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Coastal Pollution in West Bengal: Implications for Olive Ridley Turtles

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Olive ridley turtles nest all along the east coast of India, including the coast of West Bengal (Biswas 1982). Olive ridleys are carnivorous, and consume crustaceans as well as fish, sea urchins, squid and jelly-fish. Though sea turtles may not forage for long at their breeding grounds, extensive coastal pollution may still pose a threat to these animals.

The term 'sea surface micro layer' relates to 1–1000 μm of the ocean surface forming an ecosystem with its own identity. Natural surface active substances like amino acids, fatty acids, proteins, lipids, phenols and a variety of organic compounds exist in particulate phase in this layer. Anthropogenic organic compounds and metals also occur in higher concentrations in the micro layer than the deeper layer, as do trace metals—although their concentration has not been determined. Lead (Pb), cadmium (Cd), copper (Cu), zinc (Zn), some radio nucleotides, aromatic hydrocarbons and chlorinated organics are found at 10 to 100 times greater concentrations in the micro layer. Planktons produce dissolved compounds as a product of their metabolism. Air bubbles rising through the water column collect these organic materials and bring them to the surface. Accumulation of these natural organic chemicals modifies the physical and optical properties of the sea surface (Hardy 1982)

Increasing global sea surface contamination and/or ultraviolet radiation threatens important sea surface biological communities and processes. Autotrophic and heterotrophic neustons ranging in size from less than 2 μm to a metre or more occur here most frequently (Marmo et al 1972). The neustons of the ocean surface are of two kinds—epineustons, which include more than 40 species of water striders that inhabit the open ocean and coastal areas, and the hyponeustons, organisms in the centilayer including hydrozoa, molluscs, copepods, isopods, decapods, crustaceans, fish and

seaweed. Neustons are believed to connect the sea surface and water column as their larvae develop and migrate downwards and adult animals visit the surface to feed and reproduce. High densities of neustonic organisms influence air–sea exchange processes, while anthropogenic enrichment of the sea surface threatens marine plants and animals and possibly even affects global climate. Qualitative and quantitative changes in neustons due to human impact not only influences the reproduction of marine animals and plants with special stress on commercially important species, but also affects the natural mechanism involved in the dynamics of weather and climate (Marmo et al 1972).

The impact of pollution on sea turtles in Indian waters is unknown and could be of significant magnitude. In this study, we conducted environmental monitoring of sea surface micro layer quality (physico-chemical properties and quantification of pesticides, hydrocarbons and heavy metals), identified the pollution source and monitored bioavailability of pesticides and heavy metals through aquatic species in order to assess risk to olive ridley turtles.

Study Area

West Bengal has a coastline of 220 km from the mouth of the River Subarnarekha in the west, to the mouth of the River Harinbhanga in the east. It encompasses Digha, Sankarpur, Bak Khali, Frazergunge, Gangasagar Sunderbans, Haldia port and the industrial area of the Kolkata–Haldia complex. It also houses a saline area of 405,000 ha, covered under agricultural and aquacultural operations. All these interventions and human interactions pollute the coastal environment, damage living resources and ecological systems, cause hazards to human health and a hindrance to fishing.

Methods

Examination of sea surface micro layers: The simplest method is the plate sampler in which a viscous film of water from the sea surface adheres to a glass plate, which is submerged below the water surface and then withdrawn vertically (Hardy 1982). The film is removed by using a wiper blade.

Determination of total microbial load in relation to pollution: Water samples were collected from the following zones and tested for the total microbial load. The zones were grouped on the availability of hydrocarbons and pesticides. Hydrocarbon-/ pesticide-rich zones included Kakdweep, Sankarpur, Frazergunge and Haldia. Hydrocarbon-/ pesticide-poor zones include Dadanpatrabar, Sandeshkhali, Basanti and Jambudweep.

