Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Online International Journal Available at http://www.cibtech.org/jls.htm
2013 Vol. 3 (1) January-March, pp.16-23/Kaur and Dhavale
Research Article

COMPARISON OF IMMERSION EFFECTS OF IDOLS MADE OF DIFFERENT MATERIALS ON THE WATER QUALITY PARAMETERS

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ABSTRACT
Nowadays anthropogenic activities like idol immersion during certain festival occasions are putting significant stress on the water bodies across India. Commercialization of holy festivals has led to replacement of traditional clay models with bigger and brighter idols made of non- biodegradable materials like POP. Moreover the synthetic paints used contain heavy metals which are potentially hazardous as they bio- accumulate and bio-magnify along the food chain. Lab experiments were conducted to study the comparative dissolution of small, painted, identical idols made of different materials viz. shaadu clay, POP and paper mache in fresh water as well as marine water and their impact on some water quality parameters were studied for a period of 60 days. Complete dissolution of clay idols was observed, the rate of dissolution being faster in marine water than fresh water. However in case of POP and paper mache idols, dissolution occurred at a very slow rate. TSS, TD, TS, turbidity and conductivity values followed the trend: clay > POP > paper mache idol > control. Hardness values were highest for POP Idols, whereas COD values were highest for paper mache idols. Amongst the nine heavy metals analyzed in water samples at the end of the experiment, Fe and As showed slight variation in idol containing tanks as compared to the control tank.

INTRODUCTION
Immersion of idols during festivals such as Ganesh Utsav and Navratri, is a major source of water pollution in water bodies, in and around major cities in states such as Maharashtra, West Bengal, Madhya Pradesh, Andhra Pradesh etc. Studies have been conducted on the pollution caused by idol immersion activities (Reddy&Kumar 2001; Vyas et al. 2008) but no study has yet been conducted on the comparative effects that idols made of different commonly used materials have on water quality parameters. It is well known that these idols are most often made of three broadly different types of materials, plaster of paris, paper mache and clay. Thus it is important to understand to what degree these different materials affect water quality parameters and to what extent. Data on the comparative effects of the different commonly used materials on water quality parameters will help not only to understand which materials are safest and have the least harmful effects on the ecosystem, but how and how fast these materials degrade in natural ecosystems before the ecosystems can recover. The observed responses both numerical (reproductive) and metabolic (growth) of organisms such as planktons and molluscs also shed some light on biotic aspects of ecosystems that can be monitored, and measured to indicate the changes in water quality parameters caused by idol immersion.

MATERIALS AND METHODS
Experimental set up of Fresh water and Marine Aquaria
The study was a laboratory experiment involving eight aquaria. Four aquaria were set up with equal volumes 40 lit of fresh water and artificial ecosystem was established in these tanks. Aquatic plants like hydrilla, vallisnaria were planted in the tanks and along with these two individuals of *Physa sp.* (Bladder snail) and two individuals of *Melanoides tuberculata* (Malaysian trumpet snail) were also added to each of the tank. Similarly there were four smaller aquaria each of which held 20 lit volume of sea water. All eight aquaria were labeled from **A** to **H, A-D** being freshwater aquaria and **E** to **H** being seawater aquaria. **A** and **E** were controls for freshwater and seawater sets respectively, the other tanks had small painted idols immersed in them which were made up of different core materials but coated with identical paints. Aquaria **B** and **F** had paper mache idols, aquaria **C** and **G** had plaster of paris idols, aquaria **D** and **H** had

idols which were made out of a type of clay called Shaadu. Aquaria were aerated for 1-2 hours on alternate days to ensure that the water columns in the aquaria had a homogenous distribution of dissolved oxygen as would be expected in real conditions in the shallow water of the sea shore or in the shallow water near the edges of a lake where idol immersion takes place.

Water Analysis of Fresh water and Marine Aquaria

The aquaria were monitored to note the degree of dissolution of the idols over time and water quality parameters such as pH, total suspended solids, total dissolved solids, total solids, conductivity, turbidity, total hardness, dissolved oxygen and chemical oxygen demand were analyzed once prior to immersion of the idols, once 30 days after the immersion of the idols, and a third time 60 days after the immersion of the idols using standard methods .(APHA,1995).Metal analysis of the acidified water samples from all tanks were conducted at the end of the experiment using ICP. Nine heavy metals viz. Ni, Pb, Fe, Zn, Cu, Cd, Cr, Hg and As were analyzed in the water samples. At the end of experiment, all the snails were taken out, counted and depending on their size grouped into small <1 cm, medium 1-2 cm and big >2 cm size. Total phytoplankton counts of all the aquaria were also conducted at the end of the experiment using a haemocytometer.

