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ORGANOCHLORINE-INDUCED MORTALITY AND RESIDUES IN LONG-BILLED CURLEWS FROM OREGON

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The range and population size of the Long-billed Curlew (*Numenius americanus*) have diminished drastically since the early 1900s; continued loss of breeding and wintering habitats has raised concern for the future of this species (Allen 1980). We investigated organochlorine residues in eggs and tissues of curlews to determine how they were affecting this species.

Seven Long-billed Curlew eggs were obtained in 1978 and 1979 near the Umatilla National Wildlife Refuge in Umatilla and Morrow counties, Oregon. The eggs were stored in a refrigerator. External measurements and volumes (by water displacement) were taken and the eggs were opened at their equator. The contents were placed in chemically clean glass jars and were stored in a freezer. From 1981 to 1983, three adult curlews were picked up by hand by people who observed them undergoing convulsions or erratic behavior; each bird died soon after capture and was turned over to us. They were stored in a freezer and subsequently shipped to the National Wildlife Health Laboratory in Madison, Wisconsin, for necropsy; the brains were then removed, placed in glass jars, and re-frozen. The eggs and brains were shipped to the Patuxent Wildlife Research Center in Laurel, Maryland, where they were analyzed for residues of 17 organochlorine pollutants. A gas-liquid chromatograph equipped with an electron capture detector was used for the analysis; residues in two of the brains were confirmed on a gas chromatograph/mass spectrometer (Cromartie et al. 1975, Kaiser et al. 1980). Residue concentrations in eggs were adjusted to a fresh wet weight basis, and concentrations in all samples were not corrected for recovery values determined from experimental samples. The lower level of analytical sensitivity was 0.01 μg/g for the brains of two birds that were found dead in 1982 and 1983, and 0.1 μg/g for those in all other samples.

Eggshells were allowed to dry at room temperature. We measured thickness (shell plus membranes) at three sites on the equator of the egg by using a micrometer graduated in units of 0.01 mm; the three measurements were averaged. The Western Foundation of Vertebrate Zoology supplied us with eggshell thicknesses of eggs from pre-1947 and post-1947 samples. We determined shell thicknesses of each museum egg by averaging 10 measurements around the blow hole (usually located on or near the equator).

The male that was captured on a highway in 1981 was emaciated; it had markedly reduced pectoral muscles and no fat. The necropsy indicated no evidence of infectious disease or trauma. The brain contained 5.9 μg/g of dieldrin (Table 1)—a level generally related to lethality in birds (W. H. Stickel, pers. comm.).

The male that was collected in 1983 was not obviously emaciated and showed no signs of trauma or internal lesions of significance. Post-mortem autolysis of its internal organs may have obscured the less obvious lesions of infectious disease. Its brain contained 4.8 μg/g of heptachlor epoxide and 4.4 μg/g of oxychlordane. These compounds are metabolites of technical chlordane that have jointly induced mortality in experimental birds given diets containing technical chlordane (Stickel et al. 1979). Joint lethal ranges in these experiments were 1.5–5.0 μg/g for oxychlordane and 3.4–8.3 μg/g for heptachlor epoxide. When birds were given diets containing either oxychlordane or heptachlor, diagnostic lethal concentrations of oxychlordane or heptachlor epoxide in their brains were 6 and 9 μg/g, respectively (Stickel et al. 1979). The lethal action of heptachlor epoxide and oxychlordane appears additive in experimental birds; therefore, this curlew probably died from chlordane.

The female (Table 1) had a broken wing and visceral gout, but the breast musculature was normal and the amount of body fat seemed adequate. The concentration of oxychlordane (2.7 μg/g) in the brain was above the lower level associated with mortality in experimental birds that were fed technical chlordane, but the amount of heptachlor epoxide (2.2 μg/g) was below the minimal lethal residue established in the same experiments (Stickel et al. 1979). Assuming additivity of effect, the combined residue (4.9 μg/g) is insufficient to account for mortality. The other organochlorine residues in the female curlew were low. In addition, the adequate body condition indicates that this bird did not die directly from chlordane toxicity. Birds have died from predation or impact with vehicles when their brains contained lethal or near lethal levels of organochlorines such as endrin (Blus et al. 1983a).

We detected DDE residues in all seven eggs (Table 2). Residues of heptachlor epoxide, oxychlordane, and the PCBs were detected irregularly and at low levels. We did not determine the fate of nests where eggs were collected, but judging from the absence of shell thinning (Table 3) and the infrequent occurrence and low organochlorine residues other than DDE, we suspect that these contaminants had little influence on reproductive success of Long-billed Curlews in northeastern Oregon.

