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Fishery and dynamics of the fiddler shrimp, *Metapenaeopsis stridulans* (Alcock, 1905) from Chennai coast

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Original Article

Abstract

Annually 161 t of *Metapenaeopsis stridulans* was landed on an average in the Kasimedu fishing harbour (Chennai) during the period 2003-2007. The peak season of fishery was June-September and the overall sex ratio was 1:1.2. Females were slightly larger than males, the mean size was 79.8 mm against 73.8 mm for males. The length range for females was 41-125 mm and for males 41-115 mm. L∞ was estimated at 125 mm for females and 114 mm for males; the growth constant K was 1.1 yr^{-1} for females and 1.3 yr^{-1} for males. The mortality rates were: Z = 3.80, M = 1.20 and F = 2.60 for females and Z = 3.73, M = 1.52 and F = 2.21 for males. The length at first capture (L_{50}) was 63.82 mm for the species. Beverton and Holt's relative yield-per-recruit (Y'/R) analysis revealed that the current exploitation rate is higher than the optimum exploitation rate ($E_{0.5}$), hence fishing mortality should be reduced by about 45% to sustain the stock.

Keywords: *Fiddler shrimp, Metapenaeopsis stridulans, maturity, growth parameters, mortality, exploitation rate.*

Introduction

The expansion of trawling grounds paved the way for the entry of several new species of crustaceans to the fishery along the Indian coast. The penaeid shrimp fishery off Chennai is supported by about twenty one species of which *Metapenaeopsis stridulans* ranked fourth. It has been recorded from both the coasts of India and the Andaman Islands, fished mainly by trawl from a depth of 10-90 m. The species is reported to be frequently caught from the northern Arabian Sea and Sri Lanka (FAO, 1983) besides Mumbai in India. Commonly known as the fiddler shrimp, it has over the years gained importance as a food source for the local population. Few reports available on its fishery are from Mumbai (Aravindakshan, 1990) and from Mandapam (Nandakumar, 1981; Maheswarudu *et al.,* 1996). Subramaniam (2002) has indicated the season and quantum of *M. stridulans* landings during 1992-1999 from the Chennai coast and during 1972-74 and 1986-88 from Cuddalore (Subramaniam, 2000). Kulkarni *et al.* (1999) studied the food and feeding habits of the species from the Mumbai coast. This paper describes the fishery and population dynamics of the species collected during 2003-07, from trawlers operating off Chennai.

Material and methods

Samples of *M. stridulans* in the trawl landings from the Kasimedu (Chennai) fisheries harbour was collected once in a week during the period of study. On each day of observation, samples (1-2 kg) were sorted sex wise and the total length measured in mm (from the rostrum to the tip of the telson) and grouped into 5 mm class intervals for length frequency

analysis. Maturity stages of females were observed in fresh condition and grouped into five stages namely immature, early maturing, late maturing, mature and spent (Rao, 1989). Size at first maturity was estimated by King's method (1995) by grouping the late maturing, mature (ripe) and spent female as mature and percentage plotted against total length. Trawlers landed the catch throughout the period of study except during last fortnight of April and entire May (trawl ban) and the last week of December 2004 to the third week of March 2005, due to tsunami, which struck on December 26, 2004.

The length frequency data was raised to the respective day's catch based on the sample weight and later to the month. This length frequency data was subjected to the estimation of growth parameters separately for females, males and pooled samples by the Powell-Wetherall method (Wetherall *et al*, 1987) and the ELEFAN I module of FiSAT (Gayanilo and Pauly, 1997). For estimating length-weight relationship, data on 242 females (ranging in TL from 55-101 mm) and 233 males (ranging in TL from 56-98 mm) were used and the relationship was calculated following the formula $W = a L^b$ (Le Cren, 1951) where W is weight in grams and 'L' is total length in mm. The difference between the slopes of regression lines of males and females were tested by ANACOVA (Snedecor and Cochran, 1967). The total mortality rate (Z) was calculated using length converted catch curve method (Pauly, 1983). The length at first capture L_{50} (length at 50% capture) was derived from the probability of capture generated from the length converted catch curve. For estimating natural mortality rate (M) using Pauly's empirical equation (Pauly, 1980), surface temperature was taken as 28°C. The fishing mortality rate (F) was obtained by subtracting M from Z. The exploitation ratio (E) was estimated by the ratio of fishing mortality to total mortality. The length at age of males and females were calculated by von Bertalanffy growth formula (1938). The relative-yield-per-recruit (Y'/R) was derived by Beverton and Holt (1966) Y/R analysis (knife edge) in the FiSAT package. L_c/L_∞ and M/K were used as input parameters in this method.

