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Population Dynamics of an Exploited Stock of the Clam *Paphia malabarica* of Astamudi Estuary (South India)

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Abstract

Growth studies conducted in 1989-90 on *Paphia malabarica* from Ashtamudi estuary, South India, showed that it attaines 30 mm length in one year, 38 mm in two years and 41 mm in three years. The L_α was calculated as 44.4 mm. In commercial catches, 1-year class dominated, followed by 0-year, 2-year and 3+year classes.

Average total mortality rate Z, was estimated as 2.11, natural mortality rate as 1.17 and fishing mortality rate F as 0.94. The exploitation rate was 0.3915, the annual stock (Y/U) 3234.9 t and the estimate of MSY was 3408.8 t. It is concluded that the present level of exploitation is closer to the optimum.

Introduction

The venerid clam, *Paphia malabarica* contributes 80 to 90% of the total clam export of India. In the southwest coast, it is exploited mainly from the Ashtamudi estuary (Appukuttan, 1993). The increased demand for clam in the international market, has resulted in over exploitation of this clam. The need hence, has become necessary for imposing proper management measures. Even though population parameters of other species of clams have been studied (Rao, 1951; Salih, 1975; Nair, 1975; Mane and Nagabhushanam, 1979; Narasimham, 1988 and Rao, 1988), except for the report of Rao (1988) from Mulki estuary, no information exists on the population dynamica of this species from India.

The aim of the present study was to obtain data on the population parameters and assess the stock of this species in Ashtamudi estuary. For assessing the population parameters of molluscs, with free living larval stages permitting uniform dispersal and settlement in the fishing area, the model of Beverton and Holt (1957) which is still considered reliable (Caddy, 1989) was used in this case.

Materials and Methods

The study was conducted in the Ashtamudi estuary (8°) 35 9° 02 Lat. and 76° 31 to 76° 41 Long). It is the second largest estuary in Kerala with an area of 44.73 km2 and possess a permanent connection with sea. A major fishery harbour is located near the mouth of this estuary. Commercial exploitation of *P. malabarica* in this area is done mostly by four methods *viz.*, hand dredge operated from a dugout canoe, two divers collecting from a canoe, canoe with one diver and hand picking. Weekly random samples collected with hand dredge were used to obtain data on catch, effort and biological parameters. From the sample, length and weight measurements, their distribution in the total catch of the sampling day was estimated. The details for the month was obtained after pooling the data. By studying the shifting of monthly modal values from length frequency plot,growth curves were drawn. Size of a brood for every three months, from this were used to estimate L_∞, K and t_0. For estimating to, Menzor and Taylor plot was used. For fishery and stock assessment studies standardisation of fishing units was done taking hand dredge as standard. By pooling monthly landings from commercial fishing, the annual estimations were made.Since the usual methods of estimation of mortality could not be used, the method followed by Gabral-Llana (1988) was employed. According to them M/K value for bivalves is 1.4 and hence M was estimated based on this assumption. Yield - per-recruit was calculated according to the formula of Ricker (1958), was estimated from the formula, W= 0.1875 L 3.0682 obtained from commercial catches (Appukuttan, 1993). Annual average standing stock was also calculated after estimating maximum sustainable yield (MSY).

Results and Discussion

Data on the landing and catch/effort of *P.malabarica* by the four methods of exploitation as well as monthly totals are presented in Table 1. The hand dredge contributed maximum catch during the year of investigation. The annual catch obtained was 3040.8 t with high catches in june and better C/E during the period March to July. The total estimated catch for the entire fishing area of 15.5 hectare was 11367.05 t (7.31 kg/m^2) and the size at first entry into the catch was 22 mm. It was observed that the peak spawning period of this species is November (Appukuttan, 1993). Growth curve drawn from the dominant modes of size frequency distribution is given in Fig. 1a. The probable growth line was drawn based on the shifting of the modes. The value of this line at every third month was taken as growth for a quarter. November being the month of birth, the

Table 1: Total catch, effort, catch per effort and total number of *Paphia Malabarica* in the commercial catches from February 1989 to January 1990.

