UNIVERSITY OF PORT HARCOURT

THE UNSUNG HEROES OF OUR TIME

An Inaugural Lecture

By

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DEDICATION

To my Forever God who never fails and is Faithful

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I thank my FOREVER GOD who is faithful and has never failed or forsaken me. My late father Rev. Canon T. T. Green the first graduate priest of the Anglican Communion of the Old Niger Delta Diocese. He introduced me at a young age to the University setting by taking me to my first convocation ceremony as the first chaplain of the University of Nigeria Nsukka protestant chaplaincy. Later in life he threw a simple challenge to his children that if he could get a degree from Durham University at forty any of us who stops at a first degree has tried but has not put in his/her best. He did not bully, scold or force but prayed and encouraged us and by the grace of God all of us exceeded first degree. The International Daddy of all I appreciate and love you.

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My siblings you are great and wonderful ‘Amna’ (late Prof. Eldred I.I. Titus-Green) your legacy lives on. Your publications are in libraries in United Kingdom and other parts of the world, the Ibani dictionary you started is out, Ibani Christian Fellowship is going on strong, Abinye and Douye are doing great. My brother and friend you will not be forgotten.

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Our laboratory staff under the leadership of H. Onoja and P. Onyagbodor, Mr F.C. Isikaku, my brother P. P. Otufu who has been of great help all through graduate studies and Hanson Uyi. Our Administrative team ably led by our alumnus Mrs Madu. The administrative team during my tenure as HoD J. A. Wellington-Anele, Faith, Beatrice, Uchechi, Pastor Onuekwa and FFO Timan I thank you all.

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To my traditional rulers I say thank you for all the honour given me.

I will not forget my editorial assistant, Deinma Dick and the Special Team that stayed with me through the preparations, you are special people, God bless you all and your families. To all my aunties and sisys from the Greens, Uriah-Harts and Jumbos of Grand Bonny I thank you all for the encouragements.

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2.45P.M. GUESTS ARE SEATED

3.00P.M. ACADEMIC PROCESSION BEGINS

The procession shall enter the Ebitimi Banigo Auditorium, University Park, and the Congregation shall stand as the procession enters the hall in the following order:

ACADEMIC OFFICER
PROFESSORS
DEANS OF FACULTIES/SCHOOLS
DEAN, SCHOOL OF GRADUATE STUDIES
PROVOST, COLLEGE OF HEALTH SCIENCES
LECTURER
REGISTRAR
DEPUTY VICE-CHANCELLOR [ACADEMIC]
DEPUTY VICE-CHANCELLOR [ADMINISTRATION]
VICE CHANCELLOR

After the Vice-Chancellor has ascended the dais, the congregation shall remain standing for the University of Port Harcourt Anthem. The congregation shall thereafter resume their seats.

THE VICE-CHANCELLOR'S OPENING REMARKS.

The Registrar shall rise, cap and invite the Vice-Chancellor to make the opening Remarks.

THE VICE-CHANCELLOR SHALL THEN RISE, CAP AND MAKE HIS OPENING REMARKS AND RESUME HIS SEAT.

THE INAUGURAL LECTURE

The Registrar shall rise, cap, invite the Vice-Chancellor to make his opening remarks and introduce the Lecturer.

The Lecturer shall remain standing during the Introduction. The Lecturer shall step on the rostrum, cap and deliver her Inaugural Lecture. After the lectures, she shall step towards the Vice-Chancellor, cap and deliver a copy of the Inaugural Lecture to the Vice-Chancellor and resume her seat. The Vice-Chancellor shall present the document to the Registrar.

CLOSING

The Registrar shall rise, cap and invite the Vice-Chancellor to make his Closing Remarks.

THE VICE-CHANCELLOR'S CLOSING REMARKS.

The Vice-Chancellor shall then rise, cap and make his Closing Remarks. The Congregation shall rise for the University of Port Harcourt Anthem and remain standing as the Academic [Honour] Procession retreats in the following order:

VICE CHANCELLOR
DEPUTY VICE-CHANCELLOR [ADMINISTRATION]
DEPUTY VICE-CHANCELLOR [ACADEMIC]
REGISTRAR
LECTURER
PROVOST, COLLEGE OF HEALTH SCIENCES
DEAN, SCHOOL OF GRADUATE STUDIES
DEANS OF FACULTIES/SCHOOLS
PROFESSORS
ACADEMIC OFFICER

PROTOCOL

- The Vice-Chancellor
- Previous Vice-Chancellors
- Deputy Vice-Chancellors (Admin and Academic)
- Previous Deputy Vice-Chancellors
- Members of the Governing Council
- Principal Officers of the University
- Provost, College of Health Sciences
- Dean, Graduate School
- Dean, Faculty of Management Sciences
- Deans of other Faculties
- Heads of Departments
- Distinguished Professors
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- Visiting Academics and Colleagues
- Esteemed Administrative Staff
- Captains of Industries
- Cherished Friends and Guests
- Unique Students of Unique UNIPORT
- Members of the Press
- Distinguished Ladies and Gentlemen.

1.0 INTRODUCTION

The term benthos is broad and refers to all the plants and animals living on or closely associated with the bottom of a body of water. It also refers to the bottom habitat. The animal component constitutes zoobenthos, while benthic plants are phytobenthos. Zoobenthos are animals that live on or in sediments. They are classified based on size and the part of substrate where they spend more time. The forms that live mainly in sediments are called infauna, while those that live on the sediment are known as epifauna (or surface fauna). Based on size and retention by sieve, zoobenthos >0.5 mm are termed macrozoobenthos or macrofauna, <0.5mm – 0.62µm and 0.62µm – 5µm are meio and micro-zoobenthos, respectively (Schleicher and Woolridge 1996; Knox, 2001; Nybakkan & Bertness, 2005).

Hyperbenthos applies to a group of small animals living in the water layer close to the seabed (Mess and Jones, 1997). The latter group plays important role in coupling benthic and pelagic food webs (Knox, 2001). As shown in Figures 1 and 2, there are two broad subdivisions of tidal seas, estuaries and brackish waters, namely intertidal and subtidal areas. The intertidal area is covered and exposed during high and low tides, respectively. The subtidal area is permanently submerged with water. Benthic studies cover the intertidal and subtidal areas, because the overlying water column in the subtidal is underlain by substratum.

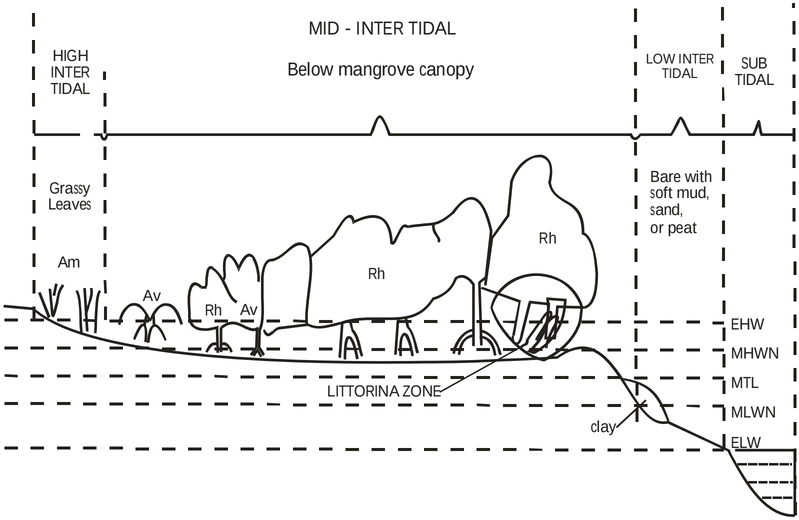

Figure 1. Diagram of hypothetical tidal zones

Zonation is based on the principles of Plaziat (1984) with modifications:

(Rh) Rhizophora, (Av) Avicennia, (Am) Acrostichum, (EHW) Extreme High water, (MHWN) Mean High Water Neaps, (MTL) Mean Tidal Low, (MLWN) Mean Low water Neaps, (ELW) Extreme Low water.

Figure 2. A typical tidal flat with sandy and muddy sections and ingressing flood water.

The adjective benthic refers to something connected with or occurring on the bottom of a water body (CSC, 2008). There are diverse benthic habitats each with varying characteristics (i.e. physico-chemical, biological, and geological features). In the benthos are different substrates or substratum, namely sandy, muddy, sandy mud, gravelly, stony/rocky, depending on which soil particle size dominates. Leaf litter or snags could also dominate the bottom substrate. Substrate includes everything on the bottom or sides of water bodies or projecting into the water, not excluding a variety of human artefacts and debris, on which organisms reside (Minshall, 1984). Substrate textural characteristics influence abundance and diversity of benthos. Other physical and chemical conditions such as water currents, wave energy and temperature, dissolved oxygen, pH, biochemical oxygen demand (BOD), salinity and organic enrichment affect the diversity of benthic animals. Biological factors include reproductive output, competition, and predation.

Mr. Vice Chancellor, Sir, the mission of the University of Port Harcourt is “the pursuit of academic excellence, advancement of knowledge and community service through quality teaching, life-long learning, social inclusion, strengthening civil society and policy-relevant research that addresses the challenges of contemporary society”. Twenty-one estuaries and numerous tributaries, creeks and streams dissect the Niger Delta region where our unique university is located. The first three lines of our university anthem reads “on the green low lands and swampy plains of the New Calabar River stands the University of Port Harcourt’’. Unfortunately, the New Calabar River is no longer GREEN because the integrity (biodiversity and water quality) has been compromised by human activities. Like Uniport, many villages, towns, institutions and industrial settlements are located on the shores of surface water bodies of the delta with attendant impact of human activities. The shores and adjoining water-covered areas are the homes of the zoobenthos. Consequently, I have devoted a greater part of my research career in studying benthic baseline conditions and the relationships between human activities and macrozoobenthos of the Niger Delta. The central thrust of this lecture is to expose to this wide audience the ingenuity, creativity, resilience, intelligence and ecosystem services of macrozoobenthos. Secondly, I will highlight some of my contributions to the subject area.

The benthic zone provides many valuable products and ecological services. It helps to buffer wave action along coastlines. It provides areas for spawning, foraging and refuge for various fish species. Benthic habitats function in nutrient cycling and removal of contaminants from the water (CSC, 2008).

1.1 Composition of Zoobenthos

This depends on the type of water body and the diversity of habitat present. The faunal composition and relative abundance in freshwater is different from those of saline waters (e.g. estuaries and seas). Insects dominate the benthos communities in freshwater, while in most saline waters, polychaetes (segmented marine worms) dominate. Broadly, zoobenthos include members of finfishes (Pisces), Crustacea, Insecta, Mollusca, Annelida, and Echinodermata. According to Korihauser (2007), crustaceans, sponges, bivalves, snails, sea stars, polychaetes and many others inhabit this zone. The benthos truly reveals the diversity of life in the aquatic system especially the sea. Their abundance, biomass, and composition may serve as indicators of changes in the environments. Groffman and Bohlen (1999) noted that microhabitats are created in the benthos by chemical gradients and microzonation in concentrations of dissolved oxygen, hydrogen sulphide, phosphates, ammonia and other critical chemicals. Cowell (1998) went on to stress that "biocomplexity" of relationships and habitats affects biodiversity. The variety of benthos involves shapes, appearances, behaviours with adaptations to different types of niches.

