Size and Mass of Grit in Gizzards of Sandhill Cranes, Tundra Swans, and Mute Swans

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Abstract.—Because it has been suggested that waterbirds may ingest lost or discarded lead fishing weights as grit, we examined grit in the gizzards of Sandhill Cranes (*Grus canadensis*), Tundra Swans (*Cygnus columbianus*), and Mute Swans (*Cygnus olor*), three species where individuals have been poisoned by the ingestion of lead fishing weights. The greatest proportion (by mass) of grit in gizzards of Sandhill Cranes consisted of particles with a minimum dimension of 2.36-4.75 mm. Grit particles in swans were much smaller, with the most prevalent (by mass) being 0.6-1.18 mm. The greatest dimension of the largest grit particle found in cranes and swans was 17.4 mm and 14.0 mm, respectively. The U.S. Environmental Protection Agency has proposed a ban on lead fishing weights of ≤25.4 mm in any dimension. Based on the size of grit particles that we found in gizzards of Sandhill Cranes, Mute Swans, and Tundra Swans, we believe it is unlikely that individuals of those species would ingest, as grit, lead fishing weights larger than 25.4 mm in any dimension. *Received 10 January 2001, accepted 28 February 2001.*

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Small stones are ingested by many species of birds as grit to aid in the grinding of food in the gizzard and as a source of calcium (Berger 1961; Harper 1964). The size and composition of grit has been evaluated in a variety of species, including gallinaceous birds, waterfowl, and passerines (Harper 1964; May and Braun 1973; Norman and Brown 1985; Best and Gionfriddo 1991). The type and size of grit selected by birds may influence their likelihood of exposure, and possibly their susceptibility, to toxic particles in the environments where they feed (Godin 1967; Trost 1981; Best and Gionfriddo 1991; Sparling *et al.* 1999; Franson *et al.* 2001). Of the toxic particles potentially mistaken as grit and ingested by birds, lead shotgun pellets are perhaps the best known (Sanderson and Bellrose 1986).

Ingested lead anglers' weights also have caused lead poisoning in waterbirds in North America and Europe, most notably Common Loons (*Gavia immer*) and Mute Swans (*Cygnus olor*), but also Trumpeter Swans (*Cygnus buccinator*), Tundra Swans (*Cygnus columbianus*) and Sandhill Cranes (*Grus canadensis*) (O'Halloran *et al.* 1988; Kirby *et al.* 1994; USEPA 1994). Waterbirds may inadvertently pick up lead sinkers, separately or attached to pieces of fishing line, as they feed in fished areas where lost and discarded fishing materials are found (USGS 1999). It also has been suggested that some lead sinkers, particularly split shot, and jig heads are sometimes mistakenly ingested as grit. An analysis of the size of grit selected by various waterbirds would be useful in an evaluation of the latter hypothesis. We found few available data on grit selection in Sandhill Cranes and swans, although one study reported that grit accounted for about 25% of the volume of material in gizzards of Sandhill Cranes collected in Texas (Guthery 1975) and an examination of gizzards from seven Mute Swans in England indicated that more than 90% of the grit was <2 mm in diameter (Owen and Cadbury 1975). A study of the frequency of ingested lead fishing sinkers in several species of waterbirds (USGS 1999) provided us an opportunity to evaluate grit size in gizzards of Sandhill Cranes, Mute Swans, and Tundra Swans.

METHODS

Gizzards were collected from 202 Sandhill Cranes, including 68 birds found dead on 27 March 1996, in Kearney and Hall Counties, Nebraska, following a severe storm. The remaining gizzards from cranes were collected from hunter-killed birds at check stations in Socorro County, New Mexico, on 26 October 1996 (N = 52), and in Cochise County, Arizona, between 1 November and 15 November 1996 (N = 82). We also received gizzards from 29 Mute Swans that were killed in Dorchester County, Maryland, on 28 and 29 April, 1997, during a program to control the range expansion of that species in the Chesapeake Bay. Gizzards of Tundra Swans (N = 43) came from hunter-killed carcasses at check stations in Box Elder County, Utah, between 10 November and 7 December 1997. Gender was determined for 174 Sandhill Cranes (92 males and 82 females) and 21 Tundra Swans (12 males and 9 females) by visual examination of the gonads. We also assigned carcasses of 111 Sandhill Cranes to two subspecies (88 *G. c. canadensis* and 23 *G. c. tabida*), based on morphometric measurements (Johnson and Stewart 1973).

