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Fishery and stock assessment of the blood clam *Anadara granosa* (Linnaeus) from Kakinada Bay

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ABSTRACT

Landing and effort data of *Anadara granosa* (Linnaeus) from Kakinada Bay were collected for the years 1988 to 1991. The landings during 1988 were 802 tonnes compared to 1600 tonnes in 1991. The effort in 1988 was estimated at 32,458 man-days, which has increased by 1.7 times in 1991. However, catch rates showed a declining trend. There has been some change in the exploitation pattern. Younger size groups (<30 mm) are being exploited more, due to their higher price realization. Stock assessment attempted by Jones' Cohort analysis and Thomson and Bell analysis showed that the current level of exploitation has already reached MSY level. There is scope to increase the yields by following 1990 pattern of exploitation. However, selective exploitation of *A. granosa* of > 30 mm, if continued may lead to declining yields over the years.

Introduction

Anadara granosa, the blood clam is the most important clam resource, contributing to about 50% of the total molluscan landings of the Kakinada Bay. Although *A. granosa* is not used for human consumption, its demand in the ornamental market in India is growing. Kakinada Bay is the only major source of *A. granosa* in peninsular India (Algaraswami and Narasimham, 1973). Information on the biology (Narasimham, 1969, 1988a), resource position (Narasimham 1973,1988 b) is already available. However detailed infor-mation based on long term study on the magnitude of the fishery of *A. granosa* from the entire Kakinada Bay is lacking. Data on the landing, effort and other aspects of fishery were collected during 1988-1991 and stock assessment is attempted here.

Materials and methods

Data on landings of *Anadara granosa* were collected at the landing centers viz., Chollangi and Yetimoga by weekly observations from January 1988 to December 1991. On each observation day information was collected on the number of boats operated, number of people engaged in the collection and the quantities of different species of molluscs landed, at random with a minimum of 10 observations. These observations were proportionately raised to the respective days and months to estimate the species wise landings of molluscs and effort in man-days. On each observation day length frequency of exploited *A. granosa*

was noted by taking length measurements of live clams at random from different heaps in the landing centre. About 200 clams were usually measured on each observation day and the total sample weights were also noted, for further estimation. Data on the price structure were collected in all months for shells of less then 30 mm and for meat, separately.

The annual length-wise estimated number of *A. granosa* were pooled for the four years (1988-1991) and length-wise mean numbers of clams landed were calculated and these data were used for Jones' length based Cohort analysis (Jones, 1981). The results of the above analysis were further utilized for predictive length based Thompson and Bell analysis (Sparre *et al.,* 1989) to predict catches and stock sizes under given assumption and different exploitation levels. The growth parameters of *A. granosa,* $L\infty = 73.4$ mm and $K=0.5816$, length-weight relationships, were taken from Narasimham (1988 a , b). M/K is taken as 1.

Result

In the past, clams were landed at several places adjoining Kakinada Bay, mostly for lime purpose. Recently there is a lot of diversification in utilization of clams; consequently there is a spurt in their exploitation, resulting in the concentration of these activities at Chollangi, 3 km south of Kakinada. Chollangi centre became a favorite place due to its location on Kakinada-Yanam Road, which makes marketing easy. *Anadara granosa* and other molluscs exploited in the Kakinada Bay by people belonging to different villages land their catches at Chollangi. Apart from Chollangi, minor molluscan fishery exists at Yetimoga.

The landings of *A. granosa* during 1988 were about 802 tonnes, at an effort of 32,458 man-days and an average catch rate of 24.7 kg. During 1989, the landings increased to 1342 tonnes, effort 52,777 man-days and catch rate 25.4 kg. During 1990 and 1991 also the landings and effort showed increasing trend, however the catch rate showed a declining trend. It is observed that the landings of *A. granosa* have doubled in 1991 from 1988 level. The maximum landings of *A. granosa* were in March (Fig .1). In general, landings were more during October-April period, compared to May-September period. The effort also followed similar trend.

The length of *A. granosa* in the landings ranged from 14 to 74 mm. In

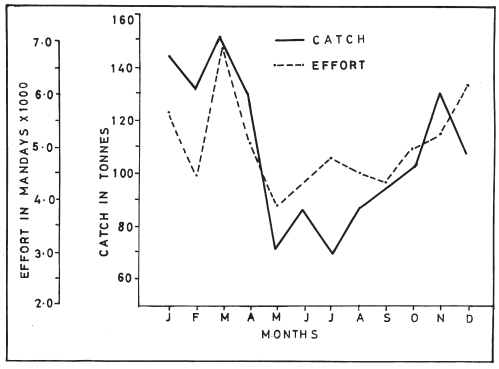

Fig. 1. Trend of effort and landings of *Anadara granosa* (1988-1991 average)

1988 the major mode was at 35 mm, in 1989 and 1990 it was at 39 mm and in 1991 it came down to 23 mm (Fig.2). During 1988 about 30.6% clams were less than 30 mm in length and in 1989 their proportion was 20.5% followed by 28.2% in 1990. However, during 1991 the proportion of clams less than 30 mm reached 43.4%. Consequently, the mean length of exploited *A. granosa* in 1988 which was at 36.3 mm, increased to 39.7 mm in 1989 and 39.5 mm in 1990. During 1991 the mean length dropped to 34.8 mm.