1.2 Feeding Modes

Benthic fauna can be grouped based on their feeding habits and there are five groups. The deposit feeders take in sediment, feeding on the microorganisms and organic matter in the sediment. Examples of this group are periwinkles, some crustaceans (hermit crab, mud shrimp etc), some polychaetes (rag worms, cat worm etc) and some sea cucumbers. Suspension feeders among which are the passive ones with feeding structures that they push into the water and the active forms that set up water current and move food particles to their mouths (example bivalves such as oyster). The herbivores feed on plant materials. These include some crabs, polychaetes and sea urchins. Carnivores feed on other animals. Examples include some crabs, sea anemones and fishes. The scavengers feed on dead remains of other organisms. Small invertebrates are functionally important in many aquatic and terrestrial ecosystems (Wilson, 1992; Palmer et al., 1997; Postel and Carpenter, 1997). Though only a small fraction of the micro, meio and macroscopic benthic animals that reside in and on sediments have been described and few estimates of total species, numbers and biogeographic pattern have been attempted.

Behold some of the unsung heroes of the Niger Delta benthic community.

Table 1: CHECKLIST OF COMMON BENTHIC MACROFAUNA OF RIVERS AND BAYELSA STATES OF THE NIGER DELTA (NIGERIA)

PHYLUM	CLASS	ORDER	FAMILY	SPECIES	COMMON NAME
Chordata	Actinopterygii	Perciformes	Periophthalmidae	*Periophthalmus papilio*	(Mudskipper)
	Actinopterygii	Perciformes	Eleotridae	*Eleotris daganensis*	Awura (Ijo)
	Actinopterygii	Perciformes	Gobiidae	*Yongeichthys thomasi* *Porogobius schlegelii*	Goby Mangrove fish
	Actinopterygii	Perciformes	Eleotridae	*Bostrychus africanus*	Sleeper gobies
	Actinopterygii	Cyprinodontiformes	Cichlidae	*Tilapia* sp (juveniles)	Blackchin tilapia (Atabala)
			Poeciliidae	*Aplocheilichthys spilauchena* (eggs and juveniles)	Banded Lampeye
			Ophichthidae	*Myrophus plumbeus*	Swamp eel

Annelida	Polychaeta		Nereidae	*Nereis falsa*	
				Ceratonereis sp	
				Perinereis sp	
				Namalycastis indica	
				Nereis diversicolor	Rag worm
				Nereis virens	King ragworm,
				Platynereis sp	Clam worm
			Capitellidae	*Notomastus latericeus*	Simple bristle worm
				Capitella capitata	Gallery worm
			Capitellidae	*Notomastus tenuis*	
			Nephthyidae	*Nephthys hombergii*	Cat worm
			Pilargidae	*Ancistrosyllis* sp	
		Eunicida	Eunicidae	*Marphysa* sp	
				Eunice sp	Rock worm
				Lysidice ninetta	
			Orbinidae	*Scoloplos capensis*	
				Scoloplos armiger	Armed bristle worm
			Sabellidae	*Sabella* sp	Feather/ duster/ Fan worm
			Sabellongidae	*Sabellonga disiincta*	
			Cirratulidae	*Audounia tentaculata*	
				Cirratulus sp	Bristle worm
			Glyceridae	*Glycera convoluta*	Blood worm

				Glycera capitata *Glycera longipirus*	
			Syllidae	*Syllis prolifera*	
			Arenicolidae	*Arenicola marina*	Lug worm
			Maldanidae	*Axiothella rubrocincta* *Clymenella torquata*	 Bamboo worm
			Lumbrinereidae	*Lumbrinereis* sp *Lumbrinereis latreilli*	
			Oenonidae	*Oenone fulgida*	
	Oligochaeta		Naididae	*Allonais paraquayensis*	
Arthropoda	Malacostraca	Decapoda	Sesarmidae	*Sesarma elegans* *Sesarma alberti* *Sesarma huzardi* *Sesarma angolense* *Metagrapsus curvatus* *Pachygrapsus gracilis* *Goniopsis pelii* *Pachygrapsus transverses*	Mangrove crab Mangrove crab Hairy mangrove crab Mangrove crab Dark shore crab Purple mangrove crab Mottled shore crab
			Gecarcindiae Panopeidae Portunidae Ocypodidae	*Cardisoma armatum* *Panopeus africanus* *Callinectes amnicola* *Uca tangeri*	Land crab (Oluu) African mud crab Swimming crab Ikoli Fiddler or ghost crab

			Diogenidae	*Clibanarius africanus*	Hermit crab
				Clibanarius cooki	Hermit crab
			Alpheidae	*Alpheus pontederiae*	Snapping shrimp
			Upogebidae	*Upogebia furcate*	Mud shrimp
			Callianasidae	*Callianassa* sp	
			Penaidae	*Penaeus notialis*	Shrimp
		Tanaidacea	Tanaididae	*Sinelobus stanfordi*	
		Isopoda	Sphaeromatidae	*Sphaeroma terebrans*	Mangrove Boring Isopod
				Deis sp	
			Anthuridae	*Cyathura* sp	
		Amphipoda			
			Melitidae	*Ouadrivisio lutzi*	
	Insecta		Aroidae	*Neomicrodeutopus cabindae*	
		Diptera	Chironomidae	*Endochironomus* sp	Non-biting midge
			Hydrophilidae	*Amphiops* sp	
			Culicidae	*Culex* sp	Midge
	Entognatha	Entomobryomorpha	Isotomidae	*Isotoma* sp	Springtails
				Zootermopsis	Dampwood termites
		Hemiptera	Gerridae	Gerris sp	Water striders
		Isoptera	Termopsidae	*Zootermopsis*	Dampwood termites

Mollusca	Gastropoda	Cycloneritimorpha	Neritidae	*Neritina adansoniana*	
		Sorbeoconcha	Potamididae	*Tympanotonus fuscatus*	Periwinkle (esem)
			Thiaridae	*Pachymelania fusca*	Periwinkle
				Pachymelania aurita	Periwinkle
			Ellobiidae	*Melampus liberianus*	Salt marsh snail
			Assimineidae	*Assiminea* sp	Salt tolerant snail
			Littorinidae	*Littorina angulifera*	
			Galeodidae	*Semifusus morio*	Whelk
			Haminoeidae	*Haminoea orbignyana*	
			Muricidae	*Thais califera*	Dog Whelk
				T. califera var coronata	
	Bivalvia		Teredinidae	*Psiloteredo senegalensis*	
			Ostreidae	*Crassostrea gasar*	Oyster (Mgbe)
		Arcoida	Arcidae	*Anadara/Senilia senilis*	Bloody cockle
			Solecurtidae	*Tagelus adansonii*	Razor clam
			Tellinidae	*Tellina nymphalis*	Tellin
			Aloididae	*Aloides trigona*	Basket shell
				Aloides striatissima	
			Lucinidae	*Loripes aberrans*	
				Keletistes rhizoecus	Lucinid
Cnidaria	Anthozoa	Actinaria	Actiniidae	*Actinia* sp	

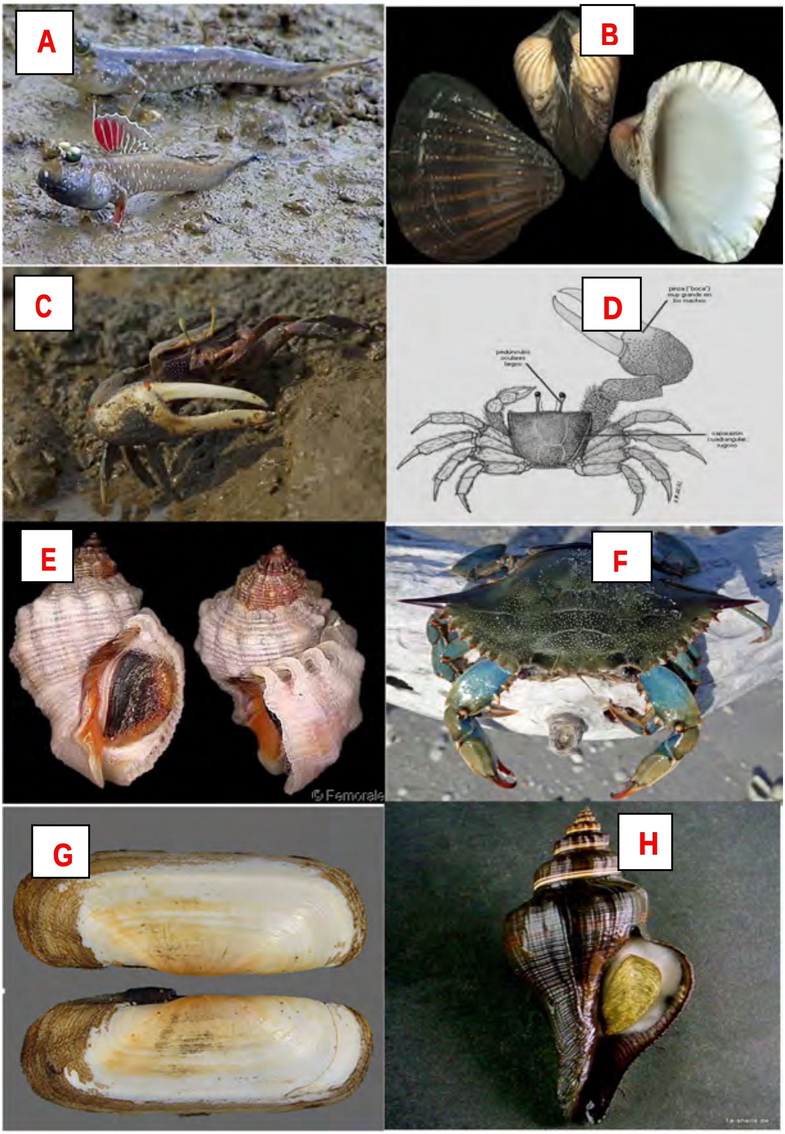

Figure 3 A-H: Some Edible Benthos
A – Mudskipper; B-bloody cockle; C- Uca .t; D-Uca Sketch; E-Thais c; F – Swimming crab; G- Razor clam; H – Whelk.

The benthos are involved in biogeochemical cycles (nitrogen, sulphur, carbon, etc.) and distribution of pollutants by regulating them. They convert organic detritus (plants and animals at different stages of decomposition) from the sediments to dissolved nutrients and the nutrients released into the water column where they can be utilized by the aquatic "producers". Covich *et al*. (1999) stated that benthic invertebrate species function in different ways that are important to maintaining ecosystem functions such as energy flow in food webs. Many benthic species convert live plant and dead organic material into prey items for larger consumers in complex food webs. They are very important in ecosystem functioning.

Benthic organisms differ in their rates of decomposition of organic matter as their mouthparts and modes of feeding are different. To carry out ecological functions, different benthic organisms undertake their activities in different ways. The integrity of freshwater depends on how different benthic species make their living and contribute to complex food webs. Benthic macroinvertebrates make up a great percentage of the food web in the different aquatic ecosystems. Fish, terrestrial animals like birds and man feed on them directly and indirectly. They also make up the food species of many fauna that we eat.

1.3 The Middle Men

Some scientists refer to them as the "middle men" of the aquatic food webs. Their diversity positions them properly as "middle men" and makes these animals important in cycling of nutrients and energy flow in the food chains and webs. Some are primary producers; some are herbivores or carnivores and others are detritivores. Hence Palmer *et al*. (1997) reported that specific benthos is basically important in the determination of how organic matter is processed in fresh water ecosystems. Wallace and Webster (1996) and other workers reported that different groups of benthic consumers use different sources of energy. They also noted that benthic invertebrates function in performing essential ecosystem services as they increase the rate of the decomposition of detritus; these organisms also through their feeding activities and excretion release bound nutrients. This makes the nutrient available to plants (Clark *et al.*, 1997). Crowl and Covich (1990; 1994) noted that many predatory benthic invertebrates control the locations, numbers and even sizes of the prey they feed on.

Covich *et al.* (1999) concluded that different species of benthos have specific roles that can be represented by only a few species. As a result of this, any decrease in diversity maybe destructive to the functioning of the ecosystem. It is therefore very important that the biodiversity of benthic communities is preserved. In addition, benthic organisms are involved in cleaning the aquatic ecosystem.

