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SOME BIOLOGICAL ASPECTS AND DYNAMICS OF THE FIDDLER SHRIMP METAPENAEOPSIS STRIDULANS (ALCOCK, 1905) FROM THE GULF OF SUEZ

BY

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ABSTRACT

The fiddler shrimp Metapenaeopsis stridulans is caught from the Gulf of Suez by trawling. The sex ratio of males to females was computed as 1:1. The length frequency distributions of the fiddler shrimp were analyzed to estimate the population parameters. The estimated growth parameters were CL_∞ = 4.82 cm. (carapace length) and $K = 0.6\ y^{-1}$. Longevity of the species in the Gulf is estimated as 1.2 years. The obtained carapace length at first capture equals to 1.47 cm. The calculated total, natural and fishing mortality rates were $Z = 3.68\ y^{-1}$, $M = 1.912\ y^{-1}$ and $F = 1.77\ y^{-1}$ respectively. The corresponding exploitation ratio was estimated as E = 0.48. The results indicated that the present exploitation rate is nearly at its optimum exploitation.

INTRODUCTION

Penaeid prawns are considered as one of the most important marine living resources in the Gulf of Suez. They are fished by trawling within a depth of about 40-50 m. The prawn catch of the Gulf of Suez constitutes about 4.7% of the total trawl landings. The commercial catch of the prawn is sorted out by the fishermen into two categories according to size. The larger category comprises *Penaeus semisulcatus*, De Haan, 1850; *P. japonicus*, Bate, 1888 and *P. latisulcatus*, Kishinouye, 1900; while the smaller category comprises *Metapenaeopsis stridulans*, Alcock, 1905 and *Trachypenaeus curvirostris*, Stimpson, 1860.

Red Sea shrimp fisheries were studied by Al-kholy and El-Hawary (1970). In the Gulf of Suez, Yassien (1992) gave the essential biological and dynamics information for the penaeid species *Penaeus semisulcatus* and *P. latisulcatus*. Yassien *et al* (1993) studied the prawn fisheries of the Gulf of Suez. Also, Abdel-Razek *et al* (1993 and 1994) studied the reproduction of the two species *P. latisulcatus* and *P. japonicus*

1994) studied the reproduction of the two species *P. latisulcatus* and *P. japonicus* respectively. Abdel-Razek *et al* (1993) gave some biological aspects on *P. semisulcatus* and Bebars *et al* (1993) studied the growth of *P. latisulcatus* using length frequency analysis. Zaghloul (1995) investigated the reproduction of *P. japonicus* and *P. latisulcatus* in the same area.

According to the available literature, no studies on the fisheries biology or population dynamics of the smaller shrimp category in the Gulf of Suez were carried out, so this is the first attempt to throw light on some biological and population parameters of the fiddler shrimp *Metapenaeopsis stridulans*, Alcock 1905, in the Gulf of Suez to help in the maintenance of this stock.

MATERIALS AND METHODS

Monthly random samples of fiddler shrimp *Metapenaeopsis stridulans* were collected from the commercial landings at Attaka fishing harbor during 2000/2001. Each sample is separated according to the sex and the length frequency distribution of each sex is carried out. A total of 6556 individuals were measured for, total length (T.L), from the tip of the rostrum to the end of the telson to the nearest mm.; carapace length (C.L), from the tip of the rostrum to the posterior mid-dorsal edge of the carapace; ocular length (O.L), from the mid-dorsal line, opposite the posterior orbital margin to the nearest millimeter and total weight to the nearest 0.1 gm.

The stomachs of 150 females, ranging from 1.6 cm to 3.9 cm in (C.L), and 150 males, ranging from 1.9 cm to 3.6 cm in (C.L), were selected from the samples of the different months to examine in detail the nature of feeding. The stomachs were dissected and the contents were examined under a research microscope. The percentage composition of the constituents was determined by eye estimation. According to this method, the contents of each sample are considered to be unity, the various items being expressed in terms of percentage by volume as estimated by inspection.

The monthly length frequency distributions were analyzed by using the appropriate routines and subroutines of the FiSAT program (Gayanilo, Sparre & Pauly 1998). A preliminary estimate of the asymptotic length (L_∞) and the growth coefficient (K) were obtained through the method of Wetherall (1986). The resultant growth estimates were then used as seed values in ELEFAN I routine (Pauly, 1984) for estimation of the best combination of (L_∞ and K). The Phi-prime index Φ' (Munro and Pauly, 1983; Moreau *et al.* 1986) was used to estimate the growth performance of *Metapenaeopsis stridulans*.

