Journal of Agricultural Science and Food Technology
Vol. 6 (5), pp. 87-93, June, 2020
ISSN: 2465-7522
Research Paper
https://doi.org/10.36630/jasft_20015
http://pearlresearchjournals.org/journals/jasft/index.html

Isolation of Parasites in Blue Swimming Crab (*Callinectes Amnicola*) From Elechi Creek in Port Harcourt, Rivers State, Nigeria

Eze, Chinwe Nwadiuto*, Owhoeli Ovutor and Chukwuma, Dorathy Tochukwu

Accepted 30 June 2020

Department of Animal and Environmental Biology, University of Port Harcourt, Nigeria

ABSTRACT

This study investigated the parasitic load of the blue swimming crabs (*Callinectes amnicola*) from Elechi Creek, Port Harcourt, Rivers State between August and October 2018. One Hundred and ten live crabs were collected and transported to the laboratory for analysis respectively. Physicochemical values were within the Nigerian Federal Ministry of Environment Standard for the survival of aquatic lives. A total of 51(46.3%) crabs, 27 (50.9%) males and 24 (42.1%) females were positive for parasites. The parasitic prevalence was determined using six different sub-samples namely, the appendages, carapace, gastrointestinal tracts, gills, hemolymph and mouthparts/eyes. Parasites were more prevalent in the gastrointestinal tracts and hemolymph; 16 (23.6%) and 13 (23.6%) respectively. Fourteen species of parasites belonging to protozoa, nematodes, arthropods, platyhelminthes and dinoflagellates were recovered. Parasites of the phylum Protozoa were most abundant with 40 (75.4%) and a diversity of 8 species of the 53 parasites identified with *Blastodinium* spp being the most abundant with 15(28.3%). Further investigations on *Vibrio* spp and *Ameson* spp in blue swimming crab (*C. amnicola*) needs to be conducted in the creek.

Keywords: *Callinectes amnicola*, Elechi creek, parasites, physicochemical parameters, *Blastodinium* spp
* Corresponding author.Email: chinwe.eze@uniport.edu.ng

INTRODUCTION

Crabs are part of the basic components of the ecosystem and they are consumed as food in many countries. Over 100 species of crabs are known worldwide, with nine species common to West African countries, especially Nigeria. The land crab *Cardisoma armatum*, the big fisted swim crab *Callinectes amnicola* and *C. latmanus* are the three edible species (Hart and Chindah, 1998; Fagbuaro et al., 2013). Crabs mostly occur at the mouth of estuaries and along the course of many rivers (Fagbuaro et al., 2013). They constitute a nuisance by damaging set nets in the water, feeds on fish, aquatic vegetation, mollusks, crustaceans, and annelids. They also serve as prey to mammals, birds and fishes but they constitute one of the most important members of the estuarine food chain (Hall et al., 2006). Crabs are mostly marine, although some freshwater and brackish water forms are occupying the littoral, supralittoral and even up shore zones (Onadeko et al., 2015) They have been found at 580 to 6000m to seas shore and are dominant in many estuarine habitats where salinity and temperatures can fluctuate dramatically daily. They also increase the breakdown of decaying organic matter into smaller inorganic forms such as phosphates and nitrates (Onadeko et al., 2015) *Callinectes amnicola* is a famous blue crab of the family Portunidae and it is one of the most important economically swimming crabs inhabiting coastal waters of the tropical, subtropical and temperate regions, where it is a key resource in the local fisheries (Lawson and Oloko, 2013). The blue crab is an inshore and estuarine crab species which dwell near the bottom of the water bodies and occupies a variety of aquatic habitats from the lower reaches of freshwater rivers; estuaries to coastal marine waters are highly mobile, making it very easy for them to move between areas and to select habitats (Ryer et al., 1997). They live on muddy bottoms in mangrove areas and river mouths (Defelice et al., 2001; Lawson and Oloko, 2013). Crabs

make up 20% of all marine crustaceans caught and farmed worldwide, with over 1.5 million tonnes being consumed annually (Onadeko et al., 2015).

Parasites in crabs have been of great concern since they often produce disease conditions causing the nutritive devaluation of crabs and have a negative influence on their growth, reproduction, egg survival, longevity and marketability Jeffrey and Overstreet (2003). Vogan et al., (2001) reported histopathological alterations to the organ and tissues system in crabs as a result of parasitic infections. The prevalence of parasites in crabs can reach up to 40% and are usually more in males than female crabs (Childers et al., 1996). Parasites and diseases of crabs depend on the prevailing environmental conditions and therefore will vary from place to place (Anderson, 1992). There has been no report on parasites of crabs such as *C. amnicola* from the Elechi Creek in Rivers State, Nigeria; thus, this study on the isolation of parasites of crabs using *C. amnicola* from the Creek was carried out to determine if there are infective larval stages that can infect man and to ascertain its suitability for human consumption.