1.4 The Monitors

Biological monitoring of an ecosystem is necessary and very important as it enables scientists to study alterations in the system from mainly anthropogenic causes. Benthos have different responses to changes in environmental quality (example chemical composition of water) and alterations in their habitats. In most cases, the reactions can be measured and, according to Enviro Science (2014), the perturbations produce measurable and usually predictable shifts in abundance and composition at the community level. In some like the chironomids the effects can result in deformities of the mouthparts. Chironomids and some other benthic macroinvertebrates are therefore used as ecotoxicological indicators (test organisms). Rosenberg and Resh (1993) stated therefore that macroinvertebrates are most frequently used for biomonitoring. Also Philips and Rainbow (1993); Kennish (1992) have said that indicator species that can accumulate pollutants in their tissues from their food and environments are important as biomonitoring agents so better than the chemical monitoring.

Benthic macroinvertebrates with their limited mobility are good candidates for biomonitoring/indicator organisms as they are likely to be affected directly/indirectly by toxic materials in the environment.

Many are infauna or live attached on other structures like stones and trees so not easily carried away by water currents and waves.

Aquatic invertebrates are referred to as having the longest history of being used for biomonitoring (Barbour *et al*., 1999). Many benthos have a planktonic larval stage, which helps in dispersion and the reduction of competition at the adult benthic stage. They are easy to sample and their population is quite high so the problem of over-sampling or exploitation is less an issue. However, it is not cast in stone that all zoobenthic species will be abundant. Very few individuals may represent some taxa in the community. Generally, biological communities are characterized by few species that are very common (represented by many individuals), while most species are rare, some represented by one or few individuals (Gray, 1981). Rarity of species is linked to the concept of minimum viable population in ecology, that there exists a minimum population density below which a species is unable to maintain itself locally without fresh introductions from outside source (Rosenweig, 1995).

At any particular time and point they give an indication of the quality of the water body as some of them are very sensitive to impacts of pollutants and disturbances (e.g. short and long term changes in environmental parameters). In addition to biomonitoring, benthos can be used for conservation purposes like assessing the degree of environmental degradation of streams and rivers and thus aid in their restoration and management. They can also be used for the monitoring of eutrophication, thermal pollution, etc. Examples of good water quality sensitive indicators include mayflies, stoneflies, caddisflies, and *Upogebia*. Pollutant tolerant forms include chironomids, *Capitella capitata* and black fly larvae. Growing and flourishing benthic communities are a result of healthy ecosystems and vice versa; while a degraded ecosystem loses the benthic communities.

2.0 LIFE IN THE COMMUNITY OF OUR HEROES

The Engineers: Like my five-year-old granddaughter said "God must have created the builders first before every other thing because the builders came, built the houses so that the people can live in". This truly tells us of the importance of the homebuilders, the burrowers of the benthic community. The concept of ecosystem engineer was first defined by Lawton (1994) as *"organisms that directly or indirectly modulate the availability of resources to other species by causing physical changes in biotic and abiotic materials"*.

According to Jones *et al.,* (1994) there are two classes of engineers.

a) The autogenic engineers that change the environment through their own tissues. These are also known as the epibenthic (above the sediment) engineers. Among these are dense vegetation of the macro-algae, sea grasses, and reef building filter feeders. By their structure they influence local hydrodynamics and therefore also influence the sediment dynamics and trapping of particles for plants. Epibenthic engineers therefore modify mainly the habitats in the sediment surface by their physical structures.

b) The Allogenic or Endobenthic engineers (below the sediment). They function mainly through the modification of the sedimentary habitats. They affect resource flows through bio-irrigation and bioturbation (Cadee, 2001; Reise, 2002). In bioturbation, the process of tube building and biological mixing of sediment occurs, which is akin to humans mixing sand and cement. This modifies the structure and the biogeochemical nature of the sediment. Their activities increase exchange rate and flow of water and materials at the interface of the water and sediment. While on the other hand, bio-irrigation involves the active flushing of burrows with surrounding water. This increases gaseous exchange rate between water and the sediment. Bioturbation and bio-irrigation modify the benthic sedimentary environment and strongly affect the functioning of the community and ecosystem.

2.1 Some Benthic Ecosystem Engineers in the Niger Delta

Our unsung heroes: mud shrimps *Upogebia, Callianassa*; amphipods, fiddler crab (*Uca tangeri)*, sesarmid crabs (*Sesarma huzardi, S. elegans, S. alberti* and *Metagrapsus curvatus*), and polychaetes like *Nereis falsa.* All these use their claws, pleopods, mouths, etc. as digging tools. By their construction activities they make positive impacts in our mangrove ecosystems and tidal flats.

Though erroneously regarded by humans as not 'intelligent' they construct their tubes and burrows in specific sand: clay/mud ratios with binding secretions that prevent their homes from collapsing. There is no cheating like ten parts of sand to one part of cement or less reinforcement with rod that result in the collapse of some of our buildings with attendant fatalities.

In the Niger Delta, crabs and polycheates are the major macrofauna ecologically engineering the mangroves and tidal flats through the processes involved in digging and maintaining of their burrows. The burrows are of different sizes and shapes. They can be simple or complex. Depending on the architectural designs there can be only one opening at the sediment surface or it may be branched with double or triple openings. The nature and type depends on the nature of the engineer. Sizes of the burrows vary. It depends, to a large extent, on the size of the owner (just like in humans the size of the pocket). The burrows provide refuges from extreme physico-chemical parameters like fluctuations in temperature and salinity.

In the burrows, the occupants are protected from predators especially the finfishes that come in with flood tide. Burrows also enable benthos moisten their gills during low tide and are constructed in such a way that the crabs can quickly run into them when threatened or pursued by a predator. They are also used for courtship and reproduction and are also microhabitats providing the occupants with favourable environmental conditions. The burrows allow for chemical and physical processes and interactions between the substrate, and over-lying water. They affect the topography and biochemistry of the sediment through the modification of particle size distribution, drainage redox conditions and organic matter as well as nutrient availability (Botto and Iribame, 2000) and food storage.

Simply put, crabs, the endobenthic ecosystem engineers, modify the physical structure, sediment chemical constituents and transport condition. In addition to burrows, some fiddler crabs (Fig. 4) construct chimneys (i.e. mounds of mud constructed around the burrows). These help in reducing the number of intruders to their burrows, as they do not link chimneys with the entrance to the burrow. *Uca* can construct holes of up to 3feet deep even when they are less than 2inches in width. These digging activities can widen tidal creeks. I put forth, therefore, that I think man copied the technology of dredging from our heroic architects, civil, mechanical, and structural engineers of the benthic community.

Figure 4: Fiddler Crab (*Uca tangeri)*

The snapping or pistol shrimp *Alpheus* (Fig. 5) is also an engineer. They are burrowers and possess an enlarged claw (usually larger than half the body size). Their claws open and snap shut at a very high speed. When the two parts snap into each other bubbles are released and through the release and collapse of the bubbles, sound, heat, and light are produced. One snap can be louder than that of a gunshot. Though they snap and make a noise, these shrimps do not hear it but it can prevent the accurate functioning of the sonar systems of submarines and ships especially when the shrimps are in colonies and snap concurrently. The noise also helps them in killing their prey, which includes small worms, crabs and fish. The bubbles release the sound and pressure that enable them stun their prey, attract their mates and defend their territories. They are special killers getting their prey without touching them.

Figure 5: Pistol /snapping Shrimp *(Alpheus sp)*

The burrows do not only provide refuge for the owners but for other organisms. They create homes for others. Mangrove fishes, the sleeper gobiids and eleotrids (*Yongeichthys thomasii, Porogobius schlegelii and Bostrychus africanus)* cohabit with the sesarmid crabs in the same burrow. The snapping shrimps harbour gobiid fishes in symbiotic relationships. The gobiids in turn serve as security men warning the shrimps of danger at which both retreat speedily into the burrows. The gobiid uses a specific movement of the tail to relay the information to the shrimp through the antennae (their own telephone system). The land crab, *Cardisoma armatum,* harbours snakes. The burrows are very conducive microhabitats with water for survival during lowtide. At lowtide, when the intertidal area is exposed to aerial weather, water retained in burrows keep the occupant's gills wet and sustains breathing. Burrows provide refuge at high tide, enabling the inhabitants to escape from their enemies. Burrows are also used for feeding, courtship, mating and incubation.

The tubiculous amphipods provide shelter and food for benthic diatoms e.g. *Navicula* and some bivalves. They are their 'Brothers Keepers'. The benthic burrowing engineers help in making sure no one in the community is stranded at lowtide. Without politics and all forms of bickering the average Nigerian provides refuge, harbours people from different parts of the country; private security guard, house help, through interethnic marriage, etc. and there is peace and unity. Presently, however, there is so much distrust and dangerous division amongst Nigerians along ethnic, political inclination and religious lines. Some persons erroneously argue that such division is normal given the multitude of ethnic groups the country is made up of.

Mr. Vice Chancellor, Sir, benthos diversity is several folds greater than Nigeria human ethnic diversity, yet members of the former community live in peace. We really have to go back, with humility and learn from these so called "unintelligent" but unsung cooperative heroes.

In summary, the benthic macrofauna are architects as they plan and chose suitable sites for their burrows. They are superb Civil Engineers as they construct solid, lasting homes. Mechanical engineers because they are able to modify the ecosystem through transforming materials from one state to another by mechanical means (for e.g. chewing).

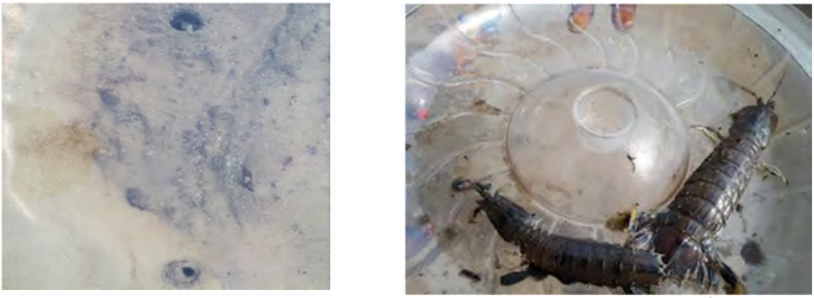

Figure 6: Two mantis shrimps (*Squilla sp.*) harvested from the paired burrow

In the benthic community God's command in Genesis 1:22a "God blessed them and said be fruitful and increase in number and fill the water in the seas" is fully adhered to.

2.2 Breeding

In this wonderful community breeding is in different forms. Among the fiddler crabs (Kambulo) the males operate in a special way. In the world there are 65 species, but in Nigeria there is only one, *Uca tangeri*. The males are masculine and proudly exhibit it.

One of their claws is enlarged (macho man) and this is for courting the females. Trust the females, they make *shakara; dem go dey pose dem go dey denge, denge, dem go dey pose*. The female leaves her own burrow and moves through the waving males, visits a number of males. She can visit up to 24 interested males before choosing her heart throb. Females may choose based on courtship signals and quality of the resource (burrow). Many also go for large crabs for protection (so to some extent, women should not be blamed when they go after the good things of life). They can also resist the males by running away or responding aggressively. She then enters accepted male's burrow and does not come out till after incubation (about 2 weeks) (Fig. 7). The male comes out after about 5 minutes, gathers sand to block the entrance. He re-enters and blocks it from inside, securely closing the burrow and sealing both of them inside to ensure optimal privacy - no facebook, no taking of photos, no phone pinging or sending of WhatsApp messages.

