STUDIES ON THE OCCURENCE AND GROWTH RATES OF TWO INTERTIDAL FOULING BRYOZOANS IN THE MATTANCHERRY CHANNEL OF COCHIN HARBOUR, SOUTH-WEST COAST OF INDIA

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Occurrence and growth rates of two species of intertidal fouling bryozoans namely *Electra bengalensis* (Stoliczka) and *Electra crustulanta* (Pallas) are presented in this paper. The former was a typically marine form, settling on panels only during the high saline conditions of the premonsoon period and were absent during the low salinity conditions of the monsoon period, while the latter appeared to be a typical brackish water form settling on panels during the low saline conditions existing during the monsoon and postmonsoon periods and were totally absent during the premonsoon months. Regression co-efficient of the former was higher than that of the latter suggesting more pronounced growth in *Electra bengalensis*. Maximum growth for this species was noticed during March, April and May (pre-monsoon) while for the other species growth was more or less similar during monsoon and postmonsoon months (June-January) showing that the species was at home in oligohaline and mesohaline waters.

Introduction

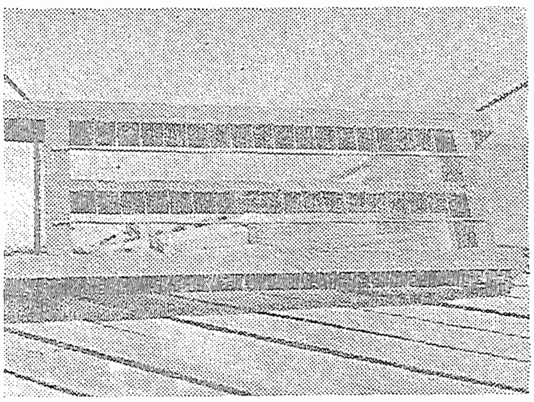
Bryozoans form part of the marine fouling organisms that are normally encountered on the ship's hull and other immersed structures in sea water. Bryozoan associations or their extensive colonies play an important ecological role in the sequence of settlement of the marine sedentary organisms (Sheer 1945). Instances have also been recorded where fouling on ship's hull has been exclusively by bryozoans (Visscher 1929). The occurrence and growth of bryozoans in the fouling complex constitute an important study in as much as their settlement has to be carefully prevented so that ships will have a smooth sailing. Friedle (1925), Marcus (1926) and Grave (1930) were some of the earliest workers to make some studies on bryozoans, followed later by

Paul (1942), Mawatari (1951, 1952 and 1953), O' Donaghue (1957), Ganapathi *et al* (1958) and Menon and Nair (1971). Scattered data on the growth of bryozoans have been published by the Woods Hole Oceanographic Institution (1952). The recent contribution by Menon and Nair (1969 b) has been on the growth rate of four species of intertidal bryozoans.

In the present paper the author describes in detail the occurrence and rates of growth of *Electra bengalensis* (Stoliczka) and *Electra crustulanta* (Pallas) from the Mattancherry Channel of the Cochin Harbour lying along the south-west coast of India. Cochin Harbour is situated on Lat, 9° 58'N, Long. 76°17'E. For greater details on the collection site attention is invited to Balasubramanyan and Menon (1963) and Nair (1967).

Materials and Methods

Surfaces chosen for the collection of bryozoa were smooth glass panels, 150 mm x 100 mm x 3 mm, fitted on to a groved wooden rack in two rows of seventeen each. The panels were arranged at a distance of 5 cm from each other and held in position by means of two brass rods screwed to the rack with its long axis horizontal. The wooden frame together with glass panels (Photograph) was slung



The Immersion Rack and Test Panels used for collecting the bryozoans

endwise on two treated (creosoted) manila ropes, tied to the station quay, exposed and examined as shown in tables I and II. Recordings of air temperature, surface water temperature, salinity and dissolved oxygen were also made corresponding to the period of exposure.

The panels were withdrawn as per the immersion schedule shown in the tables, immediately dipped in 5% formalin and dried. The bryozoan colonies in each panel were counted, identified and diameters of the circular colonies in two directions at right angles to each other were measured and the averages taken. About 10 colonies in each panel were measured taking care to select only the large forms assuming that they had settled earlier. The average of 10 colonies from each panel was taken and recorded as the growth of the bryozoa for the respective days as shown in the tables.

