E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(3): 103-107

www.fisheriesjournal.com
Received: 14-03-2018
Accepted: 15-04-2018

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Biological association of the blue crab (*Callinectes amnicola*: De Rochebrune, 1883) with invertebrate organisms in the Great Kwa River, Southeastern Nigeria

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Abstract
Investigations were conducted on biological association of the blue crab *Callinectes amnicola* with invertebrates' organisms in the Great Kwa River, from July 2016 to September 2016. Results of the investigation revealed that four barnacle species namely *Balanus glandula, Chthamallus dalli, Chthamallus stellatus* and *Semibalanus balanoides* were in common association with the crab. Total of 15 (30.61%) *Balanus glandula* were observed to be in association with the crab in, 12 (31.58%) in August and 14 (30.43%) in September. *Chthamallus dalli* had 11 individuals (22.45%) in July, with 8 (21.05%) in August and 10 (21.74%) in September. In July, 13 (26.53%) of *Chthamallus stellatus* were observed on the crabs with 11 (28.95%) in August and 9 (19.57%) in September, while *Semibalanus balanoides* had 10 individuals (20.41%) in July with 7 (18.42%) in August and 13 (28.20%) in September. A hairy macro-algae in the Chrysophyceae family was also observed to symbiotically associate with the crab particular where the larval stages of the various barnacle species were found.

Keywords: Biological association, *Callinectes amnicola,* invertebrate organisms, Great Kwa River, Southeastern Nigeria

1. Introduction
Biological associations are found everywhere in nature, where they are parasitic or mutualistic [1]. While the term biological association has frequently been used to describe the existing together of one animal with another, several of such associations are known in the animal and plant Kingdom [2]. Biological associations represent one of the most important environmental adaptation of aquatic species. Such a variety of taxa, including shrimps, crabs, amphipods, isopods and copepods, have been described in macroinvertebrates all around the world, including tropical and temperate environments [3]. Relationships such as parasitism, mutualism and commensalism have been described between several crustaceans having a wide range of sizes, morphologies of habits, and may vary widely in their general biology and ecology [4]. Crabs themselves provide a protected environment for many other animals. Apart from the camouflaging organism reviewed above, there are many filter feeders which, although usually free-living, may settle on crabs and use the latter's respiratory currents for feeding purposes [2]. Crabs have been reported to associate themselves with other animals for protection, as commensals or parasites and as hosts to commensals and parasites. Associations for protection are often formed with anemones [3] described a causal relationship in which the spider crab *Inarrchus sp.* sits at the base of the snake-locks anemone *Anemonia* under a protective cover of tentacles. Its presence does not elicit the *Anemonia's* normal feeding reactions. Closer associations are formed between anemones and hermit crabs. Here, both partners benefit since the anemone, carried on the hermit crabs shell, gains both mobility and extra food from the anemone. These causal associates include barnacles and spirorbid tube worms (which may encrust the mouthparts and branchiostegites), hydroids, bryozoans, tube -dwelling amphipods and ascidians. The brachial chambers are even more protected and, although infection may occur, is relatively rare. Parasitic isopods and even small fish have been found within hermit crabs [3]. Also, the cavity of the shell of the hermit provides a similar protected environment, and large individuals of *Pagurus herbardus* frequently play what is probably rather reluctant host to the large worm *Nereis spp.* which lives alongside the crab within the shell.

This worm feeds by seizing food from the crab's mouthparts and retreating with it into the shell [5]. The study is significant as it reveals biological associations as regard to the fitness, costs and benefits conferred to the organisms involved in such interactions, and how the varying nature of these costs and benefits interfere on the way these associations are labeled and/or classified to enhanced survival of the organisms involved. Therefore, the results of the study intends to reveal the different barnacle species that is associated biologically with blue crabs (*Callinectes amnicola*) inhabiting the Great Kwa River, Nigeria. This study aimed at evaluating the biological associations and the role of inter-specific competition in explaining the ecological traits in crabs from the Great Kwa River.

