Some biological aspects of the portunid crab *Charybdis natator* from the Gulf of Suez, Red sea

Wafaa S. Sallam [1] and Ali A. Gab-Alla [2]

1- Department of Marine Science, Suez Canal University, Ismailia, 41522, Egypt.

2- Biology Department, Faculty of Science, Um Al Qura University, Makkah Al Mukarramah, Kingdom of Saudi Arabia.

Email: address: wafaasallam@yahoo.com,

Email: aligaballa2000@yahoo.com

ABSTRACT

The population of the portunid crab *Charybdis natator* in the Gulf of Suez, Red Sea was studied by monthly sampling from September 2007 to May 2008. Crabs were sexed, measured and berried females recorded. A total of 498 individuals were obtained, of which 232 (46.6%) were males, 212 non-ovigerous females (42.5%), and 54 (10.9%) ovigerous females. The overall sex ratio (M:F) was (1:1.1) and females outnumbered females during September-November. The population showed sex differences in the size frequency distributions, with males reaching larger size than females (70-148.4mm and 47.5-130.5mm CW, respectively). Ovigerous females existed all year round and ranged in size between 83-118.4mm CW. Fecundity ranged from 45230 to 335529 eggs per female and was positively correlated with body size. The effectiveness of the closed season that runs in the Gulf of Suez on the population of *C. natator* was discussed.

Keywords: *Charybdis natator*, portunid crab, Red Sea.

INTRODUCTION

The portunid crab *Charybdis natator* (Herbst, 1789) is a widespread Indo- West Pacific species. It is distributed along East Africa, Madagascar, Red Sea, India, China, Japan, Philippines, Thailand, Malaysia, Singapore, Indonesia and Australia (Stephenson *et al*., 1958; Dai *et al*., 1986; Dai & Yang, 1991). Although not supporting a large fishery in any area of its range, it contributes to crab fisheries in India (Menon, 1952), Australia (Sumpton, 1990a) and Taiwan (Lui *et al*., 2007). In these areas the more common blue crab, *Portunus pelagicus* (Linneaus, 1758) and mud crab, *Scylla serrata* (Forskåll, 1775) are more commercially important (Sumpton, 1990a). In the Egyptian waters of the Mediterranean, the biology of *P. pelagicus* has been extensively studied (Al-Kholy and El-Hawary, 1970; Abdel- Razek, 1988; Bawab and El-Sherif, 1988) as well as in the Red Sea (Zaghloul, 2003) and other parts of the world (Batoy *et al.,* 1987, 1988, Kangas, 2000, Wang *et al.,* 2001). Similarly, the biology of

Scylla serrata has also been well documented (Hill, 1980; Hill *et al.*, 1982, Hyland *et al.*, 1984; Heasman *et al.*, 1985).

On the other hand, little is known on the biology and life history of *C. natator*. Sumpton (1990 a, b) studied the reproductive biology and fisheries of this species in Moreton Bay, Australia while Islam *et al.* (2000) described the development of larvae reared in the laboratory. In the northern coasts of the Red Sea, this crab exists in the catches of trawlers operating in the Gulf of Suez and supports a small fishery. The fished quantities are introduced to the markets of Suez city together with the commercial species *P. pelagicus* but receive little attention from consumers (Sallam and Gab-Alla, 2009). Despite the closed season that runs from June to August in the Gulf of Suez region, samples of *Charybdis natator* were obtained during the remaining months of the year. This enabled the documentation of features of this species' population in the gulf including sex ratios, spawning season, biometric relationships and fecundity of the females. This paper presents these data and compares the biology of *C. natator* with other portunids.

MATERIALS AND METHODS

Samples collection and processing:

Trawlers depart El-Ataka Port at Suez heading towards the Gulf of Suez. Three fishing trips are made monthly, each lasting between 4-10 days. Fishing operations commence in the area opposite to Ras Ghareb Port. Trawling takes place at a depth ranging between 110-130 m. From September 2007 to May 2008, monthly visits were paid to the landing site at El-Ataka Port. Samples of *Charybdis natator* were obtained from the catches of the trawling vessels. Crabs were sexed, weighed on an electric balance (±1g) and their carapace width (CW) and length (CL) were measured to the nearest millimeter using a vernier caliper. The stage of ovarian maturation of females was examined and noted according to the colour of the ovaries (Chu, 1999). Four stages were recognized: stage I (immature), colourless; stage II (maturing), white to ivory; stage III (mature), yellow to yellowish orange; and stage IV (ripe), orange. Incidence of gravid females was also recorded. For the estimation of fecundity, a sub-sample of the incubated eggs was taken from ovigerous females, weighed and the number of eggs counted. The remaining eggs were removed from the pleopods and subsequently weighed on a sensitive balance (±0.001g) and the number of eggs calculated. Statistical analysis followed Zar (1984).