For determining the maximum growth taking place during the various periods of immersion, the data were analysed statistically and 95% confidence intervals were calculated (table III). To determine which of the two species shows more pronounced growth, regression co-efficients of the two species were calculated for the different series and growth equations of the form y=abx were fitted to the data by the method of least squares after converting the curves into straight lines by taking the logarithmic values of y (Table IV). The closeness of the fit of the equations is presented in Figs 1-9. The data collected provide an idea of the occurrence and variations in growth rates of the two species under reference.

Based on hydrographical and meteorological conditions, the year was divided into three well defined periods namely, premonsoon (February, March, April and May), monsoon (June, July, August and

Table 1 Settlement, Age and Growth of *Electra Bengalensis*, Air Temperature, Water Temperature, Dissolved Oxygen and Salinity.

Date of observation	Age in days	Total number of colonies present	Average growth of the colony mm	Air temp. °C	Water temp. °C	Dissolved oxygen ml/L	Salinity ‰
1	2	3	4	5	6	7	8
Series 1 (1963 March 6 to April 19-Pre-monsoon)							
1963 March 8	2	Nil	—	31.7	30.5	2.5	30.0
,, 12	6	36	2.4	31.5	30.8	3.0	29.0
,, 13	7	39	3.2	31.8	30.8	3.5	31.4
,, 14	8	43	4.4	31.5	31.0	3.0	30.5
,, 15	9	27	4.5	31.0	30.5	2.5	31.0
,, 16	10	44	5.5	31.0	30.5	2.7	30.0
,, 18	12	41	6.4	31.5	31.0	2.5	29.4
,, 19	13	42	7.5	31.0	31.5	2.2	29.5
,, 20	14	39	8.1	31.5	30.5	2.2	30.5
,, 21	15	32	14.8	30.5	31.5	2.5	32.3
,, 22	16	42	13.0	31.0	31.0	4.0	31.8
,, 23	17	32	18.0	30.5	31.0	2.4	31.9
,, 25	19	31	18.6	30.0	31.0	4.4	30.5
,, 26	20	40	22.3	30.0	31.5	4.3	30.9
,, 27	21	24	25.5	30.0	31.5	4.2	28.9
,, 28	22	22	27.7	30.0	31.5	3.7	28.9
,, 29	23	33	36.2	31.5	30.0	4.2	30.8
,, 30	24	46	33.3	31.5	31.3	5.0	30.4
,, April 1	26	28	40.0	29.9	31.1	4.4	33.6
,, 3	28	33	53.0	30.4	31.5	4.6	33.4
,, 4	29	30	38.5	30.0	31.3	4.5	33.1
,, 5	30	23	43.2	29.8	30.0	4.4	34.0
,, 6	31	28	44.7	31.2	31.1	3.8	32.4
,, 8	33	30	39.6	32.9	31.7	4.2	32.4
,, 9	34	30	39.8	31.8	31.6	4.2	32.7
,, 10	25	26	48.9	32.4	31.2	4.1	32.2
,, 11	36	23	46.6	30.2	31.1	4.4	31.5
,, 15	40	25	33.0	32.4	31.2	4.1	32.4
,, 16	41	15	34.0	31.2	31.3	4.8	32.0
,, 17	42	5	40.5	31.0	31.1	5.1	33.2
,, 18	43	26	37.7	31.8	31.8	4.7	33.2
,, 19	44	37	22.5	33.8	32.1	3.9	32.9
Series 2 (1963 April 23 to May 29-Pre-monsoon)							
1963 April 29	6	1	1.0	32.8	31.2	2.3	33.0
,, 30	7	2	1.2	31.6	31.5	2.7	32.2
,, May 6	13	9	1.5	31.8	32.0	4.3	32.8
,, 8	15	3	3.0	31.9	31.9	3.9	32.6
,, 9	16	2	2.5	32.6	32.5	4.4	31.6
,, 10	17	7	3.6	32.4	32.2	2.3	31.3
,, 13	20	8	4.6	34.0	32.1	3.5	31.6

(Contd......)

