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Pesticide levels and shell thickness of Common Loon eggs in New Hampshire.—Eggshell thinning has been observed in many species of birds over the past 2 decades, and chlorinated hydrocarbons and PCB's have been implicated as the cause of this thinning (Ratcliffe, J. Appl. Ecol. 7:67–116, 1970; Schreiber and Risebrough, Auk 84: 119–135, 1972). Although heavy, widespread use of pesticides has probably never occurred in the Lakes Region of New Hampshire, sublethel levels of DDT, DDD, and DDE were found in salmon (*Salmo salar*), sucker (*Catostomus commersoni*), perch (*Perca flavescens*), pickerel (*Esox niger*), whitefish (*Coregonus clupeaformis*), and lake trout (*Salvelinus namaycush*) in 2 New Hampshire lakes (Seamans and Newell, N.H. Fish and Game Dept. Survey Report No. 10, 1973). The diet of the Common Loon, *Gavia immer*, consists of numerous aquatic organisms, predisposing it to accumulation of chlorinated hydrocarbons if present in the loon's food.

In this note, levels of pesticide residues (DDT, DDE, and dieldrin) and PCB's are compared with shell thickness of eggs of the Common Loon, in New Hampshire.

Methods.—Pesticide residue and PCB levels were measured by gas chromatography by the W.A.R.F. Institute, Madison, Wisconsin. Fourteen eggs, from 3 New Hampshire lakes were collected after they had been abandoned following disturbance or after prolonged incubation, or knocked into the water by an incubating adult. After collection, the egg contents were blown into sterilized containers, frozen, packed in dry ice, and mailed to the W.A.R.F. Institute.

Eggshell thickness was measured with a micrometer. In each egg sample, 4 different fragments were measured to the nearest 0.01 mm. Most measurements included membrane and cuticle, but in 8 cases the membrane was absent. To correct for the absence of the membrane, average membrane thickness, calculated by taking the difference between eggs with membrane and eggs without membrane ($n = 18$, $\bar{x} = 0.1480$), was added to membraneless eggs ($n = 8$).

Results.—Results of toxic residue analysis of 14 New Hampshire loon eggs are presented in Table 1. Average eggshell thickness of these eggs was 0.59 ± 0.05 mm. Residue levels (ppm) on a wet weight basis were: DDE $= 5.88 \pm 1.73$; DDT $= 2.44 \pm 0.741$; dieldrin $= 0.105 \pm 0.025$; PCB's (total) $= 24.6 \pm 5.70$; DDD < 0.05; and PCB's (as arochlor 1254) $= 18.30 \pm 4.82$. Both DDT and PCB levels in New Hampshire eggs were higher than those reported by McIntyre (Ph.D. Thesis. Univ. of Minn., Minneapolis. 230 pp., 1975) in Minnesota and Saskatchewan and those reported by Vermeer (Can. Field-Nat. 87:403–408, 1973) in Alberta. Dieldrin levels were lower, however, in loon eggs from

TABLE 1

PESTICIDE RESIDUE LEVELS IN COMMON LOON EGGS IN NEW HAMPSHIRE (1975–76)[a]

	Lake	Thickness[b]	DDE	DDT	Dieldrin	PCB's (Total)	DDD	PCB's (as arochlor 1254)[c]
1975	Squam	0.53	7.71	4.58	—	43.1	<0.005	
1975	Squam	0.50	6.06	3.38	0.038	31.9	<0.005	
1975	Winn.[d]	0.50	28.5	8.19	0.13	67.9	1.10	
1975	Squam	0.62	3.0	0.30	0.06	2.9	0.19	
1975	Squam	0.58	3.9	1.3	0.06	17.2	0.56	
1975	Squam	0.62	3.8	2.1	0.13	60.6	1.1	
1976	Squam	0.55	5.6	2.6	0.20	36.5	<0.05	29.5
1976	Wicwas	0.60	5.9	4.7	0.31	56.8	<0.05	46.4
1976	Squam	0.60	4.7	0.98	0.20	10.2	<0.05	7.3
1976	Squam	0.67	3.9	0.94	0.11	10.4	<0.05	7.5
1976	Squam	0.64	4.6	1.8	0.23	19.7	<0.05	15.5
1976	Squam	0.55	7.8	3.7	0.25	37.6	<0.05	29.3
1976	Winn.	0.64	5.6	2.1	0.20	22.3	<0.05	16.5
1976	Winn.	0.61	8.1	2.6	0.07	30.7	<0.05	22.4
$\bar{x}$		0.59	5.88	2.44	0.105	24.6	<0.05	18.30
SD		±0.05	±1.73	±0.741	±0.025	±5.70		±4.82

[a] Residue levels given as ppm. wet weight basis (x = geo. mean ± S.E.).
[b] Thickness with membrane, mm.
[c] Only 8 eggs, of 1976, were analyzed for PCB's as arochlor 1254. This represents a refinement of laboratory technique in 1976.
[d] Lake Winnipesaukee.

New Hampshire. DDE levels, although similar to levels reported in Minnesota and Saskatchewan, were considerably higher than levels of Alberta eggs (Table 2).

I found no significant correlation ($P > 0.05$) of PCB's (total) or PCB's (as arochlor 1254) with eggshell thickness, nor was there a significant correlation ($P > 0.05$) between dieldrin and eggshell thickness (PCB's total, $r = -0.5078$; PCB's as arochlor 1254, $r = -0.5665$; dieldrin, $r = -0.2514$). However, both DDT and DDE residue levels were significantly correlated ($P < 0.01$) with thickness of shells (DDT, $r = -0.7012$; DDE, $r = -0.8447$). McIntyre (1975) and Vermeer (1973) did not find significant correlations between eggshell thickness and any toxic chemical residues.