In this study, Zone 1 refers to Ghushighata, which receives effluents from the industrial sewage of Topsia and Tangra region of Kolkata city (where huge tanneries exist) and Kolkata city sewage from different canals through the Dhapa lock gate, Zone 2 refers to Sandeshkhali, Zone 3 refers to Kakdweep, and Zone 4 refers to Jambudweep

Method for isolation and identification of Vibrio parahaemolyticus: Water samples were diluted in a ten-fold manner and inoculated into: (i) freshly prepared salt-meat broth, (ii) Polymyxin salt broth, and (iii) peptone water, each containing 5 per cent sodium chloride and were incubated aerobically at 37^0C for 24 hours. After one night incubation the large, round, dome-shaped (2–3 mm diameter) colonies of *Vibrio parahaemolyticus*

were identified and subsequently confirmed by the crystal violet double ring test (Chakraborty et al 1994).

Assessment of heavy metal pollution in the Sunderban region: Six estuarine water samples in different areas of North and South 24 Parganas were selected for this study. Sediment soil, surface soil and water samples were collected at random from different locations. Soil samples were dried and subjected to leaching by strong nitric acid. Water samples were digested following standard method. After necessary dilution copper (Cu), zinc (Zn), chromium (Cr), cadmium (Cd) and iron (Fe) were estimated by atomic absorption spectrophotometer. The analysis were carried out following APHA, 1995. The concentration of these metals were compared to government-defined standards (Table 1).

Table 1. General standards for discharge of effluents (Source: Schedule II inserted to the Environment Protection Rules 1986 vide G.S.R.919(E) dt.12.9.88. Published in Gazette No. 488 dt 12.9.88)

Parameter	Standards for marine coastal areas (mg/1)
Zinc (Zn)	15
Iron (Fe)	1
Chromium (Cr)Total	2
Cadmium (Cd)	2
Copper (Cu)	3
Pesticides	absent
Nitrites (N) and phosphates (P)	–

Results

ASSESSMENT OF POLLUTION IN COASTAL AREAS

The presence of heavy metals and pesticides in estuarine waters, sediment and monthly variations (Tables 2–7) and microbial load (Table 8) were determined.

Table 2. Heavy metal concentration in the estuarine water of different zones (values are expressed in mg/l ± ND=not detectable).

Area	Fe	Cr	Cd	Cu	Zn
Zone 1	2.57 ± 0.12	8.8 + 1.66	4.5 ± 0.49	0.01 ± 0.007	0.08 ± 0.014
Zone 2	4.71 ± 0.18	0.16 ± 0.03	3.30 ± 2.20	0.02 ± 0.004	0.03 ± 0.01
Zone 3	1.75 ± 0.38	0.22 ± 0.04	4.8 ± 2.09	0.03 ± 0.004	0.05 ± 0.008
Zone 4	1.75 ± 0.38	0.23 ± 0.05	4.8 ± 2.09	0.03 ± 0.007	0.03 ± 0.01

Table 3. Heavy metal concentration at the surface of the estuarine sediment of different zones of the Sundarbans (values are expressed in mg/gm ± SD; ND=not detectable).

Area	Fe	Cr	Cd	Cu	Zn
Zone 1	1.10±0.09	8.8±1.66	4.5±0.49	5.7±0.62	6.5±0.47
Zone 2	2.8±0.09	7.3±1.69	3.30±2.20	ND	5.6±0.47
Zone 3	2.8±0.09	8.8±1.66	4.8±2.09	1.6±0.59	6.5±0.47
Zone 4	2.7±0.03	6.4±1.65	4.8±2.09	ND	3.7±0.50

Table 4. Monthly variations of dissolved trace metals (in mg $^{-1}$/ l. in brackish water of the Sunderbans).

Months	Fe	Cr	Cd	Cu	Zn
February	2,864	6.2	ND	128	160.5
March	2,263	7.5	ND	94.5	100
April	2,237	8.3	ND	98.3	107
May	2,256	13.2	ND	90.2	119

Table 5. Seasonal variation of heavy metals in water (mg/lt).

Station	Season	Pb	Cd	Mg
Digha	Summer	12.87	0.4	0.43
	Post-monsoon	12.07	0.4	0.19
	Winter	6.79	0.28	0.23
Subaranarekha	Summer	12.57	0.58	0.48
	Post-monsoon	10.75	0.40	0.46
	Winter	5.3	0.52	0.34

Table 6. Chlorinated pesticide residue in sediments (ng/g) dry weight.

