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Pesticide and PCB of Common Eider, Herring Gull and Great Black-Backed Gull Eggs

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The high levels of DDT, DDE, TDE, dieldrin, hexachlorobenzene, and PCBs in Herring Gull eggs in the Great Lakes region have received much attention by previous workers (KEITH 1966, GILBERTSON and FOX 1977). These levels are related to embryonic mortality and poor reproductive success (GILBERTSON 1974). Little is known about residue levels in this species off the southeast coast of Maine and virtually no information is available on two species, the Common Eider and Great Black-backed Gull, which regularly breed on the same islands as the Herring Gull. We also examined a population of Herring Gulls in northern Virginia close to the mouth of the James River.

METHODS

Thirty Herring Gull and 28 Great Black-backed Gull eggs were collected on Appledore Island, Maine. Thirty Common Eider eggs were collected on Bangs Island, Maine, and 28 Herring Gull eggs were collected on Fisherman Island, Virginia. All collections were made in May 1977.

Each egg was opened at its equator after determining its weight, length, breadth, and volume (by water displacement). The egg contents were stored frozen in chemically cleaned jars until analysis.

Eggshells were dried at room temperature for at least 30 days, then weighed and measured with the shell membranes intact. Four thickness measurements were taken randomly around the equator with a Starrett Model 1010 M micrometer. Mean shell thickness and the thickness index were calculated for each egg (RATCLIFFE 1967).

Each sample was analyzed for organochlorines and PCBs. A 10-g portion of the homogenized egg was thoroughly blended with sodium sulfate. Extraction, sample cleanup, and separation were as described by CROMARTIE *et al.* (1975). The Silicar separation for those samples from Virginia was collected in four fractions to facilitate separation of endrin and dieldrin in a separate fraction.

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The fractions were analyzed with a Hewlett Packard 5840 gas chromatograph equipped with a ^{63}Ni detector and a 1.5% OV-17/1.95% QF-1 column. Pesticides were quantitated by computer integration of the peak areas; PCBs were estimated by comparing total peak area with Aroclor 1254 or 1260. Toxaphene was estimated semi-quantitatively from the area of two peaks whose retention times were 1.4 and 1.8 compared to 1.00 for DDT. The limit of sensitivity was 0.1 ppm for all compounds.

Residues in 10% of the samples were confirmed with a gas-liquid chromatograph/mass spectrometer. Recoveries of residues in fortified egg tissues averaged 83 to 104%. The residue levels reported are not corrected for recovery.

Six Herring Gull samples collected in Virginia were also analyzed for Kepone residues. A 5-g portion of the homogenized egg was extracted with benzene-isopropanol with a tissumizer. The extract was cleaned up with fuming H_2SO_4. A Florisil column was used to separate Kepone from organochlorine pesticides and PCBs. Quantitation was done on a electron capture gas chromatograph (STAFFORD *et al.* 1978). Sensitivity was 0.1 ppm. Recoveries of Kepone residues in fortified egg tissues averaged 88%.

All residues were corrected for moisture loss as suggested by STICKEL *et al.* (1973). Residue arithmetic means and geometric means were very similar; therefore, only arithmetic means are reported.

RESULTS

All but one Common Eider egg contained detectable residues of DDE (Table 1). PCBs were detected in all eggs. Levels of both DDE and PCBs were low. No other organochlorine compounds were detected (<0.1 ppm).

There were no significant differences in the residue levels of DDT and its metabolites or PCBs in the Herring Gull eggs collected in Maine and Virginia (Table 1). However, all were significantly greater than the residues in Common Eider eggs (*t*-test, $P = 0.05$). The six Herring Gull eggs from Virginia did not contain detectable levels (<0.1 ppm) of Kepone.

Great Black-backed Gull eggs contained significantly more DDE and PCBs than Herring Gull eggs from either Maine or Virginia (*t*-test, $P = 0.05$). In addition, low levels of several other pesticides were detected in Great Black-backed Gull eggs (Table 1).

Shell weight, shell thickness, and the thickness index for the Herring Gull eggs collected on Appledore Island did not differ from the pre-1947 values of 6.29 ± 0.05, 0.37 ± 0.02, and 1.77 ± 0.01 given for Atlantic Coast Herring Gulls by ANDERSON and HICKEY (1972) (Table 1). Pre-1974 values were not available for the other two species.

