



Reproductive Biology of the Blue Crab, *Callinectes amnicola* (De Rocheburne) in the Lagos Lagoon, Nigeria

Aderonke Omolara Lawal-Are^{1,*}

¹ University of Lagos, Faculty of Science, Department of Marine Sciences, Lagos, Nigeria.

* Corresponding Author: Tel.: +234.803 302 0 969; Fax: +234.187 815 55;
E-mail: aolawalare@gmail.com

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Abstract

Sex ratio, fecundity, maturation development and oogenesis of *Callinectes amnicola* (De Rocheburne) in the Lagos Lagoon, Nigeria were investigated. The male/female ratio was 1:0.96. Fecundity estimates ranged between 478,400 and 4,480,500 eggs with a mean of 780,480 eggs. The diameter of the eggs varied between 0.25 and 0.35 mm with a mean of eggs 0.29 mm. A low positive correlation existed between fecundity and weight ($r = 0.247$) of the crab. Maturity was attained between 6.2 and 16.5 cm carapace width (CW) for the females and between 7.3 and 15.3 cm CW for the males. Fifty percent maturity (TL_{50}) was attained at 10.8 cm CW in the males and 11.0 cm CW in the females. Five maturity stages of gonads were identified. Three major developmental stages of oocytes were observed. Immature and mature crabs were obtained in the lagoon throughout the year indicating that this species breeds throughout the year with a peak between March and June.

Keywords: sex ratio, fecundity, gonadal stages, histology.

Lagos Lagünündeki (Nijerya) Mavi Yengeçlerin, *Callinectes amnicola* (De Rocheburne) Üreme Biyolojisi

Özet

Nijerya'nın Lagos Gölü'ndeki *Callinectes amnicola*'nın (De Rocheburne) cinsiyet oranı, fakondite, olgunlaşma gelişimi ve oogenezi araştırılmıştır. Erkek/dişi oranı 1:0,96'dır. Fekondite, 478.400 ile 4.480.500 yumurta arasında tahmin edilmiş olup ortalama, 780.480 yumurtdır. Yumurtaların çapı 0,25 ile 0,35 mm arasında değişmektedir ve ortalama çap 0,29 mm'dir. Yengecin fekonditesi ve ağırlığı ($r = 0,247$) arasında düşük pozitif korelasyon görülmüştür. Olgunluk, dişiler için 6,2 ve 16,5 cm karapas genişliği arasında elde edilmiş olup, bu değer erkekler için 7,3 ve 15,3 cm karapas genişliğindedir. Yüzde elli olgunluk (TL_{50}) erkeklerde 10,8 cm, dişilerde ise 11,0 cm karapas genişliğinde elde edilmiştir. Gonadlar için beş olgunluk aşaması tespit edilmiştir. Oositler için üç temel gelişimsel aşama gözlenmiştir. Olgun ve olgunlaşmamış yengeçler yıl boyunca gölden elde edilmiş ve böylelikle bu türün mart ve haziran arasında pik yaparak ürediğine işaret etmiştir.

Anahtar Kelimeler: cinsiyet oranı, fekondite, gonat gelişimi, histoloji.

Introduction

The blue crab, *Callinectes amnicola* occurs commonly in the Lagos Lagoon, an estuarine environment, and it is a very important food organism caught in the coast (inshore fishery) and lagoons in West Africa.

The biology of the genus in West Africa is restricted to the work of Kwei (1978) on the growth pattern and maturity in two Ghanaian Lagoons, Chindah *et al.* (2000) on the food habits in the New Calabar River and Lawal-Are and Kusemiju (2000) on its size composition, growth and feeding habits.

There appears to be no published work on the reproductive biology of the genus in Nigerian waters. This paper is an attempt to provide this information. In particular, aspects of sex ratio, fecundity, gonadal stages and histology were investigated.

