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Organochlorine Insecticide Residues in Nipe Bay, Cuba

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In the last decades there has been a significant increase in the production and use of pesticides in Latin America because of their role in enhancing tropical agricultural production (Carvalho et al. 1998). Agricultural activities near coastal areas generate particular concern due to the accumulation of persistent organic pollutants (POP) in marine sediments and biota. POP include pesticides such as aldrin, dieldrin, hexaclorobenzene (HCB) and DDT which have been restricted in many parts of the world but continue to persist in marine environments (Forget 1991, Castilho et al. 2000).

Pesticides in Cuba are used for agricultural pest control, as well as to eliminate insect vectors of illnesses (Official List of Authorized Pesticides 2003). From 1956 to 1989, DDT was widely used in Cuba for rice crop protection and for mosquito control to prevent malaria. Studies of environmental pesticides in Cuba are scarce in general (Dierksmeier 1996; Dierksmeier et al. 1997), and especially in coastal areas such as Nipe Bay (Palacios and Beltrán 1993). Multiple human activities, including agriculture, are currently developed along the 176 km coastal zone of Nipe Bay, driving multiple environmental studies in the region (Romero and Suárez 1993; Arencibia Carballo et al. 2002), however data on insecticides in coastal sediments of this region are lacking. The objective of the present study was to determine the organochlorine pesticide residuals in marine silts of Nipe Bay, Cuba.

MATERIALS AND METHODS

Nipe Bay, located at 20° 50' N and 75° 40' W, occupies an area of 220 km ^{2}. Inside the bay, 10 stations (Figures 1) were sampled during August, 2001. One sample of superficial silt was collected at each station using a dredge. Each sample was placed in clean glass flasks for transport to the laboratory. Sediment samples were spread on trays to dry in the shade and then the silt was sifted to separate biological remains, stones and other materials. Determination of organochlorine insecticide residuals was carried out according to previously described analytic methods (FAO 1991) using analytical grade chemicals (Chemical Services Inc. West Chester, PA 19381, USA). Samples were extracted with acetonitrile and mechanical agitation. After decanting the sample, an aliquot was taken to determine the partition coefficient using water and n-hexane. Hexane extracts were

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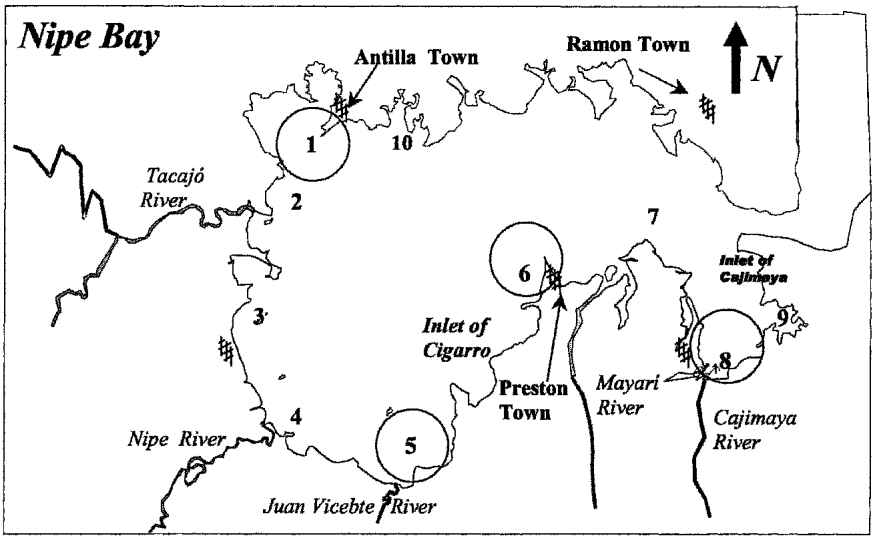

Figure 1. Sampling stations within Nipe Bay, Cuba.

then purified by Florisil column chromatography. Components of the extract were distributed in the following elution fractions: Fraction 1 (hexane): HCB, Lindane, Aldrin, and pp' DDE; Fraction 2 (hexane-dichloromethane): alpha-endosulfan, dieldrin, pp' DDD and pp' DDT; Fraction 3 (dichloromethane): beta-endosulfan and endosulfan sulfate.

Compounds were determined by gas chromatography (Varian 3300, USA) in 30 cm columns with 0.53 mm internal diameter and 1,5 μm thickness of DB-5. The initial temperature of the column was 90 °C during 2 min, and the final temperature of 280°C during 10 min, with a ramp of 10 °C/min. For each sample set, one duplicate, one standard, and one blank sample were included in order to assure the quality of the data.

RESULTS AND DISCUSSION

The recoveries of the analytic method averaged 85.8% for alpha endosulfan, 80.7 for the beta endosulfan and 78.2 for endosulfan sulfate. The detection limit of the analytical method was 0.1 ng/g. Residuals of HCB, lindane, aldrin, dieldrin and endosulfan (alpha, beta as well as endosulfan sulfate) were not detected. Similarly, pp' DDT was not detected in any samples, but its degradation product, pp' DDE was observed at four of the ten stations (Table 1).

