 0030-0950/80/0001-0043$1.00/0

TOTAL MERCURY IN HERON AND EGRET EGGS AND EXCRETA[1]

ROBERT D. HOFFMAN[2], Ohio Cooperative Wildlife Research Unit, 1735 Neil Ave., Columbus, OH 43210

Abstract. Complete clutches of great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), and great egret (*Casmerodius albus*) eggs were collected along with excreta from nesting colonies in southwestern Lake Erie during the 1973 and 1974 breeding seasons and analyzed for total mercury content. Mercury levels in eggs ranged from 0.04 to 0.47 ppm. Mercury concentrations in excreta ranged from 0.09 to 0.48 ppm.

OHIO J. SCI. 80(1): 43, 1980

Since the industrial revolution, increasing amounts of mercury have been released into the environment from improper disposal of industrial waste products containing mercury. The primary mechanisms of this transport are aquatic systems (D'Itri 1971). Piscivorous birds, representing a terminal trophic level of an aquatic ecosystem, have been shown to contain elevated levels of mercury (Dustman *et al* 1971, Greichus *et al* 1973, Parslow 1973). Hoffman (1974) has shown high concentrations in herons and egrets in the southwestern Lake Erie region.

Major routes of elimination of mercury in birds is through excretion, feather molt, and egg laying (Peakall and Lovett 1972, Tejning 1967, Mullins *et al* 1977). Mercury levels in heron and egret primary wing feathers have been reported by Hoffman (1974) for southwestern Lake Erie. This paper reports on mercury levels in complete clutches of eggs, and excreta collected from great blue herons, black-crowned night herons, and great egrets nesting in this region.

MATERIALS AND METHODS

The study was conducted in two heronries in the southwestern Lake Erie region. The West Sister Island heronry, located 9 miles north of the Ottawa National Wildlife Refuge, Oak Harbor, Ohio, contained approximately 2,000–3,000 active nests of great blue herons, black-crowned night herons, and great egrets in 1973, whereas the heronry at the Winous Point Shooting Club, Port Clinton, Ohio, contained 1,500 great blue heron nests in 1973.

Complete clutches of eggs were collected from the 4 populations of birds during the 1973 and 1974 breeding seasons. Nineteen great blue heron eggs were collected from 5 nests at the Winous Point heronry. Due to the inaccessibility of nests, only one clutch of 3 eggs was collected from a great blue heron nest on the island. Seventeen eggs each from black-crowned night herons and great egrets were collected from 6 and 5 nests, respectively. Eggs were wrapped in aluminum foil and refrigerated for subsequent analysis.

Excreta from adults and nestlings was collected on 1 m^2 polyethylene sheets placed under nests for 24 hour periods. The excreta was air dried and scraped from sheets then frozen for later analysis. Samples were prepared for analysis using variations of Adrian's (1971) wet digestion method. Total mercury concentrations were analyzed utilizing the flameless atomic absorption, cold vapor generation technique of Hatch and Ott (1968) on a Perkin-Elmer, Model 303, atomic absorption spectrophotometer.

Data were analyzed primarily by non-parametric statistics (Hollander and Wolf 1973) because of the lack of normality and unequal variance in the data. The Kruskall-Wallis test was used to test differences in mercury levels of eggs and excreta among the four populations.

RESULTS AND DISCUSSION

Mercury was analyzed in total egg contents of complete clutches totaling 17 eggs per species (table 1). The only clutch of great blue heron eggs from West Sister Island had significantly lower ($P<0.05$) mercury than eggs from the other 3 populations. These data, however, were not felt to be conclusive

[1]Manuscript received 14 November 1978 (#78-67).

[2]Present Address: 3500 South Lattimore Road, Port Clinton, OH 43452.

due to the small sample size. Mercury levels found in eggs of great blue herons (0.29 ppm) and great ergrets (0.26 ppm) by Faber and Hickey (1973) in Wisconsin were similar to those measured in great blue herons (0.04 to 0.47 ppm) and great egrets (0.10 to 0.37 ppm) from Lake Erie heronries. Dustman *et al* (1972) and Faber and Hickey (1973) found mercury levels in black-crowned night heron eggs from Lake St. Clair, Michigan (0.45 to 1.1 ppm) and Wisconsin (0.48 ppm) to exceed those levels found in night heron eggs from West Sister Island, Ohio.

