

# Biochemical Composition of Microfouling Assemblages at Two Stations in the Zuari Estuary

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Biochemical analyses of microfouling material settled on aluminum and glass panels were carried out at two stations, one at the Dona Paula jetty and the other at Marmagao harbor, located on either side of the mouth of the Zuari estuary. This study deals with the composition of microfouling in terms of organic carbon, carbohydrates, proteins, bacterial counts, and chlorophyll *a* concentrations. The study was conducted to assess the effects of oil slicks on primary film build up.

## INTRODUCTION

Chemical and biological studies have shown that oil spills have adverse effects on marine organisms (Blummer et al. 1971, Foster et al. 1971). One of our study sites, Marmagao harbor, is affected by heavy shipping, which eventually causes some degree of oil spillage from tankers, barges, and trawlers. The other site, the Dona Paula jetty, is free from such activity.

The present study was undertaken to examine the possible effects of oil spillage on microfouling settlement with respect to biomass and biochemical composition.

## METHODS

Glass and aluminum panels were cleaned and exposed to subsurface water as described by Sharma et al. (1990). Replicate panels were removed each day over a period of four days before any visible macrofouling settlement was observed. The panels were brought to the laboratory in an ice box

containing seawater, scraped under sterile conditions with a nylon brush using 100 ml filtered sterile seawater, and aliquots of this were then filtered through pre-ashed (450 °C, 3 hours) GF/C filters for study. Organic carbon and chlorophyll *a* were estimated following the methods of Parsons et al. (1984). Proteins and carbohydrates were measured according to Lowry et al. (1951) and Dubois et al. (1956), respectively. Hydrographic parameters of the water column such as salinity and dissolved oxygen content were determined using the methods of Strickland and Parsons (1965). Hydrocarbon content of the water column was estimated following Parsons et al. (1984). Bombay high crude oil was used as a calibration standard for the estimation of hydrocarbon.

## RESULTS

### Hydrographic parameters

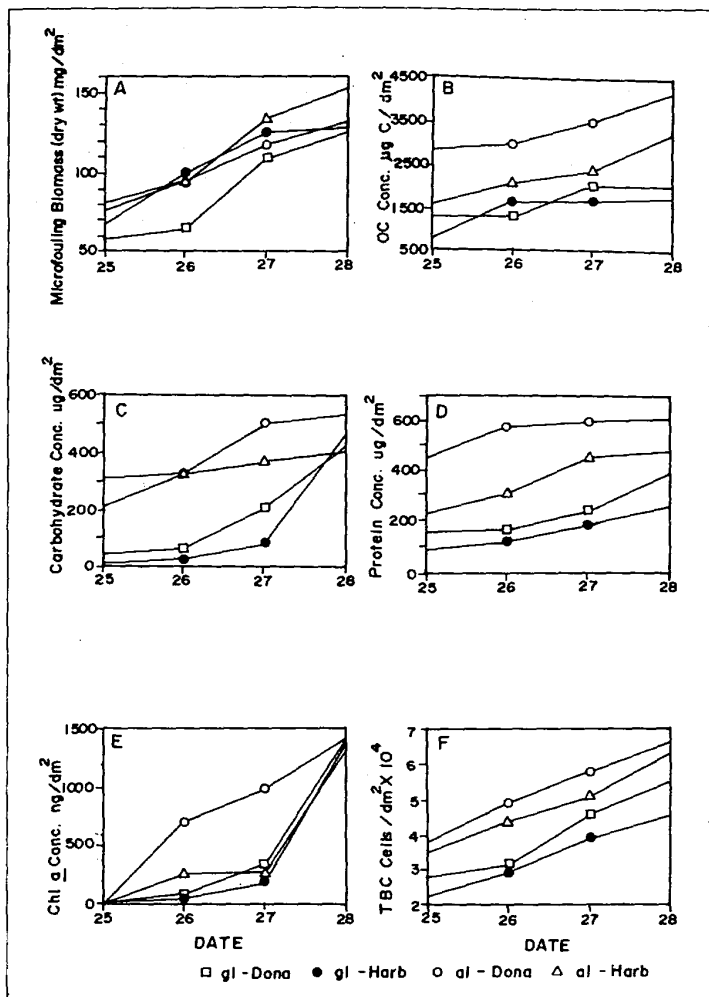
During the study period, the average water column temperature was 24 °C with salinity ranging between 33.4 and 34‰ at both stations. Dissolved oxygen content varied between 5.3 and 6.03 ml/l while pH fluctuated between 7.9 and 8.0.

The hydrocarbon concentrations at Dona Paula and the harbor were  $11.2 \pm 0.35$  and  $20.02 \pm 4.87$  ug/l, respectively. This shows that the hydrocarbon concentration in the harbor waters was almost double that present at the Dona Paula jetty.

