International Journal of Fisheries and Aquatic Studies 2013; 1(2):15-20

ISSN: 2347-5129
2013; 1(2):15-20

www.fisheriesjournal.com
Received: 01-11-2013
Accepted: 19-11-2013

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Arthropods Community of Mangrove Swamp of Great Kwa River, Southern Nigeria

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ABSTRACT
The study investigated the Arthropod community of the Great Kwa river mangrove swamp within two sites. Site A represented a muddy flat with high water capacity while Site B represented a less muddy flat with low water capacity. Arthropod abundance increased during the wet season with a mean value ($298.04+4.41^a$) for site A and ($122.90+2.0^a$) for site B versus ($198.49+2.30^b$) for site A and ($75.44+1.21^b$) for site B during the dry season. There was a significant difference between arthropods collected during the wet season and the dry season ($p < 0.05$). There was a notable effect of seasonal variation within all the different groups of arthropods sampled. The result showed that class Insecta was the most abundant group recording (71.2%), Crustacea (18.0%), Arachnida (7.6%), Diplopoda (2.0%), Symphyla (1.1%) and the least abundant was Chilopoda (0.1%).The study revealed a high distribution and abundance of arthropods in site. A when compared with site B. There was a significant difference at ($p<0.05$). There was no significant difference between Chilopoda over both sites ($p >0.05$). Finally species diversity analysis revealed that site A was more diverse with an index of 2.46 in comparison with site B having an index of 2.261.

Keywords: Arthropods, Abundance, Seasonal Variation, Mangrove Swamp, Great Kwa River.

1. Introduction
Arthropods fill a wide variety of ecological roles and show enormous variation in morphological characteristics. They are usually very active and energetic animals that utilize all modes of feeding-carnivorous, herbivorous, omnivorous, although a vast number are herbivorous. In diversity of ecological distribution, arthropods have no rivals. Although, many arthropods compete with human's for food and spread serious vertebrate diseases, they are essential for the pollination of many food plants, they also serve as food in the ecosystem, yield drugs, and generate products such as silk, honey, bees wax, and dyes[1]. These habits remind us of our ceaseless struggle with the dominant group of animals on earth today[2]. Arthropods possess unmatched ability to adapt to all terrestrial and aquatic environments and to virtually all climates, and have evolved extra-ordinary abilities to survive adverse environmental conditions[3]. The Great Kwa River is characterized by semi-tides and extensive mudflats, consisting of mangrove plants species such as *Rhizophora racemosa* and *Avicennia africana*[4]. The Wild world profile on eco-region in African Mangrove illustrates that the key factors that influence the mangrove ecosystems are river floods and tidal range. Furthermore the current status of mangrove area in African shows a range between 16,673 and 17,176 kilometers of which more than 2/3 are found in Nigeria[5]. Banjo *et al*.[6] highlighted that many forest reserved areas and mangroves characterized by complex arthropods diversity and food webs are located in Southern Nigeria as a result of the favorable climatic conditions. Horgolt[7] also noted that numerous insects' species are found in Mangrove forests; some play critical roles as Mangrove pollinators, herbivores, predators and as a food source for other animals. The ecological importance of mangrove habitat is therefore numerous and this has eventually influenced the mangroves community. Sadly, Arthropods fauna of the Great Kwa River mangrove swamp, Calabar Nigeria has not been adequately researched. The purpose of this research work is to identify, observe, examine the Arthropod community and also determine the ecology, prevalence and distribution of Arthropods in the Great Kwa River mangrove.

2. Materials and Methods

2.1 Description of Study Area

The study was conducted in the mangroves of the Great Kwa River located in Calabar Cross River State Nigeria. The mangrove lies around latitude 4.45^{0}N and longitude 8.20 ^{0}E[4]. The Mangrove is a vast area dominated by the *Nypa Fruticans* supporting an incredible array of animal life. The swampy region is greatly influenced by climate conditions as the tides continually exhibit fluctuations. 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.

2.2 Sampling Sites

Two sites were selected based on the strength of the tide and sampling was done randomly within these Sites.

2.2.1 Site A

This site is located at Obufa Esuk, Close to the University of Calabar, Staff Quarters. The Substratum here is covered by mud and clay with average depth of 0.2 m. It is swift-flowing and has a low transparency. The vegetation here includes Fan palm (*Hyphaene petersiana*) and grasses[8].

