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Polychlorinated Biphenyls in Sea Birds from Ascension Island, South Atlantic Ocean

by
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Introduction

The widespread occurrence of pollutants such as polychlorinated biphenyls (PCB's) and chlorinated hydrocarbon pesticides has been well documented for a number of marine organisms in the Atlantic Ocean (JENSEN et al. 1969; RISEBROUGH et al. 1968; RISEBROUGH et al. 1972) as well as in the Pacific Ocean off California and Panama (ZITKO 1971). Specifically, PCB's have been recently identified in marine birds from Antarctica (RISEBROUGH and CARMIGNANI 1972). Opportunity was provided for collecting vertebrates on Ascension Island, a remote volcanic island in the South Atlantic Ocean (7°57'S, 14°22'W). On this island pelagic-feeding birds such as the Sooty Tern (Sterna fuscata) nest in huge colonies on the volcanic "fairs" or "plains" (ASHMOLE 1963) and others, such as the Fairy Tern (Gygis alba) and Brown Booby (Sula leucogaster), breed commonly on nearby cliffs (DORWARD 1963). Some of these birds were taken in March 1972 for pollutant and pesticide analyses in our Florida laboratories.

Materials and Methods

With the aid of a small hand net, four adult and two nestling Sooty Terns, two adult Fairy Terns, and one immature Brown Booby were captured. The adult terns had been feeding on small fish and other marine life in the offshore waters, whereas the immature birds were being fed by their parents (one of the nestling terns regurgitated a small squid). From each bird a small amount of fat was removed from the subcutaneous depot in the interfurcular area as was also a piece of liver and much of the brain (except for the Brown Booby). These tissue samples were immediately immersed into individual vials of a 4% solution of formaldehyde according to the method of FRENCH and JEFFERIES (1971) for transport to the Florida laboratories. After some two weeks of storage at ambient temperatures, each tissue was carefully dried on filter paper, throughly homogenized in sodium sulfate, and extracted in a soxhlet apparatus for 10 hrs. in petroleum ether.

Extracts were poured into tared beakers and the ether evaporated under a hood at room temperature. Beakers were reweighed and lipid weights recorded. Lipid residues were dissolved in acetonitrile saturated with hexane, transferred to a separatory funnel

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and washed 4 times with hexane saturated with acetonitrile. After discarding the hexane washings, the acetonitrile fraction was transferred to a beaker and allowed to evaporate at room temperature. The residue was dissolved in hexane and placed on a 8% water deactivated florisil column (22x180mm). The column was eluted with 200 ml of a hexane: benzene mixture (3:1) and the eluate was concentrated or diluted, as necessary, for gas chromatography. A Varian 2100 gas chromatograph containing a 6'x1/4" glass column of 1:1 6.4% OV-210: 1.6% OV-17 on chromosorb W and a H^3 Electron Capture detector was used for analysis. A second glass column of 1.5% OV-17/1.95% QFI on Gas Chrom Q of similar dimensions was used for confirmation. Other instrumental parameters were injection port 210°C, column 200° and detector 215° with a N^2 flow rate of 40 ml/min.

Following preliminary gas chromatograph injections after florisil cleanup, the eluate was brought to 10 ml with hexane and transferred to a column of silica gel (10x70 mm) which had been washed with benzene and activated at 230° for three hours. Columns were eluted with 50 ml pentane and 200 ml benzene which were separately collected. This procedure was modified from that of SNYDER and REINERT (1971). These eluates were concentrated or diluted and injected into the gas chromatograph. Portions of these eluates from some samples were subjected to solvent partitioning in systems of hexane: acetonitrile and iso-octane: 80% acetone.

Results and Discussion

None of the DDT metabolites or dieldrin was identified from the tissues removed from these birds. On the other hand, PCB's were present in all of the birds in one or more of the tissues with the greatest quantities being found in the adipose tissue (fat) (Table 1). Aroclor 1248 produced a standard curve most closely matching those of the bird samples, so their PCB's were quantified against this one standard aroclor although admittedly some additional aroclor(s) might have been present in extremely minute quantities. Precise accuracy of the quantities presented in Table 1 might be questioned due to (a) the small amounts of extracted lipids and (b) the transportation preservative used. FRENCH and JEFFERIES (1971) in prescribing 4% formaldehyde for temporary preservation tested only for the loss of dieldrin and DDT. Although they found no significant loss of these chlorinated hydrocarbon pesticides, they made no tests for possible losses of PCB's using this temporary preservative. Hence, some PCB's could have been lost in this study. The important result, however, ever, is at least the qualitative demonstration of a PCB in these pelagic birds from an extremely remote island in the South Atlantic Ocean.