I found a significant correlation ($P < 0.05$) between PCB and DDE residues. Such parallel concentrations, in this and other studies (Peakall, Residue Reviews 44:1–21, 1972) may indicate that the movement of DDE and PCB's in the ecosystem is similar.

Average shell thickness of 51 eggs was 0.58 ± 0.01 mm (Table 3). This average was 11% less than thicknesses of museum specimens reported by Anderson et al. (Can. Field-Nat. 84:351–356, 1970) in a collective sample from the northeast maritime region, and greater than thicknesses reported by McIntyre (1975) in Minnesota and Vermeer (1973) in Alberta. Comparison of average thickness of successful eggs (hatched) and unsuccessful eggs (infertile or deserted) indicated little significant difference (Mann-Whitney test, $U = 63.5$, $0.10 > P > 0.05$).

TABLE 2

PESTICIDE RESIDUE LEVELS OF COMMON LOON EGGS IN VARIOUS REGIONS OF NORTH AMERICA[a]

Locality	N	DDE	DDD	DDT	Dieldrin	PCB's (as arochlor 1254)	Source
North Central Minnesota	9	4.99 ± 0.8	1.28	0.51	0.29	12.7 ± 1.2	McIntyre (1975)
New Hampshire	3	4.76 ± 0.14	NC[b]	0.17	0.26	20.39 ± 12.4	McIntyre (1975)
Saskatchewan	7	6.28 ± 1.6	NC	0.99	1.40	14.7 ± 1.7	McIntyre (1975)
Alberta	15	1.7 ± 0.01				1.2 ± 0.4	Vermeer (1973)
New Hampshire	14	5.88 ± 1.73	TR[c]	2.44 ± 0.74	0.105 ± 0.025	18.30 ± 4.82	This study

[a] All values given in ppm. wet weight (x = geo. mean ± S.E.).
[b] Not checked.
[c] Trace.

Summary.—During 1975 and 1976, 51 eggs of the Common Loon, *Gavia immer*, in New Hampshire were measured for thickness ($\bar{x} = 0.58 \pm 0.01$ mm). Fourteen of these eggs, from 3 lakes, were analyzed for pesticide residue (DDT, DDD, DDE, and dieldrin), and PCB (polychlorinated biphenyl) levels. Significant correlations ($P < 0.05$) were found

TABLE 3

THICKNESS OF EGGSHELLS OF THE COMMON LOON IN VARIOUS PARTS OF NORTH AMERICA

Locality	Dates Collected	N	$\bar{x}$ (mm)	± S.E.	Source
Minn.	1970–74	55	0.55	0.01	McIntyre (1975)
Me., N.H. N.Y., N.S. Lab., NFld.	museum specimens	38	0.65	0.01	Anderson et al. (1970)
Alberta	1972	15	0.57	0.01	Vermeer (1973)
N.H.	1975–76	51	0.58	0.01	This study
Hatched (N.H.)	1975–76	10	0.60	0.01	This study
Infertile or Deserted (N.H.)	1975–76	9	0.55	0.02	This study

between eggshell thickness and DDT and DDE residue levels. Little significant difference in eggshell thickness was found between successful and nonsuccessful eggs.

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Declines in environmental pollutants in Olivaceous Cormorant eggs from Texas, 1970–1977.—Changes induced by environmental pollutants in bird eggs have been reported for many species. Egg residues and shell thickness changes have been especially noted in fish-eating birds and the use of aquatic species as "indicators" of levels of pollutants in the environment has been proposed (Moore, J. Appl. Ecol., Suppl., 3:261–269, 1966). In this study we report changes in residue levels and shell thickness of Olivaceous Cormorant (*Phalacrocorax olivaceus*) eggs collected in Texas during the 1970's.

Sidney Island, a National Audubon Society sanctuary located in Sabine Lake, Texas, was the study area. In 1976 and 1977 we collected abandoned cormorant eggs after they were blown or knocked from nests. Eggs were washed and allowed to air dry before measuring. Five measurements were made from around the blowhole of intact eggs (shell plus membrane) or around the "equator" of broken eggs using a Starrett 1010 M micrometer calibrated to 0.01 mm. We also measured museum specimens collected along the Texas-Louisiana coast prior to 1940. Contents of individual eggs from different nests collected in 1976 ($n = 2$) and 1977 ($n = 5$) were analyzed for chlorinated hydrocarbons and polychlorinated biphenyls (PCBs) by the Agricultural Analytical Services Dept., Texas Agricultural Experiment Station, Texas A&M University according to established United States Department of Agriculture procedures (Pesticide Analytical Manual, United States Dept. Health, Education, and Welfare, Food and Drug Admin., Vol. 1, Sec. 212.13, 1968). Residue analysis was performed by gas chromatography using electron capture detection on a Hewlett-Packard 5700 series gas chromatograph. All analyses were performed on 2 columns for confirmation of results. Results of 1976 and 1977 residue and thickness analyses were combined due to similarity of results. To determine temporal changes in shell thickness and residue levels in Texas populations of Olivaceous Cormorants during the 1970's, our results were compared with data obtained in a similar manner by K. A. King (pers. comm., U.S. Fish and Wildl. Ser., Patuxent Wildl. Res. Center, Gulf Coast Field Station, Victoria, TX, 1977). All further reference to "1970 results" will mean this study.

All residues in 1976–77 samples were significantly lower than levels in 1970 eggs (Table 1). Zitko (Bull. Environ. Contam. Toxicol. 16:399–405, 1976) found that most reports from 1964 to 1971 indicated that levels of DDE, dieldrin, and PCBs reached a maximum around 1970 and are now either decreasing or remaining constant. DDE residues in Brown Pelican (*Pelecanus occidentalis*) eggs from Texas declined from 3.2