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## Lead Poisoning in Wild Waterfowl in Japan

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**ABSTRACT:** We collected 430 harvested ducks (*Anas* sp. and *Aythya* sp.) from nine prefectures in Japan between 1994 and 1997. Fifteen (4%) of 363 birds harvested during and after hunting seasons had one lead pellet each in the proventriculus and gizzard. In addition, 32 (34%) of 93 swans (*Cygnus* sp.) and two of 14 geese (*Anser* sp.) found dead from various wetlands had lesions consistent with lead poisoning. One to nine swans suspected of having toxicosis from ingestion of lead shot were found dead each year. Twenty-seven (84%) of the 32 lead-exposed swans were found in Hokkaido Prefecture. We concluded that lead poisoning is still a serious threat to waterfowl in Japan and that there is considerable need for environmental improvement concerning this problem.

**Key words:** Ducks, geese, ingested lead shot, lead poisoning, survey, swans, waterfowl.

Lead poisoning has been recognized as a common disease of wild waterfowl in heavily hunted areas in more than 20 countries (Pain, 1992; Bellrose, 1959). Waterfowl are affected with this disease by ingestion and retention of spent lead shot. As the disease was found to be a serious problem in the 1990's, a complete legislative ban on the use of lead shot for hunting waterfowl has already been implemented in 10 countries (Fawcett and van Vessem, 1995).

The first mortality of whooper swans (*Cygnus cygnus*) in Japan from lead toxicosis was reported in 1989 (Ochiai et al., 1992). The mortality occurred at Lake Miyajima (43°20'N, 141°43'E) which is a small lake, 0.36 km<sup>2</sup> in area, with a maximum depth of 2.4 m located in Hokkaido Prefecture (centered at 43°28'N, 142°49'E). Furthermore, mortality of geese due to the lead poisoning was observed at the same habitat in the spring of 1990 (Ochiai et al., 1993b). Our previous survey indicated the potential threat of

lead pellets to waterfowl in Japan (Ochiai et al., 1993a). After finding these mortalities, gravel was distributed in Lake Miyajima as a prophylactic replacement for lead in 1989 and 1990. In addition, hunting has been discontinued at this lake since the fall of 1989. Subsequent occurrence of lead poisoning seems to have been prevented by those actions. The disease, however, has been sporadically recognized throughout Japan since then. As the use of lead shot for waterfowl hunting is not yet prohibited in Japan, such measures are now under review by a governmental committee. The present survey was performed in order to gather more detailed, reliable data on the current prevalence of this waterfowl disease in our country.

Two hundred forty seven waterfowl were captured by net and euthanized by exsanguination during and after autumn hunting seasons from November to the next March of 1994–95 or 1995–96 in six prefectures in Japan including Miyagi (38°26'N, 140°55'E), Niigata (37°31'N, 138°55'E), Gifu (35°46'N, 137°03'E), Aichi (35°02'N, 137°12'E), Kyoto (35°15'N, 135°26'E), and Shimane (35°04'N, 132°33'E). Thirty six birds from Hokkaido Prefecture were harvested by shooting during the hunting season of 1994–95 and forty birds from Kagawa Prefecture (34°14'N, 133°59'E) and forty from Fukuoka Prefecture (33°31'N, 130°40'E) were harvested by shooting during the season of 1996–97. Twelve birds from Niigata Prefecture also were captured by net and euthanized by exsanguination immediately before the hunting season of 1994 and 25 from Aichi and 30 from Kyoto were similarly sampled before the season of 1995. The nine species of harvested birds were

examined, including 195 mallard (*Anas platyrhynchos*), 148 green-winged teal (*Anas crecca*), 30 pintail (*Anas acuta*), 19 spot-billed ducks (*Anas poecilorhyncha*), eight northern shoveler (*Anas clypeata*), 16 Eurasian wigeon (*Anas penelope*), four tufted ducks (*Aythya fuligula*), four pochard (*Aythya ferina*), and 6 greater scaup (*Aythya marila*).