MATERIALS AND METHODS

Study Area

The study area is the Elechi creek, close to Eagle Island, extending to the Iloubuchi street water bank in Diobu, Port Harcourt. It is a brackish water system influenced by tidal fluxes. Elechi creek lies Southwest of Port Harcourt between longitude 40 35" - 40 5"N and 70 00'" 70 53"E. The creek is protected from the strong wave actions prevalent in the main Bonny River Channel and the current flow is minimal (about 3m/s). The tidal amplitude is about 1.2 metres high. The detailed hydrology of the system is contained in the Netherland Engineering Consult (NEDECO, 1961). The intertidal flat consists of moderately sorted sand to silty clay with patches of hard “Chikoko” sediment types (Hart and Chindah, 1998). The vegetation is predominantly mangrove dominated by species such as *Rhizophora racemosa*, *R. mangle*, *Avicennia africana*, *Laguncularia racemosa*, *Achrostichu maurerum* and *Paspalum varginaturm* (Wilcox, 1980).

Collection of Water Samples and Determination of Physico-Chemical Parameters

A thermometer was immersed in water samples for 5- 7 minutes and the values of the readings were recorded from the thermometer by taking note of the mercury level in the thermometer. Measurement was done three times and the average recorded. Dissolved oxygen (DO) was measured with the Milwaukee Diso1ved oxygen meter (MW 600 Model). The DO meter was stabilized for 10 minutes and the probe of the meter was inserted 10-15 cm below the different concentrations. The meter was switched on and the DO reading was taken when the reading became stable. The procedure was done three times and the average values recorded. Conductivity and TDS were measured with a hand-held multimeter (The EZODO Conductivity/TDS/Salt/Temp Multimeter) model CTS-406. The probe of the meter was inserted 10-15 cm below the test medium and the meter was switched on and allowed to stabilize for 10 minutes The Conductivity reading was taken when the reading became stable. The same procedure was done three times and the values recorded. A Deluxe pH meter, model ME 963-p was used for the test of water samples from different concentrations, their replicates and the control. The pH meter was switched on, allowed for 15minutes to stabilize; the electrode was rinsed with a jet of distilled water. The pH meter was calibrated in a 4.0-7.0 buffer solution by comparing the reading of the pH meter with that of a standard solution (solution of known pH) before measuring the water sample. The same was done three times and the values recorded.

Collection of Samples

Live crabs were transported to the laboratory of the Department of Animal and Environmental Biology, University of Port Harcourt in clean ice chests with some water from the point of the catch. The identification of the crabs was carried out using an illustrated guide by (Schneider, 1992). The position of the bigger chelipe and its percentage occurrence in each species was determined. Also, the number of teeth on the bigger chelipe and the sex of each crab were determined. Samples collected were transported to the laboratory and kept in plastic tanks filled with water at room temperature (26.5-29.4°C) for analysis. The male and female sexes were identified using appropriate keys.

Collection and Examination of Crabs for Parasites

The samples were weighed using the Kinlee Electronic sensitive weighing Balance. The width and length of each crab were measured using an electronic digital caliper and the sex of each crab was noted before disserting. Male crabs have a narrow abdomen while female crab has wider abdomens, pleopods were retained (Kwei, 1978; FAO, 1990). The Crabs were laid

Table 1. Physiochemical parameters of Elechi Creek.

Physiochemical Parameters	Values Obtained	FMEVN STANDARD (2003)
pH	7.64	6.5 – 8.5
Temperature	28.10^{o}C	20 – 30.
Salinity	11.42ppt	0.5 – 35 ppm
DO	7.34 mg/l	>4.0

Table 2. Sex related prevalence of Parasites in *Callinectes Amnicola.*

Sex	No. Examined	No. Infected (%)
Males	53	27 (50.9)
Females	57	24 (42.1)
Total	110	51 (46.3)