Gizzards were sent to the National Wildlife Health Center in Madison, Wisconsin, where the contents were washed with water into a pan and rinsed to remove food items, which were not evaluated. The grit from each gizzard was washed through a series of five sieves (W. S. Tyler, Mentor, OH and Newark Wire Cloth Co., Newark, NJ) with mesh sizes of 0.30, 0.60, 1.18, 2.36, and 4.75 mm (American Society of Testing and Materials specification E11). Soil and particles of sand <0.30 mm were not used in the analysis. The grit collected in each sieve was transferred to a weighed crucible, dried for ≥14 h at 120°C, and the crucible was reweighed to the nearest 0.01 g. The longest dimension of the largest piece of grit from each gizzard was measured to the nearest 0.01 mm. We tested for statistical differences in the total mass of grit and the proportion of grit in the five size categories between genders of Tundra Swans and Sandhill Cranes, between the two subspecies of Sandhill Cranes, and between the two species of swans. Data from Sandhill Cranes were normally distributed and we used analysis of variance with interactions to compare the total mass of grit and the proportions (by mass) of grit particles in the various size categories. Because the swan data were not normally distributed, we used separate Wilcoxon 2-sample tests (Sokal and Rohlf 1995) to compare variables between male and female Tundra Swans, and between Tundra and Mute Swans.

RESULTS

We found grit in all of the gizzards. No gender-related differences were detected in the data for any of the three species, so the results for males and females were combined. On average, Mute Swans had a significantly ($P < 0.001$) greater mass of grit in their gizzards than Tundra Swans (mean ± SE = 31.4 ± 1.4 g and 7.5 ± 0.5 g, respectively). The Sandhill Cranes had an average (± SE) of 17.0 ± 0.4 g of grit in their gizzards, with the larger subspecies having a significantly ($P < 0.002$) greater mass of grit than the smaller one (22.8 ± 1.6 g vs. 16.6 ± 0.5 g). The relative proportions of grit in the various size categories were similar between the two subspecies of Sandhill Cranes and, of the five grit size categories, particles of 2.36-4.75 mm accounted for the majority of grit (by mass) in gizzards of Sandhill Cranes (Fig. 1). In both species of swans, particles with a minimum dimension between 0.6-1.18 mm accounted for the greatest mass of grit, but Mute Swans had greater proportions (by mass) of smaller grit than Tundra Swans (Fig. 1). The mean (± SE) of the greatest dimension of the largest grit particle in each bird was 9.4 ± 0.18 and 9.6 ± 0.64 mm for cranes and swans, respectively. The longest dimension of the largest single grit particle was 17.4 mm for cranes and 14.0 mm for swans. No lead fishing weights were recovered from any of the gizzards. Ingested shotgun pellets, including lead and nontoxic shot, were found in gizzards of 21 birds. The frequency of lead and nontoxic shot among species, and the concentrations of lead in tissues, will be reported elsewhere.

DISCUSSION

Although a precise comparison is impossible because different sieve sizes were used, the grit particles that we found in gizzards of Mute Swans from the Chesapeake Bay were

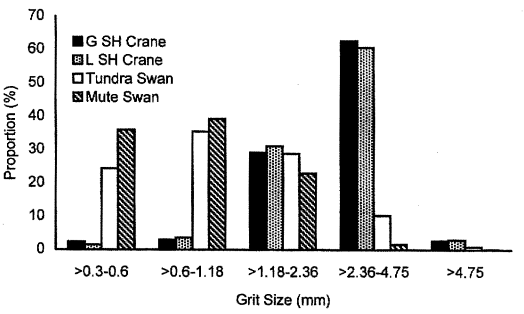

Figure 1. Proportion (by mass) of grit particles in gizzards of Greater Sandhill Cranes (*Grus canadensis tabida*, G SH Crane, N = 23), Lesser Sandhill Cranes (*Grus c. canadensis*, L SH Crane, N = 88), Tundra Swans (*Cygnus columbianus*, N = 43), and Mute Swans (*Cygnus olor*, N = 29). The proportions of grit particles in all size categories, except >4.75 mm, were significantly ($P < 0.03$) different for Mute and Tundra Swans, but there were no differences between the two subspecies of Sandhill Cranes.

similar in size to the grit reported from an earlier study of seven Mute Swans in England (Owen and Cadbury 1975). On average, 39% of the grit particles that we found in Mute Swans were 0.6-1.18 mm in minimum dimension and 23% were 1.18-2.36 mm, whereas the English study reported that 46% and 29.5% of the grit particles were 0.5-1.0 mm and 1.0-2.0 mm in diameter, respectively (percentages based on mass in both studies).

