

SHORT COMMUNICATIONS

TABLE 3 — PERCENTAGE VALUE OF ASSIMILATION EFFICIENCY (A/C), GROSS GROWTH EFFICIENCY (K₁) AND NET GROWTH EFFICIENCY (K₂) IN *M. monoceros*

Food	Protein level	Assimilation efficiency A/C	Gross growth efficiency K ₁ or P/C	Net growth efficiency K ₂ or P/A
1 Estuarine detritus ¹	5	93.3	21.6	24.1
2 Trash fish ²	87	93.3	13.15	14.1
3 Low protein pellet ²	20	70.2	6.5	9.4
4 <i>Artemia salina</i> (adult) ²	60	79.1	30	37.9
5 JF ² 5	60	87.1	12.3	14.04
6 JF ² 7	60	84.6	16.5	19.4
7 JF ² 8	60	85.8	13.6	15.80
8 TNAU ³ 9	60	84	0.34	0.4
9 TNAU ³ 10	60	84.3	4.41	5.23
10 TNAU ³ 13	40	84.06	0.84	1
11 TNAU ³ 20	60	83.95	3.36	4
12 TNAU ³ 21	60	84.07	3.16	3.79
13 WFM*	60	69.43	3.83	5.6
14 CB*	40	66.81	3.99	6.03
15 JF 10*	60	72.31	7.86	11.12
16 TNAU 7*	50	63.91	2.03	3.21

*Present work and references 1, 2, 3 respectively.

may probably be attributed to the fact that the protein is derived from vegetable source alone and the foods need to be incorporated with growth promoters.

The 3 natural foods which gave higher conversion are incidentally cheaper. In commercial fishing, trash fish do not fetch a high price and very often they are discarded. Likewise, the adult *A. salina* which occurs abundantly in nature, merely perishes after releasing the eggs; it is also not utilized in mass culture programmes of *A. salina*. Detritus, on the other hand, in spite of its low protein content, is highly nutritive as it is rich in organic matter derived from plants and animals, enriched with microorganisms⁴. It is also known to occur abundantly in nature, especially in coastal and estuarine waters^{4,6}. Trash fish, adult brine shrimps, and detritus can be collected with relative ease, practically at no cost and with simple processing these can be used as feed for shrimps effectively. However, it would be interesting to test some of these results obtained under laboratory conditions by field trials.

The authors express their gratitude to Prof. D. J. Crisp, University College of N. Wales, Menai Bridge, UK, for planning out this work and for his valuable comments. The authors are thankful to Dr S. Z. Qasim, Director, for his suggestions to improve the manuscript. Thanks are also due to Prof. M. N. Kutty of Tamil Nadu Agricultural University, Coimbatore and to Dr C. B. Cowey, Institute of Marine Biochemistry, Aberdeen, UK, for the supply of feeds used in this study.

References

1. QASIM, S. Z. & EASTERSON, D. C. V., *Indian J. mar. Sci.*, 3 (1974), 131.
2. ROYAN, J. P., SUMITRA-VIJAYARAGHAVAN & WAFAR, M. V. M., *Indian J. mar. Sci.*, 6 (1977), 100.
3. ALFRED, J. R. B., SUMITRA-VIJAYARAGHAVAN, WAFAR, M. V. M., ROYAN, J. P. & JEYACHANDRAN, P., *Maha-sagar—Bull. natn. Inst. Oceanogr.*, (in press).

4. QASIM, S. Z. & SANKARANARAYANAN, V. N., *Mar. Biol.*, 15 (1972), 193.
5. DESHIMARU, O. & KUROKI, K. I., *Bull. Jap. Soc. Sci. Fish.*, 41 (1974), 413.
6. KRISHNA KUMARI, L., SUMITRA-VIJAYARAGHAVAN, WAFAR, M. V. M., ROYAN, J. P. & RAJENDRAN, A., *Indian J. mar. Sci.*, (in press).

Growth of the Bean Clam *Donax incarnatus* Gmelin from a Sandy Beach at Benaulim, Goa

ATTYAPPAN NAIR, S. G. DALAL & Z. A. ANSARI

National Institute of Oceanography
Dona Paula, Goa 403004

Received 8 May 1978; revised received 14 June 1978

Growth rate of *D. incarnatus* was determined for 1 yr in relation to ecological factors and meristic characters. Average monthly growth rate was 2.2 mm. Growth of newly settled animals was faster than the older populations. Growth was influenced by the availability of particulate organic carbon and chlorophyll *a* in the surf water. From the multiregressional analysis it was observed that 2 variables of meristic characters gave better estimates of growth than a single variable.