Shells of Long-billed Curlew eggs that were collected in 1951 and 1952 from northern California and southern Oregon were 6.3% thinner ($P < 0.05$) than the pre-DDT sample (Table 3). Mean thickness index of curlew eggs that were collected in Utah from 1948 to 1958 was 1.4% less than that of a pre-DDT sample (Morrison and Kiff 1979). The thinning in the Oregon and California samples suggests accumulation of DDE residues higher than that de-

TABLE 1. Residues of chlorinated hydrocarbon pollutants in brains of adult Long-billed Curlews from Umatilla and Morrow counties, Oregon.

				Residues (μg/g, fresh wet weight)[a]										
Date	Sex	Body wt. (g)	Collection site	DDE	DDT	Dieldrin	HE	OXY	CCH	TNCH	CNCH	TCH	Endrin	PCBs
22 May 1981	M	348	Pendleton	7.7	ND	5.9	1.0	2.5	0.11	0.14	ND	ND	ND	2.4
25 May 1982	F	497	Irrigon	0.41	0.04	ND	2.2	2.7	0.12	1.4	0.47	0.05	0.04	0.24
1 June 1983	M	429	Irrigon	3.4	ND	0.07	4.8	4.4	0.30	4.1	0.11	ND	ND	1.1

[a] HE = heptachlor epoxide, OXY = oxychlordane, CCH = *cis*-chlordane, TNCH = *trans*-nonachlor, CNCH = *cis*-nonachlor, TCH = *trans*-chlordane, PCBs = polychlorinated biphenyls resembling Aroclor 1260; ND = no residue detected.

TABLE 2. Residues of chlorinated hydrocarbon pollutants in Long-billed Curlew eggs from Umatilla and Morrow counties, Oregon.

Year	Residues (µg/g, fresh wet wt.)[a]			
	DDE	HE	OXY	PCBs
1978	5.03	ND	ND	ND
	6.48	0.09	0.13	ND
	6.15	ND	0.12	ND
	4.40	ND	0.12	ND
	5.42	ND	ND	ND
	4.65	ND	ND	ND
1979	1.15	1.2	ND	1.2
	4.26±[b] 0.41–7.39			

[a] HE = heptachlor epoxide, OXY = oxychlordane, PCBs = polychlorinated biphenyls, and ND = no residue detected.
[b] Geometric mean ± 95% confidence limits.

TABLE 3. Eggshell thickness of Long-billed Curlew eggs from Oregon and northern California, pre- and post-DDT periods.

Period	n	Eggshell thickness (mm)[a]
1888–1944[b]	28	0.300A ± 0.005
1951–1952[c]	17	0.281B ± 0.003
1978–1979[d]	7	0.298AB ± 0.007

[a] Arithmetic mean ± standard error. Means compared by multiple range test (Kramer 1956); means showing a common letter are not significantly different ($P > 0.05$) from one another.
[b] Includes five eggs from northern Oregon, 19 from southern Oregon, and four eggs from northern California.
[c] Includes four eggs from northern California and 13 from southern Oregon.
[d] All eggs from northern Oregon.

tected in the 1978–1979 samples, but the amount of thinning is below the known critical level of 18–20% associated with population declines in other species (Hickey and Anderson 1968).

The use of organochlorine pesticides and their impact on avian populations in the United States have markedly decreased—particularly within the past 10 years (Spitzer et al. 1978, Blus 1982). High concentrations of organochlorines still occur, particularly in certain western localities where they are associated with adult mortality and sublethal effects that include eggshell thinning and reproductive impairment (Blus et al. 1983a, Henny et al. 1983, Blus et al. 1984). The chlordane-induced mortality of the curlew is the fourth record (three species) since 1978, despite restriction of technical chlordane use since 1980 to subterranean applications for termite control (Blus et al. 1983b). Nearly all uses of dieldrin in the United States were cancelled in 1974 (U.S. Environmental Protection Agency 1979).

