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OBSERVATIONS ON MARINE BIOFOULING ON ELECTROPLATED METALLIC SURFACES IN GOA WATERS

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ABSTRACT

The panels of metallic brass electroplated with cadmium as well as nickel-chromium were kept suspended in the near-shore marine environment of Goa for biofouling studies. The results for the pre-monsoon period, which coincides with the breeding period of the majority of the fouling organisms, indicated that cadmium plated panels had very small amount of settlement as compared to the nickel-chromium plated. It could be due to the toxic effects of cadmium and also due to more porosity of the panels.

Key words: Biofouling, metallic coating, metal panels, Bryozoa.

INTRODUCTION

Since the inception of shipping activity, various methods have been attempted to minimise the adverse effects of biofouling. These include, among others, protection by copper sheathing, protective paints, electrolytic coatings etc. (Laidlaw, 1952). Of these, the electrolytic coating method seems to be given up due to practical as well as the economical reasons. However, for protecting small metallic objects such as the parts of marine instruments, it could still prove as one of the practical methods.

Hence, under the marine instrumentation programme, various alloys with different metallic coatings thereon are being tested. As a part of these tests, sets of brass plates electroplated with cadmium and nickel-chromium were exposed to the marine environment of Goa. The observations were initiated during the pre-monsoon period commencing from March onwards till May, which also happens to be the breeding season of various fouling organisms along the west coast of India (Wagh, 1965; Karande, 1968; Durve, 1960). Review of the literature reveals that no work of this nature has been carried out so far. Hence, in order to augment our knowledge on the effect of these organisms on electroplated metals, this study was carried out and reported here.

MATERIAL AND METHODS

The panels of brass admeasuring 15 cm × 10 cm were electroplated, with cadmium as well as nickel-chromium by following the standard procedure (Smithells, 1978). These panels were suspended at two different depths of five and eight metres from an Iron-ore-loading platform anchored off Mormugao Harbour at a distance of about eight kilometres from the Dona Paula point. These panels were exposed from 22nd January to 2nd May, i.e., during the pre-monsoon period of 1981. The data on the intensity of fouling on the panels so suspended has been collected by recording the increase in the weight of each panel after the exposure. Thereafter, the attached organisms have been carefully scraped off and preserved for further studies. The biomass values (wet weight basis) have been expressed in terms of gm/panel. These values have also been calculated in terms of gm/sq. cm. In addition to these observations, data on the environmental parameters such as salinity, dissolved oxygen, temperature and pH were collected from three different depths, viz. subsurface, 5 and 10 metres. The water samples were collected by using Nansen reversing bottle to which reversing thermometer was fixed. The samples so collected, were analysed for salinity and dissolved oxygen by the methods described by Strickland and Parsons (1965). The pH values were obtained by using a digital pH-meter.

OBSERVATION AND DISCUSSION

The data collected on hydrographic parameters have been presented in Fig. 1. It shows very little variations during the period of observations. The temperature values ranged from 28° to 32° C. The values at subsurface indicated a slight fall in April after the rise in March. At the other two depths the temperature values indicated uniform increase. The values for May, however, exhibited definite increase in temperature at all depths. The salinity values were found to be around 35‰ throughout the period of study at all depths. The pH values have remained constant except on 30th March and 14th April. The values for dissolved oxygen were found to be minimum at 10 metres in February, whereas for rest of the period there was no appreciable difference in their values.

