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ORIGINAL ARTICLE

Habitat distribution, species composition and size structure of penaeid shrimps (Decapoda: Dendrobranchiata: Penaeidae) in inshore waters of Ghana

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ABSTRACT

Penaeid shrimps are crustaceans of high commercial value. The habitat distribution and aspects of biology of penaeid shrimps were investigated as a contribution to filling the knowledge gap on the stocks of shrimps in inshore waters of Ghana. Monthly samples of the penaeids were obtained from commercial inshore trawlers at Tema, Elmina and Sekondi fish landing sites from October 2017 to May, 2018. Secondary source of data was obtained from reports from a survey undertaken by Fridtjof Nansen vessel in 2005 in the inshore waters of Ghana and used to map the spatial distribution of the penaeid shrimps. The penaeid species encountered in the order of their abundance were *Holthuispenaeopsis atlantica* (81.49%), *Penaeus notialis* (14.66%), *Penaeus kerathurus* (2.65%), *Penaeus monodon* (0.71%) and *Metapenaeopsis miersi* (0.48%). *H. atlantica* and *P. kerathurus* were found to be more abundant at shallower depth ranging between 21.0 – 28.0 m while *P. notialis* occurred in deeper waters from 29.0 m – 57.0 m. Sex ratios deviated from 1:1 in favour of females for *P. kerathurus*, *H. atlantica* and *M. miersi*. However, there was a condition of equilibrium in the sex ratios for *P. notialis* and *P. monodon*. With respect to body sizes *P. monodon* was the largest (mean length = 18.08 ± 0.55 cm; weight = 55.01 ± 5.87 g), followed by *P. kerathurus* (13.04 ± 0.43 cm; 24.73 ± 1.85 g), *P. notialis* (12.73 ± 3.93 cm; 22.7 ± 0.74 g), *H. atlantica* (8.80 ± 0.03 cm; 4.98 ± 0.06 g) and *M. miersi* (5.84 ± 0.2 cm; 1.70 ± 0.19 g). Given the scarcity of data on shrimp population in the Gulf of Guinea, the findings could be used for future management strategies and serve as reference point for further studies.

Keywords: Penaeid shrimps, Spatial distribution, Relative abundance, Size structure, Sex ratio

1.0 Introduction

With an annual global capture production of about 3.5 million tonnes shrimp resources have become an important component of the world's fish production and one of the most valued fishery commodities (Gillett, 2008; FAO, 2018). Their fishing is widespread in tropical, sub-tropical and temperate ocean regions (Garcia, 1988; Leite & Petrere, 2006; May-Kú, Ordóñez-López, & Defeo, 2006).

Penaeid shrimps are species of crustaceans in the family Penaeidae and the largest members of the superfamily Penaeoidea (Fransen, 2014; Gillett, 2008). The family are geographically present in tropical and sub-tropical waters, prevalent along the west coast of Africa, from Mauritania to Angola and off the east coast of the Western Hemisphere from Yucatan, Mexico to Rio de Janeiro, Brazil (Fransen, 2014; King, 2007; Pérez-Castañeda & Defeo, 2000). Their vertical distribution ranges from 20 to 700 m depth on a variety of bottoms such as rock, mud peat, sand and coral reefs while a few reside in sponges and other invertebrates (Fransen, 2014). The penaeids have a complex life cycle involving either an exclusively estuarine or exclusively marine phase, however there are still others where the post larvae migrate to estuarine areas, grow for several months and then emigrate to offshore waters as sub-adults (Dall et al., 1990; García & Le Reste, 1981).

In Ghana, five different penaeid species have been reported to be prevalent in the coastal waters namely, *Holthuispenaeopsis (Parapenaeopsis) atlantica* (Balss, 1914), *Penaeus (Farfantepenaeus) notialis* (Pérez Farfante, 1967), *Penaeus* (*Melicertus*) *kerathurus* (Forskål, 1775), *Parapenaeus longirostris* (Lucas, 1846) and *Penaeus monodon* (Fabricius, 1798) (Dankwa & Gordon, 2002; Kwei & Ofori-Adu, 2005; Nunoo, 1998; Okpei et al., 2020). These penaeids constitute key crustacean fishery resources and contribute significantly to the socio-economic development of the country (Christophe, 2011). Statistics of annual landings for the penaeid shrimps in inshore waters of Ghana showed that maximum production was recorded between 2008 and 2015, during which catches ranged from 800 to 8,048 metric tonnes of shrimp (Fisheries Commission, unpublished data). Subsequently, a notable decrease in the production of this resource has occurred, causing great concern over its exploitation.