RESULTS

Population structure:

A total of 496 individuals of *C. natator* were obtained, of which 232 (46.8%) were males, 212 non-ovigerous females (42.7%), and 52 (10.5%) ovigerous females. Carapace width distributions of both sexes are shown in

Figure 1. The population shows sex differences in the size frequency distributions, with males reaching larger size than females (70 -148.4mm and 47.5-130.5mm CW, respectively). Males were on average (106.3 mm CW, n=232, SD = 19.6) larger than non-ovigerous females (99.3 mm CW n= 212, SD= 13.5) and ovigerous females (101.9 mm CW n= 54, SD = 10.9). All demographic categories were present except recruits. Small size groups (45-55, 55-65 mm CW) were predominantly constituted by females. A few number of females exceeded 130 mm, whereas several males were larger than this size. The range size class was 95-205 mm for males and 105-115mm for females. The overall sex ratio (Male: female) was (1:1.1) (fig. 2). Females outnumbered males throughout most of the year but there was a predominance of males during September-November. The ratio was insignificantly different from the expected 1:1 (X^2 = 2.06, P< 0.01).

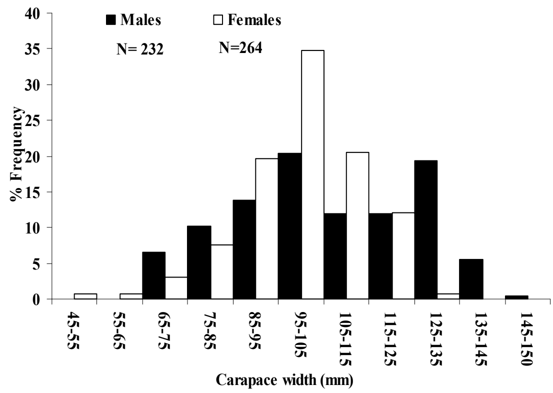

Fig. 1: Length frequency distribution of males and females *Charybdis natator*. N= number of individuals.

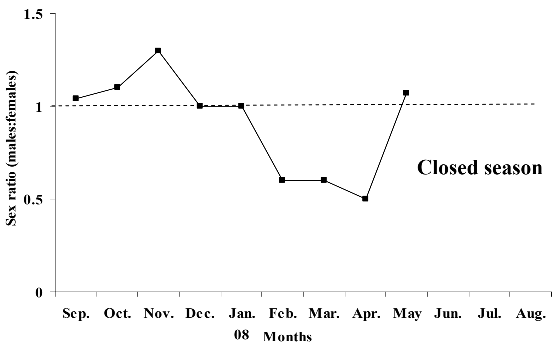

Fig. 2: Monthly variations in the sex ratio of *Charybdis natator* in the Gulf of Suez. Dotted line indicates ratio of 1:1 (males: females).

Biometric relationships:

The relationships between wet weight (WWT) and carapace width (CW) for males and females are given in figure 3. The regression equations obtained for these relationships were: ln WWT = 2.9771 ln CW – 8.2976 (r^2 = 0.89, *P* <0.05) for males and ln WWT = 3.064 ln CW – 8.9071 (r^2 = 0.79, P <0.05) for females. Analysis of covariance indicated significant differences in the equations of the two sexes (t= 7.187, P <0.05). Figure 4 displays the relationships between carapace width and carapace length (CL) for males and females. The regression equations obtained for these relationships were: CL = 0.6607CW + 1.3356 (r^2 = 0.97, P < 0.05) for males and: CL = 0.6451CW + 3.175 (r^2 = 0.98, *P* <0.05) for females. The analysis of covariance revealed that regression slopes differed significantly between the two sexes (*t*= 5.158, *P* <0.05).

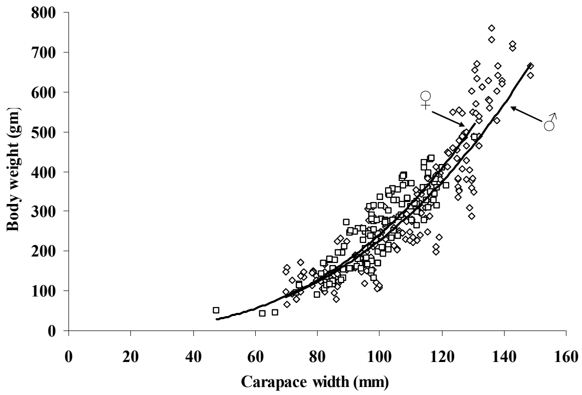

Fig. 3: Relationships between carapace width and total body weight for males and females *Charybdis natator*.

