SHELL-THINNING IN EGGS OF THE ASHY PETREL (*OCEANODROMA HOMOCHROA*) FROM THE FARALLON ISLANDS

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Shell-thinning has been documented for a number of species of birds of California coastal and marine ecosystems, including the Brown Pelican (*Pelecanus occidentalis*) (Risebrough et al. 1970a; Risebrough et al. 1971), Double-crested Cormorant (*Phalacrocorax auritus*) (Risebrough et al. 1970a), Peregrine Falcon (*Falco peregrinus*) (Hickey and Anderson 1968), Common Murre (*Uria aalge*) (Gress et al. 1971), Common Egret (*Casmerodius albus*) (Faber et al. 1972), and Great Blue Heron (*Ardea herodias*) (Faber et al. 1972). In southern California the shell-thinning is particularly severe; the majority of the eggs of the Brown Pelican and Double-crested Cormorant collapse during incubation (Risebrough et al. 1970a). The thinning of Brown Pelican eggshells has been shown to be related to DDE concentrations in the eggs (Risebrough 1972). No relationship between shell-thinning and the polychlorinated biphenyls (PCB) or the heavy metals has been found (Risebrough 1972; Connors et al. 1972).

In a preliminary study of the distribution of chlorinated hydrocarbons in California marine birds, exceptionally high residue concentrations were found in Ashy Petrels (*Oceanodroma homochroa*) breeding on the Farallon Islands (Risebrough et al. 1968). DDE concentrations were comparable to those found in Brown Pelican populations producing thin-shelled eggs, suggesting that further study would reveal comparable shell-thinning of Ashy Petrel eggshells.

MATERIALS AND METHODS

Six eggs of the Ashy Petrel with the incubating parents were collected on the Farallon Islands in June 1969. Twenty additional eggs were obtained in June 1970. A shell-thickness index, obtained by dividing the weight of the dry shell with attached membrane (g) by the product of the length (cm) and the breadth (cm) (Ratcliffe 1967), was calculated for each egg as the basis for comparison with museum specimens.

The shells were removed by cutting with a scalpel around a circumference of the frozen egg. Fragmentation of the shell was thereby avoided. Excess albumin was removed by washing with water and the shells with attached membranes were dried overnight at 38°C. Shell thickness indices of 27 Ashy Petrel eggs, collected on the Farallon Islands between 1890 and 1924 and preserved in the Museum of Vertebrate Zoology at the University of California, Berkeley, were calculated. All of the museum eggs had been collected in June.

All of the eggs obtained in 1969 and 1970 were either fresh or in the early stage of incubation. The six eggs obtained in 1969 and the incubating adults were analyzed for the DDT and PCB compounds, and for dieldrin and endrin with methods described by Risebrough et al. (1970b). Egg yolks were ground with anhydrous sodium sulfate and Soxhlet-extracted with 2:1 hexane:acetone. Adult birds were ground with anhydrous sodium sulfate in a Waring Blender and subsamples of these were similarly extracted in a Soxhlet apparatus.

TABLE 1. Eggshell thickness data.

	Pre-1925	1969–70	*t*,*P*
Length (cm)	2.97	2.98	0.439, $P > 0.5$
Breadth (cm)	2.27	2.29	0.965, $P > 0.2$
Weight (g)	0.490	0.450	3.928, $P < 0.001$
Thickness index	0.0726	0.0662	5.105, $P < 0.001$

RESULTS AND DISCUSSION

The indices of eggshell thickness are considered sufficiently Gaussian in distribution to justify comparison of the means with the "*t*" test. Mean lengths, breadths, weights, and shell-thickness indices for the two collections are given in table 1. Dimensions of the two collections are equivalent, but the mean shell weight and the mean shell-thickness index of the 1969–70 eggs were significantly reduced ($P < 0.001$), by 8% and 9%, respectively.

