



SEX DETERMINATION AND GONAD DEVELOPMENT OF A MANGROVE PROSOBRANCH *Tympanotonus fuscatus* var *fuscatus* (LINNAEUS, 1758) FROM BONNY ESTUARY, NIGERIA

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ABSTRACT

The sex determination/ratio and gonad development of *Tympanotonus fuscatus* var *fuscatus* in the mangrove swamps of Bonny River was studied for a period of twenty four months. Females were found to be dominant to males in the observed population. The trend was observed for the entire population as well as in the different seasons. Sex ratios however varied with season and maturity stages. *T. fuscatus* var *fuscatus* breeds between October and January. The non - productive season starts in February and continues till June. The breeding period which is restricted to October and January was attributed to increase in salinity and the flow of water current experienced in the dry season. Environmental factors and internal mechanism influences the initiation of gametogenesis of *T. fuscatus* var *fuscatus*. The study showed that temperature was not a controlling factor in the gonad development of *T. fuscatus* var *fuscatus*.

Keywords: gastropod mollusc, sexual dimorphism, reproductive periodicity, spawning

INTRODUCTION

Tympanotonus is a prominent gastropod mollusc and exists in the intertidal swamps of brackish water ecosystems of West Africa. It is characterized by shell in spiral form. The mantle covers the visceral mass contained within the shell, head and foot often exposed ventrally at the shell opening. They crawl or glide with their muscular foot lubricated by mucus from mucous glands. The genus *T. fuscatus* comprises of a single species which has two varieties *T. fuscatus* var *fuscatus* and *T. fuscatus* var *radula*. *T. fuscatus* var *fuscatus* is characterized by turreted, granular and spiny shells with tapering ends. *T. fuscatus* var *radula* is distinguished by absence of spiny tubercle on the shell.

It is bisexual and both types are found in most brackish water creeks and mangrove swamps in the Niger Delta area at the inter-tidal zone (Jamabo, 2007). There is no external sexual dimorphism to distinguish the sexes. Both male and female have open pallial gonaduct. The male reproductive systems consist of the testis, sperm duct and the vas deferens

which is located towards the apex of the spire close to the digestive gland. The female reproductive system is composed of the ovary and the oviduct which has an oviducal gland.

Spawning occurred only in *T. fuscatus* whose shell length was 35 mm and above and breeding season is restricted to the period of dry season (Egonmwan and Odiete, 1983). Ajao and Fagade (1990) observed that *Pachymelania aurita* spawned from mid-November and April. Egonmwan (1980) reported four stages of gonad development in both male and female *T. fuscatus* during reproduction, there are recently spawned, ripe, unripe and spawning gonads. The eggs of *T. fuscatus* are spherical in shape, measuring approximately 140 μ in diameter and surrounded by tough hyaline capsule which contain granular fluid abdomen (Egonmwan, 1980). Gonadal development is a very sensitive period for any species. It is highly influenced by the changes in ecological factors and seasons. The present study was undertaken to describe aspects of the reproduction of *T. fuscatus* var *fuscatus* from the mangrove swamps of the Bonny River Estuary. To meet these

objectives, sex ratio and gonadal development were compared for two years. Data will provide estimate of maturity and reproductive periodicity of the species.

MATERIALS AND METHODS

Study area

The study area covered the mangroves swamps of the upper Bonny River, which lies between latitudes 4° 45' to 4° 48' North and longitude 7° 05' East (Fig. 1). The creeks are tide dominated embayment with little fresh water input and are characterized by extensive mangrove swamps, tidal flats, influenced by semi-diurnal tidal regime

(NEDECO, 1961). The climate of the study area is sub-tropical. Heavy rainfall, high temperatures and relative humidity characterize the area. The vegetation consists of thick mangrove forest dominated by the red mangrove *Rhizophora racemosa* and *R. mangle*. In some areas, the white mangrove *Avicennia africana* is interspersed with *Nypa fruticans*. The low inter-tidal zone is usually bare of vegetation, with clay, peat and sand deposit. Salinity fluctuates with the season and tide regime is influenced by the Atlantic Ocean (Dagana, 1985). The predominant human activities in the area include fishing, sand mining, and mangrove timber exploitation.

