Bengal Stain.

Pole seine and beach seine nets were also used. Samples were also collected from local fishers who used various fishing gears. The collected samples were later identified.

2.4 Laboratory analysis

2.4.1 Determination of pH, TDS, DO, Turbidity, BOD

Some water quality parameters were measured *in-situ*. The measured parameters included; pH, Total Dissolved Solids, and turbidity. The pH, Dissolved oxygen and Total Dissolved Solids (TDS) were determined in situ using portable digital meter (Extech-407510A). Winkler's method was used for dissolved oxygen and BOD_5 (biochemical oxygen demand) analysis; while TSS (total suspended solids) was analyzed using gravimetric method. Hach's turbidimeter model 2100P was used for the measurement of turbidity.

2.4.2 Determination of salinity

The conductivity meter has a salinity position so that as the probe is dipped into the water body, the control switch was turned to the salinity position and when a steady reading is obtained, it was recorded as the salinity of the water sample.

2.4.3 Total suspended solids

100ml of sample was filtered and the filter paper dried and weighed. The weight difference between filter paper before and after filtration was taken as the total suspended solid ppm or mg/L.

2.4.4. Hydrogen Carbonate (HCO_3^-)

2 drops of mixed indicator were added to the solution obtained from the hydroxide-acid filtration. The solution was titrated with 0.02m standard Hcl to the pink end point.

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2.4.5 Determination of THC

The presence of hydrocarbons in water is detected by contacting the water samples with an adsorbent material to extract hydrocarbons from the water sample and then contacting the adsorbent material with a solvent for the hydrocarbons. A developer such as a miscible non-solvent liquid was mixed into the solvent to produce a test mixture. The turbidity of the test mixture is observed to determine the presence of hydrocarbons in the water sample. The non -solvent may contain 5% salt, and an emulsifier. Turbidity was measured quantitatively by measuring light scattered at 90° to a test light beam or by visual comparison to a reference scale that is determined spectrophotometrically at a wavelength of 420 nm using spectrometer model HACHDR3900.

2.4.6 Determination of COD in water

50.0 mL of sample was put in a 500 mL refluxing flask. Add 1g mercuric sulphate and a few glass beads. Add sulphuric acid to dissolve the mercuric sulphate and cool. Add 25.0 ml 0.25 N potassium dichromate solution and mix well. Attach the flask to the condenser and start the cooling water. Add the remaining acid reagent (70 mL) through the open end of condenser and mix well. Apply heat and reflux for 5 hours. Cool and wash down the condenser with distilled water. Dilute the mixture to about twice its volume and cool to room temperature. Titrate the excess dichromate with standard ferrous ammonium sulphate using ferroin indicator (2 to 3 drops). The colour change from blue green to reddish indicates the end point. Reflux in the same manner a blank consisting of distilled water of equal volume as that of the sample.

2.4.7 Determination of TOC

The sample is pipetted into the digestion cuvette and the open cuvette is positioned into the TOC-X5 shaker. The combination of the shaker and the fan drives the complete TIC out of up to eight samples within just five minutes. The cap is then screwed onto the indicator cuvette and the TOC digestion in the thermostat can begin. The shaker procedure saves time and is very easy and reliable from the point of view of handling. This involves two measurements, i.e., total carbon (TC) and total inorganic carbon (TIC). The TOC is then calculated as the difference between TC and TIC (TOC = TC – TIC). Total carbon (TC) and total inorganic carbon (TIC) are converted to carbon dioxide (CO2) by, respectively, oxidation and acidification. The CO2 passes from the digestion cuvette through a membrane and into the indicator cuvette. The change of colour of the indicator is photometrically evaluated.

3.0 RESULTS

The results of the analysis of the River Nun estuary in Akassa kingdom, Niger Delta are presented in Tables 1 - 5. The mean values of physico- chemical parameters ranged from 6.13 ± 0.02 to 6.34 ± 0.001 for pH, 3.70 ± 0.03 ‰ to 5.57 ± 0.08‰ for Salinity, 31.07 to 37.92 for Turbidity, 3.57 to 3.84 for TDS, 3.47 to 3.79 for TSS, 6.50 to 23.04 for HCO_3, 5.66 ± 0.18mg/l to 6.33 ± 0.13mg/l for DO, 0.90 ± 0.30mg/l to 1.55 ± 0.20mg/L for THC, 44.41±1.01mg/l to 72.07 ± 1.47mg/L for BOD, 139.70 ± 0.90mg/L to 169.45 ± 1.05mg/L for COD, and 0.58 ± 0.04mg/l to 1.81±0.02mg/L for TOC, respectively.