CLAMS of the family Donacidae occur abundantly on the surf-beaten sandy beaches along the west coast of India^{1,2} and these are valued as food by a large number of people in Goa. The abundance of *Donax incarnatus* at certain seasons of the year in some areas of the Goa coast is of the order of 7630 individuals/m² (ref. 2,3). Dimensional relationship of molluscs have been reported to vary with environmental factors^{4,5}. In the present communication an attempt has been made to describe the changes in growth of various meristic characters in relation to ecological parameters.

Animals were collected at monthly intervals for 1 yr (July 1973 to June 1974) from the exposed intertidal sandy areas of the beach at Benaulim, Goa. Data for the environmental parameters of the surf water were also collected from the sampling area. Analysis of water samples for oxygen, salinity, particulate organic carbon and chlorophyll *a* were

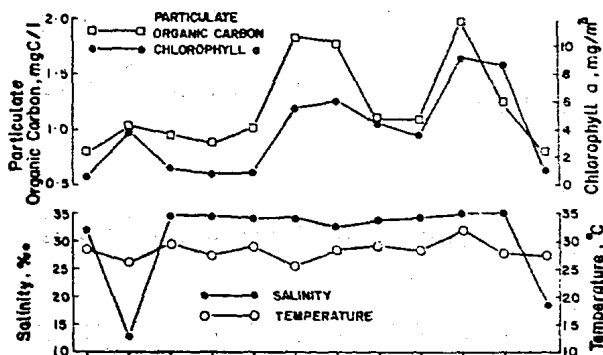


Fig. 1 — Monthly variations in salinity, temperature, particulate organic carbon and chlorophyll *a* of the surf water

carried out using standard methods⁶. The animals were measured with a vernier calipers to the nearest 0.1 mm. Individual body weights of the clams were determined on a sensitive monopan electrical balance. All calculations of meristic characters were carried out on a DCM Microsystem 1101.

Environmental factors — Surf salinity varied from 12.4 to 34.9‰ (Fig. 1). Due to the monsoonal rain, low salinities were observed in June and August. Temperature did not show a wide range of fluctuation, the lowest (25.5°C) was recorded in December and the highest (32°C) in April. The values fluctuated narrowly around 29°C during the rest of the year. Particulate organic carbon in the water column showed a gradual increase from 1.01 mg C/litre in August to 1.99 mg C/litre in April with a decline in February and March. Two peaks of organic carbon, one in December/January and another in April were observed (Fig. 1). Chlorophyll *a* in the surf also followed a similar pattern with 2 peaks, one in January (6.5 mg/m³) and the other in April (9.1 mg/m³).

Growth of meristic characters — From the length-frequency distribution no clear pattern of growth could be determined. The population was homogeneous consisting of clams of 16 mm in mean length. McLusky *et al.*² have also reported a homogeneous population of animals measuring 14.5 mm mean length from a nearby beach in Goa for the same species. Maximum sized individuals measuring 21.5 mm were recorded in April at this beach. In March and October, random sampling revealed the spatfall of clam measuring 3 mm in length. From the length frequency distribution it was observed that the growth of newly settled animals was faster by 1.5 mm than the older population. Monthly variations in growth in length ranged from 0.5 to 3 mm with an average growth rate of 2.2 mm per month. Shell weight was maximum in August with a value of about 1.4 g. Shell width/shell breadth ratios followed a similar trend as the shell length and shell weight (Fig. 2).

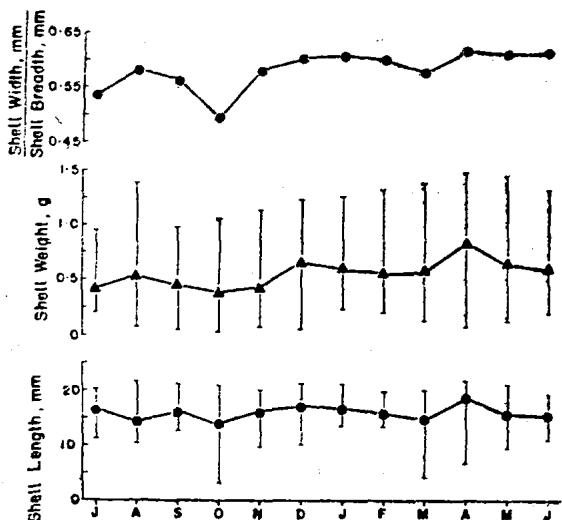


Fig. 2 — Variations in the meristic characters during different months [Dots represent mean values and lines represent range in values]

