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Condition Index, Meat Yield and Population Structure of the Marine Gastropod, *Thais coronata*, off Cross River Estuary, Nigeria

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Abstract
Samples of the (rock shell) marine gastropod *Thais coronata* were obtained at monthly intervals from the Cross River estuary, Nigeria over a five month sampling period (February-June). The condition index, *CI*% (dry tissue weight expressed as a percentage of shell weight) and population structure showed distinct monthly variation. The values of the condition index was maximum (in May) during the beginning of the rainy season and minimum during the dry months (March). The population structure showed that generally *T. coronata* in the study area is composed principally of 33.5cm rock shells with distinct peaks or modal mean lengths stable at 33.5cm for February through April with triple peaks in March and April. The monthly variations in meat yield (*MY*%) and condition index indicate a buildup of somatic and gonodal materials during the months of April and May, followed by rapid decline attributed to the shedding of reproductive material through spawning. A standard specimen of 4cm yields *CI* = 7.1% and *MY* = 16.3%. Hence, the population spawns during the rainy season. The pattern of variation of water content seems a reverse of that of dry weight, with a fall in water content accompanied by an increase in dry weight. This might imply that the species absorbs more water after spawning. Results indicate harvest and purchase of *T. coronata* are best in the month of May in the study area and the waste shells have a high potential in income generation as source of calcium for animal feed production.
Key words: seasonal variations, shape, spawning and shore animals.

1. Introduction

Thais coronata (Lamarch, 1816) commonly known as Rock Shell is a mollusc with a humped or spined, thick-walled shell, mostly with short whorls with the shell closed by a honey operculum. They are up to 5cm in length and are dirty grey to brown in colour. The aperture is red and the lip toothed (Avil and Ross, 1999). They are salt water mollusks, found on rocks and mussel banks and exhibit both restricted geographical and local distribution (Davis and Fitzgerald, 2004). The Rock Shell locally called *Nko nko* is an important source of cheap protein for the coastal people of southeast Nigeria and its fisheries supports a thriving, but subsistent economic activity. After consuming their soft-flesh, the empty shells are constantly thrown away as waste; but results of analysis of these shells show that they contain a high percentage (95.54%) of Calcium Oxide (CaO), 2.52% of Magnesium Oxide (MgO) and trace amount of other oxides which make them suitable source raw materials for the production of calcium supplements by our indigenous food industry (Malu *et al.*, 2009).

The basic building blocks of the living organisms such as proteins, fats and carbohydrates are transformed during metabolisms by living organisms, forming specific synthetic products, which contribute to meat yield and condition index of shellfish. Condition index is therefore often used as a rapid measure of ecophysiological state in exploited fisheries. It is also a very practical method used for monitoring gametogenetic activities of shellfishes (Okumuš and Stirling, 1998; Yildiz *et al.*, 2006).

Determination of condition indices is important in relation to environmental parameters, culture opportunities and to marketing. The aim of this study is to investigate the condition index and population structure of Rock Shell (*T. coronata*) with a view to determining its suitability for culture and optimum harvesting season when meat yield and condition indices were highest.

2. Materials and Methods

Monthly samples (n ~ 100) of *T. coronata* were collected from artisanal fishers at the *Esuk Nsidung* beach of Cross River Estuary, Nigeria (Fig.1). Samples were preserved in the deep freezer until analysis was carried out. In the laboratory, the following dimensions were taken; total length or shell height (TL) and aperture length (*AL*) using a vernier caliper and total weight (*TW*), fresh tissue weight (*TIW*) and dry tissue weight (*DW*) were each weighed to the nearest 0.01g using a Metler electronic balance. The dry weight was obtained by drying the fresh tissue in an oven at 60°C for 72hours. Fresh tissue weight (*TIW*) gave an indication of meat yield. The differences between fresh and dry tissue weights (*TIW* - *DW*) gave a measure of the moisture content of each