TABLE 1

Residue Levels (in ppm Wet Weight) and Egg Parameters of Common Eider, Herring Gull, and Great Black-backed Gull Eggs

Category	Mean ± Std. Dev.	Range	# with residues
COMMON EIDER - BANGS ISLAND, MAINE (N = 30)			
Residue			
p,p'-DDE	0.23 ± 0.13	0.00 - 0.43	29
PCBs	1.60 ± 1.08	0.38 - 4.30	30
Egg Parameters			
Ratcliffe Index	2.17 ± 0.14	1.94 - 2.38	
Eggshell Thickness (mm)	0.43 ± 0.03	0.37 - 0.50	
Eggshell Weight (g)	8.65 ± 0.85	7.14 - 9.99	
Lipid Content (%)	16.90 ± 0.73	15.07 -18.02	
HERRING GULL - APPLEDORE ISLAND, MAINE (N = 30)			
Residue			
p,p'-DDE	1.94 ± 1.76	0.34 - 7.50	30
p,p'-DDT	0.19 ± 0.93	0.00 - 5.10	2
Trans-nonachlor	0.05 ± 0.10	0.00 - 0.52	8
Toxaphene	0.01 ± 0.05	0.00 - 0.21	3
PCBs	7.76 ± 6.68	0.00 -32.00	30
Egg Parameters			
Ratcliffe Index	1.75 ± 0.12	1.53 - 1.98	
Eggshell Thickness (mm)	0.41 ± 0.03	0.34 - 0.47	
Eggshell Weight (g)	6.22 ± 0.66	5.07 - 7.49	
Lipid Content (%)	8.63 ± 0.87	6.10 -10.20	
HERRING GULL - FISHERMAN ISLAND, VIRGINIA (N = 28)			
Residue			
p,p'-DDE	1.93 ± 0.88	0.70 - 4.50	28
Oxychlordane	0.02 ± 0.05	0.00 - 0.18	4
Trans-nonachlor	0.04 ± 0.09	0.00 - 0.44	7
Toxaphene	0.03 ± 0.05	0.00 - 0.19	6
PCBs	9.06 ± 3.59	0.13 -16.70	28
Egg Parameters			
Ratcliffe Index	1.81 ± 0.14	1.62 - 2.11	
Eggshell Thickness (mm)	0.41 ± 0.32	0.33 - 0.46	
Eggshell Weight (g)	6.55 ± 0.60	4.88 - 7.64	
Lipid Content (%)	8.26 ± 0.77	6.2 - 9.7	

TABLE 1 (cont.)

Category	Mean ± Std. Dev.	Range	# with Residues
GREAT BLACK-BACKED GULL - APPLEDORE ISLAND, MAINE (N = 28)			
Residue			
p,p'-DDE	8.66 ± 4.67	4.0 -27.00	28
p,p'-DDD	0.01 ± 0.01	0.0 - 0.15	2
p,p'-DDT	0.03 ± 0.06	0.0 - 0.25	7
Dieldrin	0.12 ± 0.16	0.0 - 0.55	14
Heptachlor	0.05 ± 0.11	0.0 - 0.41	7
Oxychlordane	0.22 ± 0.10	0.0 - 0.43	27
Cis-chlordane	0.04 ± 0.11	0.0 - 0.50	6
Toxaphene	0.02 ± 0.07	0.0 - 0.30	3
HCB	0.03 ± 0.06	0.0 - 0.25	8
Mirex	0.02 ± 0.06	0.0 - 0.26	4
PCBs	30.96 ±22.3	8.0-130.00	28
Egg Parameters			
Ratcliffe Index	1.90 ± 0.11	1.71 - 2.11	
Eggshell Thickness (mm)	0.43 ± 0.25	0.39 - 0.47	
Eggshell Weight (g)	8.08 ± 0.55	7.21 - 9.09	
Lipid Content (%)	8.18 ± 0.89	6.0 - 9.6	

DISCUSSION

The differences in residue levels between the three species are probably due to differences in feeding habits. The Common Eider feeds primarily on marine invertebrates whereas the two gull species feed primarily on fish, human waste, and other vertebrates (Table 2). Residue levels in the Common Eider eggs were extremely low. That the reproductive success of the eider is probably not impaired by these low levels is suggested by a 96% hatching success for 98 eider eggs collected from Bangs Island in 1976 and artificially incubated (SZARO & ALBERS 1977).

