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Abundance and distribution of two blue crabs *Callinectes amnicola* and *C. pallidus* in the Volta Estuary of Ghana

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Abstract
The abundance and distribution of two blue crab species along the main channel of the Volta estuary, Ghana was studied from October 2015 to September 2016. A total of 2623 crabs were caught comprising 1535 *Callinectes amnicola* and 1088 *C. pallidus*. The percent contribution by weight to the total catch was 70% and 30% for *C. amnicola* and *C. pallidus* respectively. *C. amnicola* exhibited differential sex distribution with more females (739) concentrated within 3 km from the mouth of the estuary than males (661). Males dominated catches beyond 3 km (110) as against females (25). Both sexes of *C. pallidus* were concentrated within 3 km from the sea and dominated catches during periods of high salinity (>10‰). Distribution of the blue crabs was influenced by changes in salinity levels (5-33‰) and the tidal regime (1.29-1.69 m). For sustainable exploitation, trapping should be beyond the 3 km distance from the mouth of the estuary at high tide.

Keywords: Distribution, blue crabs, callinectes, fishery, salinity, volta estuary

1. Introduction
In Ghana and other West African countries, crab production in lagoons and estuaries play an important role in the economy of some coastal communities [1]. They provide protein and other resources for the communities and also contribute to the biodiversity and status of fish stocks in coastal waters. This is because some crab species such as the blue swimming crabs (*Callinectes* spp.) spend part of their life cycle in these water bodies [1].

The Volta estuary is a tidal estuary that supports both fin and shellfish fishery of commercial and subsistence importance [2]. Mensah [2] reported a decline in the blue crab, *Callinectes amnicola* and the pink shrimp, *Penaeus notialis* fisheries of the Volta estuary and the Keta lagoon, and attributed it to reduced inflow of water from upstream due to dam operations and the formation of sand bar across the mouth of the river. Other investigators have variously observed the post-impoundment decline in the fish and fishery resources of the Volta estuary and its associated lagoons and attributed it not only to dam operations but also to mangrove degradation and other man-induced activities [3 4 5].Similarly, Carmona-Suarez [6] partly attributed changes in the estuarine conditions at the locality of Boca de Hueque in Venezuela, which resulted in a drastic reduction of blue crabs that were adapted to the estuarine life to the construction of a dam at the beginning of the river and partly to over exploitation of the resource.

The decline in the crab fishery of the Volta estuary is worsened by increases in human population and over-exploitation that has almost decimated the population of these crabs [5]. The relative affordability of locally made basket crab traps used in fishing for these crabs at the estuary as compared to the high costs of other fishing inputs, such as nets has occasioned the involvement of more people in the blue crab fishery. In recent times, therefore, the crab fishery of the Volta estuary and some coastal lagoons in Ghana has come under threat mainly due to irresponsible trapping and environmental degradation [4]. Thus, this work was done to study the current status in abundance and distribution of blue crab species in the Volta estuary.

2. Materials and Methods
2.1 The Volta Estuary
This study was carried out along the main channel of the Volta estuary at Ada, Ghana.

Sampling was done at 3 stations. Station A was at the mouth of the estuary, station B was 3.0 km away from the mouth (upstream) whiles station C was the farthest (6.0 km) from the mouth of the estuary (Fig. 1). The distances were recorded using a handheld Global Positioning System (Garmin eTrex 10, Garmin International Inc. Olathe, KS, USA).

