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IMPACT OF OIL SPILL ON AQUATIC FAUNA AT HALDIA

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INTRODUCTION

The occurrence of oil spills in the major ports of the world and oil spill identification are well known problems. The literature on the problems of oil pollution in the marine environment and its effect on the fauna and flora has been summarised by Ferguson Wood and Johannes (1975). The impact of oil spills on animal life requires exhaustive investigations (Blumer, 1957; Englington, *et al.*, 1975).

To study the effects of oil spills occurring at Haldia Port caused during transportation of oil from oil tanker in May, 1996, a survey was undertaken by a team of scientists of the Zoological Survey of India, Calcutta, in August, 1996.

Our objective was to determine the impact of oil spill on the population density in the polluted and non-polluted areas.

STUDY AREA

The team surveyed the intertidal areas in and around Haldia Port i. e., Oil jetty, Passenger jetty, Patikhali, Nayachar and Roychak for faunal collection and Physio-chemical analysis.

MATERIAL AND METHODS

Water samples and plankton samples (high tide and low tide) were collected at three points - Tug jetty, mid-channel and northern bank of Nayachar Island in the Hooghly estuarine stretch in a cross-section manner.

(a) *Physio-chemical estimation* Salinity and pH of the aquatic medium were analysed by means of refractometer and pH meter respectively. Temperature of the surface water was measured by Celsius thermometer. The water for heavy metal analysis was passed through a 0.45μm Millipore membrane and the filtered water was treated with diethyl-dithiocarbomate and extracted in CCl_4. The extract was evaporated to dryness and the residue was mineralized with 0.1 ml of conc. HNO_3. Analytic blanks were treated with same reagent. The results obtained were expressed in $\mu g\ l^{-1}$. For analysing nutrients in water i.e., NO_3-N, PO_4-P and SiO_4-Si, water samples were processed and their absorbances were measured as per standard method (Spelleberg, 1991). For estimating heavy metals in animal tissue, the soft tissue portions of the barnacle and fish after being treated with metal free doubled distilled water were oven-dried at 110°C overnight. 1 gm of each sample was digested with conc. HNO_3 and the resulting solution was analysed through AAS along with a simultaneous blank analysis. The results obtained were expressed in µg gm^{-1}.

(b) *Plankton collection* Zooplankton samples were collected from the ambient aquatic medium by means of Nansen type plankton net made of bolting silk with 60 meshes per linear centimetre. Collected zooplankton samples after washing by water and filtering were preserved in 4% formalin.

(c) *Intertidal faunal collection* Animal communities inhabit the intertidal zone, i.e., between highest high tide mark and lowest low tide mark on that particular day, were collected. The collected specimens were washed properly and narcotised and afterwards transferred to 5% formalin.

(d) *Physico-chemical analysis* Water samples were analysed for nutrients (NO_3, PO_4 and SiO_4), Salinity, pH and dissolved heavy metals (Zn, Mn, Fe, Ni and Pb). Trace metals were analysed because crude oil is a complex mixture of hydrocarbons and some metals.

The entire network of present study involved *in situ* analysis of salinity (by mean of refractometer) and pH with a portable pH meter. Concentrations of nitrate, phosphate and silicate in the ambient aquatic medium were also analysed *in situ* with a colorimeter. Water samples collected in clean tarson bottles were sent to the Susama Devichoudhurani Marine Biological Institute for analysis of trace metals. Soft parts of fish and barnacle were also sent to the same institute for analysis by AAS for checking bio-accumulation of heavy metals.

RESULTS

The results of the analysis are given in Table 1. Salinity and pH of the surface water showed direct relationship among themselves. No interrelationship was found among the nutrients (nitrate, phosphate and silicate). The high pohsphate concentration in the present investigation near Tug jetty might be correlated to its proximity of fertilizer factory. Phosphate is an essential and important nutrient for the growth of phytoplankton and other estuarine plants, but its presence above the critical value results in the increased growth of nuissance algae.

In the domain of conservative pollutants the dissolved metals were found to be present in the following descending order Fe, Mn, Zn, Cu, Pb, Ni. In the low tide samples the concentrations of dissolved metals showed an increase in comparison to high tide samples (Table 1). This might be due to the effect of relatively low salinity and pH during low tide that favours the process of dissolution of metals from the sediment bed to the water column.

In barnacle, *Balanus amphitrite* Darwin and fish, *Nibea saldado* (Lacepede) accumulation of heavy metals in the soft parts of the body is shown in Table 2.

Faunal composition in and around Haldia

In the intertidal area in and around Haldia Port, i.e., Oil jetty, Passenger jetty, Patikhali and Nayachar the macro-faunal components are mainly Annelida, Arthropoda, Mollusca and Pisces, as listed below.