2. Materials and Methods

2.1 Description of the Study Area

The Great Kwa river, Cross River State is located between latitude 8^0 15'E and 8^0 30'E and longitude 4^0 45'N and 5^0 15'N. It has an estimated length of 56km and is about 2.8km wide at the mouth where it empties into the cross river estuary The swampy region is greatly influenced by climate conditions as the tides continually exhibit fluctuations [6]. The climate is governed by two seasons the wet and the dry but their span/durations has become somewhat an issue due to a global climatic change [7]. The shorelines are lined with dark mud plates usually exposed during low tides, the water at the shore being brackish and rich in macroinvertebrates such as crabs and debris. The banks are also surrounded by lush evergreen, forest vegetation with different species of trees, shrubs and grasses [8]. Two sampling sites were selected along the shores of the River. Site one is located at Obufa Esuk, close to the university of Calabar staff quarters. The substratum here is covered by mud or clay with an average depth of 0.2m. It is swift-flowing and has a low transparency. The vegetation here includes fan palm (*Hyphaene petersiana*) and grasses [8]. Site two is located at Esuk Atu, close to the biological science and teaching hospitals areas of the University of Calabar. Substratum here is covered with coarse sand and mud with an average depth of 0.2m. It is swift-flowing and his medium transparency. Vegetation here includes elephant grasses, palm trees and fan palms (*Hyphaene petersiana*) [8].

2.2 Collection of samples

Samples were collected from the sites selected for this study particularly from the artisanal fishermen twice a week on monthly basis for three months (July 2016 to September 2016). Samples were collected between 07.00am – 09.00am hours. The samples were transported immediately to the Department of Zoology and Environmental Biology Laboratory, University of Calabar, Calabar, Nigeria for examination and identification based on morphological structures with the aid of scheme and identification guide of [9].

2.3 Identification of the species in biological association with the crabs

The species which were observed to be in biological association with the crabs were identified based on morphological features in scheme and atlases recommended by Mann; Castro and Huber; Sverdrup *et al*. [2-3, 10]. Identification was carried out to species level and formed into Plates. Magnifying glass was used to aid the identification.

2.4 Data Analysis

Data was analysis by using summation method as described by [11]. Relative abundance of the species in each family was calculated based on the formula below:

$$R_a(\%) = \frac{n(100)}{N} \quad \text{..... (1)}$$

Where n = number of each individual species
N = total number of all individual species encountered
Ra = relative abundance in percentage

3. Results

3.1 Total number of crabs with and without barnacles

The Total of 120 crabs were collected in July, out of which 87 had barnacles, while in August 98 crabs were collected with 57 observed to be colonized by barnacles, and in September, 106 crabs were collected, out of which 79 had barnacles. The number of crabs with barnacles were higher than those without barnacles throughout the period of study (Table 1).

Table 1: Number of crabs and relative abundance per month (July 2016 – September 2016)

S/n	Months of sample	Number of of crabs collected (n)	% (n)	Number of crab with barnacles (n)	% (n)	Number of crabs without barnacles (n)	% (n)
1.	July	120	37.03	87	39.01	33	32.67
2.	August	98	30.25	57	25.56	41	40.59
3.	Sept.	106	32.72	79	35.43	27	26.73
	Total	324	100	223	100	101	99.99 ~100

3.2 Invertebrate organisms associated with crab C*allinectes amnicola* in the Great Kwa River

The invertebrate organisms observed to be in association with the crab (*Callinectes amnicola*) consisted of barnacles namely *Balanus glandula* (Plate 1A), *Chthamallus dalli* (Plate 1B), Hairy macro-algae (Plate 2A), *Chthamallus stellatus* (Plate 2B) and *Semibalanus balanoides* (Plate 3).