Results and discussion

Fishery: *M. stridulans* occupied the fourth position in the shrimp landings by trawlers at Kasimedu fishing harbour, contributing an average 9% to the total shrimp catch during the study period. The first three positions were taken by *Metapenaeus dobsoni* (16.3%), *Penaeus indicus* (14.7%) and *Parapenaeopsis maxillipedo* (11.3%). At Mandapam, the entry of *M. stridulans* into the fishery during 1979 was described by Nandakumar (1981). Later Maheswarudu *et al.* (1996) reported the dominance of the species at Mandapam during 1992-93, which replaced *P. semisulcatus* as the most dominant species.

The annual catch of *M. stridulans* declined from 284 t in 2003 to 94 t in 2004 but gradually increased to 163 t in 2007, with the catch ranging from 0.17-0.36 kg/h (Fig. 1). The lowest average monthly landing during the study period was 8.98 t (5.6%) in February and the highest was 26.22 t (16.3%) in June (Table 1). Although the species is available almost throughout the year, the peak season of fishery was from June to September. During 1992-93, the average landing of the species was 218 t at Chennai (Subramaniam, 2002). He reported increased catches during July to September and December-February and the minimum monthly catch of 2.0 t in October-November and maximum of 65 t during January 1993-94. At Cuddalore (Subramaniam, 2000), maximum monthly catch of 41.2 t was recorded in June 1987 and peak abundance was in May-June during 1986-88 and in August

Table 1. Average monthly landings (t) of *M. stridulans* during 2003-2007 at Chennai Fisheries Harbour

Month / Year	2003	2004	2005	2006	2007	Avg	%
January	43.6	5.7		18.1		13.48	8.4
February	21.5	23.4				8.98	5.6
March	40.6	3.4		8.2		10.44	6.5
April	4.4	1.5	19.8		40.38	13.216	8.2
May		Trawl ban					
June	70.8	12.4	19.5	16.1	12.3	26.22	16.3
July	23.2	16.1	15.9	25.5	18.82	19.904	12.4
August	28	6.7	21.4		24.93	16.206	10.1
September	15.9	9.1	10.7	16.6	19.82	14.424	9.0
October	12.3	3.8	18.5	16.5	13.3	12.88	8.0
November	9		10.7	15.5	18.19	10.678	6.7
December	15.2	12.1	12.5	14.8	15.5	14.02	8.7

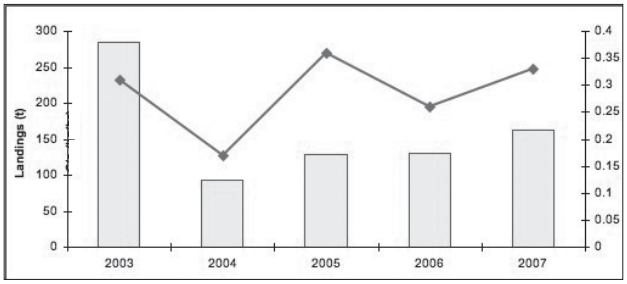

Fig.1 Annual landings of *M. stridulans* during 2003-2007 at Chennai Fisheries Harbour

during 1972-74. Aravindakshan (1990) observed higher catches during October-November in Mumbai. At Mandapam the catches were higher during May - August (Maheswarudu *et al.*, 1996).

Length range: The total length of females ranged from 41 to 125 mm and males from 41 to 115 mm. At Mumbai, the species caught were in the size range of 50-98 mm (Aravindakshan, 1990). During the study period, slight variation in length range and modes were noticed. The mean size of females was slightly larger than males, the size of females being 79.3 mm and males 73.8 mm.

Sex ratio & size at first maturity: The overall sex ratio (M: F) during the study period was 1:1.2. They probably spawn during November-December as more numbers of mature females were recorded during this period. The size of early maturing females was found to be 55 mm. The size at first maturity was estimated to be 75 mm (n=264) (Fig. 2). Aravindakshan (1990) reported the size at first maturity for female as 65 mm and for male 59 mm from Mumbai.

Length-Weight relationship: The length weight relationship estimated was $W=0.0000163L^{2.83}$ ($r^2=0.965$) for females, $W=0.00000649L^{2.99}$ ($r^2=0.925$) for males. The test of covariance did not show any significant variation at 1% level between the sexes. Therefore the common equation is $W=0.00000577L^{3.04}$ ($r^2=0.932$).