1		2	3	4	5	6	7	8
,,	14	21	11	4.9	32.0	31.6	3.7	31.1
,,	18	25	Nil	—	33.1	31.5	1.5	30.9
,,	20	27	Nil	—	29.7	31.4	3.6	30.5
,,	21	28	3	10.6	29.5	30.7	3.5	30.5
,,	23	30	6	11.6	33.5	31.8	3.6	28.9
,,	24	31	8	11.6	33.4	31.8	4.3	27.7
,,	25	32	7	13.2	28.8	31.0	4.2	26.7
,,	27	34	7	10.5	31.3	30.9	3.6	25.2
,,	28	35	9	9.2	32.9	30.9	3.2	28.0
,,	29	36	4	5.9	32.9	31.4	3.8	24.8
Series 7 (1964 January 4 to February 24-Pre-monsoon)								
1964 January 6 to 15 No settlement								
,,	16	13	1	2.8	28.0	28.1	3.8	31.8
,,	17	14	1	3.0	28.4	28.0	4.2	32.3
,, 18 to 30 No settlement								
,,	31	28	6	1.3	31.0	29.0	2.4	33.1
,, Febru:	1	29	1	1.5	28.5	29.1	6.2	33.1
,, 3 to 10 No settlement								
,,	12	40	2	6.3	28.7	28.8	6.0	33.0
,,	13	41	3	13.0	28.0	28.5	3.8	33.4
,,	17	45	15	6.4	29.7	29.1	4.5	34.0
,,	18	46	10	9.5	29.6	29.1	5.0	34.0
,,	20	48	3	5.5	31.0	30.0	4.8	34.0
,,	21	49	9	11.0	31.0	30.0	3.8	34.0
,,	22	50	7	10.5	32.0	30.5	5.2	34.3
,,	24	52	3	15.5	30.1	30.4	5.8	32.9
Series 8 (1964 February 26 to May 23-Pre-monsoon)								
1964 March	4	7	2	2.2	30 2	30.7	5.0	32.0
,,	13	16	20	6.6	32,0	31.2	2.6	33.6
,,	16	19	25	15.8	31.3	31.0	2.0	32.2
,,	17	20	21	11.7	31.3	30.6	3.8	32.9
,, April	1	35	42	27.2	31.2	30.0	6.4	32.9
,,	18	52	36	26.7	31.0	30.5	6.4	32.0
,,	24	58	70	21.6	31.8	31.0	4.8	34.0
,,	25	59	15	19.6	32.0	31.6	6.1	33.8
,, May	5	69	50	14.7	31.0	30.5	3.0	31.4
,,	6	70	120	23.8	32.0	31.5	3.6	33.1
,,	11	75	56	35.5	31.0	30.5	3.0	31.4
,,	18	82	40	37.2	31.6	31.0	4.2	32.9
,,	20	84	86	30.2	31.0	30.7	4.2	32.9
,,	23	87	70	21.3	30.5	30.8	4.2	32.8

(Concluded)

Table 2 Settlement, Age and Growth of *Electra crustulanta*, Air Temperature, Water Temperature, Dissoloved Oxygen and Salinity

