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# ECOLOGICAL STUDIES OF *ULVA RETICULATA* FORSSKAL IN CHAPORA BAY (GOA)

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## ABSTRACT

The patchy occurrence of *Ulva reticulata* Forsskal along the west coast of India lead to its ecological studies. The total annual yield of *U. reticulata* calculated for 3800 sq. m. area of the bay amounts to 6 74 tonnes wet weight and 0.932 tonnes dry weight. Anatomical structure and development of lacunae which are typical of this species have been discussed.

Benthic fauna in the algal bed showed dominance of edible bivalves *Meritrix casta* (Chemintz), *Crassostrea gryphoides* (Gmelin) and *Mytilus viridis* Linne. *M. casta* showed highest population density. Average clam landings of this bay was 6.3 tonnes a year.

*Key-words*: Ecology, *Ulva reticulata*, Chapora Bay, Goa

## *INTRODUCTION*

The ecology and biology of marine algae have been studied earlier along some parts of the Indian coast by Srinivasan (1946), Varma (1959), Misra (1960), Umamaheswara Rao and Sreeramulu (1964), Krishnamurthy (1965) and Umamaheswara Rao (1969 and 1972). Recently, the seaweed resources and its ecology along the Goa coast were studied by Agadi and Untawale (1978) and Untawale and Dhargalkar (1975). The present investigation deals with the various aspects like morphology, anatomy, growth and life cycle of *Ulva reticulata* Forsskal and its role in the productivity of Chapora Bay has been discussed. Changes in the environmental parameters caused by south west monsoon and its effect on the growth as well as production of benthic algae have been studied. Attempts have also been made to find out the possible relationship between *U. reticulata* and the edible bivalve *Meretrix casta* (Chemintz).

## MATERIALS AND METHODS

*Ulva reticulata* was collected from four stations in the Chapora Bay (Fig. 1). It was cleaned and treated with antibiotics (like streptomycin) to remove epiphytes and then washed with synthetic sea water.

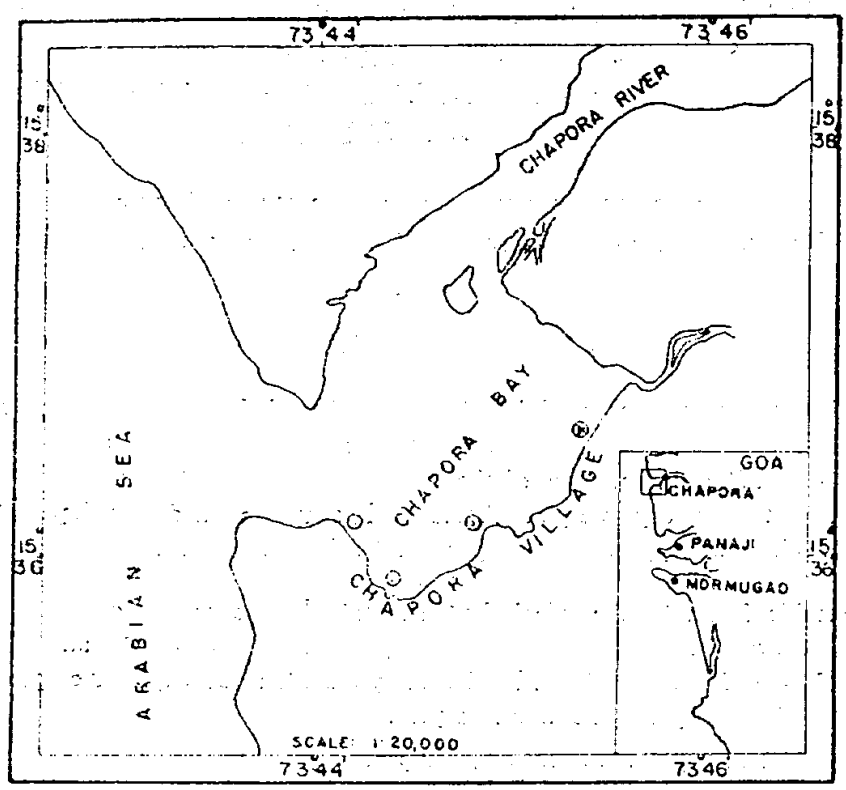


Fig. 1 Map showing station positions in Chapora Bay.