Penaeid shrimps have been the pivot of several studies globally (Dall et al., 1990). Information on their spatial distribution and basic biology have been reported in other regions, including; Brito & Pena (2007) in Mozambique; Lawal-are and Apapa (2014) in Nigeria; Mbayong et al. (2016) in Cameroon; Munga et al. (2013) in Kenya; Promhom et al. (2015) in Thailand; Ramírez and Paramo (2019) in Colombia and Sobrino et al. (2014) in Mediterranean waters. In Ghana, Atsu, (1993) studied the growth pattern of a penaeid species, *Penaeus notialis* in ponds manured with chicken droppings whiles Akorlor (2001) also studied the response of the same species fed with protein enhanced diets for aquaculture purposes. The most recent study on penaeid shrimps was conducted by Okpei et al. (2020) on the growth, mortality and exploitation of a penaeid species, *Holthuispenaeopsis atlantica,* in inshore waters of Ghana. Penaeids can be sustainably exploited and used for aquaculture purposes when there is an extensive knowledge on their basic biology. Due to the paucity of relevant information on the biology of the penaeid shrimps, fisheries managers do not have adequate scientific basis to regulate shrimp fishing in coastal waters of Ghana. This paper therefore, aimed at providing basic but relevant information on habitat distribution and size structure of the penaeid shrimps in inshore waters of Ghana.

2.0 Materials and Methods

2.1 Sample collection sites

The study was conducted along the coast of Ghana. Shrimp samples were collected from the three largest fish landing sites in Ghana namely Tema Fishing Harbour, Albert Bosomtwi-Sam (ABS) Fishing Harbour in Sekondi; and Elmina fish landing quay (Fig. 1). These landing sites contribute significantly to the fisheries industry in the country. Artisanal canoes and inshore trawlers from these sites land penaeid shrimps, which are sold locally and also exported to international market (Okpei et al., 2020).

2.2 Data collection

2.2.1 Habitat distribution data

The distribution of penaeid shrimps in coastal waters of Ghana was dependent on secondary source of data extracted from reports of an experimental survey undertaken by the Fridtjof Nansen vessel along the western Gulf of Guinea in 2005. The survey along the shelf of Ghana was conducted from 9th to 20th May, 2005. The shelf was surveyed from east to west, during daytime and semi-random swept-area hauls were carried out within depth zones of 0-30 m, 31-50 m and 51-100 m (Mehl et al., 2005). Data on depth from the survey was then used to map the distribution of penaeids in inshore waters of Ghana in the present study. Also, species encountered in the survey was compared to the species composition in the present study.

2.2.2 Sample Collection

Samples of penaeid shrimps were obtained at random from fishermen (inshore trawlers) at the three fish landing sites between the hours of 6:00 am and 7:00 am per month over