2.2.2 Site B

This site is located at Esuk Atu, close to the Biological science and teaching Hospital area of the University of Calabar. Substratum here is covered with coarse sand and mud with an average depth of 0.2m. it is also swift-flowing and his medium transparency. Vegetation here includes Elephant grasses, Palm trees and Fan palm (*Hyphaene petersiana*)[8].

2.3 Duration of the Study

The duration of the study extended across both seasons. For the rainy season samples were collected during August to September, 2012 and for the dry sampling were done throughout November to December, 2012.

2.4 Data Collection

Collection of available arthropods was done daily at each location (within the two months of each season). Samples were collected at different hours of the day morning (between 8.00 am to 11.00 am) and evening (between 15.00 pm to 18.00 pm) in a bid to understand the effects of daily variation. Ariel arthropods were collected using sweep nets while creeping, crawling, and running Arthropods were trapped by inverting sample bottles over them and by handpicking when fully engulfed. Occasionally heavy rain delayed sampling on several occasions. The Arthropod collected in each samples were sorted, counted and placed into the following taxa: Diptera, Hemiptera, Hymenoptera, Coleoptera, Orthoptera, Lepidoptera, Odonata, Phasmatodae, Scolopendromorpha, Spirobolida, Decapoda, Araneae and Symphyla.

2.5 Data Analysis

Data analysis included the calculation of Species richness and Abundance based on the number of individual caught using PAST software (Version 2.3). Relative abundance plots for each habitats and abundance for the dry and wet season were plotted to illustrate trends in the species abundance using Microsoft excel (Version 2010). Statistical analysis using the student T-test was used to detect significant difference between the numbers of arthropods collected at study sites (A and B), and during both seasons (wet and dry)[9].

3. Results

A total of 20812 Arthropods comprising six (6) different Arthropod Classes were collected in sixty days (60). These were Insecta, Chilopoda, Diplopoda, Arachnida, Crustacean and Symphyla. The Class Insecta was six (6) Orders; these include Odonata, Hymenoptera, Hemiptera, Coleoptera, Orthoptera, and Diptera. Arachnida have a single order Araneae, Crustacean also had a single Order Decapoda, likewise Chilopoda, Diplopoda and Symphyla (Table 1). The Class Insecta was the most abundant group with a total of 15540 individuals (71.2%), followed by Crustacea 3791 (18.0%) Arachnida with 1717 (7.6%) Diplopoda 4.443 (2.0%) Symphyla 237 (1.1%) and the least abundant was Chilopoda with 23 individuals (0.1%) (Table1). The study revealed a high distribution and abundance of arthropods in site A when compared with site B. for example Lepidoptera caught in site A recorded 710 versus 437 caught in site B. Arthropods caught in site A was significantly higher than those caught in site B ($P < 0.05$). The only group with a higher distribution in site B over site A was the Chilopoda having 13 individuals in site B versus 10 in site A (Table1). This difference was not significant at ($P > 0.05$). The most abundant arthropod group was from the Class Insecta, and this was the Hymenoptera with a total of 5508 individuals caught. The least group was the Order Scolopendromorpha from Class Chilopoda recording only 23 individuals (Table1).

Table I: Prevalence of Arthropods in the Great Kwa River Mangrove Swamp

TAXANOMIC	Order	Species	SITE A		%	SITE B		%	TOTAL	%
Phylum										
Arthropoda										
Class										
INSECTA	**Diptera**	**FLIES**		**842**	**5.7**		**536**			
		Fannia scalaris	354			251		8.9	1378	6.6
		Musca domestica	281			161				
		Chrysomya species	124			90				
		MOSQUITOES		**1188**	**8.0**		**538**	**8.9**	**1723**	**8.3**
		Aedes species	615			249				
		Culex species	368			166				
		Anopheles species	205			120				
	Hemiptera	**BUGS**		**591**	**3.9**		**282**	**4.6**	**880**	**4.2**
		Icerya species	214			131				
		Phenacoccus species	227			90				
		Rastrococcus species	150			61				
		TREEHOPPERS		**64**	**0.4**		**12**	**0.2**	**76**	**0.2**
		Stictocephala species	64			12				
		APHIDS		**591**	**3.9**		**282**	**4.6**	**873**	**4.2**
	Hymenoptera	**ANTS**		**2463**	**16.6**		**1718**	**28.5**	**5508**	**20.1**

