The White-necked raven in relation to agriculture / Shaler E. Aldous.

Nilson, Hugo W.

Washington, D.C. : U.S. Dept. of the Interior, Fish and Wildlife Service : 1942.

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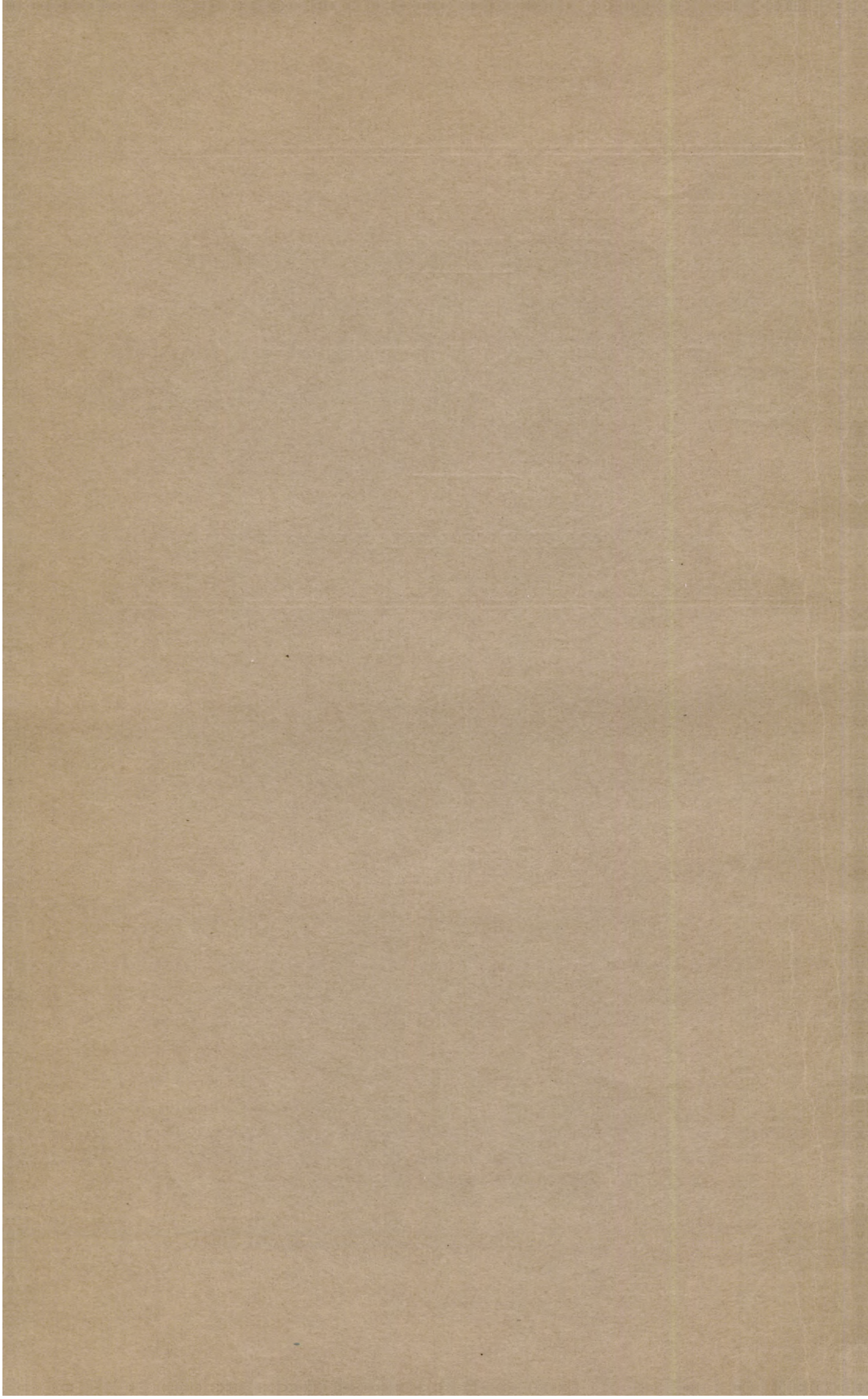
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

THE WHITE-NECKED RAVEN IN RELATION TO AGRICULTURE

RESEARCH REPORT 5



UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary
FISH AND WILDLIFE SERVICE
Ira N. Gabrielson, Director

Research Report 5

THE WHITE-NECKED RAVEN IN RELATION TO AGRICULTURE

BY

SHALER E. ALDOUS

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1942

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - - - - - - - - Price 10 cents

ABSTRACT

THE WHITE-NECKED RAVEN (*Corvus cryptoleucus*), a close relative of the common crow, is indigenous to southwestern United States and the adjoining sections of Mexico. Because in parts of its range it has gained the same ill repute as acquired by the crow and magpie in their respective ranges, a 5-year detailed study of its activities and food habits was made, during which many field data were gathered, and the contents of 827 stomachs were analyzed.

The omnivorous food habits of this raven often bring it into direct competition with farming interests, and frequently its depredations result in severe damage to crops, particularly to grain sorghums, corn, melons, peanuts, pecans, weak lambs, and poultry. To reduce these attacks and keep the losses at a minimum often is expensive and requires considerable work and ingenuity on the part of farmers and ranchers. On the other hand nearly half the raven's food is of animal origin and includes a wide assortment of insects, many of which are harmful to crops. Grasshoppers, weevils, May beetles, caterpillars, fly maggots, and like pests constitute a material part of the insect diet. Carrion is another important food of the raven, and its removal from the range is a definite aid to sanitation.

When heavy raven concentrations occur, the crops must be protected. As effective control is impossible when natural food is abundant, it is generally necessary to resort to frightening measures until winter sets in and the food supply becomes low enough to insure control success. Various contrivances to scare the birds away may be placed in the fields, but the shotgun is without question the best frightening device. The most successful, selective, and humane control measure is the use of large cage traps (illustrated in fig. 12 in this report). As the need for control is usually local and varies by seasons, depending upon the crop situation, the soundest policy is to resort to it only when necessary and to take advantage of the bird's better attributes at all other times.

THE WHITE-NECKED RAVEN IN RELATION TO AGRICULTURE

By SHALER E. ALDOUS

Biologist, Division of Wildlife Research, Fish and Wildlife Service [1]

CONTENTS

	Page
Reason for the study	1
Description	2
Distribution	4
Life history notes	6
Breeding habits	6
Mating	6
Nesting	7
Eggs	7
Nestlings	9
Behavior at the nest	9
Roosting habits	10
Movements	13
Molting	15
Parasites	15
Damage caused by ravens	16
Crop losses	16
Farm-to-farm canvass	16
Dissemination of diseases	17
Interference with telephone service	17
Food habits	18
Number and distribution of stomachs	18
Food of adults	18
Animal food	22
Plant food	32
Miscellaneous items	40
Food of nestlings	40
Animal food	42
Plant food	44
Summary of food habits	44
Items identified in the stomachs	47
Economic status	51
Crop protection	52
Frightening devices	52
Control measures	53
Trapping	53
Destroying nests, eggs, and young	54
Poisoning	54
Explosives	55
Literature cited	55

REASON FOR THE STUDY

Because of the increasing number of complaints against the white-necked raven (*Corvus cryptoleucus*) in Texas, in October 1931 the Biological Survey [2] initiated a detailed study of the bird's activities and during the following 5 years gathered information on the bird's habits. The field data obtained, supported by the findings from the laboratory analyses of 827 stomachs, constitute the basis for this report.

Inasmuch as the white-necked raven has little esthetic appeal, its economic rating depends almost wholly on its food habits. Its status is a controversial subject, but the species generally is considered wholly detrimental by the average farmer and sportsman. In western Texas, eastern and southern New Mexico, and southern Arizona it occupies the same position of disrepute as the crow in the East and Middle West and the magpie in the Rocky Mountain region. The

[1] Report prepared while the author was employed in what is now the Section of Food Habits.