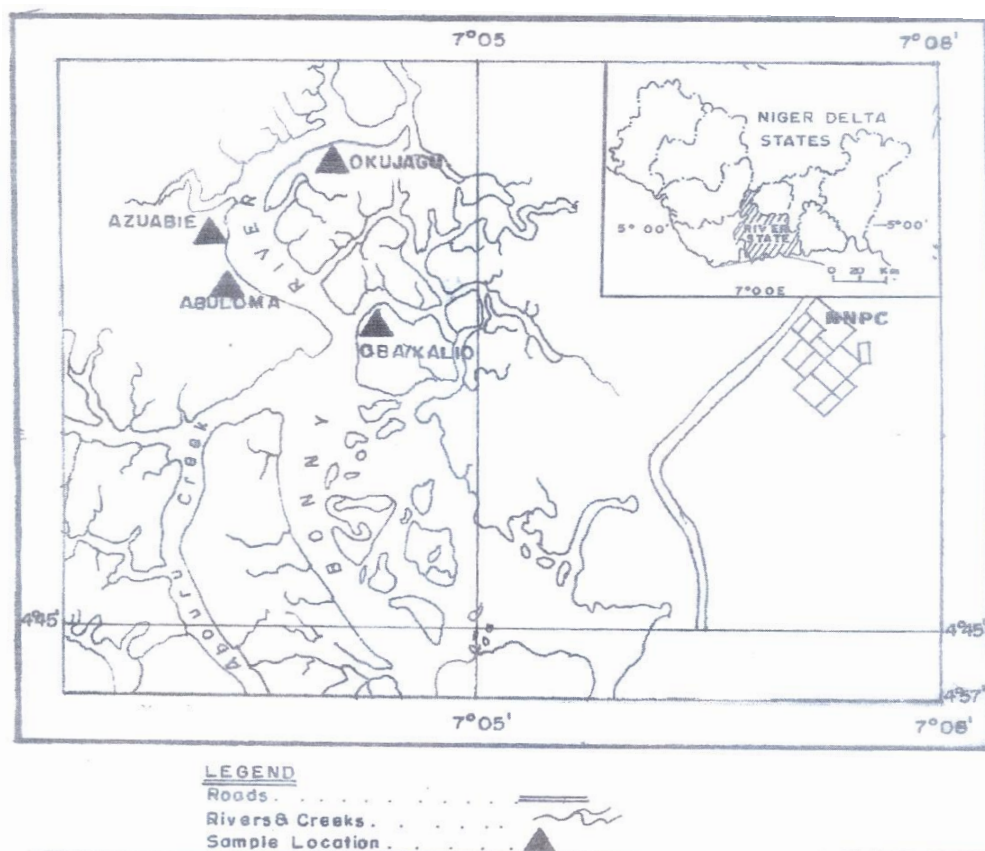


Fig 1: Map of Niger Delta, Rivers State and Bonny River showing the study stations

Specimen sample

The breeding cycle was investigated by observing the seasonal changes in the gonads. The gonads of about 1000 specimens were examined monthly. The periwinkles were collected by

handpicking from the mudflats at low tides. The tissue was removed from the shells. Smears of the gonads of each animal were examined in order to access the state of development. Gonadal smears were made using the dry smear techniques and

standing under the cover ship with Ehrlich's haematoxylin as suggested by Frazer (1956). Serial sections of the gonad fixed in Zenker's fluid and embedded in ester wax were made as outlined by Steadman (1960).

The result obtained was subjected to analysis of variance (ANOVA) to determine their variation at the different stations and season. The statistical analysis was carried out using SAS (2001) system. Where significant difference was observed, Duncan multiple range test was used to separate the means.

RESULTS

Sex ratio

The results of the sex ratio of *T. fuscatus* var *fuscatus* are presented in Table 1. The sex ratio for

2006 was 1:1:57, while 1:1:4 was observed for 2007. However, sex ratio deviated significantly, with the females' dominant in all the months. Seasonal variation in sex ratio was determined for wet and dry season for both years. During the wet season in 2006 (May - October) males (84, 38%) varied from the females (137, 61.9%) with a sex ratio of 1:1:63. Similarly, the dry season (November - April) males (77; 39.9%) and females (116, 60.1%) giving a sex ratio of 1:1:51. A sex ratio of 1:1:54 was obtained for the wet season in 2007. Males (52; 39.4%) varied from the females (80; 60.66%). The dry season had sex ratio of 1:1.40, males (76; 41.8%) and female (106; 58.2%).

