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A Survey of Lead Poisoning in Wild Waterfowl in Japan

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ABSTRACT: Ingested shotgun pellets were found in 13 of 56 hunter-killed wild waterfowl between October and December 1991 from two hunting grounds in Japan. Four of 33 other waterfowl found dead in lightly hunted areas between January 1991 and March 1992 were diagnosed as having lead poisoning. We propose that lead poisoning maybe a threat to waterfowl in Japan.

Key words: Lead poisoning, waterfowl, ingested lead shot, Japan, *Anas*, *Aythya*, *Cygnus*, *Anser*.

Lead poisoning due to ingestion and retention of spent lead shot has been recognized as a common disease of wild waterfowl in heavily hunted areas in the United States (Bellrose, 1959). This disease also has been recorded in 21 other countries, and is a serious problem in waterfowl the world over (Pain, 1992b). Lead poisoning in swans occurred sporadically in Japan during the winters of 1984 through 1987 (Honda et al., 1990). The first mortality among whooper swans (*Cygnus cygnus*) in Japan from lead poisoning was reported recently (Ochiai et al., 1992). It is estimated that the annual weight of lead shot fired into all habitats is 300 tons, of which 75 tons is fired annually into wetlands in Japan (Pain, 1992b). Our objective was to determine the prevalence of ingested shotgun pellets among harvested waterfowl in Japan from two wetlands and to estimate the prevalence of lead poisoning in waterfowl carcasses collected from various wetlands.

Fifty-six waterfowl were shot between October and December 1991 at two hunting grounds: the lower reaches of the Ishikari River from Tsukigata-cho (43°20′N, 141°40′E) to Bibai city (43°19′N, 141°51′E) in Hokkaido, and the circumference of Lake Kasumigaura (36°02′N, 140°24′E) in Ibaraki prefecture. The shore of the Ishikari River is a wetland located near Lake Miyajima (43°20′N, 141°43′E), where the first known mortality of swans due to lead poisoning in Japan had occurred (Ochiai et al., 1992). Nine species of hunter-killed birds were collected: the dusky mallard (*Anas poecilorhyncha*), pintail (*Anas acuta*), mallard (*Anas platyrhynchos*), wigeon (*Anas penelope*), teal (*Anas crecca*), falcated teal (*Anas falcata*), shoveler (*Anas clypeata*), tufted duck (*Aythya fuligula*) and scaup (*Aythya marila*).

These frozen or cooled carcasses were immediately taken to Hokkaido University, Sapporo, Japan. At necropsy, the proventriculus and gizzard from each bird were opened and the contents flushed into a bowl. Food and other light-weight materials were washed away, and the remaining heavy materials were dried. Shots were detected by sight, and by X-ray (soft X-ray apparatus SOFTEX CMBW-2; Softex Co., Ltd, Sibuya 150, Tokyo, Japan) of the proventriculus and gizzard content by the methods of Anderson and Havera (1989). If an angular or burred, full-sized, dark blue-gray pellet was suspected to have been shot into the proventriculus or gizzard, several sections were made through the organs to determine if a shot wound perforation had been overlooked. An opacity detected by X-ray was reexamined visually to determine if it was a lead shot.

For histopathology, the liver, kidney, and adrenal gland from 35 hunter-killed birds were fixed in 10% buffered neutral formalin. Tissues were embedded in paraffin, sectioned at 4 μm, and stained with hematoxylin and eosin. Selected sections were stained with acid-fast stain with Fite's carbol fuchsin (Lillie and Fullmer, 1976).

From January 1991 to March 1992, 33 waterfowl carcasses in addition to the 56 hunter-killed birds were collected from various wetlands in Japan. These birds were

found by bird-watchers in areas not heavily hunted. We determined whether these birds died from lead poisoning based on such criteria as emaciation, distended gall bladder, impacted proventriculus, greenish to gray discoloration of the liver and kidney, moderate to severe enteritis, greenish to blue-gray slate discoloration of the intestinal tract, and greenish diarrhea (Jordan and Bellrose, 1951). Lead concentrations in livers and kidneys of selected birds without these typical findings, but did ingest lead pellets, were examined. The liver and kidney samples (wet) were digested with nitric acid and perchloric acid (Uchino et al., 1987). Lead in the solutions was determined by air-acetylene flame atomic absorption spectrometry (Williams, 1984) with a Hitachi Model 180-50 atomic absorption spectroscope (Hitachi Ltd., Tokyo, Japan) at a wavelength of 217 nm. The background was corrected by a D_2 lamp. Other conditions were those recommended by the manufacturer (Hitachi). The threshold liver lead levels above which waterfowl can be considered to have been exposed to above background, and to toxic concentrations of lead, are 2 to 6 mg/kg wet weight and >6 mg/kg wet weight, respectively (Pain, 1992a).