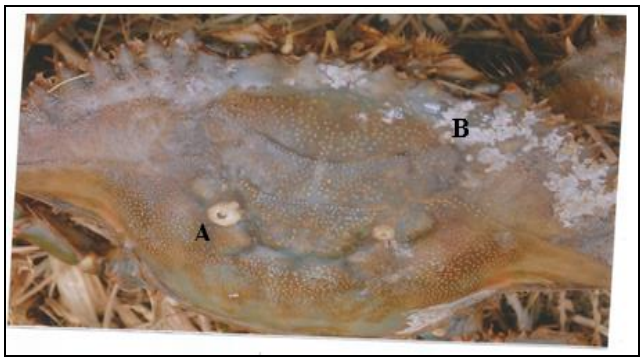

Plate 1(A): *Balanus glandula* **(B):** *Chthamallus dalli*

Plate 2 (A): Hairy macro-algae **(B):** *Chthamallus stellatus*

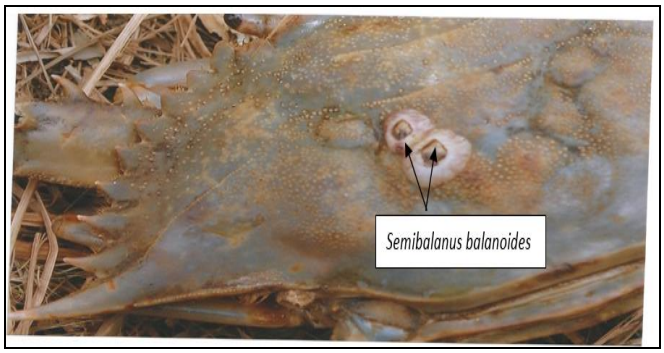

Plate 3: *Semibalanus balanoides* in association with *Callinectes amnicola*

3.3 Relative Abundance and Monthly distribution of the barnacle species in association with *Callinectes amnicola*

The Relative abundance of the barnacle species is presented in Table 2 and monthly distribution illustrated in Figure 1. In July, 15 (30.61%) of *B. glandula* were observed to be in association with the crab, with 12 (31.58%) in August and 14 (30.43%) in September. Total of 11 (22.45%) of *Chthamallus dalli* were recorded in July, with 8 (21.05%) in August and 10 (21.74%) in September, *C. stellatus* had total of 13 (26.53%) in July, with 11 (28.95%) in August and 9 (19.57%) in September, while *Semibalanus balanoides* had total of 10 individuals which formed 20.41% of the barnacle population in July, with 7 (18.42%) in August and 13 (28.26%) in September (Table 2).

Table 2: Monthly distribution and Relative Abundance of invertebrate organisms in association with the crab *Callinectes amnicola* from the Great Kwa River Nigeria (July–September, 2016).

Barnacles species observed	July		August		September		Total	
	(n)	R (%)	(n)	R (%)	(n)	R (%)	(n)	R (%)
Balanus glandula	15	30.61	12	31.58	14	30.43	41	30.83
Chthamallus dalli	11	22.45	8	21.05	10	21.74	29	21.80
Chthamallus stellatus	13	26.53	11	28.95	9	19.57	33	24.81
Semibalanus balanoides	10	20.41	7	18.42	13	28.26	30	22.56
Total abundance (N)	49	100.0	38	100.0	46	100.0	133	100.0

The total abundance of barnacle species associated with Callinectes amnicola were observed, *B. glandula* recorded 41 with relative abundance of (30.83%), *Chthamallus dalli* recorded 29 with (21.80%), *C. stellatus* recorded 33 with relative abundance of (24.81%) and *S. balanoides* recorded 30 with relative abundance of (22.50%) respectively (Table 2). The distribution pattern of the barnacles during the period of study were in the following order: *Balanus glandula* > *Chthamallus stellatus* > *Semibalanus balanoides* > *C. dalli*.