Phylum Annelida
Class Polychaeta
1. *Dendronereides heteropoda* Southern
2. *Dendronereis aestuarina* Southern
3. *Mastobranchus* sp.

Phylum Arthopoda
Class Crustacea
Subclass Cirripedia
Order Thoracica
1. *Balanus amphitrite* Darwin

Subclass Malacostraca
Order Decapoda
1. *Metaplax distincta* H. M. Edwards
2. *Metaplax dentipes* (Heller)
3. *Macrophthalmus transversus* (Latreille)
4. *Macrophthalmus depressus* Ruppell

Phylum Mollusca
Class Gastropoda
Order Archaeogastropoda
1. *Neritina violacea* (Gmelin)

Order Mesogastropoda
2. *Stenothyra deltae* (Benson)
3. *Assiminea brevicula* (Pfeiffer)
4. *Thiara scabra* (Müller)

Order Basommatophora
5. *Melampus pulchella* Petit

Order Soleolifera
6. *Onchidium typhae* Buchanan

Class Bivalvia
Order Arcoida
1. *Polymesoda bengalensis* (Lamarck)

Order Myoida
2. *Bactronophorus thoracites* (Gould)

Phylum Chordata
Class Pisces
Order Perciformes

1 *Periophthalmodon schlosseri* (Pallas)
2. *Glossogobius giuris* (Ham.-Buch.)

Prawn and Fish collected from fisherman's catch

Phylum Arthropoda
Class Crustacea
Subclass Malacostraca
Order Decapoda

1. *Palaemon* sp.
2. *Metapenaeus* sp.
3. *Exopalaemon* sp.
4. *Macrobrachium* sp.

Phylum Chordata
Class Pisces
Order Clupeiformes
Family Engraulidae

1. *Setipinna tenuifilis* Valenciennes
2. *Thryssa hamiltoni* (Gray)

Order Cypriniformes
Family Cyprinidae

3. *Puntius sophore* (Ham.-Buch.)
4. *Puntius ticto* (Ham.-Buch.)

Order Siluriformes
Family Bagridae

5. *Mystus gulio* (Ham.-Buch.)
6. *Mystus vittatus* (Bloch)

Order Perciformes
Family Centropomidae

7. *Lates calcarifer* (Bloch)

Family. Chandidae

8. *Chanda baculis* (Ham.-Buch.)
9. *Chanda nama* (Ham.-Buch.)

Family Sciaenidae

10. *Nibea saldado* (Lacepede)

Family Mugilidae

11. *Liza parsia* (Ham.-Buch.)

Family Polynemidae

12. *Eleutheronema tetradactylum* (Shaw)

Family Gobiidae

13. *Periophthalmus pearsei* Eggert

14. *Glossogobius giuris* (Ham.-Buch.)

Family Teraponidae

15. *Terapon jarbua* (Forskal)

Family Eleotrididae

16. *Eviota zonura* Jordan-Seale

Order Pleuronectiformes

Family Cynoglossidae

17. *Cynoglossus lingua* (Ham.-Buch.)

Planktonic components in and around Haldia

In the plankton samples copepods are the most dominant group. Copepod population was followed by immature brachyurans and other crustacean larvae.

Copepods : A good assemblage of oligohaline forms, e.g., *Acartiella* sp., *Neodiaptomus* sp., *Pseudodiaptomus* sp., *Cyclops* sp. and *Mesocyclops* sp. were encountered.

Other crustaceans : Immature brachyurans conceivably represented the bulk of other crustaceans followed by nauplius and zoea stages.

Crustacean groups like Mysidacea, Cladocera, Ostracoda and non-crustaceans like Chaetognatha and Hydromedusae were totally absent.

Faunal composition at Roychak

In the intertidal area at Roychak the macro-faunal components were mainly Annelida, Arthropoda, Mollusca and Pisces.