At necropsy of the hunter-killed birds, no significant lesions other than shot wounds were seen. By visual examination alone, an ingested lead pellet was seen in the content of eight (14%) of the 56 gizzards. Based on visual examination and radiography, the prevalence of ingested lead pellet was increased to 13 (23%) of 56 ducks: 8 (27%) of 30 birds from the Ishikari River and 5 (19%) of 26 birds from Lake Kasumigaura. None of the birds ingested >1 shot. The prevalence of lead shot for each species was dusky mallard (number of birds with a pellet/total number of each species examined = 4/6), pintail (2/5), mallard (3/13), tufted duck (2/6), wigeon (1/6), teal (1/13), falcated teal (0/2), shoveler (0/3) and scaup (0/2).

Thirty-five hunter-killed birds were examined histologically. None of the birds had acid-fast intranuclear inclusion bodies in the proximal tubules of the kidney. Inclusion bodies are regarded as strong evidence of lead poisoning although these cannot always be detected (Locke et al., 1967). No other significant lesions were seen in any tissue.

The prevalence for ingested lead shot among 13,779 mallards sampled in Illinois (USA), 1979 to 1985, was 5.9% (Anderson and Havera, 1989). Sanderson and Bellrose (1986) found that 8.9% of 171,697 duck gizzards contained lead shot between 1973 and 1984. Lead-poisoned birds are about 1.65 times more likely to be bagged by hunters than healthy ducks (Bellrose, 1959).

Of the 33 carcasses found in various wetlands, four birds were diagnosed as having lead poisoning (Table 1). Three cases, including two white-fronted geese (*Anser albifrons*; bird numbers 2 and 3) and one tundra swan (*Cygnus columbianus*; bird 5), were diagnosed as having lead poisoning due to ingestion of spent lead shot; another whooper swan (bird 4) had ingested a lead fishing sinker. Based on the lead levels in the livers and kidneys, bird 4 was confirmed as having acute lead poisoning biochemically and bird 1 was considered to be exposed to lead; neither had lesions typical of lead poisoning. Three of the birds (birds 1, 2, 3) that ingested lead pellets were found at Lake Miyajima.

Lead-poisoned whooper swans previously were reported at Lake Miyajima in the spring of 1989 (Ochiai et al., 1992). These swans contained 6 to 27 ingested lead shot per bird. Gravel was distributed as a prophylactic replacement for lead, but some mortality still occurred the following year. However, this exercise was repeated and no mortality has occurred since. In addition, hunters have discontinued waterfowl hunting at this lake since the fall of 1989. Based on our results, we believe that the waterfowl in the Ishikari River and Lake Miyahima are at risk from lead intoxication. The circumference of Lake Kasumigaura also may be contaminated by spent lead shot, but the magnitude

TABLE 1. Cases of lead-ingested or lead-poisoned waterfowl in Japan, January 1991 to March 1992.