Date of observation	Age in days	Total number of colonies present	Average growth of colony mm	Air temp. °C	Water temp. °C	Dissolved oxygen ml/L	Sa linity ‰
1	2	3	4	5	6	7	8
Series 3 (1963 June 13 to July 26-Monsoon)							
1963 June 24	11	56	2.0	30.0	29.6	5.4	13.4
,, 27	14	34	2.5	27.5	27.9	5.3	8.4
,, 29	16	47	2.6	28.2	28.2	6.3	6.2
,, July 1	18	41	2.7	27.2	28.4	5.5	6.0
,, 2	19	50	4.6	27.0	28.0	7.0	6.6
,, 3	20	54	4.7	30.3	28.1	6.8	6.3
,, 4	21	60	4.5	27.9	27.7	5.6	6.2
,, 5	22	80	4.8	27.6	27.6	5.4	5.0
,, 6	23	85	7.2	28.1	27.0	4.8	4.6
,, 8	25	87	5.2	24.4	26.7	5.0	1.7
,, 9	26	101	7.2	28.5	27.9	5.0	1.5
,, 10	27	85	5.5	28.5	28.1	4.5	1.0
,, 11	28	92	6.0	30.2	28.9	4.5	1.0
,, 12	29	61	7.6	29.0	29.1	5.8	1.0
,, 13	30	120	5.7	28.5	29.5	6.0	1.1
,, 16	33	120	4.7	28.6	29.9	5.9	1.1
,, 17	34	135	8.9	28.5	29.0	5.6	1.1
,, 18	35	108	9.5	28.8	29.1	5.5	1.4
,, 19	36	201	8.8	28.1	29.2	4.2	1.3
,, 20	37	178	7.2	28.3	29.4	4.6	1.6
,, 22	39	110	9.8	28.2	28.9	4.4	2.3
,, 23	40	121	11.5	28.5	29.1	6.0	5.9
,, 24	41	131	9.5	28.6	29.0	5.1	4.5
,, 25	42	95	13.5	28.5	29.1	5.3	4.0
,, 26	43	65	17.3	26.5	27.9	5.2	3.8
Series 4 (1963 July 31 to September 19-Monsoon)							
1963							
August 17	17	22	2.7	26.3	27.6	5.5	3.3
,, 19	19	24	3.6	28.8	28.8	5.7	2.5
,, 20	20	31	4.0	28.4	28.9	5.8	2.2
,, 21	21	31	5.0	26.5	27.8	3.6	2.5
,, 22	22	36	7.1	28.3	28.5	2.2	2.3
,, 23	23	26	9.7	28.9	28.6	5.4	1.6
,, 24	24	47	10.1	28.2	29.0	6.2	1.8
,, 27	27	56	14.3	25.7	28.0	4.8	2.4
,, 28	28	49	10.9	26.7	27.3	5.2	2.2
,, 29	29	47	9.5	27.5	28.3	4.4	1.2
,, 30	30	31	14.8	28.4	28.4	5.6	1.1
September 4	35	33	1.1	27.8	29.2	5.8	1.6
,, 5	36	36	15.8	29.4	29.5	5.5	2.2

(Contd.........)

1	2	3	4	5	6	7	8
1963 September 6	37	50	16.9	28.5	29.8	5.7	2.3
,, 7	38	31	22.2	29.3	29.2	5.9	2.1
,, 9	40	54	24.8	30.1	29.5	5.1	5.6
,, 10	41	38	18.6	31.0	30.0	5.5	5.5
,, 11	42	38	15.2	27.5	29.0	5.0	5.5
,, 19	50	50	20.2	29.8	30.1	4.0	5.2
Series 9 (1964 July 17 to September 21-Monsoon)							
1964 July 27	10	54	6.15	27.7	28.1	4.2	1.47
,, August 3	17	60	14.50	28.5	28.0	7.2	0.66
,, 10	24	47	18.00	30.4	28.8	6.6	0.77
,, 17	31	30	16.1	27.6	28.8	8.0	0.63
,, 28	42	28	22.4	26.0	28.0	6 6	9.11
,, 31	45	17	28.3	29.0	28.8	6.2	9.4
,, September 7	52	18	36.6	26.8	28.2	6.0	5.2
,, 21	66	14	35.3	27.7	27.2	6.0	0.5
Series 5 (1963 September 26 to November 8-Post-monsoon)							
1963 October 8	12	4	1.5	30.2	29.3	6.0	11.1
,, 10	14	6	2.1	31.0	30.0	6.2	12.1
,, 14	18	5	1.8	29.5	30.0	7.4	7.3
,, 15	19	6	3.1	28.5	29.4	6.6	8.2
,, 16	20	6	2.7	29.4	29.9	5.4	10.1
,, 17	21	3	5.7	28.6	29.4	6.0	7.5
,, 18	22	12	2.2	29.0	30.0	5.0	5.7
,, 19	23	23	5.8	29.4	30.0	6.0	5.7
,, 21	25	15	8.0	28.4	29.1	5.0	8.9
,, 22	26	19	5.8	29.0	28.2	5.2	8.0
,, 23	27	19	7.2	27.3	28.1	5.1	5 6
,, 24	28	29	6.9	25.5	27.5	5.7	3.6
,, 26	30	19	5.3	30.1	28 1	6.6	2.6
,, 28	32	27	9.0	28.8	29.0	4.8	0.7
,, 29	33	40	10.5	30.0	29.0	6.4	0.8
,, 30	34	35	11.3	29.0	29.5	6.2	1.8
,, 31	35	24	7.0	30.0	29.2	6.0	3.3
,, November 1	36	34	9.2	30.3	29.5	6.0	7.6
,, 2	37	35	12.4	30.0	28.0	6.4	7.8
,, 4	39	46	16.7	30.9	29.8	5.4	5.4
,, 5	40	36	10.9	31.0	29.9	6.2	17.5
,, 6	41	40	13.5	31.8	30.0	6.5	20.8
,, 8	43	29	14.2	29.0	29.2	6.2	16.7
Series 6 (1963 November 13 to December 28-Post-monsoon)							
1963 Nove: 20	7	1	1.0	29.7	29.9	4.2	24.8
,, 21	8	3	1.2	29.3	29.9	4.4	16.3
,, 22	9	3	4.0	29.5	30.0	4.4	18.8
,, 27	14	6	6.4	28.1	30.0	4.0	20.6
,, 29	16	8	7.0	28.4	28.8	4.1	26.0