After 24 hrs, this was once again treated with the same antibiotics and washed with seawater and then cultured in Guillard's f/2 medium. During culture, different structural and reproductive stages were studied (Dhargalkar, 1978).

Environmental parameters like temperature, dissolved oxygen, salinity, nutrients, pH and suspended particulate organic matter (from the water column) were studied at monthly intervals from the four stations for a period of one year from June 1976 to July 1977 by following standard methods given by Strickland and Parsons (1968). Organic carbon from the sediment was analysed after El Wakeel and Riley (1957) and Riley (1963).

For benthic floral study, a quadrant of 1 sq.m was placed in an area of seaweeds. Collected seaweed samples were then washed with fresh water, sorted, weighed and dried for further studies. Benthic fauna was studied, as suggested by Parulekar (1973). Triplicate benthic samples were taken from all the four stations.

## RESULTS

*Morphology and anatomy of the alga*

The thallus cells pale green in colour in surface view are polygonal and arranged with their long axis at right angle to the surface ranging from 12.4 to

18.6 μ to 24.8 to 27.9 μ in size. In the transverse section, the thallus shows two layers of cells which are longer than broad and each cell containing a single parietal chloroplast, often with deeply incised or lobed margin and single pyrenoid. The thickness of cuticle varied from 9.3 to 12.4 μ.

The thallus of *U. reticulata* generally grows parallel to the substratum and attains the length of 62.4 to 187.2 cm and 10 to 20 cm width. The two layers of the cells get dilated in some parts of the thallus and function as air bladder (Fig 2). In transverse section of the bladder, it was observed that a few marginal cell walls stretch forming an elongated strand giving additional strength to the air bladder which thus prevent them from bursting.

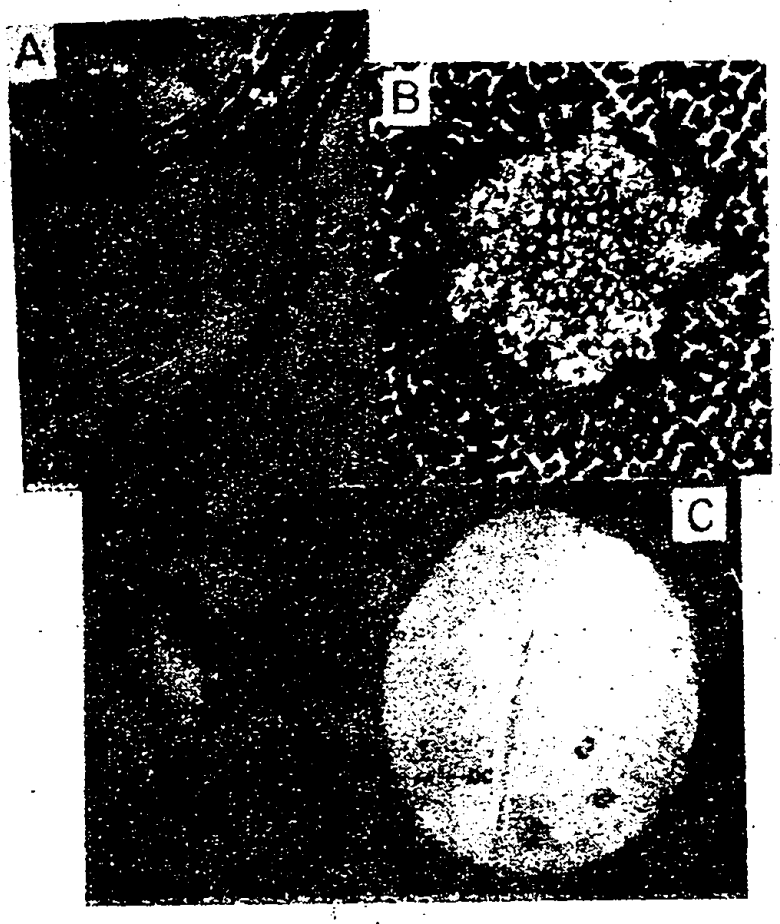


Fig. 2 A. T.S. of the thallus showing an air bladder; B. Surface view of the thallus showing degenerating cells and C. Surface view of the thallus showing lacunae. (DC — degenerating cell)

The specific character of this taxa is the reticulate nature of the thallus. However, there is no information available about the development and formation of lacunae in *U. reticulata*. It was observed that a group of thallus cells

ranging in shape and size (.4 to .7 cm) loose pigments and result in the coagulation of the contents and then gradually, degenerate thus forming a small opening or lacuna. The surrounding cells of this lacuna also degenerate in due course and widen the lacuna (Fig. 2 B&C).