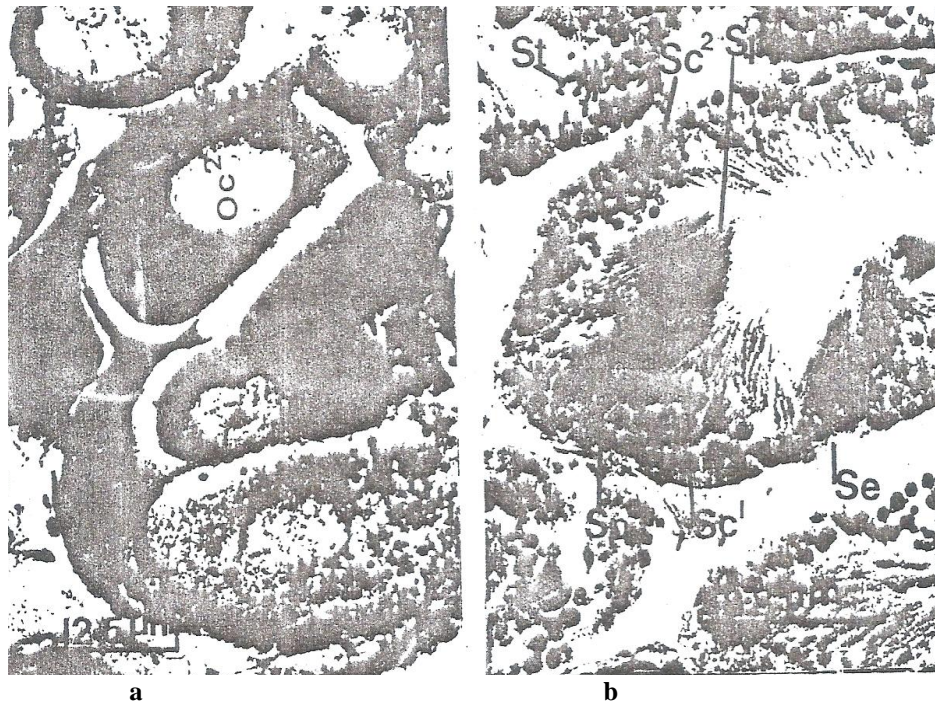
Table 1: Monthly sex ratio and gonadal changes in colour of *Tympanotonus fuscatus* var *fuscatus*

Year	Months	Gonad Colour		Sex ratio	Remarks	
		Male	Females	M : F	Male	Female
2006	JAN	Orange	Light green	1 : 1.60	Ripe	
	FEB	Orange	Light green	1 : 1.20	Ripe	
	MAR	Orange	Light green	1 : 1.17	Ripe	
	APR	Orange	Light green	1 : 1.65	Ripe	
	MAY	Brown	Dark green	1 : 1.56	Unripe	Unripe
	JUN	Brown	Dark green	1 : 1.33	Unripe	Unripe
	JUL	Brown	Dark green	1 : 1.47	Unripe	Unripe
	AUG	Brown	Dark green	1 : 1.81	Unripe	Unripe
	SEP	Brown	Dark green	1 : 2.20	Unripe	Unripe
	OCT	Orange	Light green	1 : 1.90	Maturing	Maturing
	NOV	Orange	Light green	1 : 1.91	Ripe	Spawning
	DEC	Orange	Light green	1 : 1.57	Ripe	Spawning
2007	JAN	Orange	Light green	1 : 1.31	Ripe	Spawning
	FEB	Orange	Light green	1 : 1.54	Ripe	Spawning
	MAR	Orange	Light green	1 : 1.50	Ripe	Spawning
	APR	Orange	Light green	1 : 1.40	Ripe	Spawning
	MAY	Brown	Dark green	1 : 1.57	Unripe	Unripe
	JUN	Brown	Dark green	1 : 1.67	Unripe	Unripe
	JUL	Brown	Dark green	1 : 1.64	Unripe	Unripe
	AUG	Brown	Dark green	1 : 1.56	Unripe	Unripe
	SEP	Brown	Dark green	1 : 1.43	Unripe	Unripe
	OCT	Orange	Light green	1 : 1.21	Maturing	Maturing
	NOV	Orange	Light green	1 : 1.71	Ripe	Spawning
	DEC	Orange	Light green	1 : 1.45	Ripe	Spawning