Materials and Methods

The study was carried out between May 2003 and October 2004 in the Lagos Lagoon, which is located between latitudes 6°26' N and 6°39' N and longitudes 3°29' E and 3°50' E (Figure 1). Bi-monthly samples of *Callinectes amnicola* were collected in the

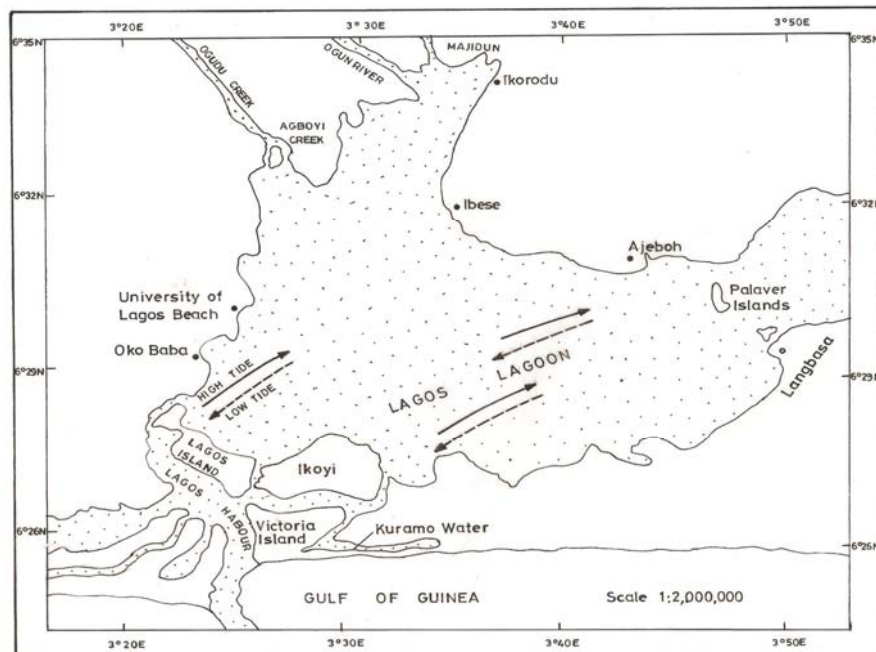


Figure 1. Map of Lagos Lagoon.

lagoon from fisherfolks who were mainly women. The fishing was done using circular liftnets as described by Nedelec (1982) and Solarin *et al.* (2003). The circular liftnets of 51-76 mm mesh size were dropped one after the other at about 3.0-5.0 m apart in the shallow lagoon (1.5-2.5 m depth), allowed to stay at the bottom and were lifted out of water at intervals of 10-20 minutes. The liftnets were baited mainly with gobies, cut pieces of fish or chicken / gut of chicken.

Selection of the crabs was done randomly as they were being brought out from the liftnets. The crabs were immediately preserved in an ice-chest with ice-blocks and later transferred into a deep freezer (-20°C) in the laboratory prior to analysis. A total of 1543 crabs were studied. Sex was determined using the method described by Kwei (1978).

The carapace length (CL) of the crab was measured from the edge of the frontal region near the eye to the base of the carapace backwall with a 0.05 cm precision Vernier caliper, while the carapace width (CW) with spine was taken from the tip of the left dorsal spine to the tip of the right dorsal spine and recorded to the nearest tenth of a centimeter. The total weight (Wt) and gonad weight of the crabs were taken to the nearest tenth of a gram. Macroscopic maturity stages were determined for each specimen.

Gonads of immature, developing, ripe female and male crabs were taken for histological study. The histological preparations were made as described by Ezenwa and Kusemiju (1985). For the fecundity, 126 fecund *C. amnicola* were examined. The eggs carried underside of the abdomen of the females were examined under the binocular microscope while still attached to the pleopods. Fecundity was estimated by

the gravimetric method (Bagenal, 1978; Kwei, 1978). The egg diameter was measured using a calibrated eyepiece micrometer. The relationship between weight and fecundity of the crabs was expressed as (Parsons, 1988):

$$\text{Log Fecundity} = \text{Log } a + b (\text{Log } Wt)$$

The gonadosomatic index (GSI) was calculated using the formula (Bagenal, 1978):