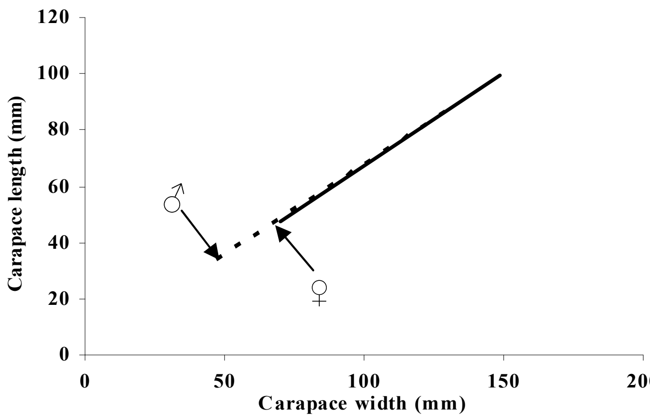

Fig. 4: Relationships between carapace width and length in males and females *Charybdis natator*. Dashed line for solid line for females

Seasonality of spawning:

Monthly variations of the different maturation stages of female *C. natator* are given in figure 5. A period of gonadal activity for females lasting from November 2007 to March 2008 was apparent during which maturing and mature females existed with high percentages. This was followed by a resting phase that apparently passes through the period of the closed season (April and May) where females with undeveloped immature ovaries had their highest percentages. Ovigerous females that had developing or mature ovaries were observed in almost all months but their percentage declined between November and February (Fig.6).

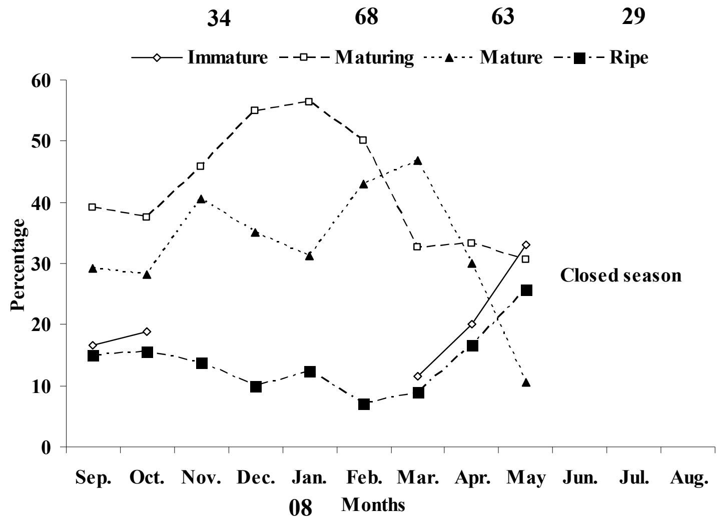

Fig. 5: Changes in the gonad condition of female *Charybdis natator* in respect to the different maturation stages. Numbers indicate females in each stage.

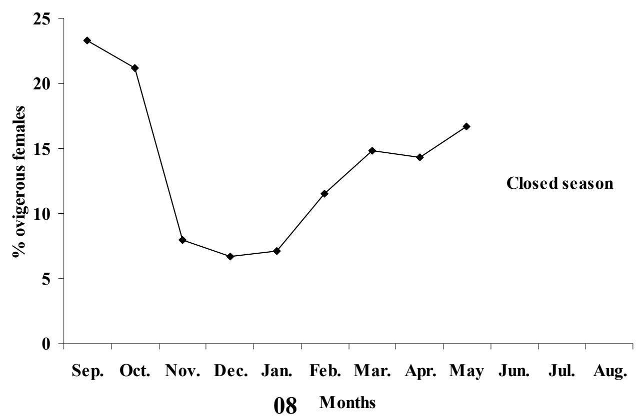

Fig. 6: Monthly variations in the percentages of ovigerous females *Charybdis natator* with developing or mature ovaries.

Size at sexual maturity:

Of the 264 female examined, 182 were sexually mature. The relationship between carapace width (CW) and the proportion of mature female (*P*) by 10 mm size classes was calculated by fitting a logistic function to the size specific maturity data for females as follows :

$$P = \frac{1}{(1 + e^{(3.1825 - 0.0435CW)})} \quad (r^2 = 0.8, P < 0.05)$$

From this, the estimated size for sexually mature females was 73.2 mm CW (Fig.7).