Figure 7: Male and female fiddler crab showing the big claw of the male

Mating takes place and the male crawls out and covers the entrance again with the female inside and she does not feed throughout this period (Sweet mother). While the females breed once a month, the males can mate every day. Remember the Nigerian law that no female should have more than four children: the unwritten aspect is that a man can decide to have four children from thirty-six women, one in each state of the federation. That way our population cannot be managed.

These heroes jealously fight for mates. Females fighting females and males fighting males but unlike humans the male hardly fights the females and does not steal a female's burrow. They are perfect

‘gentle crab men’. In some species the males even carry the females around on their backs till mating is finished

2.3 Community Relationships

In the benthic community, there are two major types of relationships -cooperative and competitive! Cooperative is important in the ecological functions of the community. This enables for better exploitation of the natural resources. In the spirit of cooperation phytal relationships take place. Macro-algae grow densely on the breathing roots (pneumatophores) of the white mangrove (*Avicennia germinas*), banks of creeks and even on the mangrove forest floor forming patches that in turn supply the bottom layers for different meio- and macrofauna to inhabit.

Competition and fighting is common among these heroes as amongst humans. It is usually among different species (inter specific) and within same species (intraspecific). When an organism with superior ability to exploit a limited resource uses the resource and prevents inferior competitor’s access to the resource, it is **Exploitative**. **Interference** competition refers to when an organism deliberately stops another from using the common resource by physically contesting access. The third form is **pre-emptive** competition, whereby a competitor recruits to and dominates a habitat, monopolizing available space, precluding the establishment of potential competitors (Bertness, 1999).

a) **For resource -** among the grapsid crabs *Hemigrapsus oregonensis* is smaller in size than *Pachygrapsus crassipes. H. oregonensis* digs its burrow while *P. crassipes* does not but pushes out the former mercilessly and enlarges the burrow and occupies it (*monkey dey work, baboon dey chop*).

   For most of the crabs that are territorial, every territory owner defends its territory and fights any stranger even with neighbours in order to establish their boundaries. Imagine the countless land cases all over the country between kinsmen and unrelated persons. If we say in evolution that simpler forms evolved to complex and higher forms then we can say we learnt from the benthic heroes. The enlarged claw of *U. tangeri,* in addition to its use in courtship, is also a good weapon for fights.

b) **Female based protection -** the brachyuran crabs aggressively guard and defend females and for some species it can last for some days, the mating burrows are also guarded. The land crab, *C. armatum* (olu) defends and competes for breeding site. Indirect competition also occurs when males indirectly use signals to attract the females. In fighting for potential mating partner some males lose their limbs and subsequently regenerate the lost limbs by molting. Imagine if this were to happen in our villages and towns, many men will be limbless in order to have a female partner. That might have reduced armed robbery, terrorism and kidnappings because without hands it will be difficult to carry guns. However, some ladies are murderously violent and perpetrate other social vices. So the above social vices would have subsisted even if all men were limbless. Viewing the above through the prism of gender equality such as 35% affirmative action (women in governance), it is apparent that Nigerian women are only asking for so little from men – far less than what male crabs give their females on the platter of gold.

Also remember Cyprian Ekwensi's The Passport of Mallam Ilia where he stated ''Gone are the days when men were men and women were won by those who deserved them''. Mr. Vice Chancellor, Sir, we need to emulate benthic crabs and bring back that era.

c) **Bold and tactful defence** – they protect their territories and attack their predators with tact such as avoidance and physical attacks. Unlike man that may insist ‘over his dead body’, benthos are smart in their self-defence, bearing in mind that, as Bob Marley said, ‘he who fights and runs away shall fight another day’. In the process, they may lose valuable body part(s) but they are mindful of the net survival benefit. For example, crabs (such as swimming crab, fiddler crab) display smart defensive behaviour called **escape autotomy**. They threaten predators including humans by extending their claws; but if threatening does not work, the crab will pinch the intruder and quickly flee, leaving the pinching claw attached to the predator. This behaviour distracts the predator (as the predator is struggling to remove the abandoned pinch-claw) long enough for the crab (minus one claw) to escape. Lost limbs are replaced at huge cost, when the crab molts; complete replacement typically takes two or three molts (Smith, 1990), but the crab stays alive!

Incredible tolerance: Science has revealed that there are hydrothermal vents spewing out hot springs rich in minerals having species of bacteria that can tolerate temperatures higher than that of boiling water. Macrozoobenthos also inhabit hydrothermal vents. The Pompeli worm, *Alvinella pompejana*, holds the record for the hottest habitat for an animal (Palumbi and Palumbi, 2014). The tail end of the worm lives at 66^0C in the chimneys of hydrothermal vents in the deep sea. The head end, an inch or two away, lives at the normal temperature of the deep sea, about 4^0C. However, the worm manages to live at both temperatures, and everywhere in between, is a mystery that has sparked a detailed search of its genome for temperature-tolerant proteins.

It must be noted that the intertidal environment where zoobenthos inhabit is harsh due to fluctuations in environmental variables, particularly temperature and salinity, as the area is exposed to aquatic and aerial weather tidally and daily. Temperature of exposed pore water may rise too high when the sun is shining or fall abruptly in cold weather or season.

2.4 Zonation

One of the “Solutions” to competition among these heroes in the benthic community is Zonation. Neves *et al.* (2007) reported that the special needs of each benthic organism and tolerance to the varying ecological parameters result in distribution of the organisms in characteristic zones and this is known as zonation. Biological and physical factors interact and help in the establishment of definite limits of zonation for each species. Zonal patterns along vertical or horizontal environmental gradients are well known biogeographic phenomena.

The patterns result from reasonably well-understood mechanisms like physical and physiological stress and especially biological interactions such as competition and predation in the shallow marine habitats (Dayton *et al., 1982)*. Organisms in the benthic community look for positions of easy access to food, protection from predators, negative effects of tides, salinity fluctuations and the nature of the sediments. Many are positioned in accordance with their abilities to tolerate exposures to the differing physico-chemical parameters. Generally zonation of benthic macrofauna is not based on a single factor but interaction of factors.

From our studies, our intertidal communities can be broadly divided into three zones. That is the Low intertidal (Government Reservation Area), Mid Intertidal (for Middle Class) and the High Intertidal (low income earners zone; the urban slums, waterside slums, face me I face you setting), each with its characteristic plants and animals.

GRA Low intertidal - here the tidal flow and the attendant fluctuations of temperature, salinity and other physico-chemical parameters are minimal. There is always water in the creek channel fringing this zone, the sediment is moist and mainly of fine sand, silt and clay. Water quality is 'good' as there is generally an improvement of water quality from inner to outer harbour. In a typical Niger Delta mangrove (Fig. 8), the polychaetes (soft-bodied segmented worms), relatives of the earthworm, crabs like *U. tangeri* with weak claws, the sea anemones (*all Ajebutters*) that cannot withstand much stress inhabit this zone. Here, there is comfort, competition is less, temperature is relatively stable and diversity is usually lowest – our GRA equivalent.

Mid Intertidal (middle income abode)- In this zone there is relatively more concentration of nutrients, shade from mangrove trees, strong peaty soil (chikoko mud) and it is densely populated. The rate of competition is higher.

Here are the homes of the mangrove crabs, mangrove fishes, the periwinkles and other gastropod snails, and the snapping shrimps.
Diversity and density are highest here for most organisms including the algae and other primary producers. It is where you have the middle-income families.

The mangrove trees, their stilt roots, pneumatophores and branches provide shelter and protection for many fauna. Accumulation of silt, detritus and algae enhance the availability of food for many benthic macrofauna. Algal mats provide shelter and food for juveniles of snails, fish eggs and detritus for deposit feeders.

Figure 8: Nwinua protected mangrove swamp in Kono Creek

In the zone are a variety of microhabitats that include algal mat, crab burrows, the invasive nypa palm (*Nypa fructicans),* the mangrove sedge (*Paspalum vaginatum*), mangrove fern (*Acrostichum aureum*) and dead wood. These account for the high variety and density of organisms found in the zone.

High Intertidal (For the Masses, the low income earners) **-** This is where the tough ones, the struggling, hustling hard working masses live. Here are mainly the snails like periwinkles, *Neritina,* the shell dwelling hermit crab with their hard shells and land crab *C. armatum* (olu) able to withstand the highest level of variations of environmental parameters.

The mudskippers join them at low tide skipping on land with its modified pelvic fins. This zone has the highest temperature. Some areas of this zone at neap tides are not submerged with water even at high tide. The snail *Melampus* is amphibious and breathes atmospheric oxygen so it is able to inhabit this zone where the exposure time (at low tide) is high. It is adapted physiologically to overcome desiccation.

2.5 Size Zonation (Care of the Young)

As humans we believe that only mammals take care of their young but truly these supposedly lower forms in their own way also take care of the young. Many of the species exhibit size zonation where the younger forms are in more comfortable and protective areas. This form of zonation reduces and, to some extent, prevents intraspecific competition. For periwinkle the sizes 0 - 11mm are more in the GRA (LIT) while the larger forms are more in the Mid and High intertidal areas. For the pulmonate snail *Melampus* the adults >4-5mm are found on trunks of trees, prop roots, pneumatophores and seedlings at the high intertidal. While the juveniles stay in holes in the trunks of trees, dead logs and under leaves.

There is usually an exception as exhibited by the crab *S. huzardi* where sizes of 1-7mm are more in the waterfront (HIT). This is an adaptive mechanism to avoid predation by fishes who come in with the tide and prey more on individuals in that size range and will not be able to access the high intertidal especially during neap tide. White mangrove pneumatophores also impede the movement of predators to the HIT.

2.6 Sex Distribution

There is respect also for pregnant females among the crabs *S. huzardi* and *M.curvatus.* There is zonation by sex with a higher density of females in the shaded, protected zones that are submerged with water during spring and neap tides. This prevents desiccation and destruction of the eggs. It also ensures a suitable environment for the release of larvae, which will be carried by the tides to appropriate areas of settlement.

In the quest for decent living and to reduce rivalry and competition, no space is wasted. So many structures are turned into microhabitats and homes. Algal mats, crab burrows, the mangrove trees, their leaves and roots; the fern *Acrostichum,* grasses (e.g. the sedge *P. vaginatum*) and even the illegal occupier that came as a squatter and is seriously inching out the original owners (Nypa); all serve as habitats for different species of benthic macrofauna like isopods, amphipods, eggs of the fish top minnow (Figure 9).

Figure 9: White mangrove with pneumatophores where topminnows lay eggs

For some of these fauna, these microhabitats serve as holdfasts so they can feed on the abundant detritus (different stages of decomposed organic materials) and on other residents. Even dead woods moved into the intertidal by tide serve as homes for juvenile crabs, polychaetes like *Namalycastis* and the mollusc *Psiloteredo* (ship worm). With proper utilization of space and food the basic essentials of life and respect for each other is guaranteed. Only healthy competition exists, no grabbing, no court cases, no kidnappings, and no 419 till man intervenes and alters their natural environment.

Mr. Vice Chancellor, Sir, we need to pause and ask ourselves this pertinent question. If 'unintelligent' crabs can protect pregnant females to successful safe delivery, how come intelligent humans (for e.g. Nigerians) cannot afford safe motherhood by preventing maternal and child mortality?

2.7 Cleaning of the Environment

In the benthic community two major processes feeding and cleaning the environment are intertwined. Macrozoobenthos maximize their food value chain and recycle materials, thereby cleaning the environment. In some cases, they do the cleaning collaboratively. A case in point is seen amongst members of the Lucinidae. The family Lucinidae currently has 500 extant species known from a wide-range of habitats and 32 species have been reported from tropical West Africa (von Cosel, 2006). One species, the West African lucinid, *Keletistes rhizoecus*, discovered in 1986 by Graham Oliver is endemic in the Niger Delta -had not been reported outside the cartographic Niger Delta (von Cosel, 2006) (Figure. 10).