$$\text{GSI} = (\text{GW}_t / \text{TW}_t - \text{GW}_i) * 100$$

Where GWt = gonad weight, TWt = crab weight

Results

Sex Ratio

Of the 1417 crabs with observable gonads collected from the lagoon, 722 were males and 695 were females giving a sex ratio of 1:0.96. A Chi-square (χ^2) test indicated that this ratio was not significantly ($P < 0.05$) different from the expected 1:1 ratio. The monthly variation in sex ratio is shown in Table 1. Females were significantly more abundant than males in the dry months of March, May and August and early month of the rainy season in September.

Fecundity

The carapace width of the crab specimens used for the fecundity estimate ranged between 8.1 and 15.9 cm (CL 3.5-7.0 cm) and weighed 61.5-230.8 g.

Table 1. Monthly variation in sex ratio in *Callinectes amnicola* from Lagos Lagoon

Month/Year	No Examined		Sex Ratio (M / F)	Chi- square (χ^2)
	Male	Female		
May- 2003	33	65	1 / 1.97	10.45*
June	50	64	1 / 1.28	1.72
July	37	24	1 / 0.65	2.77
August	66	30	1 / 0.45	13.50*
September	54	27	1 / 0.50	9.00*
October	21	19	1 / 0.90	0.10
November	12	8	1 / 0.67	0.80
December	16	10	1 / 0.63	1.38
January- 2004	96	88	1 / 0.92	0.35
February	55	48	1 / 0.87	0.48
March	64	105	1 / 1.64	9.95*
April	57	71	1 / 1.25	1.53
May	39	43	1 / 1.10	0.20
June	28	18	1 / 0.64	2.17
July	20	20	1 / 1.00	0.00
August	13	17	1 / 1.31	0.53
September	24	15	1 / 0.63	2.08
October	37	23	1 / 0.62	3.27
TOTAL	722	695	1 / 0.96	0.51

*Significant (1df, 5%)

The fecundity ranged from 478,400 to 4,480,500 eggs. The average fecundity was 780,480 eggs. The diameter of the eggs ranged from 0.25 mm to 0.35 mm with a mean of 0.29 mm.

The fecundity – size relationship is illustrated in Figure 2. The relationship between fecundity and crab weight was:

$$\text{Log Fecundity} = 2.857 + 1.536 \text{ Log Wt} \\ (n = 126, r^2 = 0.247, P \leq 0.05).$$

Size at Maturity (TL₅₀)

Maturity was attained in the species between 6.2 and 16.5 cm CW for the females and between 7.3 and 15.3 cm CW for the males. Fifty percent maturity was attained at 10.8 cm CW in males and 11.0 cm CW in females (Figure 3).

Gonadosomatic Index (GSI)

The GSI values for the 126 specimens of *C. amnicola* ranged from 4.34 to 23.10% with a mean of 11.58%. This indicated that *C. amnicola* on the average used 11.58% of its body weight for egg production.

Gonadal Stages and Morphology

In the female crab, the egg has various colours ranging from yellow to orange and black depending on the stage of maturity. Immature and developing testis has colour and shape ranging from pairs of white to creamy white spiral strand structures.

Five maturity stages were identified: Stage I –

Immature (Figure 4A), Stage II – Developing (Figure 4A), Stage III – Ripening (Figure 4B), Stage IV – Ripe (Figure 4C), Stage V – berried female (Figure 4D).

The monthly percentage occurrences of gonadal stages are shown in Table 2. The juvenile crabs (Stage I) were predominant in the lagoon throughout the year, while the ripe males and females (Stage IV) also occurred throughout the year.

