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

TABLE 1

RESIDUES IN OLIVACEOUS CORMORANT EGGS IN TEXAS[1]

	1970 (n = 5)			1976–77 (n = 7)			
Residue	x̄	S.E.	(%)	x̄	S.E.	(%)	% Change
p, p′-DDE	6.22	2.08	100	0.400	0.036	100*	–93.6
Dieldrin	0.30	—	20[4]	0.018	0.003	100	–94.0
PCB[2]	32.00	5.83	100	1.890	0.275	100**	–94.1
Heptachlor Epoxide[3]				0.032	0.016	100	—

[1] Values represent residues on a wet-weight basis.
[2] Arochlor 1254 and 1260.
[3] This residue was separated from PCBs in 1977 eggs only.
[4] Dieldrin found in detectable levels in only 1 egg in 1970 (1970 x̄ for dieldrin, all eggs = 0.06 ± 0.134; –70%; $p > 0.05$).
* $p < 0.05$, ** $p < 0.01$, t-test.

ppm in 1970 to 0.86 ppm in 1974 (King et al., Southwest. Nat. 21:417–431, 1977). Organochlorine and PCB levels have apparently declined in Texas since at least 1970.

Comparisons of 1970 and 1976–77 eggshell measurements with those of pre-1940 ("pre-DDT era") eggs revealed little difference in thickness (Table 2). Most authors agree that a 10–20% change in shell thickness is needed before reproductive failures are indicated (Faber and Hickey, Pestic. Monit. J. 7:27–36, 1973). Cormorant eggshell thickness was apparently not affected by residues in the 1970's in Texas.

Since the greatest use of chlorinated hydrocarbon pesticides in the United States was in the early 1960's (Ware, Pesticides, W. H. Freeman and Co., San Francisco, 1975), aquatic birds may have been affected by environmental contaminants during those years. We were unable to obtain eggshells collected from coastal Texas during the 1950's and 1960's. Breeding populations of Olivaceous Cormorants in Texas reached a recorded low in the early 1960's, but have been steadily increasing since about 1967 (Morrison and Slack, Am. Birds, 31:954–959, 1977). DDE residues in Olivaceous Cormorant eggs during the 1970's apparently did not adversely affect reproduction. The role that environmental pollutants played in the population levels of Olivaceous Cormorants prior to 1970 must remain speculative. However, current residues do not appear to be adversely affecting Olivaceous Cormorant populations in Texas.

TABLE 2

SHELL THICKNESS OF OLIVACEOUS CORMORANT EGGS IN TEXAS (MM)

				% Change from	
Date	n (eggs)	x̄	S.E.	Pre-1940	1970
Pre-1940	75	0.328	0.004	–	–
1970	24	0.323	0.006	−1.5	–
1976–77	21	0.341	0.004	+4.0*	+5.5*

* $p < 0.05$, t-test.

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Turkey Vulture eggshell thinning in California, Florida, and Texas.—The Turkey Vulture (*Cathartes aura*) seems to be declining in numbers in parts of North America (Arbib, Am. Birds 25:948–949, 1971; Russell, Auk 90:877–887, 1973), but neither the magnitude of the change nor its causes have been documented. Eggshell thinning has been demonstrated in 54 species of birds of 10 taxonomic orders; at least some thinning has been caused by chemical pesticides, particularly p,p′-DDE. Thinning of 20% or more has been suggested to result in reproductive failure and population decline (Stickel, pp. 25–74 *in* Ecological Toxicology Research, A. D. McIntyre and C. F. Mills, eds., Plenum Publ. Corp., New York, 1975). I examined Turkey Vulture eggshells from California, Florida, and Texas to see if significant thinning had occurred in various populations of this species.

The 76 sets of Turkey Vulture eggs examined were from the collection of the Western Foundation of Vertebrate Zoology in Los Angeles. Thirty-nine were from west-central California, 21 were from central Florida near Orlando, and 16 sets were from Texas. Sets were divided into 2 groups: those collected prior to 1947 (the pre-DDT period) and those collected since 1947 (Table 1).

Blown eggs were weighed to the nearest 0.001 g in a Mettler Top Loading Balance (Model P120), and length and breadth were measured to the nearest 0.01 mm with a dial vernier caliper. A "thickness index" (Ratcliffe, Nature 215:208–210, 1967) was calculated for each egg, and a mean thickness index was computed for the eggs from each geographic area and each time period.

Significant differences ($P < 0.05$, t-test comparison) existed between pre-1947 and post-1947 samples from all areas (Table 1). Florida eggs were somewhat lighter in weight than California eggs during both periods, but the percentage decrease after 1947 was similar in both areas. The Texas sample showed an even greater reduction. However, the sample size is small and may be biased by local environmental factors: the pre-1947 eggs were all taken from northern Texas and most of the later eggs were from the Texas lowlands. Texas eggs for both time periods averaged lighter in weight than either Florida or California eggs. I contacted several other museums for Turkey Vulture eggs to increase the sample size, but no other Texas specimens from appropriate areas could be located.

The 11–12% thinning in eggs from California and Florida is not of the magnitude