[2] On June 30, 1940, the Bureau of Biological Survey was consolidated with the Bureau of Fisheries to form the Fish and Wildlife Service.

omnivorous food habits and gregariousness of these three members of the family Corvidae combined with their ability to adjust themselves to changing environments make them recurring problems in their respective ranges. The crow and the magpie have been dealt with exhaustively in publications by Kalmbach (1918, 1927),[3] but no comprehensive treatise on the white-necked raven has been issued.

DESCRIPTION

The common name "white-necked raven" is somewhat misleading, because to the uninitiated it signifies a bird with a white neck. The term is adapted, however, from the scientific name *Corvus cryptoleucus*, which means the raven with the hidden white. Although the basal two-thirds of all the feathers of the neck and anterior parts of the breast and back are pure white, the tips of these feathers and the whole of the remaining body covering are black, so that in outward appearance the bird is wholly black (fig. 1).

The original description of the species by Couch (1854: 66) is as follows:

FEMALE. *Form.*—Bill short, high at base, compressed; nostrils covered with flat, bristle-like feathers, which are about two-thirds as long as the bill. Wings long, fourth primary longest, first short; tail moderate, rounded. About the size of or rather larger than the common crow of North America, (*Corvus americanus*).

Color. Entirely black, with violet and purple reflexions. Feathers of the neck before and behind, and of the back, pure white at their bases and for about two-thirds of their length, being, in fact, white tipped with black. Bill and feet black. Iris yellowish brown.

Total length from tip of bill to end of tail 18¾; wing 13½; expanse of wings 33; tail 8 inches.

Locality. State of Tamaulipas, Mexico; March, 1853.

The extreme and average measurements of 108 adult white-necked ravens measured by the writer are shown in table 1, from which it may be seen that the type specimen is somewhat smaller than the average of the 56 females measured. Measurements were made in accordance with the technique set forth by Baldwin, Oberholser, and Worley (1931) except that the tail was measured from the base of the uropygium to the tip of the longest tail feather.

TABLE 1.—*Measurements taken in the flesh of 108 adult white-necked ravens*

Sex	Total length		Extent of wings		Wing		Tail	
	Mm.	*In.*	*Mm.*	*In.*	*Mm.*	*In.*	*Mm.*	*In.*
Males (52):								
Largest	533	21.00	1,124	44.25	375	14.75	229	9.00
Smallest	464	18.25	1,010	39.75	337	13.25	203	8.00
Average	506	19.91	1,063	41.83	359	14.14	215	8.45
Females (56):								
Largest	521	20.50	1,067	42.00	356	14.00	216	8.50
Smallest	457	18.00	927	36.50	349	13.75	184	7.25
Average	491	19.35	1,030	40.55	347	13.65	208	8.19

[3] Publications referred to parenthetically by date (alone or with colon and specific page) are listed in the Literature Cited, p. 55.

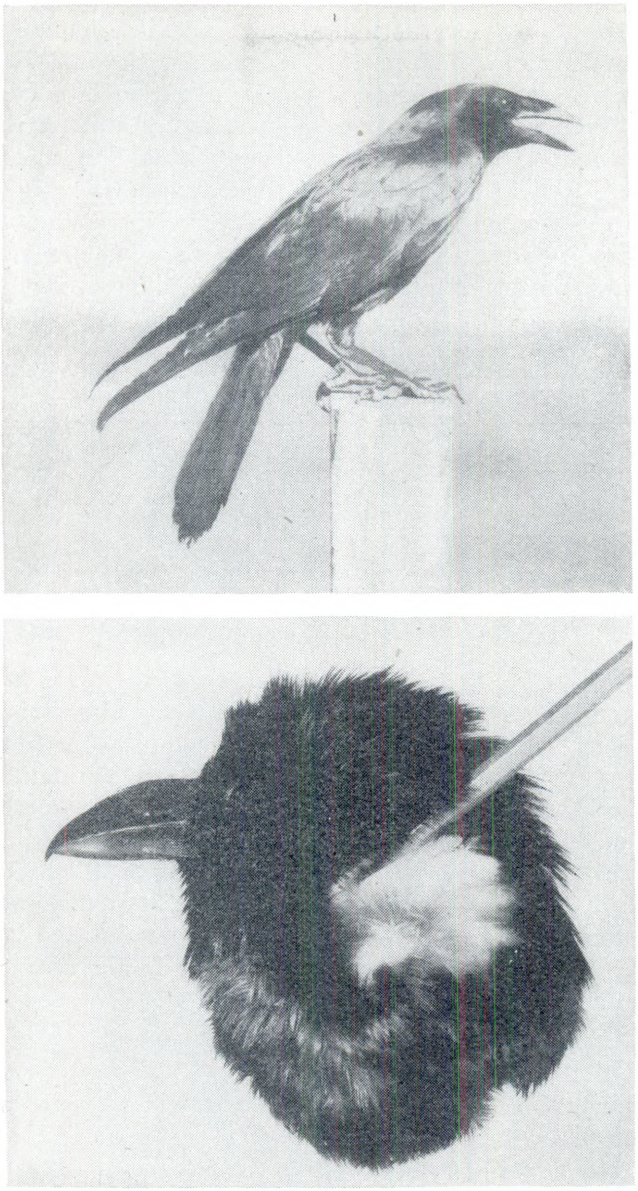


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FIGURE 1.—The white-necked raven (*Corvus cryptoleucus*). The bird receives its name from the pure white basal part of the neck feathers.

The weights of 67 female and 75 male white-necked ravens were recorded. They averaged 509 grams (17.9 oz.) for the females and 557 grams (19.6 oz.) for the males. The heaviest female weighed 607 and the lightest 407 grams. Extremes for the males were 667 and 464 grams. As all weights were taken during late fall and in winter and spring, the lighter ones do not indicate immature birds.

The statement made in the original description that this raven is slightly larger than the crow is confirmed by the data in table 2, which presents for comparison the average weights and measurements of white-necked ravens given in the preceding paragraph and in table 1 and those the writer obtained of 301 crows in Oklahoma (unpublished).

TABLE 2.—*Average weights and measurements of white-necked ravens* (Corvus cryptoleucus) *and crows* (C. brachyrhynchos)

Sex and bird	Weight	Measurements			
		Total length	Extent of wings	Wing	Tail
Males:	*Gm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
White-necked ravens	557	506	1,063	359	215
Crows	500	477	937	318	195
Females:					
White-necked ravens	509	491	1,030	347	208
Crows	443	457	904	307	187

The field character that best distinguishes the white-necked raven from the crow, with which it intermingles on the north and east boundaries of its range in Texas and Oklahoma, is without question the raven's less open-throated and distinctly lower-pitched and guttural voice. Other distinguishing field characteristics are the raven's slightly larger size; its longer and coarser beak; its slightly more rounded tail silhouette when in flight; and its tendency to soar, at which time the tips of the primaries are separated and upturned. Occasionally, also, the white bases of its neck feathers can be seen when the plumage is ruffled by the wind (fig. 1).

DISTRIBUTION

Early distribution records indicate a much wider former range for the white-necked raven than is known at present. Aiken (1873) stated that the bird was common along the base of the Rocky Mountains from Trinidad, Colo., to Cheyenne, Wyo., and from the Snowy Range to a point 30 miles out on the plain. His is the only record ever published for Wyoming. Birds of this species were reported present around Boulder, Colo., in December 1921 by Beard (1922) and in the vicinity of Denver in 1932 by W. H. Bergtold (letter). J. A. Loring (field notes) recorded them as common in December 1893

at La Plata, N. Mex., and E. W. Nelson (field notes) reported them a few miles north at Durango, Colo., in April 1914. The species might, therefore, be expected to follow along the San Juan River into Utah, but no records are known for that State.