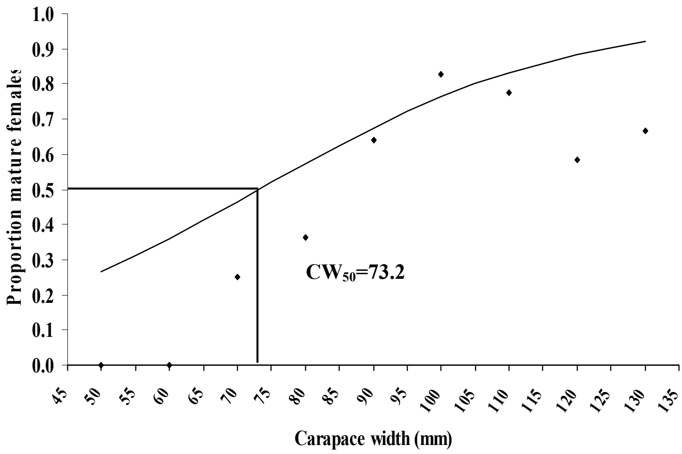

Fig. 7: Logistic function fitting proportion of mature female *C. natator* to carapace width. The value of CW_{50} which corresponds to a proportion of 0.5 is indicated.

Fecundity:

The estimated number of eggs in the egg masses of females ranging in size from 83-118.4mm CW was highly variable. Estimates ranged from 45230 eggs for 83 mm carapace width female to 335529 eggs for a female with a carapace width of 118.4mm. The relationship between fecundity and carapace width was: Log numbers of eggs = 5.3962 log CW - 12.815 (r^2 = 0.89, P< 0.05, N = 52) (Fig.8).

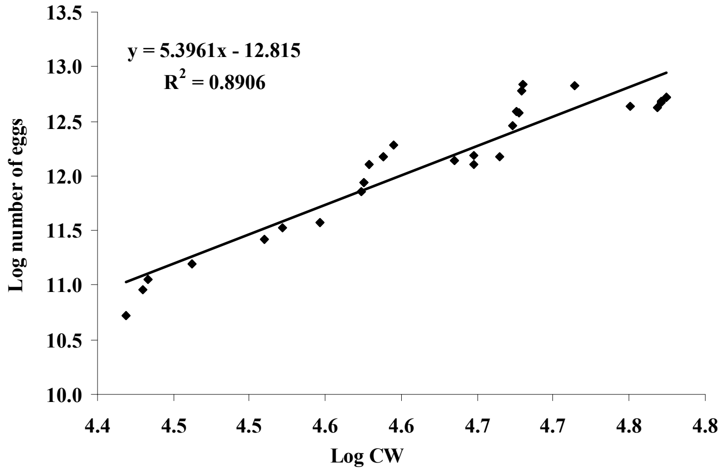

Fig. 8: Relationship between log carapace width and log batch fecundity of female *Charybdis natator*.

DISCUSSION

A wide range of size of the crab *Charybdis. natator* in the trawl fishery of the Gulf of Suez, varying between 47 and 148.5 mm CW, was recorded during the present study. This size range is slightly larger than that reported for *C. natator* in Moreton Bay, Australia (Sumpton, 1990b). The population supporting the Gulf of Suez fishery is exclusively constituted by large individuals and no juveniles were discernible. It is not certain as to whether the younger population of this species is not at all represented in the trawling grounds or they escape capture by the trawl nets while coexisting along with the adults. Padayatti (1990) reported absence of *C. feriatus* juveniles from the trawl fishery at Cochin and excluded the possibility of their existence in the same fishing grounds due to the presence of juveniles of other species in the catches. On the other hand, *C. natator* juveniles may not have a benthic life as in the case of most of the brachyuran crabs. This phenomenon has been recorded for the deep-water crab *C. smithii* in the Arabian Sea and Bay of Bengal (Balasubramanian & Suseelan, 2001). A survey of the crab landings by local gears which operate in the Suez Gulf might throw light on the availability of the juvenile population of this species.

Males *C. natator* reach a larger size than females as evidenced by the largest size class, 145-155 mm CW, consisting almost entirely of males. This result is in agreement with the general pattern of brachyuran crabs. Size difference between sexes has been observed in some *Charybdis* species

(Sumpton; 1990b; Padayatti, 1990; Balasubramanian & Suseelan, 2001) as well as other brachyuran crabs (Zaghloul, 2003, Bas, *et.al.*, 2005, Hirose & Negreiros- Fransozo, 2008, Hartnoll, 2009). Kuhlmann and Walker (1999) stated that size structure is often variable within a species and may be subjected to environmental influences. Resource availability has also been reported to affect the abundance and size structure of organisms as it influences growth, reproduction and survival (White, 1978). Hartnoll (1982) explained that in crabs generally, males reaching a larger size since females expend greater resources on reproduction, at the expense of growth.