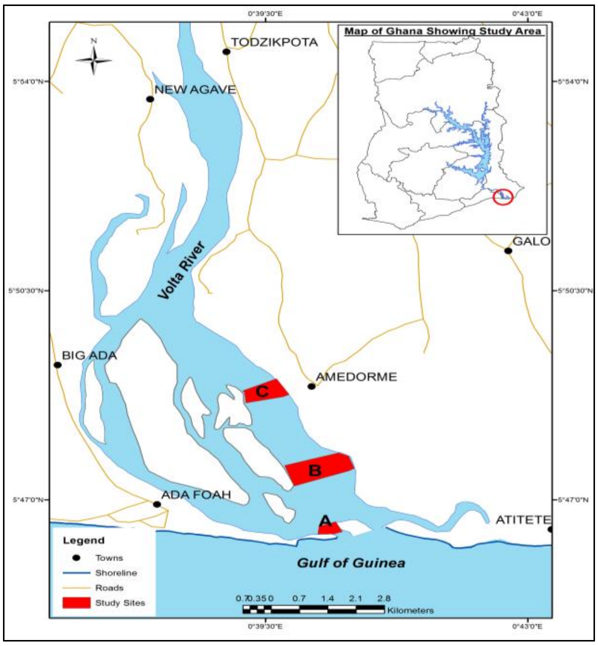

Fig 1: Map of the Volta estuary showing the sampling stations A, B and C.

2.2 Sampling of Crabs

Locally made basket traps commonly used by local fishermen in the Volta estuary were used. They were deployed at the stations (A, B and C) during flood tide and later harvested at ebbing tide, a period of about 6 h. Within each station, 20 traps were deployed. Sampling was done from October 2015 to September 2016.

2.3 Species identification, abundance and distribution

Crabs trapped each month were identified to the species level based on morphological characteristics and the shape of the male gonopods using the FAO field guide to species identification by Schneider [8]. They were further sorted into the different sexes using the shape of the abdomen. The wet weight of individual crabs was measured to the nearest 0.1 g using a top loading electronic balance (Ohaus SP401 Scout Pro, Ohaus Corporation, Parsippany, NJ, USA) and the percent abundance of each species in the total catch was determined per station and over a 12 month period. Monthly distribution of the crab species were followed in stations A, B and C. Their distribution pattern in space and time was elucidated graphically.

2.4 Salinity

In each station, the salinity at the bottom of the river, where the traps were placed was measured in-situ with a multi-parameter meter by lowering it to the bottom. The temporal variations in abundance (by numbers) with salinity at the 3 stations were plotted graphically.

2.5 Statistical Analysis

Results obtained were analyzed using Analysis of Variance (ANOVA) to get the mean and Least Significant difference (LSD) to ascertain if there are significant differences in abundance among the three sampling stations.

3. Results

3.1 Species Identification, Abundance and Distribution

Two different species of blue swimming crabs were identified. These were the big fisted swim crab, *Callinectes amnicola* (De Rocheburne, 1883) and the gladiator swim crab, *C. pallidus* (De Rocheburne, 1883). The morphological features that distinguished the two species were, body coloration, length of lateral spine, shape of the carapace and shape of gonopods. The abdominal shape of a male was slender and T-shaped; immature females had triangular shaped abdomen whiles matured females had circular or rounded abdomen.

There were more female *C. amnicola* (431) than males (197) at station A. In station B, there were 464 male *C. amnicola* which dominated the number of females (308). Males also dominated the *C. amnicola* population in station C showing values of 110 and 25 respectively. For *C. pallidus*, there were more males at stations A and B than females whiles females dominated the scanty catch in station C (Table 1).

Table 1: Abundance (by numbers) and sex ratio of *C. amnicola* and *C. pallidus* trapped from the three sampling stations in the Volta estuary.

Species	Station A			Station B			Station C		
	Male	Female	Ratio	Male	Female	Ratio	Male	Female	Ratio
C. amnicola	197	431	1:2	464	308	1.5:1	110	25	4.4:1
C. pallidus	322	316	1:1	200	155	1.3:1	36	59	1:1.6

The percent abundance by weight of each species showed a decreasing trend from station A to station C for the two species (Figs. 2 and 3). *C. amnicola* dominated the blue crab fishery contributing 70% by weight as against 30% for *C. pallidus* (Fig. 4). *Callinectes amnicola* was found in all three stations throughout the sampling period (Fig. 5). The average monthly catch by weight at stations A (2.6 ± 1.5 kg) and B (2.5 ± 2.3 kg) were not significantly different (p=0.7683). However, the average catch/month obtained for station C (0.6 ± 0.4 kg) was different significantly from stations A and B ($p<0.05$). The monthly distribution of *C. pallidus* (Fig. 6) was sparse with station A having the highest mean catch of 1.7 ± 2.6 kg/month.

