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RESEARCH ARTICLE

A STUDY ON BIOFOULING ORGANISMS ON THE SHIP HULL, A DREDGER WASHED UP AT THE MUNDAKKAL COAST, KOLLAM, KERALA

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ABSTRACT

In the present study, the unoccupied dredging vessel HANSITA V docked at Kollam Port broke loose from its mooring, washed up on the Mundakkal beach on Tuesday 21 June 2016 making waves in the city and got media coverage. The vessel showed that heavy fouling on the hull. Analysis of hull inspection on the vessel mainly focused on the characterization and percentage composition of the fouling community. The extend and composition of fouling on the vessel hull was examined through quadrate samples taken from the hull. The invading organisms include both sessile and mobile species. The heavily fouled species recorded from the hull was *Balanus sp*. and *Pinctada sp*. Heavy fouling of the biofoulers in the hull results in the corrosion and damage of the vessel. Adhesion of marine biofoulers on ship hulls may cause many problems including fuel consumptions, high maintenance costs, corrosion and damage, introduction of invasive species etc.

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INTRODUCTION

Marine fouling or biofouling is a common phenomenon found on the hull of ship, submerged substrates, under water equipment, oil rigs and allied structures, beach well structures etc. Biological clogging or biofouling is the aggregation of biological components such as in microorganisms, plants algae or animals on wetted surface (Thompson *et al*., 2004; Barnes, 2005). Every hand artificial substrate in the aquatic environment is subjected to biofouling ie, accumulation of micro and macro organisms with in time (Railkin, 2004; Durr and Thomason, 2010). Majority of the fouling species are small sized sedentary, burrow dwelling or cligning species (Galil & Zenetos, 2002) include mobile species such as crabs, brittle stars and small fish. Heavy fouling on laid up vessels may carry an average of 5 Kg of material per square meter (Walters, 1996). Many fouling species can adhere strongly grow quickly and reach sexual maturity before the eventual dislodgements due to size induced drag, hull cleaning and natural senescence. The extent of marine fouling depends on several environmental factors like geographic location, season of the year, distance from the shore, temperature, type of material, light, etc. Marine fouling can form at all depths, temperature which is commonly found on the ship hull that leads to their corrosion. Biofouling is economically significant on vessel hulls, where high levels of fouling can increase drag, reducing the overall performance of the vessel and increasing the fuel consumption by 40% the increased roughness presented by a heavily fouled ship hull can result in lowering 86% at cruising speed and inorder to maintain speed the fuel consumption result in green house gas emission (Schultz, 2007; Poloczanska and Butler, 2010). The increased fuel consumption leads to the increased emission of green house gases (extra 210 million tonnes of CO2 and 5.6 million tonnes of sulphur dioxide). Marine environment experiences biofouling in submerged substrates and vessel hulls and form an extra habitat for the foulers. More than 4000 species of marine biofoulers have been reported globally. The most important fouling organisms on ship hull includes, barnacles, mussels, oysters, polychaete worms, bryozoans and see weeds. The present study was to analyze the distribution of biofouling organism of the hull of the dredger Hansita washed upon Mundakkal Coast, Kollam, Kerala.

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MATERIALS AND METHODS

Mundakkal beach ($8^0$8'75''N to $76^0$59'91'' E) 3km south from Kollam city, is one of the potential beaches for tourism development in Kerala. An unoccupied dredger HANSITA V (a Chinese ship) owned by Mumbai based Megha Dredging Private Limited, brought to Kollam port on March 26,2013 had broken loose from its moorings and washed up at Mundakkal beach. After being caught in strong winds the vessel got swept almost near the beach on June 21, 2016 and

had been afloat there since then (Fig.1). The vessel has been lying anchored three nautical miles off the Kollam Coast since November 2013 due to technical issues have made by the owners not paying port wharfage charges. After washed up on the beach HANSITA got media coverage and people are crowding the site to get a close glimpse of a sight they had not seen before. Several attempts to raise the anchor and pull the ship back to deep waters using tugs got failed. Its anchor has got trapped deep inside the sand bed and Hansita is now on a long wait for salvation from the sand floor in to the deep waters. The ship apparently posing a threat to the shore by intensifying sea wrath. The areas of fouling on the vessel was surveyed and samples were collected from targeted areas. Five randomly placed quadrates (20 cm x 20 cm) were taken from the hull of the dredging vessel. Samples were removed with paint scrapers, chisel and hammer were collected and stored in small tubs and fixed in 4% formalin. The samples is then thoroughly rinsed with running tap water in a 100 m sieve. The samples were identified, recorded and transferred into glass vials, preserved in 70% ethanol. The presence of algae were noted and identified. Percentage composition of the fouling organisms was calculated.

RESULTS AND DISCUSSION

Characterization of fouling organisms

Of the 10 faunal species recorded from the quadrate samples taken from the vessel hull the dominant foulers were *Balanus sp*. and *Pinctada sp.* (Fig.3). Biofoulers include, family Serpulidae, Polynoidae, Balanidae, Photidae, Corophiidae, Portunidae, Mytilidae, Pteriidae, Osteridae. Among the biofouler Annelida comprises 2 orders Sabellidae and Phyllodocida, Arthropoda consist of 3 orders Sessilia Decapoda and Amphipoda. Mollusca include 3 orders Mytiloida, Ostreoida and Ostreida (Table 1).

primarily made up of crustaceans, mollusc and crabs (Gollasch, 2002). Chambers *et al* (2006) pointed out that where niche areas are available on the substrate, higher fouling organism may settle ahead of other species.