The most westerly record (Grinnell 1898: 32) is for the San Fernando Valley, Calif. It is based on the partly decomposed remains of a raven found under a tree by F. S. Daggett on April 18, 1897, undoubtedly a stray bird, as no other specimens have been reported from the State. There are dubious records for the vicinity of Yuma, Ariz., but no authentic ones, although it seems reasonable that the birds should occur there. Monson (1936) reported them common on the Papago Indian Reservation, west of Tucson, Ariz.

The most easterly record is for Galveston, Tex. (Bendire 1895:

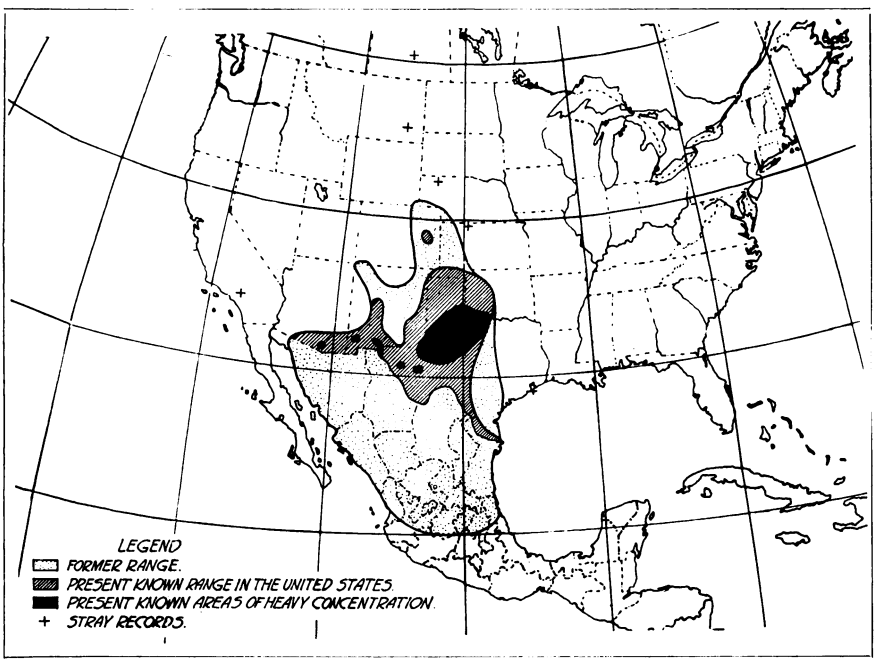

FIGURE 2.—Range of the white-necked raven.

403), where several of the birds were seen in May 1890. This is somewhat east of the usual range of the bird, as the normal eastern border is the coastal region near the mouth of the Nueces River and Bishop, Tex.

There are two records from Nebraska in the nineties (Bruner 1896: 122), probably stragglers, as in more than 40 years the birds have not again been reported in that State. Several of the birds were recorded in western Kansas in the late 1800's; and it seems reasonable to assume their presence there now in limited numbers, as the species

is known to occur in eastern Colorado. F. W. Robl (letter) wrote of a specimen shot at Ellinwood, Kans., November 8, 1934, but this is undoubtedly east of the bird's normal range. A number of early and recent records for Panhandle and western Oklahoma establish the species as a regular inhabitant of that State. Two sight records far north of the normal range include a bird reported near Fallon, Custer [=Prairie] County, Mont., in 1902 (Cameron 1907: 393) and one seen some years ago by Mrs. C. W. Cates (letter 1932) with some crows at "Bonnie brae" McLean, Saskatchewan, Canada.

At present the greatest concentrations of white-necked ravens in the United States occur in southeastern Arizona, southern and eastern New Mexico, and western Texas from about Wichita Falls south to the southern tip of the State and south of a line between Wichita Falls and Lubbock. The distribution map given as figure 2 epitomizes the records listed in the literature and the numerous observations made by the writer. Most of the material for this report was gathered from the areas in black.

Data on the distribution of the species in Mexico are rather meager and are confined mostly to reports previous to 1900 that established the northern Mexican range by records along the border in the southern parts of Arizona, New Mexico, and Texas, fairly well defined the southern and eastern boundaries of the range, but contained no records for western Mexico below the border, making the boundary line there somewhat hypothetical. The Mexican distribution as shown in figure 2 is therefore only an approximation.

LIFE HISTORY NOTES

The more outstanding traits and habits of the white-necked raven are discussed briefly in the following paragraphs, as many of them are useful in appraising the bird's economic status and in developing control measures.

BREEDING HABITS

MATING

In western Texas white-necked ravens begin pairing off early in March and at least 75 percent of them are mated by the middle of May. E. R. Kalmbach reported (letter) a few birds in eastern Colorado pairing as early as January. Soon after mating takes place, the testes, which previous to sexual maturity are about the size of wheat kernels, start enlarging, and they make enormous growth during the breeding season. One set had enlarged to 5 by 10 mm. when measured on March 27, 1936, and another pair measured 16 by 25 mm. on May 4. The parent birds remain together until the young leave the nest, after which it is difficult to keep track of individual birds.

NESTING

Activity around old nests begins in April, and sometimes the ravens stay constantly in the vicinity of chosen nests as if maintaining claim to them. Whenever old nests meet the birds' needs they are remodeled: old linings are discarded and frameworks repaired and fresh linings then installed. Entirely new nests are built at will, however. From the time the lining is completed until egg deposition commences, the nest is not protected from rains and the birds loosen up the lining after each shower, apparently so that the nest can dry more readily.

A variety of nest sites are chosen (fig. 3), the mesquite bush (*Prosopis glandulosa*) most commonly. Catclaw (*Acacia greggii*), allthorn (*Koeberlinia spinosa*), yucca (*Yucca* spp.), hackberry (*Celtis* sp.), mulberry (*Morus* sp.), oak (*Quercus* sp.), and pear (*Pyrus* sp.) are also used, and the ravens even build their nests in windmill towers and on cross bars of telephone and high-voltage power-line poles.

Nests are built above ground at heights ranging from 4 to 30 feet but usually between 7 and 10. They are constructed of dead twigs entwined into a platform about 12 inches wide and 12 to 24 inches deep with a rounded-out cavity in the top about 8 inches wide and 6 inches deep. This hollow is lined with some soft material, such as wool, cotton, rabbit fur, cow or horse hair, burlap, rags, binder twine, juniper bark, or yucca fibers, governed largely by what is readily obtainable.

EGGS

The writer's earliest record of fresh eggs is April 11, on which date in 1936 a rancher 30 miles south of Garden City, Tex., found and destroyed 2. His next earliest record is May 6, when in 1936 he found 3 fresh eggs near Vincent, Tex., but a nest found May 19, 1932, near Brownfield, Tex., contained 2 young about a week old and therefore had probably had eggs deposited in it about April 20. Bendire (1888: 555) reported May 6 as the earliest date eggs were found near Tucson, Ariz.; Clark (1899) recorded finding 5 eggs on April 18 at El Plomo, Sonora, Mexico; and Lloyd (1887: 290) reported 3 eggs found on May 5 in southern Texas. A crew of 8 men working in Lea County, N. Mex., from July 3 to 11, 1934, found and destroyed 314 eggs and 3,018 young—figures that illustrate the proportion of young to eggs in that month. The writer's examination between June 5 and 15, 1932, of 121 occupied nests revealed that 30 contained neither eggs nor young; 36, a total of 180 eggs in all stages from fresh to pipped; and 55, a total of 240 young. As Burns (1915: 285) states that the incubation period of the white-necked raven is 21 days, these findings may be interpreted to mean that the heavy egg laying occurs in May and most of the hatching in June.