(Contd.........)

1	2	3	4	5	6	7	8
1963 December 2	19	3	8.0	28.0	28.9	3.8	25.7
,, 3	20	4	7.9	28.7	29.2	3.9	26.0
,, 5	22	9	8.0	27.2	28.3	3.8	24.9
,, 6	23	9	11.4	27.9	28.5	3.8	24.9
,, 8	25	2	13.1	30.4	29.5	3.6	21.9
,, 11	28	8	14 3	27.0	28.5	4.2	13.2
,, 15	33	5	14.7	29.1	29·5	4.2	15.9
,, 18	35	3	14.2	27 8	28.2	4.0	21.3
,, 24	41	5	10.6	28.6	28.8	4.0	28.5
,, 26	43	9	13.4	26.2	28.6	3.6	28.8
,, 28	45	2	9.3	28.0	29.0	3.4	29.8

Table 3 95% Confidence Interval of Growth Rate for *Electra Bengalensis* and *Electra Crustulanta* for Different Periods

Species	Periods	Series	Periods of immersion	95% confidence interval
Electra bengalensis	Premonsoon	1	8–3–63 to 19–4–63	25.42±5.77
-do-	-do-	2	29-4-63 to 29-5-63	7.45±3.091
-do-	-do-	7	4-3-64 to 23-5-64	21±5.9
-do-	Monsoon	No settlement		
-do-	Post monsoon	No settlement		
Electra crustulanta	Premonsoon	No settlement		
-do-	Monsoon	3	24-6-63 to 26-7-63	6.94±1.49
-do-	-do-	4	17-8-63 to 19-9-63	12.5±3.10
-do-	Post monsoon	5	8-10-63 to 8-11-63	7.51±1.87
-do-	-do-	6	20-11-63 to 28-12-63	9.50±2.48
-do-	Premonsoon	No settlement		

Table 4 The Regression lines and Growth curves fitted to the data

Species	Series	Periods of immersion	Regression lines	Growth curves
Electra bengalensis	1	Premonsoon 8-3-63 to 19-4-63	Y=0.0598x + 0.1257	y=1.1336 (1.148)x
	2	Premonsoon 29-4-63 to 29-5-63	Y=0.0437x — 0.2488	y=0.5639 (1.106)x
	7	Premonsoon 6-1-64 to 24-2-64	Y=0.0398x — 0.9472	y=0.1129 (1.096)x
	8	Premonsoon 4-3-64 to 23-5-64	Y=0.0088x + 0.7814	y=6.045 (1.021)x
Electra crustulanta	3	Monsoon 24-6-63 to 26-7-63	Y=0.0228x + 0.1357	y=1.367 (1.054)x
	4	Monsoon 17-8-63 to 19-9-63	Y=0.0259x + 0.2359	y=1.721 (1.061)x
	5	Postmonsoon 8-10-63 to 8-11-63	Y=0.0292x — 0.0477	y=0.896 (1.069)x
	6	Postmonsoon 20-11-63 to 28-12-63	Y=0.0257x + 0.4134	y=2.590 (1.061)x
	7	Monsoon 6-1-64 to 24-2-64	Y=0.0114x + 0.8716	y=7.440 (1.027)x

