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Tail Weight Analysis of the Invasive Tiger Shrimp (*Penaeus monodon*) and Native Pink Shrimp (*Farfantepenaeus notialis*) in the Niger Delta Region: Implications for Selective Breeding Program in Nigeria

Sylvanus Anene NWAFILI and Doris Chibanya OLUMATI
Department of fisheries, University of Port Harcourt
P.M.B. 5323 Choba, Port Harcourt, Rivers State
Corresponding author's e-mail:
sylvanus.nwafili@uniport.edu.ng

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Abstract

Since the Asia tiger shrimp, Penaeus monodon invaded the coastal waters of Nigeria and the cpllapse of the pink shrimp, Farfentepenaeus notialis fishery in 1990s, shrimp farming have been suggested. However, information on the tail weight of the two candidate aquaculture species are inadequate. The objective of this study was to determine the sex ratio and compare the percentage of the total body weight of P. monodon and F. notialis that is available for consumption. A total of 257 individuals of P. monodon and F. notialis were obtained from three locations – New Calabar River, Andoni River System and Bille Creek in the Niger Delta Area of Rivers State. The total body weight and tail weight (weight of abdomen severed along the carapace posterior) of each individual were subjected to analysis. The Asian tiger shrimp maintained a male dominated sex ratio while it was the reverse in Pink shrimp. The tail weight was 64 – 67% and 58 – 65% in P. monodon and F.s notialis, respectively of the body weight. The tail weight in female F. notialis was meatier than in males which suggest the profitability of monosex culture. There was strong positive correlation between body weight and tail weight, implying that selection for body weight will profoundly influence tail weight.

Keywords: *Tail weight, Penaeus monodon, Farfentepenaeus notialis, Niger Delta, selective breeding*

Introduction

The idea of culturing shrimp is new in Nigeria, being borne out of the evidence that it may be difficult to increase sustainably the shrimp catches from Nigerian coastal waters due to the collapse of the pink shrimp fishery in 1990s from over-exploitation, water pollution, habitat degradation, and poor management. (Ansa, 2009; Ayoola *et al.*, 2009; Ansa *et al.*, 2010; Zabbey *et al.*, 2010). The collapse of pink shrimp (*Farfentepenaeus notialis*) fishery coincided with the appearance of the invasive Asia tiger prawn, *Penaeus monodon* in Nigerian Coastal waters (Zabbey *et al.*, 2010). *P. monodon* has since become a major commercial species as the population and size of *F. notialis*

continue to decrease. Attention has, therefore, been directed towards the development of shrimp culture as a means to increase shrimp production in the country: This shift towards shrimp aquaculture as an alternative to supply from wild capture in Nigeria is, therefore, a significant development that could open up opportunities for investors and it has the potentials of creating jobs.

However, the choice of candidate shrimp species for culture depends on defined characteristics such as high economic value and high market demand, ease of culture, and fast growth. Of the penaeid shrimp in Nigerian waters, the Asia tiger prawn, *P. monodon* and the pink shrimp, *F.s notialis* satisfy the conditions of culturable species (Anyanwu *et al.*, 2011). Tail weight is a major trait for selection of shrimp because it is the main marketing product in the industry. The tail weight is a measure used in the shrimp processing industry to estimate the meatiness or yield of the individual or population. It is the ratio of the weight of the tail meat to the total weight of the whole shrimp and the phenotypic and genetic correlation of tail weight to body weight is very high (Chandra *et al.*, 1997). According to Chandra *et al*. (1997) tail weight is highly variable, implying that it can be exploited by selection. Producers are interested in processing characteristics, such as fillet yield, amount of tail meat, or percentage of edible muscle in relation to body weight of aquaculture species (Thompson *et al.*, 2004). The low tail yield in freshwater prawns such as Macrobachium species which ranges from 28 to 51 % only (Lin and Boonyaratpalin 1988) makes their culture disadvantageous.