Table 3. Weight-Related Prevalence of Parasites in *C. Amnicola.*

Weight (g)	No. Examined (%)	No. Infected (%)
25 – 35	26 (23.6)	11 (42.3)
36 – 45	51 (46.4)	18 (35.3)
46 – 55	18 (16.3)	9 (50. 0)
56 – 65	15 (13.6)	8 (53.3)
Total	110	51 (46.3)

on a flat plane laterally underside facing up and the external anatomy of the crabs for colour changes, such as dark blotches on the carapace and appendages. Scraps from cuticles (skin) and the gills were taken from the crab specimens and spread on a clean glass slide covered with a cover slip and examined under a light microscope. Each sample was examined independently. Hemolymphs of the crabs were extracted while the crabs were still alive to avoid agglutination, using a 2ml syringe. The needle of the syringe was inserted through the eyes of the sampled crabs. The extracts were put into Ethylene diamine tetra acetic bottle (EDTA) for preservation using10% formal saline. After which they were dissected into six sub-samples namely; the appendages, gill, mouth and eye part, carapace and gastro-intestinal tract (GIT). The preserved sub-samples were filtered using a cotton wool and laboratory funnel, the filtrate was stored in a test tube and centrifuge at 2000 rotation per minute for l0 minutes, the supernatant was decanted and the sediment put in a plain sample bottle. Thick and thin film smear of the hemolymph were made, fixed in methanol and air-dried according to (Cheesbrough, 2006). After which they were stained with field stain A and B, the thin films were stained with field stain B first and later the thick films, the smears were allowed to dry. A drop of oil immersion was placed on each slide and viewed under X100 of the compound light microscope.

The identification of parasites was done using a laboratory guide by (Frimeth, 1994).

Data Analysis

Prevalence in relation to sex, weight, length and site-specificity of the parasite was expressed as a percentage of the total number of crabs sampled.

RESULTS

The measured physicochemical parameters of the Elechi creek were within the Nigerian Federal Ministry of Environment standard for the survival of aquatic organisms (Table 1).

Total prevalence of 51(46.3%) was recorded, with 27 (24.5%), 24 (21.8%) for males and females respectively (Table 2).

Callinectes amnicola with the weight range 56-65g had the highest parasite load of (53.3%) followed by 46-55g with (50.0%) (Table 3).

Table 4 indicated Length related prevalence of parasites in *C. amnicola*, which did not show a definite pattern but infection was highest among the length class; 71.9-86.9 mm which harbored more parasites (75.0%) followed by 46.6-51.6 (60.0%) and least 66.8-71.8 (35.7%).

The abundance of parasites in six predilection sites, the appendages, carapace, GIT, gills, hemolymph and mouthparts/eyes were observed. The GIT had the highest infection of 16 (29.1%) followed by the hemolymph, gills, carapace, appendages and mouthparts/eyes with 13 (23.6%), 8(14.5%), 8(14.5%),

Table 4. Length related prevalence of Parasites in *Callinectes Amnicola.*

Length (mm)	No. Examined (%)	No. Infected (%)
31.5 – 46.5	26 (23.6)	10 (38.5)
46.6 – 51.6	10 (9.1)	6 (60)
51.7 – 66.7	20 (18.2)	11 (55)
66.8 – 71.8	42 (38.2)	15 (35.7)
71.9 – 86.9	12 (10.9)	9 (75.0)
Total	110	51 (46.3)

Table 5. Sex-related and body parts specific prevalence of Parasites of *C. Amnicola.*

	Number of parasites		Overall infection
Studied samples	**Males (%)**	**Females (%)**	**(%)**
Appendages	- (0)	6 (17.6)	6 (10.9)
Carapace	- (0)	8 (23.5)	8 (14.5)
Hemolymph	7 (33.3)	6 (17.6)	13 (23.6)
GIT	12 (57.1)	4 (11.8)	16 (29.1)
Mouthpart/Eyes	- (0)	4 (11.8)	4 (7.3)
Gills	2 (9.5)	6 (16.6)	8 (14.5)
Total	21 (38.2)	34 (61.8)	55

