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60. ASPECTS OF THE BLOOD CLAM, *ANADARA GRANOSA* (LINNAEUS) CULTURE IN KAKINADA BAY

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ABSTRACT

A. granosa of mean length 25.2-25.9 mm, when grown in boxes for about 4½ months did not reveal any disparity in the growth rate at densities of 50-100/0.25m² but at 125-150/0.25m² the growth rate is significantly reduced. Growth in weight showed similar reduction. It is shown that in the Kakinada Bay, a stocking density of 100 clams/0.25 m² of about 7 g average weight gives the maximum production of marketabla size (25 g) *A. granosa* in about 4½ months. In the absence of a pen enclosure, field culture of *A. granosa* gave a production rate of 21 t/ha/6months with 41.5% retrieval. Although the clams have restricted movements their mobility is large enough to reduce both the retrieval and production rates by about 50% if pen enclosure is dispensed.

INTRODUCTION

The results of pen culture experiments conducted on *A. granosa* during 1979-80 in the Kakinada Bay on growth, production and retrieval were published (Narasimham 1980, 1983). It is of practical importance to determine the optimum stocking density in order to obtain the maximum production of marketable clams. Also, of importance is how the production was affected when culture is undertaken without pen enclosure. The results of a study undertaken during 1981-82 to throw light on these aspects are dealt in this paper.

MATERIAL AND METHODS

The details regarding the topography of the culture site, preparation of the ground, method of seed collection, stocking and harvesting are given by Narasimham (1983). The condition index, determined as percentage of wet flesh weight in total weight, was studied in a sample

of 25 clams, collected at monthly intervals from the clam farm and clam bed.

The effect of density on growth and production was studied by growtng clams of narrow length range in 5 dealwood boxes. Each box measured 50 cm x 50 cm x 15 cm. The boxes were filled to about 2/3 depth with sediment obtained from the clam bed from the top 10cm depth. After introducing the measured clams, the boxes were covered with synthetic webbing of 1 cm mesh. The boxes were positioned close to the eastern boundary of the clam culture site in the subtidal region. Once in a month all the clams were measured and reintroduced into the boxes after changing the sediment. Based on weekly observations, the monthly average temperature, salinity and dissolved oxygen of the waters over the clam culture site were calculated.

RESULTS

Environmental conditions In the clam culture site during May-October 1981 and March-September 1982, the temperature varied from 28.0 to 33.5°C and salinity from 15.06 to 34.40°/$_{oo}$. The maximum values for both these parameters were obtained during summer in May. With the onset of the south-west monsoon in June both the values declined by September/October. The dissolved oxygen was high and ranged from 5.18 to 6.80 ml/l.

Effect of density on growth and production Clams measuring 24.0 - 27.2 mm length (mean lengths 25.2-25.9 mm, mean weights 7.01-7.68 g) were stocked on 3-5-1981 in the boxes 1-5 with 50, 75, 100, 125 and 150 numbers/box respectively (Fig 1). In June and July the mean length of clams in any box was within one standard deviation of the mean length of clams in any other box. In August the mean length of 34.1 mm in box 5 was below one S. D. of the mean of clams in other boxes. On 16.9.81, when the experiment was terminated, the mean lengths in different boxes varied from 35.9 to 40.2 mm and mean weights 19.06 to 26.64 g; the mean lengths in boxes 4 and 5 at 37.3 and 35.9 mm respectively were below one S. D. of the mean lengths (39.6 to 40.2 mm) of clams in the other 3 boxes. Analysis of variance (Table 1) showed that the mean lengths attained by the clams in different boxes, at the termination of the experiment, were significantly different at 5%. The 95% confidence limits for 39.6 mm mean length (box 1) worked