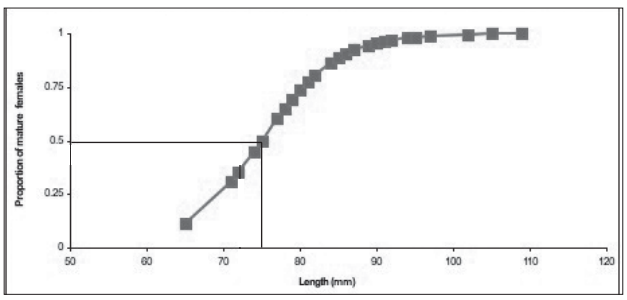

Fig.2. Length at first maturity of female *M. stridulans*

Growth parameters: Following the Powell and Wetherall method, the asymptotic length for female was estimated as 127 mm and for male as 114 mm. The L_∞ estimated was 125 mm for females and 114 mm for males by the ELEFAN I. The values of 'K' (yearly) were 1.1 for females and 1.3 for males. The L_∞ calculated for the males and females are nearer to the largest individual sampled (125 mm for female and 115 mm for male).

The females were observed to attain a length of 87 mm and 109 mm at the end of the first and second year respectively. Males comparatively had a slower growth rate, 77 mm at the end of the first year and 100 mm at the end of the second year (Fig. 3). T_{max} (3/K) for females is 2.7 years and for males 2.3 years. Although the fishable lifespan of penaeid shrimps is one year, their longevity is about 2-3 years (Garcia, 1988).

Mortality parameters: The estimated natural mortality coefficient (M) was 1.20 for females and 1.52 for males. The Z was 3.80 for females and 3.73 for males and F 2.60 for females and 2.21 for males. The exploitation rate was 0.68

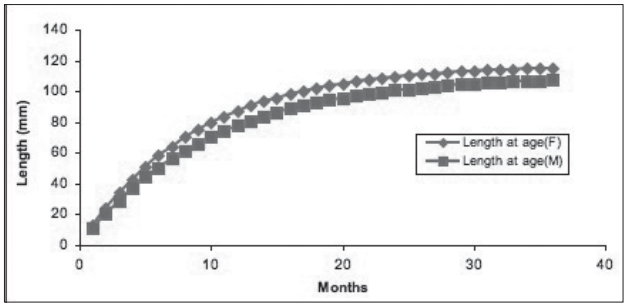

Fig.3.Length at age for female and male *M. stridulans*

for females and 0.59 for males. M is less than 2 for both males and females, which may be because of the low K value. Beverton and Holt (1959) reported that fish of high growth rates have high values of natural mortality.

Stock assessment: For stock assessment the growth parameters estimated for the pooled samples were considered which were L_∞-125 and K-1.0. The total instantaneous mortality was 3.59, natural mortality 1.22 and fishing mortality 2.37 (Fig. 4). The reliability of natural mortality is determined by the M/K ratio (Beverton and Holt, 1957) which lies within the range of 1.12-2.25 for most fishes. In the present study the M/K ratio was 1.22 which is within the required range and hence suggests that the natural mortality estimated for *M. stridulans* is reliable. The exploitation rate was 0.66 and probability of capture 63.82 mm. The relative yield-per-recruit analysis gave the maximum rate of exploitation (E_{max}) as 0.69 after which the catch declines and also the biomass, $E_{0.1}$ as

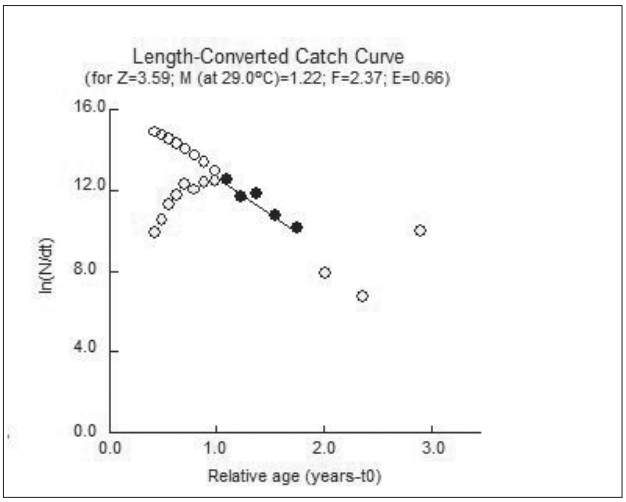

Fig.4. Total mortality of *M. stridulans*

0.60, which is the level of exploitation at which the marginal increase in yield per recruit is 1/10 of the marginal increase computed at a very low value of E and $E_{0.5}$ as 0.36, which is needed to maintain 50% of the stock biomass (Fig. 5). The present exploitation rate is higher than predicted $E_{0.5}$ at which B'/R is reduced to half of the fished level and thus the biomass level. Hence for resource management it is suggested that the present exploitation rate (0.66) should be reduced to 0.36 (45%) to sustain the fishery.