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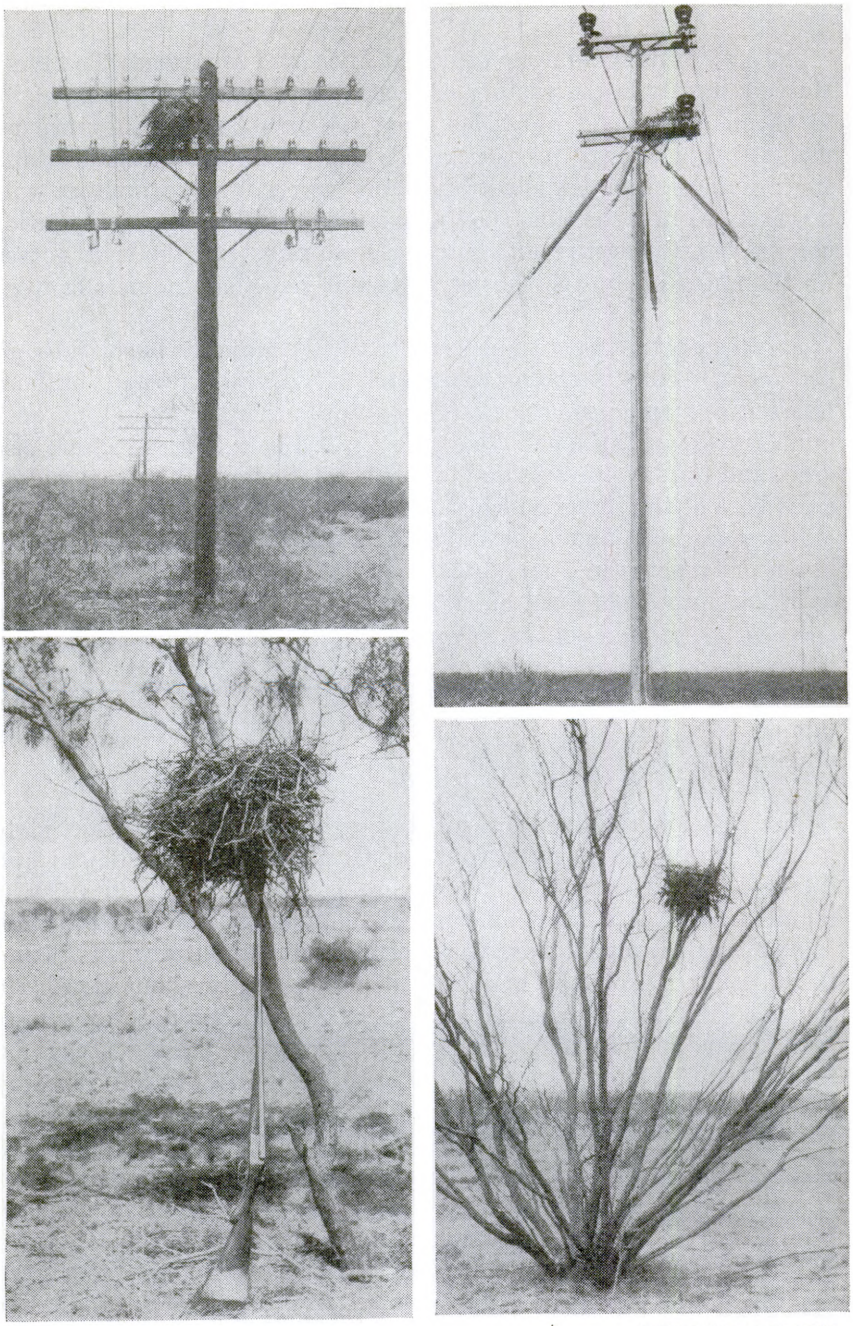

B44475; B44470; B44471; B43822

FIGURE 3.—Nests of the white-necked raven: *Above*, on cross bars of telephone and high-voltage power-line poles; and *below*, as commonly found in mesquite, showing about minimum height nest is built above ground.

It is especially interesting that these birds so far south lay their eggs and rear their young at a later date than crows as far north as Canada. This is because the appearance of leaves on the mesquite trees and the period of grasshopper abundance, with which the egg deposition is closely associated, occur relatively late for a section so far south.

The eggs, from blue green to gray green in color, are marked with pale longitudinal streaks of drab to lavender gray and lilac irregularly splotched with various shades of brown. These markings serve to distinguish the eggs of the white-necked raven from those of all other North American Corvidae.

Clark (1899) records the measurements of 5 eggs; and Sherrill (1896) gives the average, maximum, and minimum measurements of 92 eggs in his possession and Bendire (1895) of 288 in the United States National Museum. Of these 385 eggs, the largest is 2 by 1.26 inches (Clark); the smallest, 1.52 by 1.09 (Bendire); and the average, 1.84 by 1.23 inches (46.74 by 31.24 mm.).

The number of eggs found in a nest ranged from 1 to 8, complements of 4, 5, and 6 occurring most frequently. In nests containing 3 or fewer eggs the clutches were in most cases probably not completed. The distribution of eggs found in 36 nests during June 1932 was as follows: 1 egg in each of 3 nests; 2 eggs in each of 2; 3 in 1; 4 in each of 4; 5 in each of 7; 6 in each of 15; 7 in each of 3; and 8 in 1. Bendire (1888: 556) states that from 4 to 7 eggs were laid to a set, 6 being found most commonly.

NESTLINGS

The number of nestlings found in a nest ranged from 1 to 7 and averaged 4.36 in 55 nests that contained young in June 1932.

When first hatched the young are naked, but in about a week they show pin feathers on the wings and uropygium and in about 3 weeks they are completely feathered and approximately two-thirds grown. They are of adult size before they leave the nest and shortly after they begin flying are not distinguishable from the adults except at close range, and then only by the light color of the gape of the beak and the newer-appearing plumage.

Three young that attempted to fly and successfully covered about 100 yards before striking the ground averaged 17 inches in total length, 10.16 inches in wing length, and 5.83 inches in length of tail.

BEHAVIOR AT THE NEST

Adult ravens are not aggressive in defense of their nests until after the young are hatched. During the construction of the nest and throughout the incubation period they will leave the vicinity of the nest long before a human intruder can reach it and it is usually dif-

ficult to get even within gunshot range of them. They rarely return to the nest directly; usually they circle closer and closer and finally alight in a nearby tree, to go to the nest later when the intruder is at a safe distance. After the young are hatched, solicitude of the parent birds becomes much stronger and continues to increase with the development of the nestlings until by the time the young are feathered the adults remain nearby and may actually swoop at anyone who gets too close to the nest. If a young bird can be made to squawk, which is usually a difficult task, the old birds will fly to within a few feet of the intruder and by their excited cawing soon attract a group of ravens, although usually only the parents come into close range.

During the first 2 weeks of life the nestlings stretch their necks upward and open their mouths upon hearing or feeling the least disturbance and will take food whenever and from whomever offered, but as they grow older they lie low in the nest when approached and even prematurely try to fly away.

ROOSTING HABITS

White-necked ravens, like crows, have the habit of congregating in large roosts for the night. Most commonly they choose thickets of large mesquite brush (fig. 4), preferably in natural depressions, such as creek bottoms, where they are somewhat protected from the wind. As mesquite is not always present or suitable, however, other vegetation must at times be used; and thickets of tamarisk (*Tamarix*), second growth cottonwood (*Populus*), and tornillo (*Strombocarpa*), as well as old orchards, are sometimes selected.