Bird no.	Location (lat., long.)	Necropsy date	Species	Age[a]	Sex	Body weight (kg)	No. of ingested lead pellets	Lead levels (mg/kg)[b] Liver	Kidney	Main gross lesions
Lead-ingested bird										
1	Lake Miyajima	04/12/91	Whooper Swan	I	M	10	2	2.9	5.3	Contusion of right femur, distension of gall bladder, partial greenish discoloration of gizzard.
Lead-poisoned birds										
2	Lake Miyajima	05/13/91	White-fronted Goose	A	F	1.3	13	NE[c]	NE	Proventricular impaction, distention of gall bladder, hyperkelatosis, erosion and greenish discoloration of gizzard, edema of bone marrow, splenic atrophy.
3	Lake Miyajima	11/08/91	White-fronted Goose	A	M	2.0	19	NE	NE	Proventricular impaction, distention of gall bladder, hyperkelatosis, erosion and greenish discoloration of gizzard, greenish discoloration of the intestinal tract, flaccid heart with increase of cardiac fluid.
4	Lake Shirarutoro (43°11′N, 144°30′E)	02/18/92	Whooper Swan	A	M	7.5	1 Sinker[d]	12.1	81.2	Purulent peritonitis and airsacculitis, proventricular impaction, distention of gall bladder, greenish discoloration of the intestinal tract, increase of cardiac fluid.
5	Lake Tatara (36°15′N, 139°30′E)	03/26/92	Tundra Swan	I	F	3.3	35	NE	NE	Proventricular impaction, greenish liver and kidney, distention of gall bladder, greenish discoloration and hyperkeratosis of gizzard, flaccid heart, splenic atrophy, emaciation.

[a] A, adult; I, immature.
[b] Wet weight.
[c] Not examined.
[d] 2.2 × 0.75 × 0.7 cm in size, 4.2 g.

probably is lower than occurring at Lake Miyajima and the surrounding areas.

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LITERATURE CITED

ANDERSON, W. L., AND S. P. HAVERA. 1989. Lead poisoning in Illinois waterfowl (1977–1988) and the implementation of nontoxic shot regulations. Illinois Natural History Survey Biological Notes 133: 1–37.

BELLROSE, F. C. 1959. Lead poisoning as a mortality factor in waterfowl populations. Illinois Natural History Survey Bulletin 27: 235–288.

HONDA, K., D. P. LEE, AND R. TATSUKAWA. 1990. Lead poisoning in swans in Japan. Environmental Pollution 65: 209–218.

JORDAN, J. S., AND F. C. BELLROSE. 1951. Lead poisoning in wild waterfowl. Natural History Survey Biological Notes 26: 1–27.

LILLIE, R. D., AND H. M. FULLMER. 1976. Histopathologic technic and practical histochemistry, 4th ed. McGraw-Hill Book Company, New York, New York, pp. 734–737.

LOCKE, L. N., G. E. BAGLEY, AND L. T. YOUNG. 1967. The ineffectiveness of acid-fast inclusions in diagnosis of lead poisoning in Canada geese. Bulletin of the Wildlife Disease Association 3: 176.

OCHIAI, K., K. JIN, C. ITAKURA, M. GORYO, K. YAMASHITA, N. MIZUNO, T. FUJINAGA, AND T. TSUZUKI. 1992. Pathological study of lead poisoning in whooper swans (*Cygnus cygnus*) in Japan. Avian Diseases 36: 313–323.

PAIN, D. J. 1992a. Lead poisoning in waterfowl: A review. *In* Lead poisoning in waterfowl, Proceedings of International Waterfowl and Wetlands Research Bureau workshop, Brussels, Belgium, 1991, International Waterfowl and Wetlands Research Bureau Special Publication 16, D. J. Pain (ed.). International Waterfowl and Wetlands Research Bureau, Slimbridge, United Kingdom, pp. 7–13.

———. 1992b. Lead poisoning in waterfowl: Summary of national reports. *In* Lead poisoning in waterfowl, Proceedings of International Waterfowl and Wetlands Research Bureau workshop, Brussels, Belgium, 1991, International Waterfowl and Wetlands Research Bureau Special Publication 16, D. J. Pain (ed.). International Waterfowl and Wetlands Research Bureau, Slimbridge, United Kingdom, pp. 86–94.

SANDERSON, G. C., AND F. C. BELLROSE. 1986. A review of the problem of lead poisoning in waterfowl. Illinois Natural History Survey Special Publication 4: 1–34.

UCHINO, E., K. JIN, T. TSUZUKI, AND K. INOUE. 1987. Evaluation of the stability of some elements during lyophilisation of rat liver using atomic absorption spectrometry. Analyst (London) 112: 291–293.

WILLIAMS, S. (editor). 1984. Official methods of analysis of the Association of Official Analytical Chemists, 14th ed. Association of Official Analytical Chemists, Inc., Arlington, Virginia, pp. 460–464.

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