		Pheidole species	989			700				
		Dorylus nigricans	600			452				
		Oecophylla longinoda	504			372				
		Oligomyrmex species	370			194				
		WASP		**225**	**1.5**		**40**	**0.7**	**265**	**1.3**
		Vespula species	200			38				
		Heterodotongx bilolor	25			2				
		BEES		**992**	**6.7**		**70**	**1.2**	**1062**	**5.1**
		Apis species	992			70				
	Lepidoptera	**BUTTERFLIES**		**710**	**4.89**		**437**	**7.2**	**1147**	**5.5**
		Acacia species	294			226				
		Mylothris species	53			29				
		Neptis species	121			69				
		Sevenia species	106			53				
		Eagris species	136			75				
		Lepidoptera larvae		**210**	**1.4**		**13**	**0.2**	**223**	**1.0**
	Odonata	**DRAGONFLIES**		**1894**	**12.8**		**348**	**5.9**	**2242**	**10.7**
		Palpoleula lucia	1860			329				
		Aethriamanta rezia	34			19				
	Orthoptera	**CRICKET**		**220**	**1.5**		**187**	**3.1**	**407**	**1.9**
		Gryllotalpa Gryllotalpa	196			162				
		Acheta species	24			25				
	Phasmatodae	**WALKING STICKS**		36	0.2		4	0.07	40	0.2
		Diapheromera species	36			4				
CHILOPODA										
		CENTIPEDES		**10**	**0.07**		**13**	**0.2**	**23**	**0.1**
	Scolopendromorpha	*Scolopendra morsitans*	10			13				
DIPLOPODA										
		MILIPEDES		**393**	**2.6**		**40**	**0.7**	**433**	**2.0**
	Spirobolida	*Pachybolus ligulatus*	311			31				
		Coromus vittatus	82			9				
CRUSTACEA										
		CRABS		**2849**	**19.2**		**942**	**15.7**	**3791**	**18.0**
	Decapoda	*Callinectes amnicola*	2111			700				
		Uca tangeri	738			242				
ARACHNIDA										
		SPIDER		**1241**	**8.3**		**476**	**7.9**	**17.7**	**8.0**
	Araneae	*Brancus* species	742			204				
		Thiroloiirtus species	396			191				
		Myrmarachne species	103			81				
SYMPHYLA										
				191	**1.2**		**46**	**0.8**	**237**	**1.1**
TOTAL				**15540**			**6003**		**21543**	

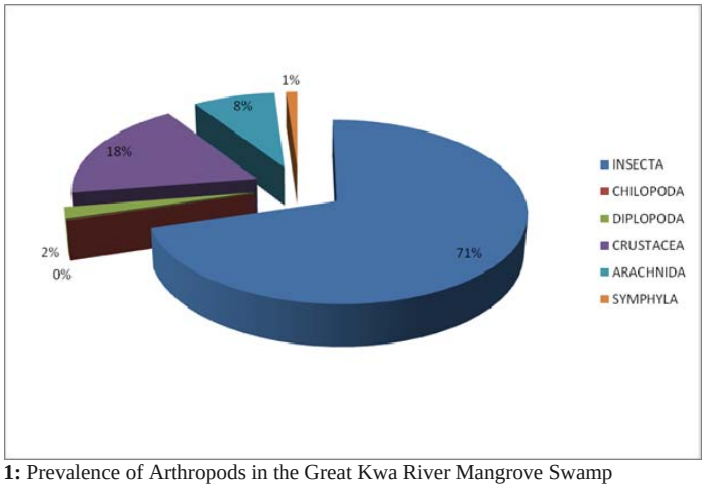

Fig 1: Prevalence of Arthropods in the Great Kwa River Mangrove Swamp

3.1 Seasonal Variation of Arthropods in the Great Kwa River Mangrove Swamp: A total of 9621 Arthropods were collected during the wet season in site A and 5919 collected during the dry season. In site B a total of 3708 Arthropods were collected in the wet season while 2295 were collected during the dry season (Table 2). The mean abundance of arthropods varied greatly during both seasons with the highest abundance recorded in the wet season 13329 (61.87%) Arthropods were collected during the wet season and 8214 (38.13%) were collected during the dry season. There was a significant difference between the abundance of arthropods in the wet and dry season (P <0.05).The abundance of

