FASA RA(ID)-1-67

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By Donald F. Mott, Richard R. West, John W. De Grazio and Joseph L. Guarino

Made in United States of America
Reprinted from The Journal of Wildlife Management
Vol. 36, No. 3, July 1972
pp. 983–987

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DONALD F. MOTT, Bureau of Sport Fisheries and Wildlife, Wildlife Research Center, Denver, Colorado
RICHARD R. WEST, Bureau of Sport Fisheries and Wildlife, Wildlife Research Center, Denver, Colorado
JOHN W. DE GRAZIO, Bureau of Sport Fisheries and Wildlife, Wildlife Research Center, Denver, Colorado
JOSEPH L. GUARINO, Bureau of Sport Fisheries and Wildlife, Wildlife Research Center, Denver, Colorado

Abstract: An analysis of the gizzard contents of 702 red-winged blackbirds (*Agelaius phoeniceus*) collected from 1959 through 1965 during the spring, summer, and early fall in northeastern South Dakota showed that a weed seed, bristle grass (*Setaria* spp.), occurred most frequently (68 percent of the gizzards) and in the largest quantity (23 percent of the volume). Corn (*Zea mays*) was eaten more frequently (30 percent) and in larger amounts (11 percent) than all other cultivated grains. Oats (*Avena sativa*), wheat (*Triticum aestivum*), and millet (*Panicum miliaceum*) made up most of the remaining plant food consumed. Animal matter, mostly beetles (Coleoptera), contributed 25 percent of the total volume eaten, with the greatest incidence and volume (56 and 45 percent) being recorded during the nesting period. Grit accounted for 14 percent of the volume eaten.

Because of their wide distribution, large numbers, reported beneficial feeding habits, and documented damage to crops (primarily corn), red-winged blackbirds have been the subject of numerous food habits studies. Beal (1900:43–44) was the first to present data from a large sample of redwing gizzards and judged the redwing "most decidedly a useful bird." He felt that the destruction of noxious insects and weed seeds by this species far outweighed the damage it did to grain crops. Although he admitted that grain damage was often serious, he indicated that it oc-

curred when fields of grain replaced the native grasses and weeds of the prairies. Several recent studies (Meanley 1961, Bird and Smith 1964, Hintz and Dyer 1970) also suggested that the type of food eaten by redwings is related to availability.

We thank Ann H. Jones for editorial assistance; J. L. Olšemeyer and C. P. Stone for statistical assistance; and L. J. Schoonover of the Sand Lake Refuge staff and staff members of the Section of Birds of the Denver Wildlife Research Center for assistance in collecting blackbirds.

STUDY AREA

All redwings were collected within a 94-section area surrounding the Sand Lake National Wildlife Refuge, Brown County, South Dakota. This refuge, situated in the flat James River Valley, for many years has provided spring nest habitat and also roost habitat for blackbirds during late summer and early fall. Two impoundments on the refuge create water and marsh areas. Open water covers about 8,000 acres, and the bordering marsh covers 4,000 acres. Marsh vegetation, consisting primarily of cat tail (*Typha latifolia*) and reeds (*Phragmites* spp.) provides nest and roost habitat for the blackbirds.

Approximately 70 percent of the land is cultivated, and the remainder is mainly in pasture and hay. More than 20 percent of the total cropland is planted to corn, the major crop in the study area (South Dakota Crop and Livestock Reporting Serv. 1959). Other grains include oats, wheat, millet, barley (*Hordeum vulgare*), and rye (*Secale cereale*). Strip cropping is used extensively as a soil conservation measure, and numerous shelterbelts have been planted to control wind erosion. Weeds, primarily bristle grass, are common in fields and along roadside ditches.

METHODS

In conjunction with investigations designed to reduce blackbird damage to ripening corn, 702 red-winged blackbirds were collected throughout the daylight hours, from April through September. Spring migrants first appear at Sand Lake in mid-March, and the last birds, dependent on weather conditions, migrate south by mid-November. Beginning in 1959, 7, 38, 62, 48, 163, 189, and 195 redwings were collected yearly. There were 504 males, 186 females, and 12 birds of unknown sex in this collection. Shortly after the birds were shot, the gizzards were removed and were either preserved in a 5 percent formalin solution or frozen.