TABLE 1 — EQUATIONS DESCRIBING THE DIMENSIONAL RELATIONSHIP AMONG MERISTIC CHARACTERS OF *D. incarnatus*

Variables	Equation	r value	SE
WT	L = 8.16 + 7.68 WT	0.84	0.421
WF	L = 10.86 + 27.26 WF	0.9	0.389
WD	L = 10.42 + 132.96 WD	0.71	0.384
WS	L = 9.7 + 10.94 WS	0.93	0.371
SW	L = 3.64 + 1.8 SW	0.95	0.289
SB	L = 3.85 + 1.13 SB	0.96	0.301
WT, WS	L = 8.52 + 5.23 WT + 8.64 WS	0.81	0.25
WT, SW	L = 5.31 + 4.31 WT + 1.31 SW	0.86	0.245
WT, SB	L = 4.39 + 3.12 WT + 1.58 SB	0.79	0.23
WS, SW	L = 6.51 + 6.69 WS + 1.61 SW	0.88	0.201
WS, SB	L = 4.89 + 6.86 WS + 1.56 SB	0.8	0.198
SW, SB	L = 3.56 + 0.9 SW + 2.05 SB	0.86	0.189

L = length, WT = total weight, WF = wet flesh weight, WD = dry flesh weight, WS = shell weight, SW = shell width and SB = shell breadth.

Shell length when plotted against total weight, shell weight, wet meat weight and dry meat weight, gave the following isometric form of relationship:

$$L = a + bX$$

where *L* is shell length (independent variable), *X* is weight (total weight, shell weight, wet meat weight or dry meat weight) or width or breadth (dependent variable) as the case may be and *a*, *b* are constants determined by the least square method.

Regression equations obtained from different variables along with correlation coefficients and SE are given in Table 1. Relationships between the length and different meristic characters were linear (Table 1). Rao⁷ also observed a similar relationship in *Mytilus californianus*. However, Ansell *et al.*¹ reported an allometric type of relationship for the same species from Cochin and Shertalai beaches which generally holds good between 2 parts of the same animal. Isometric relationship inferred in the present study is probably due to environmental factors affecting the growth.

The rate of growth of different species of *Donax* has been reported earlier from the Indian Coasts^{1,8,9}. Mean monthly growth in different body measurements, calculated from the data obtained during the year, was: length, 2.2 mm; width, 1.4 mm; breadth, 1.1 mm; total weight, 1.25 g; shell weight, 0.96 g; wet meat weight, 0.28 g; and dry meat weight, 0.055 g.

Maximum size attained by *D. incarnatus* coincided with the high values of organic carbon in the surf (Fig. 1). Wade¹⁰ also suggested that the maximum size of the genus *Donax* is related to the organic carbon content of the surf. The shell weight and shell width/shell breadth ratio indicated a similar relationship with the availability of particulate organic carbon and chl. *a* content in the surf water (Fig. 2) as also observed in *Modiolus metcalfei*¹¹.

From Table 1 it is clear that variability in the estimate based on the shell weight is much smaller than that of any other character. This indicates that the use of shell weight of *D. incarnatus* is more accurate in estimating the growth than any other variable. Shell breadth and shell width or

SHORT COMMUNICATIONS

ratios of these two variables were considered the next best practical index for the growth as evidenced by the standard error shown in Table 1. More than 2 variables did not show any appreciable improvement in SE.

The authors thank Dr S. Z. Qasim, Director, for his constructive suggestions towards improvement of the manuscript. Thanks are due to Drs M. J. George and A. H. Parulekar for helpful discussions.

References

1. ANSELL, A. D., SIVADAS, P., NARAYANAN, B. & TREVALLION, A., *Mar. Biol.*, **17** (1972), 318.
2. McLUSKY, D. S., NAIR, A., STIRLING, A. & BHARGAVA, R., *Mar. Biol.*, **30** (1975), 267.
3. NAIR, A., *Indian J. mar. Sci.*, (in press).
4. DURVE, V. S. & DHARMA RAJA, S. K., *J. Mar. Biol. Ass. India*, **7** (1965), 69.
5. ANSARI, Z. A., NAIR, A., HARKANTRA, S. N. & PARULEKAR, A. H., *Bull. natn. Inst. Oceanogr.* (in press).
6. STRICKLAND, J. D. H. & PARSONS, T. R., *Bull. Fish. Res. Bd Can.*, **167** (1968), 1.
7. RAO, K. P., *Experimentia*, **9** (1953), 465.
8. NAIR, K. N., *Indian J. Fish.*, **2** (1955), 325.
9. ALAGARSWAMI, K., *J. Mar. Biol. Ass. India*, **8** (1966), 56.
10. WADE, B. A., *Proc. Gulf. Caribb. Fish. Inst.* (17th Ann. Sess.), 1964, 36.
11. PARULEKAR, A. H., ANSARI, Z. A., HARKANTRA, S. N. & NAIR, AYYAPPAN., *Indian J. mar. Sci.*, **7** (1978), 51.