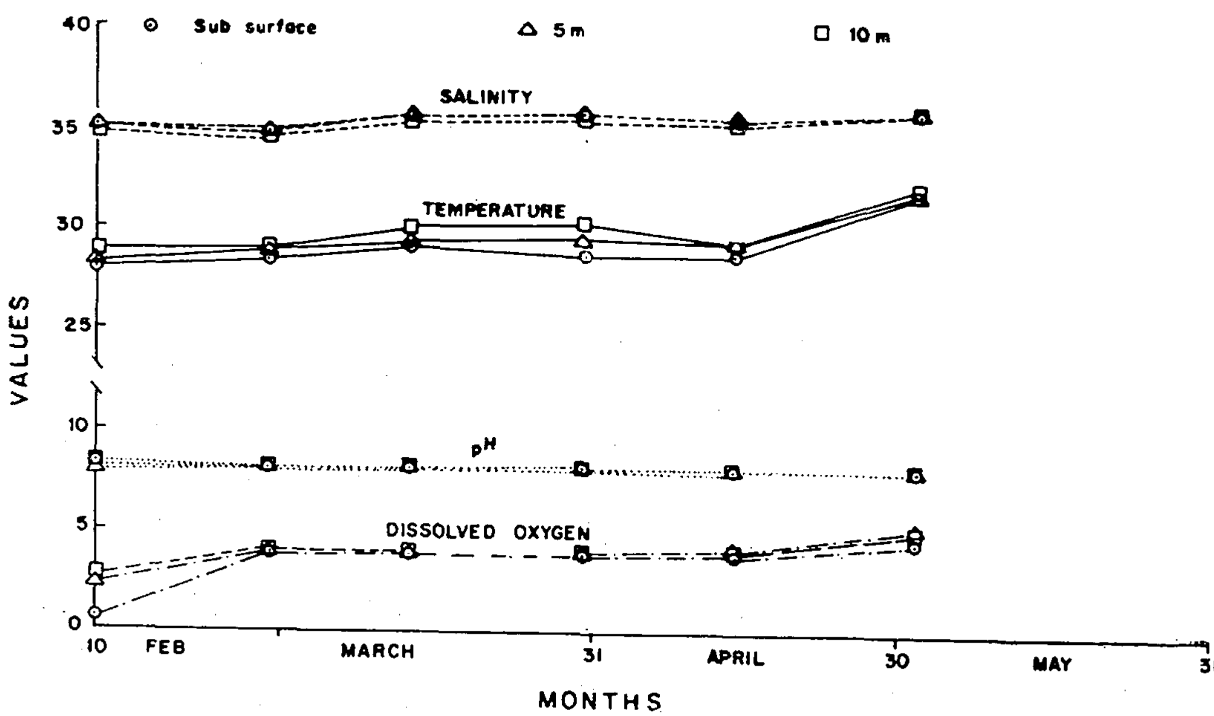

Fig. 1. Temperature, salinity, dissolved oxygen and pH values during pre-monsoon period.

The observations on fouling assemblages on these panels have been presented in Figs. 2 and 3. It is observed that the cadmium plated panel suspended at 5 metres had very little biomass (4.22 gm) whereas nickel-chromium plated panel at the same depth had 61.350 gm of fouling organisms. Even the composition of fouling community on these two types of panels showed remarkable differences (Fig. 2). The cadmium plated panel had mainly encrusting bryozoa (*Membranipora* sp.)

