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FOODS OF BREEDING TRICOLORED BLACKBIRDS IN AGRICULTURAL AREAS OF MERCED COUNTY, CALIFORNIA

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The Tricolored Blackbird (*Agelaius tricolor*), a species largely endemic to California (Neff 1937), breeds colonially with as many as 20,000 nests (about 30,000 adult birds) in an area of 4 ha or less (DeHaven et al. 1975). During a recent (1968–1972) range-wide survey (excluding Baja California), 78% of the 168 colonies located by DeHaven et al. (1975) were in the highly agricultural Central Valley of California. Because the blackbirds breed primarily in areas where rice and other crops are grown (Orians 1961), they could have a significant economic impact on agriculture, especially in the vicinity of the colonies.

Foods eaten by Tricolored Blackbirds received little quantitative study until recently (see Crase and DeHaven 1975, 1977). Although dietary data have been gathered for blackbirds breeding in the California foothills (Payne 1965, Collier 1968) and in the rice-growing regions of the Sacramento Valley (Crase and DeHaven 1978), little is known about the food habits of blackbirds in the San Joaquin Valley, where flocks often forage in irrigated fields of alfalfa and small grains.

We studied the food habits of Tricolored Blackbirds in Merced County, a well established breeding area in the northern San Joaquin Valley (DeHaven et al. 1975), during the 1978 nesting season. We present here our findings and compare them with those reported for other breeding habitats.

STUDY AREA AND METHODS

We collected 27 adult males, 107 adult females, 16 fledglings, and 79 nestlings from nine locations in Merced County between 26 April and 7 June 1978. The principal crops grown in these collection areas were hay and small grains; the areas were interspersed with marshland.

We shot at random an average of 18 adult birds per week for four weeks as they were returning to one of three colonies located within 7 km of Gustine or to a colony 3 km north of Snelling. Sixty-three adults were shot as they fed in fields of oats (20) or alfalfa (43) within 7 km of Gustine. We collected an average of 13 nestlings (age 3–11 days) per week for six weeks. One nestling was selected from each randomly chosen nest located in the three Gustine colonies. The 16 fledglings (age 12–16 days) were shot during one day at one of the Gustine colonies. Since the fledglings were collected at an age when they, like the nestlings, were still totally dependent on the adults for food, and, since the gizzard contents of the two age-classes were similar (97% animal matter for fledglings vs. 90% for nestlings), we combined them for our analysis.

The esophagus and proventriculus (= gullet) and the gizzard were promptly removed from each bird and immersed in 50% isopropyl alcohol for later examination. In the laboratory, constituent food taxa in each gullet and gizzard were segregated, briefly blotted, and air-dried to remove surface moisture. The proportion of the total volume for each taxon was then visually estimated using a 2.0-ml syringe graduated in 0.1-ml intervals, and the total volume was determined by water displacement (Crase and DeHaven 1977). Data were pooled for all specimens by age and sex category to obtain aggregate percentages of total volume for each food taxon (Martin et al. 1946). Food items were identified with the aid of a binocular microscope, reference collections, appropriate keys, and taxonomic specialists.

Although the many variables related to the collections may have biased our results somewhat (Medin 1970), we believe that the data show the general diet of the Tricolored Blackbirds that were breeding in the study area.

RESULTS

We identified 10 insect orders (20 families), 3 other animal taxa, and 9 plant genera from the collected blackbirds (Table 1). The most often consumed (percentage incidence) animal foods were: beetles and weevils (order Coleoptera), cutworms and loopers (order Lepidoptera), and various flies (order Diptera). Animal matter made up 91% of the food volume from nestlings and fledglings, 56% of the adult female food volume, and 28% of the adult male food volume. These differences reflect the nutritive requirement of developing birds for a rich protein diet to support their rapid growth. Although plant matter made up only 7% of the food volume collected from nestlings and fledglings, 42% of the adult female food volume and 69% of the adult male food volume was plant matter. The plant foods used most often were: oats (*Avena*), chickweed (*Stellaria*), filaree (*Erodium*), and pigweed (*Amaranthus*).

Of the 20 insect families identified, 7 were classified as primarily injurious to agricultural crops, 1 as beneficial, and the remaining 12 as either neutral or too variable in their food habits to be classified (Essig 1915). The composite ratio of injurious to beneficial insects consumed (by volume) was 16:1 in our sample. Weevils (*Hypera* spp.), variegated cutworms (*Peridroma saucia*), and alfalfa loopers (*Autographa californica*) were agricultural pests that were identified as major food items.