A common experience when one walks through intertidal mud is the smell of rotten egg, caused by accumulation of hydrogen sulphide gas. The gas is toxic; the higher the concentration, the more intolerant species get excluded from the environment. Lucinidae is one of five bivalve families presently known to be chemoautotrophic, because they harbour sulphur-oxidizing bacteria in their gills (Reid, 1990).

The bacteria convert the chemical energy of hydrogen sulphide into raw cellular energy, which benefits the bivalve. Overall, reduction in hydrogen sulphide concentration in the tidal flat makes the environment benign for hydrogen sulphide sensitive species to inhabit.

Figure 10: Different size classes of *K. rhizoecus* collected from Bodo Creek

2.8 Filter Feeders

Every animal needs energy to sustain itself, which comes mainly from and through foods. In filter feeding, aquatic organisms take in small pieces of matter of different sizes in water filtering out unwanted materials and taking in needed materials. Filter feeders have specialized structures for obtaining their food. Some macrobenthic filter feeders in the Niger Delta are Oyster (*Crassostrea gasar),* some polychaetes, clams (*Macoma innominata*), Oysters have very high filtration rate. An oyster can filter up to 5 litres of water an hour and when the population is high these engineers and cleaners remove excess nutrients from the water. Eutrophication, which is uncommon enrichment of a water body with nutrients and minerals, is counteracted by the filter feeders.

Ostroumov (2003) reported that in some ecosystems total volume of water is filtered within some days. Through this filtering mechanism pollutants are extracted from the water, eaten (bio-transform) by the oysters or they deposit them on the sediments and by this time they are no longer harmful. Deposited materials after filter feeding can also be of benefit to other species of the ecosystem in form of nutrients; which fertilize macroalgae and other benthic flora. This will indirectly encourage development of more herbivores that are also food to crabs and fish.

So generally, filter feeders perform four main functions.

1. Ecologically restore the quality of water by removing inorganic sediments, particles, excess phytoplankton (from eutrophication) so reducing turbidity and enabling light penetration and deposit pellets of organic matter.

2. Filter feeders help create heterogeneous habitats. With increase in light penetration development of submerged plants is increased (microhabitats). This in turn form habitats and nursery grounds for macrofauna like crustaceans and fish.

   Paine and Suchanek (1983) and Beadman *et al.* (2004) have reported multiple layering of mussels in beds as creating unique habitats inhabited by at least 300 species of invertebrates. When not disturbed by the activities of man *Crassostrea gigas* (oyster), sibling of our own *C. gasar* can form reefs that provide habitats for other animals like polychaetes thereby modifying the composition of their community and may increase biodiversity. The new habitats can also affect patterns of water flow, which will in turn affect the chemistry, biology, and geology of the benthos.

3. Through filter feeding these animals help in the biogeochemical cycling of elements like phosphorus, carbon and nitrogen. The pellets released after filtering out their food needs are transported faster to the sediment or deep layers of the water thereby releasing organic material for cycling.

4. Clusters or reefs of filter feeders help in stabilizing shorelines. Many species of molluscs help in preventing erosion caused by waves. The hard shells stabilize the sediments. *Tridacna gigas* (giant clam) cements and stabilizes the sediment. Our own oyster, *C. gasar* (mgbe), properly clustered and decked in their exquisite beauty hanging on the prop roots of red mangrove trees (*Rhizophora* spp) serve indirectly as barriers to the waves reducing their strong impact on the shoreline.

2.9 Biodegraders

Consumption of mangrove leaves and other aquatic vegetation leads to their biodegradation. Many crabs are omnivores. The sesarmid crabs are referred to as omnivorous scavengers. Most of the sesarmid crabs have chelipeds adapted and used for shredding of leaves.

The most herbivorous are from the family Sesarmidae. Theses crabs are important players in the degradation of leaves of different species of mangrove because they feed on a large quantity of leaf litter. Other macrofauna involved are isopods, some polychaetes like *Capitella* and *Perinereis.* They can shred whole leaves to as small as 35μm. The snail *Melampus liberianus* is also important in the decomposition of leaf litter as it feeds on mangrove leaves (Figure. 11).

In the mangrove benthic community the sesarmid crabs usually start off the breakdown of leaf litter and thereby increasing the activities of microorganisms. They feed on algal mats, bury, breakdown, store and feed on leaf litter. Ingested leaf litter are broken down mechanically and chemically. After absorption of required nutrients the remnant materials come out as faeces. These re-enter the food web as they increase the production of bacteria. They shred into bits leaf litter (green, yellow or brown) (i.e. fresh or aged). This reduces the size, increases the surface area, which will in turn increase the presence of microbes.

Figure 11: ***Melampus liberianus***

Herbivorous crabs enhance the productivity of the mangrove ecosystem. The detritus that results after the feeding of *M. liberianus* can also aid in retaining humidity on the forest floor and forming a favourable microhabitat for juvenile snails to inhabit and avoid desiccation. Through the activities of these benthic degraders (if population density is high) about 70% of litter is removed from the mangrove ecosystem. Their involvement in mangrove nutrient regeneration and export benefit directly or indirectly other occupants of the community including microorganisms, the mangrove trees and other animals (detritus feeders). Islam *et al.*, (2002) had reported sesarmid crabs as major players in the degradation of leaves and regeneration of nutrients. Detritus produced by crabs may increase the moulting frequency and reduce mortalities in the amphipod *Paryela* sp.

Among the crabs *Neosarmatium meinerti* leaf consumption per gram of crab was higher in females than males (Olafsson *et al.*, 2002). (You wonder why females on the average are fatter than males they eat more). Even the dead decomposing woods and parts of the red mangrove *Rhizophora* are biodegraded by the mollusc *Teredo* (shipworm). The isopod *Sphaeroma* is a woodborer in the root of mangroves. *Sphaeroma* spp avoid predators by occupying heights on mangrove stems and roots that will preclude them from their natural enemies living at the sediment surface or those that ingress with flood tides (Hogarth, 2007). The isopod damage to growing mangrove root tip may lead to branching; causing increased firm anchorage and stability. *S. terebrans* also creates holes that serve as microhabitats for other organisms (Estevez, 1978).

With their limited movement benthic macrofauna still have choice of food. Some of the degraders prefer one species of mangrove e.g. *Avicennia* leaves to *Rhizophora* leaves and also different stages of decay of the mangrove leaves. This, thus, limits competition for food. In this community, this is one way to ensure that all have food.

These heroes practice what I term **'foundational development'**, which is equivalent to sustainable development. Many of the biodegraders feed more on leaves than propagules (seedlings) of mangroves. This reveals their commitment in ensuring the community had enough food (cycling of nutrients) allowing the propagules to settle and develop into mature mangrove trees. If these ones lower in the evolutionary tree can do it, what are we waiting for? With food security our country will excel in education, health and economically. Biodegradation has positive effects on the biogeochemical reaction in the sediment. It enhances an efficient transfer of organic matter from mangrove detritus to sediments.

2.10 Deposit Feeders

In the benthic community especially in the mangrove ecosystem there are detritus. This includes decomposing particles of mangroves, algae, fragments of dead animals, diatoms, etc. it is rich and fed on by a number of macrofauna. Detritivores, animals that feed on detritus have special adaptations that enable them scoop up the detritus and filter out their food and discard the remnant. Some crabs have spoon-like claws; some others have tentacles covered with mucus. Deposit feeders are also referred to as the link between the sediment and the benthos.

Bertness (1999) stated that they enhance sediment re-suspension and nutrient exchange with the water column and increase productivity by increasing oxygen and nutrient levels in the benthos. Deposit feeders in the intertidal benthic community of the Niger Delta include *U.tangeri* (fiddler crab), shrimps like *Palaemon* and *Palaemonetes*, polychaetes and oligochaetes (aquatic earthworm). *Allonais* and *U.tangeri* feed on small pellets, reducing the organic matter in sediment (thereby reducing eutrophication) and also affecting sediment grain size. Their feeding increases the rate of metabolism of microbes which may encourage breakdown of matter thereby making nutrients available AND CLEANING UP THE SEDIMENT.

2.11 Scavengers

Benthic macrofauna in this feeding group are staffers of the Intertidal Ministry of Environment or Sanitation unit or better still Sanitary Officers of the mangrove ecosystem. These feed on decaying or leftover decomposing matter. They are mainly omnivores. Examples include the hermit crab *Clibanarius*, sea anemone (*Actina)*, isopods and some polychaetes. Hermit crabs can aggregate quickly to feed on carrion. They end up feeding on dead producers and consumers. They aid in the stabilization of food webs in this community and ecosystem.

2.12 Indicators

Water quality can be described in terms of physical, chemical and biological characteristics. Aquatic organisms have preferred habitats, which are defined by physical, chemical and other biological features. Variation in one or more of these can lead to stress on individuals and possibly a reduction in total number of species and individuals that are present. Aquatic organisms integrate effects on their specific environment throughout their lifetime. Therefore, they can reflect earlier conditions when conditions may have been worse. This enables the biologist to give an assessment of the past state of the environment as well as the present state. This is the concept of **Biological Monitoring**.

Two main approaches have been used: methods based on community structure (e.g. diversity, distribution and relative abundance) and methods based on indicator organisms. An indicator organism is a species selected for its sensitivity or tolerance (more often sensitivity) to various kinds of pollution or its effects. Simply put, indicator species are species that their absence or presence denotes a particular habitat, environmental conditions or community. Some species decrease or increase in number or are intolerant or tolerant to environmental parameters and pressures. These indicator organisms warn or let us know the health status of the community. They let us know of change in the biological condition of the ecosystem. Even in our families especially among children there are the ones that pick up measles, cough, chicken pox (maybe due to weak immune system) and some whom no matter the intensity of the disease are resistant to the infections.

In order to detect environmental disturbance using biota it is important that the organisms reflect the situation at the site from which they are collected, i.e. they must not migrate. As a result, the most widely used group of aquatic organisms is the benthic macroinvertebrates because they are sedentary, ubiquitous, diverse, and are represented by many species and feeding groups. Insects dominate the macroinvertebrates of most freshwater systems. Figure 12 shows the order of sensitivity of freshwater macrozoobenthos.

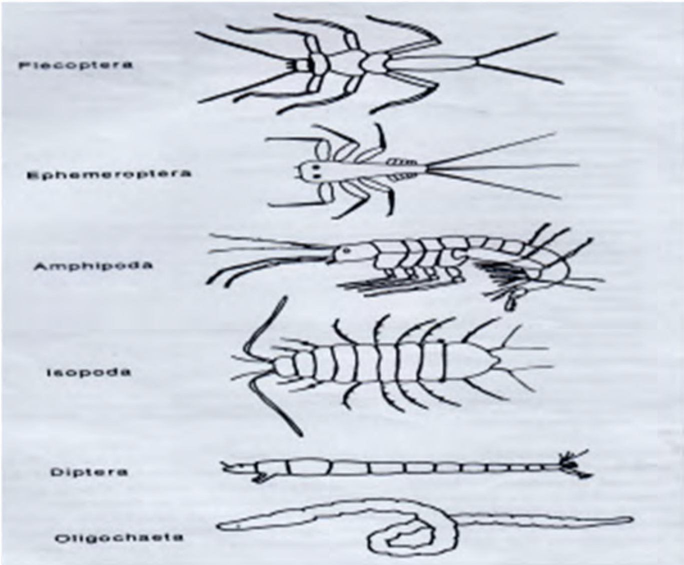

Figure 12. The relative tolerance to organic pollution of some key groups of aquatic macroinvertebrates (Adapted from Mason, 1981); tolerance increase from top to bottom.