TABLE 1

Mercury Conient of Complete Clutches of Eggs (1973–1974) from West Sister Island and the Winous Point Shooting Club.

Species	No. Eggs	Hg (ppm)
Winous Point Shooting Club		
Great Blue Heron	2	0.08±0.01*
	5	0.15±0.04
	4	0.39±0.03
	4	0.09±0.02
	4	0.45±0.03
Total	17	0.21±0.07
West Sister Island		
Great Blue Heron	3	0.08±0.03
Black-crowned Night Heron	3	0.28±0.07
	3	0.11±0.04
	3	0.09±0.03
	1	0.24±——
	4	0.11±0.03
	3	0.37±0.05
Total	17	0.19±0.05
Great Egret	4	0.30±0.04
	4	0.17±0.01
	3	0.25±0.01
	3	0.13±0.02
	3	0.18±0.02
Total	17	0.21±0.07

*Mean ± standard deviation.

Eggs within a clutch had a lower variation around mean mercury levels than levels in eggs from the population as a whole. This indicates that residues are consistant among eggs within a clutch and that only one egg per clutch may be needed for analysis. Vermeer (1971) has shown a similar correlation in mercury levels between gull eggs within a clutch.

Several studies take differing views on the effects of mercury on eggshell thinning. Faber and Hickey (1973) showed eggshell thinning in heron eggs in relation to increased use of mercury in society, and Stoewsand *et al* (1971) associated high mercury levels in Japanese quail (Coturnix coturnix) with eggshell thinning. Mullins *et al* (1977) showed a decrease in hatchability, eggshell thickness, and chick weight and survival of pheasants (*Phasianus colchicus*) administered 20 mg Hg/kg body weight. Heinz (1974) and Haegele *et al* (1974), however, concluded that mercury did not contribute to eggshell thinning in mallards (*Anas platyrhynchos*), and Peakall and Lincer (1972) did not find that mercury had a thinning effect on eggs of Ring Doves (*Streotopelia risoria*) or American Kestrels (*Falco sparverius*). In herring gull eggs analyzed by Vermeer *et al* (1973), mercury levels up to 15.8 ppm appeared to have little effect on hatching success. Based on these reports, the effects of mercury on reproduction appear to be somewhat species specific. In a study by Gilman *et al* (1977) regarding the effect of mercury in herring gull eggs from 4 great lakes, Lake Erie was the lowest with median levels of 0.22 ppm. Edford (1976) showed the reproductive success of the Winous Point colony in 1975 was similar to great blue heron colonies in other parts of North America. This relationship suggests concentrations of mercury in eggs were either similar to concentrations in eggs of other colonies or that levels found in eggs of the Lake Erie area were insignificant to the reproductive success of the colony.

Mercury levels in excreta collected during my study on 4 populations of birds ranged from 0.09 to 0.48 ppm (air dry) in 37 samples from great blue herons in the Winous Point heronry, 0.11 to 0.20 ppm in 4 samples from island nesting great blue herons, 0.27 to 0.47 ppm in 5 black-crowned night heron samples, and 0.12 to 0.28 ppm in 5 excreta samples of great egrets. Mercury levels in black-crowned night heron excreta were significantly higher ($P<0.01$) than levels in island nesting great blue herons. Median mercury levels were highest in excreta of night herons (0.37 ppm), followed by

egrets (0.24 ppm), mainland great blue herons (0.21 ppm), and island nesting great blue herons (0.13 ppm).

Domestic fowl (*Gallus gallus*), given methyl mercury dicyandiamide excreted 11% over a 3 day period (Tejning 1967) and Mullins *et al* (1977) showed elevated mercury levels in pheasant excreta for a short period after administration of 20 mg Hg/kg body weight. Based on these studies and the data obtained in my study, excreta can be considered an important means of mercury elimination in birds.