The sex ratio of *C. natator* in the Gulf of Suez was biased toward females almost throughout the year, but males predominated between September and November when breeding was found to be commencing. A similar pattern has been reported for females *C. bimaculata* in Tokyo Bay (Doi *et.al*., 2008) which was attributed to reproduction-associated migration during the reproductive season. Silas (1969) noted exclusive mono-sexed catches of *C. smithii* in Cochin and indicated the existence of sexual segregation at least during some seasons. Sex ratio deviations in crab populations usually involve sexual differences in longevity (survival rate), migration, growth rate, and even sex reversal (Wenner, 1972).

The pattern of spawning of females indicates that *C. natator* from the Gulf of Suez spawn year round. There is a prolonged breeding season commencing from March and terminating in September. The occurrence of developing and mature ovaries in most ovigerous females suggests sequential broodings occur. The same trend has been observed for *Portunus pelagicus* inhabiting the same region (Zaghloul, 2003) and for other species of *Charybdis* in other parts of the world, *C. feriatus* in southwestern Indian waters (Pillay and Nair, 1973), and *C. bimaculata* in Tokyo Bay (Doi *et al*., 2008). However, *C. natator* in the subtropical waters in Moreton Bay, Queensland had two major spawning peaks and a low percentage of females with undeveloped gonads that indicated that this species did not spawn year round (Sumpton, 1990b). In Ubatuba Bay, Brazil, ovigerous *C. helleri* females were present throughout most of the year with a peak of spawning activity during winter. Pillay and Nair (1973) stated that breeding in tropical crustaceans extends for several months of the year, with pronounced activity during certain months. An extended breeding season may show that individuals of a species breed asynchronously, i.e., some are in the earlier stages of maturation while others are already spent (Giese, 1959).

Females attained sexual maturity at 73.2 mm CW. Balasubramanian and Suseelan (1998) recorded size at 50% maturity for females *C. smithii* at 48.7 whereas those of *C. bimaculata* matured at 14.6 mm (Doi *et al*., 2008). Among the environmental factors influencing size at maturity, water temperature (Somerton, 1981), photoperiod condition (Hines, 1989) combined with food resources for larval development (Mantelatto, 2000) are noteworthy. Body weight showed sexual dimorphism, increasing relatively faster in males, and this was probably associated with the enlargement of the male chelipeds as reported for other *Charybdis* species, *C. affinis* (Chu, 1999) and *C. bimaculata* (Doi *et al.,* 2008).

The estimated batch fecundity for *C. natator* in the study area was 45230- 335,529 eggs per batch for a range of carapace width of 83-118.4mm CW. This estimate was much smaller than that recorded for the same species in Moreton Bay (181,230- 976,248 (100-117 mm CW) (Sumpton, 1990b) but within the range reported for other *C. feriata* (52000- 310,000) (67-112.1 mm CW; Padayatti, 1990). The present results indicated a good linear relationship between body size and batch size. The comparatively lower batch fecundity of *C. natator* than other commercial portunids in Moreton bay was not related to the limited fishery of this species since interspecific competition, habitat and environmental parameters influenced the crabs' distribution and abundance (Sumpton, 1990b). Hence, the small population of *C. natator* supporting the trawl fishery in the Gulf of Suez is probably due to interspecific competition. Sumpton (1990a) reported that the presence of *C. natator* in a trap will reduce the subsequent existence of the more commercially important species *Portunus pelagicus*, due to agonistic interaction.

Closed seasons are often imposed during the breeding period of the targeted species in the belief that this will increase reproductive success. Closure of fishing during the breeding period is effective only for species that is prone to disturbance or aggregates to breed or when used as a means of reducing annual fishing mortality (Arendse *et.al,* 2007). Subsequently, the closed season that currently runs in the Gulf of Suez region is not necessarily effective in the case of *C. natator* population since females breed all year round, however, its application would generally improve the reproductive output of this species. This edible crab is regarded as a new resource to the gulf area (Sallam & Gab-Alla, 2009). Unless implications for conservation is considered, possible fishing pressure could be anticipated on this population considering the disappearance of large individuals by unregulated fishing. Further work will be necessary to the better understanding of the life history of this species which will be vital when passing regulations for the proper exploitation of this resource.

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