In estuarine and marine environments, polychaetes (segmented marine worms) are the major indicator species. Polychaetes can be referred to as 'opportunistic organisms'. These thrive even in tough situations and organically enriched or polluted benthic habitats. Polychaetes are very informative in assessing the health of benthic environments. They are widely distributed and occur in variable bottom types in estuarine and marine habitats. They comprise 60–70% in soft bottoms (Dogan *et al.*, 2005), and may account for up to 90–100% of macroinvertebrates in disturbed soft-bottom sediments (Çinar *et al.,* 2006; Zabbey and Uyi, 2014).

Grall and Glemarec (1997) and Stark (1998) reported that crustaceans appear to be more sensitive than polychaetes and become less abundant at contaminated or altered sites. Levin *et al.,* (2001) stated that high diversity is a good indicator of the degree of complexity of the ecosystem and can indicate positive interactions among the species responsible for promoting stability and resistance to different forms of disturbance. They also reported other authors as stating that based on the tolerance and life history characteristics, attributes of certain species may be useful indicators for specific environmental conditions and their presence, absence or a certain reference range of abundance can indicate changes in ecosystems.

In this group of our benthic heroes are the sea anemones, the thalassanid *U. furcata,* which tend not to tolerate organic enrichment and other forms of pollutants. Polychaete (e.g. *Capitella capitata)* and the larvae of the insect *Chironomus* increase in numbers in response to organic enrichment and seem to enjoy the degraded conditions. The bivalve *Cardium edule* and the polychaete *Nephthys* are sensitive to physical disturbance of the sediment.

Though we might not see these changes physically but scientifically as humans let us monitor this community regularly to know when our activities are threatening their existence.

2.13 Security of their Environment

Our heroes protect their environment they are positioned in a way to guard their community. From the land is the land crab with its large claws and tenant the snake ready to attack any intruder. From the creek the swimming crab with its very sharp claws fights any enemy approaching from the sea. The small and mighty sea anemone stations its self at the low intertidal and releases toxins that scare away their enemies. They are always ready to protect their community.

3.0 Ecological Goods and Services

1. Food

With the exception of the mangrove fishes, all edible benthic macrofauna are called ‘shellfishes’. Shellfishes are aquatic invertebrates that have an outer skeleton or a shell. They are from two main groups, molluscs and crustaceans. They serve as food we consume nationally and trade in internationally. The common forms eaten that are from brackish water include periwinkles, oysters, bloody cockles, crabs, and shrimps. They are good sources of omega-3 fatty acids especially swimming crab, land crab, rock snail, oyster and periwinkle (alias esem, isam and piom piom troway).

Our results from the proximate analysis of five shellfishes revealed that they have low fat, high crude protein level and low carbohydrates. So if you want to avoid obesity, stroke, heart attack and high blood pressure, eat these tasty, nutritious shellfishes. If you want to eat them continuously, then I ask you to faithfully join from today to advocate for the protection of macrozoobenthos. In Bonny, my origin, some 20 years ago, meat was not common. Soups and stews were loaded with shellfish, so there were hardly cases of high cholesterol. Instead we had beautiful skins and people. Shellfishes can be used as substitutes to meat and even finfish. They can also be used for livestock feed formulation.

For the crabs, the males are cherished for their muscles, the moulting species for their soft new shells and the berried females for their tasty eggs. Eat and enjoy!

2. Sustainable job creation

It provides employment for the rural populace especially the women. It is a major source of income for many women in the riverine areas of the Niger Delta especially for the large number that are engaged in shrimps and periwinkle fishery (i.e. fishing, processing, transporting, marketing products and fishing inputs). The harvesting of the swimming and land crabs are sources of income for male youths. It provides employment for manufacturers of fishing gears.

3. Raw Materials

The shells of the snails and bivalves in some local communities are used for road construction. They can be ground and added to animal feeds and as local cement. Using the calcium carbonate from the shells of these aquatic molluscs will reduce the mining of limestone and the ancillary negative environmental effects. It can also be used for the treatment of wastewater. Local farmers use the crushed shells to control acidity of the soil.

4. Foreign Exchange

Commercially, macrozoobenthos contribute to national development. Sale of benthos brings in foreign exchange when exported especially the peneaid shrimps, which are exported to the USA, Japan and Europe.

5. Ornaments

The shells of many molluscs are used for jewellery, decorations and buttons. Some species of oysters produce pearls and are used as jewellery.

6. Medicinal Ingredients

Shells of crabs prepared in form of ointment can heal wounds and even prevent the formation of scars. Some species can be used for treating cough in children (I am currently working on this with a PhD student and a colleague from the Basic Medical Sciences). Some macrobenthic species have been reported to have active ingredients (biocompounds) with anti-coagulant, antimicrobial properties.

7. Nutrient Recycling

Benthic macrofauna are very important in the estuarine and marine food webs. Many serve as food to many species of fish. They are very important in the transfer of energy and recycling of nutrients.

8. Socio-cultural Agents

Socio-culturally, some of these organisms have been objects of worship by some cultures. For e.g. the Romans called a species of crab the sea god Neptune. The cancerous abnormal growth of cells in the body got its name from the crab *Cancer* spp because of its resemblance to their nesting ground.

9. Other Uses

- Snails of the species *Murex* are used in the manufacture of Tyrian purple (a dye).
- Different cultures at different times had used shells of shellfishes as currency. Example cowry used for long as money is the species *Cypraea moneta* (money cowry). Other shells used were *Oliva carneola* and *Dentalium.*
- Some molluscan shells like *T. fuscatus* and *Thais* serve as protective shells and homes for hermit crabs.

Fig. 13: A - Cowry, B – Hermit Crab in borrowed shell

4.0 MY CONTRIBUTIONS

My studies of some creeks, rivers and estuaries of the Niger Delta provide useful information on the region's aquatic ecology, particularly benthic ecology. Results of the studies are contained in some of the publications listed below and they are accessible for your private read.

a. Water bodies

These ranged from inland fresh water bodies to tidal estuaries.

- Elechi Creek (**Hart, A.I.** 1994, **Hart, A. I**. and Chindah, A.C. 1998; **Hart, A. I** and Chidah, A. C. 1999; Chindah, A. C. and **Hart, A. I.** 2000).

- Woji Creek (**Hart, A. I.** and Zabbey, N. 2005; Zabbey, N. and **Hart, A.I.** 2005)
- Bonny Estuary (**Hart, A. I.** and Hart, S. A. 1998.)
- Bodo Creek (Zabbey, N., Onwuegbuta-Enyi., Erondu, E.S., and **Hart, A. I.** 2006; Zabbey, N., **Hart, A. I.** and Wolff, W. J.2010; Zabbey, N., and **A. I. Hart** 2011,)
- Nun Estuary (Abowei, J. F. N., Sikoki, F. D., **Hart, A. I.,** and Allison M. E. 2007; **Hart, A. I.,** and Abowei, J. F. N. 2007; Abowei, J. F. N., and **Hart, A. I**. 2007; Abowei, J. F. N., and **Hart, A. I**. 2007; Allison, M. E., Sikoki, F. D., **Hart, A. I**., and Ansa, E. J. 2007; Gijo, A. H., **Hart, A. I.,** and Seiyaboh, E.I. 2016; Gijo, A. H., **Hart, A. I.,** and Seiyaboh, E. I. 2017).
- Sombreiro River (Abowei, J. F. N., Tawari, C. C., **Hart, A. I**., and Garrick, D. U. 2008a Abowei, J. F. N., Tawari, C. C., **Hart, A. I.,** and Garrick, D. U. 2008b)
- Taylor Creek (Kingdom, T., and **Hart, A. I.** 2012a; Kingdom, T., and **Hart, A. I**. 2012b; Kingdom, T., and **Hart, A. I.** 2013)
- Kugbo Creek (Edoghotu, A. J., and Hare, A. I.)
- Fishponds in the flood plains of Odhioku-Ekpeye (Ezekiel, E. N., Abowei, J. F. N., and **Hart, A. I.**)

b. Macrobenthos

- Epifauna and infauna (Chindah, A. C. and **Hart, A. I.** 2000; **Hart, A. I**. and Zabbey, N. 2005; Zabbey, N. and **Hart, A.I**. 2005; Zabbey and **Hart,A.I** 2011; Zabbey and **Hart A.I,** 2014)
- Shellfish (**Hart, A. I** and Chidah, A. C. 1999; Zabbey, N.,Erondu, E. S., and **Hart, A. I.** 2010)
- Epibenthic algal community (Chindah, A. C and **Hart, A. I,** 2000)
- Toxicity and histopathology of macrozoobenthos (Gijo, A. H., **Hart, A. I.,** and Seiyaboh, E.I. 2016; Gijo, A. H., **Hart, A. I**., and Seiyaboh, E. I. 2017, **Hart, A. I**., Abowei, J. F. N., and Iroegbu, B. C. 2007, **Hart, A. I**., and Ulonnam, C. P. 2008, , , Nte, M. E., **Hart, A. I.**, Edun, O. M., and Akinrorotimi, O. A., 2011a, Nte, M. E., **Hart, A. I**., Edun, O. M., and Akinrorotimi,

O. A., 2011b, Nwakama, C., and **Hart, A. I**. 2012a, Nwakanma, C., and **Hart, A. I**. 2012b, Nwakanma, C., and **Hart, A. I**. 2012c, Okogbue, B. C., Ansa, E. J., and **Hart, A. I**. 2014, Okogbue, B. C., **Hart, A. I**., Ansa, E. J., and Ikpi, **Hart, A. I**., Ulonnam, C. P., and Zabbey, N. 2007, Oriakpono, O., **Hart, A. I,** and Wokoma, E. 2012, Babatunde, B. B., Sikoki, F. D., and **Hart, A. I.** 2015, Enyi, I. O., Babatunde, B. B. and **Hart, A. I.** 2017, Wala, C., Babatunde, B. B., **Hart, A. I.,** and Zabbey, N. 2016a, Wala, C., Babatunde, B. B., **Hart, A. I**., and Zabbey, N. 2016b.

- Sediments physico-chemical conditions (Gijo, A. H., Hart, A. I., and Seiyaboh, E. I. 2017, Ezekiel, E. N., Hart, A. I., and Abowei, J. F. N. 2011)

C. Others

- Physico-chemical parameters (Zabbey, N. and Hart, A.I. 2005; Gijo, A. H., **Hart, A. I.,** and Seiyaboh, E.I. 2016)
- Plankton (Abowei, J. F. N., Tawari, C. C., **Hart, A. I.,** and Garrick, D. U. 2008a; **Hart, A. I.**, Amah, E., and Zabbey, N. 2007; Abowei, J. F. N., Tawari, C. C., **Hart, A. I.,** and Garrick, D. U. 2008b)
- Fish stock assessment (**Hart, A. I**., and Abowei, J. F. N. 2007; Abowei, J. F. N., and **Hart, A. I**. 2007; Abowei, J. F. N., and **Hart, A. I**. 2007; Kingdom, T., and **Hart, A. I.** 2012a; Kingdom, T., and **Hart, A. I**. 2012b; Kingdom, T., and **Hart, A. I**. 2013; Nte, M. E., **Hart, A. I**., Edun, O. M., and Akinrorotimi, O. A., 2011)
- Fecundity and gonadosomatic index (Kingdom T., and Hart, A. I. 2012.)
- Feeding habits (**Hart, A. I**. and Hart, S. A. 1998)
- Fish gear selectivity an Relative efficiency (Kingdom, T., and **Hart, A. I**. 2013)
- Fin fish (Iroegbu, B. C., **Hart, A. I.,** and Abowei, J. F. N. 2008; **Hart, A. I.,** Abowei, J. F. N., and Iroegbu, B. C. 2008; Nte, M. E., **Hart, A. I.,** Edun, O. M., and Akinrorotimi, O. A., 2011;)
- Biomarker (Oriakpono, O., **Hart, A.I**, and Wokoma, E. 2012)

- Aquaculture (Ansa, E. J., **Hart, A. I.,** Okosimiema I., Bekiebele, D. O., and Opara, J. Y. 2014, Ansa, E. J., **Hart, A. I.,** Assayomo, E., and Davies, O. A. 2011, Ansa, E. J., **Hart, A**. **I**., Davies, C. B., and Yakubu, A. S. 2010.)