Months	A	B	C	D	Total catch (kg)C	Standard Effort E	Catch/effort C/E	Total Numbers
Feb, 1989	86671	147264	37736	2301	273972	1787	153.3	33417264
Mar	188750	157000	96560	22375	464685	1956	237.6	50185980
Apr	141750	216300	43365	19950	421365	1682	250.5	35817895
May	228800	127075	62888	13975	432738	1820	237.8	37215468
Jun	226850	89375	19500	13000	348725	1320	264.0	33128875
Jul	153065	102251	-	13161	268477	1591	169.0	25373885
Aug	84966	63308	53104	15872	217250	1444	150.4	28190634
Sep	115625	80000	21875	3750	221250	1123	197.9	17257500
Oct	121500	49375	32375	2500	205750	1374	150.0	21809560
Nov	104000	21125	-	-	125125	1250	100.0	13888875
Dec	23875	25500	8125	400	57900	348	117.0	6027000
Jan, 1999	-	-	-	-	-	-	-	-
TOTAL	1475852	1078573	375528	107284	3040837	15695	2027.5	302.3 million
Monthly Average	**134168**	**98052**	**41725**	**10728**	**276112**	**1427**	**284.3**	

A - Canoe with hand-dredge; B - Canoe with 2 divers

C - Canoe with 1 diver D - Hand-picking

size during February was 17 mm, in May 23 mm, in August 26 mm, in November 29 mm, in next February 32 and May 35 mm.

From the estimated 3 monthly ages, values of L_∞ and K calculated were 44.426 and 0.2026 (0.8389 - annual value) respectively. However Menzor and Taylor plot (Fig. 1b) gave a value of 1.808 for t. The VBG equation obtained for the species was

$$L_t = 44.4260\,[1 - e^{-0.8389\,(t + 0.3452)}].$$

Subsequently, size were recorded as 30.05 mm, 38.21 mm and 41.44 mm at the end of 12, 24 and 36 months respectively with a probable life span of 1+3 years. The 1-year class dominated the fishery with 1973 t (65%) followed by 0-year class with 806 t (28.4%), 2-year class with 147 t (4.8%) and +3 year class with 54.3 t (1.8%).

Total mortality Z was estimated for samples from commercial catch and transect samples and an average value of 2.11 was taken for estimation. Natural mortality (M) was 1.17. Fishing mortality (F) was 0.94 (Fig 2a).

Eventhough the age at first recruitment was obtained as 0.5522 year (22 mm), the value of 0.955 corresponding to the first mode (29.5 mm) was considered as the age at first recruitment. W estimated was 19.17, t_0, -0.3452 and K, 0.8389. Accordingly the yield/recruit values were estimated (Fig. 2b) for different F values and the optimum was found as F = 2 which further indicated that the F obtained has to be doubled.

The stock parameters estimated for *P. malabarica* in the present study from the area of fishing are, exploitation rate (U) as 0.3915, total annual catch (Y) 3040.8 t, estimated total annual stock 7767 t, annual average standing stock 3234.9 t and maximum sustainable yield (MSY) 3406.8 t.

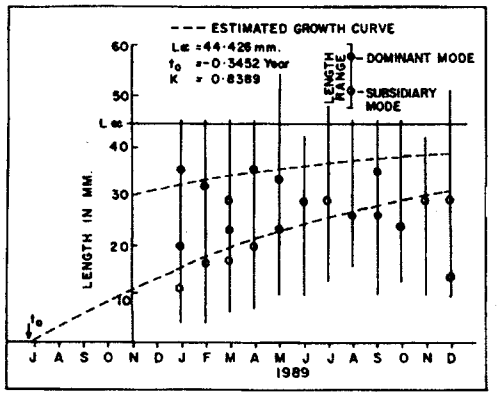

Fig 1(a) Growth curve drawn from the dominant modes of size distribution of *P. malabarica*