RESULTS

Dissolution of idols

All the clay idols in the aquaria had dissolved by the end of the experiment, though the dissolution was faster in marine aquaria than fresh water aquaria. Idols of plaster of paris showed small cracks in their wall by day 20 from which a small amount of dissolution of the material took place but neither of the two plaster of paris idols broke down completely by the end of the experiment, while the paper mache idols didn't break down at all.

Chemical parameters (PLATE-I, Fig 1.1 – 1.9)

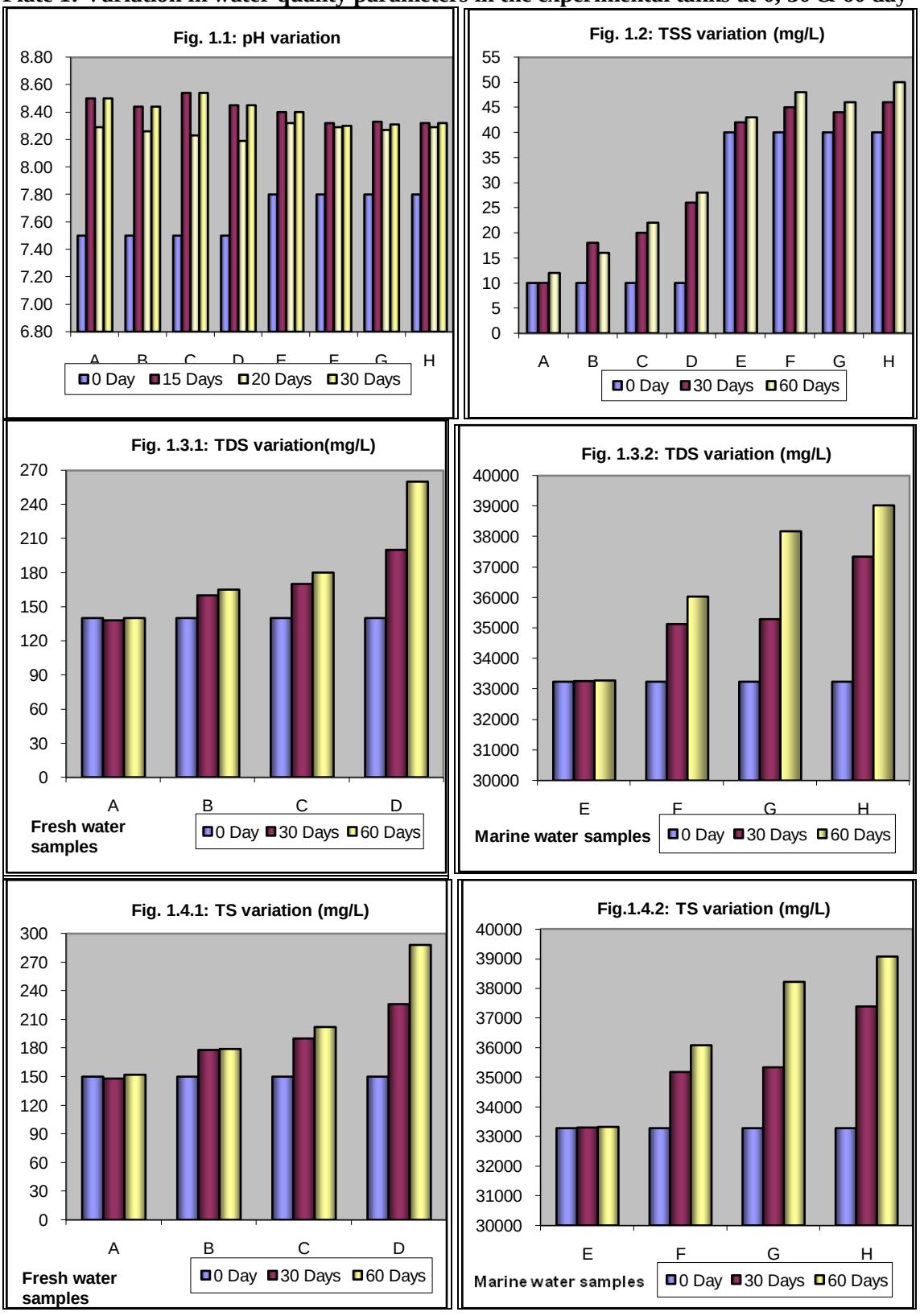
As far as the chemical parameters are concerned even though the differences in pH were minor, the paper mache aquaria showed slightly lower pH than the controls while the plaster of paris aquaria generally registered a higher pH than the controls. With the total suspended solids, total dissolved solids and total solids, as was expected all the aquaria containing idols had higher levels of these parameters but the aquaria containing clay had the highest levels. The conductivity tests revealed that all the test aquaria had higher conductivities than the control aquaria.