Phylum Annelida

Class Polychaeta

1. *Dendronereides gangeticus* Misra (in press)

2. *Namalycastis fauveli* Rao

Phylum	Arthropoda
Class	Crustacea
Subclass	Malacostraca
Order	Decapoda
	1. *Metaplax intermedia* de Man
	2. *Sesarma kraussi* de Man
	3. *Tympanomerus stapletoni* de Man
Phylum	Mollusca
Class	Gastropoda
Order	Mesogastropoda
	1. *Littorina melanostoma* Gray
	2. *Assiminea brevicula* (Pfeiffer)
	3. *Stenothyra blanfordiana* Nevill
Phylum	Chordata
Class	Pisces
Order	Perciformes
	1. *Glossogobius giuris* (Ham.-Buch.)
	2. *Periophthalmus vulgaris* Eggert

Table 2 Concentration of heavy metals in the tissue sample of *Balanus amphitrite* **Darwin**

Tissue Zn	8683.29µg	gm^{-1} dry weight
Tissue Cu	4682.10µg	gm^{-1} dry weight
Tissue Mn	567.72µg	gm^{-1} dry weight
Tissue Fe	6820.06µg	gm^{-1} dry weight
Tissue Pb	19.85µg	gm^{-1} dry weight

Concentration of heavy metals in the muscle of fish, *Nibea saldado* **(Lacepede)**

Zn	83.89µg	gm^{-1} dry weight
Cu	15.48µg	gm^{-1} dry weight
Pb	6.93µg	gm^{-1} dry weight

Table 1 : Variations of physio-chemical parameters and heavy metals during high tide and low tide in water samples collected from Haldia zone in August, 1996.

Parameter	Tug jetty		Mid-Channel		Nayachar Island-West Bank	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
Zn ($\mu g\ l^{-1}$)	541.62	602.84	499.57	521.23	488.76	503.81
Cu ($\mu g\ l^{-1}$)	318.87	463.29	302.23	367.84	298.31	317.65
Mn ($\mu g\ l^{-1}$)	613.21	687.75	565.28	605.66	520.08	581.62
Fe ($\mu g\ l^{-1}$)	2024.85	2781.29	1937.70	2368.10	1673.21	2001.57
Ni ($\mu g\ l^{-1}$)	51.48	81.62	46.23	53.29	31.72	50.85
Pb ($\mu g\ l^{-1}$)	130.63	141.89	59.76	102.34	66.93	111.80
NO_3 ($\mu g\ l^{-1}$)	27.93	Not done	20.65	Not done	15.23	Not done
PO_4 ($\mu g\ l^{-1}$)	11.23	Not done	5.21	Not done	3.85	Not done
SiO_4 ($\mu g\ l^{-1}$)	120.83	Not done	89.75	Not done	63.83	Not done
Sur. water temp. (^0C)	31.3	30.9	30.2	30.0	31.0	31.0
Salinity (ppt)	0.42	0.20	0.35	0.10	0.46	0.21
pH	8.10	8.04	8.17	8.14	8.19	8.16
D. O. ($mg\,l^{-1}$)	6.32	5.97	6.97	5.83	6.36	5.98

Table 3 : Concentration of dissolved Zinc (Zn) ($\mu g l^{-1}$) in three stations along the Hooghly estuary from Jan., 95 to Dec., 96

	Station 1 (Chemaguri)		Station 2 (Nayachar Island)		Station 3 (Haldia Tug jetty)	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
1995						
January	323.64	389.21	406.35	433.20	485.62	502.85
February	206.29	283.28	Not done	Not done	Not done	Not done
March	216.36	313.70	Not done	Not done	Not done	Not done
April	300.23	406.22	397.15	431.62	370.23	400.82
May	356.28	495.28	385.29	400.17	399.26	432.37

Table 3 (Contd.)

	Station 1 (Chemaguri)		Station 2 (Nayachar Island)		Station 3 (Haldia Tug jetty)	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
June	208.52	313.08	Not done	Not done	Not done	Not done
July	363.28	402.21	Not done	Not done	Not done	Not done
August	286.39	340.25	Not done	Not done	Not done	Not done
September	407.65	491.11	Not done	Not done	Not done	Not done
Ocotober	413.70	488.26	Not done	Not done	Not done	Not done
November	298.65	333.30	320.54	397.66	401.82	454.76
December	308.70	373.29	Not done	Not done	Not done	Not done
1996						
January	319.00	416.26	Not done	Not done	Not done	Not done
February	330.21	Not done	Not done	Not done	Not done	Not done
March	Not done	Not done	356.27	398.12	380.50	432.57
April	Not done	Not done	Not done	Not done	Not done	Not done
May	313.60	373.82	Not done	Not done	Not done	Not done
June	320.51	391.62	Not done	Not done	Not done	Not done
July	Not done	Not done	Not done	Not done	Not done	Not done
August	304.52	337.89	488.76	503.81	541.62	602.84
Sept. to Dec.	Not done	Not done	Not done	Not done	Not done	Not done

Table 4 Concentration of dissolved Lead (Pb) ($\mu g l^{-1}$) in three stations along the Hooghly estuary from Jan., 95 to Dec., 96

	Station 1 (Chemaguri)		Station 2 (Nayachar Island)		Station 3 (Haldia Tug jetty)	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
1995						
January	3.96	5.13	15.82	21.36	39.28	46.23
February	6.00	7.19	11.23	17.85	34.84	41.35
March	9.33	13.66	13.08	19.66	37.28	46.20
April	5.00	11.23	10.00	14.65	29.85	33.64
May	4.32	7.19	16.28	21.80	Not done	Not done

Table 4 : (Contd.)