Gonad Histology

The stages of gonadal development were similar to those described by Marcus and Kusemiju (1984). The various stages of egg development on receptacle of pleopod of fecund *C. amnicola* are shown in Figure 5, while the stages of gonadal development of female *C. amnicola* are shown in Figure 6 and Figure 7. In the female crabs, the immature (Stage I) and developing (Stage II) were characterized by the presence of primary vitellogenic oocytes. The growth of the follicle and subsequent changes that took place led to yolk formation (Stage III) and deposition (vitellogenesis). The oogonia and oocytes increased in size as they matured. The mature eggs (Stage IV) have prominent nuclei with tertiary vitellogenic oocytes. Three major developmental stages of oocytes were observed; these were primary oocytes, secondary oocyte and tertiary vitellogenic oocyte.

In the male crabs, immature (Stage I) and developing (Stage II) as shown in Figure 8, there is the presence of thick testicular wall, primary and secondary spermatocyte with septa. The ripening stage- Stage III had spermatozoa, tertiary spermatocyte and peritoneum (Figure 9), while the

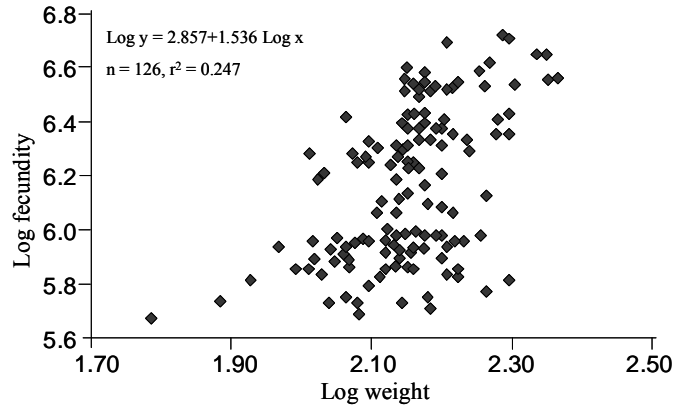


Figure 2. Log weight / Log fecundity relationship of *C. amnicola* from Lagos Lagoon.

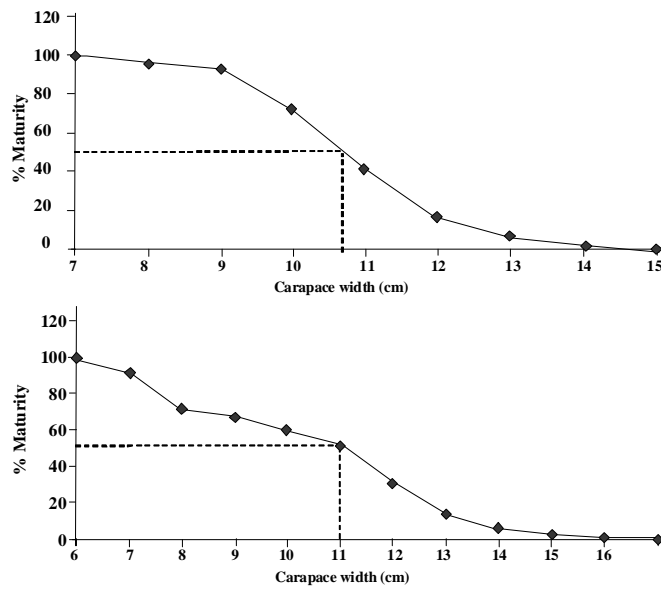


Figure 3. Maturity in (a) male, (b) female *C. amnicola*.

