Ecological Studies on the Fauna Associated with Economic Seaweeds of South India-2. Distribution in space and time

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Introduction

Quantitative studies are of great value in ecological investigations as the numerical, volumeteric or gravimetric estimations of the populations provide estimates of productivity and standing crop and enable numbers and weights of animals in a given habitat to be compared both in time and in space. Colman (1940) was the first to estimate the numerical abundance of the fauna inhabiting intertidal seaweeds. Later, many attempts have been made by various workers (Wieser, 1952, 1959; Chapman, 1955; Glynn, 1965; Hagerman, 1966; Jansson, 1967; Moore, 1971) to study the algal communities in the temperate waters. From the Indian coasts, the only study of similar nature is by Sarma and Ganapati (1972) who studied the numerical distribution of phytal fauna on 13 species of seaweeds from the intertidal regions of Visakhapatnam coast. The spatial and temporal distribution of the macrofauna inhabiting intertidal seaweeds at Mandapam Camp is discussed in this paper.

Materials And Methods

The intertidal region at Mandapam Camp (Lat. 90° 16′ N; Long 79° 12′E) presents a typical surf beaten tropical rocky shore. The intertidal substratum, formed of sandstone, has a vertical expanse of seven metres. 25 belt transects, each of 25 cm in breadth, running from the highest higher highwater level (HHHWL) to the infralittoral fringe were fixed. In each month, one transect was selected at random for sampling. Monthly samplings were made from January to December 1970 during the neap tides. From each transect, samples were collected by scraping the algae present in a 25 cm^2 quadrat at intervals of 50 cm from the HHHWL to the infralittoral fringe. The highest vertical limit of the algae was at the quadrat situated at a distance of 4 m from the HHHWL. The levels of the quadrats in relation to the zero of Chart Datum were: 4.0 m = +0.60; 4.5 m = +0.50; 5.0 m = +0.40; 5.5 m = +0.35; 6.0 m = +0.30; 6.5 m = +0 25. In the laboratory each sample was washed thoroughly and holdfasts of algae teased out. The washings were filtered through a mesh (1.0 mm) which retained the macrofauna. The animals were sorted out into various groups under a dissection microscope. The sediment content was estimated as percentage volume of the total from each quadrat.

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Results

The quantitative (numerical) distribution of the various dominant animal groups are given below:

Table 1. The quantitative distribution of Polychaetes (No/m²) on the inter-tidal algae during the period January-December 1970.

Distance from HHHWL / Months	4.0 m	4.5 m	5.0 m	5.5 m	6.0 m	6.5 m
January 1970	14176	12064	11024	15664	13904	11184
February	0	4128	114320	68800	22512	27312
March	0	0	14368	10144	7456	8008
April	0	0	1248	592	13488	2004
May	0	3088	63552	912	2832	1886
June	0	9024	10640	29280	—	—
July	12560	17280	18200	—	—	—
August	15320	18530	17820	20400	19530	21320
September	14380	17590	18410	18360	20140	19830
October	16000	13480	21300	—	—	—
November	14880	13920	17120	—	—	—
December	16320	15040	20640	—	—	—

— = Collections were not possible from these levels due to severe wave action.

1. Polychaetes

Table 1 presents the vertical distribution of polychaetes during the period January—December 1970. During January, when the observations commenced, the distribution of polychaetes was more or less uniform on the intertidal algal bed. The period February to April recorded a gradual downward migration in the population from the + 0.60 level to 0+.40 and lower levels. The least density was during April, when the distribution was limited to a narrow belt in between + 0.25 and + 0.40 levels. An upward migration in the distribution during May. During July-December, population density increased considerably at all levels studied, resulting in a luxurient population of intertidal polychaetes. The highest density at + 0.35 level during August shifted to + 0.40 level during September—December.

Table 2. The quantitative distribution of Gastropods (No/m²) on the inter-tidal algae during the period January-December 1970.