specimen. The shell shape was computed as: *S* = *TL/AL*, total length/aperture length (Osuala, 1990). The condition index (*CI*) and meat yield (*MY*) were calculated as:
CI (%) = [dry meat weight (g) / dry shell weight (g)] x 100 (Crosby and Gale, 1990; Etim, 1990).
MY (%) = [tissue weight (g)/total weight (g)] x 100 (Freeman, 1974; Yıldız *et al.*, 2011). Specific Growth Rate (SGR) was determined as: SGR (% g, body weight day^{-1}) = (*Ln* final weight – *Ln* initial weight) (no. of $days)^{-1}$ x 100 (where *Ln* is natural log). The length-weight relationship was determined by a correlation-regression analysis. The linear pair wise regression equation between the length and other variables: Aperture length (AL), shell shape (T*L/AL*), Total weight (*TW*), shell weight (*SW*), Fresh Tissue weight (*TIW*), moisture weight (*MW*), dry weight (*DW*) and condition index (*CI*) were determined for each month; and compared with a standard specimen of 4cm.

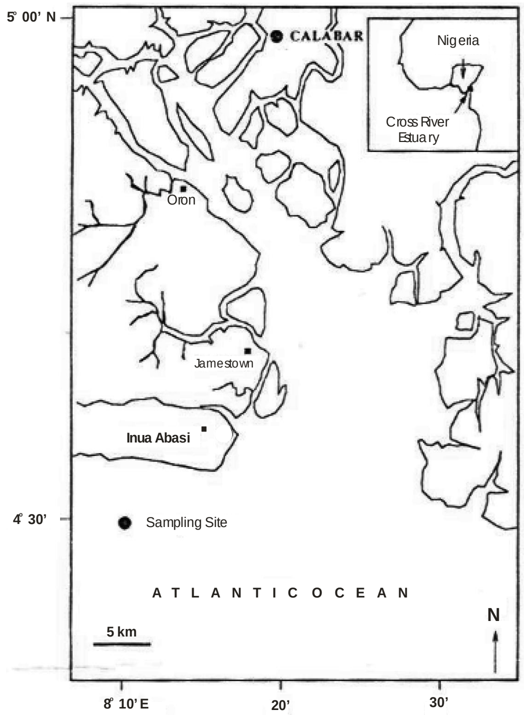


Fig. 1. The Cross River Estuary, Nigeria, showing sampling station - Nsidung beach in Calabar

3. Result

3.1 Length frequency distribution

The rock shells sampled ranged from 11.0-39.8, 24.0-43.7, 25.1-43.6, 22.4-46.8 and 26.3-43.7mm TL with corresponding mean lengths of 33.1, 33.9, 36.5, 37.3 and 37.6mm in February to June, respectively (Fig.1). The modal mean length was stable at 33.5cm for February through April with triple peaks in March and April. From 33.5cm it peaked prominently at 38.5cm in May and June, with three modal classes in June. Generally the *T. coronata* population in the study area is composed principally of 33.5cm rock shells (Fig. 1F).

3.2 Variations in measured parameters

The variations in all the measured parameters during the study period are shown in Fig. 2, described by the equations (Fig. 3) while the derived values for a standard specimen of 4cm are indicated in brackets:

- A. Aperture Length: Log AL= 0.6276LogTL + 0.1313; $r^2 = 0.5258$; r = 0.73; [AL= 3.2cm]
- B. Shell shape: LogTL/AL = 0.1266LogTL + 0.0068; $r^2 = 0.0202$; r = 0.14; [TL/AL = 1.2]
- C. Total Weight: Log TW = 1.628Log TL + 0.312; $r^2 = 0.3454$; r = 0.59; [TW = 19.6g]
- D. Fresh Tissue Weight: Log TIW = 2.8014Log TL - 1.1773; $r^2 = 0.6297$; r = 0.79; [TIW = 3.2g]
- E. Moisture Content: Log MW = 2.5547Log TL - 1.2269; $r^2 = 0.4574$; r = 0.68; [MW = 2.0g]
- F. Dry Weight: Log DW = 2.4021Log TL - 1.4071; $r^2 = 0.287$; r = 0.54; [DW = 1.1g]
- G. Shell Weight: Log SW= 1.3247Log TL + 0.3967; $r^2 = 0.1324$; 0.36; [SW = 15.6g]

- H. Condition Index: Log CI = 1.3319Log TL- 0.007; $r^2 = 0.1222$; r = 0.35; [CI = 7.1%]