These frozen or cooled carcasses were sent to our laboratory and necropsied. The proventriculus and gizzard from each bird were opened and the contents flushed into a bowl. Similarly, as in our previous report (Ochiai et al., 1993a), lead pellets were detected by sight and by X-ray (soft X-ray apparatus Softex CMBW-2; Softex Co., Ltd, Tokyo, Japan) of the proventriculus and gizzard contents. An opacity detected by soft X-ray was reexamined visually to determine if it was a lead pellet.

Between 1991 and 1997, 124 carcasses, including 93 swan species, 14 goose species, and 17 duck species other than the harvested waterfowl were collected specifically for investigating lead poisoning from various wetlands in Japan and necropsied in our laboratory. These birds were found dead or weakened by bird-watchers or government employees. Dead birds were directly sent to our laboratory. Weakened birds were sent to the teaching animal hospital in our university for medical treatment and they were sent to us after they subsequently died. We examined these birds for the typical gross findings of lead poisoning, including emaciation, a distended gall bladder, an impacted proventriculus, greenish to gray discoloration of the liver and kidney, greenish to blue-gray slate discoloration of the intestinal tract, greenish diarrhea which tended to stain the feathers surrounding the vent and the presence of ingested lead shots in both proventricular and gizzard content (Jordan and Bellrose, 1951; Ochiai et al., 1992).

Four hundred thirty three waterfowl from nine prefectures were totally examined in 1994–97. None of 67 birds collected immediately before hunting seasons

TABLE 1. Prevalence of ingested shotgun pellets in harvested waterfowl during and after hunting seasons in nine prefectures of Japan.

Year	Location (Prefecture)	Number of gizzards	Number (%) of gizzards with a lead pellet
1994–1995	Hokkaido	36	4 (11)
	Miyagi	87	2 (2)
	Niigata	15	1 (7)
1995–1996	Gifu	49	1 (2)
	Aichi	19	0
	Kyoto	23	0
	Shimane	54	0
1996–1997	Kagawa	40	4 (10)
	Fukuoka	40	3 (8)
Total		363	15 (4)

had ingested lead pellets within the content of the proventriculus and gizzard, while ingested shotgun pellets were found in 15 (4%) of 363 waterfowl harvested during and after the hunting seasons. None of the birds ingested >1 shot. The prevalence of ingested lead pellets in the harvested waterfowl was slightly higher in Hokkaido (11%; number of birds with a pellet/total number examined = 4/36) and Kagawa prefectures (10%; 4/40) as compared with other districts (Table 1). The prevalence of ingested lead shot for each species (number of birds with a pellet/total number of each species harvested during and after hunting seasons) was 8.1% (12/148) for mallard, 1% for green-winged teal (2/148), and 25% for tufted ducks (1/4). Other species had no ingested pellets.

Of 124 waterfowl found dead or weakened between 1991 and 1997, 38 (31%) birds had gross lesions consistent with a diagnosis of lead poisoning. The prevalence of this toxicosis for each bird family was swans (36/93; 39%), geese (2/14; 14%) and ducks (0/17; 0%). Birds suggested to be affected with lead poisoning included 29 whooper swans (eight immature (I)-male (M) birds, seven mature (Mt)-male (M), four I-female (F), 10 Mt-F), six tundra swans (*Cygnus columbianus jankows-*

TABLE 2. Number of swans found dead and suggested to be poisoned by lead shot between 1991 and 1997.

Year	N <sup>a</sup>	Prefecture (number poisoned)			
		Hokkaido	Iwate	Miyagi	Gunma
1991	5	1	—	—	—
1992	20	2	—	2	2
1993	11	3	—	—	—
1994	19	2	—	—	—
1995	17	7	—	—	—
1996	7	3	1	—	—
1997	14	9	—	—	—
Total	93	27	1	2	2

<sup>a</sup> Number of swans examined.

