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DDT Residues in Sediments from the Bay of Bengal

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The large scale use of persistent organochlorine pesticides in developing countries has caused serious concern due to the presence of their residues in the environment. Organochlorine compounds are characterised by their stability for long periods and may lead to marked changes in the aquatic ecosystem (Addison,1976). Uptake and accumulation of such chlorinated hydrocarbons by sediments, micro-organisms and fish led to build up of such compounds in the food chain (Mecek and Korn, 1970).

In developing countries like India organochlorine insecticides, especially DDT are extensively being used in agriculture and vector control programmes. High concentration of DDT found in the marine environment has led to a total ban on its use in USA, Europe and Japan and restricted the use of other chlorinated pesticides (Harvey,1974). About 55000 tons of pesticides are used every year in India for agricultural purposes (Sen Gupta and Qasim,1985). The cumulative effects of these chlorinated pesticides over time on our coastal environment can be expected to be considerable. A very few data is available on their levels of concentration from the seas around India (Jenson et al.1972; Tanabe et al. 1980; Kureishy et al.1978; Kannan and Sen Gupta 1987; Sarkar and Sen Gupta 1987, 1988) This work aims to asses the prevailing levels of DDT and its metabolites in the sediments from the Bay of Bengal off the east coast of India.

MATERIALS AND METHODS

Sediment samples were collected from different region along the east coast of India during the cruises (No. 141, 155, 157) of RV Gaveshani with the help of Peterson grab and hydrographic winch on board. Immediately after collection the sediment samples were wrapped in aluminium foils and stored in deep freeze on board to avoid further bio-degradation of the pesticides. The

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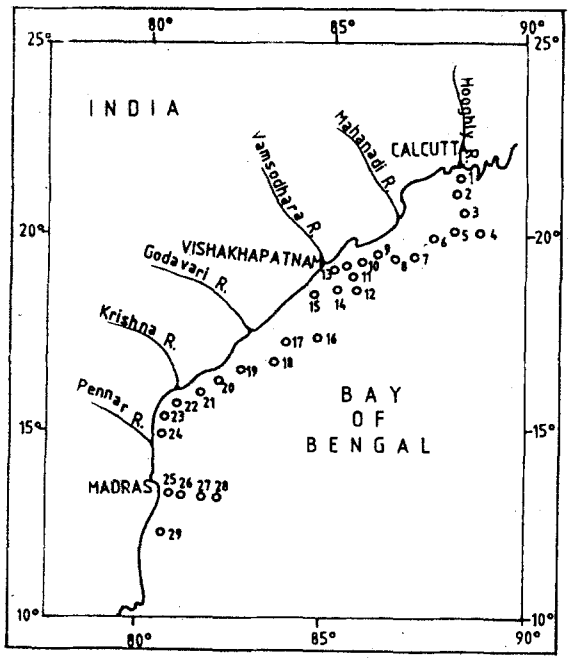

Figure 1. Showing the sample collection sites along the east coast of india.

location of the sample collection sites was reproduced in fig 1. Each sediment sample was extracted and cleaned up according to a previously described procedure (Sarkar and Sen Gupta 1987, 1988) using n-hexane, dichloromethane as the extracting solvents. Residues were detected by electron capture (63 Ni) gas chromatography using Perkin Elmer 3920 B instrument on a 3.6 m X 0.63 cm id glass column packed with 2.5% OV-17 and 2.5% QF-1 on 80/100 chromosorb W, carrier gas was Argon with 5% methane at a flow rate of 75 ml/min. Peaks were identified by comparing relative retention time with those of EPA standards (Moye 1980)

RESULTS AND DISCUSSION

Results presented in Table 1 show the residue level of DDT and its metabolites in the sediments from the Bay of Bengal off the east coast of India. The results reproduced in the table are the mean values of five individual observations for each of the sample. Altogether six compounds of DDT family are detected from the coastal sediments. Total DDT ranged from 0.02 - 0.49 ppm with a mean value of 0.02 ppm, whereas the conc. of other metabolites are in the following ranges: pp'-DDT (0.01 - 0.02 ppm), op'-DDT (0.02-0.04 ppm), pp'-DDE (0.01-0.34 ppm), op'-DDE (0.02-0.21 ppm), pp'-DDD (0.02-0.30 ppm) and op'-DDD (0.04-0.35 ppm).