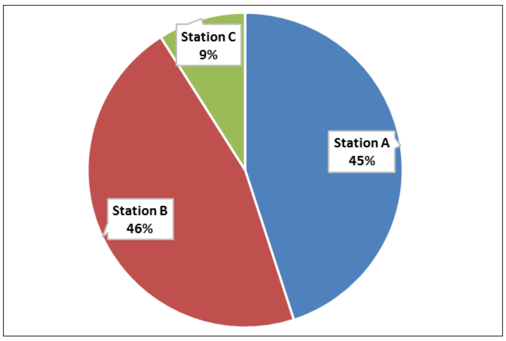

Fig 2: Percent abundance of *C. amnicola* at the three stations in the Volta estuary.

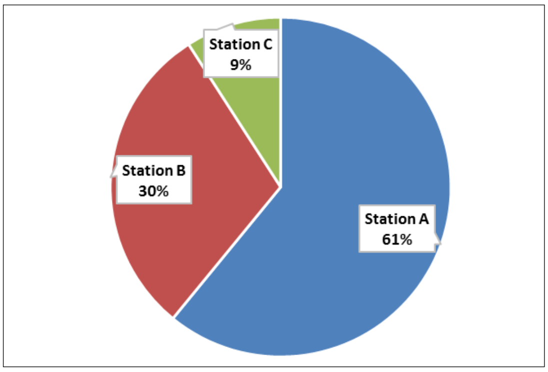

Fig 3: Percent abundance of *C. pallidus* at the three stations in the Volta estuary.

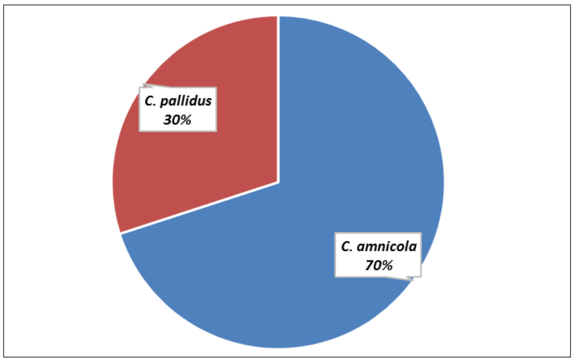

Fig 4: Percent contribution of *Callinectes amnicola* and *C. pallidus* to the blue crab fishery of the Volta estuary

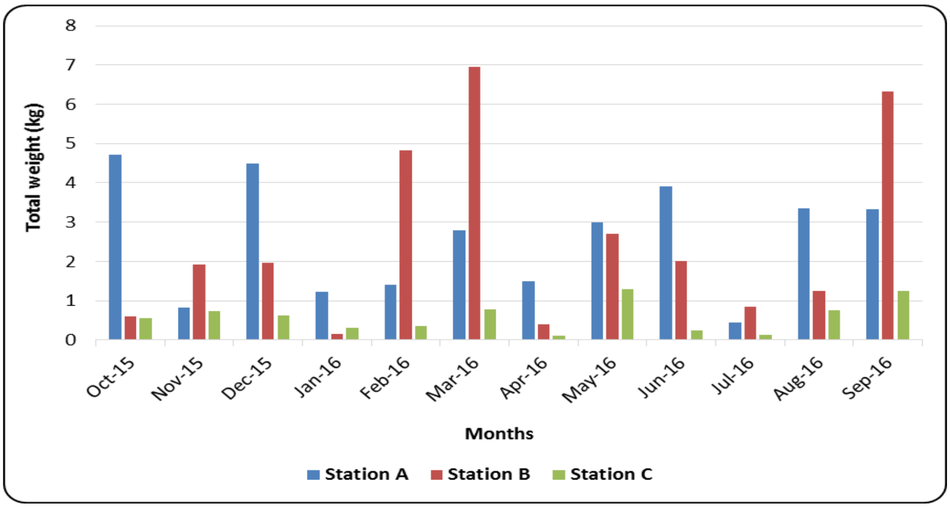

Fig. 5: Monthly distribution of *C. amnicola* at the three stations in the Volta estuary.