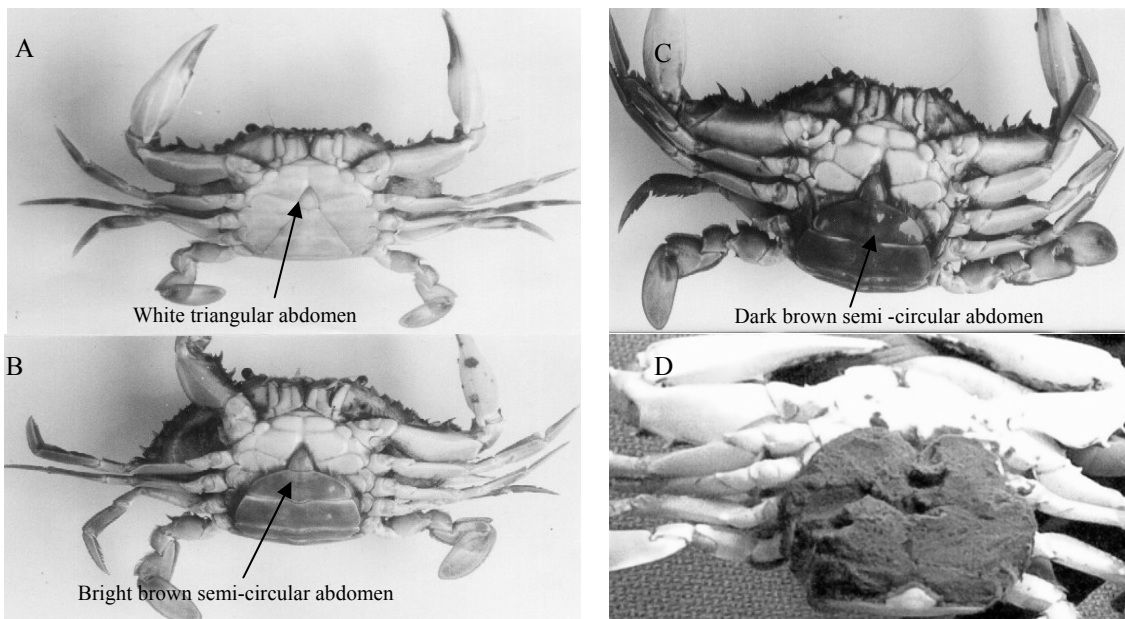
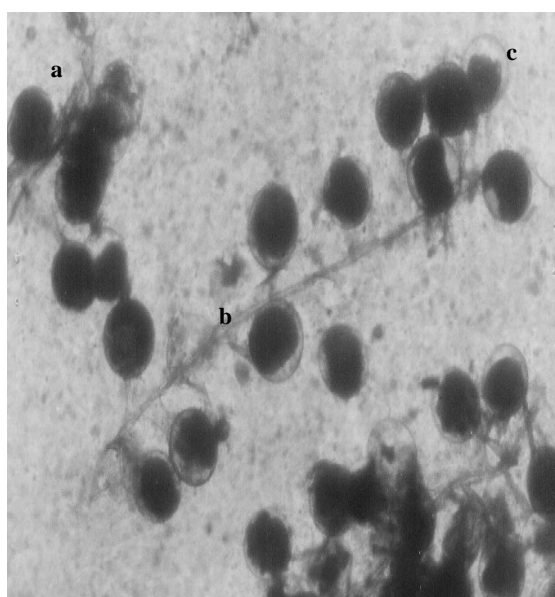


Figure 4. The ventral view of Female *C. amnicola* (Mg: X4).

Table 2. Percentage occurrence of gonadal stages in *C. Amnicola*

Month / Year	Male						Female					
	No of Crabs	Immature	Developing	Ripening	Ripe	Spent	No of Crabs	Immature	Developing	Ripening	Ripe	Spent
May- 2003	33	81.8	3.0	0.0	15.2	0.0	65	63.1	3.1	0.0	33.8	0.0
June	50	58.0	10.0	2.0	28.0	2.0	64	37.5	4.7	0.0	54.7	3.1
July	37	25.8	10.6	10.6	9.1	0.0	24	70.8	12.5	12.5	4.2	0.0
August	66	74.1	14.8	18.5	11.1	3.7	30	63.3	6.7	3.3	20.0	6.7
September	54	40.7	18.5	29.6	11.1	0.0	27	66.7	33.3	0.0	0.0	0.0
October	21	90.5	4.8	0.0	4.8	0.0	19	89.5	10.5	0.0	0.0	0.0
November	12	75.0	8.3	0.0	8.3	8.3	8	62.5	37.5	0.0	0.0	0.0
December	16	25.0	37.5	31.3	6.3	0.0	10	30.0	70.0	0.0	0.0	0.0
January- 2004	96	91.7	7.3	1.0	0.0	0.0	88	83.0	17.0	0.0	0.0	0.0
February	55	72.7	1.8	9.1	14.5	1.8	48	89.6	10.4	0.0	0.0	0.0
March	64	42.2	26.6	7.8	23.4	0.0	105	37.1	13.3	1.0	48.6	0.0
April	57	68.4	17.5	7.0	7.0	0.0	71	94.4	4.2	1.4	0.0	0.0
May	39	53.8	15.4	17.9	12.8	0.0	43	41.9	32.6	7.0	18.6	0.0
June	28	50.0	14.3	7.1	25.0	3.6	18	50.0	16.7	0.0	33.3	0.0
July	20	30.0	15.0	20.0	35.0	0.0	20	20.0	5.0	0.0	75.0	0.0
August	13	15.4	30.8	23.1	30.8	0.0	17	64.7	5.9	17.6	11.8	0.0
September	24	54.2	8.3	8.3	29.2	0.0	15	86.7	0.0	6.7	6.7	0.0
October	37	59.5	27.0	10.8	2.7	0.0	23	52.2	43.5	0.0	4.3	0.0