In a study of grit characteristics in 22 diverse species of birds, ranging in size from Barn Swallows (*Hirundo rustica*) to Ring-necked Pheasants (*Phasianus colchicus*), Best and Gionfriddo (1991) reported that, in general, grit size increased with species body mass. Of the three species of waterbirds that we studied, however, we found that the heaviest species (Mute Swan) had the greatest proportion (by mass) of small grit particles and the lightest species (Sandhill Crane) had the greatest proportion of large grit particles. Our finding of a greater total mass of grit in Mute vs. Tundra Swans agrees with a previous study reporting a positive relationship between grit mass and body mass among related species (Norman and Brown 1985).

The U.S. Environmental Protection Agency recently proposed a ban on lead sinkers and jig heads of ≤25.4 mm in any dimension, because large sinkers are generally not considered to be a problem in cases of lead poisoning in waterbirds (USEPA 1994). Our findings indicate that Tundra Swans, Mute Swans, and Sandhill Cranes are not likely to consume large (>25.4 mm) lead sinkers as grit, because more than 90% (by mass) of the grit particles that we found in gizzards of those species were less than 4.75 mm in size and the greatest dimension of the largest grit particles were less than 20 mm. However, our study did not address the possibility that large lead sinkers could be ingested by cranes as they probe for food items and by swans as they dig up sediments in search of submergent foods in areas with lost and discarded fishing tackle.

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LITERATURE CITED

Berger, A. J. 1961. Bird study. John Wiley & Sons. New York.

Best, L. B. and J. P. Gionfriddo. 1991. Characterization of grit use by cornfield birds. Wilson Bulletin 103: 68-82.

Franson, J. C., S. P. Hansen, M. A. Pokras and R. Miconi. 2001. Size characteristics of stones ingested by Common Loons. Condor. 103: 189-191.

Godin, A. J. 1967. Test of grit types in alleviating lead poisoning in Mallards. Special Scientific Report–Wildlife No. 107, U.S. Fish and Wildlife Service, Washington D.C.

Guthery, F. S. 1975. Food habits of Sandhill Cranes in southern Texas. Journal of Wildlife Management 39: 221-223.

Johnson, D. H. and R. E. Stewart. 1973. Racial composition of migrant populations of Sandhill Cranes in the northern plains states. Wilson Bulletin 85: 148-162.

Harper, J. A. 1964. Calcium in grit consumed by hen pheasants in east-central Illinois. Journal of Wildlife Management 28:264-270.

Kirby, J., S. Delany and J. Quinn. 1994. Mute Swans in Great Britain: a review, current status and long-term trends. Hydrobiologia 279/280: 467-482.

May, T. A. and C. E. Braun. 1973. Gizzard stones from adult White-tailed Ptarmigan (*Lagopus leucurus*) in Colorado. Arctic and Alpine Research 5: 49-57.

Norman, F. I. and R. S. Brown. 1985. Gizzard grit in some Australian waterfowl. Wildfowl 36: 77-80.

O'Halloran, J., A. A. Myers and P. F. Duggan. 1988. Lead poisoning in swans and sources of contamination in Ireland. Journal of Zoology, London 216: 211-223.

Owen, M. and C. J. Cadbury. 1975. The ecology and mortality of swans at the Ouse Washes, England. Wildfowl 26: 31-42.

Sanderson, G. C. and F. C. Bellrose. 1986. A review of the problem of lead poisoning in waterfowl. Special Publication 4, Illinois Natural History Survey, Champaign, IL.

Sokal, R. R. and F. J. Rohlf. 1995. Biometry: the principles and practice of statistics in biological research, 3rd ed. W. H. Freeman and Company, New York, NY.

Sparling, D. W., D. Day and P. Klein. 1999. Acute toxicity and sublethal effects of white phosphorus in Mute Swans, *Cygnus olor*. Archives of Environmental Contamination and Toxicology 36: 316-322.

Trost, R. E. 1981. Dynamics of grit selection and retention in captive Mallards. Journal of Wildlife Management 45: 64-73.

U.S. Environmental Protection Agency. 1994. Lead fishing sinkers: response to citizens' petition and proposed ban. Federal Register 59: 11122-11143.

U.S. Geological Survey. 1999. Prevalence and effects of lead poisoning resulting from ingestion of lead fishing sinkers and other fishing tackle on selected avian species. Final report, U.S. Fish and Wildlife Service, Division of Federal Aid, Project No. AP95-018.