Table 1: Physico- chemical parameters of the Nun River Estuary

PARAMETERS	STATION 1	STATION 2	STATION 3
pH	6.13 ± 0.02	6.33 ± 0.01	6.34 ± 0.001
Salinity	3.70 ± 0.03	4.73 ± 0.09	5.57 ± 0.08
Turbidity	36.04 ± 0.67	37.92 ± 4.64	31.07 ± 0.42
TDS	3.57 ± 0.01	3.69 ± 0.01	3.84 ± 0.11
TSS	3.47 ± 0.13	3.79 ± 0.47	3.57 ± 0.08
HCO_3	6.50 ± 1.50	21.48 ± 1.09	23.04 ± 1.60
DO	6.33 ± 0.13	5.66 ± 0.18	5.90 ± 0.10
THC	1.15 ± 0.20	1.55 ± 0.20	0.90 ± 0.30
BOD	44.41 ± 1.01	68.54 ± 0.18	72.07 ± 1.47
COD	139.70 ± 0.90	158.75 ± 2.05	169.45 ± 1.05
TOC	0.58 ± 0.04	0.71 ± 0.15	1.81 ± 0.02

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Table 2: Pearson's Correlation of the Physico-chemical Parameters of the Nun River Estuary

PARAMETERS	pH	Sal	Turb	TDS	TSS	HCO_3	DO	THC	BOD	COD	TOC
pH	1	.915*	-.284	.710	.200	-.095	-.849*	.021	.984**	.949**	.625
Sal	.915*	1	-.525	.886*	.097	.175	-.619	-.318	.937**	.994**	.851*
Turb	-.284	-.525	1	-.526	.741	-.416	.168	.865*	-.257	-.490	-.390
TDS	.710	.886*	-.526	1	.136	.567	-.346	-.374	.797	.862*	.862*
TSS	.200	.097	.741	.136	1	-.160	.027	.664	.300	.101	.312
HCO_3	-.095	.175	-.416	.567	-.160	1	.251	-.530	.015	.134	.313
DO	-.849*	-.619	.168	-.346	.027	.251	1	-.160	-.762	-.697	-.146
THC	.021	-.318	.865*	-.374	.664	-.530	-.160	1	.022	-.254	-.389
BOD	.984**	.937**	-.257	.797	.300	.015	-.762	.022	1	.961**	.715
COD	.949**	.994**	-.490	.862*	.101	.134	-.697	-.254	.961**	1	.797
TOC	.625	.851*	-.390	.862*	.312	.313	-.146	-.389	.715	.797	1

***Correlation is significant at 0.05 levels. ** Correlation is significant at 0.01 levels Crustaceans**

The checklist of the crustaceans that were identified during the current study is presented in Table 3 while that of the ecology and distribution of these crustaceans are presented in Tables 4 and 5, respectively. Twenty-seven (27) species of crustaceans belonging to four orders, fifteen families and eighteen genera were encountered during the study (Tables 3, 4, and 5). Among these, the decapods crustaceans were the most abundant. Also, the family Graspsidae had the highest numbers of species (7 species) followed by the families Panaeidae (4 species), Portunidae (3 species), and Ocypodae (3 species), respectively.