*Environmental parameters*

*Salinity*:- Salinity values exhibited wide range (0.76 to 35.7‰) of fluctuations in Chapora Bay during south west monsoon. Minimum and maximum salinity values at all the four stations coincided with peak monsoon and peak summer respectively. Dissolved oxygen concentrations at 4 different stations fluctuated between 2.5 to 6 ml/1. No definite patterns were observed during the period of observations.

*Nutrients* : Phosphate concentration in Chapora Bay waters did not show much variation except at stations 2 and 3 where high values of 2.25 and 4.05 $\mu$g at PO4-P/1 were observed in December and February respectively. High concentration of nitrate was observed during the monsoon season at all stations. Nitrite also did not show much variation except in the month of July, at station 2.

*Organic carbon* : Organic carbon values were high at station 4 and ranged from 2.6 to 9.0% while at stations 1, 2 and 3, it varied from 0.24 to 3.2% Stations 1 and 2 are sandy in nature and showed high values of organic carbon during September. Station 3 showed comparatively high values during July when the substratum was silty sand and during December and February when the substratum was sandy, silty clay and sandy silt, respectively. Percentage composition of substratum during different seasons is given in Table I.

Table I. Percentage composition of sand, silt and clay.

| Season | Stn.No. | Sand | Silt | Clay |
|---|---|---|---|---|
| Pre-monsoon | 1 | 78.52 | 18.05 | 3.45 |
| | 2 | 81.80 | 16.20 | 2.00 |
| | 3 | 23.29 | 57.76 | 18.95 |
| | 4 | 31.56 | 49.74 | 18.70 |
| Post-monsoon | 1 | 82.46 | 15.66 | 1.88 |
| | 2 | 79.95 | 17.72 | 2.33 |
| | 3 | 36.53 | 42.65 | 20.81 |
| | 4 | 44.32 | 38.91 | 16.76 |
| Monsoon | 1 | 82.94 | 15.33 | 1.73 |
| | 2 | 82.39 | 17.24 | 0.37 |
| | 3 | 56.52 | 34.02 | 9.46 |
| | 4 | 38.15 | 45.56 | 16.28 |

*Suspended particulate organic matter* : Suspended particulate organic matter at stations 2 and 3 showed three peaks during October, February and May. Maximum value observed in the month of June at station 4 was 3782 mg C/$m^3$. Values showed monthly fluctuations ranging from 78.9 mg C/$m^3$ to 3872 mg C/$m^3$ .

*Benthic algal distribution and biomass* : At station 1, maximum algal production of *U. reticulata* was 749.8 g/$m^2$ during December. At station 2 and 3, production was 1220.3 g/$m^2$ and 535.0 g/$m^2$ during January and February respectively. At station 4, highest production of 1518.0 g/m was observed in February. Second dominant species, during the month of January was *Enteromorpha clathrata* which showed production of 1410.0 g/$m^2$. *Ectocarpus* species showed production of 20.63 and 180.3 g/m in January at station 1 and 4 respectively. Other algal species namely *U. fasciata, Gracilaria verrucosa, Padina tetrastromatica, Hypnea musciformis* were observed in negligible quantity. Total annual yield of *U. reticulata* calculated for 3800 $m^2$ area at Chapora bay comes to 6.74 tons wet weight and 0.932 tons on dry weight basis.

*Benthic faunal distribution and biomass* : Benthic population in sandy and silty substratum were dominated by bigger sized faunal elements, such as pelecypoda and polychaeta. Mean percentage composition of the bomass for different groups in Chapora Bay during the year were, Polychaeta 26.88%, Mollusca 24.44%, Gastropoda 41.55% and Crustacea 7.12% (Fig 3).