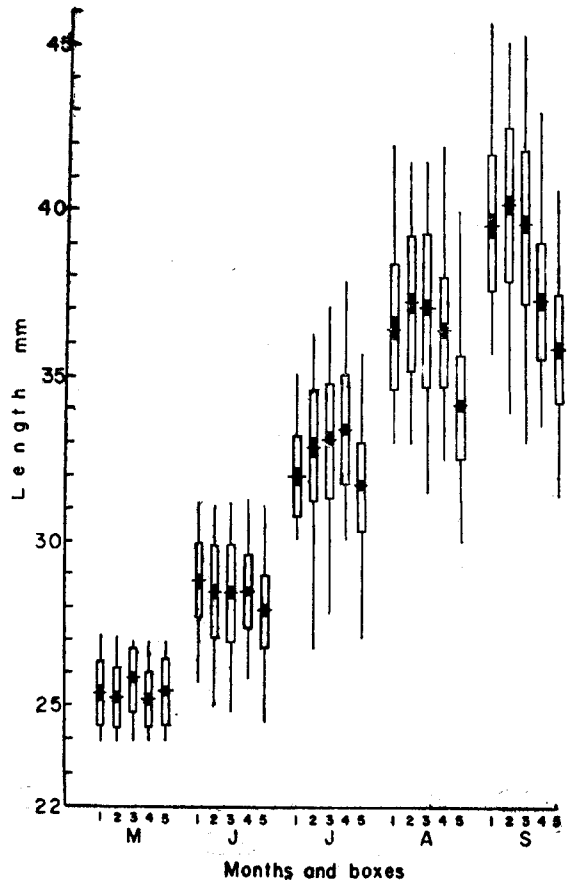

Fig. 1. *A. granosa* : Study of growth by placing clams in boxes during May-September 1981. The vertical line (not depicted in the area showing S.E and S.D) shows the range, the small horizontal line the mean, the shaded and open boxes together one standard deviation and the shaded boxe alone one standard error on either side of the mean. The numerals 1-5 in each month indicate the box numbers.

TABLE 1. *Analysis of variance of mean lengths of* A. granosa *in boxes as on 16-9-1981*

Sources of variation	d. f.	S. S.	M S.	F
Between boxes	4	1424.66	356.1650	92.573
within boxes	473	1819.83	3.8474	
Total	477	3244.49		

F. (d. f. 4. 473) 5% = 2.39

out to ± 0.6724; the mean lengths obtained in boxes 2 and 3 are within these limits while those recorded in the boxes 4 and 5 are outside the 95% confidence limits. This indicates that the slow growth observed in boxes 4 and 5 is significant when compared to the growth in the other boxes. On termination of the experiment, in boxes 1-3, the mean weight varied from 25.95 to 26.64 g whereas in boxes 4 and 5 it was low at 21.82 and 19.06g respectively. Thus the growth in weight also showed reduction in boxes 4 and 5. In the course of this study mortality of the clams was 11 in box 1, 2 in box 2, 1 in box 3, 2 in box 4 and 6 in box 5 and this could be due to predation by the crab, *Charybdis* sp (carapace length 5-7 cm) as inferred by their presence in the boxes which they obviously entered by damaging the webbing, covering the boxes.

To study the effect of density on production the data pertaining to box 1 was excluded from analysis since the mortality was 22%. In the remaining 4 boxes survival rate varied from 96-99% and it is assumed that the slight mortality of the clams observed is not significant to affect production. The production increased from1944.7 g in box 2 to 2744.6g in box 5 (Table 2) suggesting higher production with increase in density. However, the clams attained the marketable size of 25 g only at densities 75-100/0.25m²; at higher densities of 125-150/0.2 m² they did not reach the marketable size. In an earlier experiment (Narasimham 1983) it was shown that clams stocked at densities 10-60/0.2m² did not show any disparity in the growth rate. It is concluded that in the Kakinada Bay, under the prevailing conditions, maximum production of marketable size *A. granosa* can be obtained at a density of 100/0.25m².

TABLE 2. *Initial density (no/0.25 m²),survival, survival rate, average weight attained and production of* A. granosa *grown in boxes.*

Box no.	Initial density	Final no	Survival rate %	Mean wt g	Total wt g.
1	50	39	78.0	26.15	1019.9
2	75	73	97.3	26.64	1944.7
3	100	99	99.0	25.95	2569.0
4	125	123	98.4	21.82	2683.9
5	150	144	96.0	19.06	2744.6

Field culture: An estimated 1 million clams of the length range 17-25mm (mean length 21.8mm, mean weight 5 68 g) were transplanted in a 0.5 ha area between 22 and 31-3-1982 (Table 3).