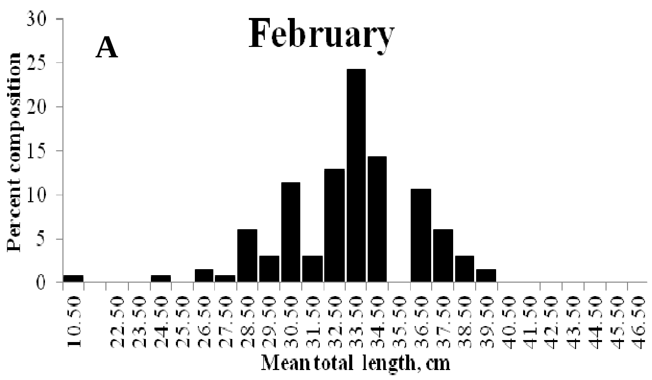
The Aperture Length showed no change between February and March but varied and peaked in April (Fig. 2A). The shell shape in February and June were the same; varied in March and April and peaked in May (Fig. 2A) while Total Weight as depicted in Fig. 2B showed unique variation with a distinct peak in June. Shell weight peaked in February and March, decreased in April reaching its lowest value in May, followed by a steep increase in June (Fig. 2B). Fresh tissue weight or meat yield (Fig 2C) showed a unique peak in June. There was an increase from February to March and a decline was observed in April, from here, the weight rises linearly and peak in June.

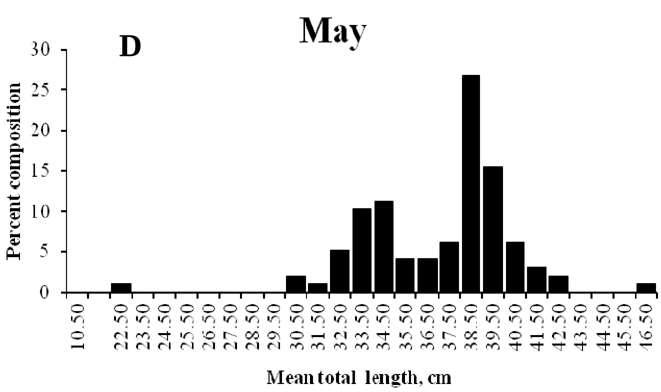
The variation in moisture content (Figure 2C) shows a decrease from February to March, with the lowest value in April, the value of May was same as that of March and a peak was observed in June. There was a distinct variation in dry weight throughout the research period with a fall from February to March followed by a linear increase reaching a peak in May (Fig. 2C). Variations in condition index and meat yield are depicted in Fig. 2D; with a fall from February to March followed by rapid increase in April and a geometric increase with a peak in May. Thereafter, there was a decline from the peak to June. The specific growth rate, SGR, was 0.077, 0.246 and 0.070 g% day^{-1} for March, April and May.

4. Discussion

Results obtained from this study showed that the highest length frequency was obtained in the month of April with a peak at 40.1-41mm. This seasonal change in size is attributed to the spawning period and the presence of nutrient. This is in consonance with a similar study by Udoidiong (2005) on macrobenthic faunal assemblages in the saline wetland of Eastern Obolo, Nigeria. The monthly variation in the aperture as shown in Fig 2a shows a peak in April which is the beginning of the rainy season. This is corroborated by Ogogo (2004) that the broad aperture lengths of shell fish confer an advantage under conditions of powerful wave action or other strong water movements like current and tides. Hence mammals with greater shell lips would have a broader aperture length. Age also account for variation, Cowel and Crothers (1970) and Crothers (1971) showed that growth ceases at maturity and the animal lay down a row of teeth which have the effect of strengthening and narrowing the aperture length against attack by predators.