Arthropods increased during the wet season in site A with a mean value of (298.04+4.41[a]). There was significant difference between both seasons (P <0.05). Similar variations were observed in site B, where the mean value in the wet season was (122.90+2.0[a]) with the dry accounting for (75.44+1.21[b]). The data showed a significant difference over both season (P <0.05) (Table 2; Figure 2). Seasonal variation occurred within all the different groups of Arthropod. Hymenoptera, Decapoda, Hemiptera, Diptera, Odonata recorded a higher abundance in both wet and dry season (P <0.05). Odonata and Lepidoptera showed greater abundance in the dry season than in the wet season at site A. Nevertheless, this difference was not significant at (P >0.05) (Table 2).

Table 2: Shows the effect of seasonal variation on the arthropods community of the Great Kwa River mangrove swamp

SITE A					SITE B				
ARTHROPODS	**NUMBER COLLECTED (Wet season)**	**MEAN WET SEASON**	**NUMBERS COLLECTED (Dry season)**	**MEAN DRY SEASON**	**ARTHROPODS**	**NUMBER COLLECTED (Wet season)**	**MEAN WET SEASON**	**NUMBER SCOLLECTED (Dry season)**	**MEAN DRY SEASON**
DIPTERA	1217	24.5+1.35[a]	813	18.2+1.04[a]	**DIPTERA**	631	16.4+0.80[a]	440	15.1+0.39[b]
HEMIPTERA	1357	26.7+2.61[b]	403	16.3+0.89[b]	**HEMIPTERA**	213	14.6+040[a]	124	5.2+0.40[b]
HYMENOPTERA	2402	65.0+4.89[a]	1208	24.1+1.19[b]	**HYMENOPTERA**	1190	25.2± 2.77[a]	638	17.4.0± 1.34[b]
LEPIDOPTERA	387	15.0±2.10[a]	524	16.6+1.26[b]	**LEPIDOPTERA**	295	15.7± 1.39[a]	155	5.90+0.54[b]
ODONATA	812	18.1+0.92[a]	1082	23.5+0.77[b]	**ODONATA**	195	6.7+0.25[a]	153	5.42+0.12[b]
ORTHOPTERA	372	12.4+0.60[b]	243	16.0+0.72[a]	**ORTHOPTERA**	262	15.9+0.23[a]	192	6.5+0.30[b]
PHASMATODAE	21	0.7±0.12[a]	15	0.40+0.21[b]	**PHASMATODAE**	4	0.27+0.21[a]	0	0+00[b]
SCOLOPENDROMORPHA	8	0.2+0.21[b]	2	0.1+0.01[a]	**SCOLOPENDROMORPHA**	10	0.32+0.45[a]	3	0.12+0.30[b]
SPIROBOLIDA	242	15.9+0.77[a]	151	6.3+0.56[b]	**SPIROBOLIDA**	33	5.60+0.65[a]	7	0.34+0.65[b]
DECAPODA	1946	64.8+3.5[a]	903	19.2+0.40[b]	**DECAPODA**	531	172+0.21[a]	411	14.9± 0.43[b]
ARANEAE	723	17.3+0.75[a]	518	17.8+0.55[b]	**ARANEAE**	310	16.3± 0.41[a]	160	6.9+0.23[b]
SYMPHYLA	134	5.7+0.05[a]	57	4.23+0.04[b]	**SYMPHYLA**	34	2.30+0.15[a]	12	0.34± 0.31[b]
TOTAL	**9621**	**298.04± 4.41[a]**	**5919**	**198.49± 2.3[b]**	**TOTAL**	**3708**	**122.90± 2.0[a]**	**2295**	**75.44+1.21[b]**