x=Days y=Diameter of the colony Y=log y

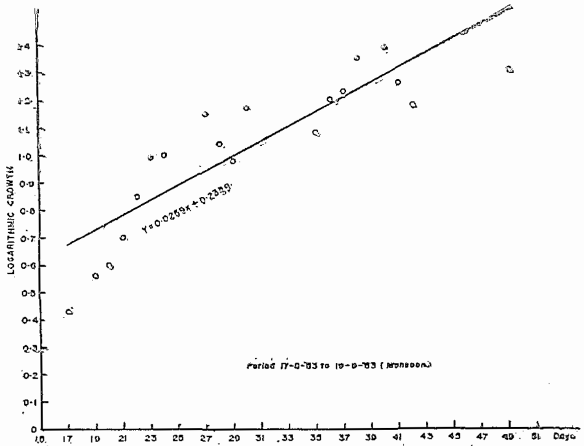


Fig.1. REGRESSION LINE OF ELECTRA CRUSTULANTA PALLAS IN SERIES IV

Fig 1

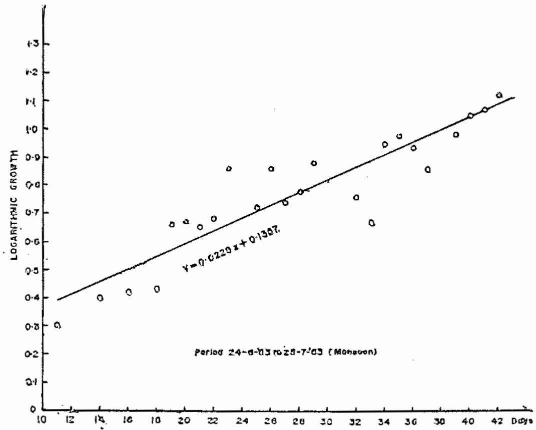


Fig.2. REGRESSION LINE OF ELECTRA CRUSTULANTA PALLAS IN SERIES III

Fig 2

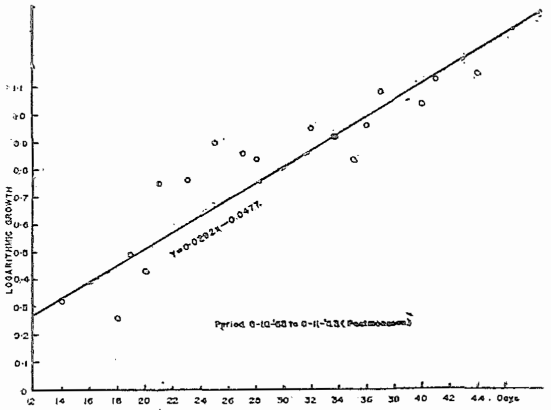


Fig.3. REGRESSION LINE OF ELECTRA CRUSTULANTA PALLAS IN SERIES V

Fig 3

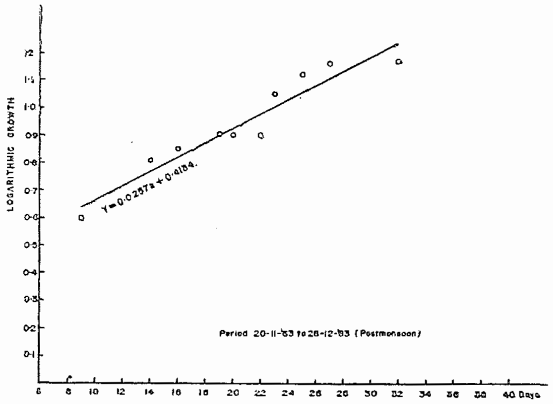


Fig.4. REGRESSION LINE OF ELECTRA CRUSTULANTA PALLAS IN SERIES VI