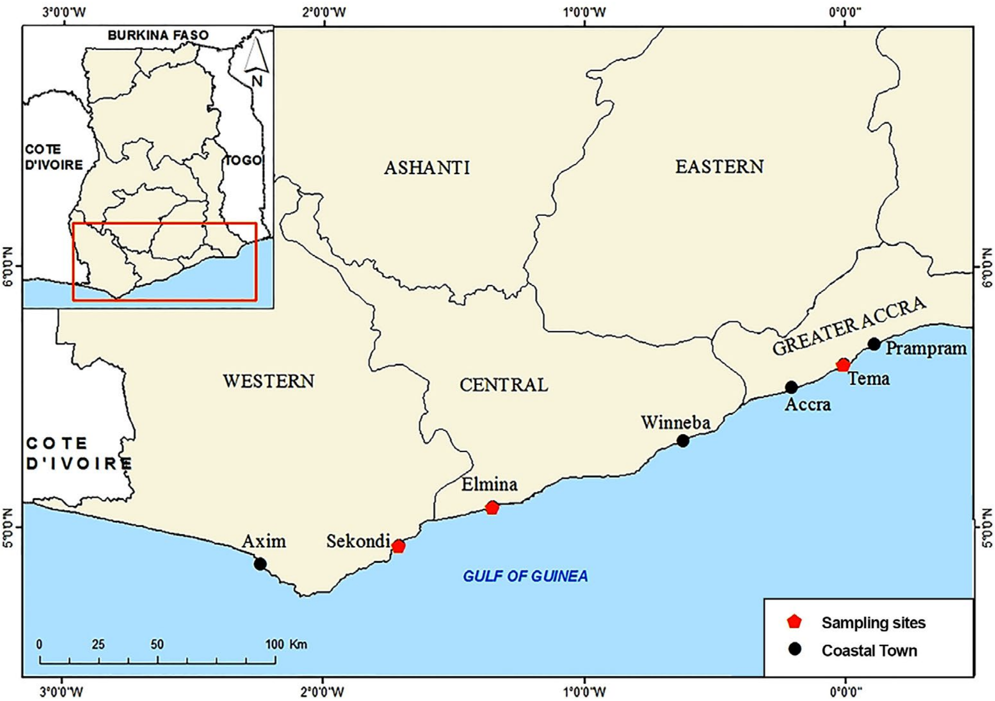

Figure 1: Map of Ghana indicating sampling sites along the coast (first presented in Okpei et al., 2020).

a period of eight months from October 2017 to May 2018. Once the samples were obtained, they were immediately preserved in ice and subsequently transported to the USAID Fisheries and Coastal Research Laboratory at the University of Cape Coast for examination. Examination of specimens obtained from each sampling site was conducted immediately on arrival at the laboratory and completed within five days maximum depending on the amount of number of specimens obtained. In the laboratory specimens were sorted and identified to species level, using FAO species identification manual (Fransen, 2014) and the World Register of Marine Species (WoRMS) website [http://www.marinespecies.org/] was used to confirm the acceptance of the scientific names and their authorities. The relative abundance of each species was ascertained.

Morphometric measurements taken in the study included: carapace length (CL), measured from the base of the rostrum to the posterior margin of the carapace to the nearest 0.01 cm using Vernier caliper; total length (TL), measured from the rostral extremity to the telson extremity to the nearest 0.1 cm using fish measuring board; and total body weight (BW) measured to the nearest 0.01 g using an electronic balance.

The sex of each specimen was determined by visual examination of external characters. The females were identified by the presence of thelycum, located on the ventral side of the thorax which functions as a seminal receptacle and males by an intromittent organ attached to the first pair of pleopods called petasma (Fransen, 2014).

2.3 Data analyses

Data obtained from the samples from the three landing sites were pooled and used for the analyses. Chi-square (χ^2) test was undertaken to compare the male to female ratios with the hypothesized sex-ratio of 1:1 (Brase & Brase, 2009). A student's t-test was applied to infer whether there were any statistical differences between the means (± Standard Errors) of the total lengths of females and males at 95%

confidence level (α = 0.05).

3.0 Results

3.1 Habitat distribution

Figure 2 illustrates the depth range and habitat distributions of the penaeid shrimps (*H. atlantica, P. notialis* and *P. kerathurus*) based on data extracted from the Fridtjof Nansen survey (Mehl et al., 2005). *H. atlantica* was trawled at depths ranging from 17.0 to 40.9 m and was abundant at 21– 28 m depth. *P. notialis* was trawled at a depth range of 17.0 – 57 m and occurred mostly from 29 to 57 m deep whiles *P. kerathurus* was trawled at a depth range of 17.0 – 24.9 m. *M. miersi* and *P. monodon* were not encountered by the Fridtjof Nansen survey.

3.2 Species composition and relative abundance

A total of 4,344 specimens comprising 5 species from 3 genera were sampled. *Holthuispenaeopsis atlantica* formed the bulk of the catch comprising 81.49% by numbers. This was followed by *Penaeus notialis, Penaeus kerathurus, Penaeus monodon* and *Metapenaeopsis miersi* which represented 14.66%, 2.65%, 0.71% and 0.48% respectively (Fig. 3).

Of the five species, *H. atlantica* and *P. kerathurus* persistently occurred in the monthly samples throughout with *H. atlantica* consistently recording large numbers and numerically dominating the samples by over 50% in each month (Fig. 4). Although *H. atlantica* was dominant, their numbers decreased as the numbers of the other species increased from January to May, 2018. *P. kerathurus*, *P. monodon* and *M. miersi* were represented by infrequent smaller numbers occurring in less than 11% of the samples. *P. notialis* recorded its highest composition in January 2018 at 36.39% albeit absent in