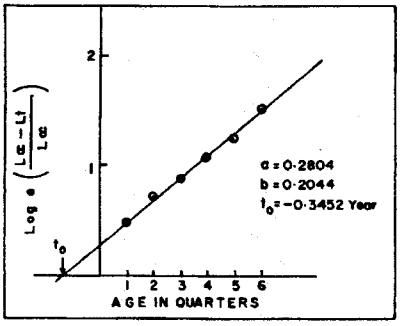

Fig 1(b) Menzor and Taylor plot for *P. malabarica*

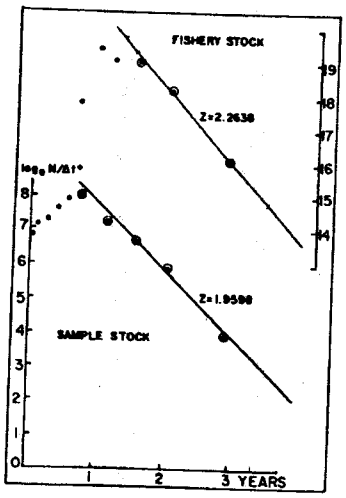

Fig. 2(a) Total mortality Z estimate of *P.malabarica*

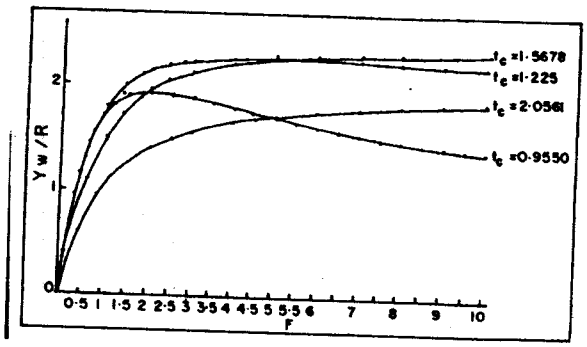

Fig. 2(b) Yield/recruit, Y_w/R values of *P.malabarica*

Growth rate and other population parameters obtained for *P. malabarica* during the present study seems to be comparable with that of other species (Winckworth, 1931 on *P. undulata*. Mane and Nagabhushanam, 1979 on *P. laterisulca*). In *P. malabarica* inhabiting Mulki estuary, North-west coast of India, Rao (1988) recorded significantly higher growth rate than in Ashtamudi. The low population density in the prevailing environmental condition and the difference in the nature of substratum of Mulki estuary may probably be the main reasons for these high values. Moreover, no commercial fishing was taking place in Mulki estuary during the period of investigation. Since the beginning of large-scale commercial exploitation of clams at Ashtamudi, larger size groups have been exploited mainly for export and thus became rare in the catches. This probably might have resulted in the lower L_∞ and L *max* values obtained in the present investigation.

The estimated MSY of the species with a calculated F *max* = 2.0 seems to be only 366 t higher than the present exploitation rate. However, exploitation of this excess quantity by doubling the effort will lead to a decrease in CPUE and subsequent increase in operational costs. For the tc values of 1.2 and 1.6 F values were beyond 5, hence the increase in yield beyond and F value of 2 is negligible and not beneficial (Fig. 2 b). If the age at first capture can be fixed before 2 years, the present fishing intensity can be increased without much reduction in catch per effort. If the mesh size of the dredge is increased from the present 20-25 mm, more clams above 30 mm (2-year classes) can be exploited. As the demand for export is for higher size groups, a mesh regulation allowing capture above 30 mm size would be advisable, at Ashtamudi. But continuous monitoring of the stock in the estuary is necessary to formulate effective management strategies for rational exploitation without depletion. This present study will help, as a baseline, to initiate further research on stock estimation of this species from Indian waters.

In Ashtamudi estuary, judicious exploitation coupled with semi-culture practice can increase the production in the coming years since the 15.55 hectare area has a production rate comparable to controlled farm condition.

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