

## PHYTOPLANKTON PRODUCTION OF TWO ATOLLS OF THE INDIAN OCEAN

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### ABSTRACT

Primary productivity studies on two atolls in the Lakshadweep Archipelago indicate that the contribution of larger phytoplankton to the reef production is not significant. Nannoplankton ( $< 64 \mu$ ), on the other hand, account for 65-75% of the total phytoplankton production. Dissolved carbohydrate content near the reef was high and ranged from 20 to 50 mg l<sup>-1</sup>. This appears to be related to the high benthic productivity. Particulate organic carbon was also high in the reef waters and the high levels of dissolved carbohydrate might be contributing to an increase in the organic carbon. Zooplankton biomass was higher outside the reef than in the lagoon, indicating a decrease in the zooplankton organisms as they pass over the reef.

### INTRODUCTION

Our knowledge of the total productivity of coral reefs is largely based on flow studies and little attention has been given to the contribution of individual groups such as benthic microalgae, bacteria and phytoplankton to the reef economy. Furthermore, the high primary production in the reef waters would evidently mean an accumulation of dissolved or particulate organic matter. Considering the conflicting information on the abundance of zooplankton in the reef waters and the suggestion that the bulk of planktonic food in these waters is composed of detrital forms such as 'organic aggregates' rather than phytoplankton (Johannes, 1967; Qasim and Sankaranarayanan, 1970), it becomes important to investigate the phyto- and zooplankton production in these waters and the contribution of dissolved carbohydrates (DCHO) in relation to reef productivity.

Two atolls, Kavaratti (10°35' N 72° 36' E) and Agathi (10°51' N 72°11' E)

in the Lakshadweep Archipelago (Fig. 1) were selected for this study. The description of Kavaratti atoll has been given earlier (Qasim, Bhattathiri and Reddy, 1972). Agathi atoll has a similar orientation with the island on the east, the reef on the west and the lagoon in the middle communicating with the open ocean through two channels. The main channel is found on the northern end, the other on the west. The former remains functional for navigational purposes. Although both the atolls are similar in orientation, the Kavaratti lagoon is narrow and small, with an average width of 1 km and a mean depth of 2 m. The Agathi lagoon, on the other hand, is 2 km wide and 3-4 m deep. The Kavaratti lagoon supports a luxuriant seagrass bed (Qasim and Bhattathiri, 1971) consisting of *Thalassia hemprichii* and *Cymodocea isoetifolia*. In the Agathi lagoon, the seagrasses occur in patches. In both the lagoons, the flow is unidirectional, from south-west towards the north.

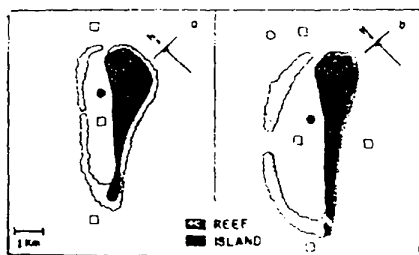


Fig. 1. (a) Kavaratti Atoll and (b) Agathi Atoll. Closed circles: Lagoon stations; Open circles: Oceanic station; Squares: Zooplankton stations.

#### MATERIALS AND METHOD

Nannoplankton was separated by filtering the lagoon water through a No. 25 bolting silk. Production of total phytoplankton and nannoplankton was estimated by  $^{14}\text{C}$  method. Standard procedures were adopted for the estimation of chlorophyll, dissolved carbohydrate and particulate organic carbon. Zooplankton was collected with a net of 625  $\text{cm}^2$  mouth area and 300 $\mu$  mesh width. The total number of  $^{14}\text{C}$  measurements were 14

in Kavaratti, 22 in Agathi and 6 in the oceanic waters.

Samples were collected in December 1976 and apart from DCHO estimations, which were immediately carried out using a Klett Summerson photoelectric colorimeter, the other estimations were made in January, 1977 at NIO, Goa.

#### RESULTS

The total phytoplankton and nannoplankton production rates in Kavaratti lagoon were 22.7 and 14.8  $\text{mgC m}^{-3} \text{day}^{-1}$ . In the Agathi lagoon the values were 27.4 and 20.5  $\text{mgC m}^{-3} \text{day}^{-1}$  and in the open ocean north of Agathi, the primary production values were 25.2  $\text{mgC m}^{-3} \text{day}^{-1}$  for total phytoplankton and 23.1  $\text{mgC m}^{-3} \text{day}^{-1}$  for nannoplankton. The contribution by nannoplankton was 91% in oceanic waters. It also exceeded the production of larger phytoplankton both in Kavaratti (65%) and Agathi (75%) lagoons. The mean chlorophyll-*a* values for total phytoplankton and nannoplankton were 0.319 and 0.247  $\text{mg m}^{-3}$  in the Kavaratti lagoon and 0.523 and 0.414  $\text{mg m}^{-3}$  in the Agathi lagoon res-

