

## Studies on the associate flora in the mangrove environment of Goa, India

T. G. JAGTAP

National Institute of Oceanography, Dona Paula 403 004, Goa, India

### Introduction

It has been reported that mangrove swamps and other marshy areas support growth of marine algae and seagrasses (Fritsch, 1952; Marathe, 1965; Nienhuis, 1971; Chapman and Chapman, 1973; Johnson, 1979).

The marine algae, seagrasses and phytoplankton, with associate fauna, form a part of the complex food web in the mangrove ecosystem (Milward, 1974; Lenz, 1977 and Beumer, 1978). The algae growing in the salt marsh and mangrove swamps have been studied for their ecology in other countries (Nienhuis, 1971; Hartog, 1971; Munda, 1978; Sage 1978). However, very little information is available on the ecology of marine algae and seagrasses from mangrove ecosystems (Kannan and Krishnamurthy, 1978 and Jagtap and Untawale, 1980 and 1981).

In the present investigation, few ecological observations have been made on marine algae and seagrasses from the mangrove environment of Goa.

### Materials and Methods

The mangrove ecosystem of Goa was studied monthly for marine algae and seagrass distribution, at nine stations; viz. Mandovi ( $M_1-M_3$ ), Zuari ( $Z_1-Z_3$ ) and Terekhol ( $T_1-T_3$ ), the numbers being from mouth to upstream.

Plant samples (Algae and seagrass) alongwith thallus and rhizoides were collected, washed thoroughly to remove epiphytes, adhering mud and debris and preserved in 4% formalin for further identification. At station  $T_1$ , the biomass (wet weight) of *Monostroma* species was estimated. Similarly, the biomass of *Halophila beccarii* (Aschers) was estimated, at few localities.

### Results

#### *Marine Algae*

A total of 44 species of marine algae belonging to 30 genera have been reported from the mangrove swamps of Mandovi, Zuari,

Terekhol and Chapora estuaries from Goa. The distribution of these species was very seasonal (Table 1).

#### Seagrass

The seagrass sp. *Halophila beccarii* Aschers, was observed to be associated in the mangrove environment of Goa along Terekhol, Chapora, Mandovi and Zuari estuaries. The drifted fronds of *H. ovalis* (R. Brown) Hook. f. were collected at M<sub>1</sub> during May (Table-1).

#### Discussion

Primary production in the mangrove ecosystem is marginally useful part of a mangrove ecosystem compared to mangroves, benthic macro and micro algae and seagrasses. Benthic algae from the mangrove environment play a significant role in the food chain of the mangrove ecosystem (Schuster, 1952; Odum and Heald, 1972). However, not much attention has been paid to the algal flora in the mangrove ecosystem. Earlier reports indicate that the coastal wetlands support rich algal flora (Fritsch, 1952; Nienhuis, 1971; Chapman and Chapman, 1973; Johnson, 1979).

About 65 species of marine algae have been reported from the southeast Asian Mangrove ecosystems (Saenger *et al.*, 1983). In the present investigation 44 species are reported from the mangrove along the Goa coast. The algal growth was either epiterranean (on muddy, sandy substratum, on pebbles, dead shells) or epiphytic on mangrove trunks, prop roots, pneumatophores and plant debris. Lewmanomont (1976) also recognised the same groups of marine algae in the mangroves. Species like *Caloglossa leprieurii* (Mont.) J. Ag. and *Catnella impudica* (Mont.) J. Ag. form the characteristic flora in mangroves of Goa. These species have the capacity to withstand the wide range of exposure, salinity and brackish water conditions. A number of species of *Catnella* and *Bostrychia* are adapted to life in mangroves (Fritsch, 1952; Johnson, 1979). The occurrence of *C. leprieurii* from mangrove swamps has been mentioned by many workers (Agardh, 1876; Fritsch, 1952 and Hartog, 1971). The ecological studies on *C. leprieurii* from mangrove swamp of Goa showed that the alga reached the maximum biomass of 26.44 gm<sup>-2</sup> during October, when salinity was 10.8‰ (Jagtap and Untawale, 1980).