The instantaneous rate of total mortality (Z) was derived from the length converted catch curve method described by Pauly (1983). The instantaneous rate of natural mortality (M) was computed from the empirical equation of Pauly (1980) considering the mean annual temperature of the Gulf of Suez as 22.2 °C (Yassien, 1998). The instantaneous rate of fishing mortality (F) was extracted as F = Z-M. The exploitation ratio (E) was calculated E = F/Z. Carapace length at first capture (L_c) was estimated using the plot of probability of capture (Pauly, 1984) incorporated in FiSAT software. The relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) were calculated according to the model of Beverton and Holt (1966) as modified by Pauly and Soriano (1986) .

RESULTS AND DISCUSSION

Catch analysis

The catch statistics of the small shrimp were obtained from the office of the General Authority for the Development of Fish Resources. This small shrimp category in the Gulf of Suez comprises the fiddler shrimp *Metapenaeopsis stridulans*, and the southern rough shrimp *Trachypenaeus curvirostris*. The total annual catch of the small shrimp from 1989/1990 to 2002/2003 (Fig. 1) fluctuated between a maximum catch of 127.35 tons in 1989/1990 fishing season and a minimum catch of 31.66 tons in 1998/1999. The mentioned total catch showed a tendency to oscillate from year to year. The average recorded catch in the last 7 years (from 1995 to 2002) was 74.46 tons and the average recorded catch of the previous seven years (from 1989 to 1994) was 55.91 tons with a decreasing percentage of 24.9%.

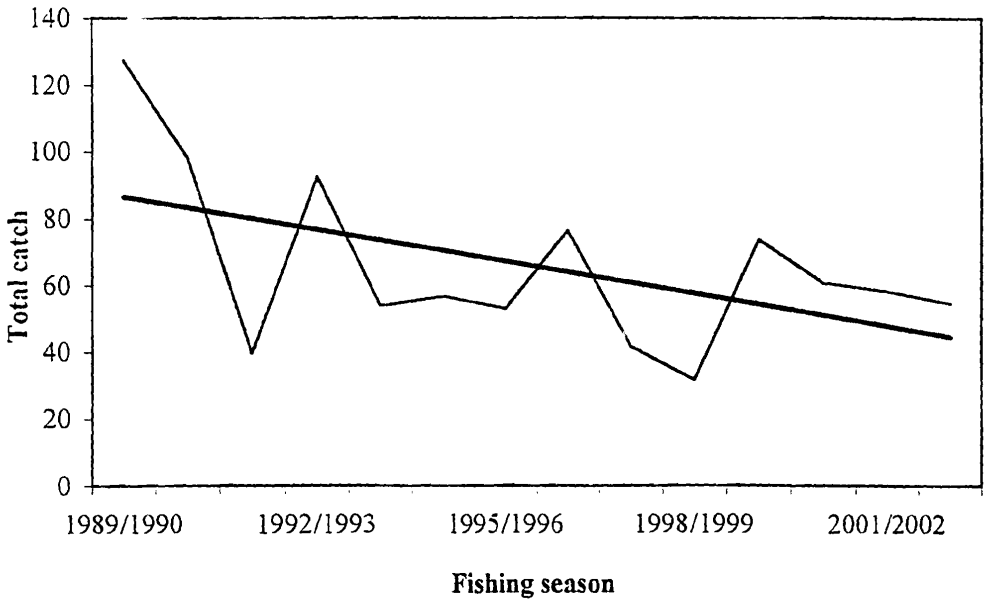

Fig. 1: Annaul total catch of the fiddler shrimp *Metapenaeopsis stridulans* from the Gulf of Suez .

Morphometric relationships

Several workers considered the total length as the most reliable measure of size in prawns (Hall, 1962), while others have been using carapace length (Garcia, 1985 and Garcia and Le Reste, 1981) in assessing growth and other characteristics. A series of morphometric relationships of *M. stridulans* were investigated for both sexes separately, these are total-length vs. total-weight, carapace-length vs. total-weight, total-length vs. carapace-length, ocular-length vs. total-weight and total-length vs. ocular-length (Fig. 2 and 3). Table (1) shows the constants (a and b) of the applied equations for each relationship. It can be seen that females reach bigger sizes and gains more weights than males. Yoo-Sook-Swat and Thubthimsang (1988) recorded the maximum sizes of the related species *M. palmensis* in Thailand as 10.5cm for females and 8.5 cm for males. De Bruin (1995) recorded the maximum size of both male and female *M. stridulans* about 8.0 cm and 9.0 cm respectively in Sri Lanka. These values are approximately the same as recorded in the present study.