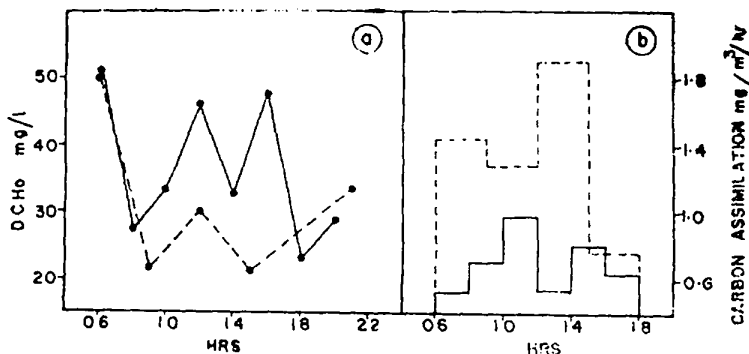


Fig. 2. Diurnal changes in DCHO concentration and  $^{14}\text{C}$  assimilation in lagoon waters. Continuous lines: Kavaratti Atoll; Broken lines: Agathi Atoll.

pectively. The mean particulate organic carbon concentrations for Kavaratti and Agathi lagoons were 1080 and 870 mg m<sup>-3</sup> respectively.

Fig. 2 gives the diurnal variations (0600–1800 hrs) in <sup>14</sup>C assimilation and DCHO production in both the lagoons. Carbon assimilation ranged from 0.518 to 0.968 mgC m<sup>-3</sup> hr<sup>-1</sup> in Kavaratti and from 0.766 to 1.903 mgC m<sup>-3</sup> hr<sup>-1</sup> in Agathi. The production values in the forenoon were nearly similar to those in the afternoon and based on this observation, production values obtained for 3 hr incubations were converted to daily production. DCHO ranged from 23 to 50 mg l<sup>-1</sup> in Kavaratti lagoon and from 20 to 49 mg l<sup>-1</sup> in Agathi lagoon.

Table I gives the major groups constituting zooplankton, their density and biomass (dry weight) around the reef and in the lagoon of both the atolls. The biomass was low in the lagoons than in the waters surrounding the reefs.

## DISCUSSION

Logistic reasons generally prevent gathering of large data from remote reef areas and this study is no exception. Nevertheless, the usefulness of these data becomes apparent when considered against the scarcity of similar data from these atolls, especially from Agathi.

Primary production in coral reefs is high, amounting to 8–12 gC m<sup>-2</sup> day<sup>-1</sup> (Nair and Pillai, 1972). However, much of this is derived from benthic sources and phytoplankton production is insignificant and represents only that of the surrounding waters (Balasubramanian and Wafar, 1974). The low phytoplankton production found near the atolls confirms that atolls occur in oligotrophic waters. However, the abundance of zooplankton around these atolls, observed in the present study and also in the earlier studies (Tranter and George, 1972; Goswami, 1972) would imply that the zooplankton must derive nutrition from sources other than phyto-

Table I. Zooplankton density (No./m<sup>3</sup>) and biomass (mg dry wt/m<sup>3</sup>) in stations outside the atolls and in the lagoons.

Group	Kavaratti south	Kavaratti north	Kavaratti lagoon	Agathi south	Agathi north	Agathi east	Agathi lagoon
Copepods	731	1109	828	696	398	40	242
Decapods	69	50	18	124	73	0.5	26
Chaetognaths	9	37	12	73	20	1.5	1
<i>Oikopleura</i>	6	1	12	10	11	0.5	1
Siphonophora	1	0.2	—	—	2	—	—
Pelagic polychaetes	—	1	1	4	2	0.5	1
Fish eggs and larvae	2	1	1	4	2	0.2	2
Mysids	—	26	5	10	—	—	—
Amphipods	—	0.8	12	1.2	—	—	—
Others	—	1.2	1	—	0.6	—	—
Biomass	8.1	8.1	5.2	7.1	7.3	5.5	0.7

plankton. An alternate source that has been identified is the organic aggregate; whose abundance in reef waters is of much ecological significance (Johannes, 1967; Qasim and Sankaranarayanan, 1970).

Mucus secreted by corals is an important constituent of these detrital particles (Johannes, 1967). However, Qasim and Sankaranarayanan (1970) suggested that the dissolved organic matter plays an important role in the reef economy and based on experimental evidences (Sheldon, Evelyn and Parsons, 1967; Riley, 1963), they suggested that the dissolved organic matter is transformed to particulate form by mechanical processes. The high amount of dissolved carbohydrates occurring in the reef waters, as against in the normal oceanic waters ( $1 \text{ mg l}^{-1}$ ), supports this view and it appears that the dissolved organic matter is equally important in the formation of organic aggregates.

The contribution of phytoplankton to dissolved organic matter and subsequently to organic aggregates is also insignificant. A comparison of the carbon assimilated by phytoplankton and the carbon present in the dissolved carbohydrates (Walsh,

1965b) indicates that the contribution of phytoplankton to dissolved organic matter is only 0.024% in Kavaratti and 0.038% in Agathi. The direct relationship between primary production and the concentration of DCHO (Walsh, 1965a) would then place the production by corals and seagrasses as the major source of DCHO in the reef waters.

Thus, it is evident that phytoplankton organisms assume low importance in the energy flow of atolls. However, this does not apply to fringing reefs as several fringing reefs support moderate levels of phytoplankton production (Sournia, 1968), probably because of their location in shelf waters, where phytoplankton production is of much significance. Perhaps a functional classification of these ecosystems, as suggested by Sournia and Ricard (1976) might help to define the extent of phytoplankton contribution to the reef economy.

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