	Station 1 (Chemaguri)		Station 2 (Nayachar Island)		Station 3 (Haldia Tug jetty)	
	High tide	Low tide	High tide	Low tide	High tide	Low tide
June	4.00	6.38	Not done	Not done	Not done	Not done
July	13.33	17.20	Not done	Not done	Not done	Not done
August	14.38	20.70	Not done	Not done	Not done	Not done
September	11.85	16.20	20.60	29.32	50.35	57.83
October	9.23	13.85	16.45	19.88	48.11	53.54
November	8.11	12.44	Not done	Not done	Not done	Not done
Dec. 95 to Feb. 96	Not done	Not done	Not done	Not done	Not done	Not done
March	10.65	15.28	14.28	18.99	Not done	Not done
April	Not done	Not done	Not done	Not done	Not done	Not done
May	3.98	7.66	Not done	Not done	Not done	Not done
June	6.01	10.42	Not done	Not done	Not done	Not done
July	Not done	Not done	Not done	Not done	Not done	Not done
August	Not done	Not done	66.93	111.80	130.63	141.89
Sept. to Dec.	Not done	Not done	Not done	Not done	Not done	Not done

(Data of the Table 3 and 4 are taken from "Cybernatics and the biological world with special reference to coastal ecosystem" by A. Chowdhury & A. Mitra, pp. 48-52, In : The Living World, (Ed.) Sivaprasad Dasgupta, 1997).

Table 5 : Metals in water ($\mu g l^{-1}$) around Haldia

Location	Tide	Cu	Fe	Cd	Pb
1	Low	0.86	25.9	0.21	0.08
2	High	0.67	29.3	0.21	0.19
3	Low	0.22	74.0	0.20	0.09
4	High	0.11	7.9	0.20	0.11

Table 6 Variation of Temperature. pH. Salinity around Haldia

Season	Mean surface water temp (°C)	Mean pH	Mean Salinity (%)
Post-monsoon (Nov. to Feb.)	24.1	7.91	4.07
Monsoon (July to October)	31.7	7.23	1.04
Pre-monsoon (March to June)	32.3	8.12	9.17

(Data of Table 5 and 6 are taken from "Role of bio-chemical variables in the sedimentation of the Hooghly estuary, India" by K. Chakraborty, A. Mitra, T. Sanyal and A. Chowdhury, pp. 2089-2096, Seminar on International Coastal Zone Management, Halifax. Canada, 1994).

Table 7 Mean metal concetrations (in µg gm^{-1} drywt.) in *Balanus balanoides* of Nayachar Island from March, 1993 to February. 1994 (Body part-Flesh)

Season	Zn	Cu	Mn	Fe	Pb	Cd
Pre-monsoon (Mar. to June)	5638.10	1987.94	185.67	3446.12	5.29	8.25
Monsoon (July to Oct.)	7031.84	3205.15	236.49	5298.46	12.62	14.72
Post-monsoon (Nov. to Feb.)	6876.24	2056.72	197.21	4981.75	8.86	9.11

Data of Table 7 is taken from "*Balanus balanoides* as an indicator of heavy metals" by A. Mitra, *et. al.*, 1995, *Indian J. Environ. Hlth.*, Vol. 37, No. 1 42-45.

Table 8 : Fish juveniles collected around Haldia during 1995

1. *Thryssa hamiltonii* (Gray)
2. *Rhinomugil corsula* (Ham.-Buch.)
3. *Mugil cephalus* Linnaeus
4. *Pisodonophis boro* (Ham.-Buch.)
5. *Liza parsia* (Ham.-Buch.)
6. *Eupleurogrammus glossodon* (Bleeker)
7. *Coilia* sp.
8. *Pseudorhombus* sp.
9. *Stolephorus* sp.
10. *Hilsa* sp.

(Data of Table 8 is collected from "Impact of mass collection of prawn seeds in Sundarban mangrove ecosystem" by S. D. Marine Biological Research Institute - Report submitted to Ministry of Environment & Forests, Zoological Survey of India, in 1996, Sanction No. J - 22014/93).