Station	t-DDT			t-Endosulfan		
	Min	Max	Mean	Min	Max	Mean
Digha	4.5	6.5	5.5	1.1	2.7	1.9
Subaranarekha	1.7	14.8	8.25	1.2	4.8	3.0

- t-DDT = O,P,DDE + O,P,DDD + O, P, DDT + P, P, TDE + P, P. DDt
- t-Endosulfan = ? Endosulfan + ? Endosulfan
- t-MCM = ? MCM + YMCM.

Table 7. Pesticides (mg/l) in surface water under the Sunderban area.

Parameter	Ghushighata	Sandeshkhali	Kakdweep	Jambudweep
DDT	1174.22	6922.01	7322.4	NT
BHC	684.60	2621.00	2534.01	NT
Lindane	118.50	995.75	1607.00	NT
Endosulfan	185.65	275.65	585.10	NT

Table 8. Microbial load increase in relation to availability of hydrocarbons / pesticides.

Zones from which water sample was collected	Presence of pesticides/ hydrocarbons	Microbial count bacteria found	Predominant
Haldia	+ + + +	57.9 X 10^5 / ml.	Bacteria of the Vibrio
Kakdweep	+ + +	40.5 X 10^5 / ml.	group, predominantly
Frazergunge	+ + +	38.2 X 10^5 / ml.	*V. parahaemolyticus*
Sankarpur	+ + +	42.9 X 10^5 / ml.	
Dadanpatrabar	Negligible	9.4 X 10^5 / ml.	Various Gm +ve and
Basanti	+ +	28.9 X 10^5 / ml.	Gm –ve bacteria as
Jambudweep	+	17.4 X 10^5 / ml.	well as *Vibrio* spp.

FIELD STUDY ON POLLUTION UPSTREAM

The Hugli–Matla estuary in West Bengal is possibly the most polluted estuary in the world. A large number of factories located close to the mouth discharge almost half a billion litres of untreated waste per day including the effluent from pulp and paper mills, pesticide manufacturing plants, distilleries, thermal power plants, and yeast, rayon, cotton, vegetable oils, soap, fertilisers and antibiotic plants. Preliminary bioassays indicate that cotton effluents are extremely toxic to many fish species, as also isvarnish from rubber and rayon industries.

ENVIRONMENTAL ASSESSMENT IN HALDIA, EASTERN-MOST LIMIT OF THE DIGHA–SANKARPUR OPEN COASTAL SYSTEM

Haldia is located in Midnapore district of West Bengal at 22^0 30' N and 88^0 30' E, at the confluence of the Haldia and Hugli rivers, 130 kms from Kolkata. There are a large number of industrial units including large- and medium-scale industries, and also small-scale factories. The area has a number of drainage channels flowing towards the Hugli and Haldia rivers. Both sewage and industrial effluents are discharged into the rivers. The analysis of the surface water in the Haldia, Hugli and the green belt canals is indicated in Table 9.

Table 9. Analysis of the surface water in the rivers Haldia and Huglin and the green belt canals.

Parameter	Haldia	Hugli	Green Belt
PH	7.9	8.0	6.9
TSS	866	24.5	7
D.O(mg/l)	6.3	6.6	4.6
T-P(?g/l)	51	31	23
T-N_2(?g/l)	112	266	250
Salinity (ppt per cent)	4.52	10.05	14.93

GROUNDWATER: POTENTIAL USE AND QUALITY

The area has enough brackish groundwater which is recharged by the percolation of rainwater, fresh surface water from the two rivers and brackish water from the sea. The groundwater table in this area varies between 2.3–2.5 m below ground level. An analysis of the sample is given in Table 10.

Table 10. Analysis of ground water at various sites.

