

THE USE OF GRIT IN PIPITS, ESPECIALLY THE AMERICAN PIPIT

N. A. M. VERBEEK

*Department of Biological Sciences
Simon Fraser University*

Burnaby, British Columbia V5A 1S6 Canada

Abstract.—It appears that both adult and nestling pipits (*Anthus* spp.) use grit for the mechanical breakdown of seeds and insects. Pipits in temperate regions have larger amounts of seed in their diets during fall and winter than during the summer, and apparently take more grit then than during the summer to help grind the seeds. Grit is also used for its mineral content, which is needed for growth and maintenance of both young and adults. Larger quantities of grit in nestlings than in adults during the summer, when the diet consists of insects, suggests that the mineral content is particularly important for nestling development. Grit may also be used for egg shell formation, but there was no significant difference in the mean quantity of grit per gizzard in both sexes of the American Pipit (*Anthus rubescens*). The possibility that females take grit particularly rich in calcium during egg laying could not be ascertained. Pipits thus take grit for different reasons throughout the year, and they may take it in different quantities depending on why it is needed at any one time.

EL USO DE ARENAS EN EL GÉNERO *ANTHUS* ESPECIALMENTE EN *ANTHUS RUBESCENS*

Sinopsis.—Aparentemente tanto adultos como polluelos del género *Anthus* usan arenas para romper mecánicamente semillas e insectos. En regiones templadas, este género tienen mayores cantidades de semillas en su dieta durante el otoño e invierno que en el verano, y aparentemente toman más arenas que durante el verano para poder moler las semillas. Las arenas también se usan por su contenido mineral, e cual es necesario para el crecimiento y mantenimiento de jóvenes y adultos. Las cantidades de arenas en los polluelos son mayores que en los adultos durante el verano, cuando la dieta es principalmente de insectos, lo cual sugiere que el contenido mineral es particularmente importante para el desarrollo de los polluelos. Las arenas pueden ser usadas para la formación del cascarón del huevo, pero no se hallaron diferencias significativas en la cantidad promedio de arenas por molleja en ambos sexos de *Anthus rubescens*. La posibilidad de que hembras tomen arenas particularmente ricas en calcio mientras están poniendo no se pudo clarificar. El género *Anthus* toman arenas por diferentes razones a través del año, y puede que las tomen en diferentes cantidades dependiendo de para qué se necesitan en ese momento.

Meinertzhagen (in Campbell and Lack 1985: p. 256) states that grit consists of "particles of stone of varying coarseness taken by birds that eat vegetable matter, to grind their food to pulp through the action of the powerful stomach muscles." This limited view of the role of grit was also stressed by Jenkinson and Mengel (1970), Royama (1970) and Ziswiler and Farner (1972). Grit of the right kind also contributes calcium needed for egg shell formation in many birds (Betts 1955, Dalke 1938, Verbeek 1971). In addition, many birds feed grit to their young (Alonso 1985, Barrentine 1980, Betts 1955, Hagvar and Ostbye 1976, St. Louis and Breebaart 1991, Verbeek 1967), presumably to aid in the mechanical breakdown of food and as a source of minerals for skeleton formation and other physiological needs.

Walton (1984) showed that 67% of 237 adult and 21% of 66 juvenile

TABLE 1. The mean mass (mg) of grit/gizzard and the number of gizzards with grit in adult and nestling (4–14 d old) American Pipits.

	Adults				Nestlings
	June	July	August	September	July
Mean mass of grit/gizzard (SE)	6.7 (1.5)	8.5 (4.4)	14.0 (2.2)	32.5 (14.3)	141.4 (25.6)
Number of gizzards with grit	9	10	28	4	24
Number of gizzards examined	12	17	29	4	25

(hatched in the current year) Meadow Pipit (*Anthus pratensis*) gizzards, obtained from March to October, contained no grit. He wondered why so many individuals did not contain grit if it is so important for the mechanical breakdown of food. He speculated that it is primarily ingested for the trace elements it contains. Walton's (1984) report prompted me to re-examine my own data (Verbeek 1970) pertaining to grit in *Anthus rubescens* and to review the literature on the presence of grit and its possible function(s) in the genus *Anthus*.