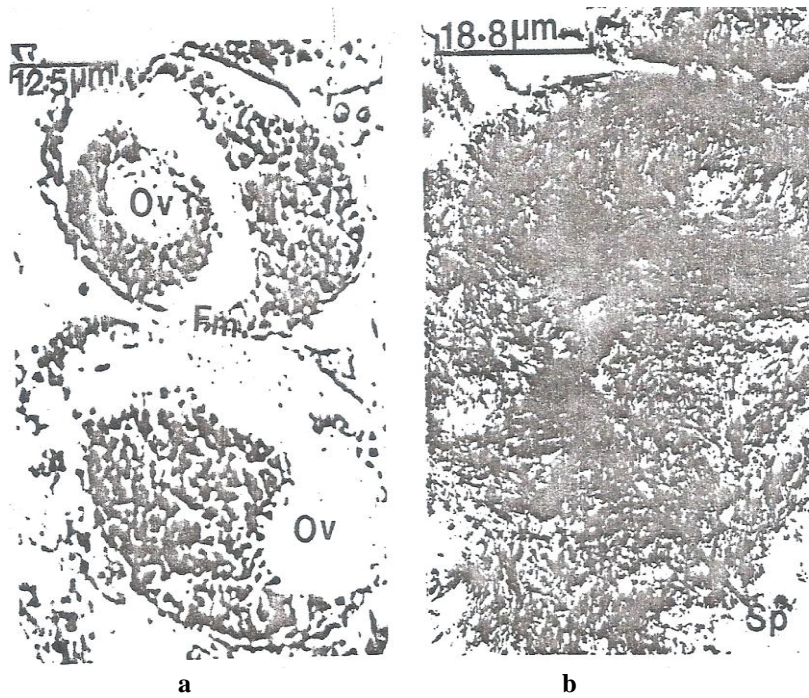
Gonadal Changes

Four stages of gonad development were observed in mature *T. fuscatus* var *fuscatus* during the reproductive season. These are ripe gonads, spawning gonads, unripe gonads, and recently spawned gonads:

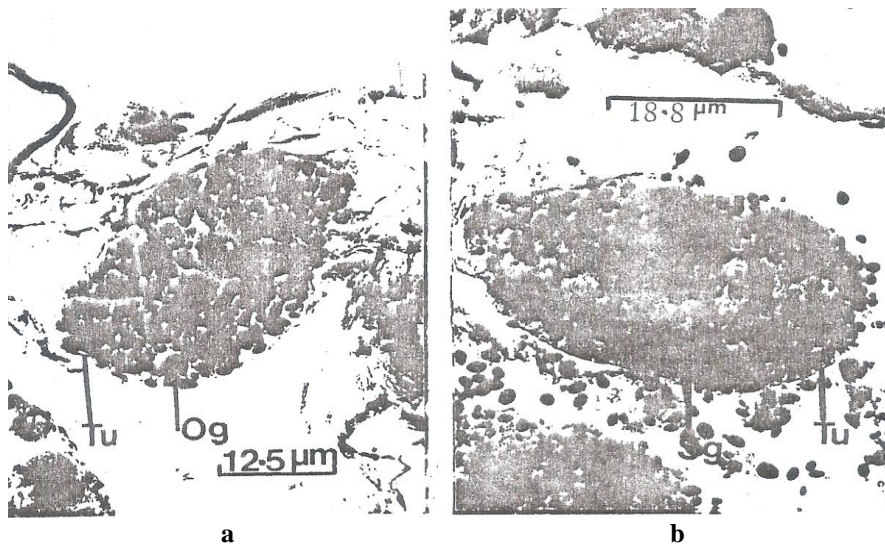
- a. Ripe gonads: The ripe ovaries were characterized by having large closely packed tubules of various shapes with oocytes and eggs packed together. Ovaries were bright light green in colour. In the males, ripe spermatozoa predominated in the lumen of the extended tubules which measured between 120 and 180 micrometers. The ripe tests were bright orange in colour (plates 1a and b).
- b. Spawning gonads: The ovaries were also light green in colour and were characterized by the fluid nature of its contents. The tubules contain few unshed eggs. The tests were bright in colour (plates 2a and b).
- c. Unripe gonads: The ovaries had numerous oogonia cells and few developing oocytes. The unripe ovaries were of dark green coloration. The tubules of the unripe tests were filled with numerous spermatogonia, spermatocytes and spermatids. There were no spermatozoa in the lumen. The unripe tests were yellowish green in colour (plates 3a and b).
- d. Recently spawned or maturing gonads: The ovaries are pale and empty. Tubules measured about 35 micrometers in diameter and contain varying number of ripe but unspawned eggs. Ovaries were light green in colour. A few spermatozoa were found in the lumen of the tubule while spermatocytes and few spermatids were located on or near the germinal epithelium. These recently spawned tests had a dark brownish orange coloration (plates 4a and b).