Table I: Heavy metal levels in different tanks at the end of 60 days

	Ni	**Pb**	**Fe**	**Zn**	**Cu**	**Cd**	**Cr**	**Hg**	**As**
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(ug/l)	(ug/l)
A	0.01	< 0.005	0.09	0.03	< 0.005	< 0.002	< 0.01	< 0.5	6.69
B	0.01	0.01	0.09	0.03	< 0.005	< 0.002	< 0.01	< 0.5	5.27
C	0.01	< 0.005	0.14	0.01	< 0.005	< 0.002	< 0.01	< 0.5	4.97
D	0.01	0.02	0.22	0.04	< 0.005	< 0.002	< 0.01	< 0.5	5.07
E	< 0.005	< 0.005	0.09	<0.005	< 0.005	< 0.002	< 0.01	< 0.5	5.81
F	< 0.005	< 0.005	0.1	<0.005	0.07	< 0.002	< 0.01	< 0.5	9.26
G	0.01	< 0.005	0.12	<0.005	0.05	< 0.002	< 0.01	< 0.5	9.33
H	< 0.005	< 0.005	0.07	<0.005	0.03	< 0.002	< 0.01	< 0.5	7.5

Amongst the freshwater samples, the clay idol containing aquarium registered the highest conductivity while the paper mache idol containing aquarium from the seawater samples registered the highest conductivity. Turbidity was clearly higher in test aquaria than control aquaria and the clay idol containing

Plate 1: Variation in water quality parameters in the experimental tanks at 0, 30 & 60 day



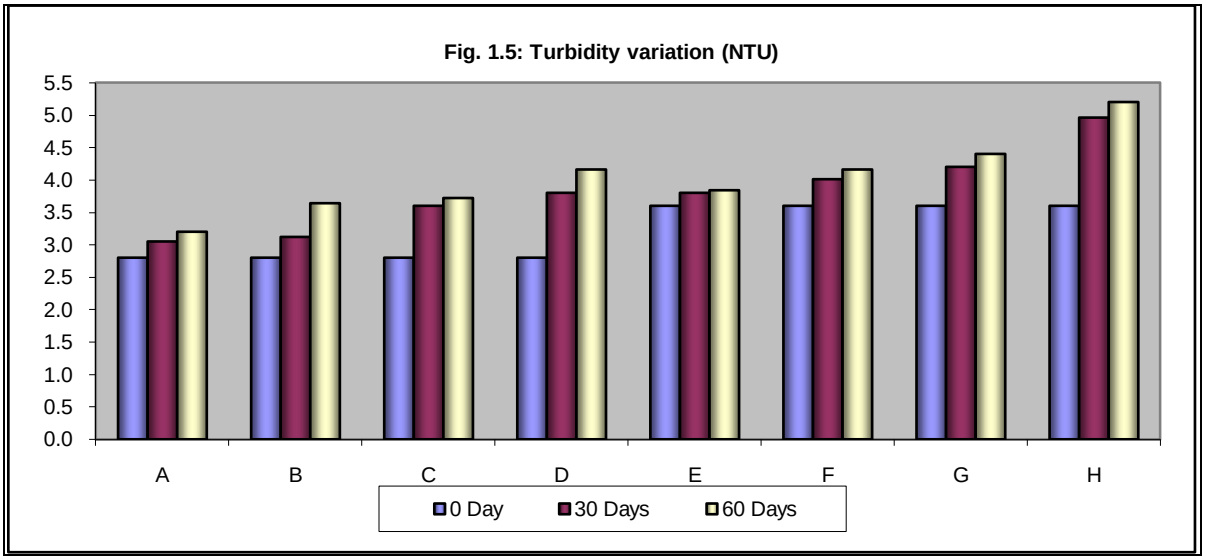


Fig. 1.5: Turbidity variation (NTU)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
A
B
C
D
E
F
G
H
0 Day
30 Days
60 Days