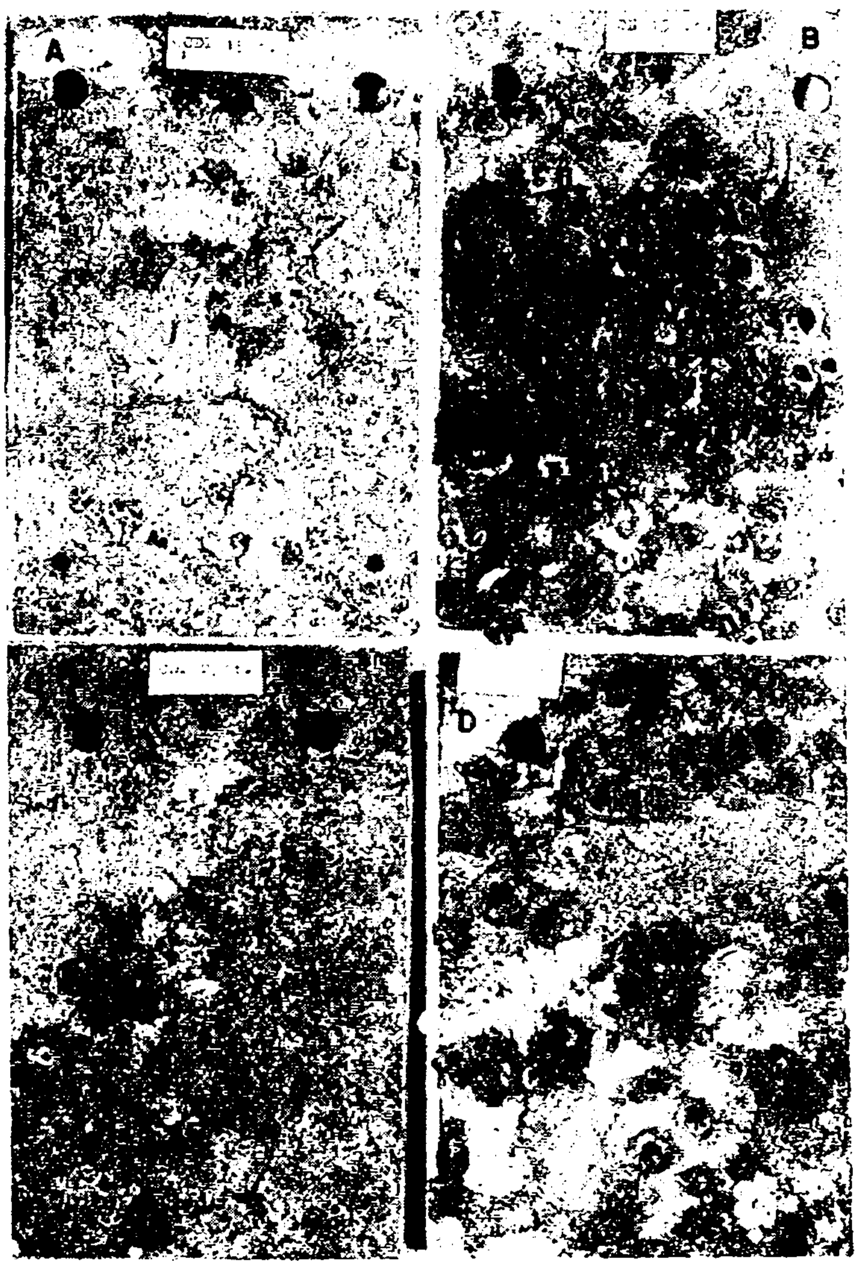

Fig. 2. Electroplated brass panels showing fouling settlement at 5 and 8 m.

A. Cadmium plated brass at 5 m. B. Nickel-chromium plated brass at 5 m.
C. Cadmium plated brass at 8 m. D. Nickel-chromium plated brass at 8 m.

with 4-5 shells of sessile barnacles. Though these shells were devoid of soft parts, these forms appear to be *Balanus venustus* (Henry and McLaughlin, 1975). The rostro-carnial diameters of these shells ranged between 6.2 to 8.8 mm. As against this, the assemblage on the nickel-chromium plated panel consisted of *B. venustus*, serpulid worms (probably *Serpula* sp.) as well as the encrusting bryozoa *Membranipora* sp.). The rostro-carinal diameters of balanid shells varied between 9.1 to 15.5 mm and the length of serpulid tubes was found to be varying from 9 to 13 mm.

As regard to the observations on panels at 8 metres, almost identical patterns were observed. The difference in biomass values is slightly less, the values being 5.020 gm and 48.270 gm on cadmium and nickel-chromium plated panels respectively. The compositions of fouling assemblage were somewhat similar to those found on panels at 5 metres depth. The only difference observed was the less number of serpulid worms and the larger size of barnacle shells settled on the nickel-chromium plated panel.

Another interesting point which deserves mention was that quite a few balanid shells on the lower panel were devoid of soft parts indicating higher rate of mortality at that depth.