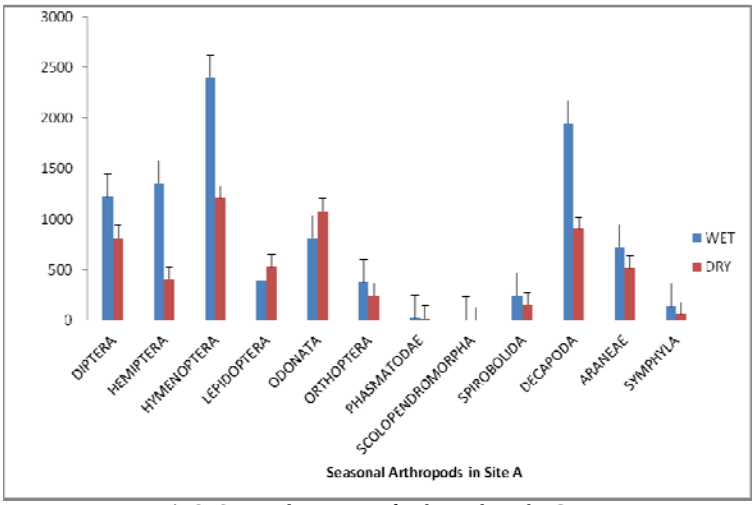

Fig 2: Seasonal variation of arthropods in the Great

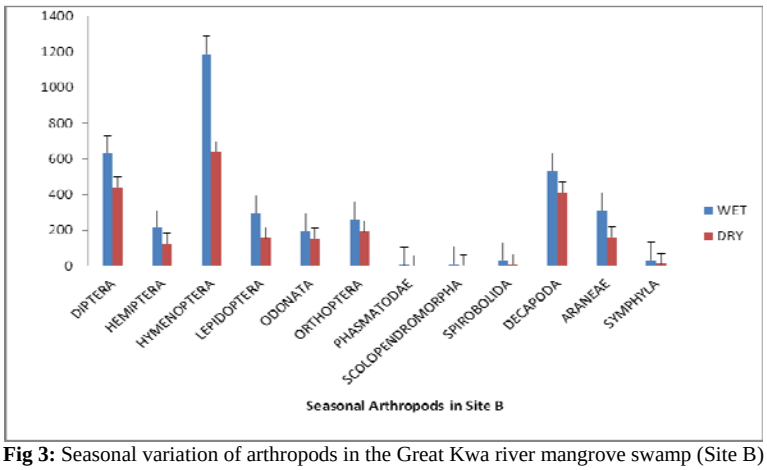

Fig 3: Seasonal variation of arthropods in the Great Kwa river mangrove swamp (Site B)

3.2 Abundance and Diversity Indices of Arthropods in the Great Kwa River

The sum of arthropods caught in both sites was used to obtain the abundance. The most abundant species was the Hymenoptera (5508), closely followed by Decapoda (3791), Diptera (3101), Odonata (2242), Hemiptera (1769), Araneae (1717), Lepidoptera (1370), Orthoptera (1069), Spirobolida (433), Symphyla (237), Phasmatodae (40), Scolopendromorpha (23) (Table 3). Analysis for species diversity (Shannon Weiner, 1949) showed that Site A was more diverse with an index of 2.4630 in comparism with site B having an index of 2.2608. Site A had higher species richness than site B (number of individuals) which was however attributed to a rich vegetable cover.

Table 3: Abundance of Arthropods in the Great Kwa River Mangrove Swamp

Rank	Arthropods	Numbers Collected	Percentage (%)
1.	**Diptera**	3101	14.56
2.	**Hemiptera**	1769	8.30
3.	**Hymenoptera**	5508	25.86
4.	**Lepidoptera**	1370	6.43
5.	**Odonata**	2242	10.53
6.	**Orthoptera**	1069	5.01
7.	**Phasmatodae**	40	0.19
8.	**Scolopendromorpha**	23	0.11
9.	**Spirobolida**	433	2.03
10.	**Decapoda**	3791	17.79
11.	**Araneae**	1717	8.06
12.	**Symphyla**	237	1.11
Total		**21300**	**100**

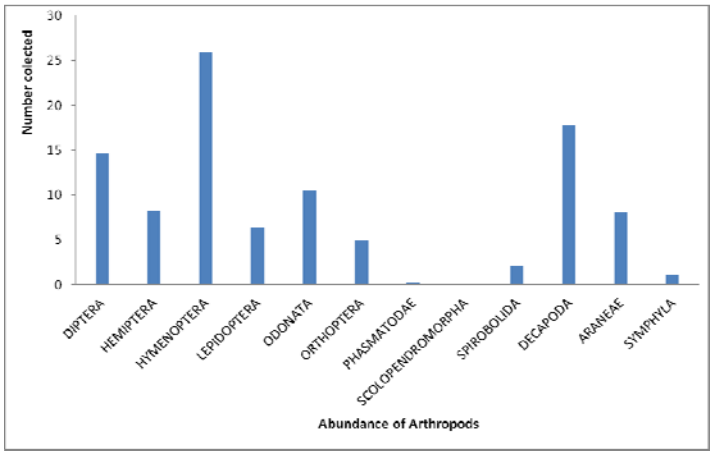

Fig 4: Abundance and Distribution of Arthropods in the Great Kwa River Mangrove Swamp