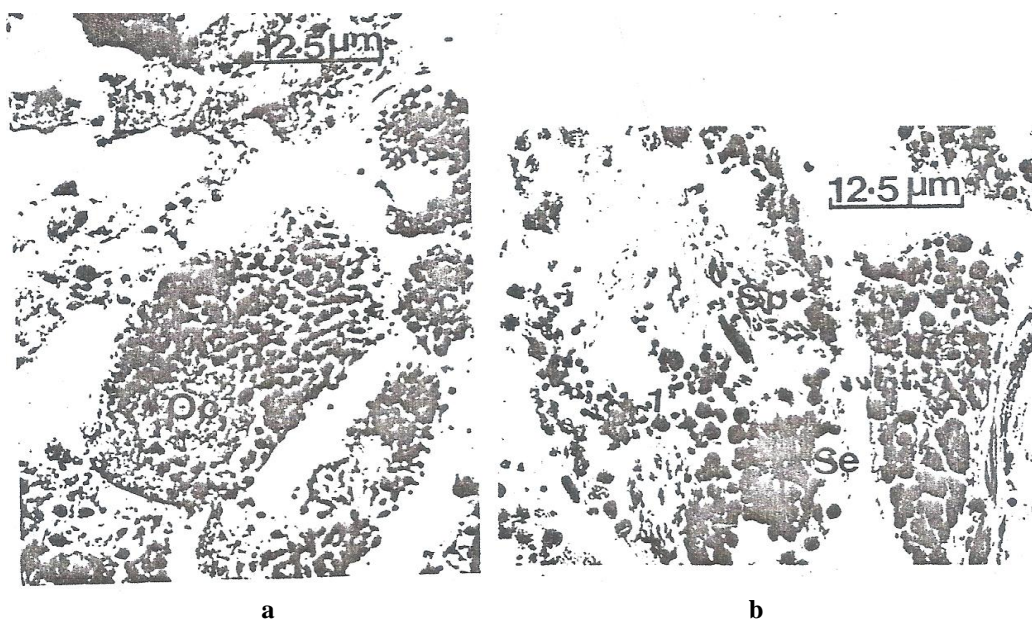
Plates 1a and b: Cross section through a ripe ovary and testis of *Tympanotonus fuscatus* var *fuscatus*



Plates 2a and b: Cross section through a spawning ovary and testis of *Tympanotonus fuscatus* var *fuscatus*



Plates 3a and b: Cross section through an unripe ovary and testis of *Tympanotonus fuscatus* var *fuscatus*



Plates 4a and b: Cross section through a recently spawned ovary and testis *Tympanotonus fuscatus* var *fuscatus*

DISCUSSION

The sex ratio in this study showed females as being dominant to the males. The trend was observed for the entire population for both years as well as in the different seasons. The ratios however, varied with the seasons and maturity stages. Egonmwan (1980) observed a similar sex ratio of 1:1.62 in *T. fuscatus* in the mangrove swamps of the Lagos lagoon. The trend of more females than males was also reported in *Pachymelania aurita* in the Lagos lagoon (Ajao and Fagade, 1990). Egonmwan (2007) reported a similar trend for *Pachymelania fusca* var *quadriseriata* in the mangrove swamps of Lagos lagoon. *T. fuscatus* breeds between October and January end of rainy season and beginning of dry season. The non-productive season starts in February and extends to June. The spawn of *T. fuscatus* is similar to those described for some *Cerithium* species by Houbrick (1973). The breeding period which is restricted to October and January could be as a result of increase in salinity and the flow of the water current experienced during the dry season. The salinity of the water during the study was 11.8 mg/l in October and 18.7 mg/l in January. Therefore, salinity and flow characteristics play an important

role in gametogenesis as reported by Egonmwan, (1980).

