

Biofouling of an offshore oil platform: Faunal composition and biomass

V P Venugopalan* & A B Wagh

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

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Studies using test panel exposure technique for biofouling of offshore oil platform indicated that a total of about 100 species were involved in fouling. Though initial rates of fouling were low due to soft bodied primary colonizers, with increase of exposure time, biomass buildup could become significant as calcareous organisms increasingly became abundant. Conspicuous zonation was observed in the region 0 to 62 m. Severity of fouling is restricted to the upper 22 m.

Biofouling occurs as a result of the settlement and growth of sedentary and semisedentary organisms on artificial structures placed in marine or estuarine waters. The occurrence of this "marine growth" on submerged parts of offshore platforms has been a cause of great concern to oil companies having offshore activities. In addition to influencing the loading of the platform, there are problems caused by accelerated corrosion and impairment of visual inspection of underwater structures¹.

At Bombay High area in the northern Arabian Sea a number of platforms have been built for the purpose of the production and processing of oil and gas. A comprehensive study has been undertaken to assess the impact of these activities on the marine environment and the results of the studies on biofouling of an oil platform are reported here.

Materials and Methods

The investigations were carried out at the Bombay High area, located about 170 km off Bombay (19°20'N, 71°21'E). The observations have been made from an oil producing and processing platform standing in a water depth of about 78 m.

Panels made of mild steel (MS) and aluminium measuring 15 × 10 × 0.3 cm were used as the test coupons. Panels were exposed at 4 depths (2, 22, 42 and 62 m) for monthly and yearly durations. Other details of the test panel exposure strategy were given elsewhere². The work was carried out during the period May 1983 to March 1986. However, there was a break in observation during April to

September 1984 due to unexpected loss of the sampling devices.

Results

A total of 101 organisms, including diatoms were recorded (Table 1). Other important groups were 10 species of algae, 10 species of hydroids, 10 species of bryozoans, 15 species of crustaceans, 7 species of bivalves and 5 species of compound ascidians, indicating a rich faunal assemblage. Biomass (wet weight in g.dm^{-2}) values of the fouling on monthly panels are given in Fig. 1. The maximum biomass values recorded on MS panels were 2.64, 5.59, 4.59 and 0.97 g.dm^{-2} at 2, 22, 42 and 62 m respectively. Corresponding values for the aluminium panels were 2.87, 2.80, 3.23 and 1.67 g.dm^{-2} . The biomass values on both MS and aluminium panels increased during May–June 1983 and July–August 1985, suggesting a seasonality in the pattern of variation. Samples during the corresponding period of 1984 could not be collected. On the aluminium panels exposed at 2 m, there was an increase in biomass during October to December 1984 and February 1986.

The yearly biomass values (given as kg.m^{-2}) indicated a pattern similar to the monthly ones in that greater biomass values were recorded at 2 and 22 m (Table 2). At the upper two depths (2 and 22 m), values exceeding 10 kg.m^{-2} were recorded, the maximum being 15.12 kg.m^{-2} . Mean biomass values recorded on aluminium panels were slightly higher compared to MS panels (except at 2 m). At the lower 2 depths, the biomass values were almost an order of magnitude less, indicating the strong influence of depth on the build up biomass in open ocean waters.

*Present address: Indira Gandhi Centre for Atomic Research, Kalpakkam 603 102, India