The month (May) that has the highest total length and lowest aperture length possess the highest shell shape (Fig. 2a). Osborne (1977) found that sheltered shore animals grow faster and reach their larger size compared to those from exposed shore. The exposure to wave action tends to make the shell shorter than when there is no much action as in the dry season. This pattern was described by Cooke (1985) and Osborne (1977) who stressed that animals with short shells present minimal surface area to the moving water and large foot maximizes adhesion to the rock surface. Yildiz *et al.* (2006) made similar observations. It is probable that diet influenced the monthly variations exhibited in shell shape. Variation was observed in total weight. The highest weight was observed in the month of June and the lowest in May. As shown in Fig. 2B the peak of total weight correspond with the period of peak rain (June) where nutrient is available for rapid growth hence rapid increase in total weight. This is in agreement with Egborge (1993).





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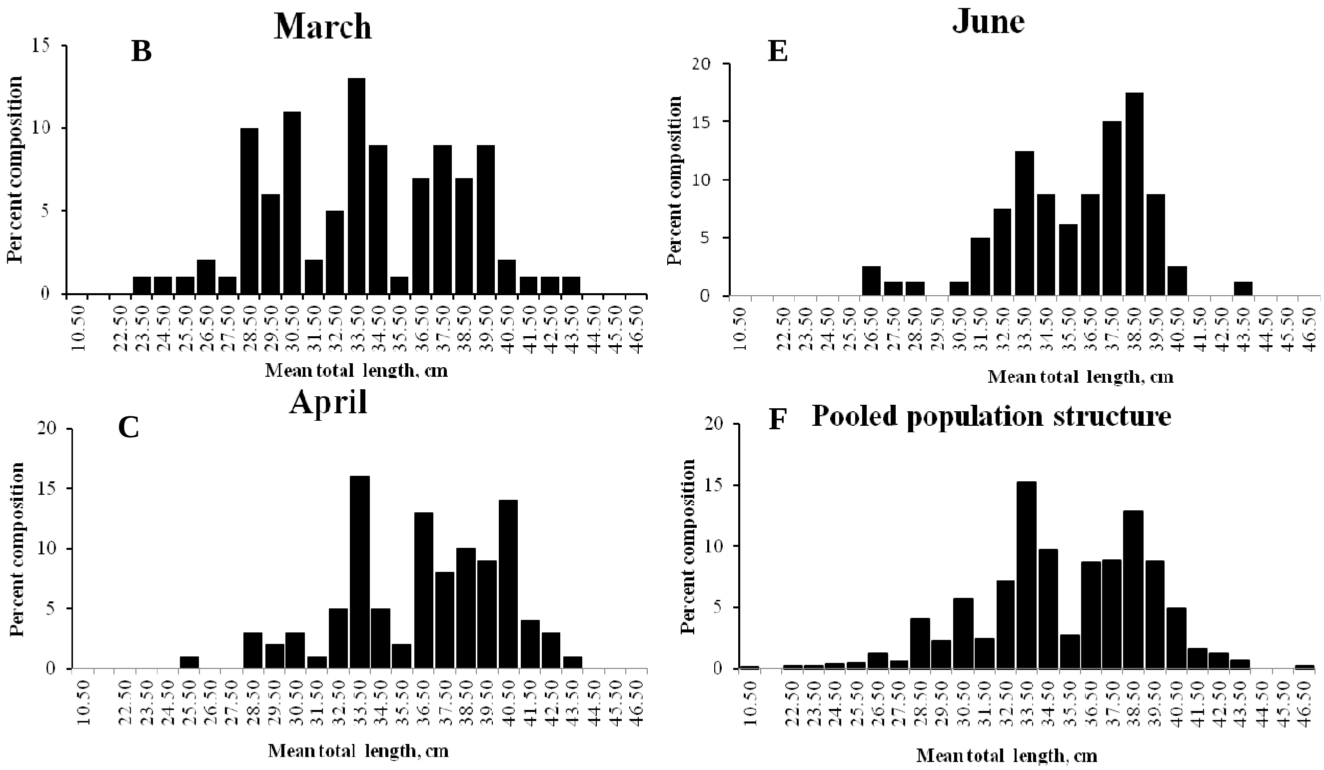
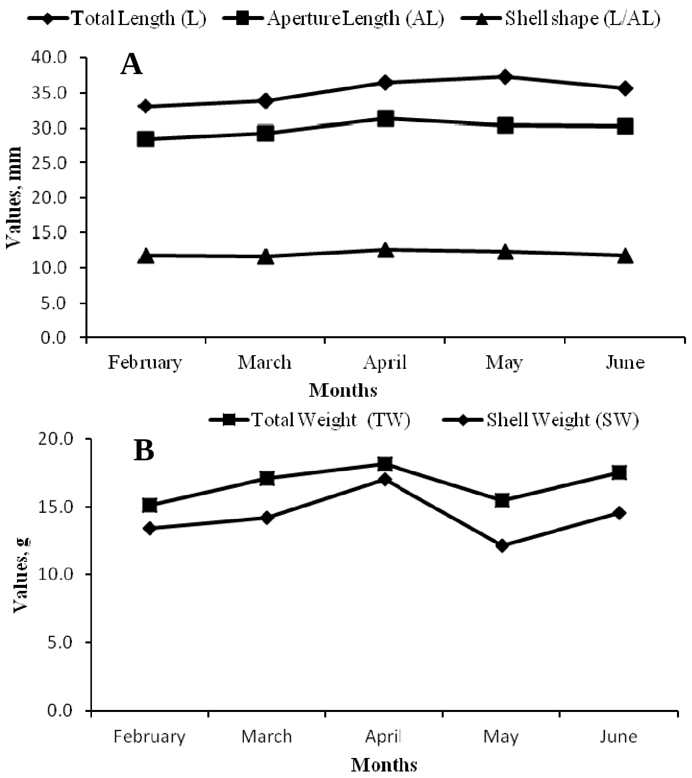