The environmental parameters indicate very slight variations during the period of observations. With regard to salinity, the variations could be due to fresh water

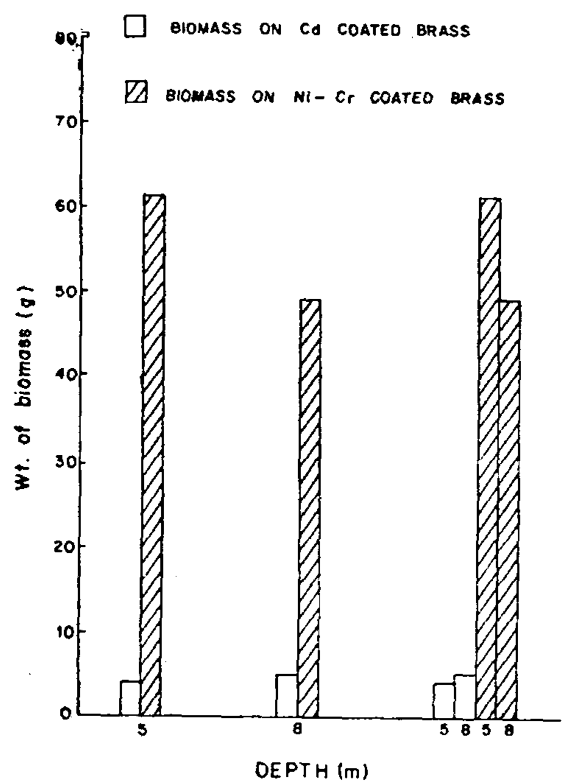

Fig. 3. Total biomass of fouling assemblage on electroplated brass during pre-monsoon period.

run-off from the rivers Mandovi and Zuari. The consistently reduced values of water temperature in relation to depths throughout the period is natural. Only during the month of April slightly low temperature at subsurface was observed (29° C) which could be due to wind circulation in the area at that time. These observations agree well with those observed by Goswami (1979) for premonsoon period of 1974-1976. The values for dissolved oxygen were found to be declining according to depth during the period of observations. It could be partially, due to planktonic organisms as observed by Pant, Bhargava and Goswami (1976) and Goswami (1979). Similarly, the slight increase in these values at subsurface level during February end and beginning of May could be due to phytoplankton production at that time. The gradual rise in pH values along with the depth is natural but for their decline in late March and early April needs further investigation.

The observations on fouling assemblage on various panels indicate that the biomass values for cadmium plated panels suspended at both the depths are considerably less as compared to those on nickel-chromium plated panels. This could be mainly attributed to the highly poisonous nature of cadmium coating, which must have prevented the settlement of the larvae of the fouling organisms. It is also likely that the porosity of cadmium coating being comparatively more than that of nickel-chromium plating it might have exposed, subsequent to initial leaching of cadmium coating, the underlying brass to the settling larvae. The cupric element of the brass might have also contributed to the prevention of the fouling settlement. This explanation is supported by the size of balanid shells found on these panels. As mentioned earlier, the rostro-carinal diametres of balanid shells on cadmium plated panels ranged between 6.2 to 8.8 mm whereas these values for the nickel-chromium plated panels were found to be between 2.5 to 15.5 mm. Furthermore, the latter panels had three size groups of barnacles thereby indicating the settlement of cyprid larvae and their subsequent growth in three batches representing each month of observation. Similarly, the Serpulid worms also show distinct size groups supporting the observations made on the barnacles. It leads to the inference that the larvae of fouling organisms could not settle on the cadmium plated panels during the initial phase of the observations due to toxic effects of the cadmium.

As regard to the meagre settlement on these panels, it could be explained by the fact that the encrusting bryozoa which are known to be considerably tolerant to toxic substances, must have settled on these panels initialy, thereby preventing the settlement of other fouling organisms as observed by Hutchins (1945) and Osburn (1944). From these observations it appears that the cadmium plating of metallic surfaces might prove useful in preventing the settlement of fouling organisms on marine instruments. It, however, needs further studies of longer duration and which are being undertaken.

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