*kii*; one Mt-M, one I-F, four Mt-F), one American subspecies of the tundra swan (*C. columbianus columbianus*; Mt-M) and two white-fronted geese (one Mt-m, one Mt-F). More adults were found to be affected than juveniles. Thirty swans had ingested lead shots and lead pellet was not found in two whooper swans having the gross lesions consistent with lead poisoning. Four whooper swans ingested lead fishing sinkers. The number of lead pellets ingested in the proventriculus and gizzard of each swan ranged from 0 to 148 pellets ( $\bar{X} \pm SD = 16 \pm 32$ ). These birds were found in Hokkaido, Iwate (39°35'N, 141°21'E), Miyagi and Gunma (36°30'N, 138°59'E) Prefectures (Table 2). One to nine swans suggested to die of lead poisoning by ingestion of lead shot pellets were found each year. Twenty-seven (84%) of the 32 suggested swans were found in Hokkaido Prefecture and 20 (63%) of them were collected in and around Lake Miyajima. Two geese also were found around Lake Miyajima.

Previously, Anderson and Havera (1989) reported that the mean prevalence for ingested shot among 13,779 mallard in Illinois (USA) from 1979 to 1985 was 5.9%. Sanderson and Bellrose (1986) reported that 8.9% of 171,697 ducks contained shot pellets according to their compiled data about shot ingestion rates from 1973 through 1984. In the present survey, the

sample size of harvested waterfowl for each location was too small to decide the prevalence rates for ingested lead pellets. However, it was noteworthy that 4% of 363 waterfowl harvested during and after hunting seasons ingested one lead pellet and 8% of 148 harvested mallard and 1% of 148 green-winged teal had one pellet. These results suggest that lead contamination occurs in heavily hunted areas in Japan during the hunting season.

The gross pathologic results in the waterfowl carcasses that we examined demonstrated that more swans seemed to be affected by this toxicosis than geese or ducks. However, the credibility of this result also largely depends on the sample size of each species. As larger birds with fine white feathers are attractive for bird-watchers and citizens, swans showing abnormal behavior or weakness may be more easily found and captured by bird-watchers than geese and ducks before being captured by predators. Similarly, the prevalence of the toxicosis for each prefecture except Hokkaido should be considered tentative in this survey because we could collect only 13 swans, one goose and eight ducks from locations other than Hokkaido.

According to an administrative report (Japanese Wildlife Research Center, 1997) on lead poisoning in waterfowl, at least 13 waterfowl poisoned by lead shot other than our examined cases were recognized between 1991 and 1997, and these birds were found in the prefectures of Miyagi, Gunma, Ishikawa (36°45'N, 136°46'E), Saitama (35°59'N, 139°20'E) and Nagano (36°07'N, 138°02'E). However, lead-poisoned waterfowl have not been reported from Kagawa and Fukuoka, where ingested lead shot was detected as frequently as in Hokkaido. In some years we could examine only about one-tenth of the number of carcasses observed because the visceral organs had already been taken away by predators. Therefore, the number of waterfowl suspected to have died of lead poisoning in our survey should be considered

minimal, and only represents a portion of lead-poisoned waterfowl in Japan.

More than 80% of the swans suspected to have been poisoned by ingestion of lead shot were found in Hokkaido and more than half of them were collected in and by Lake Miyajima, where the first observed mortality of swans in Japan occurred in 1989. In addition, the number of lead-poisoned carcasses found around Lake Miyajima slightly increased during the last 3 yr. Gravel distribution in and around the lake has not been performed since 1991. Although the voluntary regulation restricting hunting since 1989 is currently valid at this lake, hunting waterfowl is performed at other lakes around Lake Miyajima. Based on our results, we believe that waterfowl in Japan are faced with a risk of lead intoxication similar to that seen in Europe and the United States before environmental conditions were improved by laws and regulations prohibiting lead shot. In our country, lead poisoning is still a threat to waterfowl, especially to swans in Hokkaido.

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