SHELL THICKNESS IN BROWN PELICAN EGGS FROM TAMPA BAY, FLORIDA

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Introduction

Among birds, the Brown Pelican (*Pelecanus occidentalis*) has been central in investigations of DDE, eggshell thinning, and attendant population declines. The eggshell thinning and population decline phenomena have been most severe in California (Risebrough et al. 1971), but with a decline in levels of environmental contamination by DDE since 1972, eggshells have increased in thickness and the California population is recovering (Anderson et al. 1975). Blus et al. (1975, and references therein) have extensively explored the logarithmic relationship between DDE residues and amount of shell thinning in South Carolina and Florida Brown Pelican populations, primarily with eggs collected in 1969 and 1970. The Florida population appears stable (Williams and Martin 1968, 1970; Schreiber and Schreiber 1973; S. A. Nesbitt, pers. comm.) and its level of eggshell thinning is the lowest of any geographic area in the United States (Schreiber and Risebrough 1972, Blus et al. 1974).

Data for the Brown Pelican provide an encouraging picture regarding DDE environmental contamination (Anderson et al. 1975) and I wish to report additional encouraging information in this regard.

Methods and Results

From 1969 through 1976 I made weekly visits during the nesting season to the large Brown Pelican colony on Tarpon Key, Pinellas County, Florida. In 1969 and 1970 eggs were collected for chemical analysis and shell thickness measurements (Schreiber and Risebrough 1972). Since 1972 I have picked up shell fragments beneath nests. Many could readily be identified as crushed, hatched (the large end broken off), or eaten (holes in the center of the shell) by Fish Crows (*Corvus ossifragus*). I measured these shells for thickness with a dial micrometer as close to the waist of the egg as possible. Three to 5 measurements were made on each shell, and a mean calculated that was compared to the pre-1943 shell thickness of 0.557 mm for Brown Pelicans in Florida (Anderson and Hickey 1970). This sample represents primarily hatched eggs that may undergo some natural shell thinning during the incubation process and shells that broke during various stages of incubation. While considerable variability in

Table 1. Shell Thickness and Percent Thinning of Brown Pelican Eggs Collected From Nests or the Ground in a Colony in Tampa Bay, Florida, Compared to a Pre-1943 Thickness of 0.557 mm for Florida Eggs in Anderson and Hickey (1970)

Year	n	Mean thickness ± 95% Confidence Limit in mm (Range)	Percent decrease in shell thickness
1969	14	0.506 ± 0.022 (0.55 - 0.42)	9*
1970	21	0.509 ± 0.024 (0.58 - 0.39)	9*
1972	32	0.529 ± 0.053 (0.62 - 0.40)	5
1973	15	0.487 ± 0.065 (0.58 - 0.39)	12
1974	6	0.524 ± 0.061 (0.58 - 0.44)	6
1975	31	0.533 ± 0.053 (0.64 - 0.39)	4
1976	31	0.545 ± 0.037 (0.62 - 0.47)	2

* published in Schreiber and Risebrough (1972)

thickness exists within the total sample, the variability within any one year is no greater than the total. With a sample of 115, I believe these eggs provide a random sample of the eggshells laid during these years by this breeding population.

An increase in mean shell thickness since 1973 and especially in 1975 and 1976 compared to 1969 and 1970 is obvious from these results (Table 1). I could detect no differences between thickness of crow-abused eggs and those that hatched.

No crushed eggs were found in 76 nests in 1969 in this colony. In 1970 I found 4 crushed eggs in 62 nests. I found one crushed egg in 1972, 4 in 1973, and one in 1975. The measurements of the 6 crushed eggs collected in 1972-1975 and their percent shell thinning are as follows:

Year	Thickness(mm)	Percent Thinning
1972	0.400	28.2
1973	0.390	30.0
	0.402	27.8
	0.415	25.5
	0.422	24.2
1975	0.393	29.4
	$\bar{X}$=0.403±0.012	27.5

The 4 crushed eggshells found in 1973 undoubtedly account for the low mean thickness for that year. I cannot explain why such a high percentage of the eggshells collected that year were crushed. Additionally, in my total sample (Table 1), 11 eggs that hatched showed a mean thickness of 0.459 ± 0.019 mm (range 0.417-0.481) or a percent thinning of 17.6 (range 13.7-26.8). All other eggs measured over 0.500 mm in thickness. These data demonstrate the variability in the amount of shell thinning and in the level at which eggs are crushed. One hatched egg is actually thinner than 2 that were crushed.

Discussion

DDE is the chemical found most overwhelmingly in pelican eggs, it is strongly associated with all cases of pelican shell thinning thus

far investigated, and was the only residue that consistently accounted for all or most of the shell thinning in Brown Pelican eggs in Florida (Blus et al. 1972, 1974, 1975). The cause and effect relationship between DDE in the diet and shell thinning is established in wild populations of other species (Cooke 1973, Stickel 1975). Thus, Brown Pelican eggshell thinning is assumed to be most closely related to DDE. Other compounds which cause shell thinning in other species in experimental studies are not found in pelican eggs in appreciable amounts, if at all. Eggshell thinning and DDE show a highly significant inverse correlation in pelican eggs: i.e., as the amount of DDE increases the shells are thinner. It is thus valid to assume that the level of eggshell thinning provides an accurate index to the chemical residue burden of DDE in the female that laid the egg. Therefore, a large sample of pelican eggs provides an index to the DDE burden of a population and its environment.

The presence of a few extremely thin shells in my sample probably results from a few females that still have high body burdens of DDE. However, the general increase in eggshell thickness in recent years demonstrated here, and the thicker upper and lower limits of the range of thickness, are indications of the decreasing level of contamination by DDE of the marine fishes on which this population of pelicans feeds.

Eggshell thickness can be measured using an inexpensive instrument immediately upon obtaining eggs. These measurements give a highly accurate index to the chemical residue burdens of DDE in the female that laid the egg. Thus the need to perform expensive chemical analyses simply to detect DDE do not seem to be warranted in this species, although analysis for other chemicals may be important as monitors of potential deletrious effects on the species.

However, measuring reproductive success is the most important population monitoring technique biologists can perform for this species. The knowledge of reproductive performance contributes importantly and relatively inexpensively to timely habitat and species management. I suggest that any recovery plan intended for pelicans can best be implemented by measurement of reproductive success and other biological parameters such as use of nesting-roosting-loafing-feeding habitat. This should be accompanied with measurement of eggshell thickness as an immediate and inexpensive index to the body burdens of the DDT type chemicals in the reproductive segment of the population as demonstrated in this study.

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