The production of *P. monodon* has already commenced in Badagry by Atlantic shrimpers. Despite the importance of Pink shrimp as native, baseline studies on important economic traits are either lacking or inadequate, particularly those relating metric traits. The objective of this research was to determine the sex ratio and determine the yield characteristics (tail weight) of two candidate aquaculture species, *P. monodon* and *F. norialis* in the coastal waters of Nigeria. The result will guide potential investors and farmers in the choice of species for farming. The study will provide fresh insight on the potential yield and efficiency of culturing each species.

Materials and methods

Study area

The study was carried out in three locations in the Niger Delta axis of River State. These locations were New Calabar River, Andoni river system, and Bille Creek. The New Calabar River is located between longitude $7^0$60'E and latitude $5^0$45'N in the coastal area of the Niger Delta (Dienye and Woke, 2015). The Andoni River is located between latitudes $4^0$28' to $4^0$45'N and longitudes $7^0$45'E in the coastal region of the Niger Delta (Komi and Sikoki, 2013). The Bille Creek is tributary of the Sombriero River located between latitude $4^0$36'0"N and longitude $6^0$55'60"E (Wikepedia, 2020).

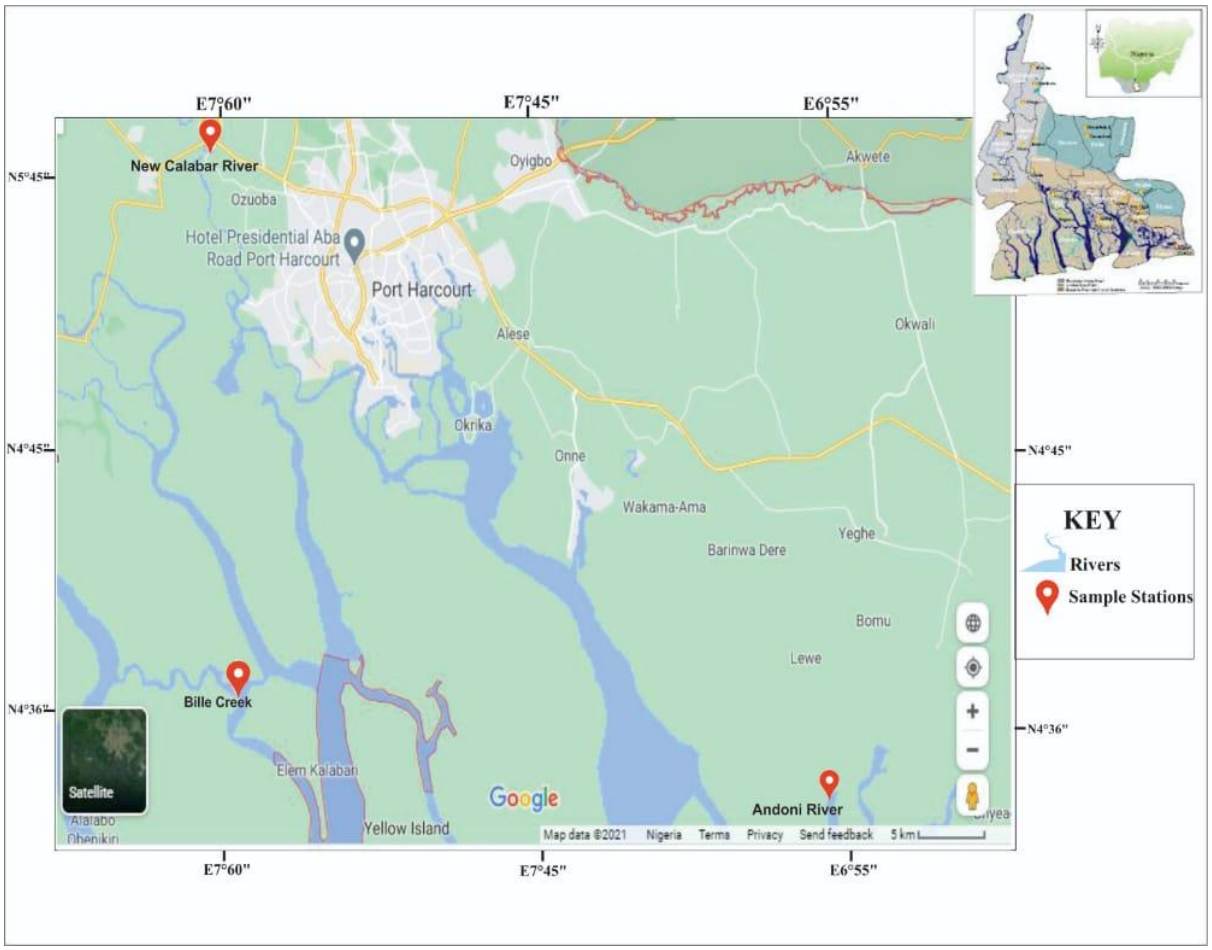

Fig 1: Map showing Sample locations of *P. monodon* and *F. notialis*

Sample collection

Penaeus monodon and *Farfantepenaeus notialis* were collected from local fishermen fishing with cast net. The samples were transported in ice box to the laboratories where they were identified and sorted using appropriate keys (Powell, 1982).

Laboratory Procedures

Each individual of *P. monodon* and *F. notialis* were identified and sorted as male or female. The petasma in the first pleopod was used to identify the males, while the thelycum in between the fourth and fifth pereopods in females. They were then preserved in 96% alcohol.

The total body weight and tail weight of each individual were obtained using a weighing scale (0.01g). The tail weight (TW) refers to weight of abdomen severed along the carapace posterior.

Data handling and Analysis

The sex ratio of the samples collected was derived by evaluating the proportion of male individuals to female individuals for each population in both species (SR = male: female). Chi square executed

in Microsoft Excel was used to determine significant difference between the observed sex ratio and expected sex ratio. The software "Past326b" was used to obtain the means, standard error, linear regression between the total body weight and tail weight as well as the coefficient of correlation (R^2) which was used to determine the level of relationships that exist between the total body weight and tail weight of species.