Table 1—Checklist of fouling organisms

I DIATOMS	III PORIFERA	VIII CIRRIPIEDIA
1 <i>Amphora</i> sp.	42 <i>Calcarea</i> sp.	72 <i>Lepas</i> sp.
2 <i>Cymbella</i> sp.	43 <i>Callyspongia</i> sp.	73 <i>Balanus tintinnabulum</i>
3 <i>Stauroneis</i> sp.		74 <i>B. amphitrite</i>
4 <i>Navicula</i> sp.	IV CNIDARIA	75 <i>B. amaryllis</i>
5 <i>Bellarochea</i> sp.	44 <i>Obelia bidentata</i>	
6 <i>Pleurosigma</i> sp.	45 <i>O. dichotoma</i> *	IX AMPHIPODA
7 <i>Amphiprora</i> sp.	46 <i>Clytia gracilis</i>	76 <i>Stenothoe gallensis</i>
8 <i>Achnanthes</i> sp.	47 <i>Cuspidella humilis</i> *	77 <i>Maera pacifica</i>
9 <i>Orthoneis</i> sp.	48 <i>Sertularia inflata</i> *	78 <i>Elasmopus</i> sp.
10 <i>Cocconeis</i> sp.	49 <i>S. turbinata</i>	79 <i>Podocerus</i> sp.
11 <i>Fragilaria</i> sp.	50 <i>Dynamena crisioides</i>	80 <i>P. brasiliensis</i>
12 <i>Thalassiothrix</i> sp.	51 <i>Diphasia digitalis</i>	81 <i>Erichthonius brasiliensis</i>
13 <i>Synedra</i> sp.	52 <i>Halopteris diaphana</i>	82 <i>Caprella equilibra</i>
14 <i>Raphoneis</i> sp.	53 <i>Aglaophenia pluma</i> *	83 <i>Paracaprella pusilla</i>
15 <i>Plagiogramma</i> sp.	54 <i>Anemonia</i> sp.	
16 <i>Licmophora</i> sp.	55 <i>Dendrophyllidae</i>	X ISOPODA
17 <i>Grammatophora</i> sp.	(Unidentified)	84 <i>Synidotea</i> sp.
18 <i>Striatella</i> sp.		85 <i>Cirolana bovina</i>
19 <i>Nitzschia</i> sp.	V NEMATODA	86 <i>Cilicæa latreillei</i> *
20 <i>Hantzschia</i> sp.	(Unidentified species)	
21 <i>Homeocladia</i> sp.		XI PYCNOGONIDA
22 <i>Guinardia</i> sp.	IV BRYOZOA	87 <i>Endeis</i> sp.
23 <i>Rhizosolenia</i> sp.	56 <i>Aetea</i> sp.	
24 <i>Chaetoceros</i> sp.	57 <i>Tubulipora</i> sp.	XII BIVALVIA
25 <i>Bacteriastrum</i> sp.	58 <i>Flustra</i> sp.	88 <i>Modiolus</i> sp.
26 <i>Stephanopyxis</i> sp.	59 <i>Idmonea</i> sp.	89 <i>Pinna atropurpuratus</i>
27 <i>Melosira</i> sp.	60 <i>Electra</i> sp.	90 <i>P. tulipa</i>
28 <i>Hyalodiscus</i> sp.	61 <i>Parasmittana</i> sp.	91 <i>Pinctada fucata</i>
29 <i>Biddulphia</i> sp.	62 <i>Bugula</i> sp.	92 <i>P. margaritifera</i>
30 <i>Triceratium</i> sp.	63 <i>B. neritina</i>	93 <i>Spondylus</i> sp.
31 <i>Coscinodiscus</i> sp.	64 <i>Scrupocellaria</i>	94 <i>Saccostrea</i> sp.
	65 <i>Membranipora</i> sp.	
II ALGAE		XIII ECHINODERMATA
32 <i>Oscillatoria</i> sp.		95 <i>Ophiactis savignyi</i>
33 <i>Phormidium</i> sp.	VII POLYCHAETA	96 <i>Eucidaris metularia</i>
34 (Unidentified green alga)	66 <i>Chaetopterus</i> sp.	
35 <i>Dictyota</i> sp.	67 <i>Chloeia</i> sp.	XIV ASCIDIA
36 <i>Ectocarpus</i> sp.	68 <i>Syllis</i> sp.	97 <i>Lissoclinum fragile</i>
37 <i>Polysiphonia</i> sp.	69 <i>Serpulida</i>	98 <i>Ecteinascidia krishnani</i>
38 <i>Callithamnion byssoides</i>	(Unidentified)	99 <i>Symplegma brackenhielmi</i>
39 <i>Giffordia sandriana</i>	70 <i>Salmacina dysteri</i>	100 <i>Didemnum</i> sp.
40 <i>Centroceras</i> sp.	71 <i>Spirorbis</i> sp.	101 <i>Botryllus schlosseri</i>
41 <i>Jania adhaerens</i>		

*New records for Indian waters.

Discussion

The results show that about 100 species, including diatoms, are involved in fouling in the area studied (Table 1). Out of these, a few are new

records to Indian waters^{3,4}. Karande⁵, during his studies on the fouling of coastal waters of Bombay, has enumerated as many as 75 organisms including bacteria, fungi and diatoms. His study has also