Fig. 1 Mean length and population structure of *T. coronata*



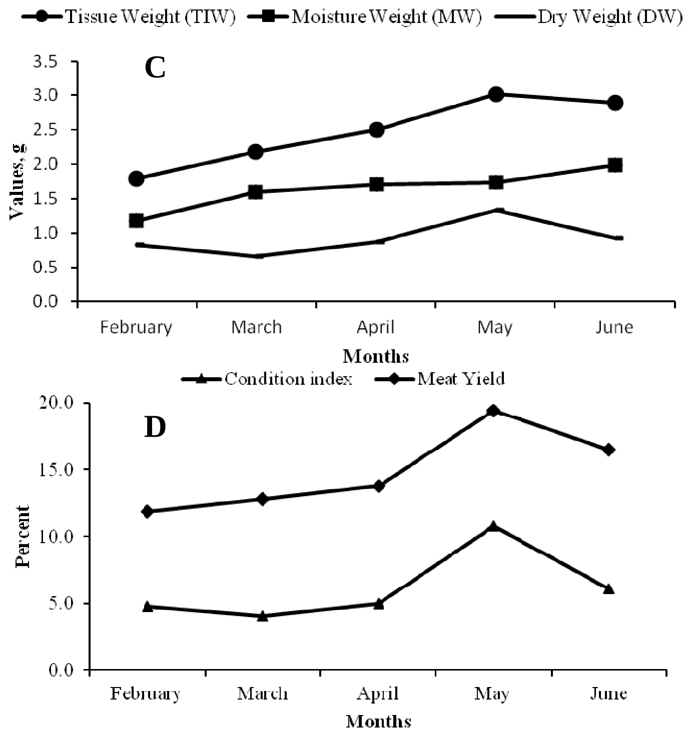
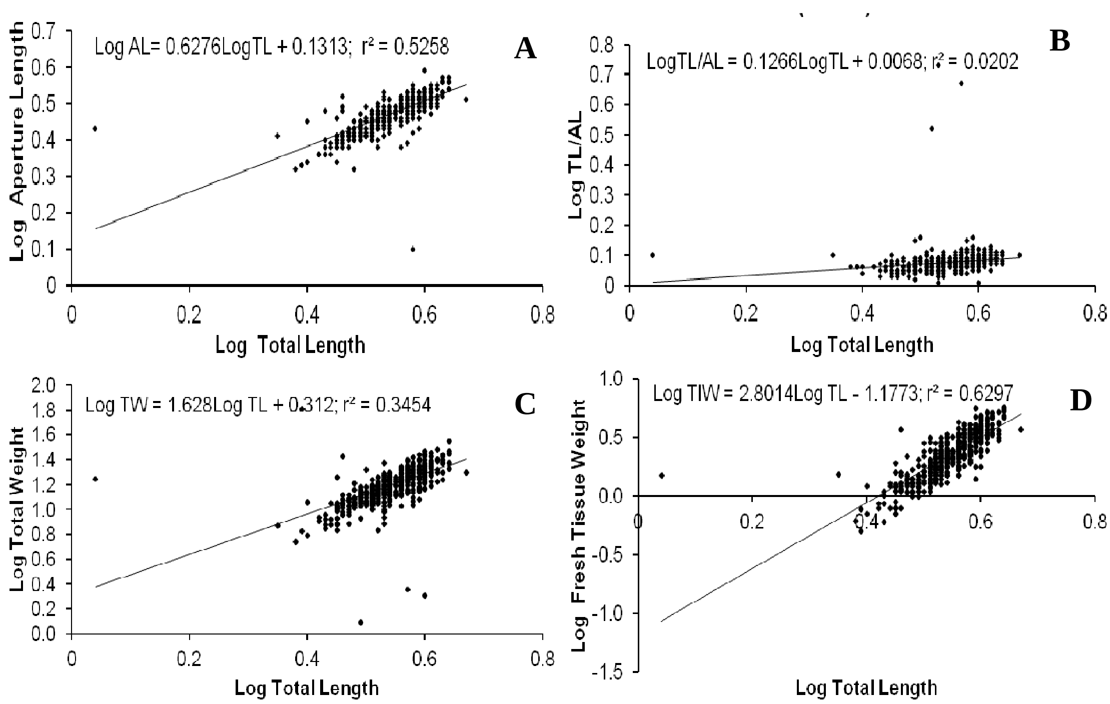