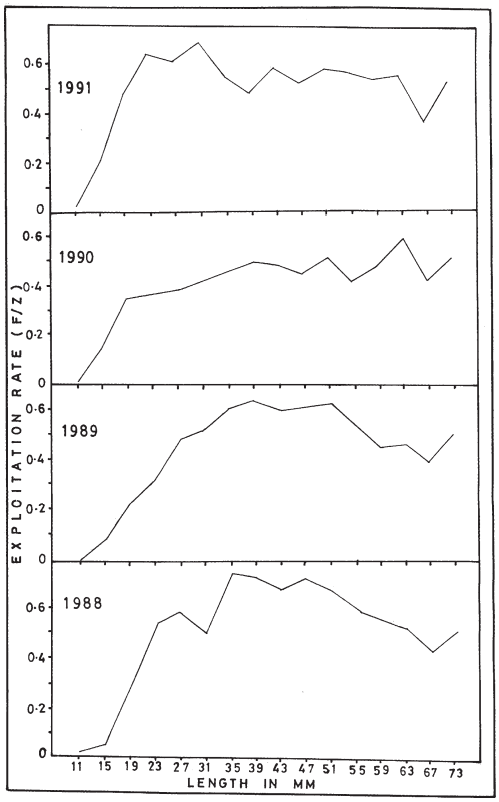

Fig. 2. Length-wise exploitation rates (F/Z) of *Anadara granosa* during 1998-91.

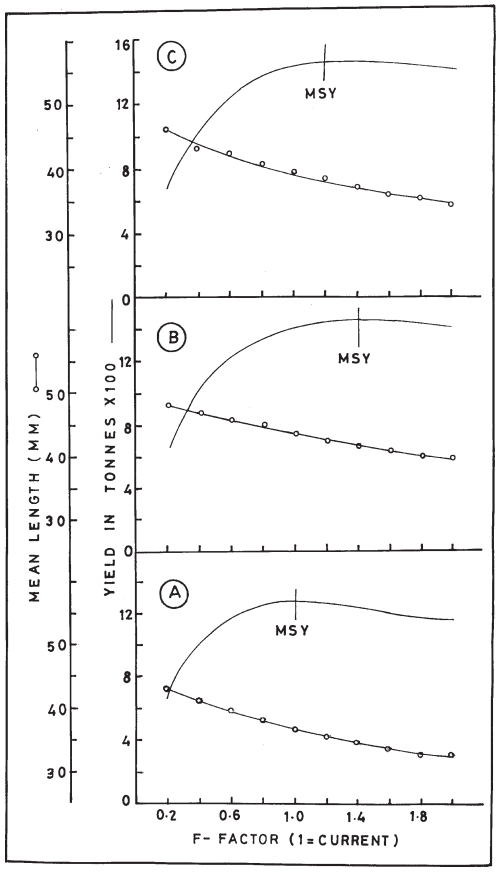

Fig. 3. Yield curves of Kakinada bay (a). Based on 1988-91 average (b) based on 1988-91 average with restriction of exploitation up to 31 mm and (c)based on 1990 pattern of exploitation.

Jones' Cohort analysis (Jones 1981, 1984) was used to determine the exploitation rates at different lengths of *A. granosa* (Fig.2). It revealed that during 1988 exploitation was more in the size range 31 and 51 mm. However, from the following year there was a gradual increase of exploitation of clams below 31 mm, reaching peak in 1991. The exploitation rate curves gradually flattened in the middle lengths with progressive elevation at the younger length groups.

Utilization

The shells of *Anadara granosa* are utilized mainly for ornamental purpose. They are being transported to Tamil Nadu for further processing and making final products. The meat of bigger clams (>30 mm) extracted after boiling is in demand from the local prawn farmers for its use as prawn feed. The demand for clam meat is only seasonal and its utilization process is yet not fully optimized. Due to prohibitive cost, the shells of *A. granosa* are not used for making lime.