Table 1.Residue levels of DDT and its metabolites in the marine sediments off the east coast of India.

st. no.	Conc. of DDT and its metabolites in the sediments ug/g (wet wt.)						
	pp'-DDT	op'-DDT	pp'-DDE	op'-DDE	pp'-DDD	op'-DDD	t-DDT
1	0.05	0.02	0.02	0.06	nd	nd	0.15
2	0.07	nd	0.03	0.09	0.30	nd	0.49
3	0.01	nd	0.01	0.04	0.02	0.35	0.43
4	nd	nd	0.02	0.21	nd	nd	0.23
5	nd	nd	0.02	0.07	nd	nd	0.09
6	nd	nd	nd	0.02	nd	nd	0.02
7	nd	nd	0.05	0.08	nd	nd	0.13
8	nd	nd	0.03	0.03	nd	0.06	0.12
9	nd	nd	0.05	nd	nd	nd	0.05
10	nd	nd	nd	0.05	nd	0.04	0.09
11	nd	0.04	0.09	0.11	nd	nd	0.24
12	nd	nd	0.05	0.04	nd	nd	0.09
13	nd	nd	0.06	nd	nd	nd	0.06
14	nd	nd	0.06	0.06	nd	nd	0.12
15	nd	nd	0.07	0.07	nd	nd	0.14
16	nd	nd	0.01	0.12	nd	nd	0.13
17	nd	nd	nd	0.04	nd	nd	0.04
18	nd	nd	nd	nd	nd	nd	nd
19	0.07	nd	nd	0.06	nd	nd	0.13
20	nd	nd	nd	0.04	nd	nd	0.04
21	nd	nd	nd	0.03	nd	nd	0.03
22	0.07	nd	0.02	0.13	nd	nd	0.22
23	nd	nd	0.02	0.11	0.03	nd	0.16
24	nd	0.03	0.09	0.08	nd	nd	0.20
25	nd	0.02	nd	0.03	nd	nd	0.05
26	nd	0.03	nd	nd	nd	nd	0.03
27	nd	nd	nd	nd	nd	nd	nd
28	0.13	nd	nd	0.06	nd	nd	0.19
29	0.20	nd	0.34	0.17	0.08	nd	0.79

nd indicated not detected

The variation of the residue level of each of the compounds of DDT family in different samples was shown in fig 2. The vertical lines at the top of each histogram indicated the standard deviation of five individual observations for each of the sample. Such a variation of the concentrations of DDT and its metabolites in the coastal sediments is derived from the influx of huge amount of pesticide in contaminated water into the Bay of Bengal through runoff from the rivers on the east coast of India.Quite a large number of river mouths are situated on the east coast of India, among which Hooghly, Mahanadi, Vamsodhara, Goadavari, Krishna, Penner and Palar are the major rivers carrying the pollutants into the sea.

It has been found that pp'-DDT was detected mostly near the Hooghly and Godavari estuarine region