The manner and time of entering and leaving the roost vary locally and seasonally but in general are much the same, wherever the place or whatever the season. Late in the afternoon the birds start congregating at temporary gathering places some distance from the roost. From these, they leave in small groups that keep joining each other until continuous lines are formed drifting toward the roost. Disturbances, such as shooting, tend to break the line, but it is formed again after the birds have passed the point of disturbance. In the early flight lines much playful maneuvering takes place, but the later birds are more intent on getting to the roost and make a more direct flight. On cold or windy evenings the flight is direct and close to the ground, but on warm, quiet ones it is high and vacillating. The early arrivals rarely go directly into the roost but usually alight on the ground in nearby fields, so that it is common to see acres of the ground adjoining a large roost black with the birds.

The great massing preparatory to entering the roost has often been falsely interpreted as being indicative of large-scale depredations, for investigations on several occasions showed that the massed birds were

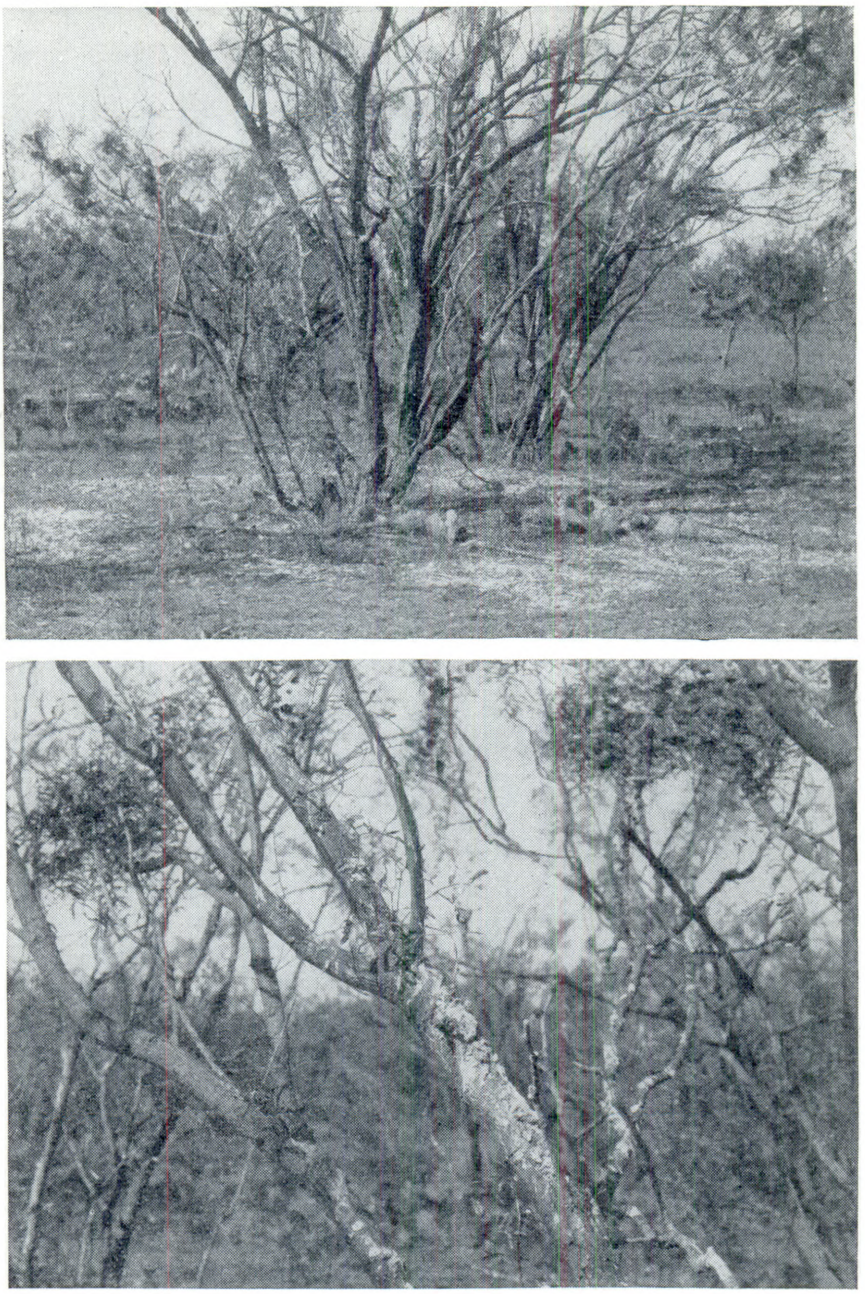

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FIGURE 4.—Typical mesquite pasture used by white-necked ravens for roosting site. The accumulation of excreta and pellets produces an offensive odor when wet and is a storehouse of weed seeds.

not feeding. Ravens that for two or three consecutive evenings covered the shocks of grain sorghum in a field next to their roost did no damage.

About dark the ravens leave the ground and enter the roost in one big influx. This is accompanied by considerable croaking and weird calls, some of which are so strange that if heard elsewhere they would not be associated with these birds. All the while the ravens are finding their roosting places and adjusting themselves, there is continual commotion and hubbub, caused by the crowding and unbalancing. The din is greatest when several large flocks attempt to settle in the roost at one time. Gradually the clamor diminishes and finally—after the last birds are settled in the roost—ends. Even after all is quiet, however, breaking branches or other disturbances cause an occasional brief outburst.

Once settled in the roost, the birds are so compactly massed it seems incredible that the brush will support them. Often the upper branches do break, and trees in which roosts have been used for some time have the tops leveled off like a trimmed hedge. Observed from above, an occupied roost gives the impression of a sea of black, broken only by occasional openings where the brush is thin or missing (fig. 5).

About half an hour before daybreak the birds start leaving the roost in small flocks, and by the time it is light most of them have departed for their feeding grounds. Those that leave before dawn usually fly until it is almost light before beginning to feed. Because of this habit less damage is inflicted on farms immediately surrounding the roost than on those farther away.

The daily cruising radius from the roosts probably averages somewhere between 5 and 15 miles, with most of the birds feeding within an 8-mile radius. A few birds from one roost that were traced night and morning were found to go 25 miles each way daily, which is undoubtedly about the maximum.

The number of birds in a roost varies in response to available food supplies and roosting sites. The long lines of birds entering various roosts afford means of obtaining a reasonably accurate estimate of roost populations, which range from 200 in a roost near Plains, Tex., to between 25,000 and 50,000 in one near Anson, Tex.

Supplementary roosting places can usually be found in the vicinity of each regular roost, and the birds resort to these whenever they are severely disturbed at the established roost. The new site may be used for one night or for several nights, or it may become a new regular roost if the disturbance at the old one is great and prolonged. Factors sufficiently potent to cause roost shifting include bombarding with guns or dynamite and cutting down the trees that harbor

the roosts. The shifting of roosts from place to place during the course of years has often led to the mistaken idea that there are many roosts in a single community. Rarely, however, are regular roosts established closer to each other than 10 miles air line, even in the areas of heaviest concentration.

The general location of a roost can be ascertained by getting the direction of flight lines late in the evening and noting where they converge, and the exact place and size can be determined by finding the characteristic accumulation of excreta and pellets on the ground.

B37974

FIGURE 5.—White-necked ravens in a roost. Note density.

Inasmuch as most roost sites are in mesquite, which has slight leaf litter, these signs loom up conspicuously (fig. 4). The quantity of pellet accumulation on the ground is an index both of the number of birds in the roost and of the length of time the roost has been used. Some old apple and locust trees noted in 1934 around a deserted home site in Lea County, N. Mex., where native trees are scarce, had been used so long as a roost site that the ground beneath them was covered to a depth of 6 inches with pellets and excreta. When wet these wastes often produce an offensive odor.

MOVEMENTS

White-necked ravens are less migratory than crows, but some of them do drift back and forth for distances up to about 100 miles.