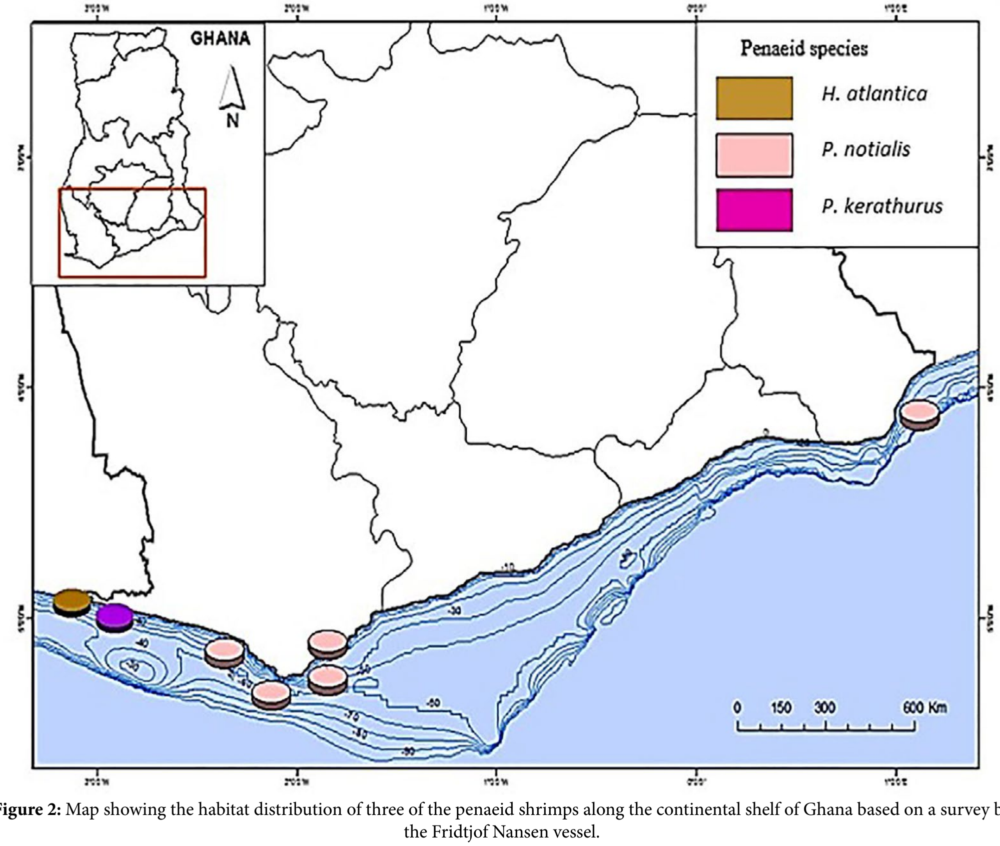

Figure 2: Map showing the habitat distribution of three of the penaeid shrimps along the continental shelf of Ghana based on a survey by the Fridtjof Nansen vessel.

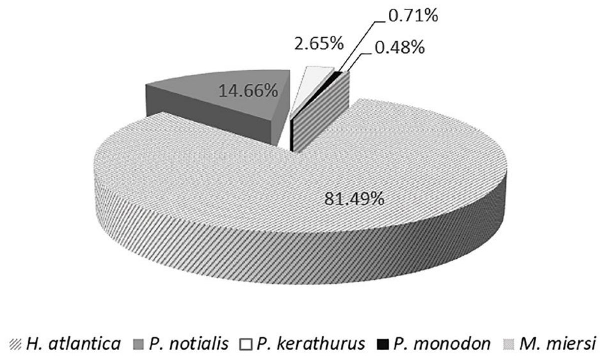

Figure 3: Relative abundance of penaeid shrimp species sampled from commercial landings from October 2017 to May 2018.

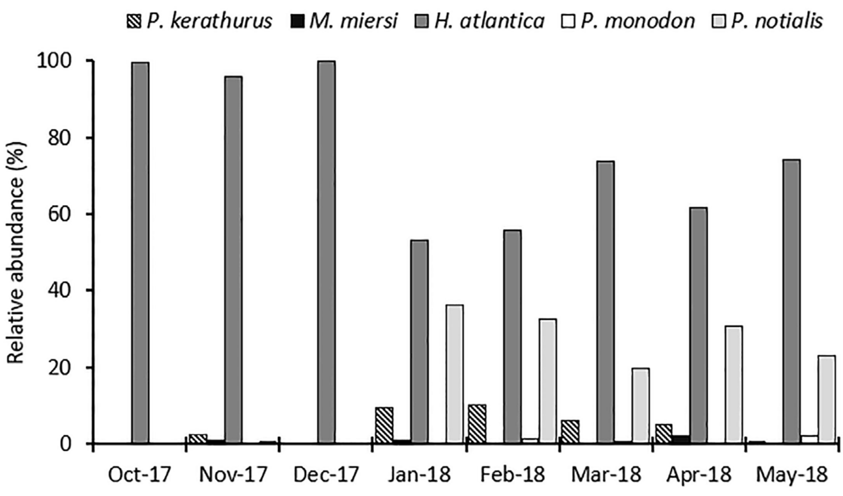

Figure 4: Monthly relative abundance of the penaeid shrimps in the coastal waters of Ghana.