Snail and clam (Mollusca) shells were found in more nestlings/fledglings (75%) than in either adult males (4%) or females (16%). However, we could not tell if the shells were being given to the nestlings as grit or if snails and clams were being fed to them whole. The incidence and volume of mineral grit was similar for all the age- and sex-classes.

The most significant contrast in food habits among adult blackbirds was the differential consumption of larval moths (Lepidoptera), which accounted for 20% of the digestive tract contents for adult females but less than 1% for adult males. The basis for this difference is unknown, but it may be related to the dominant role that females play in the feeding of the young (Payne 1965:39–40, Collier 1968:156–161).

DISCUSSION

The 91% animal matter, by volume, that we found in the Merced County nestlings/fledglings was similar to both the 86% animal matter found by Crase and DeHaven (1977) in nestlings from the "rice district" and to the 90% found by Collier (1968) in the "foothills." However, in Crase and DeHaven's (1977) study, beetles (Coleoptera) were represented to a much greater extent (61% vs. 9%) and moths (Lepidoptera) to a

TABLE 1. Foods of Tricolored Blackbirds in Merced County, California, during the 1978 breeding season (sample sizes given in text).

	Nestlings-fledglings[a]		Adult males[b]		Adult females[c]		Composite colony food habits[d]	
	% Vol.	% Inc.	% Vol.	% Inc.	% Vol.	% Inc.	% Vol.	% Inc.
ANIMAL								
Mollusca	3.3	74.7	T[e]	3.7	0.5	15.9	1.7	41.6
Arthropoda								
Arachnida	0.2	6.3	T	14.8	0.6	12.1	0.3	9.8
Insecta								
Lepidoptera	30.4	47.4	0.4	3.7	20.3	33.6	21.6	34.9
Coleoptera	9.2	71.6	13.5	44.4	16.1	60.8	12.4	63.0
Diptera	3.2	11.6	7.0	25.9	1.3	11.2	3.2	14.0
Homoptera	T	1.1	0.1	14.8	2.2	12.2	0.8	7.4
Orthoptera	1.3	3.2	—	—	0.2	2.8	0.7	2.5
Dermaptera	0.6	10.5	T	3.7	0.3	3.7	0.4	6.9
Other insects[f]	0.1	3.2	T	7.4	T	2.8	T	3.8
Unidentified animal	42.8	97.9	6.6	55.6	14.4	82.2	26.5	85.0
Subtotal: Animal	91.1	100.0	27.6	81.5	55.9	93.5	67.6	94.5
PLANT								
Avena	0.4	3.2	43.3	59.3	31.9	43.0	19.0	27.0
Erodium	T	1.1	5.0	25.9	3.1	10.3	2.0	8.7
Zea[g]	0.2	2.1	1.4	3.7	0.8	0.9	0.6	2.0
Montia	—	—	0.6	3.7	0.3	0.9	0.2	1.0
Amaranthus	T	3.2	T	7.4	0.4	7.5	0.1	5.4
Stellaria	T	21.1	0.1	11.1	T	6.5	T	15.1
Other plant[h]	T	1.1	—	—	T	1.9	T	1.2
Unidentified plant	6.0	65.3	18.4	37.0	5.1	26.2	7.8	46.6
Subtotal: Plant	6.6	71.6	68.8	81.5	41.6	72.9	29.7	73.8
Subtotal: Mineral grit	2.3	36.8	3.6	48.2	2.7	52.3	2.7	44.2

[a] Gizzard contents only.
[b] 88% gizzard contents and 12% gullet contents.
[c] 81% gizzard contents and 19% gullet contents.
[d] Weighted means, see text.
[e] T = trace amount.
[f] Includes trace amounts from orders Collembolla, Hemiptera, Hymenoptera, and Odonata.
[g] Cracked corn, probably from cattle feedlot.
[h] Includes trace amounts of three genera: *Aristida*, *Hemizonia*, and *Rubus*.

lesser extent (1% vs. 30%) than we have reported here (Table 1). Thus, although nestlings appear to be uniformly dependent upon animal matter, the taxa consumed may vary with time or location, or both.

The percentage volume of animal matter consumed by adults, in contrast to nestlings, may vary much more by location. For example, although 96% of the total volume from adult blackbirds collected in May in the foothill areas was animal matter (Collier 1968), only 50% of the volume was animal matter in our agricultural study area. Crase and DeHaven (1978) reported an even lower figure (28%) for adults collected in the spring from the rice area. The primary food of adults in the foothills was beetles (Coleoptera, 42%), whereas oats were the primary food in our study, and rice (48%) was the primary food in the rice-growing regions (Crase and DeHaven 1978).