Table 9 : Faunal composition reported from intertidal area in and around Haldia

Phylum	Annelida
Class	Polychaeta
	1. *Dendronereides heteropoda* Southern
	2. *Dendronereides gangetica* Misra (in press)
	3. *Dendronereis aestuarina* Southern
	4. *Goniada emerita* Audouin & M. Edwards
	5. *Mastobranchus* sp. (cf. *indicus* Southern)
	6. *Marphysa sanguinea* (Montagu)
	7. *Namalycastis fauveli* Rao
	8. *Namalycastis indica* (Southern)
	9. *Neanthes chingrighattensis* (Fauvel)
	10. *Neanthes meggitti* (Monro)
Phylum	Arthropoda
Class	Crustacea
Subclass	Cirripedia
Order	Thoracica
	Balanus amphitrite Darwin
Subclass	Malacostraca
Order	Decapoda
	1. *Metaplax distincta* H. M. Edwards
	2. *Metaplax dentipes* (Heller)
	3. *Macrophthalmus transversus* (Latreille)
	4. *Macrophthalmus depressus* Ruppell
	5. *Uca dussumieri spinata* Crane
	6. *Uca lactea annulipes* (Milne-Edwards)
	7. *Uca rosea* (Tweedie)
Phylum	Mollusca
Class	Gastropoda
	1. *Neritina violacea* (Gmelin)
	2. *Neritina smithi* Wood
	3. *Pseudonerita sulculosa* (von Martens)
	4. *Stenothyra deltae* (Benson)
	5. *Assiminea brevicula* (Pfeiffer)
	6. *Assiminea francesiae* (Wood)

7. *Thiara scabra* (Müller)
8. *Melampus pulchella* Petit
9. *Littorina scabra scabra* (Linnaeus)
10. *Larina burmana* Blanford
11 *Onchidium tenerum* Stoliczka
12. *Onchidium typhae* Buchannan

Class Bivalvia

1 *Polymesoda bengalensis* (Lamarck)
2. *Bactronophorus thoracites* (Gould)

Phylum Chordata

Class Pisces

1. *Sideria picta* (Ahl)
2. *Pisodonophis boro* (Ham.-Buch.)
3. *Periophthalmodon schlosseri* (Pallas)
4. *Periophthalmodon tredecemaradiatus* (Ham.-Buch.)
5. *Pseudapocryptes borneensis* (Bleeker)
6. *Scartelaos histophorus* (Valenciennes)
7. *Odontamblyopus rubicundus* (Ham.-Buch.)
8. *Trypauchenichthys typus* Bleeker

(Data of Table 9 is taken from "Hooghly Matla Estuary, West Bengal", Estuarine Ecosystem Series, Part 2, Zoological Survey of India, Calcutta, 1995, 542 pp.)

DISCUSSION

A survey conducted in August, 1996 after the oil spill at Haldia revealed an increase in dissolved heavy metals in the water. These were analysed as crude oil is a complex mixture of hydrocarbons (of varying molecular weights) and various metals. In general, level of dissolved metals in the estuarine water becomes high during monsoon due to huge run off from adjacent industrial belt and also dissolved chemicals in the sediment beds. The abrupt rise of Zn, Fe, Cu, and Pb concentrations in August, 1996 as compared to that of the previous years (Table 3 & 4 for 1995 and 1996 and Table 5 for 1994) might be related to the recent oil spill at Haldia.

The bio-accumulation of metals in the body tissue of Crustacea, *Balanus amphitrite* Darwin, as sampled from the boulders and hard substrata and in the muscle of Fish, *Nibea saldado* as samples from fisherman's catch in the vicinity of Haldia Port-cum-industrial complex, also revealed high metal concentrations in the body. Previous data on concentration of heavy metals in *Balanus balanoides* is given in Table 7 but the same for the particular species of fish is not available.

Any environmental hazard has a direct impact on the biological diversity of the area. The influence may be directed towards the depletion of a large number of species from the affected area due to accumulation of toxic substances beyond their lethal doses of contamination of their food resources. In comparison to Table 9 the present survey showed the presence of less number of the phyla Annelida, Arthropoda, Mollusca (Gastropoda) and Chordata (Pisces). In class Polychaeta under phylum Annelida only 3 species were recorded after the oil spill against 10 species reported earlier from the area and Crustacea was represented by 5 species against 8 species reported earlier. The gastropods have a wide range of tolerance to environmental variables. Even then reduction in the species number of this faunal group during the present survey indicates a deteoration of their habitat. In Pisces 6 species particularly represented by their intertidal forms were not found in and around Haldia. The fact may explain that the effect of oil spill worked even in the secondary level of the ecosystem.

During the period of survey no shoot net for the collection of fish juveniles was found to be operated in the Haldia region although it was a very common practice as learnt from the local fishermen as well as information given in Table 8.

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