Table 1 : Different morphometric relationships of the small shrimp *Metapenaeopsis stridulans*

Parameters	Relationship	Correlation coefficient r^2
Males		
Total length against total weight	$W = 0.006881\ L^{3.06891}$	0.9233
Carapace length against total weight	$W = 0.28478\ L^{2.679}$	0.9726
Total length against carapace length	CL = -0.6677 + 0.3438 TL	0.9379
Ocular length against total weight	$W = 1.3478\ L^{2.1106}$	0.7692
Total length against ocular length	OL = 0.6420 + 1.2147 TL	0.8605
Females		
Total length against total weight	$W = 0.00529\ L^{3.2019}$	0.9760
Carapace length against total weight	$W = 0.2622\ L^{2.6886}$	0.9654
Total length against carapace length	CL = -0.4084 + 0.3999 TL	0.9705
Ocular length against total weight	$W = 1.0332\ L^{2.5569}$	0.9558
Total length against ocular length	OL = -0.30648 + 0.2544 TL	0.9004

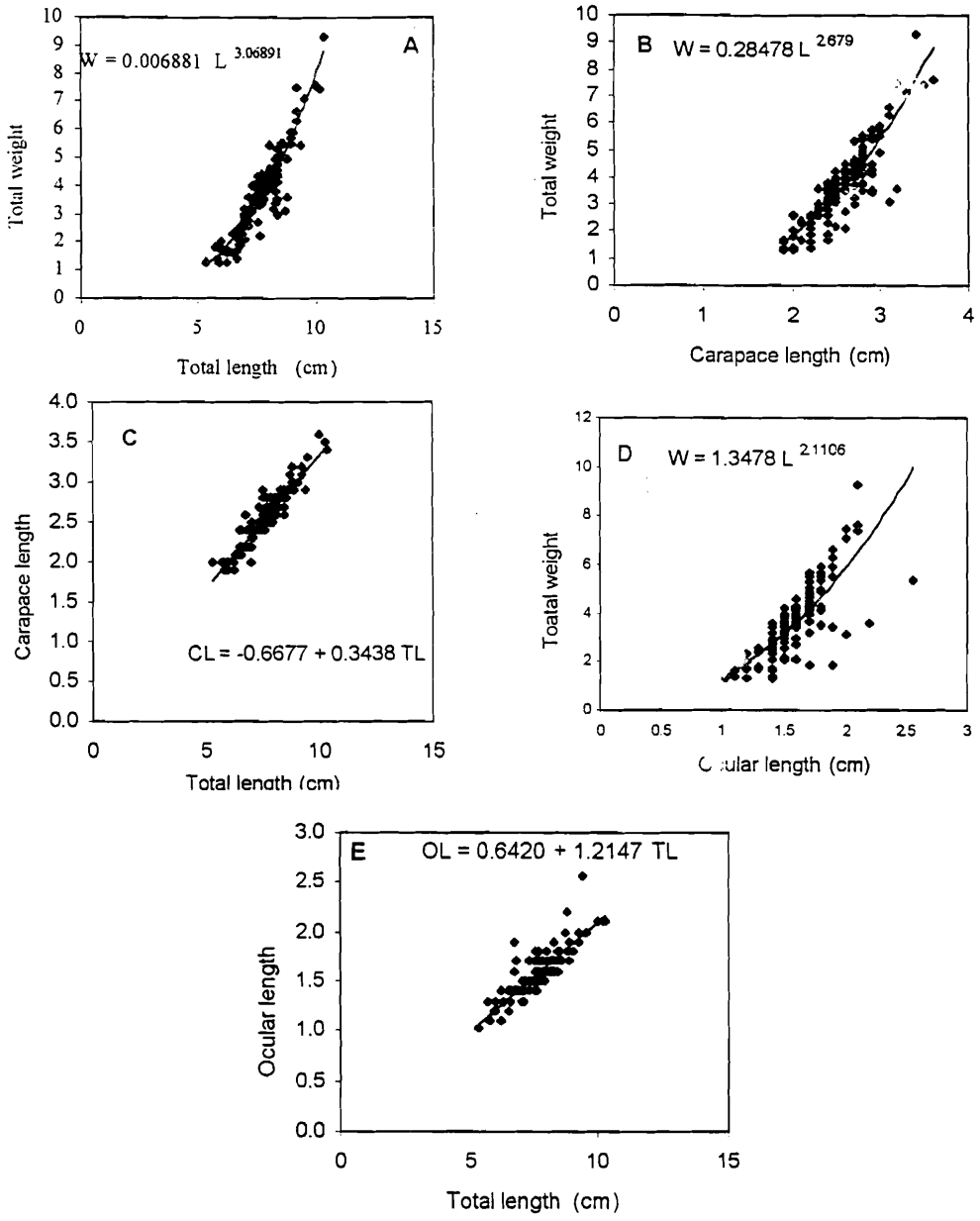

Fig. (2) Morphometric relationships of males *Metapenaeopsis stridulans* from the Gulf of Suez. (A) total length-total weight, (B) carapace length total weight, (C) total length-carapace length, (D) ocular length-total weight and (E) total length-ocular length.