**Figure 5.** Stages of egg development still attached to the receptacle of the pleopod of fecund *C. amnicola* (Mg – 1000 μ m) (a- immature egg, b- developing egg, c- ripe egg).

ripe and spent stage have little spermatozoa, spermatids, and empty spaces.

Discussion

Sex ratio in a majority of species is close to unity, despite some variations between populations of a species, and from year to year in the same population (Nikolsky, 1963; Ofori-Danson, 1990).

The overall sex ratio in *Callinectes amnicola* did not differ significantly from the expected 1:1 ratio. Most of the months with higher occurrences of female crabs were within the peak spawning period.

The high variation of fecundity within *C. amnicola* (478,400-4,480,500 eggs) was similar to results obtained by Kwei (1978). Reported a total of 1.9-2.82 million eggs in fecund female crabs, *C. latimanus* from two Ghanaian Lagoons. Van-

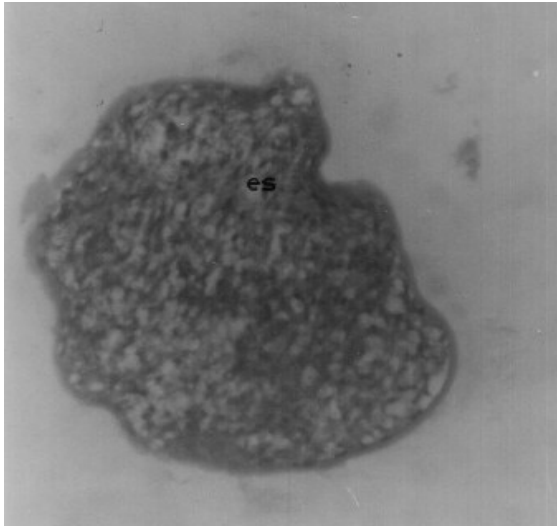


Figure 6. Section through an ovary of *C. amnicola* in the immature stage (Mg – 1000 μ m). (es – empty space, y – yolk).

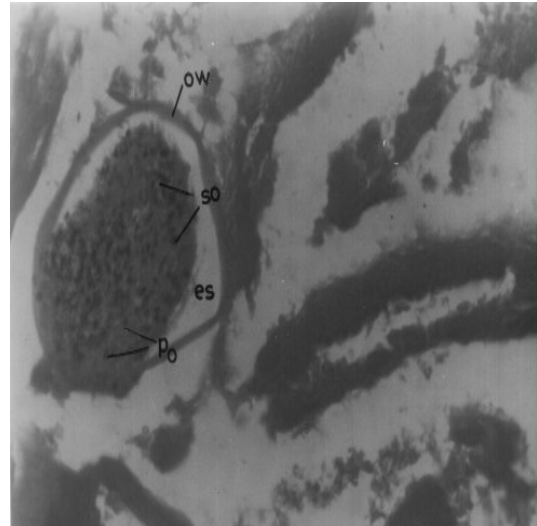


Figure 7. Section through an ovary of *C. amnicola* in the ripening stage (Mg – 1000 μ m). (ow – thick ovarian wall, so – secondary oocytes, es – empty space, po – primary oocyte).