METHODS

The American Pipit nests in short vegetation in alpine and arctic tundra. The pipits examined in this study were obtained on the Beartooth Plateau, Wyoming, at a mean elevation of 3200 m, from June to early September 1963 and 1964. The soils of the area consist of granitic gneiss and schist and non-calcareous argillitic rock (Nimlos and McConnell 1962). The gizzards of 62 adult and 25 nestling (4–14 d old) American Pipits, stored in 70% alcohol, were examined under a compound microscope. The grit and food remains in each gizzard were carefully separated from each other, and the grit was then oven-dried before it was weighed.

RESULTS

This Study

Adults.—The percentage of adult American Pipits that contained grit was significantly lower in June and July (prior to and during egg laying) combined than in August and September combined (Table 1, $\chi^2 = 10.67$, $df = 1$, $P < 0.005$). In the total sample of adults, 51 (82.3%) gizzards contained grit. The smallest amount of grit per gizzard was found in June, the highest in September, and the mean for all adults was 12.3 mg (SE = 2.0, $n = 62$, range 0–80). All but two adult gizzards also contained insects, and in two of 29 (6.9%) adults in August (24 and 27 August) and two of four (50.0%) adults in early September I found seeds.

Among the 62 adult American Pipits (25 females, 36 males and one unsexed bird), seven (28%) females and four (11%) males contained no grit. The proportions of females and males with and without grit did not differ significantly ($\chi^2 = 2.86$, $df = 1$, $P > 0.05$). If I considered only the 14 females and 14 males obtained in June and July, when egg laying

occurred (Verbeek 1970), the proportions with or without grit still were not significantly different ($\chi^2 = 1.47$, $df = 1$, $P > 0.05$). Considering only birds with grit, the mean mass of grit per gizzard in males (16.6 mg, SE = 3.5, $n = 32$, range 5.0–80.0) was not significantly different (approximate t -test, $P > 0.05$) from that in females (11.1 mg, SE = 1.8, $n = 18$, range 5.0–30.0).

Nestlings.—The 25 American Pipit nestlings contained significantly ($P < 0.001$) more grit per gizzard than did adults (Table 1). Considering only gizzards that contained grit, the average amount per gizzard was 147.5 mg (SE = 26.0, $n = 24$, range 5–470).

Other Studies

Adults.—Garrick (1981) found grit in most (number not given) of 57 Richard's Pipits (*A. novaeseelandiae*) obtained in New Zealand in all months except January and July. Borrett and Wilson (1970) reported grit in 11 of 51 Richard's Pipits and in 10 of 67 Buffy Pipits (*A. vaalensis*) collected in Zimbabwe in spring and summer. Lebeurier and Rapine (1935) found grit (not quantified) in Meadow Pipits in Brittany, France, throughout the year and its occurrence and abundance were strongly correlated with the presence of vegetable matter in the diet. Seeds of *Poa annua*, *Carex*, *Polygonum*, *Radiola linoides*, *Raphanus*, *Atriplex hastata* and wheat (not specified) were present in the diet from the fall until the end of April to May. In summer only a trace of seeds and grit occurred in some individuals. Similarly, Bent (1950), Knowlton (1944) and Martin et al. (1961) reported notable amounts of plant material in American Pipits only in fall and winter; up to 40% by volume in mid-winter (Martin et al. 1961). Smetana and Gusewa (1981) did not report grit in the gizzards of adult Tawny Pipits (*A. campestris*) collected in April ($n = 15$) and in August–September ($n = 28$).

Nestlings.—Nestling Meadow Pipits had more grit per gizzard than did adults (Hagvar and Ostbye 1976). Smetana and Gusewa (1981) found that nestling Tawny Pipits contained grit, egg shell and mollusks when 3–6 d old and that this material formed 6.1% of the diet when the nestlings were 7–11 d old. Tawny Pipit nestlings younger than 3 d contained no grit.

DISCUSSION

The increased presence of grit in adult American Pipits in late summer (Table 1) and in Meadow Pipits (Hagvar and Ostbye 1976, Lebeurier and Rapine 1935) in fall and winter coincides with the increased use of vegetation in the diet during that time of the year (Lebeurier and Rapine 1935, Martin et al. 1961). In Walton's (1984) study as well, the largest mean number of pieces of grit per gizzard was found in September (gizzards of adult birds beyond September were not available). The increased use of grit when seeds are part of the diet supports the notion that pipits consume grit to aid in the mechanical breakdown of those seeds. Bearded Tits (*Panurus biarmicus*) also take more grit in fall and winter, when seeds

are an important part of the diet, than in summer, when they eat mainly insects (Spitzer 1972). Spanish Sparrows (*Passer hispaniolensis*) take more and smaller grit particles in winter and spring, when they eat mostly small seeds, whereas in summer, when they eat insects and large seeds, they take fewer but larger grit particles (Alonso 1985).