The stations with measurable pp' DDE were 1, 5, 6 and 8. Stations 1 and 6 are located close to the towns of Antilla and Preston, respectively, whose populations are 10, 000 and 7, 000 inhabitants. Station 5 is located close to sugar cane crops and Station 8 is located close to the Cajimaya River, which receives the outflow of several towns with industrial activities.

The accumulation of organochlorine insecticides in coastal environments

Table 1. Residuals (ng/g) of the organochlorine insecticide metabolite, DDE in silt samples from Nipe Bay, Cuba.

Sampling Station	pp' DDE
1	**48**
2	ND
3	ND
4	ND
5	**2**
6	**4**
7	ND
8	**16**
9	ND
10	ND
Average	**10**

ND -Not Detected

continues to be a concern in many countries throughout Latin America (Wu et al. 2000; Páez-Osuna et al. 2002; Gardner et al. 2003) The pp' DDE quantities found in Nipe Bay ranged from 2 - 48 ng/g, which is low and similar to those observed in other coastal areas of Cuba (2.39 to 23.15 ng/g; Dierksmeier et al. 1997). Federal regulations in Cuba have prohibited the use of organochlorine insecticides, including DDT, since the 1990's (Official List of Authorized Pesticides 2003). Government studies at that time (Palacio and Beltrán 1993) reported concentrations of DDT and its metabolites (2.6 – 83.3 ng/L) in water in Nipe bay suggesting a relatively contemporary source of this insecticide (Palacio and Beltrán, 1993). Whereas in many parts of the world, the DDT/DDE ratios have increased (Borrell and Aguilar 1999; Tavares et al. 1999), our findings of relatively low pp DDE and no DDT, suggest that DDT use in this region of Cuba has been reduced during the last decade. These results indicate that restrictions on DDT use in Cuba during the last 15 years, have been successful in decreasing organochlorine insecticide influx to coastal regions.

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REFERENCES

Arencibia Carballo G, Isla M, Capetillo N, Almira I, Castillo D (2002) Fuentes

contaminantes de la Bahía de Nipe, Cuba. ISSN 1726-7986. Fopcana (julio-diciembre, 2002). 1:42-50
Borrell A, Aguilar A (1999) A review of organochlorine and metal pollutants in marine mammals from Central and South America. J Cetacean Res Manage suppl. I:195-207
Carvalho FP, Fowler SW, Gonzalez-Farias F, Mee LD Readman JW (1998) Agrochemical residues in teh Altata-Ensenada del Pabellón Coastal Lagoon. (Sinaloa, México): a need for integral coastal zone management. Int J Environ Health Res 6:209-220.
Castilho JAA, Fenzl N, Guillen SM, Nascimento FS (2000) Organochlorine and organophosphorus pesticide residues in the Atoya river basin, Chinandega, Nicaragua. Environ Pollut 110:523-533
Dierksmeier G (1996) Pesticides contamination in the Cuban agricultural environmental. Trends Anal Chem 15:384-389
Dierksmeier G, Hernández R, Moreno P, Martínez K, Ricardo C (1997) Organochlorine pesticides in sediment and biota in the costal region to the south of Pinar del Rio Province, Cuba. IAEA-SM-343/42
FAO (1991) Sampling of Selected Marine Organism and Sample Preparation for the Analysis of Chlorinated Hydrocarbons: Reference Methods for Marine Pollution Studies, No 12, Revisión 2, FAO, Roma, 1991.
Forget G (1991) Pesticides and the third world. J Toxicol Environ Health 32:11-31
Gardner SC, Pier MD, Wesselman R, Juárez JA (2003) Organochlorine contaminants in sea turtles from the Eastern Pacific. Mar Pollut Bull 46:1082-1089
Anonymous. Official List of Authorized Pesticides . República de Cuba (2003)
Palacio F, Beltrán J (1993) Manejo Ambiental de la Bahía de Nipe. Informe Final. CIMAB.
Páez-Osuna F, Ruiz-Fernández AC, Botello AV, Ponce-Vélez G, Osuna-López JI, Frías-Espericueta MG, López-López G, Zazueta-Padilla HM (2002) Concentrations of selected trace metals (Cu, Pb, Zn), organochlorines (PCBs, HCB) and total PAHs in mangrove oysters from the Pacific coast of Mexico: An overview. Mar Pollut Bull 44:1296-1313
Romero LT, Suárez AG (1993) Distribución de la contaminación orgánica en la Bahía de Nipe, Cuba. Ciencias Marinas. 19:371-386
Tavares TM, Beretta M, Costa MC (1999) Ratio of DDT/DDE in the All Saints Bay, Brazil and its use in environmental management. Chemosphere 38:1445-1452
Wu TH, Rainwater TR, Platt SG, McMurry ST, Anderson TA (2000) Organochlorine contaminants in Morelet's crocodile (Crocodylus moreletii) eggs from Belize. Chemosphere 40:671-678