4. Discussion

The result obtained from the study revealed an enormous array of Arthropods inhabiting the Great Kwa River Mangrove Swamp. The swamp represents an ecosystem created by a mesh of intricate root system and dense foliage of leaves. This provides a conducive milieu for the Arthropod community found here. This study revealed a high abundance of arthropods in site A over site B. This was attributed to the rich vegetative covered which means greater amount of food. The relatively muddy substrate also served as an attractant, as it is generally rich in alluvial deposit[10]. Previous studies on the zonation and distribution of crabs in Pichavaram mangrove Swamp. Ravichandran and Soundarapandian[11] revealed a high prevalence of *Uca* species along the open mud flats. As would be expected, huge numbers of Decapoda utilized the mud flats and roots for nursery grounds. This however contributed to the increased abundance of Decapoda over both sites. The interaction between arthropods and plants has long been reported by Richard [12]. It was noted that arthropods attain higher relative densities in habitats rich in plant species. It is therefore not surprising that we found the highest abundance of arthropods in site A. The rich vegetative cover meant increased number of arthropods being attracted to the plants as well as predators attracted to the herbivores. There was rather a low abundance of arthropods in site B. This was unarguably due to a less rich environment lacking more vegetative cover and conducive milieu. Invariably the low density of plants meant a low abundance of arthropods. Hymenoptera were the most abundant group as they chewed through leaves, barks and roots. Their high abundance is attributed to their preference for wood and leaves. Similar findings were also reported by Adeduntan[13] that Hymenoptera such as Ant are generally more found where there are favorable environmental conditions and other factors like light, litter falls, food and rocky ground which also favour the abundance of species in the mangrove swamp in this study. The nature of wet season encountered during this study could have contributed and influenced the abundance and diversity of Arthropods in the mangrove swamp. This is also similar to the findings of Novtony *et al.*[14] who noted that the greater the tree species in

the tropics, the higher the insect diversity. Murdoch *et al*.[15] reported that physical complexity of an environment could affect arthropods abundance and diversity. Large numbers were often seen in migratory routes as the rain comes more heavily. The high abundance of dragonflies and spiders is obviously attributed to the availability of preys. According to Uzenbaeu[16], Predatory arthropods interact closely with other groups and their abundance is dependent on the presence of their preys. This however explains the high abundance of predatory arthropods like wasps, dragonflies and spiders. Turnbull[17] highlighted the importance of these obligate carnivores in natural and agricultural ecosystems as they help in stabilizing the invertebrate community in different habitats. The presence of mosquitoes in large numbers at the swamp indicates their ability to breed in virtually all habitats where water can be found [18]. This was observed as they were ranked the fourth most abundant species. Aedes species are known to breed in mud plains and other temporary water habitats (Per Com). During heavy downpour, the shrubs, trees and other plants grew and bloomed rapidly. The results showed that the population of Arthropods was greater during the wet season and less during the dry season. However, this pattern is widely attributed to seasonal changes in abiotic conditions and resource availability. Richard[12] revealed that during his study on the seasonal variation of predatory Arthropods that insect abundance was low when food resources for herbivores were few and there were higher during high temperature and low humidity. Contrastingly, insect abundance seemed to increase drastically when more resources were available for herbivores and temperature and humidity moderate. Although most arthropod such as Hymenoptera in the mangrove swamp during the study, recorded a slightly higher abundance in the dry season, this finding agrees with that of Adeduntan and Olusola[19] their report shows that insect diversity and abundance was not significant in rainy season but slightly significant in dry season in each of the ecological areas selected during their study.

5. Conclusion

Although arthropod groups displayed difference in the relative abundance between habitats and seasons, there is an underlying pattern of higher activity in the muddy flat than the less muddy flat (i.e. Site A and Site B).This underlying pattern of higher activity can be explained by the combination of food availability and abiotic conditions. Thus, habitat heterogeneity may not only enhance diversity of arthropods but may also allow seasonal shifts to accommodate pulses in food resources and periods of stress.

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