Table 6. Parasitic Fauna found in *C. Amnicola*

Phylum	Class	Order	Family	Genus	Abundance (%)
Arthropoda	Copepoda	Cyclopoida	Lernaeidae	*Lernea* sp.	
Total	1	1	1	1	3 (5.6)
Protozoa	Sarcomastigophora	Mastigophora	Peridiniaceae	*Blastodinium* sp.	15 (28.3)
		Eugregarinida	Opalinidae	*Opalina* sp.	2 (3.8)
	Sporozoea		Moxocystidae	*Monocystis* sp	4 (7.5)
				Nematocystis sp	4 (7.5)
		Rhizopoda	Paramoebidae	*Paramoeba* sp.	2 (3.8)
			Paramoebidae	*Gregarine* sp.	7 (13.2)
	Perkinsea	Perkinisida	Perkinidae	*Perkinsus* sp.	1 (1.9)
	Microsporea	Microsporida	Pereziidae	*Ameson* sp.	5 (9.4)
Total	4	5	6	8	40 (75.3)
Dinoflagellata	Dinophyceae	Peridiniales	Syndiniaceae	*Hematodinium* sp.	1 (1.9)
Total	1	1	1	1	
	Adenophora	Rhabditida	Raphidascarididae	*Hysterothylacium* sp.	1 (1.9)
		Trichurida	Trichuridae	*Trichuris* sp.	2 (3.8)
Nematode	Secernentea	Ascaridida	Oxyuridae	*Enterobius* sp.	5 (9.4)
	2	3	3	3	8 (15.0)
Platyhelminthes	Trematoda	Plagiorchiida	Troglotrematidae	*Paragonimus* sp.	1 (1.9)
Total	1	1	1	1	
Total	9	11	12	14	**53**

6(10.9%) and 4 (7.3%) respectively (Table 5).

Table 6 showed the different species of parasites recovered, *Blastodinium spp* had the highest prevalence of 15(28.3%). However, the study showed that phylum Protozoa had the highest diversity of up to eight (8) species of parasites, nematode had 3 species. One species of bacteria (*Vibrio*) was also recovered during this study.

Plate 1 showed *Callinectes amnicola* species from Elechi Creek.

Male and female *Callinectes amnicola* species (Plate 2).

DISCUSSION

The result from this study showed a total parasite prevalence of 46.3% in *C. amnicola* in Elechi creek, Port Harcourt with male crabs having 24.5% prevalence which was higher when compared to 21.8% for females. This finding was higher when compared to the 40% prevalence recorded by Childers et al., (1996) and 12.38% recorded by Anderson (1992), but lower than findings by Ikhuoriah and Awharitoma (2018) who recorded a 49.71% prevalence in freshwater crabs (*Sudanonautes africanus)*. The studies recorded a

Plate 1:*Callinectes amnicola* showing bright blue colour in the walking legs.

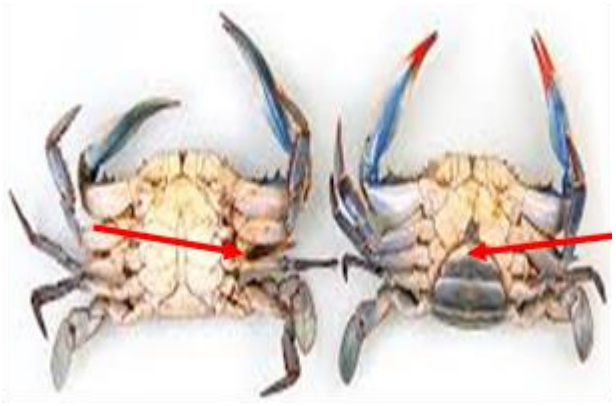

Plate 2: Male and Female *C. amnicola*(Female with broad abdomen).

higher prevalence in males than female crabs. *C. amnicola* with the weight range 56-65g had the highest parasite load of 53.3%, while Length related prevalence of parasites in *C. amnicola*, did not show a definite pattern but infection was highest among the length class; 71.9-86.9mm. This is contrary to the findings of Messick and Shield (2000) who reported that prevalence was significantly higher in crabs measuring 3-30mm than in longer crabs. There were differences in the parasite loads of six predilection sites with the gastrointestinal tract being the most infested. Similar findings were also observed by Jimmy et al. (2012) and Ugbomeh et al. (2015).

The parasites isolated from *C. amnicola*in this study were from 5 different phyla which are protozoan (*Blastodinium* spp*, Opalina* spp*, Nematocystis* spp*, Monocystis* spp*, Paramoeba* spp*, Gregarine* spp*, Perkinsus* spp and *Ameson* spp), nematodes (*Hysterothylacium* spp, *Trichuris* spp and *Enterobius* spp.) arthropods (*Lernea* spp) dinoflagelleta (*Hematodinium* spp) and platyhelminthes (*Paragonimus* spp) and the prevalence in the males and the females were not statistically significant ($p > 0.05$). This was in accordance with the study of (Ruhay and Ibrahim 2016) but differs from that of Ugbomeh et al., (2015),

who recorded more of rotifers and copepods in their study. The parasites isolated in the present study were more of protozoa and nematodes which may have some pathological implications on their host and pose a health risk to crab consumers.