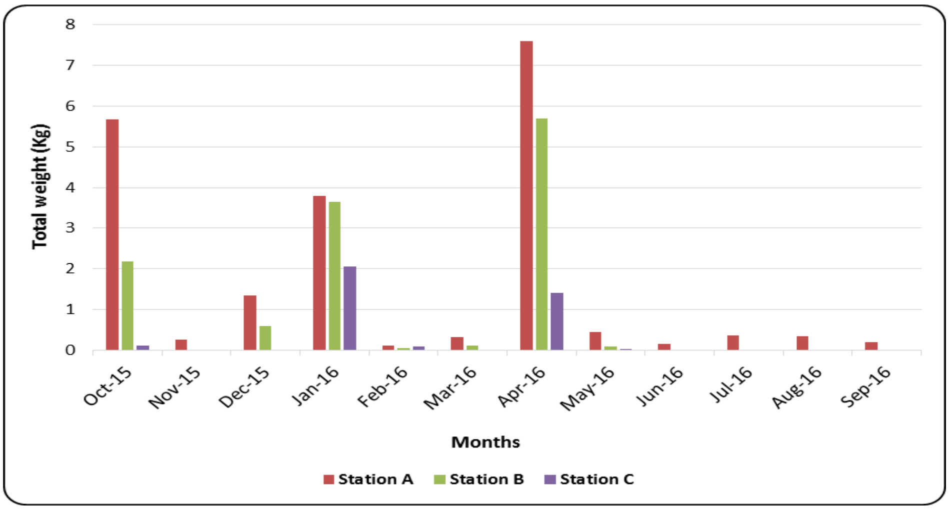

Fig 6: Monthly distribution of *C. pallidus* at the three stations in the Volta estuary

3.3 Effect of Salinity on Distribution and Abundance of the Blue Crabs

At station A, which was closest to the mouth of the estuary, salinity levels were higher and did not fall below 20.0‰ (20.9‰ – 33.5‰) during the period of study. Although there were large numbers of both species of crabs obtained from this station, *C. pallidus* showed higher numbers with higher salinity than *C. amnicola*. The latter showed a sharp decline in January and April when very high salinity values were recorded with corresponding large numbers of *C. pallidus* (Fig. 7). In general, abundance (by numbers) of *C. amnicola* at station B fluctuated with salinity. The peak abundance occurred in February (184 individuals) when the salinity was lowest (9.0‰). On the contrary, *C. pallidus* was more abundant when high salinity (>9.0‰) occurred in October 2015, January 2016 and April 2016. At station C, as presented in Figure 8, salinity levels during the study period did not rise above 5.0‰ except in January and April, where the high salinity levels of 19.9‰ and 16.0‰ respectively engendered the highest numbers of *C. pallidus*. In general terms, it was observed that high numbers of each species corresponded with lower numbers of the other in all the stations. Comparatively, *C. amnicola* occurred more in lower salinities whiles *C. pallidus* was more abundant in higher salinities.