Distance from HHHWL / Months	4.0 m	4.5 m	5.0 m	5.5 m	6.0 m	6.5 m
January 1970	0	0	304	9440	368	320
February	0	0	0	5008	256	432
March	0	0	800	9120	832	0
April	0	0	0	8256	544	0
May	3200	0	80	0	0	0
June	0	0	160	224	—	—
July	16	0	1280	—	—	—
August	64	2192	1168	1088	368	0
September	512	2592	1248	2816	832	0
October	480	4896	2688	—	—	—
November	592	960	1376	—	—	—
December	640	768	1584	—	—	—

— Collections were not possible from these levels due to severe wave action.

2. Gastropods

The vertical distribution of gastropods during the period under observation (Table 2) showed two trends : a wider distribution on the intertidal algae at levels lower than + 0.40 during January—July and a narrower but more abundant distribution at the higher levels (+ 0.30 to + 0.60) during August-December. Maximum densities were found at + 0.40 and + 0 50 levels. They were either totally absent or present in small numbers at the lower levels (+ 0.30 and + 0.25) during August-September.

Table 3. The quantitative distribution of bivalves (No/m²) on the inter-tidal algae during the period January–December 1970.

Distance from HHHWL / Months	4.0 m	4.5 m	5.0 m	5.5 m	6.0 m	6.5 m
January 1970	2192	1696	2688	640	1552	2880
February	0	2912	368	2096	1872	1440
March	0	0	1152	608	1184	0
April	0	0	640	160	1536	0
May	0	544	128	160	2048	0
June	0	688	640	784	—	—
July	928	1280	0	—	—	—
August	1168	1360	2112	1328	1696	608
September	1968	2816	2880	2208	1552	272
October	1776	2560	2928	—	—	—
November	2176	2688	1644	—	—	—
December	2576	2864	368	—	—	—

— Collections were not possible from these levels due to severe wave action.

3. Bivalves

Although the bivalves were more or less uniformly distributed on the intertidal algae during January, a characteristic feature during the period February–May was the confinement of the upper and lower limits to the levels + 0.50 and + 0.30 respectively (Table 3), During the rest of the year an upward migration by shifting the upper limit to +0.60 level was evident. Maximum densities during this period were around + 0.40 level, with the higher and lower levels indicating marked reduction in numbers.

Table 4. The quantitative distribution of amphipods (No/m²) on the inter-tidal algae during the period January–December 1970.

Distance from HHHWL / Months	4.0 m	4.0 m	5.0 m	5.5 m	6.0 m	6.5 m
January 1970	1424	2976	1280	3520	2720	1760
February	0	208	2144	5808	2112	1744
March	0	0	3408	3568	2448	0
April	0	0	256	288	80	0
May	0	160	64	16	0	0
June	32	0	128	32	—	—
July	80	112	160	—	—	—
August	256	370	960	1104	576	432
September	160	560	1088	1280	496	288
October	960	1120	4576	—	—	—
November	1168	1408	4480	—	—	—
December	1328	1536	5216	—	—	—

— Collections were not possible from these levels due to severe wave action.

4. Amphipods

A tendency to concentrate at levels between + 0.35 and + 0.40 was exhibited by amphipods during February–May period (Table 4). During June and Jnly a clear-cut upward migration to the level + 0.60 was noticed. August–December recorded the highest densities of ampipods during the year. Maximum concentrations during this period were at levels + 0.40 and + 0.50.

Table 5. The quantitative distribution of isopods (No/m ²) on the inter-tidal algae during the period January - December 1970.

Distance from HHHWL / Months	4.0 m	4.5 m	5.0 m	5.5 m	6.0 m	6.5 m
January 1970	496	1408	2016	2752	1920	736
February	0	1392	64	224	368	368
March	0	0	480	4384	128	0
April	0	0	1984	32	384	0
May	512	64	0	16	0	0
June	0	0	0	128	—	—
July	32	96	160	—	—	—
August	160	208	256	352	512	640
September	320	720	1632	1376	368	272
October	480	1952	2768	—	—	—
November	704	2336	4384	—	—	—
December	864	2976	3696	—	—	—

— = Collections were not possible from these levels due to severe wave action.