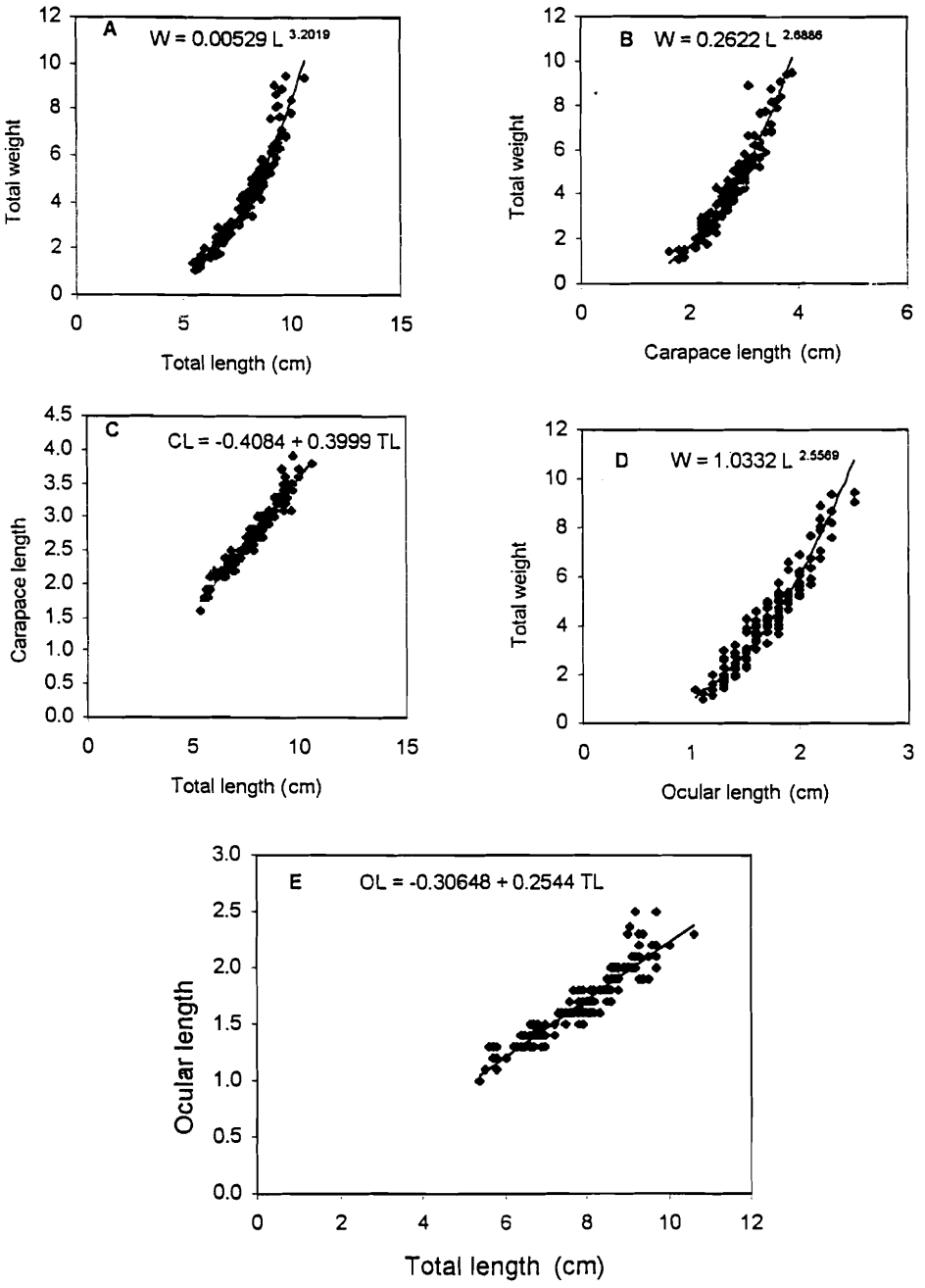

Fig.. 3: Morphometric relationships of females *Metapenaeopsis stridulans* from the Gulf of Suez.(A) Total length-total weight, (B) Carapace length- total weight, (C) Total length-carapace length, (D) Ocular length-total weight and (E) Total length-ocular length.