The economically important species such as *Monostroma* sp. appeared only along Terekhol (T<sub>1</sub>) during January to June, when salinity remained high (30-40‰). The maximum of 68.5 g m<sup>-2</sup> (wet weight) biomass was obtained during March. (Untawale *et al.*, 1980). *Monostroma* sp. has been also reported from the Gujarat coast (Oza *et al.*, 1983). The high salinity and high intensity of light seemed to favour the growth of *Monostroma* sp. in mangrove environment. *Ulva* spp. were observed only along Chapora and Mandovi (M<sub>1</sub>) during







January when the salinity was 30‰. However, *U. lactuca* and *U. reticulata* were observed in plenty in the mangroves of Ratnagiri (personal observation) during October to March.

*Chara succinata* A. Brawn, was observed in the mangrove areas of upstream region only at station Z<sub>3</sub> (upstream), during October when the water salinity of the area was very low (0.3‰) due to greater freshwater inflow. Earlier (Pal *et al.*, 1962) had reported *C. succinata* from the saline (2.5% NaCl) mudflats of Bombay Region.

Another economically important alga, *Gracilaria verrucosa* (Huds) Papen, was also found growing on pebbles and dead oyster shells in mangroves towards mouth region (M<sub>1</sub>, T<sub>1</sub>, and Z<sub>1</sub>) in poor quantity. Most of the cyanophyceae forms in mangrove environment were reported during the rainy season (Table 1).

The observations reveal that mangrove environment of Goa supports a few algae with low standing crops. However, occasionally the *Monostroma* sp. are abundant. Mangrove habitats are regarded as unfavourable for many algae because of the lack of habitat diversity, lack of stable substrate, mud in suspension and physiological stress on algae due to the fluctuating salinity. The distribution and the growth of marine algae in the mangroves seem to be influenced mainly by salinity, high nutrients and pH (Munda, 1978). The tidal conditions also play the major role in the growth and distribution of algae since it affects the prevailing salinity (Johnson, 1979).

The only seagrass, *Halophila beccarii* was observed in the mangrove swamps of Goa. A patchy growth of *H. beccarii* was noticed, generally in the vicinity *Avicennia officinalis* and *Sonneratia alba*, along Mandovi, Zuari, Chapora and Terekhol estuaries. The richness of this seagrass was observed in the Terekhol (T<sub>1</sub>) mangroves compared to other three estuaries. The biomass of 750 g m<sup>-2</sup> (wet weight) was obtained at station T<sub>1</sub> during January. *Halophila beccarii* was found to be available throughout the year in the mangrove swamps of Goa. The same seagrass was observed to be very rich in the mangrove areas of Ratnagiri, Vijaydurga and Deogad, along the central west coast of India (personal observations).

The growth and survival of seagrass depend on factors like salinity, temperature and light. Mangrove waters are, generally, turbid which does not allow much light to penetrate upto the seagrass during high tide. So naturally, these plants carry maximum photosynthesis during low tide exposure only. It was observed (Jagtap and Untawale, 1981) that the maximum growth of *H. beccarii* was attained during the months when a greater number of low tides fall during the day time. The flowering in *H. beccarii* was noticed

in October when salinity of the water was considerably low. Long exposures and low salinity during August to October may be influencing factors for the flowering in *H. beccarii*. The seagrass beds in mangrove ecosystems promote sedimentation by trapping waterborne particles and by the retention of organic material derived from seagrass itself (Zieman, 1975; Burrell and Schubel, 1977).

The drifted seagrass beds of *H. Ovalis* were located in the deeper and under waters and the disappearance of this seagrass from the monsoon onward may be related to erosion during monsoon season, low salinity, low intensity of light and high turbidity, in Mandovi.