Parameters	Dock complex	Rai Chak	Bhagwan-pur	Nadaram-pur
Total suspended solid (mg/l)	14	11	8	5
Total dissolved solid (mg/l)	779	994	550	628
Total solid (mg/l)	792	104	557	632
PH	7.2	7.2	7.3	7.3
EC maximum at 25^0 C (?m hos/cm)	1472	1919	1016	1248
Alkalinity (mg $CaCo_2$/l)	313	361	361	351
Hardness (mg $CaCo_3$/l)	344.	349.7	217.2	288

Table 10 (contd.)

Parameters	Dock complex	Rai Chak	Bhagwan-pur	Nadaram-pur
Chloride (mg/l)	25.5	358.6	112.0	164.0
TVC	15.7	8.4	24.4	18.1
Cd (?g/l)	6.1	6.1	BDL	2.1
Pb (?g/l)	BDL	BDL	BDL	BDL
Cu (?g/l)	3.5	4.7	2.5	7.1
Mn (?g/l)	94.5	153.1	73.3	58.3

INTERVIEWS WITH FISHER FOLK

Fishers were interviewed to understand the downstream impacts of pollution. They suggested that fish catch in this area has drastically decreased over the years, which could be due to pollution. Fishers indicated that the deep-sea trawlers were actually six cylinder mechanised boats, and were not in favour of bycatch reduction devices because the full catch is utilised. The fishermen's association is against trawling since it is believed to disturb the breeding ground/nesting ground of different fishes. The fishers also claimed that modern trawlers were overexploiting fish, leading to the loss of many species. In addition, hilsa (*Tenualosa ilisha*) generally lays its eggs in freshwater (upstream) but the eggs do not survive due to pollution. They said that there should be a monsoon trawl ban in all the coastal states.

ADDITIONAL THREATS

1. Eutrophication and toxins from Dianoflagellate blooms.
2. Oil spill from Kolkata dock and from several dry docks is another major source of pollution.
3. Dumping of plastic packets in the canals, creeks, estuaries and coastal waters.
4. Artificial lightning.
5. Large-scale introduction of mechanised boats as well as proliferation of gill nets.

Discussion

When large quantities of potentially harmful substances, e.g. pesticides, heavy metals and hydrocarbons, are released into the aquatic environment, the impact can be seen in large-scale mortalities of aquatic organisms. Lower level of discharge may result in an accumulation of the pollutants in aquatic organisms. This may result in immuno-suppression, reduced gonadal development, outbreak of disease, reduced metabolism, neural dysfunction, etc (Jash and Bhattacharya 1983, Ghosh and Bhattacharya 1992, Guillette et al 1996).

For example, in fish, cholinergic nerves also regulate the release of various hormones from the pituitary and hypothalamus and the inhibition of Acetylcholine Esterase thus leads to hypo-function of the pituitary and hypophysation. The hormonal changes are positively correlated to ovarian damages recorded in a phenthoate exposed fish (Dey and Bhattacharyya 1989) and also in a methyl parathion and carbaryl-exposed fish

(Choudhury et al 1993). Thus even non-lethal doses of pesticides can take their toll on aquatic animals.

The predominant organism detected in water samples collected in various hydrocarbon rich zones belong to the vibrio group. Harmful vibrio species like *V. parahaemolytus* and *V. anguillarum* need salinity for their survival. Recent reports have shown that *V. parahaemolytus* are able to utilise hydrocarbon compounds like benzene, napthalenes, phenols, etc and the rapid multiplication of this species in marine environments may be due to their utilisation of coal tar derivatives.

Sea turtle populations can be severely impacted by infectious diseases (George 1997) Ingestion of plastic and other marine debris kills turtles by obstructing the gut (Gramentz 1988, Bjorndal et al 1994) and exposure to petroleum products affects the health of sea turtles (Lutcavage et al 1995). Studies have shown clearly that human impacts upon sea turtles through pollution can be severe (Lutcavage et al 1997), and even diseases like fibropapillomatosis may be related to environmental stressors (George 1997). Olive ridley turtles spend nearly six months of the year in the nearshore waters along the coast of India. Large congregations occur near the mass-nesting beaches in Orissa, which emphasises the importance of evaluating and mitigating pollution in the region.

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