Each sample was labeled with the date, time, age, sex, and habitat. When examined, the gizzard contents were washed, dried, and viewed under a wide-field binocular microscope. Each food item was separated and its percentage of the total volume was visually estimated. Seed and insect collections at the Denver Wildlife Research Center were used as a reference to identify food items. For 102 gizzards collected during 1965, dry weights and volume measurements were also recorded.

Statistical comparisons of consumption among different classes of birds were made by analysis of variance on arcsin-transformed data for percentage volume of gizzard contents.

RESULTS AND DISCUSSION

The redwing gizzards contained small amounts of food. For the 102 gizzard contents collected during 1965, the average dry weight was only 0.29 gram (range, 0.02 to 0.86 gram). The average dry weights of gizzard items were: vegetable 0.15, animal 0.07, and grit 0.11 gram. The average

Table 1. Percentage of total volume and percentage frequency of occurrence of food items in gizzards of red-winged blackbirds collected in Brown County, South Dakota, 1959–65.

	Time Period (number of gizzards)											
	April 6–May 15 (65)		May 16–June 30 (206)		July 1–Aug. 15 (233)		Aug. 16–Sept. 15 (155)		Sept. 16–Sept. 25 (41)		Total (702)	
Food Item	Volume	Occurrence	Volume	Occurrence	Volume	Occurrence	Volume	Occurrence	Volume	Occurrence	Volume	Occurrence
VEGETABLE												
Corn	8	31	9	21	3	10	24	56	27	83	11	30
Oats	3	17	8	29	20	44	5	14	<1	5	10	28
Wheat	8	42	6	16	12	24	9	12	0	0	7	19
Millet	7	17	2	8	<1	3	2	10	16	20	3	9
Incidental grains	2	15	3	11	1	3	2	6	2	7	2	7
Bristle grass seeds	31	91	10	50	17	55	41	54	37	90	23	68
Buckwheat seeds (*Polygonum* spp.)	3	48	1	19	2	33	3	36	<1	20	2	30
Ragweed seeds (*Ambrosia* spp.)	3	29	<1	10	<1	1	2	19	5	46	1	13
Sunflower seeds (*Helianthus* spp.)	<1	17	<1	3	<1	1	<1	4	5	34	<1	6
Needlegrass seeds (*Stipa* spp.)	<1	2	<1	1	2	9	<1	4	0	0	<1	4
INCIDENTAL AND UNIDENTIFIED SEEDS	<1	12	<1	6	<1	10	<1	11	<1	7	<1	9
Total	66	100	41	84	58	94	82	100	94	100	61	93
ANIMAL												
Beetles (Coleoptera)	13	75	29	92	19	88	4	51	1	15	17	76
Flies (Diptera)	0	0	6	16	1	5	<1	2	0	2	2	7
Grasshoppers (Orthoptera)	0	0	<1	3	3	8	<1	2	<1	2	1	4
Ants, wasps, and bees (Hymenoptera)	<1	3	<1	3	<1	4	<1	5	<1	2	<1	4
Butterfly and moth larvae (Lepidoptera)	2	8	5	15	1	3	0	0	0	0	2	6
Incidental and unidentified insects	<1	2	3	13	2	13	<1	7	0	0	2	10
Spiders and mites (Arachnida)	<1	5	<1	7	<1	<1	<1	1	0	0	<1	3
Snails (Gastropoda)	0	0	<1	12	<1	7	<1	2	0	0	<1	6
Total	15	83	45	96	26	91	5	57	1	22	25	80
Corn	18	69	14	65	16	82	13	78	5	49	14	73

volume of these gizzard contents measured 0.27 cc.

The estimated volume percentage and frequency of occurrence of the various food items are summarized in Table 1 according to five periods of time: April 4–May 15, May 16–June 30 (nesting), July 1–August 15, August 16–September 15 (peak damage to corn), and September 16–25.

Vegetable Matter

From April through September, redwing gizzards contained an average of 61 percent vegetable matter. The highest amount (94 percent) was found during late September.