5.0 CHALLENGES OF BENTHOS IN THE NIGER DELTA

As humans we do not appreciate the activities of these benthic macrofauna, the unsung heroes of the aquatic ecosystems and our food. Most of the challenges they face are from **US**.

5.1 Deforestation –This involves the cutting down of trees and in this case mangrove trees and other riparian vegetation and associated algal mats. As we cut macrophytes we render these heroes homeless and deprive them of food. Imagine what happens when landlords de-roof or lock out tenants from their buildings. The tenants suffer various environmental and social vagaries, for e.g. rain, sun, exposure to avoidable rogues, psychological torture, etc.

From our studies deforestation is a serious challenge to benthic fauna. Without proper management of forest resources and with a high percentage of the coastal communities depending on coastal forest wood for cooking, drying of fish, oysters, and other marine resources and for building, we de-roof nature’s canopy on benthic animals. Remember their movement is limited, which delimits relocation and we are not building Internally Displaced Benthos camps in the form of protected areas. With deforestation there is decrease in diversity and density of some organisms like shrimps and mangrove fishes.

The effects are more on those that lack physiological adaptations to desiccation – stenothermal forms. It limits their distribution.
All these can bring about changes in the natural activities of the ecosystem. While species that are dependent on algae for food and cover like *Namalycastis* will increase. Deforestation without other forms of pollution encourages growth of algae.

Grass mats e.g. that of Kugbo Creek serve as sites for fishes like *Gymnarchus niloticus* (Asa) and *Hepsetis odoe* to build their spawning nests. Deforestation can therefore limit their rate of reproduction (imposed family planning). Thus, fish species such as *Neolebias powelli* that inhabit grass mats are endangered. Deforestation also enhances greenhouse effect.

5.2 Pollution- There are various forms of pollutants and many toxic materials like crude oil and its components, drilling muds, pesticides, industrial effluents and plastic (Figure 14). All these affect the tissues and community structure (e.g. diversity, abundance and biomass) of benthic animals. One of the silent but weighty pollutants from my results is nutrient enrichment. Sources of nutrient pollution in water bodies include runoff from agricultural activities, storm water contaminated with fertilizers, and nutrient-rich wastewater effluent.

Comparatively, nutrient contaminated runoff from agricultural sources is the main way that nutrient pollutants such as nitrogen and phosphorus gets to the aquatic environment. Do you wonder where most of the fertilizers applied to agricultural fields in Nigeria end up? They mostly end up in the mangroves of the Niger Delta due to the relatively low-lying topography. The fertilizers are washed by runoff into the interconnected network of tributaries that form the Niger Delta and eventually empty in the Atlantic Ocean.

What of the sewage from our septic tanks (soakaways) evacuated by trucks when they are full or direct discharges into adjoining creeks, as is the case along our rural and urban shores (Figure 15). Untreated and partially treated industrial wastes all end up in the 'homes' of our unsung heroes.

Figure 14: Plastic bags clogging red mangrove prop roots (oyster home) in Bundu Creek

Figure 15: Sewage piped directly into creek water, near Abuloma Jetty

We have even turned their homes into toilets. Depending on the quantity and also the quality, organic enrichment can be a source of food to macrofauna or a source of stress. Heavy organic enrichment reduces dissolved oxygen, increases suspended matter and also affects sediment structure. It also affects the trophic structure.

My studies revealed decrease in some species e.g. *Upogoebia* (mud shrimp), the shrimp (Palaemonetes spp), sea anemone, echinoderms and *Hydrobia* (gastropod) after months of disposal of organic waste (sewage) at the intertidal area of Elechi Creek. These species are no longer sighted in the area. Meanwhile, the densities of polychaetes like *C. capitata, N. falsa, N. indica* (Figure 16) increased in response to organic input. Organic sewage provided good source of nourishment for these polychaetes –they are opportunistic species.

Figure 16: Polycheates collected from mangrove fringe on the Bonny Estuary

Just like our society, when the economic situation is harsh (e.g. economic recession), few persons make more money and the majority would feel the excruciating hardship. After all, “one man’s meat”, it is said, “is another man’s poison”. Thus, in the recent past, Nigeria had economic recession but some persons were still erecting gigantic buildings; SUV cars are everywhere, owned by few persons. This group of Nigerians can be termed opportunistic.

For our well beloved periwinkles (e.g. *Tympanotonus fuscatus),* the response to environmental stress may involve reduction in percentage of juveniles (7-18mm) and an increase in percentage of shell sizes of 37-48mm. Thus, Zabi (1982) reported *T. fuscatus* as a pollutant indicating species. Gabriel (1981) observed a higher growth rate for *T. fuscatus* at Borokiri, where there was organic waste. Pollutants affect the juvenile stages of benthos more than the adult forms, and also impact their larval settlement. This means we share with the benthos the response to pollutant pattern. Dysentery, cholera, in short high infant mortality is associated with dirty habits and environments and children are more vulnerable than adults.

When economic recession occurs our feeding and the foods we eat change. We now eat what is available and no longer what we like and want (especially the masses whose choices and income are limited). People move from real beef muscle to the outer skin (*kponmo),* from chocolates to palm kernel. So also when man wages war against the benthic community and disposes and enriches it overtly with organic matter, opportunistic feeders emerge and dominate the community. It is an adaptive process. Evolution tells us that life is survival of the fittest.

For mudskipper and topminnow fish, instead of feeding primarily on insects (which are easily affected by pollution) now feed primarily on polychaetes and detritus. When there is unusual enrichment with organic matter and, therefore, degradation there may be a shift in food chain types. Generally a community dominated by deposit feeders may be one with organic enrichment and degraded nature.

5.3 Artisanal Refineries "*Kpo Fire*": One of the greatest of them all (the latest 'Baba') is 'make shift oil refineries' or artisanal refineries or artisanal modular refineries, alias *Kpo fire* (Figures 17 – 21). Is this the solution to fuel, diesel and kerosene scarcity that we experience on a regular basis in this country? Unfortunately *Kpo fire* is now a big attraction to people (youths, adults) from all parts of the country. It is a wonder that a country without a functional refinery, has so many ‘uneducated’ youths who are able to refine crude oil in locally crafted heating drums in the bush. This has gone on for years now. Soot spewing out from *Kpo fire* sites alongside our industrial contributors has enveloped Port Harcourt and its environs. The crude refineries are set up indiscriminately in and near mangrove swamps. These sensitive ecosystems and adjoining ecosystems in the seascape are the recipients of *Kpo fire* wastes, which are disposed of haphazardly.

Nobody was worried until some two years ago when soot started decorating our homes and other infrastructures, our feet, our palms and our nostrils and lungs. There has been outcry from the health sector that patients with respiratory ailments are on the rise. Recently, concerned citizens in Port Harcourt had mobilized to form an advocacy group tagged “Stop-the-soot”.

Fig. 17: Stop the Soot Campaign

I will leave the human health implications of soot to medical professionals. However, as a benthic ecologist it is my obligation to advocate for the defenceless and unprotected benthos.

Mr. Vice Chancellor, Sir, the first recipients of the impacts of *Kpo fire* are the benthos who are crying out for rescue from man's inhumanity. These include the ones we relish and eat daily such as periwinkles, bloody cockles, and whelk, dog whelk, oyster, swimming crab, land crab, gobiids and mudskipper. Their homes and sources of food are destroyed and their numbers greatly reduced; some of the species are now at the verge of local extinction. We all are trading blames at each other but no one is really doing anything and this war by humans against benthic organisms is raging stronger and stronger. How could fully armed men wage such a catastrophic war against defenceless unarmed original owners of the coastal land, the benthos. Money is flowing into few pockets in hard and local currencies so the benthos do not matter? Our sources of animal protein? As Albert Schweitzer rightly noted, "man has lost the capacity to foresee and to forestall. He will end by destroying the earth and himself".

Figure 18: Typical Kpo fire site in mangrove swamp in the Niger Delta

Figure 19: Intertidal swamp devoid of mangroves and zoobenthos by *kpo fire*

Figure 20: Extensive soot covering the homes of our unsung heroes. Bodo Creek tidal flat 27 January 2018.

Our studies on the impacts of makeshift refineries on the benthic community reveal significant alterations of the physico-chemical parameters of the impacted environment. High total hydrocarbon content, low dissolved oxygen, acidic pH, high biological oxygen demand, sulphate, phosphate and nitrate concentrations have been documented. These are signs of a 'seriously sick' environment. There was a shift in dominance (by number of taxa and abundance) in the macrozoobenthic community from crustaceans or polychaetes to gastropods. The number of species reduced from that of the baseline (from 30 to 18 as at the time of sampling). The areas closest to the 'refineries' were void of benthic macrofauna. Market surveys reveal smaller sizes of benthic shellfishes like the swimming crab and the shrimps (Gijo and Hart, 2016, 2017).

Destruction of homes sometimes lead to reduction of population growth because breeding and growth require stability and privacy.
In low levels the swimming crabs (*Callinectis*) from the study area had tendencies of bioaccumulating hydrocarbon, but they are killed by high concentrations. Consumers of shellfish in Rivers and Bayelsa States now complain of crabs of small sizes with less meat and, that shrimps are tasteless.

These heroes have nowhere to run to because their movement is limited, no voice, no representative in the State Houses of Assembly and the Federal Parliament (House of Representative and Senate) but they are crying out through the incredible results of our studies. We must act or perish because most of the survivors of the pollution assault that we harvest and eat had bioaccumulated and biomagnified hydrocarbon and associated heavy metals.

Figure 21a: Harvested swimming crabs in dugout canoe heading to our kitchen

Figure 21b: Swimming crab (*C. amnicola*), unsung hero killed by human activity

5.4 Overfishing and Underfishing:

With no control on population and lack of adequate management of natural resources, some zoobenthic resources are overharvested. A good number of benthic macrofauna are shellfishes e.g. periwinkles, shrimps, clams, oysters, cockles, swimming crab and also mangrove fishes like mudskipper. They renew themselves but the pressure especially by man is too much –far more than their carrying capacity.

From our market survey on sources and distribution routes of periwinkles traded in some major markets in Rivers State, large size periwinkles come from Edo State where it is not eaten and also the Brass Nembe area where it is not harvested for economic purposes. For the swimming crab the sizes have reduced greatly overtime.

The shrimp *Macrobrachium felicinum* is overfished in the lower Taylor Creek through indiscriminate use of traps of different mesh sizes. In Bodo Creek area, increase in human population, improvement of road transport, and more income from the sale of diminishing quantity of harvested bloody cockle resulted in exploitation rate higher than that of replenishment. This had almost destroyed the cockle fishery before the creek was polluted by major oil spill in 2008.

A number of the mangrove crabs are not eaten by people in areas where they are found. Apart from cultural dispositions, all crabs in the Niger Delta tidal flats are edible; none is poisonous. If we eat all crabs, it will reduce the pressure on the swimming and land crabs that are consumed regularly. Why are we not feeding on the mangrove crabs (about 8 species) instead we are importing plastic rice and fish, hormone and chemical loaded frozen chicken and tilapia.

5.5 Dredging, Reclamation and Sand Mining

Dredging to a large extent deepens the water body, alters the structure and nature of the sediments. It dislodges benthic fauna and renders them homeless. Dredging may increase total dissolved solid (TDS) that may clog the feeding structures of filter feeders. Our results revealed that human activities like paddling in shallow waters during ebb tide or low tide could dislodge animals like polychaetes and cockles.