Residents in Baylor County, Tex., and also some in the extreme western part of the State report that the birds are numerous late in spring, in summer, and early in fall but are practically absent in winter. There is a short drifting late in spring from farming sections, where the birds winter, to mesquite pastures, their usual nesting grounds. There is seldom if ever a complete exodus of the birds from any area.

Banding studies have been the source of some information on the bird's movements. From November 1931 through December 1935 a total of 652 white-necked ravens—138 of them nestlings—were banded and released. Up to April 1938, 74 adults and 14 of the birds banded when nestlings had been retrieved. Figure 6 maps the drifting of the adults. Of 60 released from the station at Spur, Tex., 20 were retaken within 20 miles, at intervals up to 5⅓ years (2 birds) after their release. The longest elapsed time between banding and recapture of a bird was 6¼ years. The greatest distance traveled was about 250 miles air line, covered by an adult released at Spur in November 1931 and picked up 80 miles northwest of Del Rio, Tex., in October 1932. Of the 14 recoveries of birds banded as nestlings 1 occurred 45 miles from the point of release and all the others within 25 miles, 3 within 3 miles. Two of the birds were recovered 3½ years after banding and 2 others more than 5 years after.

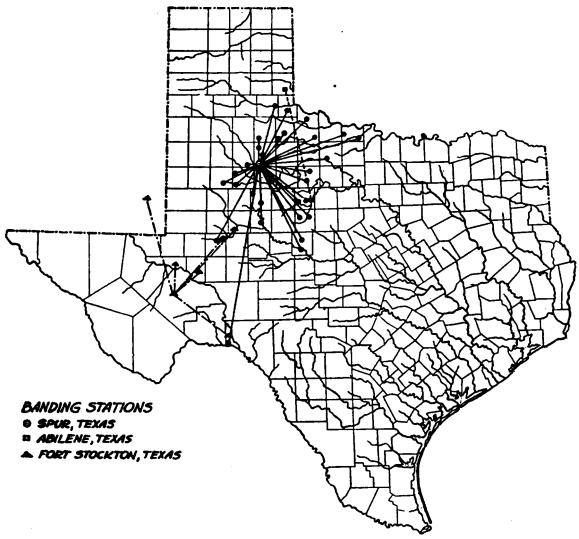

FIGURE 6.—Drifting of 74 adult white-necked ravens as revealed by banding studies.

From a group of ravens trapped at Abilene, Tex., on December 15, 1935, some were banded and released from the station the same day but seven were transported to Chickasha, Okla., and freed there on December 30. Of the seven, two were recaptured in Oklahoma—one at Enid just 9 days after its release and the other near Manguam at a point directly west of Chickasha and close to the Texas line about 6 weeks after being liberated. It is of interest that a month and a half after the latter capture one of the birds released from the Abilene

station was taken at Wellington, Tex., within 25 miles of Manguam, as this may indicate that the spring and summer home of some of the wintering Abilene ravens is to the north, where these two, trapped together at Abilene but liberated 15 days apart at points 200 miles distant from each other, were recovered.

MOLTING

Only one molt was observed in the white-necked ravens, and it took place during August and September. Throughout the period, flight silhouettes commonly showed tail and wing feathers missing and the birds so bedraggled and different looking that many residents assumed they were either sick or extremely lousy. The solicitude usually shown by them for wounded fellows was almost entirely lacking. Moreover, the birds became so wary that it was almost impossible to get within shotgun range of them and the writer found it difficult to collect enough birds for stomach analysis, whereas at other times of the year he could easily shoot more than were needed.

PARASITES

White-necked ravens are heavily infested with a number of parasites. Without exception every bird examined showed some type of parasitism, but no ill effects on the hosts were noticeable. The more common species of parasites were preserved and identified.

All the birds examined were infested with biting lice (Mallophaga), among which *Menopon* sp., *Degeeriella secondaria*, and *Colpocephalum subaequale* were recognized.

Internal parasites were identified as follows: A filarial worm (*Diplotriaena* sp.) was common in the coelomic cavity, chiefly within the air sacs; heavy infestations of gizzard worms were found in many specimens; another roundworm (*Physaloptera* sp.—probably *galinieri*), was commonly found in the proventriculus; and the tapeworms *Raillietina* sp. and *Hymenolepis* sp. were present in the small intestines.

The intestines were also commonly infested with coccidian protozoa. No attempt was made to study the bacterial flora of the birds.

An interesting published record by Smith (1908) recounts his shooting a raven that was performing a strange circular flight and upon examining it finding "directly back of the eyes, and extending partly into the brain, a parasite more than an inch in length, about the thickness of wrapping twine, pale yellow in color." The parasite was not identified, but it was probably the larval stage of a fly, perhaps a screwworm.

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DAMAGE CAUSED BY RAVENS

CROP LOSSES

Because of their appetites and gregarious habits white-necked ravens are capable of causing severe damage to cultivated crops. The birds congregate close to farming districts for about 8 months of the year, being absent from them only during the nesting season, which they usually spend in the open brushland pastures until the young are old enough to join the flock.

The amount of damage varies locally according to the crops grown, seasonal conditions, climatic variations, and roosting facilities available. The greatest losses inflicted are upon grain sorghums, corn, melons, and peanuts. Less damage is usually done to pecans, fruits, truck crops, small grains, poultry, sheep, and game and song birds. Crop losses are discussed in the account of food habits.

FARM-TO-FARM CANVASS

In order to obtain the farmer's point of view regarding the raven, a farm-to-farm canvass covering 100 farms was made in Howard County, Tex., in April 1936. This county is typical of western Texas, where the ravens are an agricultural problem. The same questions were put in each interview as follows:

1. What acreage of grain sorghums do you usually grow?
2. What is your estimate of the yearly loss to your grain sorghum crop caused by the ravens?
3. Which of your crops suffer the greatest monetary loss due to ravens?
4. Do you think the ravens should be controlled in your vicinity?
5. Who do you think should pay for any raven control work that might be inaugurated?
6. Would you personally contribute toward the costs of a control program?
7. Are you opposed to the use of poison or its exposure on your premises for controlling ravens?

The 100 farmers interviewed estimated that they grew about 13,644 acres of sorghum each year, and every farmer but one considered that the greatest loss the ravens caused him was to this crop. The estimated annual loss per acre ranged from nothing to $3 and averaged $0.66. At this average rate the annual loss from the total acreage of grain sorghums grown in Howard County would be $49,500.

Control in their own communities was considered necessary by 93 farmers; and control in the county as a whole but not in their immediate vicinities, by 7. Willingness to contribute toward the cost of control was voiced by 73, but 27 either were unwilling to pay or considered their losses too small to justify the expenditure.

As to poison, 85 farmers had no objection to using it or to having it exposed on their land for controlling birds; the others feared that it

might poison livestock or game and preferred other, more selective, methods of control.

The farmers in general were opposed to ravens more because of the watermelon losses they caused than because of the losses to grain, although the latter were many times greater. One farmer expressed this attitude by saying that he would rather have the ravens destroy a hundred dollars' worth of his feed crop than ruin his little melon patch.

The following opinions comparing the ravens with other pests were volunteered. Six farmers considered small birds—including lark buntings, English sparrows, and blackbirds—more detrimental than ravens to the grain sorghum crop; two thought that rabbits were as bad as ravens and two thought them worse; two believed that ducks consumed more grain sorghums than ravens; and two said that coyotes were more destructive than ravens to their melons.