The tail weight percentage of the body weight was derived using this formula:

Percentage Tail Weight= $\frac{Total\ weight\ of\ whole\ shrimp}{Weight\ of\ tail}$ x 100

Results

Sex ratio

A total of 257 specimens of penaeid shrimps (*Penaeus monodon* and *Farfantepenaeus notialis*) were obtained from three different locations. The sex ratio of *Penaeus monodon* and *Farfantepenaeus notialis* are presented in Table 1. It showed that the number of males were more compared to the number of females for *P. monodon* in New Calabar River and Andoni River systems ($p>0.05$), while for *F. notialis* the number of females were more than the number of males in Andoni River system ($p<0.05$) and Bille Creek ($p>0.05$) but equal in New Calabar River.

Table 1: Sex ratio of sampled *Penaeus monodon* and *Farfantepenaeus notialis*

SPECIES	LOCATION	MALES	FEMALES	RATIO
Penaeus monodon	New Calabar River	29	22	1.3:1
	Andoni River	38	24	1.6:1
	POOLED	67	46	1.5:1
Farfantepenaeus notialis	New Calabar River	20	20	1:1
	Andoni River	18	32	1:1.8
	Bille Creek	25	29	1:1.2
	POOLED	63	81	1:1.3

Total body weight – Tail weight relationship

The correlation and coefficient of determination between total body weight and tail weight of *P. monodon and F. notialis* are shown in Table 2. In both species the correlation (0.7576 - 99183) and coefficient of determination (0.574 - 98372) were high. The result showed that both species displayed positive linear relationship for the sexes.

Table 2: Total body weight and tail weight relationship of Penaeus monodon and *Farfantepenaeus notialis*

Species	**Location of Sampling**	**Sex**	**r**	**R^2**
Penaeus monodon	New Calabar River	M	0.9858	0.9718
		F	0.99183	0.98372
	Andoni River	M	0.9752	0.95117
		F	0.9891	0.97835
Farfentepenaeus notialis	New Calabar River	M	0.9830	0.96643
		F	0.9319	0.8685
	Andoni River	M	0.9658	0.9329
		F	0.9569	0.91567
	Bille	M	0.8680	0.75389
		F	0.7576	0.574

Where r = correlation value, R^2 = coefficient of determination

The yield (Tail weight) characteristics of *Penaeus monodon* and *Farfentepenaeus notialis*

The tail yield characteristics of *P. monodon* and *F. notialis* are presented in Table 3. The tail weight yield ranged from 64 - 67% in *P. monodon* and 58 - 68% in *F. notialis*. For *P. monodon*, the tail weight occupied more than 60% of their total body weight, ranging from 64% to 67% in female and 66 – 67% in males. The tail weight of *F. notialis* occupied some 60% of the total weight with a range of 61 – 65 % and 58 – 61% respectively for females and males.