Although the importance of orthopterans (grasshoppers and crickets) as a food during the breeding season has been emphasized by several authors (see Crase and DeHaven 1977 for review), based on this study and that by Collier (1968), coleopterans and lepidopterans must also be considered important animal foods. In general, our results and those done earlier suggest that adult Tricolored Blackbirds feed opportunistically during the breeding season.

It is generally recognized that different age- and sex-classes within a species have different effects upon agricultural crops. To estimate what the potential impact of a breeding colony of Tricolored Blackbirds might be on a crop, the feeding habits of each age- and sex-class must be weighted by the proportion of that class in the total colony population. Assuming an adult male:female breeding ratio of 1:2 (Lack and Emlen 1939) and a mean fledgling rate of 1.35 per nesting attempt (Collier 1968:167), we estimated the composite feeding habits of a colony of breeding blackbirds (Table 1). Although our estimate of the percentage volume of animal matter consumed by a colony was nearly 70%, this is a conservative estimate, since it does not account for either the food (about 90% animal matter) fed to nestlings that fail to fledge, or the larger daily volume of food that nestlings consume compared with adults. In addition, a comparison of gullet and gizzard contents collected from adult blackbirds showed that, although animal matter made up 34% of gullet contents, its relative representation among gizzards was significantly less (21%) ($n = 37$, $P < 0.05$, paired t-test). This comparison indicates another possible bias in favor of plant matter (Gartshore et al. 1979), which could result in an even more conservative estimate of the composite consumption of animal matter.

Although estimates of food consumption by a population may indicate the potential impact of that population (Wiens and Dyer 1977), translating food habits data into impact estimates depends on a knowledge of many other variables. As Tricolored Blackbird colonies are physiologically (Payne 1969) and ecologically (Orians 1961) adapted to the exploitation of an abundant food supply (such as highly cyclic insects injurious to crops), and since injurious insects compose a substantial portion of their diet during the spring, breeding

blackbirds may thus protect or improve the yield of some agricultural crops.

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LIMBER PINE SEED HARVEST BY CLARK'S NUTCRACKER IN THE SIERRA NEVADA: TIMING AND FORAGING BEHAVIOR

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The preferred seed sources for the Clark's Nutcracker (*Nucifraga columbiana*) in the Sierra Nevada of California are the whitebark (*Pinus albicaulis*), Jeffrey (*P. jeffreyi*), ponderosa (*P. ponderosa*), and singleleaf piñon (*P. monophylla*) pines (Tomback 1977). Nutcrackers prefer these species because: 1) the seeds are large and easily harvested, 2) the trees are locally abundant, and 3) the timing of cone ripening and/or opening allows sequential exploitation of the seeds of two or more pine species (Tomback 1977).

Nutcrackers harvest and store limber pine (*P. flexilis*) seeds in the San Francisco Mountains of north-central Arizona (Vander Wall and Balda 1977). As we report here, nutcrackers also harvest and store limber pine seeds in the Sierra Nevada. Like the other preferred seeds, those of the limber pine are large, the pine is locally abundant (although patchy in distribution), and most of the cones open after the peak of whitebark pine seed harvest by nutcrackers. In the Sierra Nevada, limber pine occurs from Mono Pass southward, primarily on the eastern slope, in stands less than 3 km across (Sudworth 1908, Griffin and Critchfield 1972).

On 5, 6, and 16 September 1979 we watched nutcrackers harvest and store limber pine seeds in the southern Sierra Nevada, Onion Valley, Inyo Co. (2,700 m elevation). Our observation point was above Independence Creek, about 1 km below the Kearsarge Pass trailhead, and about 0.2 km south of the Onion Valley road. Here, limber pine is scattered over the steep north- and south-facing valley walls, interspersed with foxtail pine (*P. balfouriana*) and red fir (*Abies magnifica*). New cones were plentiful on all three conifer species. On 5 and 6 September, limber pine cones were in various stages of ripening, both among trees and, to a lesser extent, on individual trees. Half the cones or more were entirely green, highly resinous, and completely closed. The others were partly brown and opening, with scales extending to various degrees from the cone core. Open, brown cones of the previous year remained on most limber pines.

At 15:30 on 5 September, we observed an adult nutcracker harvest seeds for 15 min from the top of a limber pine tree on the north-facing slope above Independence Creek. On 6 September from 15:00 to 17:00, we watched two nutcrackers on the same north-facing