DISSEMINATION OF DISEASES

Because they are more buzzardlike than crows in their carrion-eating proclivities, white-necked ravens are often accused of being important disseminators of contagious diseases of livestock and poultry, chief among which are hog cholera, blackleg, and roup. Possibly this is true, but nothing definite is known about the matter. The sanitary disposal of all carcasses, however, will largely reduce the possibility of raven-borne diseases. It must be remembered that other animals also—dogs, cats, wild flesh-eaters, and numerous insects, for instance—are all potential spreaders of diseases and that sanitary measures will produce quicker, cheaper, and more complete protection than any attempt to control all the potential carriers.

INTERFERENCE WITH TELEPHONE SERVICE

In 1930 the Bell Telephone Co. of Denver, Colo., reported trouble with "crows" on a line constructed in 1929–30 between Denver and Lamar as part of the long distance hook-up across the United States. The "crows," which it has since been determined were white-necked ravens, had adopted the cross arms of the telephone poles as nesting sites, and their nests were causing short circuits. There is still trouble, almost 95 percent of it within a 72-mile stretch beginning about 15 miles northwest of Lamar and extending toward Denver. The greatest concentration of ravens seems to be along and near Big Sandy and Rush Creeks, between the towns of Eads and Boyero, a relatively flat, dry, and treeless area. It is the lack of tree growth that makes the poles attractive nesting sites, and the short circuits are caused by the old barbed wire fences and hay wire discarded by the farmers and used by the ravens as part of their nesting material.

Ever since the trouble started, the company has had a crew of 4 men patrol this section daily between March and July each year in an attempt to keep the line clear and has tried various control and prevention devices, at a total annual cost of $2,500 to $5,500. There have been as many as 202 instances of wire trouble that called for special investigation in a year (1934), and between 700 and 800 pounds of scrap wire have been removed annually from the nests and the ground beneath the lines. Shooting, poisoning, and trapping have accounted for 1,500 to 2,000 ravens yearly, but the trouble persists. The most satisfactory short-circuit preventive tried so far is the insulation of the wires with a split rubber hose for about 30 inches out from each side of the cross arm.

FOOD HABITS

NUMBER AND DISTRIBUTION OF STOMACHS

Laboratory analyses were made of the contents of 827 white-necked raven stomachs—707 adult and 120 nestling—collected in 4 States and in every month. The numerical distribution of the stomachs by States was as follows: *Adult*—10 Arizona, 14 New Mexico, 3 Oklahoma, and 680 Texas; *nestling*—16 Oklahoma and 104 Texas. The numerical monthly distribution was as follows: *Adult*—17 January, 68 February, 73 March, 102 April, 65 May, 42 June, 6 July, 26 August, 66 September, 158 October, 59 November, and 25 December; *nestling*—8 May and 112 June.

As the bird's range is relatively small, as most of the stomachs were taken from densely inhabited areas, and as enough stomachs to give a good indication of the monthly food preferences were available for every month except January and July, the data obtained from the stomach analyses are considered fairly representative of the bird's food habits.

FOOD OF ADULTS

Both stomach analyses and field observations showed that white-necked ravens are omnivorous and can usually be found feeding where the greatest abundance of palatable food is available. The animal and vegetable portions of the adults' food were practically equal but varied materially with the seasons. The monthly volume and occurrence percentages of the principal food groups are given in table 3 in order of volumetric importance, and the volumetric food percentages are shown graphically in figure 7. An itemized list of the foods, arranged in systematic order, is given in table 5 (p. 47).

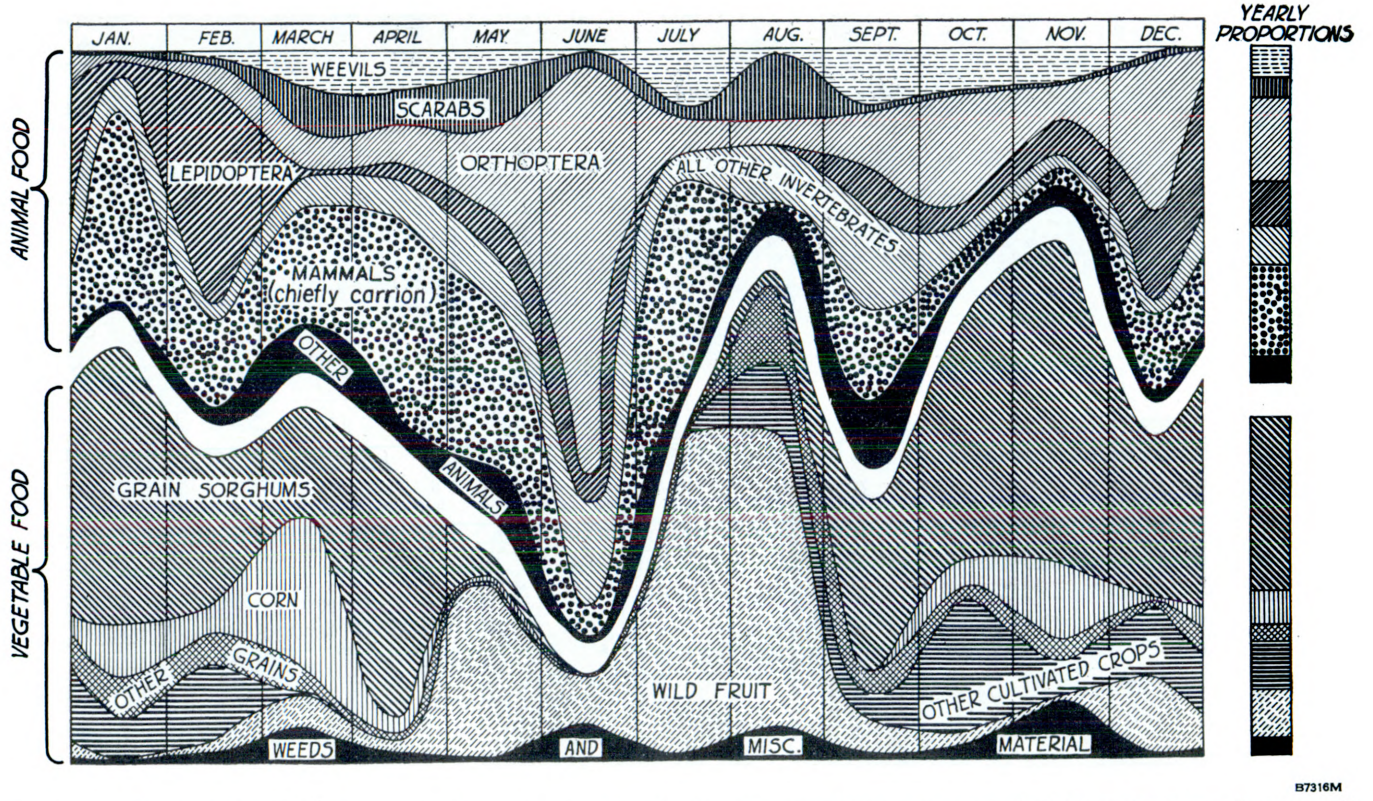

FIGURE 7.—Food of 707 adult white-necked ravens, showing the varying quantities of the principal items from month to month and the yearly average of each. Figures for both volume and occurrence percentages are given in table 3.