October and December 2017 samples.

3.3 Sex Ratio

A total of 46 (40%) males and 69 (60%) females of *P. kerathurus* were examined. The sex ratio differed from the expected 1:1 ratio indicating a preponderance of females over males ($\chi^2 = 4.6$; $P < 0.05$) (Table 1).

Out of a total of 637 *P. notialis* specimens that were examined, 318 (49.9 %) were males and 319 (50.1 %) were females. The sex ratio did not differ significantly from the expected 1:1 ratio ($\chi^2 = 0.08$; $P > 0.05$) (Table 2).

For *P. monodon* 14 were males and 17 females with overall sex ratio as 1: 1.2 ($\chi^2 = 0.599$; $P > 0.05$) (Table 3) while *M. miersi* had 4 males and 17 females with overall sex ratio as 1:4.25 which was skewed towards females ($\chi^2 = 8.05$; $P < 0.05$) (Table 4).

Table 5 represents the monthly sex ratio of *H. atlantica* based on results from Okpei et al. (2020). A total of 3540 specimens of *H. atlantica* were sexed, out of which 842 (23.79%) were males and 2698 (76.21%) females. The sex ratio showed a preponderance of females over males (1: 3.2; $\chi2 = 971.8$; $P < 0.05$).

3.4 Size structure

Figure 5 illustrates the pooled length-frequency data of the penaeid shrimps. The largest size encountered was *P. monodon* which ranged in size from 12.8 to 26.5 cm TL with a

Table 1 - Monthly sex ratio of *Penaeus kerathurus* from commercial catches from October 2017 to May 2018. S, Significant; χ^2, Chi-square; P (0.05), Probability at 0.05 significant value; *, none or low numbers of individuals in sample, –, Chi-square values and sex ratio not determined.

Months	Number of specimens		Sex ratio M: F	χ^2	$P_{(0.05)}$
	Male	Female			
October 2017	0	2	-	-	*
November	8	15	1: 1.9	-	*
December	0	0	-	-	*
January 2018	0	6	-	-	*
February	12	9	1.3:1	-	*
March	15	22	1: 1.5	-	*
April	10	13	1:1.3	-	*
May	1	2	-	-	*
Total	46	69	1: 1.5	4.6	S

Table 2 - Monthly sex ratio of *Penaeus notialis* from commercial catches from October 2017 to May 2018; *, none or low numbers of individuals in sample; –, Chi-square values and sex ratio not determined; NS, Not Significant.

Months	Number of specimens		Sex ratio M: F	χ^2	$P_{(0.05)}$
	Male	Female			
October 2017	0	0	-	-	*
November	5	2	-	-	*
December	0	0	-	-	*
January 2018	25	34	1: 1.4	1.37	NS
February	79	62	1.3: 1	2.05	NS
March	76	76	1: 1	0	NS
April	63	74	1: 1.2	0.88	NS
May	70	71	1: 1	0.01	NS
Total	318	319	1: 1	0.002	NS

Table 3 - Monthly sex ratio of *Penaeus monodon* from commercial catches from October 2017 to May 2018; *, none or low numbers of individuals in sample; –, Chi-square values and sex ratio not determined; NS, Not Significant.

Months	Number of specimens		Sex ratio M: F	χ^2	$P_{(0.05)}$
	Male	Female			
October 2017	0	0	-	-	*
November	0	0	-	-	*
December	0	0	-	-	*
January 2018	0	0	-	-	*
February	11	3	1: 0.3	4.6	S
March	0	5	-	-	*
April	0	0	-	-	*
May	3	9	1: 3	3	NS
Total	14	17	1: 1.2	0.29	NS

Table 4 - Monthly sex ratio of *Metapenaeopsis miersi* from commercial catches from October 2017 to May 2018. *, none or low numbers of individuals in sample; –, Chi-square values and sex ratio not determined; NS, Not Significant; S, Significant.