Fig. 2 Seasonal variations in total length, aperture length and shape (A), total and shell weights (B), tissue, moisture and dry weights (C) and condition indices and meat yield (D) in *T. coronata* during the study period



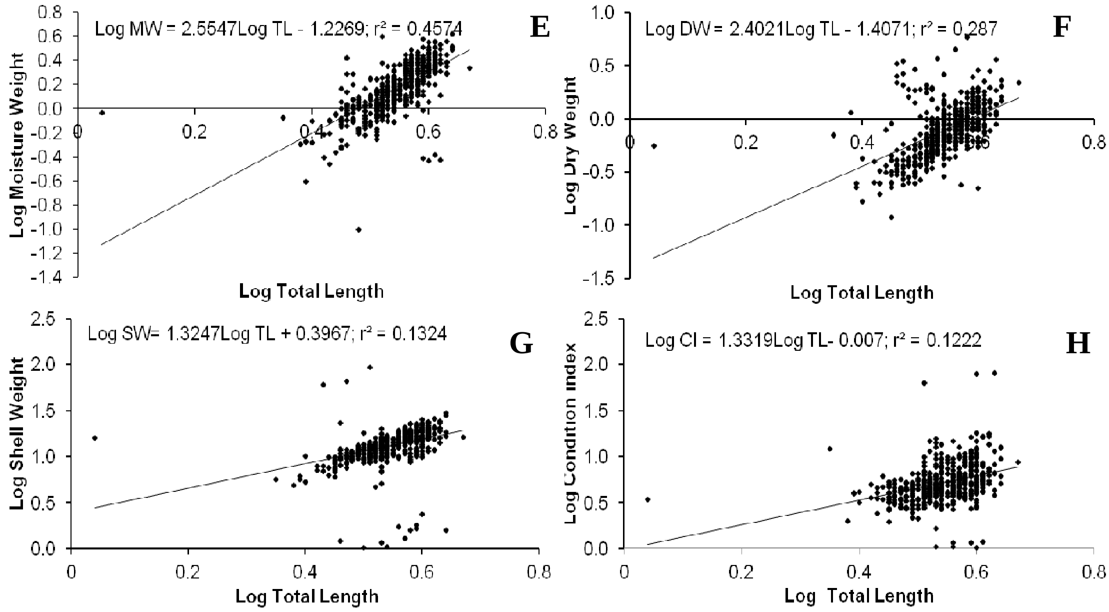


Fig. 3. Logarithmic relationships of measured parameters: A. Aperture Length, B. Shell shape, C. Total Weight, D. Fresh tissue weight, E. Moisture content, F. Dry Weight, G. Shell weight and H. Condition Index with total length in *T. coronata* during the study period