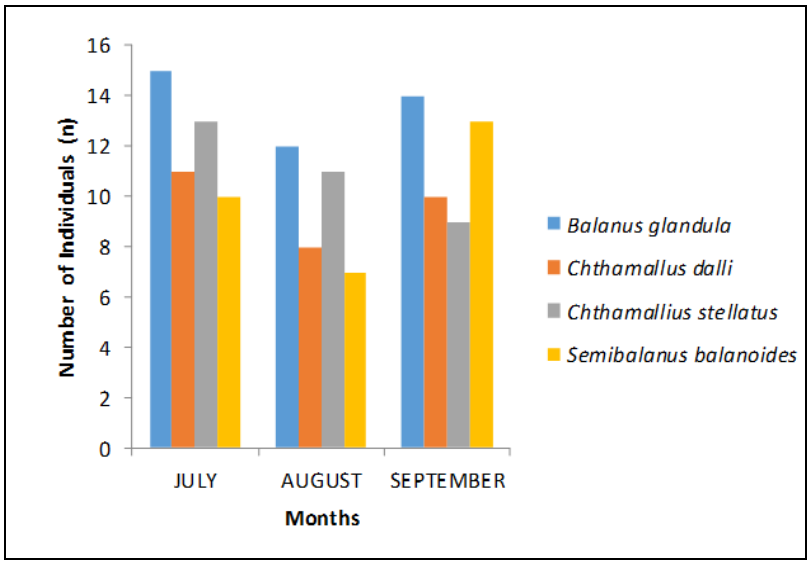

Fig 1: Monthly Distribution of the barnacle organisms in association with crab (*Callinectes amnicola*) from Great Kwa River

4. Discussion

Barnacles are sessile organisms and they have become adapted for a life on rock or other hard substrates in tropical and temperate waters and the heavy somewhat fused ring of wall plates probably protects them from currents, pounding waves, and browsing fish species [12]. In both the tropical and temperate intertidal zones, barnacles commonly occur in enormous numbers in association with other organisms. In an ecological setting, species do not exist alone. They live in a community of several other species in an interactive process [13]. During such interactions, some act as competitors, while others act as commensals, mutual, predators or parasites [3]. The barnacles are known to be commensals, and hence, while they are benefiting from the association, are clearly harmless. However, in situations where the barnacles are in heavy association (that is, large numbers becoming attached to the other organism such as the *C. amnicola* in this case, may impede the swimming capability of the crab. This situation was reported in Aleutian Islands, Alaska, where *Chthamallus dalli* was found in large numbers associating with the hermit crab *Calcinus laerimanus*, in which the crab's movement was reported to be impeded [14], these shows to exhibit tropical and temperate existence. The large number of barnacle individuals of each species usually reported in the aquatic systems where they occur, has been attributed to their ability to reproduce faster, as they are hermaphroditic in their mode of reproduction and capable of self- fertilization [15]. From the results of the study, four species of barnacles were observed to be in association with the blue crabs (*C. amnicola*) in the Great Kwa River, Nigeria, during the period of study. The barnacle species which included; *Balanus glandula, Chthamallus dalli, Chthamallus stellatus* and *Semibalanus balanoides* were found attached on all parts of the crab's body. Barnacles are generally commensals [16-18], and as such, they become attached to other organisms or objects to enable them obtain shelter and food [18, 3]. The results of the present study agree with that of Hoek *et al*. [19], who independently reported the Association of *Balanus glandula* with mussels in the Pacific waters of North America and that the barnacle species is of a wide distribution in Californian coastal waters, where it is found attached to rocks, pier pilings, floating objects and other organisms. C*hthamallus dalli* found to be in association with *C. amnicola* in the Great Kwa River, Nigeria, has also been reported by Nybakken and Webster [15], where the barnacle was observed to associate as a commensal with mussels, crustaceans and crabs. This shows to exhibit tropical and temperate existence. This also corroborates with the results of the present study as *C. dalli* was observed on the *C. amnicola* body during the period of study. *Chthamallus stellatus* and *Semibalanus balanoides* also observed to be in association with *C. amnicola* inhabiting the Great Kwa River, were also reported in the Gulf of California as having strong association with whales. These barnacles, according to Castro and Huber [3], were reported to be found on the dorsal, ventral and lateral area of the whale. As the results of the present study reveal, the barnacles species were found to be associated with the crab at all sites. In this study the barnacle species where in some cases found to have more than one species being in association with the crab. This result corroborates with that of Hoek *et al*. [19]. The occurrence of other species on the crab were interesting. For instance, the occurrence of macro-algae such as that of the Chrysophyceae family (hairy form of Diatom) in this study agrees with that of Kier and Vander [20] who reported on the mutualistic stability as regards invertebrates association. The result of this study clearly shows that the number of crabs with barnacles were higher than others without barnacles throughout the period of study.