Acknowledgments. This project was funded by the Ohio Cooperative Wildlife Research Unit, U.S. Fish and Wildlife Service, and The Ohio State University. I gratefully acknowl edge the assistance of R. Curnow and G. White. K. Morrow and M. Shieldcastle provided valuable technical assistance in the field and laboratory.

LITERATURE CITED

Adrian, W. J. 1971 A new wet digestion method for biological material utilizing pressure. Atom. Absorp. Newsl. 10: 96.

D'Itri, F. M. 1971 Mercury in the aquatic environment. Inst. of Water Res., Tech. Rep. No. 23, Mich. State Univ. 100 pp.

Dustman, E. H., L. F. Stickel and J. B. Elder 1972 Mercury in wild animals, Lake St. Clair, 1970, pp. 46–52. *In* R. Hartung and B. D. Dinman (ed.) Environmental Mercury Contamination. Ann Arbor Science Publ., MT. 349 pp.

Edford, L. H. 1976 Breeding biology of the Great Blue Heron in southwestern Lake Erie. Unpub. M.S. Thesis, Ohio State Univ., Columbus. 152 pp.

Faber, R. A. and J. J. Hickey 1973 Eggshell thinning, chlorinated hydrocarbons, and mercury in inland aquatic bird eggs, 1969 and 1970. Pest. Mono. J. 7: 27–36.

Gilman, A. P., G. A. Fox, D. B. Peakall, S. M. Teeple, T. R. Carroll and G. T. Haymes 1977 Reproductive parameters and egg contaminant levels of great lakes Herring Gulls. J. Wildl. Manage. 41(3): 458–468.

Greichus, Y. A., A. Greichus and R. J. Emerick 1973 Insecticides, polychlorinated biphenyls, and mercury in wild cormorants, pelicans, their eggs, food and environment. Bull. Environ. Contam. Toxicol. 9: 321–328.

Hatch, W. R. and W. L. Ott 1968 Determination of submicrogram quantities of mercury by atomic absorption spectrophotometry. Anal. Chem. 40: 2085–2087.

Haegele, M. A., R. K. Tucker and R. H. Hudson 1974 Effects of dietary mercury and lead on eggshell thickness in mallards. Bull. Environ. Contam. Toxicol. 11: 5–11.

Heinz, G. 1974 Effects of low dietary levels of methyl mercury on mallard reproduction. Bull. Environ. Contam. Toxicol. 11: 386–392.

Hoffman, R. D. 1974 Mercury in herons, egrets, and their nesting environment. Unpub. M.S. Thesis, Ohio State Univ., Columbus. 85 pp.

Hollander, M. and D. A. Wolf 1973 Nonparametric statistical methods. John Wiley and Sons, New York. 503 pp.

Mullins, W. H., E. G. Bizeau and W. W. Benson 1977 Effects of phenyl mercury on captive game farm pheasants. J. Wildl. Manage. 41(2): 302–308.

Parslow, J. L. F. 1973 Mercury in waders from the Wash. Environ. Pollut. 5: 295–304.

Peakall, D. B. and J. L. Lincer. 1972 Methyl mercury: its effect on eggshell thickness. Bull. Environ. Contam. Toxicol. 8: 89–90.

——— and R. J. Lovett 1972 Mercury: its occurrence and effects in the ecosystem. Bioscience 22: 20–25.

Stoewsand, G. S., J. L. Anderson, W. H. Gutenmann, C. A. Bache and D. L. Lisk. 1971 Eggshell thinning in Japanese Quail fed mercuric chloride. Science 173: 1030–1031.

Tejning, S. 1967 Biological effects of methyl mercury dicyandiamide-treated grain in the domestic fowl *Gallus gallus* L. Oikos Supl. 8, 116 pp.

Vermerr, K. 1971 A survey of mercury residues in aquatic bird eggs in the Canadian prairie provinces. Trans. N. Amer. Wildl. Nat. Res. Conf. 36: 138–152.

———, F. A. J. Armstrong and D. R. M. Hatch. 1973 Mercury in aquatic birds at Clay Lake, Western Ontario. J. Wild. Manage. 37: 58–61.