The above contradicts Walton's (1984) conclusion that grit is clearly not needed by pipits to aid the mechanical breakdown of food. Instead, he suggested grit was taken for its calcium and trace element content. The need for calcium does lead to an increased intake of calcium-rich grit by female birds (MacLean 1974, Repasky et al. 1991), and perhaps by pipits as well. In my study, however, an equal proportion of females and males contained grit and the mean quantity of grit per gizzard did not differ significantly between the sexes. This suggests that, at least in the American Pipit on the Beartooth Plateau, reproductive females do not depend on grit as a source of calcium for egg production, unless the sexes collected different kinds of grit, that of females containing more calcium than that of males. As the grit was not analyzed for its chemical composition I can shed no further light on this possibility. That both sexes obtain trace elements other than calcium from grit need not be questioned.

Nestling American Pipits contained significantly more grit than adults (Table 1), as was the case in nestling Meadow Pipits (Hagvar and Ostbye 1976) and Tawny Pipits (Smetana and Gusewa 1981). Larger amounts of grit in pipit nestlings than in adults, even though both age classes feed exclusively on insects during the nestling period, and the occurrence of rodent teeth (Verbeek 1970), bone fragments (Hagvar and Ostbye 1976) and mollusk shells (Smetana and Gusewa 1981) all suggest that these materials are fed to nestlings mainly as a source of calcium and other trace elements for bone growth and other body needs. I did not find rodent teeth, bone fragments and mollusk shells in adult American Pipits.

The occurrence of grit in adult Meadow Pipits is lower in summer than in winter (Lebeurier and Rapine 1935) and some (Hagvar and Ostbye 1976, Verbeek 1970) to many (Walton 1984) adults in summer may not contain grit at all. Grit is generally associated with seed-eating birds (Terres 1980). The discovery that grit is taken by many caprimulgids (Jenkinson and Mengel 1970) and by hirundinids (Barrentine 1980, Brown 1976), birds that feed almost exclusively on insects, suggests that it may also be used by adults and nestlings for the mechanical breakdown of hard parts of insects. This has been noted for Meadow Pipits (Hagvar and Ostbye 1976) as well as for other species (Barrentine 1980, Brown 1976, Jenkinson and Mengel 1970, Royama 1970).

I have tried to make the point in this paper that grit consumed by a bird can have a number of functions, and that these may vary throughout the year. That some individuals contain more grit than others, or no grit at all (a temporary event?), may depend on an individual's food preference (some foods may require less grit than others), age (adults vs. nestlings), the type of grit available (some types are harder than others, there-

fore probably last longer and thus may accumulate in the gizzard), the time of year, the time of day (Alonso 1985), a bird's gastric motility, which affects the rate at which grit will clear the digestive tract, the choice of diet in terms of its chemical content (e.g., calcium), as well as on the mineral richness of the habitat and the kinds of food eaten.

ACKNOWLEDGMENTS

I thank A. Ohanjanian for the partial translation of a paper in Russian, and C. Barrentine, D. Klem, Jr. and an anonymous reviewer for several very helpful suggestions.