Sex ratio

The monthly percentage of males and females are represented in Fig. (4). There is no apparent trend in the monthly sex ratio but the overall percentage for the whole period of investigation showed a slight outnumber of males with a percentage of 52.5% of the small shrimp catch. The difference in the monthly sex ratio was examined using (ANCOVA, T-test) (Zar, 1984). The overall sex ratio of males to females was computed to be 1.04:1.00 which is not significantly different from 1:1 where $P>0.05$ (df = 12 and F = 0.276).

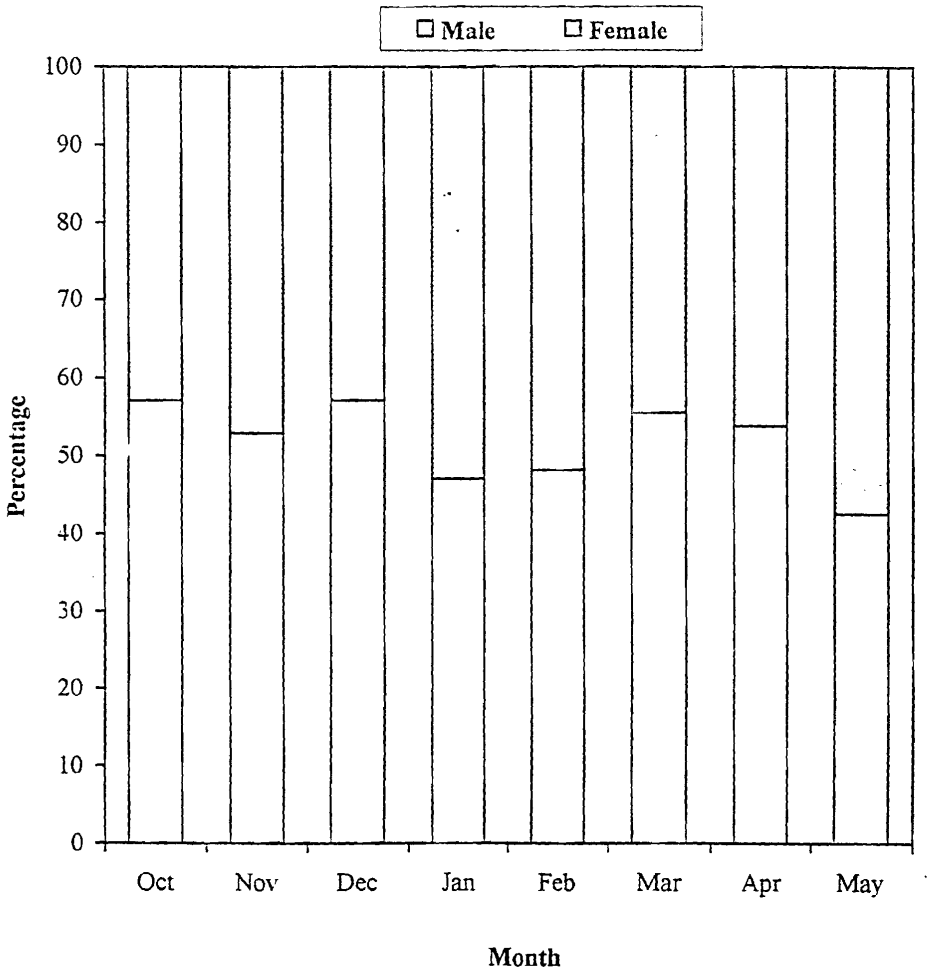

Fig . 4 : Monthly variations in sex ratio of the fiddler shrimp *Metapenaeopsis stridulans* from the Gulf of Suez .

Gut analysis

About 60% of the shrimps examined were found to be with empty stomachs or almost empty. There is no appreciable differences was noticed in the stomach contents of both males and females of different size classes. The average percentage composition and occurrence of the various constituents of the stomach contents are presented in Table (2). It can be seen that the food consists of varying amounts of organic matter mixed with sand, foraminifera, fragments of entire bodies of crustaceans (exoskeleton, appendages and antennae), broken shells and algae including diatoms (*Chaetoceros sp., Nitzschia sp.*, and *Navicula sp*). Thus they are scavengers in their feeding habits. Hall (1962) found that polychaete debris formed a part of the stomach contents of *M. stridulans* in Singapore Strait. He also reported that small crustacea form the main source of food of the genus Metapenaeopsis.

Table 2: The average percentage composition and occurrence of the stomach contents of *Metapenaeopsis stridulans* from the Gulf of Suez.