Bristle grass was found most often and in the largest quantity. It comprised 23 percent of all gizzard contents and was noted in 65 percent of all gizzards. Highest amounts were recorded in the spring when gleanings of the previous year were taken, and also in late summer and early fall when the current seed crop was mature and abundant.

Cultivated oats, the principal plant food taken during July 1–August 15, were found in 44 percent of the gizzards and made up 20 percent of all gizzard contents. Feeding on oats coincided with the maturing of the crop, which was harvested from the third week in July through the second week in August. Wheat and oats were also suggested as the preferred plant food during a comparable time in Ontario (Hintz and Dyer 1970).

Corn was eaten more frequently and in larger quantity than all other cultivated grains. During the peak period of bird damage to corn (August 16–September 15), 25 percent of all foods taken was corn (grit excluded). The impact of this feeding on corn could be seen in the annual losses of more than 30,000 bushels of corn to blackbirds in the 94-section study area at Sand Lake (De Grazio 1964). In Ontario, during a comparable time interval, 51 percent of the redwing diet, excluding grit, was corn (Hintz and Dyer 1970). The high consumption of corn in Ontario can possibly be attributed to intensive farming practices and to a consequent reduction in alternative foods, primarily weed seeds. At Sand Lake, bristle grass was found in 94 percent of all gizzards and made up 41 percent of all gizzard contents during the period of damage to corn. The availability of this weed seed undoubtedly reduced feeding on corn.

The indicated increase in consumption of corn during the last half of September (after the peak period of damage) was probably because mature corn was more easily detected in the gizzard. Water, milk, and dough stages of the corn could not be identified in the gizzard unless the bird had ingested some of the seed coat. Dented corn can be identified by the texture of the endosperm as well as from the seed coat. Thus, the true consumption of corn during the peak damage period (August 16–September 15) might have been higher than was indicated.

To delineate any disproportionate feeding on corn by sex- or age-classes of redwings, 137 birds from all habitat types, excluding cornfields, were compared for differences in the volume of corn consumed. We noted a significant difference ($P < 0.01$) between males and females in the volume of corn consumed during August 16–September 15. Male gizzards contained 29 percent corn, whereas female gizzards held 9 percent. There was no difference in the amount of corn consumed among the different age-classes of each sex.

Besides corn, oats, wheat, and bristle grass, no other vegetable food item accounted for more than 3 percent of the total volume consumed. All lesser vegetable foods combined made up only 9 percent of the volume of all gizzard contents.

Animal Matter

Beetles were found most often and were highest in volume of all animal matter recorded. They constituted 17 percent of all gizzard contents; all other animal matter made up only 5 percent. From May 16 to June 30, animal matter was found in 96 percent of the gizzards and accounted for 45 percent of all gizzard contents. This high incidence of animal matter in the diet is in contrast to the 15 percent of animal matter consumed during April 4–May 15 and only 1 percent present in late September. Hintz and Dyer (1970) suggested that this increase in animal matter during the breeding season might be a result of a greater availability of insects in the breeding areas or that breeding activity required a higher protein diet.

In order to show any unequal feeding on animal matter between sexes, we analyzed the gizzard contents of 64 adult males and females collected after noon in marsh habitat from May 16 to June 30. There was no significant difference ($P > 0.50$) between the sexes in the volume of animal matter consumed. Females averaged 59 percent animal matter and males, 57 percent during this period.

Grit

Mineral grit occurred in 74 percent of all gizzards and accounted for 14 percent of the total volume. The amount of grit was greatest during the period of April 4–May 15 and lowest in late September when 94 percent of all gizzard contents was vegetable matter. Bent and Smith (1964) found that grit was highest when vegetable food was highest. Grit was absent when the diet was solely insects. During the nesting season, when consumption of animal matter was high, we did not record any dramatic reduction in intake of grit. We found, however, that gizzards with 100 percent animal food contained significantly less grit by volume ($P < 0.1$) than those with 100 percent vegetable food.

In some instances, in addition to mineral grit, hard parts of insects, especially jaws of beetles, and hard seeds such as ragweed (*Ambrosia*), probably functioned as grit. Some snail fragments may have been picked up to serve as grit.

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Received for publication December 30, 1971.