Among Molluscs dominant edible species observed were *Meretrix casta, Crassostrea gryphoides* and *Mytilus viridis*. Vast beds of *M. casta* were present at stations 3 and 4. Total annual yield of this clam at this locality has been estimated to be 6.3 tons a year (Goa Fisheries, personal communication).

## DISCUSSION

Earlier reports on *U. reticulata* for the west coast of India are by Boergesen (1935) from Bombay and Krishnamurthy and Joshi (1969) from Diu in Gujarat. The present record at Chapora Bay is the third report on *U. reticulata* along the west coast of India and the first report from the Goa coast.

Boergesen (1935) reported *U. reticulata* from Bombay and compared it with the original species of Forsskal. On comparison, it was observed that Indian species of *U. reticulata* has broader reticulate tissue which also agrees with the species under investigation. Thivey and Sharma (1966) reported similar species from Okha, which has narrow ribbons between the lacunae

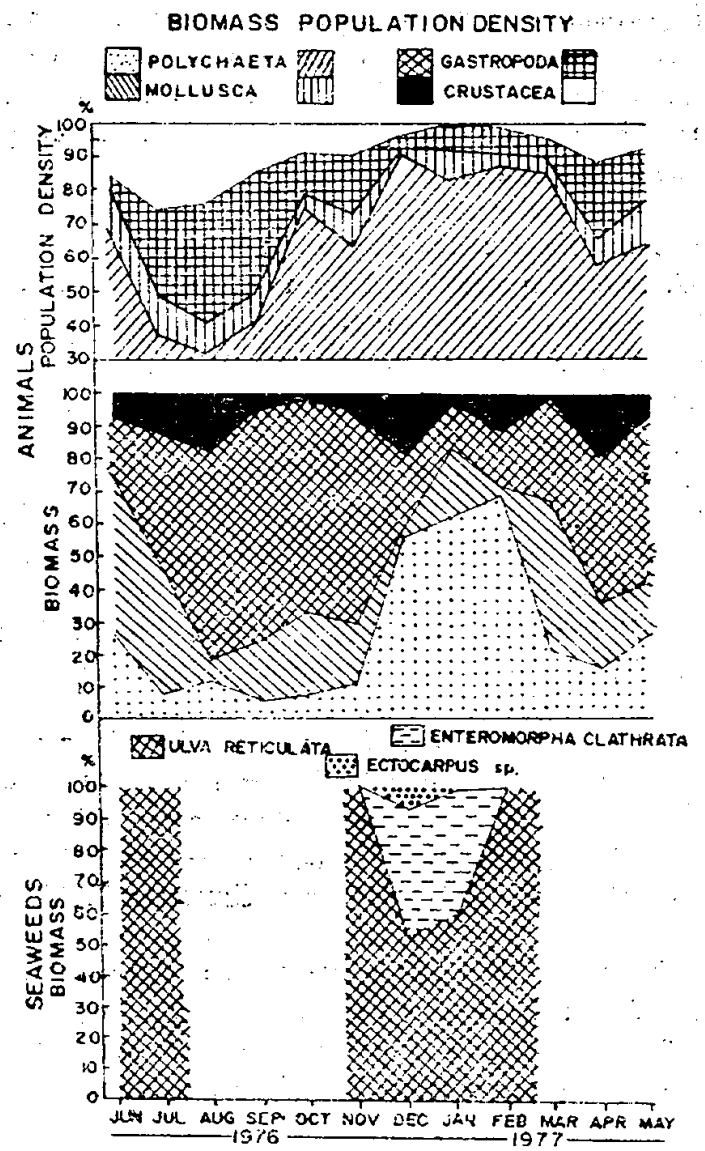


Fig. 3 Mean production of seaweed and benthic animals.

with clear geometric pattern. Based on this minor difference, the species from Okha was named as *Ulva beytensis* by Thivey and Sharma (1969). *Ulva reticulata* species showing similar characters have been collected by the authors from Killakkarai (Tamil Nadu). Further, Krishnamurthy and Joshi (1969) differentiated *U. reticulata* from *U. beytensis* on the basis of "microscopic teeth" on the margin of the lacunae. However, detailed observations revealed that no such teeth are present in the species.