### Microfouling biomass

Figure 1 shows the microfouling biomass measured as dry weight, organic carbon, carbohydrates, proteins, chlorophyll *a*, and total bacterial counts on glass and aluminum panels deployed at the two test sites for a period of four days. The microfouling biomass increased with the exposure period. The highest concentrations of all observed parameters were found on the panels exposed for four days.

**Dona Paula Test Site:** The highest values for microfouling biomass (dry weight) were 125 and 131.6 mg/dm<sup>2</sup> for glass and aluminum panels, respectively. Thus, there was a slightly higher microfouling biomass on the aluminum panels. A similar pattern was observed when organic carbon was used to estimate the biomass. The maximum carbohydrate and protein concentrations were 429 and 386 ug/dm<sup>2</sup> for glass and 535 and 607 ug/dm<sup>2</sup> for aluminum, respectively. Chlorophyll *a* concentrations were negligible on the first day of immersion for both glass and aluminum. The maximum concentrations were 1,414 and 1,417 ng/dm<sup>2</sup> on glass and



**Figure 1.** Variations in the biochemical compositions of microfouling assemblages at Dona Paula and Marmagao harbor stations: A - microfouling biomass (dry weight), B - organic carbon, C - carbohydrate, D - protein, E - chlorophyll *a*, F - total bacterial count.

gl = glass, al = aluminum.

aluminum, respectively. The total bacterial counts also showed a similar trend with a maximum of  $5.56 \times 10^4$  and  $6.64 \times 10^4$  cells/dm<sup>2</sup> on glass and aluminum.

Harbor Test Site: The maximum microfouling biomasses (dry weight) were 128.3 and 153.1 mg/dm<sup>2</sup> for glass and aluminum panels, respectively. Maximum organic carbon content was 1,738 ug/dm<sup>2</sup> for glass and 2,324 ug/dm<sup>2</sup> for aluminum. The maximum carbohydrate and protein concentrations were 467 and 255 ug/dm<sup>2</sup> for glass and 406 and 476 ug/dm<sup>2</sup> for aluminum, respectively. The chlorophyll *a* concentrations following the first day of exposure were negligible, as were those observed at Dona Paula. The maximum concentrations were 1,386 and 1,331 ng/dm<sup>2</sup> on glass and aluminum, respectively. The total bacterial counts were  $4.6 \times 10^4$  and  $6.3 \times 10^4$  cells/dm<sup>2</sup> on glass and aluminum, respectively.

## DISCUSSION

The increased hydrocarbon concentration in the waters at the Marmagao harbor compared to those at the Dona Paula jetty is possibly due to harbor operations. The average hydrocarbon concentration for the coastal waters around Goa is 30.9 ug/l (Fondekar et al. 1980). Toxic levels of most hydrocarbons are greater than 100 mg/l (Oppenheimer 1980). The concentrations reported here are comparatively low, indicating unpolluted waters.

The microfouling biomass increased with exposure periods at both stations as previously reported by Bhosle et al. (1990). As is evident from figure 1, considerable differences were observed in the concentrations of carbohydrates, proteins, and chlorophyll *a* between the glass panels exposed at Dona Paula and the harbor waters for one, two, and three days, respectively. A similar trend was found in the aluminum panels. However, there was little difference in the carbohydrate and chlorophyll *a* concentrations on both substrata exposed for four days at these two stations. The initial low concentrations on the panels exposed in the harbor waters could be due to the higher hydrocarbon concentration in these waters. The later increase could be due to increases in bacterial number and degradation of oil adsorbed, thus making the surface more conducive for settlement.

The biomass was greater in the harbor waters. However, when biomass was expressed as organic carbon, a different pattern was observed. For example, the organic carbon was much higher on both panels at Dona Paula. This suggests that there was more nonorganic matter adhering to the panels exposed in the harbor waters. The possible source of this could be the loading-unloading of iron ore in the harbor area. As with the organic carbon, the biochemical constituents and total bacterial counts were higher,

while chlorophyll *a* was higher on the second and third days on both types of panels deployed at Dona Paula. This could be due to the low hydrocarbon concentration in these waters compared to the harbor waters.

The glass panels initially showed low concentrations of carbohydrates and chlorophyll *a* compared to aluminum, which may be due to the surface physical characteristics of glass. Glass is smoother than aluminum and, thus, it takes more time for surface conditioning by bacteria. The bacteria form an exopolysaccharide matrix on the surface, causing the attachment of more bacteria and other microfouling communities followed by macrofoulers (Baier 1984). The considerable differences observed in the proteins, chlorophyll *a*, and total bacteria for glass and aluminum could be attributed to this factor.

From these data, it is evident that the microfouling organic biomass was higher on panels exposed at Dona Paula, possibly due to the comparatively low hydrocarbon concentration there as related to the harbor, which is affected by shipping activities. The microfouling biomass was greater on the aluminum panels compared to glass at both Dona Paula and in Marmagoa harbor waters.

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