Stomach contents	Percentage composition by volume	Percentage of occurrence
Debris	45	100
Remains of large crustacea	19	97
Broken shells	12	80
Diatoms	8	87
Fish remains	6	38
Foraminifera	5	72
Sand grains	5	29

Length frequency analysis

The monthly length frequency distributions (Fig. 5) of *M. stridulans* were used for the estimation of growth parameters and construction of the growth curve. The values estimated from the modified Powell-Whetherall method CL_∞ and Z/K were 4.49 cm and 2.574 respectively. The estimated growth parameters were CL_∞ = 4.82 cm and K = 0.6 $year^{-1}$. The growth performance index Φ' was estimated as 1.144. Recorded results about this species are very scarce in the available literature. However, kubo (1956) stated that the life of prawns and shrimps is in most cases one year or a little more in warm water regions, while it is several or more years in cold water regions. According to him, the average longevity of *Trachypenaeus curvorostris, metapenaeopsis barbatus* and *M. acclivis* was about 1 or 1.5 year.

With respect to the fiddler shrimp *Metapenaeopsis stridulans* caught from the Gulf of Suez; and as based on the von Bertalanffy growth model of body length as a function of age as presented by the equation: $L(t) = L_\infty *[1 - \exp(-K*(t-t_0))]$; If one can assume that longevity of the animal is about 0.95 of its asymptotic length (L_∞) =(0.95*4.82cm); then substituting for L(t) =(0.95*4.82cm), $t_0 = 0$ and K = 0.6 in the above equation, then the resultant will be $0.5 = \exp(-0.6*t)$. Hence it could be concluded that the longevity of the fiddler shrimp *Metapenaeopsis stridulans* caught from the Gulf of Suez is about 1.2 years.

Mortality rates and exploitation ratio

The length-converted catch curve was used to estimate the total mortality coefficient Z. The obtained values for the mortality coefficients are Z = 3.68y^{-1}, M = 1.912 y^{-1} and F = 1.77 y^{-1}. The high values of the estimated mortality parameters are similar to those of other shallow water penaeid shrimps (Pauly *et al.*, 1984; Garcia, 1985 and Garcia and Le Reste, 1981). Garcia and Le Reste (1981) reported that for the penaeid shrimp with a maximum life span of two years, the natural mortality should be between 2 and 3, thus the estimated M in the present study is within this range. The corresponding exploitation ratio was estimated as E = 0.48.