5. Isopods

Table 5 presents the numerical distribution of isopods. It appears from the data that they preferred to occupy rather lower levels (+ 0.30 to + 0.40) during Feburary–April. During May and June their distribution was irregular. However, during July–December, a clear-cut preference to higher levels (> + 0 35) was evident. Maximum densities were recorded at + 0.40 during this period.

Table 6. The quantitative distribution of harpacticoids (No/m^2) on the inter-tidal algae during the period January-December 1970.

Distance from HHHWL / Months	4.0 m	4.5 m	5.0 m	5.5 m	6.0 m	6.5 m
January 1970	2586	5296	11776	7152	3680	2080
February	0	6080	15744	4256	400	48
March	0	0	15600	848	80	0
April	0	0	6240	12480	3136	0
May	0	2752	6000	16	224	0
June	0	3728	640	96	—	—
July	60	2176	224	—	—	—
August	6720	8768	13760	3760	3600	2080
September	6800	9536	16096	3920	4288	3696
October	8352	10848	15776	—	—	—
November	9216	11904	16384	—	—	—
December	6240	13840	19904	—	—	—

— Collections were not possible from these levels due to severe wave action.

6. Harpacticoids

High densities of harpacticoids were recorded throughout the year at various levels on the intertidal algae (Table 6). The highest densities during February-May were at + 0.40 level. May, June and July witnessed an upward shifting of the concentrations to + 0.50 level. Very dense populations were recorded at all levels higher than around + 0.30 during August-December.

Table 7. The quantitative distribution of miscellaneous groups of animals (No/m^2) on the inter-tidal algae during the period January–December 1970.

Distance from HHHWL / Months	4.0 m	4.5 m	5.0 m	5.5 m	6.0 m	6.5 m
January 1970	16	480	714	842	1226	2080
February	0	0	490	768	1408	944
March	0	0	32	80	800	0
April	0	0	0	16	48	0
May	0	0	0	0	0	0
June	0	0	0	48	—	—
July	0	0	0	—	—	—
August	0	0	592	768	5472	7104
September	496	1408	7104	4800	2080	2272
October	384	2080	6176	—	—	—
November	640	1466	7360	—	—	—
December	160	4896	5888	—	—	—

— = Collections were not possible from these levels due to severe wave action.

7. Miscellaneous groups

This included porifera, turbellaria, ostracoda, tanaidacea, decapoda and egg masses. They were present in any appreciable quantity only during August–January. A striking decline in the abundance was evident during February–April (Table 7). Further, their reduction in numbers or absence from intertidal algae was conspicuous during March–July. Dense populations appeared at the lower levels (+ 0.25 and + 0.30) during August which migrated to higher levels (+ 0.40 and + 0.50) during September–December. The upper limit of their distribution was + 0.60 level during this period.

Table 8 The temporal distribution of dominant species of algae and the sediment content (as % shown in brackets) at various levels (— = no data)