An interesting feature which has not been reported so far in any species of *Ulva* is the formation of air bladder in the thallus. The water column in Chapora Bay is more turbid, particularly during the high tide. In order

to float near the surface to obtain maximum sunlight for photosynthesis, it appears that the alga has developed this particular morphological adaptation.

Zygote or zoospores of *U. reticulata* show longer resting period as compared to other species of *Ulva* along the Goa coast. On the basis of present investigation, it was observed that *U. reticulata* crop in Chapora Bay comes to an end in June and reappears in the month of December, while species of *Ulva fasciata* present in Chapora Bay and elsewhere along the Goa coast grow from September onwards. Thus, the resting period of reproductive stages of *U. reticulata* is 5 months while for *U. fasciata* it is only 3 months (Dhargalkar, 1978). This may be because of the environmental factors also. However, due to the delay in monsoon in 1976, stray occurrence of *U. reticulata* was observed up to the 1st fortnight of July.

Low salinity values from July to September coincide with the low growth of *U. reticulata*. However, *U. fasciata* present at station 1 was found growing during the monsoon months also. This shows that *U. reticulata* requires high salinity for its growth unlike *U. fasciata*.

Nutrient concentrations were found to be high during the monsoon months due to the rain water runoff as suggested by Emery and Stevenson (1957) and also sewage drainage coming from the surrounding Chapora Village. High algal biomass of 1518.0 g/m$^2$ in the Chapora Bay was recorded in February. The alga has the ability to utilize organic nitrogen present in the sewage in the form of ammonia. Nutrients for the alga are derived from aerobic decomposition of organic matter from the sewage by bacteria to ammonia. Growth of *Ulva* and the influx of sewage have been linked by many workers and confirmed by the report of Wilkinson (1964), Subbaramaiah and Parekh (1966), Golubic (1970) and Burrows (1971).

Luxurient growth of *U. reticulata* at station 4 may be due to sewage disposal which increases the nutrients, while at other stations, it gets diluted due to tidal currents. Ganapati and Raman (1973) obtained similar results while studying the effect of pollution on the algae of Alexandria. Probably, this may be the reason that demarcates the quantity of algal production from station 4 to station 1 at this locality.

The amount of organic carbon produced in Chapora bay depends on the degree of decomposition of *U. reticulata*. After the release of spores, the alga usually degenerates and within a short period, gets completely decayed forming detritus. Sediments hold organic carbon for some time and then release or lose it either in the water column or because of animals which feed on them. The

black silty clayey mud of Chapora Bay has a high percentage of organic carbon. concentration of organic carbon in the sediment in the Chapora Bay is inversely proportional to the sand grain size. Kuenen (1950) has also observed similar relationship. The detritus as well as the suspended organic matter is consumed by the detritovorous animals and filter feeder bivalves. It gives additional evidence for the luxurient crop of bivalves in this bay.

According to Newell (1965) and Odum (1968), detritus derived from the alga serves as a link between different trophic levels as many animals feed on the detritus. Hence, it can be said that contribution of *U. reticulata* to the productivity of the bay is substantial.

Suitable substratum is an important factor for the growth of *U. reticulata* During the present investigation it was found that suitable substratum for this alga are polychaete tubes inspite of silty and sandy substratum. High population density of polychaete in Chapora Bay provides a suitable substratum to this alga. Hence, high nutrients and suitable substratum coupled with high salinity, increase the productivity of *U. reticulata.* It can be said that *U. reticulata* and polychaetes are symbiotic in nature.

It is known that qualitative and quantitative distribution of benthic fauna has a direct relationship with the type of substratum and feeding grounds. This commercially important clam forms a major part of the community due to its euryhaline and euroecious ability (Parulekar, Dwivedi and Dhargalkar, 1973). The high population density *of M. casta* may be attributed to the dissolved organic matter originated from *U. reticulata* of Chapora bay.

Thus, on the basis of the above studies, it can be concluded that luxurient growth of *U. reticulata* in the Chapora Bay was due to the presence of high nutrients from sewage effluent, suitable substratum like polychaete tubes and optimum salinity. The algal detritus increases the productivity of the Bay and provides necessary feeding grounds rich in organic matter to *M. casta* and other bivalves. Hence, the alga after decay forms a pathway to the trophic chains and thus supports the benthic population of the area.

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