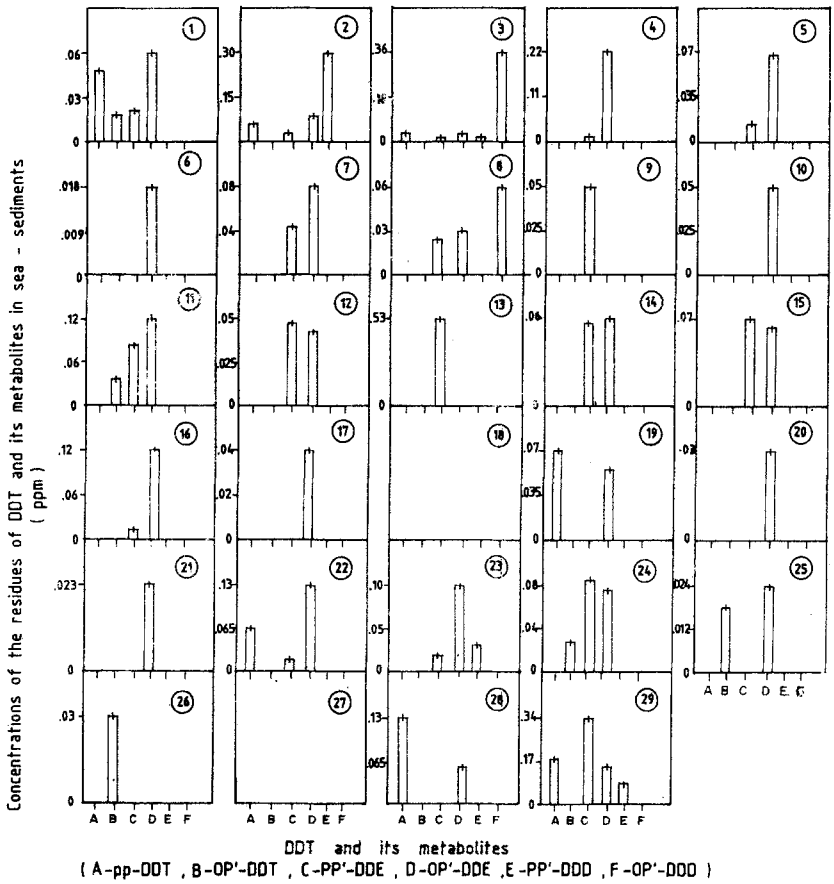

Figure 2. Diagram showing the variation of the level of concentrations of the residues of DDT and its metabolites in sea-sediments along the east coast of india. Vertical lines at the top of each histogram indicate the sample standard deviations of five individual observations with respect to EPA standard samples. Numbers at the corner of each of the diagram represent the sites of sample collections

although its highest conc. was estimated from the sediments near the mouth of Palar river indicating the prolonged use of this pesticide in the peripheral land region. op'-DDT could be detected only in the samples collected from the mouth of Hooghly (0.02 ppm), Mahanadi (0.04 ppm), Krishna (0.03 ppm) and Penner river (0.02 - 0.03 ppm). Among the metabolites of DDT, both pp'-DDE and op'-DDE were very consistent all along the east coast of India, which may be expected due to the degradation of DDT to DDE in the coastal sediments. Unlike DDE, both pp'-DDD and op'-DDD were very sparingly observed. This result clearly indicated that the conversion of DDT to DDD is very insignificant in marine sediments. On the other hand, the conversion of DDT to DDE is highly favourable in marine sediments. Such a significant concentration of DDE in the coastal sediments may be attributed to

various kinds of degradation of DDT to DDE in marine environment (Sarkar and Sen Gupta 1987, 1988). Firstly, presence of various kinds of marine benthic organisms are likely to accelerate the bio-degradational process. Secondly, alkaline nature of the marine system is expected to be highly favourable for such types of degradation. Moreover, marine sediments were found to be highly rich in some of the chemical characteristics such as salinity, clay mineral concentration (Bentonite, Kaolinite, Illite etc.), organic matter (Humic substances), major elements (eg. Fe, Co, Ni, Mn, Zn, Cu, etc.) which are most likely to play important role towards the degradative process. Thirdly, from the thermodynamic point of view, the ocean thermal energy evolved due to continuous turbulence of seawater, resulting into considerable amount of entropy change in the system, could be sufficient to accelerate degradational process even at a lower temperature (10-15°C). It was observed that the residue levels of different isomers and metabolites of DDT detected so far in the coastal sediments are in the following order:

op'-DDT < pp'-DDD < op'-DDD < pp'-DDT < pp'-DDE < op'-DDE

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