Table 3: Tail weight of *Penaeus monodon and Farfentpenaeus notialis as percentage of total body weight*

Species	Location	Sex	$\bar{X}$±SE		% TW of TBW
			TBW	**TW**	
Penaeus monodon	New Calabar River	Male	26.51±1.24	17.72±0.85	67
		Female	37.32±3.02	24.86±1.97	67
	Andoni River	Male	63.5±1.9	41.76±1.26	66
		Female	90.12±7.25	57.83±4.50	64
Farfentepenaeus notialis	New Calabar River	Male	2.35±0.15	1.38±0.14	59
		Female	2.65±0.22	1.72±0.19	65
	Andoni River	Male	7.17±0.57	4.39±0.37	61
		Female	10.56±0.92	6.5±0.6	62
	Bille Creek	Male	1.96±0.19	1.14±0.12	58
		Female	1.89±0.15	1.14±0.09	61

Where $\bar{X}$= mean, SE= Standard error, TBW= total body weight, TW= tail weight.

Discussion

Various researches have been carried out on Penaeid shrimps using their morphological characteristics. These range from the sexual dimorphism, growth pattern, stock identification, genetic makeup and diversity, and even cultivability of the species. In the present study, two species of Penaeid shrimps were studied to reveal sex ratio and significance of tail weight.

Sex ratio

The sex ratio of observed in this study for *P. monodon* is in contrast with the expected 1:1 but in agreement with Sarada (2010). However, for *F. notialis*, population obtained from New Calabar River showed the expected ratio of 1:1 as reported by Brito and Pena (2007) in the peak season of penaeid shrimps. Other populations were observed to higher number of females. This is in agreement with Costa *et al.* (2010), who suggested that the sex ratio of females may be related to the greater vulnerability of females to fishing due to their size. The observation of higher proportion of females is also in agreement with Uddin *et al.* (2015), who reported that it could be attributed to changes in the fishing ground and fishing pattern of trawl nets, and the pattern of migration during breeding seasons of both sexes.

Significance of tail weight

The tail weight is about the most important metric trait in shrimps. It is the edible portion of the shrimp. The percentage tail weight of shrimp is a measure used in the shrimp processing industry to estimate the meatiness or yield of the shrimp. A higher percentage tail weight indicates that a larger portion of the shrimp's weight consists of meat, making it more desirable for consumers and potentially commanding a higher price in the market. In this study, the percentage meat yield was in the range of a previous report (Chemonics, 2002; Campos-Montes *et al.*, 2017). This study reveals that the mean tail weight the penaeid shrimps examined were more than 60% (pooled) of their mean total body weights. This is in agreement with the report of Chemonics (2002) and Durand *et al.* (2003) that, in the penaeid species, the tail makes up approximately 60 percent of the total weight and higher than those reported for freshwater species which ranges from 28 to 51 % only (Lin and Boonyaratpalin 1988; Tidwell and Coyle, (2011)).

In *F. notialis*, the percentage tail weight was skewed towards a higher value in females suggesting that all female culture of the species may be more profitable to farmers.

Furthermore, the high positive correlation between body weight and tail weight implies that selecting for body weight will indirectly improve tail weight simultaneously. Genetically, both traits are influenced by the same genes.

Conclusion

This study has revealed sexual dimorphism in tail weight of *Farfentepenaeus notialis*. This situation can encourage monosex production of *F. notialis*. Secondly, tail weight or tail yield is higher in *P. monodon* suggesting that it is meatier than *F. notialis*, a characteristic that will favour farmers and investors choice of the species. There is strong correlation between body weight and tail weight.

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