Price structure

During 1988 the price for shells of *Anadara granosa* was uniform at Rs. 345/ tonne. Differential pricing for shells of length, less than 30 mm (Rs.633/tonne)

TABLE 1: *Price* Structure and value of landings of* Anadara granosa *during 1988-1991 1988-1991*

Year	1988	1989	1990	1991
Shells <30 mm/tonne	Rs. 345	Rs.633	Rs. 720	Rs.1,955
Shells >30 mm/tonne	-	Rs.370	Rs.435	Rs.1,570
Meat/tonne	-	Rs.4,500	Rs.3,950	Rs.4,150
Total value of landings	Rs.2,76,615	Rs.6,78,008	Rs.7,96,236	Rs.23,12,127

was started in 1989. The details of price structure during different years is presented in Table 1. It is seen that there is a fast escalation in the price of shells, particularly in 1991. The total value was calculated at 90% recovery of shells for clams less than 30 mm and 80% of shells for clams more than 30 mm. The meat value is calculated at 20% recovery, only from clams more than 30 mm and at 25% utilization demand of annual landings of *A. granosa*. It was observed that the value of exploited *A. granosa* has almost increased by more than 8 times in the past four years.

Stock Assessment

Jones' length based cohort analysis (Jones, 1981) for the length-wise pooled average (1988-1991) number of *A. granosa* landed from Kakinada Bay results in an MSY of 1277 tonnes corresponding to the current level of fishing effort. Length-wise exploitation rates, fishing mortalities, number of clams landed and their weights were estimated. These estimates were treated as F-factor 1 for predictive length based Thompson and Bell analysis (Sparre *et al*., 1989). Taking the above (F-factor 1), fishing mortalities by length groups as input, number of clams caught (yield) was calculated for different exploitation levels from 0.2 to 2.0 (Fig. 3 a). Similarly MSY was calculated by hypothetically restricting the exploitation of clams up to 31 mm. This gave an MSY of 1464 tonnes at F-factor 1.4 (Fig. 3b). The exploitation pattern during 1990 appeared to be rational, spreading through entire length range with almost equal weightage. Hence the above exercise was repeated for the 1990 data also (Table 3). This gave an MSY of 1466 tonnes at F factor 1.2 (Fig. 3c). Mean length corresponding to each F factor was also estimated (Fig.3). The contribution of younger size groups to the yield enhanced with the increased yields, as reflected by the mean length of clams. The mean length at the current level of exploitation is 37.1 mm (1988-91 average), 42.7 mm for hypothetically restricted fishing (1988-91 average) and 38.4 mm for 1990 pattern of exploitation (Fig. 3)

Discussion

Kakinada Bay is rather the only place in India where *Anadara granosa* supports a fishery. Due to its diversified utilization, the landings are increasing at a fast rate. However, the meat of *A. granosa* as human food in some form or the other is not well appreciated still. Even its utilization as prawn feed is only seasonal. Thus, there exists great potential for developing and propagating techniques for preserving the meat in some other form, like dried powder , which can be mixed in the prawn feed and used at any time. This will help to avoid the wastage and pioneer the future development of other molluscan fisheries.

Narasimham *et al.* (1984) estimated the stock of *A. granosa* at 6895 tonnes by direct assessment. However landings data before 1988 for the entire Kakinada Bay was not available. The landings of

TABLE 2 : *Calculaltion of Yeild by Jones' Length Based Cohort analysis for* Anadara granosa *from Kakinada Bay based on 1988-1991 data*