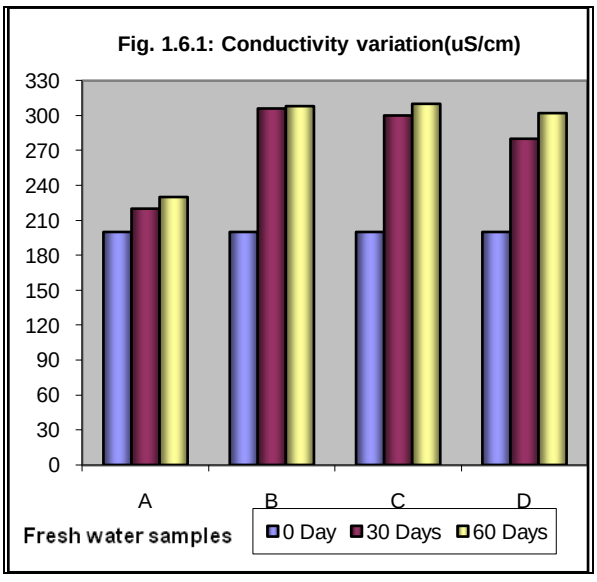


Fig. 1.6.1: Conductivity variation(uS/cm)
330
300
270
240
210
180
150
120
90
60
30
0
A
B
C
D
Fresh water samples
0 Day
30 Days
60 Days

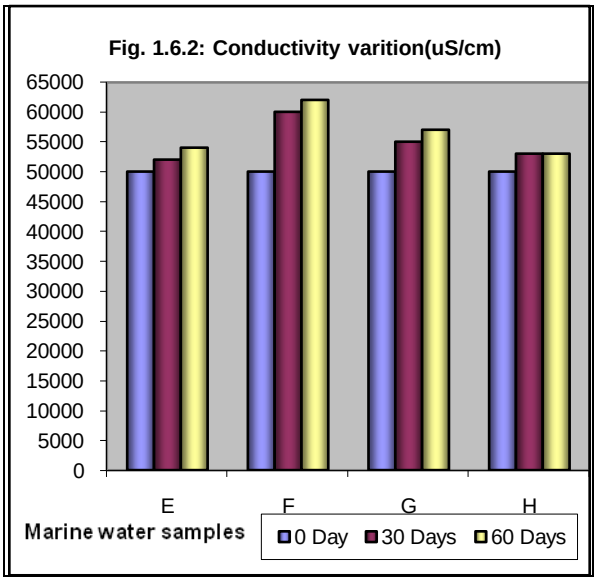


Fig. 1.6.2: Conductivity varition(uS/cm)
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
E
F
G
H
Marine water samples
0 Day
30 Days
60 Days

