

# Regulation and Grinding Ability of Grit in the Gizzard of Norwegian Willow Ptarmigan (*Lagopus Lagopus*)

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**ABSTRACT** Fluctuations in grit composition in the gizzards of willow ptarmigans and the grinding ability of various grit assortments from wild ptarmigans were examined. We confirmed reports of other investigators that larger, fewer and rounder stones were present in the winter than in the autumn. Experiments showed that ptarmigans prefer stones with diameters between 2-5 mm. Birds on a constant diet maintained a constant stone intake throughout the year. The composition of gizzard grit was influenced by the availability of stones as well as of the type of food the ptarmigans ate. Using an artificial gizzard, grit from birds shot during the autumn was found to be a more efficient grinding material than grit from winter birds. We suggest that other functions than grinding, such as supplying minerals, may be equally important functions of the grit.

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## INTRODUCTION

SEVERAL investigators have noted a seasonal fluctuation in quantity, size and angularity of gizzard stones (grit) in Norwegian willow ptarmigans *Lagopus lagopus* (Olstad and Lid, 1923, Kolderup, 1924, Myrberget *et al.*, 1975). Briefly, there are larger, fewer and rounder stones in the winter than in the autumn. It is generally assumed that the grit is important in grinding food and Siivonen (1962) states that lack of grit may be a severe mortality factor in wild ptarmigans during winters with heavy snow. We have investigated the regulation of the grit content and its grinding function.

Specifically, we have raised the following questions: 1) Is the variation in grit content truly seasonal like the change in plumage colour, or is it more connected to availability of grit? 2) Does the ptarmigan regulate the amount and composition of stone intake and excretion according to diet? 3) How efficient are different grit assortments in grinding different types of natural food? These problems have been investigated partly by exami-

nation of grit from wild birds and partly by experimental work on captive ptarmigans.

## MATERIAL AND METHODS

**Grit composition.** Gizzards were collected from:

- 1) Wild ptarmigans shot during the autumn and winter in Troms county, Norway.
- 2) Captive ptarmigans killed during autumn and winter while on a diet of:
  - A) Pellets, grit and water *ad lib.* or,
  - B) Simulated winter diet consisting of twigs and buds of willow (*Salix spp.*) and birch (*Betula spp.*) with water and grit *ad lib.*

The number of birds in each group is shown in Table 2.

The gizzards were opened and the contents mixed with water where the grit sank while the rest of the gizzard material floated off the top. The stones were dried and sized, using standard sieves with hole diameters of 4 mm., 3 mm., 2 mm. and 1 mm. The number of stones in each class was counted.

**Regulation of Grit.** Experiments were carried out to see if stone intake and excretion were correlated with 1) the amount of grit

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TABLE 1.—*Ptarmigans' diet during grit regulation trials*

Day	Up to day 0	1-8	9-12	13-16	17-22	23-28	29-34
Diet	Birch, willow, pellets	pellets	willow	birch	pellets	willow	birch

TABLE 2.—*Average number and size of gizzard stones in wild ptarmigans during different snow conditions and in captive ptarmigans. n = number of birds*

Time of year	Snow cond. food	n	Avg. # of stones	<2 mm. (%)	2-3 mm. (%)	3-4 mm. (%)	>4 mm. (%)
<i>Wild ptarmigans</i>							
Sept. Oct. Dec. 1972	No snow	18	134	30	64	35	5
	Natural			(22)	(48)	(26)	(4)
Jan. Feb. Mar. 1973	Snow	25	26	0	3	13	10
	Nat.			(0)	(12)	(50)	(38)
Sept. 1973	No snow	40	195	83	82	26	4
	Nat.			(43)	(42)	(13)	(2)
Dec. 1973	Snow	4	23	2	2	14	5
Feb. 1974	Nat.			(9)	(9)	(61)	(22)
Mar. 1974	No snow	3	48	0	2	17	29
	Nat.			(0)	(4)	(35)	(61)
April 1974	Snow	3	21	0	0	12	9
	Nat.			(0)	0	(57)	(43)
<i>Captive ptarmigans</i>							
Dec. 1973	Pellets	3	266	147	87	24	7
				(55)	(33)	(9)	(3)
Dec. 1973	Birch willow	4	46	6	8	19	13
				(13)	(17)	(41)	(29)

present in the gizzards and 2) the diet. Four captive ptarmigans, weighing from 490 g. to 585 g., were used in this experiment. Prior to the experiment, they had been kept on a diet consisting of large amounts of birch, some willow, some pellet feed, snow and grit *ad lib*.

At the beginning of the experiment the grit content was increased in two of the birds (#1951, ♂, and #1688, ♂). They were force-fed 185 (3.8 gms.) and 129 (3.0 gms.) stones, respectively, which had been collected from the gizzard of wild birds shot in late autumn. The other two birds (#1748, ♂ and #1686, ♀) were not force-fed and served as controls. The pairs were placed in separate outdoor cages. Ample grit of known weight and size, ranging from 2 mm. to greater than 5 mm. in diameter, was available to both pairs. The grit containers were constructed to minimize scattering.

The experiment lasted for 34 days and the diet was changed every 3 to 8 days as shown

in Table 1. During each willow and birch period small amounts of pellet feed were available to the birds to help keep their weights constant.

At the outset of the experiment and at each change of diet, the stones offered the birds were weighed and sized, and the weight and size composition of stones consumed per day were calculated. All the feces were collected, and the stones separated as described previously. The grit was then dried, sized and weighed. The weight and size composition of grit consumed and excreted per bird per day was calculated for the different diet periods.

*Grinding Ability of Grit in an Artificial Gizzard.* An artificial gizzard (Fig. 1) was constructed to study grinding ability of typical grit assortments. The gizzard sac was made from the thumb of a rubber glove, closed by tape and placed in a spherical depression. A top plate, with a 500 gram weight, rested