Length Group mm	Relative Age	T(L1) ("000")	X (L1,L2) ("000")	Number caught	Number Survived (F)	Exploitation Rate (F/Z)	Fishing Mortality (Z)	Total Mortalities	Body Weight (kg)	Mean Number ("000")	Mean Biomass (tonnes)	Yield (Tonnes)
11-15	0.275	0.118	1.0337	59	110817	0.0082	0.0048	0.5884	0.0014	12211	16.7	0.08
15-19	0.393	0.112	1.0361	1037.8	103656	0.1281	0.8054	0.667	0.0037	12146	44.9	2.8
19-23	0.515	0.131	1.0389	3935.8	95555	9.3639	0.3327	0.9143	0.0047	11828	55.1	18.34
23-27	0.646	0.143	1.0422	6545.2	84740	0.5033	0.5893	1.1709	0.0073	11107	81.3	47.91
27-31	0.789	0.155	1.0461	6382.5	71735	0.5195	0.6288	1.2104	0.0108	10150	109.2	68.67
31-35	0.944	0.17	1.0508	687.5	59450	0.5658	0.758	1.3396	0.0151	9071.7	136.7	103.62
35-39	1.114	0.189	1.0565	638.21	47297	0.5819	0.8095	1.3911	0.0203	7884	160.1	129.2
39-43	1.303	0.213	1.0638	5287.9	36330	0.5751	0.7872	1.3688	0.0266	6717.8	178.4	140.4
43-47	1.156	0.242	1.0731	4276.2	27134	5660	0.7585	1.3401	0.0339	5637.9	190.8	144.75
47-51	1.758	0.283	1.0856	3276.3	19579	0.5475	0.7037	1.2853	0.0423	4656	196.9	138.55
51-55	2.041	0.338	1.1034	2681.2	3594.6	0.552	0.7166	1.2982	0.0509	3741.8	190.5	136.53
55-59	2.379	0.421	1.1304	2268.7	8737	0.5808	0.8058	1.3874	0.0628	2815.6	176.8	142.5
59-63	2.88	0.55	1.1767	1315.1	4830.6	0.5347	0.6683	1.2499	0.075	1967.7	147.6	98.63
63-67	3.35	0.845	1.2748	754.3	2371.2	0.5016	0.5853	1.1469	0.0886	1288.7	110.3	66.8
67-71	4.1947	1.686	1.633	285.6	867.4	0.3983	0.3983	0.9799	0.1036	731.7	75.8	29.6
71	0	0	0	75.2	150.4	0.5	0.5816	1.1632	0.1156	129.3	14.8	8.95

A. granosa doubled between 1988 and 1991, whereas the effort increased by 174%. However, the catch rates showed declining trend, indicating the pressure in the fishery. The yield curve (Fig. 3a) for the period 1988-1991 showed that the landings are already at MSY level. Even by hypothetically restricting the exploitation at 31 mm, there is only marginal scope to increase the yield to 1464 tonnes with increasing F by 40% (Fig. 3b). A look at 1990 data indicated that the size distribution was somewhat rationally spread along the whole range, and by following that pattern, there is scope to increase the yield to 1466 tonnes with increasing F by only 20%. Under the prevailing restricted conditions, this may appear a better alternative (Fig. 3C).

Deep burrowing habit of *A. granosa* coupled with soft muddy substrate in the Kakinada Bay provides natural protection from over exploitation and aid in natural conservation. However, selective exploitation of *A. granosa* of < 30 mm, if continued may lead to decline of yield over the years.

Under the existing methods there may not be any need to impose any such restrictions to the fishery of *A.granosa* in Kakinada Bay. However, regular monitoring of fishery along with size composition is essential to undertake stock

Table 3 : *Calculaltion of Yeild by Jones' Length Based Cohort analysis for* Anadara granosa *from Kakinada Bay based on 1991 data*

Length Group mm	Number caught ("000") L1-L2	Number of Survivors N(Li)	Exploitation Rate (F/Z)	Fishing Mortality (F)	Total Mortality	Body Weight (Z)	Mean Number (kg)	Mean (tonnes) ("000")	Yield (tonnes)
11-15	159	123792	0.0196	0.116	0.5932	0.0014	13644	18.7	0.21
15-19	1579	115698	0.1672	0.1168	0.6984	0.0037	13525	50	5.84
19-23	4063	106252	0.3467	0.3086	0.8902	0.0047	13164	61.3	18.93
23-27	4283	94533	0.3689	0.3389	0.9216	0.0073	12598	92.2	31.35
27-31	4175	82923	0.3845	0.3635	0.9451	0.0108	117736	126.3	44.92
31-35	4725	71785	0.4195	0.4203	1.0019	0.0151	11248	169.5	71.2
35-39	5225	60515	0.4648	0.5051	1.0463	0.0203	10806	219.5	106.2
39-43	5480	49274	0.5035	0.5899	1.1714	0.0266	9291.8	246.7	145.49
43-47	4599	38389	0.4925	0.5644	1.146	0.0389	8184.2	275.8	155.67
47-51	3440	29052	0.4544	0.4844	1.066	0.0423	7100.9	300.3	145.48
51-55	3144	21481	0.5101	0.6056	1.1872	0.0509	5632.5	286.5	160.09
55-59	2184	14795	0.4242	0.4285	1.0101	0.0628	5097.1	320.1	137.18
59-63	2117	9646.4	0.4727	0.5214	1.103	0.75	4060.5	304.5	158.78
63-67	2183	5167.7	0.5899	0.8366	1.4182	0.0856	2609.1	223.2	186.78
67-71	510	1467.5	0.4148	0.4122	0.9938	0.1034	1237.2	128.1	52.81
71	119	238	0.5	0.5816	1.1632	0.1156	204.6	23.7	13.76

assessment at frequent intervals and take suitable management measures, if required to regulate the fishery.

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