Table 3: Checklist of Crustaceans in the Nun River Estuary

S/N	CLASS	ORDER	FAMILY	GENUS & SPECIES	COMMON NAME	LOCAL NAME
1	**Malacostaca**	**Decapoda**	Crangonidae	*Exhippolysmata hastatoides*	Champion shrimp	Otoku
2			Palemonidae	*Nematopalaemon hastatus*	Estuarine shrimp	Opoli
3			Pandalidae	*Parapandalus narval*	Narval shrimp	Opoli
4			Aristeidae	*Aristeus varidens*	Stripped red shrimp	Opoli
5			Panaeidae	*Parapenaeus longirotius*	Deep water rose shrimp	Opoli
6				*Penaeus karathurus*	Caramote shrimp	Opoli
7				*Penaeus monodon*	Giant tiger prawn	Opu opoli
8				*Penaeus satiferus*	White prawn	Idumafu
9			Ocypodae	*Ocypodae cursor*	Tufted ghost crab	Abadi- akongho
10				*Ocypodae Africana*	Ghost crab	Abadi- akongho
11				*Uca tangeri*		Akongho
12			Gecarcinidae	*Cardisoma armatum*	Land crab	Ilu
13			Graspsidae	*Sesarma huzardi*	Mangrove crabs	Ito
14				*Sesarma elegans*	Mangrove crabs	Ito
15				*Sesarma alberti*	Mangrove crabs	Ito
16				*Sesarma angolense*	Mangrove crabs	Ito
17				*Pachygrapsus sp.*	Mangrove crabs	Ito
18				*Goniopsis pelii.*	Mangrove crabs	Ito
19			Portunidae	*Callinectes amnicola*	Blue crab	Ango
20				*Callinectes pallidus*	Blue crab	Ango
21				*Callinectes marginatus*	Blue crab	Ango
22			Alpheidae	*Alpheus pontederiae*	Snapping shrimp	Ikpaikpai
23			Diogenidae	*Clibanarius cooki*	Hermit crab	-

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24			Balanidae	*Balanus sp.*	Barnacle	-
25		Isopoda	Ligiidae	*Ligia oceanica*	Isopod	-
26		Copepoda	Canthocamptidae	*Mesochra sp.*	Copepod	-
27		Stomatopoda	Squillidae	*Squilla mantis*	Mantis shrimp	-

Table 4: Habitat and Ecology of Crustaceans in the Nun River Estuary

S/N	Crustaceans	Habitat/ Ecology
1	*Exhippolysmata hastatoides*	Muddy and sandy bottoms of the estuary.
2	*Nematopalaemon hastatus*	Sandy and muddy bottoms in estuarine and coastal marine waters
3	*Parapandalus narval*	Sandy and muddy bottoms, often near rocky areas
4	*Aristeus varidens*	Muddy bottoms of the estuary.
5	*Parapenaeus longirotius*	Muddy bottoms of the estuary.
6	*Penaeus karathurus*	Muddy bottoms of the estuary.
7	*Penaeus monodon*	Muddy bottoms of the estuary.
8	*Penaeus satiferus*	Muddy bottoms of the estuary.
9	*Ocypode cursor*	Inhabits the high intertidal zones sandy beaches close to the ocean. It lives in burrows when the tide is high and comes out to feed and breed when the tide ebbs.
10	*Ocypode Africana*	
11	*Uca tangeri*	High and mid intertidal zones of swamps and mud flats. It resides in burrows when the tide is high and comes out to feed and breed when the tide ebbs.
12	*Cardisoma armatum*	High intertidal zones of estuaries. It resides in burrows when the tide is high and comes out to feed and breed.
13	*Sesarma huzardi*	Found at the high intertidal zones, usually around mangroves. Can also be seen around mangrove pneumatophores.
14	*Sesarma elegans*	Found at the high intertidal zones, usually around mangroves. They also inhabit the stems and branches of mangroves and on other areas such as boats, canoes, piles of stones etc
15	*Sesarma alberti*	Found at the high intertidal zones, usually around mangroves. Can also be seen around mangrove pneumatophores.
16	*Sesarma angolense*	
17	*Pachygrapsus sp.*	Found at the high intertidal zones, usually around mangroves. They also inhabit the stems and branches of mangroves and on other areas such as boats, canoes, piles of stones etc. Can also be seen around mangrove pneumatophores.
18	*Goniopsis pelli.*	
19	*Callinectes amnicola*	Usually found in sandy and muddy bottoms at less than 30cm depth. Usually found around mudflats. Sometimes left stranded on mud flats when the tide ebbs.
20	*Callinectes pallidus*	
21	*Callinectes marginatus*	
22	*Alpheus pontederiae*	
23	*Clibanarius cooki*	Found at the low, mid, and high intertidal zones of estuaries. Usually inhabits the empty shells of estuarine molluscs such as periwinkles.
24	*Balanus sp.*	Sessile crustaceans usually attached to the shells of periwinkles, blue crabs, concretes, and some plastics. They are filter feeders.
25	*Ligia oceanica*	Commonly seen on the shores of the estuary especially on concrete jetties, piling stones, canoes, boats (abandoned ones). They are scavengers.
26	*Mesochra sp.*	Found at the high intertidal zones in sandy areas of the estuary. Lives in moisture at the base of debris or leaves.
27	*Squilla mantis*	They occur in coastal waters but are sometimes found in the estuary. Many species live in burrows. Both adults and larvae are excellent swimmers. They live on muddy bottoms and among organic debris.