Distance from HHHWL / Period	4.0 m Level: +0.60	4.5 m Level: +0.50	5.0 m Level: +0.40	5.5 m Level: +0.35	6.0 m Level: +0.30	6.5 m Level: +0·25
January 1970	Cladophora (90.4)	Cladophora Hypnea (77.3)	Cladophora Hypnea (90.7)	Champia Hypnea (82.0)	Jania Champia Padina (87.5)	Jania Padina (84.0)
February	0	Cladophora (70.0)	Hypnea Champia (85.0)	Hypnea Champia (41.6)	Jania Padina (84.7)	Jania Padina (83.3)
March	0	0	Hypnea Jania (78.2)	Hypnea Champia (77.8)	Jania Padina (60.6)	Jania Padina (80.8)
April	0	0	Chaetomorpha Hypnea Jania (76.2)	Jania Hypnea (72.5)	Jania Hypnea (20.7)	Padina (62.5)
May	0	Cladophora Hypnea (82.5)	Hypnea Chaetomorpha Jania (87.8)	Jania Padina (23.0)	Padina (17.0)	—
June	Enteromorpha Cladophora (14.3)	Chaetomorpha (36.7)	Hypnea Jania (92.4)	Hypnea Jania (90.0)	—	—
July	Cladophora (77.0)	Chaetomorpha (88.0)	Champia (90.8)	—	—	Gracilaria (0)
August	Cladophora (90.1)	Hypnea Jania (84.5)	Champia Jania (93.0)	Champia (92.3)	Padina Gracilaria (43.0)	Gracilaria (0)
September	Cladophora (91.8)	Hypnea Jania (88.0)	Champia Jania (88.7)	Padina (70.0)	Gracilaria (0)	—
October	Cladophora (90.0)	Hypnea Jania (92.5)	Champia Jania (90.7)	—	—	—
November	Cladophora (88.0)	Hypnca Jania (90.0)	Champia Jania (89.3)	—	—	—
December	Cladophora (83.4)	Hypnea Jania (84.7)	Champia Jania (82.1)	—	—	—

Discussion

The spatial and temporal distribution of the fauna can be related to the changes in the hydrographic characteristics of the surface water, meteorological changes in the climate and seasonal succession in algal communities. The surface water temperatures during 1970 were as follows: <28° C during October-December; 28-30°C during January, February and June-September; >30° C during March-May. The surface water salinity was <32‰ during January and October-December and >32‰ during February-September. The highest salinity (36.39‰) was during July. A clear-cut change in the wind velocities is apparent. During January-May, the shore experiences normal wind velocities up to 10 knots per hour while wind velocities as high as 16 knots per hour are common during June-December (Indian Daily Weather Reports, 1970). The period October-December is also characterised by stormy weather and very turbulent sea. While the high wind velocities are thus typical of the south-west monsoon (June-September) and the North-East monsoon (October-December) periods, the bulk of the rainfall is limited to the November-January period (La Fond, 1958). The distribution of the dominant species of algae and the sediment content are given in Table 8.

A critical analysis of the distribution of the algae and the inhabiting fauna reveals a very interesting pattern. During the summer months (February - May) the algae occupy a lower level on the intertidal region. This period is characterised by intensive insolation and high temperatures. The tidal effect is very pronounced on the intertidal region, resulting in a narrow, more or less mixed belt of intertidal algae. It has been found that during this period of intensive desication, comparatively rich populations of polychaetes, amphipods and harpacticoids are supported by the intertidal algae. The other groups of animals are less dense and distributed in between + 0.40 and + 0.50 levels. The sediment content of the algae varied over a wide range during this period. The distribution pattern changed by the onset of the South-West monsoon. The severe wind and the resultant wave action shifted the upper limit of the algae to a much higher (+0.60) level. The effects of low tides were nullified by the high waves wetting the intertidal region. This resulted in a wider and more marked distribution of the algal communities. This situation was intensified by the North-East monsoon during October-December. Not only did this result in an upward shifting of the upper limit of the algal belt, but also the appearance of many algal species which are otherwise subtidal, at the +0.25 level. The sediment contents were high at the higher levels. The cryptofauna also exhibited a similar upward migration along with the algae. Denser populations of all groups were recorded during this period, most of which however, preferred a higher level on the shore.

The vertical distribution of the animals inhabiting seaweeds is more strongly influenced by the nature of the substratum than is the distribution of normal intertidal fauna of rocky shores (Wieser, 1952). Therefore, the upper limits of the algae will determine the upper limits of many organisms living on algae. It is evident from the tables that two types of organisms inhabit the intertidal algae: one group lives on it permanently throughout the year and the other only during those months when the algae are constantly wetted by waves and tides. It is also evident that such types are constitued not by taxonomic groups, but by individual species or even ecological variants.