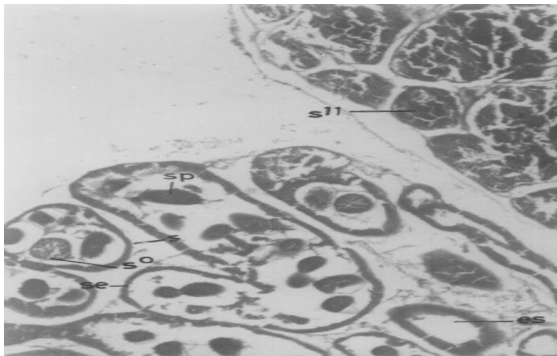


Figure 8. Section through the testis of *C. amnicola* in the immature stage (Mg – 1000 μ m). (s11 – tertiary spermatocyte, so – secondary spermatocyte, sp – spermatozoa, se – septum).

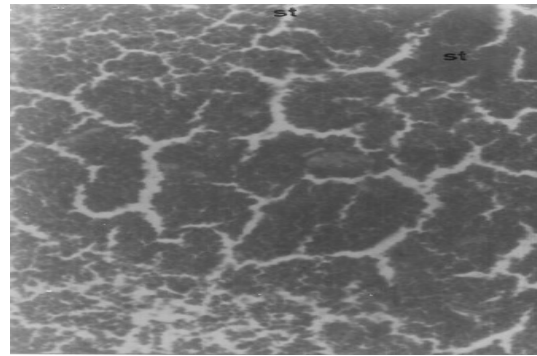


Figure 9. Section through a testis of *C. amnicola* in the ripening stage (Mg – 1000 μ m). (st – spermatids).

Monfrans *et al.* (1995) reported fecundity of 1.75 to 2.0 million eggs for blue crabs from western Atlantic estuaries. A mean fecundity of 3.2 million eggs was documented by Guillory *et al.* (1996) for blue crabs, *C. sapidus*. Shields *et al.* (1990) noted variations in fecundity amongst brachyuran crabs may be caused by many factors including climatic regimes, habitat and biological constraints.

The measurement of the egg diameter showed variations in egg sizes. The diameter ranged from 0.25 to 0.35 mm with a mean of 0.29 mm. According to Millikin (1979), the eggs of the blue crabs are about 0.25 mm in diameter.

There was a low correlation between fecundity and carapace width in this species. Strong size-fecundity relationships are found in brachyuran families (Hines, 1982; Hartnoll, 1985) this may generally not be a rule as fecundity was not correlated with weight in a few *Cancer* species documented by

Shield (1992) while *Cancer magister* had correlation coefficient (r) = 0.245 (Hankin *et al.*, 1985)

Sexual maturity was attained in *C. amnicola* between 6.2 and 16.5 cm CW. Portunid crabs attain maturity at highly variable sizes. Some species attain maturity at a minimum size of about 90 mm carapace width (e.g. *Cancer anthonyi*, *C. magister* and *C. pagurus*) while maturity has been achieved in *C. gracilis* at 54 mm CW (Shields, 1992). Individual crabs mature at different rates and sizes at which 50% of the population matures (TL_{50}) is often used as when crabs are considered adults (Campbell and Eagle, 1983; Shields, 1992)

Various stages of egg development were found attached to the receptacle of the pleopod of fecund female at the same time. According to Guillory *et al.* (1996), eggs are fertilized as they pass through the spermatheca and are attached to the receptacle of the pleopod of the fecund crabs, developing

independently as the female crabs move to spawn at higher salinity. According to Guillory and Hein (1997), the colour change is caused by absorption of the yellow yolk and development of dark pigment in the eggs and on the body of the embryos. The stages of maturation were similar to those described by Guillory and Hein (1997).

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