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Table 5: Distribution/ Occurrence of Crustaceans in various parts of the River Nun estuary

S/N	CRUSTACEANS	DISTRIBUTION												
		STN 1			STN 2			STN 3			STN 4			STL
		H	M	L	H	M	L	H	M	L	H	M	L	
1	*Exhippolysmata hastatoides*	-	-	+	-	-	+	-	-	+	-	-	+	++
2	*Nematopalaemon hastatus*	-	-	+	-	-	+	-	-	+	-	-	+	++
3	*Parapandalus narval*	-	-	-	-	-	-	-	-	-	-	-	-	++
4	*Aristeus varidens*	-	-	-	-	-	-	-	-	-	-	-	-	++
5	*Parapenaeus longirotius*	-	-	-	-	-	-	-	-	-	-	-	-	++
6	*Penaeus karathurus*	-	-	-	-	-	-	-	-	-	-	-	-	++
7	*Penaeus monodon*	-	-	-	-	-	-	-	-	-	-	-	-	++
8	*Penaeus satiferus*	-	-	-	-	-	-	-	-	-	-	-	-	++
9	*Ocypode cursor*	-	-	-	-	-	-	-	-	-	+	++	-	-
10	*Ocypode Africana*	-	-	-	-	-	-	-	-	-	+	++	-	-
11	*Uca tangeri*	-	-	-	+	+	-	++	++	-	-	-	-	-
12	*Cardisoma armatum*	-	-	-	+	-	-	+	-	-	-	+	-	-
13	*Sesarma huzardi*	+	-	-	-	-	-	+	-	-	-	-	-	-
14	*Sesarma elegans*	+	-	-	-	-	-	+	-	-	-	-	-	-
15	*Sesarma alberti*	+	-	-	-	-	-	+	-	-	-	-	-	-
16	*Sesarma angolense*	+	-	-	-	-	-	+	-	-	-	-	-	-
17	*Pachygrapsus sp.*	+	-	-	-	-	-	+	-	-	-	-	-	-
18	*Goniopsis pelli.*	+	-	-	-	-	-	+	-	-	-	-	-	-
19	*Callinectes amnicola*	-	-	+	-	-	+	-	-	+	-	-	-	++
20	*Callinectes pallidus*	-	-	+	-	-	+	-	-	+	-	-	-	++
21	*Callinectes marginatus*	-	-	+	-	-	+	-	-	+	-	-	-	++
22	*Alpheus pontederiae*	-	-	+	-	-	+	-	-	+	-	-	-	++
23	*Clibanarius cooki*	+	+	+	+	+	+	+	+	+	-	-	-	-
24	*Balanus sp.*	+	+	+	+	+	+	+	+	+	-	-	-	-
25	*Ligia oceanica*	+	-	-	+	-	-	+	-	-	-	-	-	-
26	*Mesochra sp.*	-	-	-	+	-	-	-	-	-	-	-	-	-
27	*Squilla mantis*	-	-	-	-	-	-	-	-	-	-	-	-	+

STN= Station. H= High intertidal. M= Mid intertidal. L= Low intertidal. ST: Sub- tidal.
- = Absent. + = Present. ++ = Abundant

Plate 1: *Ligia oceanica* and *Balanus sp.*(white)

Plate 2: *Balanus sp.* on the carapace of *C. amnicola.*

Plate 4: *Pachygrapsus sp.* on concrete pilings

A B C D

Plate 3: **A.** *G. pelli* on the mid intertidal zone of station 1; **B.** *G. pelli* on the high intertidal zone of station 1; **C.** *Goniopsis pelli* on mangrove root; **D.** *Goniopsis pelli* on concrete pilings

SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
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Plate 5: *Seserma elegans* on mangrove roots


Plate 6: *Callinectes amnicola*


Plate 7: *C. amnicola*, *C. pallidus*, and *C. marginatus*


Plate 7: *Uca tangeri* at the mid intertidal zone of station 3.