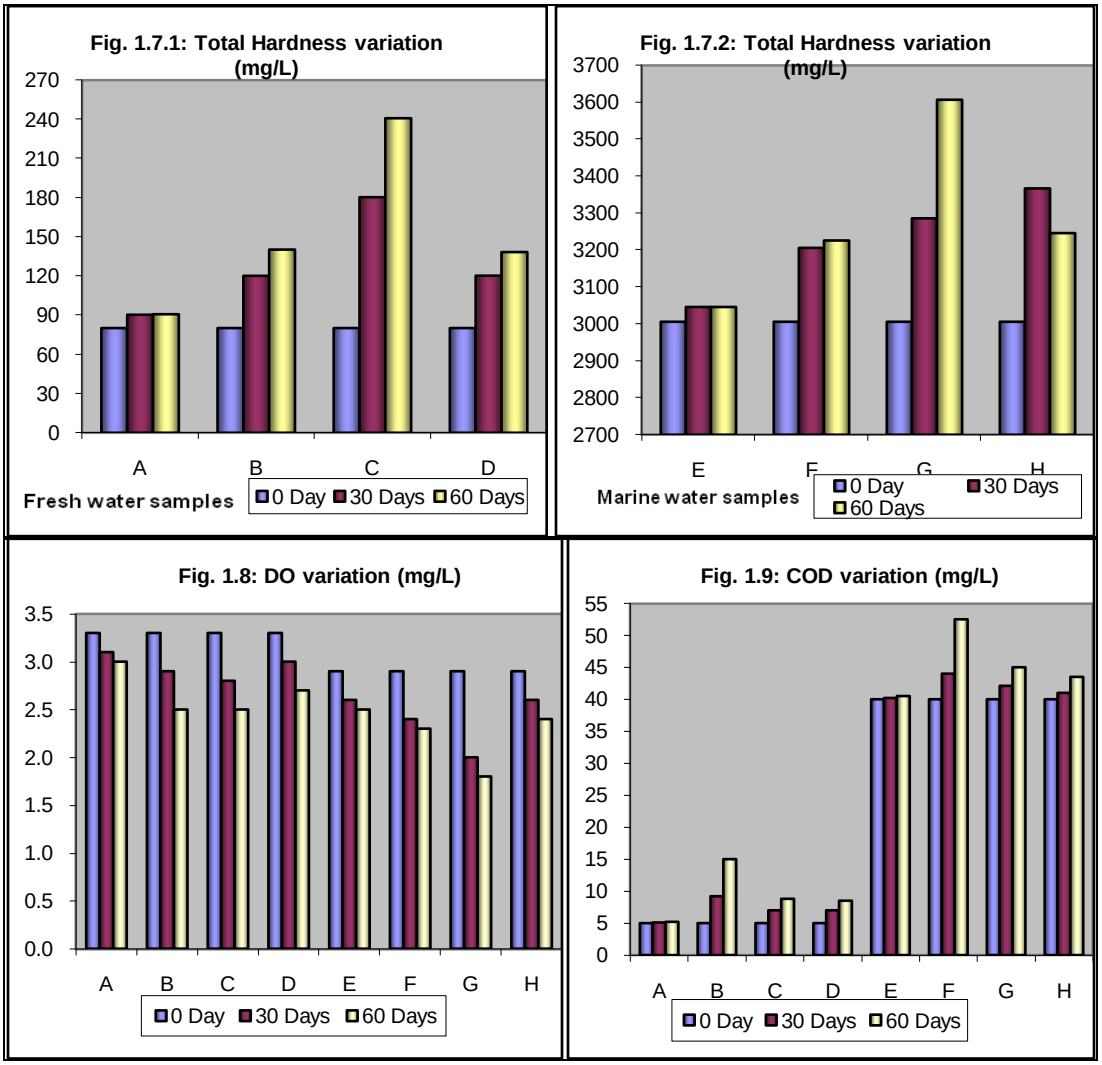
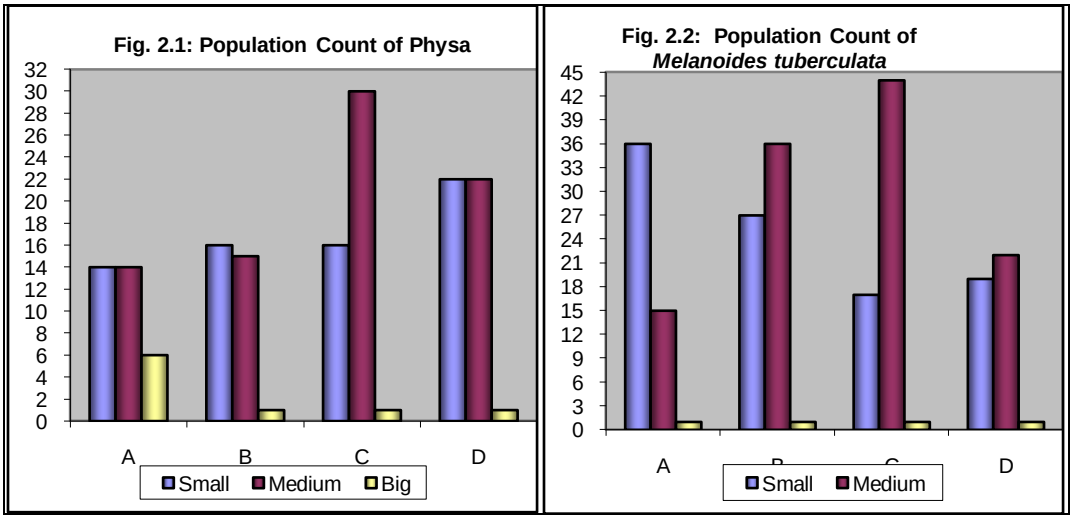
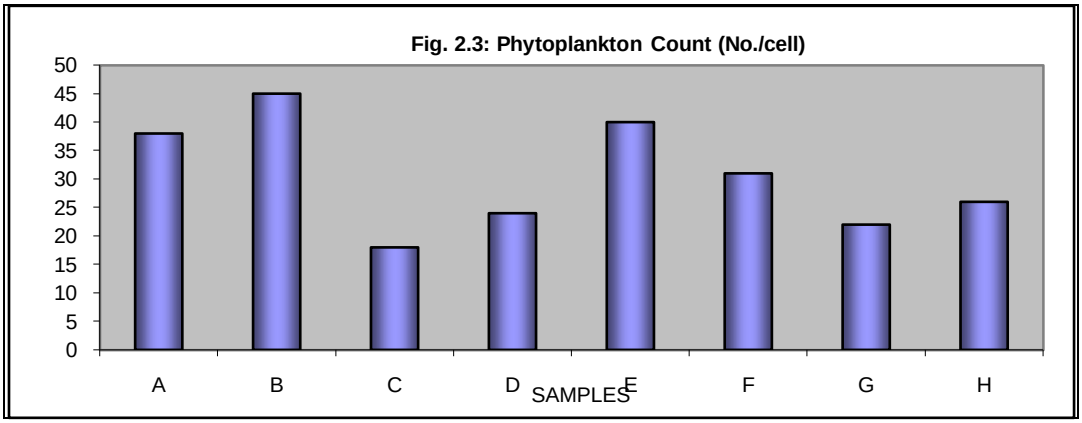