Fig 4

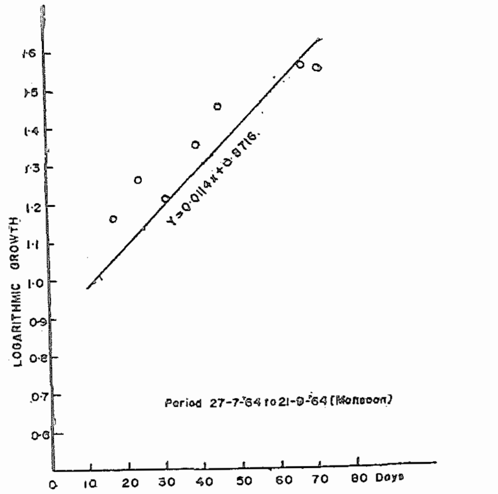


Fig.5. REGRESSION LINE OF ELECTRA CRUSTULANTA PALLAS IN SERIES IX

Fig 5

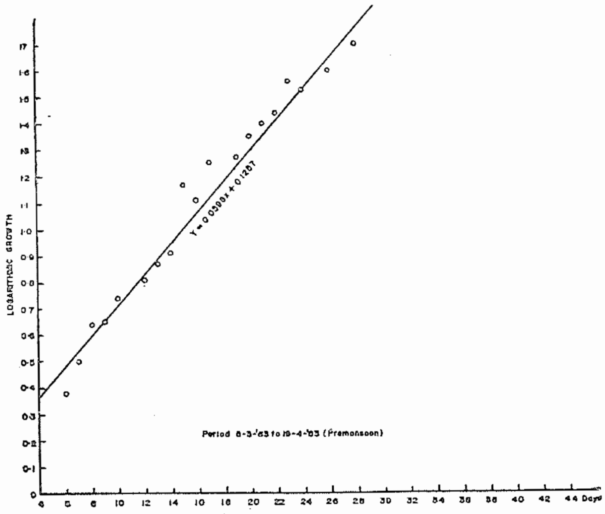


Fig.6. REGRESSION LINE OF ELECTRA BENGALENSIS IN SERIES I

Fig 6

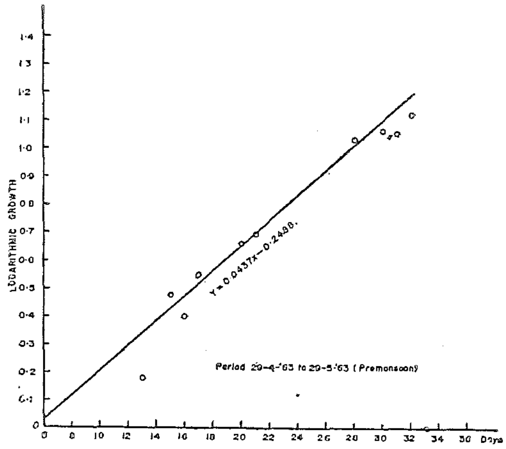


Fig 7. REGRESSION LINE OF ELECTRA BENGALENSIS IN SERIES II

Fig 7

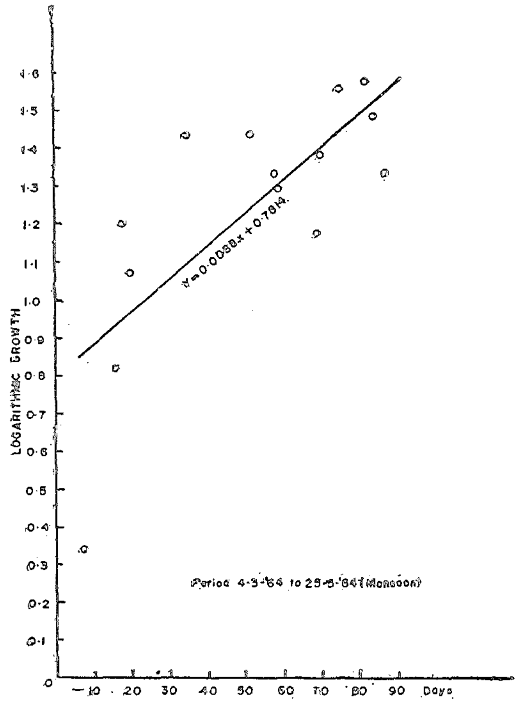


Fig 9 REGRESSION LINE OF ELECTRA BENGALENSIS IN SERIES VIII.