Plate 8: *Parapandalus narval*


Plate 9: *Peneus notialis*


Plate 10: *Peneus karathurus*


Plate 11: *Penaeus monodon* (Giant tiger prawn). Size: 23.8cm!


Plate 12: *Parapeneus longirostris*


Plate 13: *Alpheus pontederiae*

4.0 DISCUSSION

4.1 Physicochemical parameters

The physico-chemical parameters of the overlaying water of the River Nun estuary were measured to ascertain the level of environmental/ ecological parameters or variables that the crustaceans have adapted to. The ranges and fluctuations of values for physico-chemical parameters recorded in the River Nun estuary during the investigation were within the range of physico-chemical parameters values of natural and manmade water bodies for optimal growth and survival for aquatic life in tropical Africa [6, 7, 8, 9]. The pH of most natural waters falls in the range of 4.0 to 9.0 and much more often in the range of 6.0 to 8.0 [10]. The range of pH (6.13, to 6.34) obtained in this research work was adequate for aquatic life. pH range of 5.50 to 9.50 [11] is suitable for aquatic production. Similar range of pH was recorded by Eyo and Ekwonye [9], Attama [12] and Odo [13].

The dissolved oxygen (DO) content of water results from the photosynthetic and respiratory activities of the biota in the open waters. The significant decrease in DO in station 2 in the river-nun estuary is probably as a result of high organic load of the water mainly in form of leaf litter which causes increase oxidation. While the increase in DO content in station 1 would be due to the increased aeration during rainfall and increased wind speed experienced in that period.

The variation in salinity can be accounted for by the fluctuation in river discharge, precipitation and tidal currents. Salinity varied from 3.70 recorded at all three stations to 5.57 in river-nun estuary. The lowest mean value (3.70±0.03) was recorded for station 1, whereas station 2 returned the greatest mean, 5.57±0.09. The results of the present study emphasize the influence of salinity level on the distribution of crustaceans found in this region.

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4.2 Crustaceans

The results of this research revealed that the River Nun estuary around Akassa kingdom is endowed with a high biodiversity of crustaceans. Twenty-seven (27) species of crustaceans belonging to four (4) orders, fifteen (15) families and eighteen (18) genera were encountered during this study. Among these, the decapods crustaceans were the most abundant, having 24 species out of the 26 species of crustaceans that were identified. Also, the family Graspsidae had the highest numbers of species (7 species), followed by the families Panaeidae (4 species), Portunidae (3 species), and Ocypodae (3 species), respectively. Geetha and Bijoy [14] identified 34 species of crustaceans belonging to twenty-seven families and thirty-four genera in a similar study on the ecology, diversity, and abundance of Macro-benthic Crustaceans in Cochin estuary, India. They were comprised of seven groups represented by amphipods (80%), isopods (7%), tanaids (4%), mysids (2%), decapods (1%), acarids (3%) and dipterans (3%). Among these, the amphipods were the major group. In another related research on the biodiversity of Decapods associated with four different Seaweeds in Manakudy estuary India, Agneswari and Jansi [15] recorded 9 species of decapods.

In this study, the abundance and preponderance of indicator crustaceans such as Decapods, Isopods, and copepods which are known to be negatively correlated to the density of solid waste, which in turn is affected by the presence of human activity reveal an unpolluted environment. Therefore, these crustaceans are very abundant and most are consumed as food. Some are even exported to the cities and other communities where they are sold and form part of the enjoyable delicacies

4.3 Ecology and Distribution of Crustaceans in the River Nun Estuary

Exhippolysmata hastatoides, *Nematopalaemon hastatus*, and *Parapandalus narval* are usually associated with sandy and muddy bottoms in estuary while *Aristeus varidens*, *Parapenaeus longirotius*, *Penaeus karathurus*, *Penaeus monodon*, and *Penaeus satiferus* prefer muddy bottoms. Most of the crustaceans, except *Parapenaeus longirotius*, *Penaeus monodon*, and *Penaeus satiferus*, are usually found either close to or around the fringes of the estuary or around mudflats.