The results of the chemical analyses of the six eggs and the incubating adults obtained in 1969 are summarized in table 2. Residue concentrations are expressed as parts per million of the extracted lipid. Division by the percentage lipid weight of the fresh weight permits conversion to concentrations on a wet weight basis. The most abundant chlorinated hydrocarbon detected was p,p'-DDE; concentrations of PCB were somewhat lower. Dieldrin concentrations averaged 0.20 ppm of the egg lipid but endrin was not detected, with maximum concentrations in the egg lipids less than 0.10 ppm. No p,p'-DDD was detected. The eggs obtained in 1970 were not analyzed.

The magnitude of shell-thinning is apparently less

TABLE 2. Chlorinated hydrocarbon residues found in eggs and adult Ashy Petrels obtained from the Farallon Islands in 1969.[a]

Tissue sample	N	p,p'-DDT	p,p'-DDE	Dieldrin	PCB
Adult, whole bird	9	13.4 (8.3–19.6)	456 (257–684)	nm	202 (122–321)
Egg	6	18.1 (11.9–27.9)	390 (298–512)	0.20 (0.09–0.40)	236 (130–366)

[a] Arithmetic means of the concentrations (parts per million of the lipid weight) with range. Lipid weights averaged 11.1% and 15.9%, respectively, of the wet weights of the eggs (including shells) and of the adults. nm:not measured.

than a critical level that would affect reproductive success. Further reductions in shell thickness, however, would pose a threat to the continued survival of the species, which is restricted in its breeding range to central and southern California and northwest Baja California (A.O.U. 1957).

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LITERATURE CITED

AMERICAN ORNITHOLOGISTS' UNION. 1957. Check-list of North American Birds. Fifth ed., p. 23. A.O.U., Baltimore.

CONNERS, P. G., V. C. ANDERLINI, R. W. RISEBROUGH, J. H. MARTIN, R. W. SCHREIBER, AND D. W. ANDERSON. 1972. Heavy metal concentrations in Brown Pelicans from Florida and California. Trans. Wildl. Soc.

FABER, R. A., R. W. RISEBROUGH, AND H. PRATT. 1972. Organochlorines and mercury in Common Egrets and Great Blue Herons. Environ. Pollut. (in press).

GRESS, F., R. W. RISEBROUGH, AND F. C. SIBLEY. 1971. Shell thinning in eggs of the Common Murre, *Uria aalge*, from the Farallon Islands, California. Condor 73:368–369.

HICKEY, J. J., AND D. W. ANDERSON. 1968. Chlorinated hydrocarbons and eggshell changes in raptorial and fish-eating birds. Science 162: 141–154.

RATCLIFFE, D. A. 1967. Decrease in eggshell weight in certain birds of prey. Nature 215:208–210.

RISEBROUGH, R. W. 1972. Effects of environmental pollutants upon animals other than man. Proc. Sixth Berkeley Sympos. on Mathematical Statistics and Probability (in press).

RISEBROUGH, R. W., P. REICHE, D. B. PEAKALL, S. G. HERMAN, AND M. N. KIRVEN. 1968. Polychlorinated biphenyls in the global ecosystem. Nature 220:1098–1102.

RISEBROUGH, R. W., J. D. DAVIS, AND D. W. ANDERSON. 1970a. Effects of various chlorinated hydrocarbons. *In* J. W. Gillett [ed.]. The biological impact of pesticides in the environment. Environmental Health Series 1, Oregon State Univ. Press, Corvallis.

RISEBROUGH, R. W., G. L. FLORANT, AND D. D. BERGER. 1970b. Organochlorine pollutants in Peregrines and Merlins migrating through Wisconsin. Can. Field Nat. 84:247–253.

RISEBROUGH, R. W., F. C. SIBLEY, AND M. N. KIRVEN. 1971. Reproductive failure of the Brown Pelican on Anacapa Island in 1969. Amer. Birds 25:8–9.

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