Figure 1. Dredger HANSITA V washed up on Mundakkal Coast

Balanus sp. is a fast growing and gregarious has high reproductive potential and tolerate wide fluctuations of salinity and temperature. Their fouling on ship hull cause corrosion and affect biodiversity, change community structure and alter trophic levels. Perna sp. also tolerates wide fluctuations of salinity and temperature and reaches high densities. Crab sp. can withstand salinity and tolerates starvation. They also disrupts existing community structure through competition and behavioural activities. Dredging is an excavation activity usually carried out underwater, in shallow seas. The physical structure and the geographic location of the port environment can influence the fouling on hulls of resident ships (Florel, 2005). The fouling on the dredgers is not considered to be truly representatives of homeport since silt-laden water around an operating dredger probably impose some degree of selection of the survival of attached fouling organisms (Skerman, 1960). Baker *et al* (2004) made similar observations on the private yachts and fishing vessel on Tampay Bay area. Here a reverse trend is observed. Introduction of anti-fouling paints (Synthethic, Biocides or Mimetic) on ship hull to some extend it protects the hull from biofoulers. The adverse effect of ship hull fouling include higher fuel consumption cause frictional resistance making the hull rougher and the ship heavier (Yebra *et al*, 2004). Fuel consumption increased about 40% have been observed because of biofouling, more expensive and time consuming hull maintenance (Abbott *et al*, 2000). Hull cleaning process can generate a large number of toxic substance that are discharged in to the marine environment.

Table 1. Classification and percentage composition of biofouling organisms collected from the dredging vessel Hansita

Phylum	Order	Family	Genus	% composition
Annelida	Sabellida	Serpulidae	*Serpula sp*	6.2
			Pomatoceros sp	14.6
	Phyllodocida	Polynoidae	*Polynoe sp*	3.6
Arthropoda	Sessilia	Balanidae	*Balanus sp*	23
	Decapoda	Portunidae	*Brachuran sp*	2.8
	Amphipoda	Photidae	*Photis sp*	8.4
		Corophiidae	*Corophium sp*	6.4
Mollusca	Mytiloida	Mytilidae	*Perna sp*	9.2
	Ostreoida	Ostreidae	*Cassostrea sp*	7.9
	Ostreida	Pteriidae	*Pinctada sp*	18

Percentage Composition

The extend and composition of the fouling on the vessel hull was examined though quadrate sampling. The percentage composition of the foulers on the dredger was shown in figure 2, They include *Balanus sp.>Pinctada sp. >Pomatoceros sp.>Perna sp>Photis sp> Cassostrea sp.> Corophium sp.>Serpula sp.>Polynoe sp.>Brachuran sp*. The heavily fouled group was *Balanus sp.* and *Pinctada sp* and the brachurans were lowest in the fouling group. Pioneering macrofouling species include green filamentous alage, Serpulid tubeworms and barnacles. Green alage include *Entermorpha sp* and *Ulva sp* were noticed during the study. *Perna sp*. were dominant on propeller fouling. Study on ship's hull in the Northern Sea showed that fouling community was

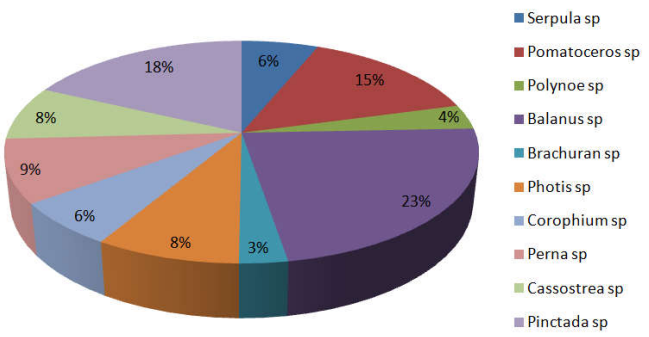

Fig.2. Pie chart showing the percentage composition of fouling organisms from the vessel hull

Figure 3. Biofoulers attached on the hull

Figure 4. Corrosion caused by biofoulers on the hull

Biofouling makes the hull surface more susceptible to corrosion and discoloration (Joseph and Ruey, 1999). The present findings on the hull of dredging vessel, biofouling leads to discoloration and corrosion. On conclusion the *Barnacle sp.* and *Pinctada sp.* were heavily fouled on the vessel result in the corrosion. The dead organisms stimulates local corrosion leaving more or less circular patches of damage (Fig.4). The metabolic products of fouling and particularly the production of acid conditions and hydrogen sulphide by dying members of the community creates a condition that favourable corrosion (Clapp, 1944). The Dredger HANSITA washed up on the Mundakal beach gives a clear picture of heavy fouling on the vessel hull top to bottom that leads to corrosion of the vessel. In the aftermath of this incident, over 15 houses in the locality got collapsed, while about 250 metre of the shore was lost due to surge in sea levels, posing risks to the Coastal Road.

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