Ocypode cursor and *Ocypodee africana* were found at the high intertidal zone of a sandy beach close to the mouth of the River Nun estuary at Sampling station 4 (Tobukiri), where this estuary opens into the Atlantic Ocean. It lives in burrows when the tide is high and comes out to feed and breed when the tide ebbs.

Uca tangeri inhabits the sandy high and mid intertidal zones of swamps and mud flats. It resides in burrows when the tide is high and comes out to feed and breed when the tide ebbs. Also, *Cardisoma armatum* is an edible crab that inhabits the high intertidal zones of estuaries and moist muddy soils of inlands. Some penetrate inland as far as 8 km (about 5 miles). It resides in burrows. They are typically terrestrial, square-bodied crabs that only occasionally, as adults, return to the sea. They feed on both animal and plant tissue.

Sesarma huzardi, *Sesarma alberti*, *Sesarma angolense*, *Pachygrapsus sp.*, and *Goniopsis pelii* are usually found at the high and mid intertidal intertidal zones, usually around mangrove swamps. It is also seen around mangrove pneumatophores. Furthermore, *Sesarma elegans* inhabits the high intertidal zones, usually around mangroves. They also inhabit the stems and branches of mangroves and other areas such as boats, canoes, piles of stones and so on. These mangrove crabs were found at the high and mid intertidal zones of stations 1and 3. *Sesarma elegans* was found in station 2 also in canoes and abandoned boats.

The Blue Crabs (*Callinectes amnicola*, *C. pallidus*, and *C. marginatus*) and the snapping shrimp (*Alpheus pontederiae*) are usually found in sandy and muddy bottoms of the estuary, at less than 30cm depth. They are usually found around mudflats and sometimes left stranded on mud flats when the tide ebbs. They were found at the low intertidal zones of stations 1, 2, and 3 and in other parts of the estuary. The hermit crabs (*Clibanarius cooki*) inhabit the low, mid, and high intertidal zones of estuaries (mostly found at the mid intertidal zone). They usually inhabit the empty shells of estuarine molluscs such as periwinkles. They were found in stations 1, 2, and 3. The barnacles (*Balanus sp*.) are sessile crustaceans that are usually attached to the shells of periwinkles, blue crabs, concretes, and some plastics. They are filter feeders. They were found in stations 1, 2, and 3. The isopods (*Ligia sp*.) are seen on the shores of the estuary especially on concrete jetties, piling stones, canoes, boats (abandoned ones). They are scavengers. The copepods (*Mesochra suifunensis*) inhabit the high intertidal zones in sandy areas of the estuary. They live in moisture at the base of debris or leaves. The isopods were found in stations 1, 2, 3, and 4 and copepods were found in station 2. Copepods (*Mesochra sp.*) are of great ecological importance, providing food for many species of fish. A few live-in moistures at the base of leaves, or in humus. The mantis shrimp (*Squilla mantis*) occur in coastal waters but are sometimes found in the estuary. Many species live in burrows. Both adults and larvae are excellent swimmers. They live on muddy bottoms and among organic debris.

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5.0 CONCLUSION

The observed ranges and fluctuations of values for physico-chemical parameters recorded in the River Nun estuary during the investigation were within the range of physico-chemical parameter values of natural and manmade water bodies for optimal growth and survival of aquatic life in tropical Africa.

Most of the crustaceans that were encountered and identified during this study inhabit the intertidal benthic zones of the River Nun estuary. While some crustaceans are aquatic, some species have occupied almost every conceivable niche within the aquatic environment.

The abundance and preponderance of indicator crustaceans such as Decapods, Isopods, and Copepods which are known to be negatively correlated to the density of solid waste, which in turn is affected by the presence of human activity suggest an unpolluted environment. This explains the abundance of crustaceans in the River Nun in this study.

The crustaceans of most obvious importance to humans are the larger species, chiefly decapods. Fisheries in many parts of the world capture shrimps, prawns, and spiny lobsters. Many species of true crabs- such as the blue crab are valuable sources of food. Many species have only local market value whereas some are even exported to the cities and other countries where they are sold and form part of the enjoyable delicacies. The River Nun is not under serious threat of pollution as observed in the diversity and distribution of crustaceans in the environment.

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