LITERATURE CITED

- ALONSO, J. C. 1985. Grit in the gizzard of Spanish Sparrows (*Passer hispaniolensis*). Vogelwarte 33:135-143.
- BARRENTINE, C. D. 1980. The ingestion of grit by nestling Barn Swallows. J. Field Ornithol. 51:368-371.
- BENT, A. C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. U.S. Natl. Mus. Bull. 197.
- BETTS, M. M. 1955. The food of titmice in oak woodlands. J. Anim. Ecol. 24:282-323.
- BORRETT, R. P., AND K. J. WILSON. 1970. Comparative feeding ecology of *Anthus novaeseelandiae* and *Anthus vaalensis* in Rhodesia. Ostrich, Supplement 8:333-341.
- BROWN, C. R. 1976. The use of gravel by Purple Martins. Auk 93:842.
- CAMPBELL, B., AND E. LACK. 1985. A dictionary of birds. T & AD Poyser, Calton, Staffordshire, England. 670 pp.
- DALKE, P. D. 1938. Amount of grit taken by pheasants in southern Michigan. J. Wildl. Manage. 2:53-54.
- GARRICK, A. S. 1981. Diets of pipits and skylarks at Huiarua Station, Tokomaru Bay, North Island, New Zealand. New Zealand J. Ecol. 4:106-114.
- HAGVAR, S., AND E. OSTBYE. 1976. Food habits of the meadow-pipit, *Anthus pratensis* (L.), in alpine habitats at Hardangervidda, south Norway. Norwegian J. Zool. 24:53-64.
- JENKINSON, M. A., AND R. M. MENGEL. 1970. Ingestion of stones by goatsuckers (Caprimulgidae). Condor 72:236-237.
- KNOWLTON, G. F. 1944. Pipits eat injurious insects. Auk 61:137-138.
- LEBEURIER, E., AND J. RAPINE. 1935. Ornithologie de la Basse-Bretagne. Le pipit des prés. Oiseau 5:462-480.
- MACLEAN, S. F. 1974. Lemming bones as a source of calcium for arctic sandpipers (*Calidris* spp.). Ibis 116:552-557.
- MARTIN, A. C., H. S. ZIM, AND A. L. NELSON. 1961. American wildlife and plants. Dover, New York, New York. 500 pp.
- NIMLOS, T. J., AND R. C. MCCONNELL. 1962. The morphology of alpine soils in Montana. Northwest Sci. 36:99-112.
- REPASKY, R. R., R. J. BLUE, AND P. D. DOERR. 1991. Laying Red-cockaded Woodpeckers cache bone fragments. Condor 93:458-461.
- ROYAMA, T. 1970. Factors governing the hunting behaviour and selection of food by the great tit (*Parus major* L.). J. Anim. Ecol. 39:619-668.
- SMETANA, N. M., AND W. S. GUSEWA. 1981. Food habits of the Tawny Pipit in the Naursum pine-forest. Ornithologija 16:88-92.
- SPITZER, G. 1972. Jahreszeitliche Aspekte der Biologie der Bartmeise (*Panurus biarmicus*). J. Ornithol. 113:241-275.
- ST. LOUIS, V. L., AND L. BREEBAART. 1991. Calcium supplements in the diet of nestling Tree Swallows near acid sensitive lakes. Condor 93:286-294.
- TERRIS, J. K. 1980. The Audubon Society encyclopedia of North American birds. Knopf, New York, New York. 1109 pp.
- VERBEEK, N. A. M. 1967. Breeding ecology of the Horned Lark in alpine tundra. Wilson Bull. 79:208-218.

- . 1970. Breeding ecology of the Water Pipit. *Auk* 87:425–451.
- . 1971. Hummingbirds feeding on sand. *Condor* 73:112–113.
- WALTON, K. C. 1984. Stomach stones in Meadow Pipits *Anthus pratensis*. *Bird Study* 31: 39–42.
- ZISWILER, V., AND D. S. FARNER. 1972. Digestion and the digestive system. Pp. 343–430, in D. S. Farner, J. R. King, and K. C. Parkes, eds. *Avian Biology*, Vol. 2. Academic Press, New York, New York.

Received 13 Sep. 1993; accepted 20 Dec. 1993.

CONFERENCE VII OF THE HAWK MIGRATION ASSOCIATION OF NORTH AMERICA

The Hawk Migration Association of North America will hold its 7th conference at the Ramada Inn in Windsor, Ontario, Canada on 4–7 May 1995. The theme of the 1995 conference is "Wings Across the Borders." Keynote speakers will be David Bird and Peter Sherrington. Session topics include: education, habitat and food; raptor identification; weather and migration; technology and hawk watching; Great Lakes and Canadian hawk sites; management and growth of North American hawk sites; and population endangerment. Papers or proposals for 35-min presentations or posters on the conference theme and session topics are invited. Send a 250-word abstract or summary for review and inclusion in the conference booklet by 31 Dec. 1994 to:

Robert C. Petit
HMANA Conference Chairperson
Monroe County Community College
1555 South Raisinville Road
Monroe, Michigan 48161
Phone: 313-242-7300
FAX: 313-242-9711