The sources of organochlorine residues in these Long-billed Curlews are uncertain. Judging from the residue profiles, most of the residue burden is probably accumulated in the wintering range that includes the southern United States from central California southeastward to southern Louisiana and coastal South Carolina southward to Florida and southern Mexico, irregularly to Guatemala, Honduras, and Costa Rica (AOU 1983). In support of the notion that residues are probably accumulated on the wintering grounds, we know that heptachlor was used extensively as a seed treatment from about 1975 to 1981 in the area where the curlew samples were collected (Blus et al. 1984); these birds, however, spend only about four months in their breeding areas (Allen 1980) and migrate before planting of treated wheat seed begins. The ratios of heptachlor epoxide to oxychlordane (about 1:1) in brains of the adults and in three of the four eggs containing both of these pollutants suggest exposure primarily to technical chlordane rather than to heptachlor (Blus et al. 1983b). Nearly all other avian samples from the vicinity of the Umatilla National Wildlife Refuge with heptachlor epoxide and oxychlordane residues had ratios of ≥8:1; these ratios indicated exposure to heptachlor from either treated seed or prey that had consumed the treated seed. The egg collected in 1979 was the only curlew sample with a residue profile that suggested exposure primarily to heptachlor. Residues of heptachlor epoxide in birds declined rapidly and were rarely detected after the heptachlor seed treatments were discontinued (Henny et al. 1983, Blus et al. 1984, Henny et al. 1984). Also, dieldrin was found irregularly and usually at low levels in these samples. DDE concentrations in the curlew eggs were similar to those found in Great Blue Heron (*Ardea herodias*) eggs from colonies on the Umatilla National Wildlife Refuge and in Washington State (Blus et al. 1980); DDE concentrations in eggs of other species were much lower than in these two species (Henny et al. 1984, Blus et al. 1984).

The continuing decreases in populations of Long-billed Curlews are most likely related to loss and degradation of their habitat. Nevertheless, the mortality of adults and possibly other sublethal effects from organochlorines provide an additional insult of undetermined significance.

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RECENT PUBLICATIONS

Threatened birds of Africa and related islands. The ICBP/IUCN red data book, part 1. Third edition.—N. J. Collar and S. N. Stuart. 1985. International Council for Bird Preservation and International Union for Conservation of Nature and Natural Resources, Cambridge, U.K. 761 p. Hardcover. Price not given. Source: ICBP, 219c Huntingdon Road, Cambridge CB3 0DL, England. Previous Red Data Books for birds (noted in Condor 83:309) were global in coverage, but for updating them the ICBP has decided that "regional" books will be of greater local impact and usefulness. Under that scheme, this volume covers the avifauna of continental Africa plus the adjacent or outlying islands in the Atlantic and Indian oceans. (Next will come a book on the Americas, followed by those on Europe and Asia, and Australasia and the Pacific Ocean, although not necessarily in that order.) A further decision is that, for reasons of time, man-power, and subjectivity, subspecies are henceforth excluded from the Red Data Books, although not from consideration by the ICBP and IUCN. This volume treats 172 species as "threatened," with one more being "out of danger" and four "of special concern"; other categories of threatened or "near-threatened" species are listed in the appendices. The accounts are organized as to distribution, population, ecology, threats, and conservation measures taken or proposed; each is furnished with references. Treatment is as detailed as possible, in the belief that full information is essential for choosing and carrying out conservation programs. A third innovation in this edition is the inclusion of color plates: 12 fine paintings by Norman Arlott. "Some of the depicted species have never been illustrated before; some of them have not been seen for decades; some, sadly, may never be seen again by any human being; others, it is to be hoped, may be rediscovered, perhaps resulting from stimulation given by this book." Its geographic scope notwithstanding, this grim volume should be of importance to ornithologists everywhere.

South African red data book—birds.—R. K. Brooke. 1984. South African National Scientific Programmes Report No. 97, Foundation for Research Development, Pretoria. 213 p. Paper cover. Free. Source: The Liaison Officer: Nature Conservation Research, FRD, CSIR, P.O. Box 395, Pretoria 0001, South Africa. This catalogue follows the general purposes and plan of the "red data books" pioneered by the IUCN, but it has been produced under the auspices of a South African national program. It is the revised edition of a work published in 1976, several years before the ICBP and IUCN decided to switch from global to regional treatment. The categories of conservation status follow those of the IUCN, modified for relevance to a limited area. Accounts are given for 102 species of birds that breed on the South African mainland and a further six species for the oceanic Prince Edward islands. The accounts are organized clearly and furnished with distribution maps and selected bibliographies. Their data are usefully combined in several ways: an analysis of major findings; lists of species that call for investigation, monitoring, or conservation action; and a tabular summary. This book includes many species not listed by Collar and Stuart (above) yet, surprisingly, its accounts for the duplicated species tend to be shorter and less detailed. Critical comparison of both books would be needed in order to understand these differences. In any case, South African ornithologists are fortunate—perhaps, more properly, unfortunate—to have so much information about their rare and endangered birds. Appendices, references, indices.