The high proportion of birds and mammals in the Great Black-backed Gull's diet probably contributes to its high egg residues, which were four times those in Herring Gull eggs from the same area. HUNT and HUNT (1973) observed Great Black-backed Gulls in both Europe and Maine eating carrion ranging from fish to seal carcasses. Residue levels in the Herring Gull eggs are much lower than the 202 ppm DDE reported by KEITH (1966) for the Great Lakes. MCGILL (1977) reported a hatching success of 71% for 424 Herring Gull eggs in 1976 on Appledore Island. Hatching success was 76% for 423 Great Black-backed Gull eggs in 1976 (MCGILL 1977) and 41 eggs in 1977 on Appledore Island (MCGILL 1978). This is identical

TABLE 2

Food Habits of the Black-backed Gull, Herring Gull, and Common Eider

			Percent of Diet						
		N	Fish	Human waste	Birds & mammals	Marine invert.	Plants	Misc.	Authority
Herring Gull	Skomer Islands, Wales	3208	27	41	1	24	4	3	Harris, 1965
	Britain	539	21	0	1	47	7	22	Collinge, 1924-27
Great Black-backed Gull	Skomer Islands, Wales	420	21	8	52	16	0	3	Harris, 1965
	Britain	41	36	0	36	19	9	0	Collinge, 1924-27
Common Eider	Britain	24	5	0	0	91	4	0	Collinge, 1924-27
	W. Atlantic	96	0	0	0	98	0	2	Cottam, 1939

to the 76% hatching success for Great Black-backed Gull eggs in Wales (HARRIS 1964). ERWIN (1971) concluded that an 82% hatching success for this species at Sandy Point, Rhode Island, was very high.

The differences in pesticide burdens in the three species appear to be related to their feeding habits. None of the residues are high enough to cause any apparent reproductive problems.

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REFERENCES

ANDERSON, D. W. and J. J. HICKEY: Proc. Int. Ornithol. Congr. 15, 514 (1972).
COLLINGE, W. E.: The food of some British wild birds. 2 ed. York: Collinge 1924-1927.
COTTAM, C.: Food habits of North American diving ducks. Washington, D. C.: U.S.D.A. Tech. Bull. 643 1939.
CROMARTIE, E., W. L. REICHEL, L. N. LOCKE, A. A. BELISLE, T. E. KAISER, T. G. LAMONT, B. M. MULHERN, R. M. PROUTY, and D. M. SWINEFORD: Pestic. Monit. J. 9, 11 (1975).
ERWIN, R. M.: Wilson Bull. 83, 152 (1971).
GILBERTSON, M.: Can. Field Nat. 88, 356 (1974).
GILBERTSON, M. and G. A. FOX: Environ. Pollut. 12, 211 (1977).
HARRIS, M. P.: Ibis 106, 432 (1964).
HARRIS, M. P.: Ibis 107, 43 (1965).
HUNT, G. L., JR. and M. W. HUNT: Auk 90, 827 (1973).
KEITH, J. A.: J. Appl. Ecol. 3, (Suppl.), 57 (1966).
MCGILL, P. A.: Breeding ecology and competition between Great Black-backed and Herring Gulls. Unpubl. Masters Thesis, Ithaca, N.Y.: Cornell Univ. 1977.
MCGILL, P. A.: Bird Banding 49, In Press (1978).
RATCLIFFE, D. A.: Nature 215, 208 (1967).
STAFFORD, C. J., W. L. REICHEL, D. M. SWINEFORD, R. M. PROUTY, and M. L. GAY: J. Assoc. Offic. Anal. Chem. 61, 8 (1978).
STICKEL, L. F., S. N. WIEMEYER, and L. J. BLUS: Bull. Environ. Contam. Toxicol. 9, 193 (1973).
SZARO, R. C. and P. H. ALBERS. In Wolfe, D. A.: Fate and effects of petroleum hydrocarbons in marine ecosystems and organisms. New York: Pergamon Press 1977.