PLATE II: Population counts of snails & phytoplankton in the tanks at end of 60 days





aquaria had the highest turbidity values. The hardness of all the test aquaria was higher than control aquaria, but from amongst the test aquaria the aquaria containing plaster of paris idols registered the highest rise in total hardness. Dissolved oxygen content was much lower in tests than controls and amongst the test aquaria, the aquaria containing plaster of paris idols registered the lowest levels. The chemical oxygen demand of the controls was less than that of the test aquaria but the aquaria containing the paper mache idols registered the greatest chemical oxygen demand.

Metal analysis (TABLE – I)

The metal levels were quite low and below permissible levels in all the tanks. The metal levels in idol containing tanks were almost similar to that in the control tanks in case of Ni, Cd, Cr, Hg- fresh and marine tank, Pb, Zn- marine tanks, Cu- fresh water tank. Slightly higher levels of metals were observed in idol containing tanks as compared to control tanks in case of Fe – fresh and marine tanks, Cu, As- marine tanks, Pb, Zn – fresh water tanks. However in case of as, metal levels in fresh water control tank were slightly higher as compared to idol containing tanks.

Snails (PLATE – II, Fig 2.1 – 2.2)

In case of Physa, number of snails – small and medium size was more in idol containing tanks as compared to control tank. However reverse trend was observed in case of big size snails. In POP idol containing tank, number of snails in medium size was almost double to that of small size snails. In case of *Melanoides tuberculata*, small size snails were maximum in control tank and least in POP idol containing tank. Opposite trend was however observed in case of medium size snails. The number of big size snails was similar in all the tanks.

Phytoplankton count (PLATE – II, Fig 2.3)

At the end of experiment, it was observed that aquarium **B** had the highest phytoplankton count followed by aquarium **A**, then **D** and last **C**. In the seawater aquaria (**E** to **H**), **E** had the greatest phytoplankton count followed by **F**, then **H** and finally **G**. In case of fresh water as well as marine water, tanks containing POP idols had least phytoplankton count.

DISCUSSION

Water which is "Exilir of life" is facing severe threat due to pollution, hence its management and conservation is important. Idol immersion is a religious activity which is responsible for adding pollution load in the water bodies in India (Kulshrestha,SK. et. al, 1988). These idols are made up of POP, clay and clothes supported by small iron rods and types of paints such as varnish and water colours (Tamot & Bhatnagar, 1988) The toxic paints deplete the water quality while POP clogs the natural springs inside the lakes (Yeolekar & Bavdekar, 2007). Thermacol and plastic materials which are non biodegradable are used for decorating these idols. In addition flowers and fruits accompany them which decompose and increase the organic load of the water bodies.