5. Conclusions

An investigation was conducted on biological association of the blue crab *Callinectes amnicola* with animal invertebrates in the Great Kwa River, Nigeria. Results revealed that four barnacles' species namely *Balanus glandula, Chthamallus dalli, Chthamallus stellatus* and *Semibalanus balanoides* were in common association with the crabs in Great Kwa River. A hairy brown macro-algae in the Chrysophyceae family was also observed to be in symbiotic association with the crab, where larval stages of the various barnacle species were also observed on the crab.

6. Acknowledgement

Authors acknowledge all the technologists in the Department of Zoology and Environmental Biology, University of Calabar, Faculty of Biological Sciences for their assistance and for providing the laboratory facilities for carrying out this research work.

7. References

1. Douglas AE, Fernandez JC. Symbiotic interaction among crustaceans. Oxford University Press, Oxford. 1994; 13:97-111.
2. Mann KH. Ecology of coastal waters with implication for management. 2nd Edition. Blackwell science incorporated. Massachusetts, U.S.A, 2000, 406.
3. Castro P, Huber ME. Marine Biology. 5th Edition. McGraw-Hill Higher Education, 2005, 452.
4. Olaniyan CIO. An Introduction to West African Animal Ecology. 2nd Edition Heinemann Publisher, Ibadan, 1989, 170
5. Prasad SN. Marine Biology. Campus Books International 433/2-1, Prahlad, India, 2000, 467.
6. Akpan ER, Ofem JO, Nya AE. Baseline ecological studies of the Great Kwa River, Nigeria. Physico-chemical studies. African Journal of Environmental Pollution and Health. 2002; 1(1):80-90.
7. Oku EE, Andem AB, Eni GE, Effiong BK. Arthropods Community of Mangrove Swamp of Great Kwa River, Southern Nigeria. International Journal of Fisheries and Aquatic Studies. 2013; 1(2):15-20
8. Okorafor KA, Andem AB, Okete JA, Ettah SE. The Composition, Distribution and Abundance of Macro invertebrates in the Shores of the Great Kwa River, Cross River State, South-east, Nigeria. European Journal of Zoological Research. 2012; 1(2):31-36
9. Schneider W. Field guide to the commercial marine resources of the Gulf of Guinea. FAQ species identification sheets for fishery purposes. FAQ, Rome, RAFR/FI/90/2, 1990, 268.
10. Sverdrup KA, Duxbury AB, Duxbury AC. Fundamental of oceanography. 5th Edition McGraw- Hill Higher Education, Boston, 2006, 242.
11. George EE, Samuel IU, Andem AB. Composition and Abundance of Phytoplankton of Adiabo River in Calabar River System, Southeast, Nigeria. European Journal of Zoological Research. 2012; 1(4):93-98
12. Dorit R, Walker FW, Barnes RD. Zoology. Saunders College Publishing. Chicago, 1991, 1008.

13. Caughley G, Sinclair AR. Wildlife Ecology and management. Blackwell Scientific Publication Boston, 1994, 334.
14. Burrows MT, Hawkins SJ, Southward AJ. Larval development of the intertidal barnacles, *Chthamallus stellatus* and *Chthamallus montagui*. Journal of the Marine Biological Association of the British Isles. 1999; 24(4):214-228.
15. Riley K. *Chthamallus stellatus.* Polis stellates barnacle. Marine Life Information Network, 2002, 124.
16. Nybakken JW, Webster SK. Life in the Ocean. Scientific American. 1996; 9(3):74-78.
17. Cote IM. Evolution and ecology of cleaning symbiosis in the sea. Oceanography and Marine Biology: An Annual Review. 2000; 38:311-355.
18. Abrams PA. The evolution of predator – prey interaction. Theory and evidence. Annual Review of Ecology and systematic. 2000; 31:79-105.
19. Schwindt E. The invasion of the acorn barnacle (*Balanus glandulai*), in the Southwestern Altantic 40 years later. Journal of the Marine Biological Association of the United Kingdom. 2007; 87(5):1219-1225.
20. Hoek CV, Mann DG, Jahns HM. Algae: An Introduction to Psychology. Cambridge University Press, Cambridge, 1995, 326.
21. Kiers ET, Vander D. Mutualistic Stability in the *Arbushcular mycorrlizal* symbiosis: exploring hypothesis of evolutionary cooperation. Ecology. 2006; 87:1627-1636.