Reclamation is carried out indiscriminately all around Port Harcourt and other coastal cities in Nigeria. Dredging and reclamation require mandatory environmental impact assessment (EIA) as stipulated in the EIA Act of 1992. However, at some instances, even government whose responsibility it is to enforce environmental laws and regulations sometimes blatantly skip the essential EIA precondition. Around the waterfronts people reclaim land on a regular basis to build houses. The intertidal area of Eagle Island is now almost a terrestrial ecosystem (Fig. 22a to d). Sand is mined and sold. Sand mining is a big threat to our heroes. It destabilizes them because it affects their habitats. It also affects the settling down of their larvae. Even the Choba bridge area of the New Calabar River is now given over to sand mining. Eastern By-Pass is now a full terrestrial system. The unsung heroes have been bulldozed and pushed out of their homes. **It is forced benthic eviction**!

Fig. 20a: Studied mangrove swamp at Eagle Island 26 years ago: 20b: The same mangrove swamp at Eagle Island 26 years after. c: Sand mining d: reclaimed land

5.6 Exotic species

Nypa palm (*Nypa fructicans*) has out competed native mangrove plants in the Niger Delta (e.g. along the Opobo channel) and is gradually taking over our mangrove forests. Though a native of the Indian and Pacific Oceans, it was erroneously introduced by man into Nigeria to check erosion (Zabbey and Tanee, 2016). It is the only palm adapted to live in the mangrove ecosystem.

Our results from studies on macrofauna associated with nypa revealed a decrease in the number of species when compared with that of the native mangrove species. Since nypa palm is not a native species and its products are under appreciated or not being contemplated, the palm is not fully utilized by the populace –this contributes to why the nypa is flourishing (Fig. 23).

Fig. 23: Non-native nypa palm (*N. fructicans*) outcompeted native mangroves at Kono Creek; impacting negatively on macrozoobenthos.

Another aquatic exotic species is the Sea Urchin *Temnopleurus*. According to my late mentor, the revered Charles Bruce Powell (1943 - 1998), the species might have been introduced into the Nigerian waters through ballast water. The species spines destroy set nets of fisher folks and at low tide if marched on cause's serious injury.

5.7. Problems with aquaculture practices: Attempts have been made to culture (mainly) shrimps, periwinkles and oysters in Nigeria but this has not been successful on a large scale.

5.8. Legitimate Oil Activities: There exists well-documented knowledge of degradation of the Niger Delta through activities of oil exploration, production and transportation. From my studies, one obvious avoidable challenge with the legitimate oil companies is lack of implementation of Environmental Management Plans proposed by Environmental Impact Assessment. Lack of follow up or enforcement by the regulatory agencies.

5.9 Insecurity

Scientific investigations require field and laboratory studies. Unfortunately it is no longer safe for field based ecological research in the creeks and rivers. This is due to insecurity orchestrated by armed gangs, sea pirates, militants, cultists, and intra and inter communal conflicts. Researchers are not spared. If allowed, they have to pay ‘marching ground’ and other royalties before sample collection. This is a dangerous trend. It has contributed partly to the ‘new normal’ research trend whereby natural science undergraduate and postgraduate students in the Niger Delta choose to conduct laboratory based bioassay research in preference to field based ecological studies. Bioassays are toxicity tests in which test organisms are exposed, in laboratory setting, to different concentrations of a toxicant. Bioassay helps to determine regulatory limits of chemicals. However, bioassay cannot supplant field-based ecological studies that enable us to understand complex interactions amongst organisms and how abiotic factors structure biological communities.

5.10. Identification of Species.

This is a big challenge. In this part of the world almost all the species have been identified morphologically using taxonomic keys only, without DNA sequencing. In some cases, the taxonomic keys are from distant unrelated regions. So, there seems to be a lot of misidentification or lumping of species. If we do not know what we have, we cannot know what we are losing!

Mr. Vice Chancellor, Sir, lets us listen to the relics of the united song of Niger Delta zoobenthos as they sing:

“By the rivers of Niger Delta there we sat down and there we wept when we remembered our homes. But the humans have scattered our homes and we have no place to go. How can we survive in a strange land? O let the sounds that we make and the services that we provide touch their hearts”. (Psalm 137; Music by Boney M. remixed by A. I. Hart)

6.0 RECOMMENDATIONS

Mr Vice-Chancellor Sir, I humbly present some recommendations:

1. A multi-disciplinary group should carry out more research on '*kpo fire'*, and the effects; there should be enhanced regulatory control of the petroleum industry to forestall avoidable oil spills. The government should immediately work the talk by replacing *kpo fire'* with modular refinery. Oil spills from any source must be prevented and the environment adequately remediated when impacted.

2. As a community service, educational institutions and concerned individuals should sustainably embark on awareness campaigns to communities close to the mangroves on the need to stop indiscriminate felling of trees and disposal of wastes in the intertidal regions, creeks and rivers.

3. The establishment of a 'Molecular based laboratory' for DNA analysis and proper identification of organisms. This should be followed with well-structured taxonomic training. In fact, special scholarship should be made available for natural science researchers interested in taxonomy and systematics. THERE IS URGENT NEED TO SET UP "NIGER DELTA BIODIVERSTY CENTRE OF EXCELLENCE". I will humbly suggest the centre be named after late Charles Bruce Powell. I make this recommendation purely on merit, not sentiments. He was adjudged "Mobile encyclopaedia of Niger Delta Ecology and Biodiversity" based on his contributions in this area of science -he discovered many species. For example, he discovered 13 species of crabs and shrimps hitherto unknown to science. As the revered Professor Kay Williamson (2002) noted, "the most spectacular of these was the discovery of a new subspecies of the Red Colobus monkey, now named *Procolobus badius epieni* after its local name in Izon language".

Mr. Vice Chancellor, Sir, ten years after Powell passed on, a new alpheid shrimp genus and species he collected was described and named after him, *Leptathanas powelli* (De Grave and Anker, 2008).

Fortunately before his death in 1998 he had donated some of his collections to the Nationaal Natuurhistorich Museum (Naturalis) in Leiden, The Netherlands. Among these donations were several specimens labelled as "*Lepthalpheus* sp.nov'' collected from burrows of upogebiid mudshrimps in the Niger Delta, which is now known as *L. powelli.*

4. Marine or Mangrove protected areas should be created and gazetted. Intertidal regions should be preserved and not sand filled. The University of Port Harcourt jetty should be reactivated and maintained to facilitate enhanced aquatic studies and eco-tourism in the Niger Delta region. A number of our macrofauna are endemic. For example, out of the 65 species of *Uca* (fiddler crab) only one is in Nigeria, *U. tangeri*. There is the need to preserve the special heroes before we lose the species completely.

5. Integrated Coastal Zone Management is vital for the conservation of coastal ecosystems. This will require National collaborations (e.g. inter-agency and institutional collaboration), regional collaborations (Guinea Current Large Marine Ecosystems - GCLME) and domestication of the Abidjan Convention on Biodiversity Conservation).

7.0 CONCLUSIONS

Vice Chancellor, Sir, macrozoobenthos are the unsung heroes of our water bodies. We should appreciate their roles in societal development and protect the health of their habitats. They have endured a lot from human activities but they still stand tall and strong, providing us with signals of looming danger that will befall humanity when we destroy the ecosystems our lives depend on –the very garden God asked Adam and all of us to take care of. God gave us dominance some would argue, no doubt, but He also charged us with the responsibility of care in the same Genesis, Chapter 2 when He commanded "And Replenish the Earth". This is when the concept of Sustainability was born.

On the World Day of Peace 2010, Emeritus Pope Benedict XVI warned, "if you want to cultivate peace, protect creation''. Mr. Vice Chancellor, Sir, it is obvious that benthos functions are very important in maintaining aquatic ecosystem integrity. Thus, I assert today 'to manage our surface water resources effectively and live a quality life, we must study and protect benthos'.

Without a Senate, House of Representatives, State Houses of Assembly, Governors, Ministers and all the paraphernalia of power, these unsung heroes interact with one another (e.g. feeding, reproducing, sharing and competing for resources, building homes) and perform ecological functions (cleaning the environment, recycle nutrients, protect shorelines, etc.) cooperatively with precision and devotion. No wonder the good book says 'Go to the ant thou sluggard, consider her ways and be wise' (Prov. 6:6) and Revelation 5:13 (NIV) states 'Then I heard every creature in heaven and on earth and under the earth and on the sea and all, in them singing.'

So here comes the band, though small in stature but mighty and loud in sound production with singers, drummers and dancers of the benthic community, for all created things must praise our Creator. Let's sing and dance with them.

Thank you for listening.

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Aduabobo Ibitoru Hart (Nee Green) was born to late Rev. Canon Titus Tamunoomoni and Adeline Siminibigha Green on 11th October 1955; the only female in a family of four. Aduabobo Ibitoru Hart is married to Sir Engr. Amaopusenibo Hart and they are blessed with children and grandchildren.

Her primary education was at Cyprian's and St. Paul's Schools in Port Harcourt and Nsukka, respectively. Secondary education was at Queens' School Enugu and Archdeacon Crowther Memorial Girls Secondary School, Elelenwo, Port Harcourt. A levels at Federal Government College, Port Harcourt. She obtained B.Sc (Hons.) Zoology – University of Ibadan, M.Sc., Hydrobiology/ Fisheries, University of Port Harcourt, Ph.D. Zoology (Hydrobiology/Fisheries option), University of Port Harcourt

A Professor of Benthic Ecology, with more than 76 publications in local and international peer-reviewed journals. She is also co-author of six professional books.

She has been involved in human capital development of men and women for almost 38 years, rising from a Graduate Assistant to

Professor. A teacher of teachers, a daughter of teachers and a teacher per excellence; a mother to many. She has supervised many undergraduates, masters and **13 PhD** graduates.

Her research work has been mainly in the Niger Delta region covering the ecology of a wide range of shell and finfishes and water bodies. Results from her numerous researches continue to inspire and guide younger researchers. .

Prof. Hart has been actively involved with Environmental Impact Assessment Consultation for SPDC, NAOC, Chevron and Federal Ministry of Environment. She has attended and delivered papers at many local and international conferences, workshops, seminars, and trainings. She has assessed papers of several candidates for professorial appointments and conducted external examination in many Nigerian Universities.

She is Editor of Scientia Africana and Journal of Aquatic Sciences, and a member and mentor of African Women in Agriculture Research and Development. Prof. Hart is a proactive member of many professional organizations, including Pan African Fish and Fisheries Association; World Aquaculture Society; International Association for Impact Assessment; Fisheries Society of Nigeria; Tilapia Aquaculture Developers Association of Nigeria; Association for Aquatic Sciences of Nigeria; Renewable and Alternative Energy Society of Nigeria. She has been elevated to the exalted position of Fellow Fisheries Society of Nigeria (FFS).

She serves on the Technical Sub-Committee on Naming, Registration and Release of Fishes (Nigeria). In addition, Prof. Hart has served and currently serving on several ad-hoc and standing committees at the Department, Faculty and University levels at different times. She had held administrative posts including HoD and Associate Dean, Assistant Director/Coordinator General Studies Unit. Prof. Hart is the Chair Occupant of Charles Bruce Powell Chair of Hydrobiology/ Fisheries. She has been admitted to the Faculty of Science Hall of Fame of Unique Uniport. She is matron of many students' associations. She has received more than eight academic-related awards from different groups.

Prof. Hart is a titled citizen, Amaopuorubo of Grand Bonny Kingdom. A practicing Christian with seven awards at Parish, Archdeaconry and Diocesan levels. A lay reader and knight of the Blessed Virgin Mary (Dame) of the Anglican Communion.

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