The distribution of parasites varies from one habitat to the other which could be due to host-parasite relationship and abiotic factors like dissolved oxygen, temperature and pH (Anderson, 1992) and not sex-related.

In this study, the measured physicochemical parameters were noted to be within the FMEVN, 2003 standard for the survival of aquatic organisms. Dissolved oxygen and pH are the most important factor for all living organisms especially fish survival (Bartram

and Balance, 1996). Dissolved oxygen is very crucial for the survival of aquatic life and it is also used to evaluate the degree of freshness of an aquatic environment. The physicochemical parameters monitored in this study tend to have had no effect on the parasitic loads of *C. amnicola*.

According to (Jeffrey and Overstreet, 2003), Blue crabs were exposed to a variety of diseases-causing agents such as viruses, bacteria, fungi, protozoa, helminths, and other crustaceans. Although most of these agents cause little or no pathological alteration in the crab host, some may be responsible for considerable alterations and mortalities in affected hosts (Ekanem et al., 2013).

However, unlike dead fish that floats, dead crabs generally sink; hence large mortalities often go unnoticed or underreported in the wild. The true influence of several diseases on the crab, therefore, may be difficult to assess without intensive sampling. Although the present study focused strictly on parasites of *C. amnicola,* only a few parasites with no disease implications were isolated in the Creek.

Conclusion

The blue swimming crab, *C. amnicola* is a very popular food item in the diet of Riverine inhabitants of Rivers State, Nigeria. Though the study shows high prevalence of parasites in *C. amnicola*, it is worthy of note that the parasites were normal parasites of aquatic animals. These were protozoan, nematodes, arthropods, platyhelminthes and dinoflagellates, although one species of bacteria (*Vibrio*) was also isolated during this study. It is hoped that this study will serve to facilitate further research work on other acceptable and edible species of crabs in different coastal areas across the country. More cleaning and cooking time should be allocated to crab before eating. There is a need for similar work to be carried out on the flesh of crabs to ascertain the parasitic fauna found therein.

REFERENCES

Anderson RC (1992). Nematoda parasites of vertebrates, their development and transmission.C.A.B international Wallingford; 99.

Boschi EE (2000). Biodiversity of marine decapod brachyurans of the Americas. Journal of Crustacean Biology, 2: 337-342

Deardorff TL, Overstreet RM (1981). Review of *Hysterothylacium*and *Iheringascaris*(both previously=*Thynnascaris*) (Nematoda: Anisakidae) from the northern Gulf of Mexico. Proceedings of the Biological Society of Washington, (93):1035-1079.

Defelice RCL, Eldredge LG, Smith C (2001). Coordinators, Guide book to the introduced marine species in Hawavian waters. Bishops Museums Technical Report, 21: 217-274.

Ekanem AP, Eyo VO, Imaobong EE, Bassey BO (2013). Parasites of Blue Crab (*Callinectesamnicola*) in the Cross River Estuary, Nigeria. International Journal of Fisheries and Aquatic Studies, 1(1):18-21.

Fagbuaro O, Oso J, Abayomi J, Majolagbe FA, Oladapo AO (2013). Quality Analysis of Freshwater Crab *Cardisomaarmatum* and Marine Blue Crab *Callinectesamnicola* Collected From Yaba, Lagos Nigeria. Nature and Science, 11(8):22-29.

FAO (United Nations Food and Agricultural Organization) (2005). Nutritional elements of fish FAO, Rome.

Federal Ministry of Environmental Protection (FMENV) (2003). Guidelines to Standards for environmental pollution control in Nigeria.

Fransozo A, Negreiros-Fransozo ML (1996). Brazilian coastal Crustacea Decapoda. In: Biodiversity in Brazil: 141 A First Approach (de Bicudo CE, Menezes MNA, eds). Proceedings of the Workshop Methods for the assessment of biodiversity in plants and animals. ConselhoNacional de desenvolvimento Cientifico e Techologico. 275-287, Sao paulo Brazil.

Frimeth JP (1994). NWFHS Laboratory Procedure Manual.1:3.

Guillory V, Perret PW (1998). Management, history, and status and trends in the Louisiana blue crab fishery. Jour.Shellfish Res. 17(2):413-424.

Hall D, Lee SY, Meziane T (1996). Fatty acid as tropic tracer in experimental estuarine food chains. Tracer transfer Journal of Experimental Marine Biological Ecology, 336:42-53.