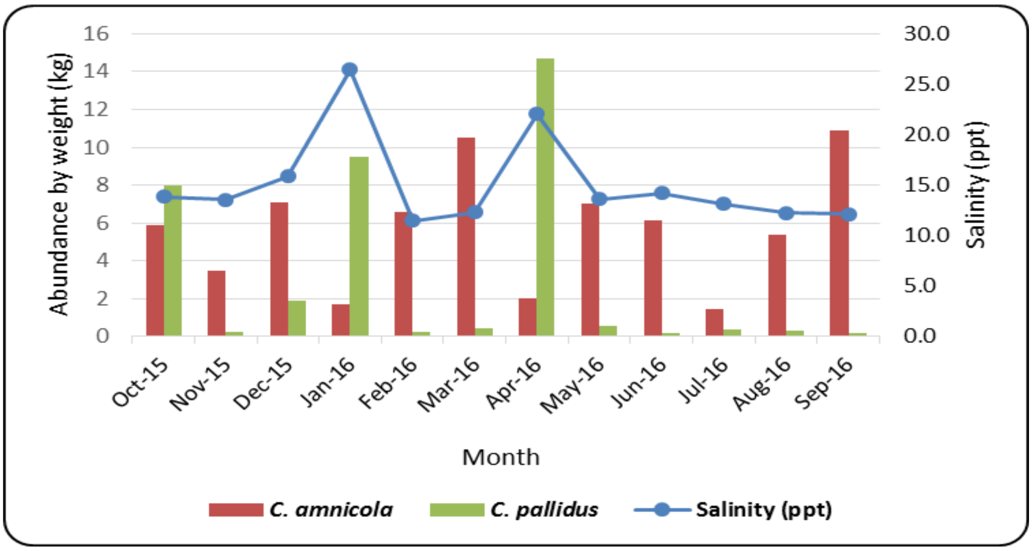

Fig 7: Variations in monthly total catch of the two blue crab species with salinity in the Volta estuary

4. Discussion

In West Africa, three species of the genus *Callinectes* namely *C. amnicola*, *C. pallidus* and *C. marginatus* have been documented by Fischer *et al.* [7] and Schneider [8] as occurring in the Gulf of Guinea. Among these, *C. amnicola* has been identified as the most common species in estuaries and lagoons in West Africa where it forms a regular trap fishery [2]. This species is of special interest since it lives only occasionally in the sea but spends a greater part of its life in estuaries, lagoons and creeks.

By proportion (both in numbers and weight), *C. amnicola* contributed more to the fishery of blue crabs in the Volta estuary from this study. This might probably be due to their distribution over the entire study area and also their relatively larger size as compared to the other species whose distribution followed the salinity wedge and were smaller in size. Generally, *C. amnicola* were larger in size per crab (44.3±12.4 g) than *C. pallidus* (33.6±7.8 g). *Callinectes amnicola*, particularly, dominated the blue crab fishery of the area from earlier studies, and has also been reported in many other coastal lagoons in the country [2 3 9] and the West African subregion [10, 11].

According to Guillory and Hein [12] gravid females of blue crabs tend to move to higher salinity water while males are often found in very low salinity water. They observed that generally, males predominated in low salinity areas while females predominated in high salinity areas. This assertion was true for *C. amnicola* which exhibited a clear differential sex distribution. Females were more than males only at station A, which was closer to the mouth of the estuary. The females were probably migrating into the sea to spawn. The males were, however, further upstream in Stations B and C, the areas where they probably mate with sexually matured females. Since salinity at the mouth of the estuary was higher than that upstream, it may also stand to reason that the female *C. amnicola* preferred higher salinity than the males. On the whole, the distribution of *Callinectes* species was greatly influenced by the salinity of the environment and climatic conditions [13]. Among the two species, however, *C. pallidus* showed a higher afinity for salinity and followed the salt wedge during spring high tide to stations A and B. Both sexes of this species appeared to move closely together with the salt wedge. The intrusion of saline water into station C during spring high tide was low likely due to its distance from the sea which is a major reason for the lesser occurence of both *C. amnicola* and *C. pallidus* at this station.

The sex ratio of the blue crabs in this study indicated a slightly male biased population which is at variance with the normal 1:1 sex ratio and most studies which concluded on having more female biased population such as Arimoro and Idoro [14], Omolara and Barakat [15], Abowei and George [16]. However several other authors like Snowden *et al.* [17] and Sumpton *et al.* [18] have recorded sex ratios that were male-biased. The deviation from theoretical 1:1 sex ratio between males and females are linked to several causative factors, one of which is the fact that *Callinectes* species usually presents differential distribution according to the environmental conditions, leading to male dominance in much lower salinities, while females are present in higher numbers in more saline environments, since they migrate to open seas for spawning [19, 20]. The migration of females into the sea to spawn could probably explain why the Volta estuary was male dominated in this study.

5. Conclusion

It can be concluded that the distribution of *C. amnicola* was ubiquitous while *C. pallidus* was confined to more saline regions of the estuary. There was differential sex migration in *C. amnicola* with males predominant in low saline waters whiles females preferred waters of medium to high salinity. Distribution of both species of blue swimming crabs and their abundance were driven by the salinity regime of the Volta estuary.

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