Fig 9

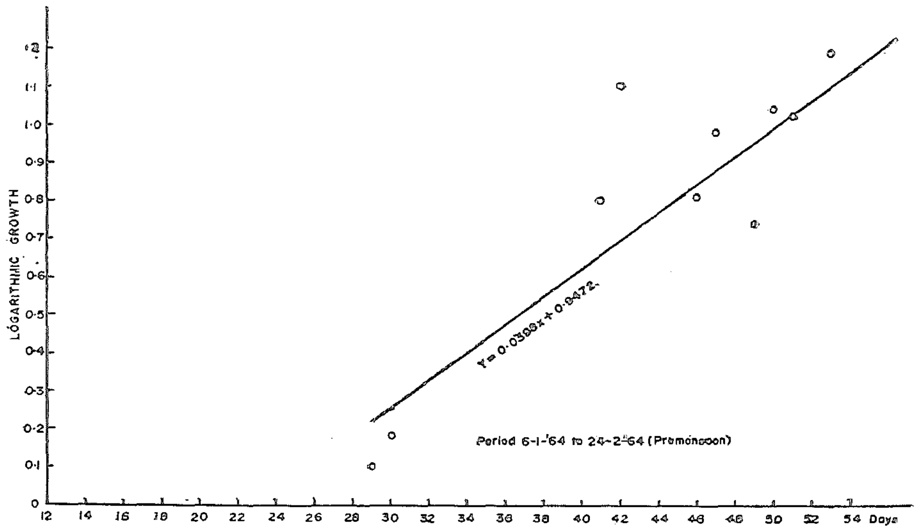


Fig 8. REGRESSION LINE OF ELECTRA BENGALENSIS IN SERIES VII

Fig 8

September) and post-monsoon (October, November, December and January) as followed by George and Kartha (1963), Nair (1965) and Nair (1967).

Results and Discussion

It was interesting to note that there was distinct period of occurrence for the two species with reference to the distribution of salinity in the estuary. During the study the salinity of the medium was fluctuating from 0.5‰ to 34‰ due to the influx of freshwater as a result of monsoon rains. *Electra bengalensis* settled on the panels only during high saline conditions at the pre-monsoon period and they were completely absent during the low saline conditions occurring during the monsoon months showing their typical marine nature. *Electra crustulanta* appears to be a typical brackish water form settling on the panels during low salinity periods of monsoon and post-monsoon. They were able to tolerate vide fluctuations in salinity, though not typical marine conditions of the pre-monsoon period during which they were totally absent. The former were not found below a salinity of 24.8‰ (Table I) while the latter were found settling on panels when the salinity of the estuary varied from 0.5 to 29.8‰ (Table II), their numbers being maximum on test panels during very low salinity (series 3). The settlement of a significant nature during June-July was indicative of the fact that for breeding of this species, though continuous during the monsoon and post-monsoon periods, a reduction in salinity of the ambient water by mid-July appears to trigger off a spontaneous breeding resulting in subsequent increase in their rate of settlement as has been clearly observed during the present study. Skerman (1957) attributed the influence of sea water temperature to the growth of *Bugula neritina* and *Corella eumyota* in the Littleton port investigations. However temperature variation was not very much marked in Cochin Harbour but variation in salinity influenced the sequence of occurrence and growth of the two species of *Electra* under study.

Electra bengalensis showed maximum growth rate during the pre-monsoon months of March, April and May (series, 1,7 Table III) while for *Electra crustulanta* growth was more or less the same during monsoon and post-monsoon periods (Table III) and extended from monsoon to post-monsoon period evidently suggesting that the species was at home in oligohaline and mesohaline waters. Comparison of the regression co-efficients of the two species presented in Figs 1-9 showed higher co-efficient for the former indicating more pronounced growth. The regression curves and growth lines fitted to the data are presented in table IV.

Acknowledgement

I wish to record my thanks to Dr. A. N. Bose, former Director of Central Institute of Fisheries Technology, for his interest and encouragement in the work and to Dr. V. K. Pillai, present Director for kindly permitting to publish the data. I also thank Mr. R. Balasubramanyan, Head of the Craft Materials Section for his guidance in the work and critical reading of the manuscript, Dr. N. R. Menon, Meere Station, Biologische Austalt Helgolands, West Germany, for the correct identification of the species and Shri. H. Krishna Iyer for the Statistical treatment of the data.

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