Hart AI, Chindah AC (1998). Preliminary study on the benthic microfauna associated with different microhabitats in mangrove forest of Bonny Estuary, Niger Delta, Nigeria. ActaHyrobiol., 40 (1): 9-15.

Jeffrey SD, Overstreet RM (2003). The Blue Crab Diseases Parasites and Other Symbionts Faculty Publications from the Harold W. Manter Laboratory of Parasitology; 426

Kwei EA (1978). Size composition, growth and sexual maturity of *Callinectes latimanus* (Rath) in two Ghanaian lagoons. Zoology Journal Linnaeus Society 64: 151-157.

Lawal-Are AO, Kusemiju K (2000). Size composition, growth pattern and feeding habits of the blue crab *Callinectes amnicola*(De Rocheborne) in the Badagry Lagoon. Nigeria Journal of Science Research and Development; 4: 117-126.

Lawson EO, Oloko RT (2013). Effect of salinity on survival and growth of blue crab, (*Callinectes amnicola*) from Yewa River, Southwest Nigeria.

Miller TJ, Houde ED (1999). Blue crab target setting. Final report to USEPA Ref. (UMCES) CBL TS. 177-199.

NEDECO (1961). The waters of the Niger Delta. Netherland Engineering Consult. The Hague .112.

Nzeako SO, Nduka FO, Wogu MN, Monye JI (2015). Isolation of Parasites from Black Tiger Prawn; *Peneausmonodon* from Isaka River, Okirika Local Government Area, Rivers State, Nigeria. Annual Research and Review in Biology 8 (1): 1-11.

Onadeko AB, Lawal-Are AO, Igborgbor OS (2015). Habitat diversity and species richness of brachyuran crabs off university of Lagos lagoon coast, akoka, Nigeria.The Bioscientist, 3(1): 14- 28.

Ryer CH, Van Montfrans J, Moody KE (1997). Cannibalism, refugia and the molting Blue crab. *Marine Ecology Programme Series* 147, 77-85.Roberts, R. J. (2000). Fish pathology. Edn 3, Hagerman, Idaho; 472.

Ruhay A, İbrahim C (2016). The Investigation of Bacteria, Parasite and Fungi in Blue Crabs (*Callinectessapidus*, Rathbun 1896) Caught From Akyatan Lagoon in East Mediterranean Sea. 5th International Conference on Agriculture, Environment and Biological Sciences (ICAEBS-16) April 28-29, 2016 Pattaya (Thailand).

Schneider W (1992). FAQ Species identification sheet for fishery purpose. Field guide to the Commercial Marine resources ofthe Gulf of Guinea.FAQ, Rom; 268.

Smallegange IM, Van Der Meer J (2003). Why do shore crabs not prefer the most profitable mussels? Journal of Animal Ecology (72): 599-607.

Ugbomeh AP, Bajor P (2015). Parasites of the Brachyuran Crab *Cardisoma armatum* from Bakana in Rivers State, Nigeria. Journal of Environmental and Applied Bioresearch,03(02): 56 -60.

Vogan CL, Coasta-Ramos C, Rowley AF (2001). A historical study of shell disease syndrome in the edible crab *cancer pagurus*. Diseases of Aquatic Organisms (47):209-217.

Wilcox BHP (1980). Angiosperm flora of the Mangrove Ecosystem of the Niger delta. In The mangrove ecosystem of the Niger Delta Wilcox B H R and Powell C B (editors) Proceedings of a Workshop. University of Port Harcourt 34-44.

Childers RK, Erchao L, Na Y, Zhenyu D and Liqiao C (2013). Biochemical composition and nutritional value analysis of Chinese mitten crab, Eriocheirsinensis, grown in pond. Global Advancement Research Journal Agricultural Science 2 (6): 164-173.

Messick GA, Shields JD (2002). Epizootiology of the parasitic dinoflagellate *Hematodium* sp. in the American blue crab, *Callinectes sapidus*. Dis. Aqua. Org. 43(2): 139-152.

Ikhuoriah SO, Awharitoma AO (2018). Prevalence of parasitic infestation in fresh water crabs *Sudanonautes africanus* (A. Milne-Edwards, 1869) (Brachyura: Potamonautidae)from selected Rivers in Edo and Delta States Nigeria. J. Appl. Sci. Environ. Manage. 22(11) 1761-1767.

Jimmy AP, Arazu VN (2012). The proximate and mineral composition of two edible crabs Callinetes amnicola and Uca tangeri (crustecea:Decapoda) of the cross River Nigeria. Pakistan Jour. Nutri, 11 (1): 78-82.