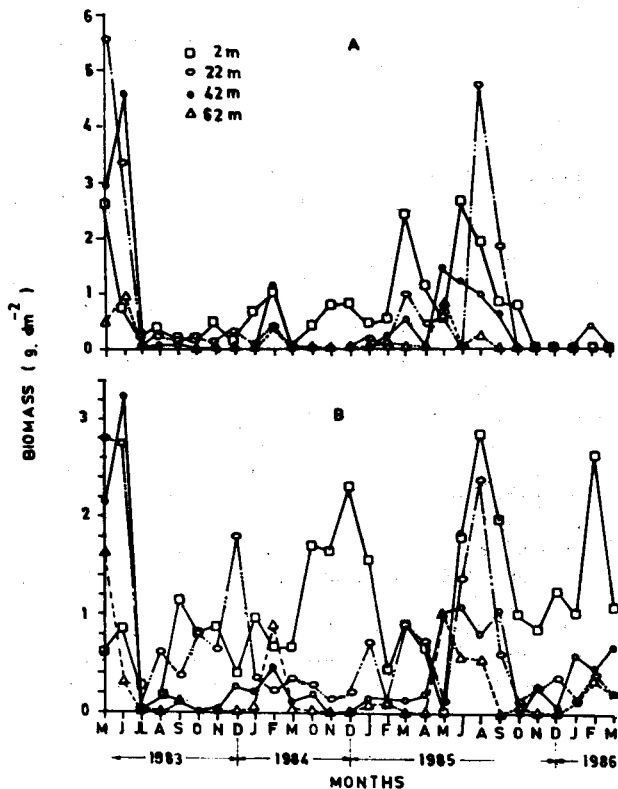


Fig. 1—Variations in the biomass values recorded on mild steel (A) and aluminium (B) panels

Table 2—Biomass of fouling organisms on yearly panels expressed as kg.m^{-2}

Depth (m)	Mean biomass	Range*	\pm SD
Mild steel panel			
2	9.25	4.07–15.12	3.71
22	8.17	5.31–10.28	1.79
42	1.10	0.66–1.96	0.53
62	0.34	0.12–0.82	0.23
Aluminium panel			
2	7.09	6.02–8.73	1.44
22	10.29	7.15–13.42	4.43
42	1.18	0.95–1.46	0.25
62	0.59	0.25–1.44	0.49

*Values given are maxima and minima recorded

indicated that major fouling species in Bombay harbour belong to hydrozoans, cirripedes, polychaetes, bryozoans, and tunicates. In the present study, the important groups of fouling organisms recorded are oysters, composite ascidians, hydroids, anemones, polychaetes and filamentous algae.

Monthly biomass values are low when compared to those reported from coastal waters⁶. This is

caused by the growth of soft foulers such as hydroids during the initial periods of immersion. Hydroids, incidentally, are among the first macrofoulers to appear on freshly immersed panel surfaces. Such a behaviour of hydroids is widely reported and can be considered a general rule⁷. With the increase in the exposure period, a more diverse fauna, including hard calcareous organisms, appear on the panels, thereby increasing the biomass. The yearly biomass values recorded from Bombay High are greater compared to reports from some other localities such as Bombay and Goa^{8,9}.

Among the two types of panels exposed, aluminium is consistently found to be infested more with foulers than MS panels. This is closely related with the inherent corrosion behaviour of both the metals. Unlike aluminium, MS panels during their initial periods of exposure, are characterized by the presence of a loosely adherent corrosion product which does not give much scope to settling organisms. However, with the passage of time, the formation of a hard insoluble cover of ferric hydroxide favours good attachment¹⁰.

Some of the major foulers present at Bombay High exhibit marked depth preferences. This results in the zonation of marine growth on the platforms. Zonation of fouling has been reported to be a characteristic feature of offshore platforms¹¹. In the present investigation, where 4 depths were sampled, the 2 m depth had a mixed community consisting of algae, hydroids, oysters and ascidians. Panels immersed at 22 m were invariably dominated by oysters (*Saccostrea* sp.). At 42 m, serpulids, bryozoans and oysters were present. At 62 m, the most common forms were anthozoans and erect bryozoans.

The study also shows that the buildup of biomass is very less at 42 m level and below. At this depth the average biomass is about $1.1 \text{ kg.m}^{-2}.\text{y}^{-1}$, whereas at 62 m, it is only half as much. Therefore, cleaning measures to be undertaken to relieve loading may be concentrated above 42 m. Even in North Sea, where fouling of offshore platforms is reported to be severe¹², it has been shown that foulers are dense on the upper 30 m of the underwater structures and removal of fouling could be confined to this depth^{13,14}. Moreover, Heaf¹ has reported that major part of the loading induced by waves on fixed offshore platforms will be concentrated on the upper 30 m of the structure, below the mean water level.

In conclusion, the present study has clearly shown that materials immersed in offshore areas are

also prone to severe fouling by marine organisms. The faunal composition is quite diverse and biomass values are comparable to or even more than those reported from some coastal localities. The fouling is found to be strongly influenced by depth.

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