Months	Number of specimens		Sex ratio M: F	χ^2	$P_{(0.05)}$
	Male	Female			
October 2017	0	0	-	-	*
November	0	2	-	-	*
December	0	0	-	-	*
January 2018	0	5	-	-	*
February	0	0	-	-	*
March	2	0	-	-	*
April	2	8	1:4	3.6	NS
May	0	2	-	0.01	*
Total	4	17	1: 4.2	8.05	S

Table 5 - Monthly sex ratio of *Holthuispenaeopsis atlantica* from commercial catches from October 2017 to May 2018. S, Significant; χ^2, Chi-square; P (0.05), Probability at 0.05 significant value.

Months	Number of specimens		Sex ratio M: F	χ^2	$P_{(0.05)}$
	Male	Female			
October 2017	183	449	1: 2.5	115.3	S
November	146	440	1: 3.0	147.5	S
December	99	421	1: 4.3	199.4	S
January 2018	57	199	1: 3.5	78.8	S
February	99	308	1: 3.1	107.3	S
March	50	362	1: 7.2	236.3	S
April	73	202	1: 2.6	60.5	S
May	135	317	1: 2.3	73.3	S
Total	842	2698	1: 3.2	973.1	S

mean length of 18.08 ± 0.55 cm and weighed between 16.22 and 164.06 g. Males ranged from 14.8 to 20.3 cm TL, with a mean length of 16.69 ± 0.5 cm whereas females ranged from 12.8 to 26.5 cm TL with a mean length of 19.23 ± 0.9 cm. A student's t-test performed on the mean sizes of males and females indicated that females were larger than the males ($P < 0.05$) (Fig. 6). This was followed by *P. kerathurus* with a size range of 4.0 – 21.5 cm TL with a mean length of 13.04 ± 0.43 cm and weighed between 0.52 and 82.6 g. The mean length for males was 12.9 ± 0.6 cm TL, ranging from 4.1 to 19.6 cm TL; for females 13.1 ± 0.6 cm TL, varying from 4.0 to 21.5 cm TL There was no significant difference in the mean lengths for

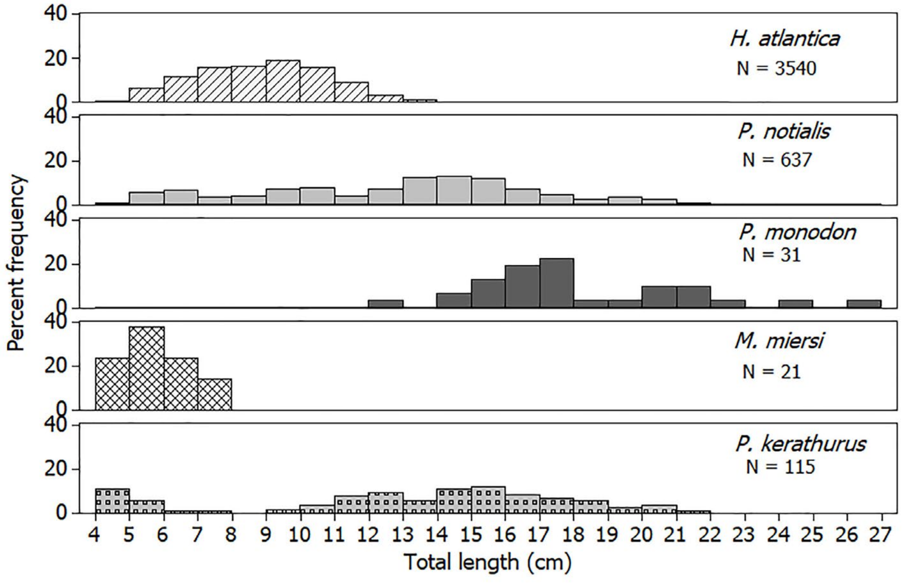

Figure 5: Length-frequency distribution of penaeid shrimps from commercial landings from October 2017 to May 2018.

males and females (Student's t-test; $P > 0.05$).

P. notialis also had a size distribution range of 4.7 – 21.9 cm TL with a mean length of 12.73 ± 3.93 cm and weighed between 0.82 and 98.02 g. Females ranged from 4.9 to 21.9 cm (mean = 13.2 ± 0.3 cm) whiles males ranged from 4.7to 17.5 cm (mean =12.3 ± 0.2 cm). A student's t-test performed on the two sexes showed significant difference in the mean sizes indicating females were larger than males ($P < 0.05$). With a mean length of 5.84 ± 0.2 cm *M. miersi* was the smallest species measured. The species ranged from 4.3 to 7.9 cm TL and weighed between 0.42 and 4.27 g. The mean length of males was 4.9 ± 0.3 cm TL ranging from 4.3 to 5.6 cm TL; for females the mean length was 6.0 ± 0.2 cm TL ranging from 4.8 to 7.9 cm TL. Females were found to be significantly larger than males (Student's t-test; $P < 0.05$).