TABLE 3. *Stocking, growth and harvesting particulars of* A. granosa *in 5000 sq. m during 1982.*

		Size range(mm)	Mean length	Mean weight g
Stocking:				
Dates 22 to 31-3-82		17-25	21.8	5.68
Estimated no	10 00,000			
Weight	5688 kg			
Density (No)	200/m²			
Grow out phase				
	30-4-82	21-31	26.1	10.00
	29-5-82	28-37	31.8	14.03
	29-6-82	30-39	33.6	17.02
	27-7-82	30-42	35.4	20.34
	31-8-82	32-44	37.8	23.81
Harvesting:				
Dates 20 to	30-9-82	34-50	39.7	25.33
Estimated no	4,15,000			
Retrieval rate	41.5%			
Production	10.51 t/0.5 ha/6 months			

This gave density of 200/m². Pen enclosure was not used. The clams were harvested between 20 and 30-9-1982 and an estimated 4,15,000 clams were retrieved (retrieval rate 41.5%). At harvest the mean length was 39.7 mm and mean weight 25.33 g. A production of 10.51 t/0.5 ha/6 months was obtained.

The condition index of the transplanted clams varied from 15.6 to 24.4 during May-September and this compared well with those studied from the clam bed (Table 4).

TABLE 4. *Monthly average condition index in* A. granosa *from the farm and clam bed*

Month	Condition index	
	Culture site	Clam bed
May'82	15.6	17.3
Jun	17.5	19.8
Jul	19.7	20.0
Aug	22.4	22.0
Sep	24.4	23.3

DISCUSSION

Broom (1982) stated that density and exposure are the main factors controlling the growth of *A. granosa* in Malaysia. It is shown that in the Kakinada Bay, densities of 75 and 100 clams/0.25m² did not affect the growth whereas growth rate is reduced at densities of 125-150/0.25m². Overcrowding may result in reduced food supply which in turn adversely affects the growth.

In Malaysia, *A. granosa* is stocked at high densities in the commercial farms and thinned more than once to attain final densities of 300 to 600/m² (Bardach et al 1972). In the pen culture experiments conducted at Kakinada (Narasimham 1980, 1983), the clams were stocked at densities 30 to 175/m². The present study suggests that in the Kakinada Bay, a stocking density of 400/m² is optimum for maximising the production of commercial size *A granosa*.

A. granosa has restricted movements and in the commercial culture operations in China and Malaysia, pen enclosures are not used (Zhong-Qing 1982, Oon et al 1982). However, in Taiwan for the nursery rearing of the spat of the same species, fencing by nylon netting is used (Chen 1976) and in Thailand, during the grow-out phase bamboo fences are erected to prevent the movement of *A. granosa* from the farm area (Saraya 1982). In the U. S. A., fencing was found to be necessary to exclude predators (chiefly crabs) in the experimental plots where the hard clam *Mercenaria mercenaria* was grown (Bardach et al 1972). In the earlier studies at Kakinada, when pen enclosure was used, a retrieval rate of over 83% and production rates of 38.5-41.6 t/ha in 5 to 5½ months were obtained for *A. granosa* (Narasimham 1980, 1983), whereas in the present study the retrieval and production rates came down to 41.5% and 21:0 t/ha/6 months respectively when the pen was not used. This suggests that under the local conditions, the movemements of the clams away from the farm area are substantial so as to reduce the retrieval and thereby production within the farm by about 50% when the pen enclosure was not used. In other words, although the clams have restricted movements, their mobility is sufficiently large so as to affect the production. In these studies a few crabs were observed in the boxes in which *A. granosa* was grown and they never occurred in abundance in the farm to warrant attention.

Considerable variation in the duration of the culture and production rate of *A. granosa* was reported from different countries. From China production rates of 23 5-60 t/ha/4.5 years were given (Zhong-Qing 1982). In Malaysia, this species reaches marketable size in 6-10 months (Bardach et al 1972) and a production rate of 40 t/ha/year was reported (Oon et al 1982). In Thailand the duration varies from 5 to 12 months depending on the size of the seed stocked and production rate of 31-109 t/ha/year were mentioned (Saraya 1982). The production figures obtained for *A. granosa* in the Kakinada Bay compare well with those reported from Malaysia and Thailand while in China, under the temperature conditions, the growth is slow requiring longer time to reach marketable size.

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