Variation in shell weight (Fig 2B) showed gradual increase from February with peak in April. The shell weight declined to the lowest in May which coincide with the period of the lowest total weight hence factors attributed to decrease in total weight are also applied for the fall in shell weight. As reflected in Fig 2C the fall in fresh tissue weight in April depict the period of spawning, when the gametes are released (Lutz *et.al.*, 1980). From April, there is a linear increase in the fresh tissue weight till its peak at June. This has been attributed to mean that the animal absorbs more water to fill the lumen created in gonad after the release of gamete (Taylor and Venn, 1979) and also because of abundance of nutrient during the peak of the rainy season (Etim, 1990; Yildiz *et al.*, 2006). Although tissue weight, vary from month to month, high meat yields can be anticipated from early April through June where there is a linear increase in the fresh tissue weight. Hence, it is advisable to concentrate harvest efforts in this period which return the highest meat yield especially for processing purposes (Malu *et al.*, 2009). Moisture weight or content show monthly variation throughout the research period (Fig 2C). The lowest value was reached in April then increases and reached peak in June. The fall in moisture weight is attributed to the spawning of the animal (Barnes *et al.*, 1963; Ogogo, 2004). The rapid increase in moisture weight corresponds with the animal absorbing more water to fill the lumen created in the gonad after the release of the gamete (Taylor and Venn 1979). Dry tissue weight was lowest during the month of March and highest in May (Fig 2C). This monthly variation correlates with other factors like spawning and availability of nutrient. This has been demonstrated in several other mollusk like *Ostrea edulis* (Walne, 1970; Gabbot and Walker, 1971); *Crassostrea madrasena* (Nair and Nair, 1987); *Mytilus edulis* (Gabbott and Bayne, 1973; Lutz *et al*., 1980 and Oyekan, 1984). From the result of this study, the decline in weight from May coincide with the spawning of other studied species.

In this study, the results of MY correlated to CI (Fig. 2D), similar to the observations of Yıldız and Lök (2005) and Yıldız *et al*. (2011). CI and MY of shellfishes are affected by endogenous activity such as gametogenic cycle and exogenous parameters such as water temperature, pH, oxygen level and food availability (Flores-Vergara *et al.*, 2004). CI, in this study, varied between 4.1% and 10.7%, while MY varied from 11.9% to 19.5%. The highest CI, TIW and MY co-occurred in May (Fig. 2C, D). Etim (1991) in his work in a similar animal observed a fall in condition index from the month of June which reflects the spawning period. The fluctuations in the CI and MY have important implications for cultivation and harvesting strategy (Okumus and Stirling, 1998; Yildiz *et al.*, 2006; Yıldız *et al.*, 2011) and indicate spawning season; during which gonads formed in their mantle cavities are discharged creating a lumen. Similarly, at times of low food availability shelfishes use energy reserves in their body thereby reducing their nutritive quality and harvest values. Protein and fat content increases during gametogenesis whereas it decreases after spawning (Wolowicz *et al.*, 2006). This is because; gonads consist mainly of protein and fat in bivalves (Pieters *et al.*, 1980). The measured parameters particularly aperture length, total weight, fresh tissue weight and dry weight strongly correlated ($r > 0.5$) with total length (Fig. 3).

5. Conclusion

There was a distinct monthly pattern of variation in the parameters studied. It is probable that the onset of rains might be the environmental factor that triggers the spawning process and changes in condition indices and meat yield of *Thais*. The economic importance of the *Thais* fishery dwells largely in its nutritional quality, availability and affordability where it provides food security the local populace. Each specimen provides at least 16% meat yield alongside empty shells locally used as supplement or complement to gravels in building construction. However, in view of the gear and technology currently employed, investment in developing the fishery to obtain year-round good quality *Thais* meat processed with added value and suitable for export and marketing would improve the fishery and enhancing local livelihood and economies. Additionally, *Thais* shells also have great potential as cheap calcium source for animal feed production.

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