Some Aspects of Culture of Mullet (*Mugil cephalus*) & Pearl Spot (*Etroplus suratensis*) in Siridaon Fish Farm, Goa

S. G. PRABHU MATONDKAR

National Institute of Oceanography
Dona Paula, Goa 403004

Received 22 March 1978

Results of a study on the culture of *M. cephalus* and *E. suratensis* in Siridaon Fish Farm are presented and the influence of ecological parameters on the growth is discussed. In spite of understocking the culture is economical and hence with proper stocking strategy the profit margin can be increased to higher level.

FISH farming, using traditional methods, is being practised in Goa since many years, and is proving quite economical¹. Application of scientific methods in aquaculture, especially raft culture of green mussels in Goa has shown high yield of quality food at high margins of profit². In these studies^{1,2}, stress has been laid on environmental and biotic parameters in undertaking successful aquacultural programme. This paper presents variations in temperature, salinity, dissolved oxygen, phosphate (PO₄-P), nitrate (NO₃-N), dissolved carbohydrate (D-CHO) and particulate organic carbon (P.O.C.) with special reference to stocking, growth and harvesting of mullet (*M. cephalus*) and pearl spot (*E. suratensis*), during Oct. 1975 to Feb. 1977. Organic carbon in the sediment has also been investigated.

Siridaon Fish Farm (Fig. 1) measuring about 3.5 hectares is situated on the Siridaon river, a tributary of the river Zuari. The fish farm is surrounded by paddy fields and there is also dense

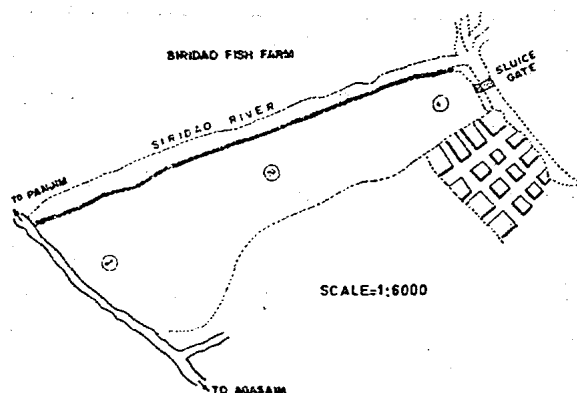


Fig. 1 — Siridaon Fish Farm, Goa with station positions 1 to 3

mangrove vegetation, especially on the 2 banks of the river Siridaon. The average depth of water in the farm is about 1 m and the water level is controlled through a single sluice gate situated in the eastern part of the farm. The Zuari estuary is highly productive at different trophic levels^{3,4}.

Monthly sampling was done at 3 stations (Fig. 1). In the farm in July 1976, 1000 fingerlings of mullet (*M. cephalus*) and 1500 of pearl spot (*E. suratensis*) were stocked. The intake of water was done during spring and neap tides and draining of water was controlled through a fine mesh nylon netting, for preventing the escape of organisms. The whole population was harvested in Feb. 1977 using drag and cast nets. All analysis were done by standard procedures^{5,6}.

Variations in different environmental parameters at 3 stations and at 2 depths, tested by *t* test, showed no significant difference between the stations. Maximum and the minimum water temperature value was recorded in April and December, respectively. Salinity varied markedly during the monsoon season (June to September) but the maximum value of 37.9 ‰ was recorded in March. Dissolved oxygen values did not vary significantly during the year. Variations in all the hydrological parameters were similar to those reported for Zuari estuary⁷. Dissolved carbohydrate cycle (Fig. 2) followed similar trend of variations, as in Zuari, where it is explained as a result of phytoplankton activity and a breakdown product of detritus⁸. Concentration of P.O.C. averaged from 540 to 4248 mg C/m³ in September and June respectively. High values in June may be due to high land drain off due to heavy monsoon showers. It is clear (Fig. 2) that P.O.C. and soil organic carbon is significantly related to the fish stocking time. Low level of P.O.C. at the time of harvesting shows that fish was obviously feeding on planktonic as well as sedentary communities. High level of soil organic carbon at the time of harvest may be related to fish excreta. The direct source of organic carbon in fish farm, was from dense mangrove vegetation in the surrounding areas. The organic carbon in the soil is equally important as average depth of water in the farm is 1 m.

Mean weight and length of *E. suratensis* and *M. cephalus* were recorded at the time of release and finally at harvesting. As seen in Table 1,