H. atlantica had a size range of 4.0 – 14.8 cm TL with a mean length of 8.80 ± 0.03 cm and weighed 0.4 to 19.34 g. The modal length class was 9.0 – 9.9 cm TL group. Males ranged from 4.0 to 9.5 cm TL with a mean of 6.5 ± 0.03 cm TL. Also, females ranged in size between 4.1 and 14.8 cm TL with a mean of 9.5 ± 0.3 cm TL. Significant difference occurred between the means of both sexes with the females being larger than males in all measurements [Student t-test; $P < 0.05$) (Okpei et al., 2020)].

4.0 Discussion

The dominance of *H. atlantica* in the monthly samples from the three main fish landing sites in this study indicates that the species is the most dominant penaeid shrimp in inshore waters of Ghana, followed by *P. notialis*, *P. kerathurus*, *P. monodon* and *M. miersi* in that order. From the Fridtjof Nansen survey data analyzed (Mehl et al., 2005), the highest catch rates of *H. atlantica* occurred at depth ranging from 21 to 28 m. At this same depth range *P. notialis* were present in lower proportions. Conversely, *P. notialis* were most abundant at deeper waters ranging from 29 to 57 m. *P. kerathurus* were rare in the catches recorded by Fridtjof Nansen survey whiles *M. miersi* were completely absent in all catches landed by the vessel. *Metapenaeopsis* sp. have been reported to be coral reefs dwellers (Dall et al., 1990). Their occurrence in this study and complete absence in the Nansen survey may suggest the presence of coral reefs in the inshore waters of Ghana. This is conceivably possible since coral reefs have been discovered on the western continental shelf off Ghanaian waters (Buhl-Mortensen et al., 2017) and could be providing habitat for the species.

The occurrence and abundance of shrimps are influenced by several ecological factors of which Dall et al. (1990) considered depth as an essential factor in penaeid shrimp distribution. Somers (1987), studied the depth preference of some penaeids in the Gulf of Carpentaria and reported that the depth preference of penaeids varied from species to species. The depth preference of penaeid shrimps may therefore explain the variations in the occurrence and abundance of penaeid shrimps encountered during the study period. Additionally, the inshore trawlers from whom the samples were obtained are bound by law to operate within the Inshore Exclusive Zone (IEZ) of 30 to 50 m depth (Fisheries Act 625, 2002) . It is therefore not surprising that majority of the catches constituted *H. atlantica* and *P. notialis*.

Furthermore, there were some variations in the monthly species composition during the period. Catches of *H. atlantica* increased from October to December comprising more than 90% of the total sample but then decreased from January to May, 2018 (Fig .4). *P. notialis*, *P. kerathurus*, *M. miersi* and *P. monodon* were absent in the samples obtained in October to December, 2017, however, were present in the samples from January to May, 2018. The months of November to February are usually characterized by the dry season whiles March to October by the wet season with varying temperatures in the southern part of Ghana (Mensah et al., 2019). The high catches of *H. atlantica* which coincided with the dry season may suggest a particular temperature preference for the species. The changes in the monthly catches recorded in the penaeids could therefore be attributed to seasonal variations. Also, in some studies, catchability, habitat selection and abundance of penaeid shrimps have been correlated with temperature preference (Costa et al., 2016; Dall et al., 1990). Other environmental factors such as nature of substratum, burrowing and emergence, dissolved oxygen and salinity may have also influenced their distribution (Dall et al., 1990).

As indicated by the size structure, the juvenile to adult life history stages were prominent in *H. atlantica P. notialis*, *P. kerathurus* and *M. miersi* but not in *P. monodon*. Juveniles and sub-adults of *P. monodon* were entirely absent from samples during the study period. With the exception of *Metapenaeopsis* spp which have been reported to have a life cycle that is entirely marine, *H. atlantica* and the other *Penaeus* spp have a life cycle where juveniles migrate to estuarine environment and emigrate to marine environments as adults to spawn (Dall et al., 1990). Juveniles of *P. monodon* have been reported to prefer brackish waters and their absence in all samples obtained may be ascribed to their preference for mangrove edges and muddy bottoms where trawling may be impossible (Rosle, & Ibrahim, 2017; Vance et al., 2002)