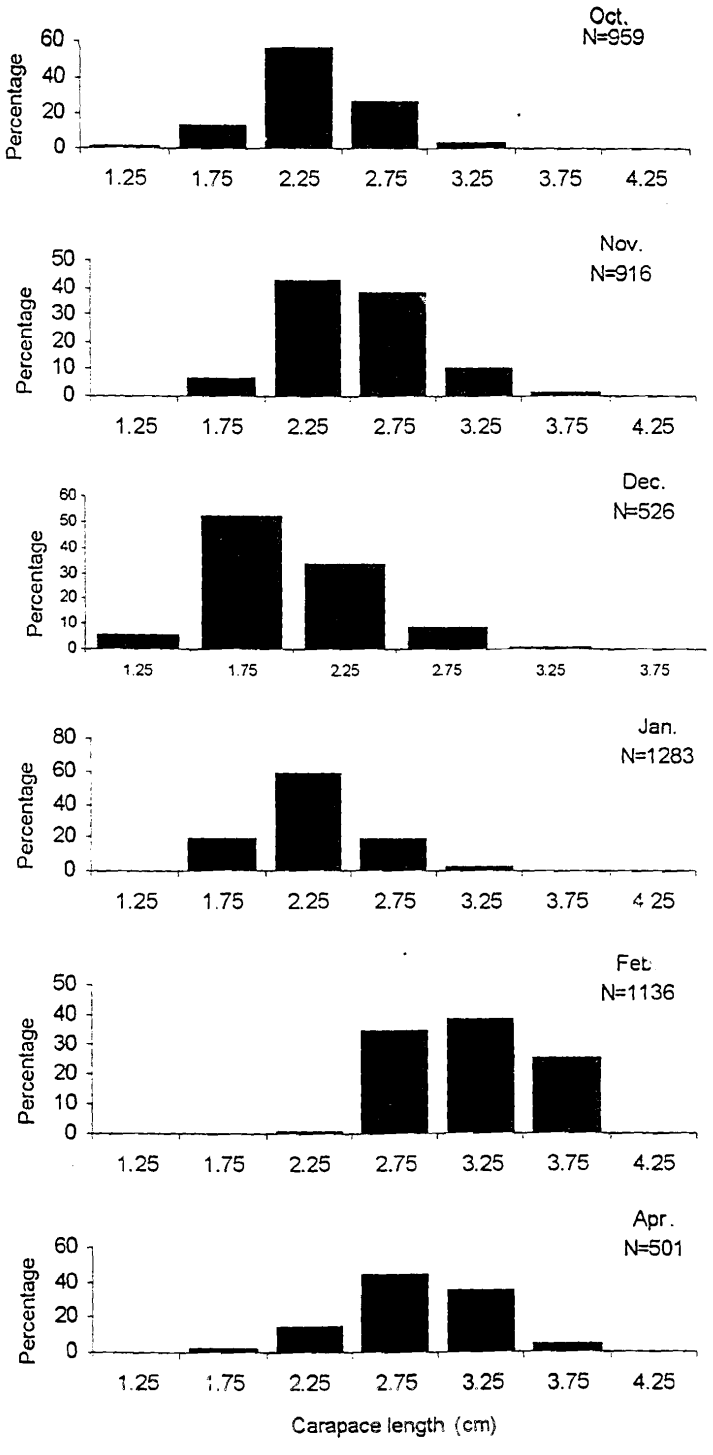

Fig. 5: Monthly length frequency distributions of the fiddler shrimp *Metapenaeopsis stridulans* from the Gulf of Suez.

Carapace length at first capture

The carapace length at first capture (L_c) was estimated from the left ascending part of length-converted catch curve (Pauly, 1984). Based on this method the carapace length at first capture (Fig. 6) of *M. stridulans* was estimated as 1.47 cm.

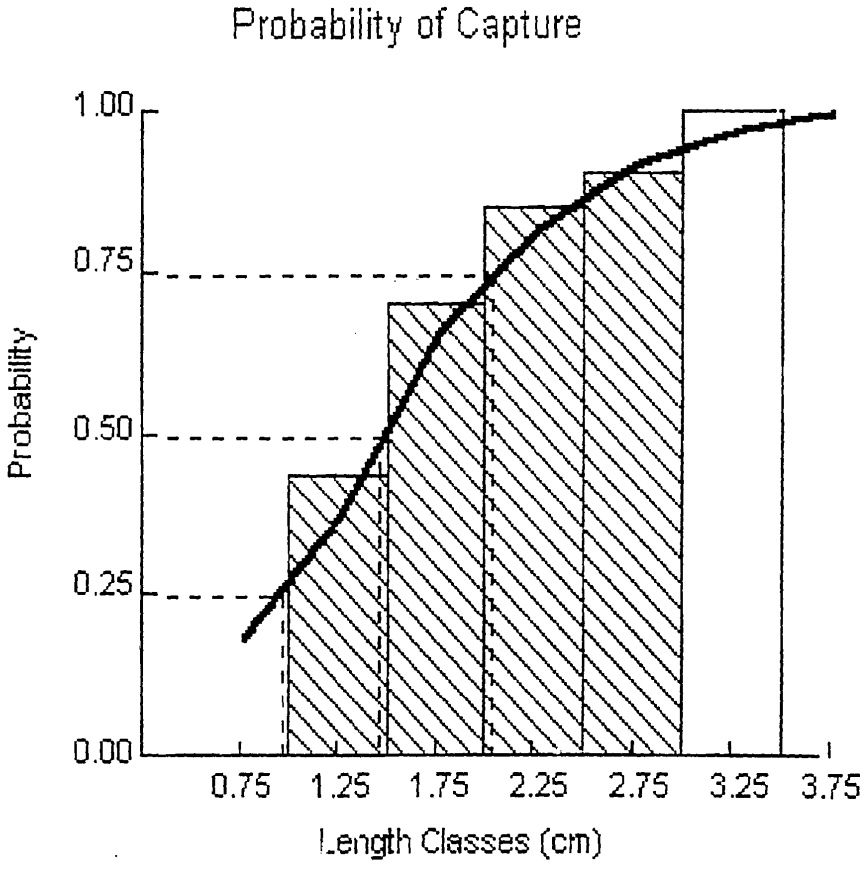

Fig. 6: Probability of capture of *Metapenaeopsis stridulans* In the Gulf of Suez.

Relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R)

Future yields and stock biomass levels are the basic elements in the assessment of any stock. The relative yield per recruit (Y`/R) and biomass per recruit (B`/R) model derived by Beverton and Holt (1966) was applied to predict accurately changes in population abundance as a result of various fishing strategies.