Various authors have investigated the effect of environmental factors and internal mechanism on the initiation of gametogenesis in mollusks. Loosanoff (1937) demonstrated that some exogenous factors such as temperature control gametogenesis in adult clam, *Venus mercenaria*. Smith and Carefoot (1967) reported that temperature also stimulate gonadal development in *Aplysia punctata*. These various authors worked on temperate species hence there was great fluctuation in temperature. During this investigation temperature was near constant, between 27.0 and 30.0 °C, hence temperature cannot be a controlling factor in the gonadal development of *T. fuscatus* var *fuscatus*.

CONCLUSION

Gonadal development was found to commence towards the end of the rainy season in *T. fuscatus* var *fuscatus*. *T. fuscatus* var *fuscatus* is dioecious, sex is only determined by the appearance and colour of the gonad. Sex ratio indicated female dominance over the male and spawning occurs from October to April. Environmental factors and internal mechanism influence the initiation of gametogenesis of *T. fuscatus* var *fuscatus*.

REFERENCES

- Ajao, E. A. and Fagade, S. O. (1990). The distribution and abundance of *Pachymelania aurita* in Lagos lagoon, Nigeria. *Arch. Hydrobiologia*. 119 (4): 475 – 488.
- Dangana, L. B. (1985). Hydrogeomorphological controls of the mangrove environment. In: The mangrove ecosystem of the Niger Delta. Proceedings of a workshop. University of Port Harcourt. 357p.
- Egonmwan, R. I. (1980). On the biology of *Tympanotonus fuscatus* var *radula* (Gastropoda: Prosobranchia: Potamididae). Proceedings of the 8th International Malacological Congress, Budapest.
- Egonmwan, R. I. and Odiete, W. O. (1983). The seasonal gonadal charges, spawning and early development of *Tympanotonus fuscatus*. *Journal of Molluscan Studies*, Supplement 13A. 43-46.
- Egonmwan, R. I. (2007). Reproductive cycle of the Mangrove Prosobranch, *Pachymelania fusca* (Gray) (Gastropoda: Melaniidae) in Lagos, Nigeria. *Pakistan Journal of Biological Science*, 10: 649-653.
- Frazen, A. (1956). Comparative morphological investigations into spermiogenesis among molluscs. *Physiology and Zoology* . 30, 399-456.
- Houbrick, J. R. (1973). Studies on the reproductive biology of the genus *Cerithium*, (*Gastropoda prosobranchia*). In the western Atlantic. *Bulletin of Marine Science*. 23. (4). 875-904.
- Jamabo, N. A. (2007). Ecology of *Tympanotonus fuscatus* var *fuscatus* (Linnaeus, 1758) in the mangrove swamps of the upper Bonny River, Niger Delta, Nigeria. PhD Thesis in Aquaculture, Rivers State University of Science and Technology Port Harcourt. 231pp.
- Loosanoff, V. L. (1937). Seasonal gonadal changes of adult clams, *Venus mercenaria* (L). *Biological Bulletin*. 72, 406-416. SAS 2001, Statistical Analysis System. User's Guide. SAS/STAT version, 8th edition, SAS. Institute, Inc. Cary, N. C, U. S. A.
- NEDECO (1961). The waters of the Niger Delta: Reports of an investigation by NEDECO (Netherlands engineering consultants). The Hague.
- SAS (2001). Statistical Analysis System. User's Guide. SAS/STAT version, 8th edition, SAS. Institute, Inc. Cary, N. C, U. S. A.
- Smith, S. T. and Carefoot, T. H. (1967). Induced maturation of gonads in *Aplysia punctata*. *Nature, London*. 215, 652-653.
- Steadman, H. F. (1960). *Section cutting in microscopy*. Blackwell: Oxford.