Traditionally idols were made from shaadu clay. Now a day's paper mache idols are also being made. Increasing price of shaadu (clay), longer time and greater skill needed for making clay idols, demand for bigger and brighter idols have forced the idol makers to shift from clay to POP as base material The lab experiments indicate that clay idols have better dissolution rate than POP and paper mache idols. Hence the values of TSS, TDS, TS and turbidity were higher in the tanks containing clay idols. POP is calcium sulphate hemihydrate and it breaks down very slowly releasing toxic elements into the water body. Total hardness was therefore more in tanks with POP idols because of release of calcium. Maximum value of COD were observed in tanks containing paper mache idol possibly due to breakdown of organic components such as flour used to make the glue used in the idol. Deterioration in water quality and increase in various parameters like TSS, TDS, TS, turbidity, conductivity, hardness, COD during immersion period have been reported (Dhote et al., 2001; CPCB 2003; Vyas *et al*. 2006,2008; Khapekar & Nandkumar,2009; Dhote & Dixit 2011 ; Gupta et.al, 2011). The idols were painted with oil paints of various colours viz. red, yellow, orange, white, black, golden and skin colour. These paints contain heavy metals like Cu, Zn, Cr, Cd, Pb, Fe, As &Hg which are non-biodegradable and bioaccumulate & biomagnify along the food chain and are neuro and nephrotoxic & some even carcinogenic (Goswami & Pradhan, 2009) The reservoir can serve as a model for studying heavy metal contamination through idol immersion (Bubicz, M,1982). In the present study identically painted idols of different materials were kept in aquaria which can be considered as a small enclosed water body. In present study metal levels analyzed in all tanks at the end of 60 days were found much below the permissible level. The levels of nine heavy metals analyzed in all the water tanks at the end of the experiment were quite low and much below the permissible levels. Metal levels in water bodies are generally low as the heavy metals tend to settle down at bottom or form complexes with the other elements. However metal levels increase as they move along the food chain. Increase in concentration of heavy metals like As, Pb, Hg, Cr, Cd due to immersion of idols in the lake waters have been reported (Reddy & Kumar, 2001; Bajpai, A. et.al., 2008; Dixit & Tiwari 2008). However according to a case study on effect of idol immersion in the river Ganga by WBCB (2002-2003),metal content of parts of idols which was high enough contributed only a little in the water body of river Ganga and contamination what so ever was subsequently carried away in the flow of the river. CPCB (2010) has issued guidelines to use small idols made of unbaked clay and painted with natural colours to reduce water pollution caused by immersion. Idol immersion produces pollution and has harmful effect on animals and fishes (Chaudhary P.et al, 2009) as well as plants (Nayana and Malode, 2011). In the present study two species of snails, Physa and *Melanoides tuberculata*, two individuals each were introduced in fresh water tanks. It was quite surprising to find that there were actually more snails in the aquaria containing the idols than the control aquaria. Also the plaster of paris containing aquaria which would be expected to have a greater toxicity of the water than other aquaria actually had the highest amounts of snails with the medium sized snails being far more in number (almost twice) than the smaller sized snails in the same tank. This may indicate that although the snails produced more eggs to start with as the toxicity of the water increased, the number of eggs produced also reduced or possibly a greater number of the newly hatched young from the second batch died due to increased toxicity of the water as time passed. Either way more detailed studies should be conducted to ascertain the reason for the increase of the snail populations in the aquaria containing the plaster of paris idols as the reverse was expected.

Planktons are very sensitive to their immediate environment. Any alteration in the environment leads to change in the plankton communities in terms of tolerance, abundance, diversity and dominance in the habitat (Mathivanan,V.,et.al., 2007). Therefore plankton population observation may be used as a reliable tool for biomonitoring studies to assess the pollution status of aquatic bodies (Mathivanan and Jayakumar, 1995) .In the present study as expected the toxicity to the water caused by the plaster of paris is believed to be the reason for the lowest plankton count in aquarium **C** and **G** which contained POP idols. But unexpectedly aquarium B had a higher count than the control aquarium **A**. We believe that the flour used to make the glue for the paper mache idol in aquarium **B** might have increased the nutrient load in the

water through its decay, thus enabling phytoplankton populations to rise above that of the control aquarium.

ACKNOWLEDGEMENT
The Author is grateful to University of Mumbai for sanctioning the grant for the project and Dr. Nilesh Amritkar of Envirocare for helping in metal analysis.

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