Estimates of (Y'/R) and (B'/R) are represented in Fig. (7). Estimated values of exploitation rates are (E_{10}=0.505, E_{50}=0.307 & E_{max}=0.604) where; E_{10} is the exploitation rate at which the marginal increase of Y'/R is 1/10 of its value at E=0; E_{50} is the exploitation rate under which the stock has been reduced to 50% of its unexploited biomass; and E_{max} is the exploitation rate which produces maximum yield. The results (Table 3) indicate that the value of the current exploitation rate (E = 0.48) is nearly equals to the value of the optimum exploitation rate of *M. stridulans* which corresponds to the point on the yield per recruit curve where the slope is $1/10^{th}$ of the value at the origin of the curve, this provides an estimate of E_{opt} which generates the economic yield per recruit.

The results of this study provide an overall conclusion that the fiddler shrimp *M. stridulans* resource in the Gulf of Suez is at its optimum condition of exploitation. For the proper management of the multi-species resource in the area, further studies must be undertaken on the other shrimp species inhabiting the Gulf of Suez.

Table (3) Estimated relative yield per recruit and biomass per recruit for different values of exploitation ratio of *Metapenaeopsis stridulans* from the Gulf of Suez.

Exploitation Ratio	Relative yield per recruit Y`/R	Relative biomass per recruit B`/R
0.01	0.004	0.818
0.20	0.007	0.654
0.30	0.009	0.510
0.40	0.010	0.384
0.50	0.011	0.278
0.60	0.012	0.190
0.70	0.011	0.120
0.80	0.011	0.066
0.90	0.010	0.027
0.99	0.009	0.002

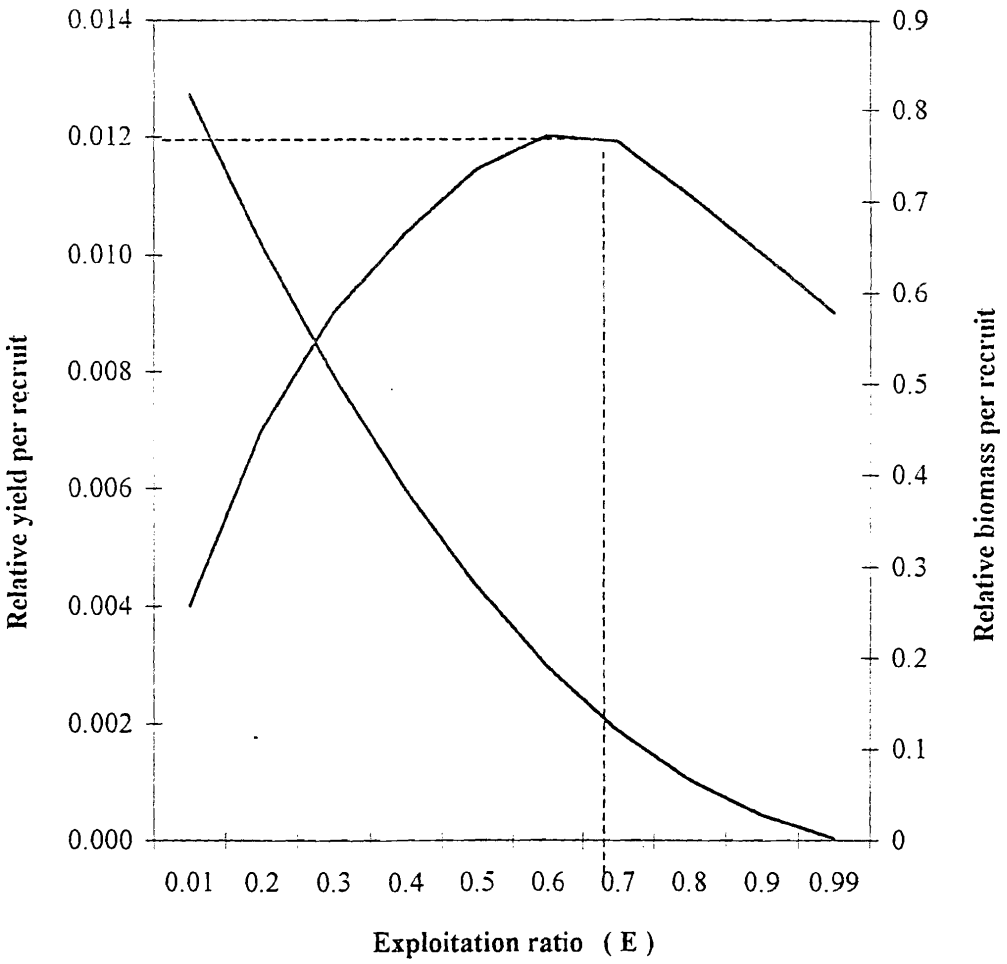

Fig. 7: Relative yield per recruit and relative biomass per recruit of *Metapenaeopsis stridulans* from the Gulf of Suez .

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