Generally, the sex ratios of penaeids differ from species to species. *P. kerathurus* and *M. miersi* exhibited a deviation from the hypothetical 1:1 sex ratio in favour of females whiles *P. monodon* and *P. notialis* showed a condition of equilibrium. *H. atlantica,* exhibited a female dominance (see Okpei et al., 2020). Similar observations on equal sex ratios were reported on *P. notialis* in Columbia (Pérez-Castañeda & Defeo, 2000) and *P. monodon* in Nigeria (Munga et al., 2013). Also Lumare et al. (2011) reported a 1:1 sex ratio in *P. kerathurus* (as *Melicertus kerathurus*) in the south-eastern coast off Italy. In the Mediterranean Sea, Kevrekidis and Thessalou-legaki (2006) observed two different sex ratio patterns in *P. kerathurus* (as *Melicertus kerathurus*) where males dominated in autumn and females dominated in the summer period. A male dominance was observed in *Metapenaeopsis sibogae* in Japan (Rahman & Ohtomi, 2018) but observations by Lawal-Are and Apapa (2014) on *P. monodon* in Nigerian waters; Garcia et al. (2016) on *Rimapenaeus constrictus* in southern coast of Brazil; De Croos et al. (2011) on *Metapenaeopsis dobsoni* in Sri Lanka; Teikwa and Mgaya (2003) on *Fenneropenaeus indicus* and Munga et al. (2013) on *Penaeus japonicus* and *Metapenaeus monoceros* in Malindi-Ungwana Bay, Kenya, reported female dominance in these penaeid shrimps.

Courtney et al. (1996) reported that preponderance of one sex is rare in penaeids, however a probable elucidation for the dominance of one sex in a sample could be as a result of variations in the selectivity of the mesh size between sexes. In addition, the maximum size reached by most penaeid females which is greater than that of males have also been reported to affect the sex ratio of penaeid shrimps (Garcia & Le Reste, 1981; Glaister et al., 1987). Cha et al. (2002) suggested that higher growth rates observed in females and high mortalities presented by males may contribute to the deviation of the sex ratio usually in favour of the females. In contrast to reports by Cha et al. (2002) and Glaister et al. (1987), the maximum size reached by females of *P. notialis* and *P. monodon* did not affect their sex ratios estimated (sex ratio = 1:1). The sex ratio profile of the penaeids observed in the present study could, therefore, be influenced by some interaction of factors such as pattern of movement, feeding habits, growth rates and spawning cycle.

Females of *P. notialis, P. monodon, M. miersi* and *H. atlantica* were larger in total and carapace lengths measurements than males with the exception of *P. kerathurus*. Similarly, studies on some penaeids including: *H. atlantica* in Nigeria (Udoinyang et al., 2016); *Parapenaeopsis stylifera* in Iran (Safaie, 2017); *Parapenaeus fissuroides* in Kagoshima bay, Southern Japan (Farhana & Ohtomi, 2017); *Penaeus notialis* in Colombian Caribbean Sea (Páramo & Saint-Paul, 2010)Decapoda; *Farfantepenaeus subtilis* in North-Eastern Brazil (Silva et al., 2015); and *P. kerathurus (as Melicertus kerathurus*) in the Aegean Sea, Turkey (Turkmen & Yilmazyerli, 2006) have reported females of these species were larger than males in all length measurements including total length, carapace length, carapace width, rostrum length and body length, and therefore exhibit sexual size dimorphism. Sexual size dimorphism has been reported to be an intrinsic and a characteristic life-history trait in penaeids where females are larger and heavier than males (Baelde, 1994; Sardà et al, 1998; Lakshmi & Maheswarudu, 2018). According to Robey et al. (2013), the sexual size dimorphism reported in penaeids has been suggested to be due to an increase in female growth rates caused by the enlargement of the ovaries and other reproductive structures perhaps to accelerate reproductive processes. Notwithstanding the larger size of females of *P. notialis, P. monodon* and *M. miersi* than their male counterparts in this study the morphometric variabilities between the sexes in the proportions of carapace length and total length cannot be ascribed to sexual size dimorphism due to inadequate data on the morphometric parameters in this study.

In conclusion, females of *P. notialis*, *P. monodon, M. miersi* and *H. atlantica* were observed to be larger than males except for *P. kerathurus* which showed no size variation by sex. *P. monodon* has a potential for aquaculture purposes because of its maximum size reached. The study indicated that the penaeid shrimps inhabit distinct depth ranges and these findings could be used for future management strategies for the sustainable exploitation of the penaeid shrimps in the Ghana and also form the basis for further comprehensive studies.

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