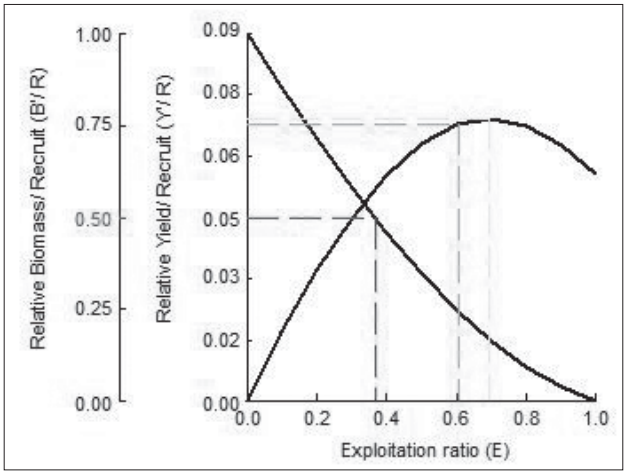

Fig.5. Relative yield-per-recruit analysis by Beverton and Holt knife edge selection of *M. stridulans*

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References

Aravindakshan, M. 1990. A fishery for fiddler shrimp *Metapenaeopsis stridulans* Alcock off Maharashtra coast. *Mar. Fish. Infor. Ser., T & E Ser.*, 106: 10-11.

Beverton, R. J. H and S. H. J. Holt. 1957. On the dynamics of exploited fish populations. Ministry of Agriculture, Fisheries and Food Investigations, UK, Series 2. 19 pp.

Beverton, R. J. H and S. H. J. Holt. 1959. A review of the life spans and mortality rates of fish in nature and their relation to growth and other physiological characteristics, In: G. E. W. Wolstenholme and M. O. Connor (Eds), CIBA. *Foundation, Colloquia on Ageing.* Vol.5. *The Life span of Animals.* London, Churchill. 5: 142-180.

Beverton, R. J. H and S. H. J. Holt. 1966. Manual of methods for fish stock assessment. Part II. Tables of yield function. *FAO Fish. Tech. Pap.*, 38: 10 + 67 pp.

FAO. 1983. *FAO species identification sheets for fishery puposes.* Western Indian Ocean. (Fishing Area 51). Vol.4. FAO, UN, Rome.

Garcia, S. 1988. Tropical penaeid prawns. In fish population dynamics, J. A. Gulland (Ed). J. Wiley and Sons Ltd. 219-249 pp.

Gayanilo, Jr. F. C and D. Pauly (Eds). 1997. The FAO-ICLARM Stock Assessment Tools (FiSAT) Reference Manual. *FAO Computerized Information Series (Fisheries)-* 8. FAO, Rome, 262 pp.

King, M. 1995. *Fisheries, biology, assessment and management.* Fishing News Books/ Blackwell Scientific Books, Oxford, England, 352 pp.

Kulkarni, B. G, V. D. Deshmukh and V. R. Kulkarni. 1999. Food and feeding habit of a penaeid prawn *Metapenaeopsis stridulans* (Alcock 1905). *J. Bombay Nat. Hist. Soc.*, 96(2): 262-267.

Le Cren E. D. 1951. The length weight relationship and seasonal cycle in gonad weight and conditions in the perch (*Perca fluviatilis*). *J. Anim. Ecol.*, 20: 201-219.

Maheswarudu, G, P. E. Sampson Manickam, P. Vedavyasa Rao and M. R. Arputharaj. 1996. Observations on the exploitation of Penaeid prawn resources in the Palk Bay of Mandapam during 1986-93. *Indian J. Fish.*, 43(3): 205-213.

Nandakumar, G. 1981. Observations on the prawn fishery of the Mandapam area. *Indian J. Fish.*, 27(1&2): 257-260.

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters and environmental temperatures in 175 fish stocks. *J. Cons. Inst. Explor. Mer.*, 39: 175-192.

Pauly, D. 1983. Some simple methods for the assessment of tropical fish stocks. *FAO Fish. Tech. Pap.*, 234: 52 pp.

Snedecor, G. W and W. G. Cochran. 1967. Statistical Methods. Oxford and IBH Publishing Co., New Delhi, 539 pp.

Rao, G. S. 1989. Studies on the reproductive biology of the prawn *Metapenaeus monoceros* (Fabricius, 1978) along the Kakinada coast. *Indian J. Fish.*, 3(2): 107-123.

Subramaniam, V. T. 2000. Prawn fishery of Cuddalore, northern tamilnadu coast with special reference to long term changes. *Mar. Fish. Infor. Serv., T & E Ser.*, 166: 1-12.

Subramaniam, V. T. 2002. Prawn fishery along Chennai coast in North Tamil Nadu. *Indian J. Fish.*, 49(4): 335-349.

von Bertalanffy L. 1938. A quantitative theory of organic growth, (Inquiries on growth laws 11). *Hum. Biol.*, 10: 181-213.

Wetherall, J. A, J. J. Polovina and B. Ralston. 1987. Estimating growth and mortality in steady state fish stocks from length frequency data. *ICLARM Conf. Proc.*, (13): 53-74.