Considering the absence of streams on this tiny island and the absence of all industrial wastes in the surrounding waters, the question must be asked as to the origin of the PCB in these birds' diets. Despite intensive studies of these species as breeding birds on Ascension Island (ASHMOLE 1963; DORWARD 1963), it is not possible to delineate or even circumscribe their feeding

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grounds, especially in the nonbreeding season. However, since juvenile Sooty Terns are known to travel some 7,000 miles from Florida to Africa (ROBERTSON 1969), it seems plausible that the Ascension Island terns, especially the Sooty, are not only pelagic but could have obtained this pollutant in their food gathered anywhere over a huge expanse of the Atlantic Ocean. Especially is this explanation reasonable with the recent identification of PCB's in zooplankton from the North Atlantic (RISEBROUGH et al. 1972).

A PCB, specifically aroclor 1254, has been demonstrated in breast muscle of other terns, namely deformed young Common (Sterna hirundo) and Roseate (S. dougallii) terns from the Long Island Sound region of New York (HAYS and RISEBROUGH 1972). The data from these birds, reported in ppm wet weight basis, cannot be compared directly with the lipid weight bases in the present paper, but their values of 4.9-140ppm (wet weight of breast muscle) (median of about 25 ppm) would certainly be much higher on a lipid weight basis because breast muscle contains a relatively small amount of lipid. Thus the terns and booby from Ascension Island contained rather inconsequential quantities of PCB's which quite likely at present are not deleterious to these remote insular populations.

TABLE 1

Polychlorinated Biphenyls in Tissues of Sea Birds

	ADIPOSE TISSUE		LIVER		BRAIN	
	extractable lipid	PCB*	extractable lipid	PCB*	extractable lipid	PCB**
Sterna fuscata ad♂	392.3mg	0.44	not run		12.8mg	+
Sterna fuscata ad♂	316.6	9.22	2.6	0	17.3	+
Sterna fuscata ad♂	133.7	0	5.2	0	11.0	+
Sterna fuscata ad♀	175.2	5.03	0.7	+	11.9	+
Sterna fuscata juv♂	133.2	0	6.3	+	10.9	+
Sterna fuscata juv♀	38.4	39.7	2.2	+	6.4	+
Gygis alba ad♂	23.5	0	2.8	+	6.8	0
Gygis alba ad♂	2.0	+	0.8	+	10.8	+
Sula leucogaster im	2.3	+	not run		not run	

* total PCB (chiefly aroclor 1248) in ppm, lipid weight

** inasmuch as the sample lipid weights were so small, PCB's are simply recorded as present (+) or absent (0)

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BRAIN

actable ipid	PCB**
2.8mg	+
7.3	+
1.0	+
1.9	+
0.9	+
6.4	+
6.8	0
0.8	+

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References

ASHMOLE, N. P., The biology of the Wideawake or Sooty Tern Sterna fuscata on Ascension Island, Ibis 103b, 297 (1963)

DORWARD, D. F., The Fairy Tern Gygis alba on Ascension Island, Ibis 103b, 365 (1963)

FRENCH, M. C., and JEFFERIES, D. J., The preservation of biological tissue for organochlorine insecticide analysis, Bull. Env. Contam. Toxicol. 6,460 (1971)

HAYS, H., and RISEBROUGH, R. W., Pollutant concentrations in abnormal young terns from Long Island Sound, Auk 89, 19 (1972)

JENSEN, S., JOHNELS , A. G., OLSSON, M., and OTTERLIN, G., DDT and PCB in marine animals from Swedish waters, Nature 224 (5216), 247 (1969)

RISEBROUGH, R. W., REICHE, P., PEAKALL, D. B., HERMAN, S. G., and KIRVEN, M. N., Polychlorinated biphenyls in the global ecosystem, Nature 220 (5172), 1098 (1968)

RISEBROUGH, R. W., and CARMIGNANI, G. M., Proceedings of the Colloquium: Conservation on the Seventh Continent, Antarctica, in press (1972)

RISEBROUGH, R. W., VREELAND, V., HARVEY, G. R., MIKLAS, H. P., and CARMIGNANI, G. M., PCB residues in Atlantic zooplankton, Bull. Env. Contam. Toxicol. 8, 345 (1972)

ROBERTSON, W. B., Jr. Transatlantic migration of juvenile Sooty Terns, Nature 223, 632 (1969)

SNYDER, D., and REINERT, R., Rapid separation of polychlorinated biphenyls from DDT and its analogues in silica gel, Bull. Env. Contam. Toxicol. 6,385 (1971)

ZITKO, V., Polychlorinated biphenyls and organochlorine pesticides in some freshwater and marine fishes, Bull. Env. Contam. Toxicol. 6, 464 (1971)

MONS 084601