Thus, it could be concluded that phytoplankton, benthic algae and seagrass beds in the mangroves of Goa, marginally contribute towards food chain in the mangrove ecosystem. The mangrove ecosystems towards mouth region look promising for cultivation of economically important seaweed species like *Monostroma* and *Gracilaria verrucosa*.

#### Acknowledgements

Author is very much grateful to Dr. A. G. Untawale and Dr. T. S. S. Rao for critically going through the manuscript and offering valuable suggestions. I am also grateful to Dr. H. N. Siddique, Director, National Institute of oceanography (C. S. I. R.) for his encouragement.

#### References

- Agardh J. G. 1876. Species genera et ordines algarum, Lund. 2 : 701-1291.
- Beumer J. P. 1978. *Jour. Fish. Biol.*, 12 : 475-490.
- Burrell D. C. and Schubel J. R. 1977. In : *Seagrass Ecosystem* ( eds. McRoy and Helfferich ), Marcel Dekker, NY. p. 197-232.
- Chapman V. J. and Chapman D. J. 1973. *The Algae*, 2nd Edi., Macmillan, London.
- Fritsch F. E. 1952. *The structure and Reproduction of Algae*, Vol. III, Univ. Press, Cambridge.
- Hartog C. den. 1971. In : *Proc. VIIth Int. Seaweed Symp.*, sapor, Japan.
- Jagtap T. G. and Untawale A. G., 1980. *Seaweed Res. Util.*, 4 : 17-24.
- Jagtap T. G. and Untawale A. G. 1981. *Indian J. mar. Sci.*, 10 : 402-404.
- Johnson, A. 1979. In : *Proc. Mangrove and Estuarine Vegetation In Southeast Asia*. (eds. Srivastava, Ahmad, Dhanrajan and Hamzah), Univ. Pertanian, Malay, BITROP Publ. 10 : 45-50.
- Kannan L. and Krishnamurthy K. 1978. *Seaweed Res. Util.*, 3 : 1-4.

- Lenz J. 1977. In : *Microbial Ecology of a Brackish Water Environment* (Ed. Rheinheimer G.) Springer-Verlag, Berlin. 25 : 37-59.
- Lewmanomont K. 1976. In : *Proc. 1st Thai Natn. Semi. Mangr. Ecol.*, Phuket, 1976 NRC, 2 : 202-215.
- Marathe K. V. 1965. *Jour. Indian Soc. Soil Sci.*, 13 : 81-84.
- Milward N. E. 1974. *Studies on the taxonomy, ecology and physiology of Queensland Mudskippers*, Ph. D. Thesis, Univ. Queensland.
- Munda I. M. 1978. *Botanica Marina*, 21 : 451-468.
- Nienhuis P. H. 1971. In : *Proc. VIIth Intern. Seaweed Sympo.*, Sapporo, Japan, 251-254.
- Odum W. E. and Heald E. J. 1972. *Bull. Mar. Sci.*, 22 : 671-738.
- Pal B. P., Kundu B. C., Sundarlingam V. S. and Venkatraman G. S. 1962. *Charophyta*, ICAR Publ. New Delhi, 89.
- Saenger B., Hegerl E. J. and Davie J. D. S. 1983. *Global Status of Mangrove Ecosystems*, IUCN, COE, No. 3 : 88 pp. Reprinted from *Environmentalist*, 3 (1983), Supp. 3.
- Sage W. W. 1978. *Jour. Physiol.*, 14 : 333-337.
- Schuster W. H. 1952. *Indo-Pacific Fisheries Comm. Spec. Publ.* 1 : 1-143.
- Untawale A. G., Jagtap T. G. and Dhargalkar V. K. 1980. *Mahasagar, Bull. NIO.* 13 : 73-76.
- Wetzel R. G., Rich P. H., Miller M. C. and Allen H. L. 1972. *Mem. 1st Ital. (Suppl.)*, 29 : 185-243.
- Zieman J. C. 1975. In : *Tropical Marine Pollution* ( eds. Wood and Johannes ), Elsevier Oceanography Series, 12 : 63-74, Elsevier, Amsterdam.