TABLE 3.—*Monthly and yearly volume and occurrence percentages of the principal food groups in the diet of 707 adult white-necked ravens*

[Roman figures indicate volume percentages; italic, occurrence percentages. The former are presented graphically in fig. 7]

Food group	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average [1]
ANIMAL FOOD													
Insects:													
Grasshoppers and allies (Orthoptera)	1.50	3.76	5.68	5.39	12.34	60.32	5.17	13.65	7.86	16.23	5.31	22.58	12.56
	29.41	*52.56*	*42.47*	*56.86*	*49.23*	*90.48*	*55.55*	*53.85*	*50.30*	*77.85*	*49.15*	*88.00*	*56.01*
Beetles and weevils (Coleoptera):													
Weevils (Curculionidae)	(2)	1.15	5.33	5.79	3.05	.12	8.33	(2)	8.03	6.19	5.36	1.00	4.49
	5.88	*27.94*	*45.21*	*51.96*	*27.69*	*9.52*	*16.67*	*3.85*	*37.87*	*47.47*	*61.02*	*28.00*	*28.61*
Scarab beetles (Scarabaeidae)	.06	.46	6.43	5.30	8.36	2.41	1.67	.77	1.65	.89	.15	.63	2.77
	5.88	*8.82*	*31.51*	*43.14*	*40.00*	*30.95*	*33.33*	*11.54*	*19.69*	*5.06*	*1.69*	*16.00*	*20.37*
Other beetles	.13	.06	1.62	1.56	1.00	3.61	3.66	.35	11.14	1.50	1.15	.46	2.29
	25.53	*4.41*	*36.02*	*32.35*	*31.82*	*28.57*	*33.34*	*34.60*	*62.12*	*35.57*	*15.25*	*32.00*	*30.26*
Total Coleoptera (volume)	.19	1.67	13.38	12.65	12.41	6.14	13.66	1.12	20.82	8.58	6.66	2.09	9.55
Moths and caterpillars (Lepidoptera)	2.06	31.70	.66	2.42	6.17	3.83	----------	----------	6.94	3.50	4.98	13.54	6.64
	41.18	*64.71*	*24.66*	*23.53*	*32.31*	*14.29*	----------	----------	*16.67*	*21.52*	*5.25*	*72.00*	*27.16*
Other insects [3]	5.06	1.60	2.94	4.15	5.15	7.00	.83	7.49	2.92	1.03	.64	.87	2.93
	47.06	*26.47*	*54.79*	*71.57*	*60.60*	*42.86*	*33.33*	*34.60*	*24.24*	*29.68*	*15.25*	*60.00*	*19.09*
Total insects (volume)	8.81	38.73	22.66	24.61	36.07	77.29	19.66	22.26	38.54	29.34	17.59	39.08	31.68
Mammals, chiefly carrion	28.13	12.94	17.33	29.41	24.19	4.93	31.67	.54	13.76	4.47	2.49	11.29	13.63
	70.59	*42.65*	*65.75*	*76.47*	*58.46*	*19.05*	*50.00*	*15.38*	*36.36*	*15.19*	*10.17*	*16.00*	*39.32*
Other vertebrates [4]	1.25	2.33	7.02	2.89	7.69	.78	.83	4.39	9.85	.96	3.06	1.96	3.76
	12.50	*19.20*	*28.68*	*25.42*	*21.47*	*21.40*	*16.66*	*23.00*	*27.22*	*6.33*	*22.00*	*16.00*	*19.40*
Other invertebrates [5]	(2)	.97	.04	.30	.99	4.73	(2)	.31	.08	.14	.17	.29	.60
	5.88	*11.76*	*19.19*	*24.51*	*27.20*	*42.86*	*33.33*	*7.69*	*7.57*	*14.55*	*5.08*	*28.00*	*17.68*
Total animal food (volume)	38.19	54.97	47.05	57.21	68.94	87.73	52.16	27.50	62.23	34.91	23.31	52.62	49.67
PLANT FOOD													
Grains (Gramineae):													
Grain sorghums	41.06	21.74	16.92	36.07	3.80	----------	----------	2.58	24.83	35.63	48.19	23.79	25.66
	70.59	*67.65*	*53.42*	*68.73*	*20.00*	----------	----------	*30.77*	*60.61*	*55.06*	*77.97*	*80.00*	*53.04*

Corn	8.25	4.08	22.07	2.66	1.14	----------	----------	----------	----------	4.44	10.86	.13	5.28
	11.76	*10.29*	*43.84*	*10.78*	*7.69*	----------	----------	----------	----------	*8.86*	*22.03*	*8.00*	*12.16*
Other grains	5.81	4.66	3.82	.81	.09	.02	----------	11.15	3.12	1.36	2.96	1.34	2.41
	29.41	*22.06*	*26.03*	*6.86*	*6.15*	*2.38*	----------	*30.77*	*10.61*	*6.96*	*10.17*	*12.00*	*12.16*
Total grains (volume)	55.12	30.48	42.81	39.54	5.03	.02	----------	13.73	27.95	41.43	62.01	25.26	33.35
Other cultivated crops	5.94	11.41	.10	----------	----------	----------	----------	10.70	3.93	19.70	5.78	10.21	7.27
	6.25	*20.60*	*9.59*	----------	----------	----------	----------	*19.20*	*16.67*	*54.40*	*18.65*	*28.00*	*20.14*
Wild fruits	(2)	1.38	4.53	2.11	25.54	6.74	47.01	43.11	5.00	2.20	.31	11.29	7.00
	5.88	*10.29*	*10.96*	*19.61*	*50.77*	*23.81*	*83.33*	*73.08*	*15.15*	*7.59*	*5.08*	*44.00*	*19.66*
Miscellaneous seeds	.75	1.76	5.51	1.14	.49	5.51	.83	4.96	.89	1.76	8.59	.62	2.71
	50.00	*20.60*	*47.90*	*26.42*	*16.92*	*21.40*	*16.67*	*15.38*	*21.20*	*26.59*	*33.95*	*36.00*	*27.50*
Total plant food (volume)	61.81	45.03	52.95	42.79	31.06	12.27	47.84	72.50	37.77	65.09	76.69	47.38	50.33

[1] Obtained by dividing total volume of food by total number of stomachs; not by adding average percentages for each month and dividing the total by 12.
[2] Trace.
[3] Hemiptera, Hymenoptera, Diptera, Isoptera, Neuroptera, and Odonata.
[4] Birds and their eggs, reptiles, amphibians, and fishes.
[5] Arachnida, Oligochaeta, Gastropoda, and Myriapoda.

ANIMAL FOOD

About half (49.67 percent) the food of the adult white-necked ravens was composed of an assortment of animal matter, including earthworms; spiders and scorpions; centipedes and millepedes; insects; snails; amphibians; reptiles; birds and bird eggs; and mammals, chiefly carrion. The animal diet was greatest during June while the birds were rearing their young and least in November when the birds could more easily obtain vegetable material (mostly grain sorghums).

INSECTS

One of the greatest benefits of birds to man is their destruction of harmful insects; and so, in order to appraise a given bird, one should know how many and what kinds of insects it destroys and weigh this evidence against its detrimental habits. In the present study insects contributed the greatest bulk of any class of animal food eaten by the adult white-necked ravens and were consumed by the birds during every month. Nearly two-thirds (63.78 percent) of the animal food and almost a third (31.68 percent) of the entire food consisted of insects. The year-round consumption was possible because of the mild winter climate that prevails over most of the bird's range. Even in midwinter there are warm days when a few insects are active and ground forms usually may be obtained by turning over ground litter, such as cow chips and small rocks.

The economic importance of insects in the raven's diet can be demonstrated only by separate discussion of the various types consumed. The following monthly consumption percentages of insects as a whole are of interest, however, as showing variations in response to the progress of the seasons: January, 8.81; February, 38.73; March, 22.66; April 24.61; May, 36.07; June, 77.29; July, 19.66; August, 22.26; September, 38.54; October, 29.34; November, 17.59; and December, 39.08. The insect foods are discussed in the order of their volumetric importance. The species identified are listed in table 5 (p. 47).

Orthoptera.—Grasshoppers and their allies ranked first among the insect foods in both volume and frequency of occurrence, forming 12.56 percent of the entire food, or 39.65 percent of the insect food, and being found in 56.01 percent of the stomachs. In eight stomachs (one taken in May, five in June, and two in September) they were the only food present. They were eaten during every month, reaching their high in both volume (60.32 percent) and occurrence (90.48 percent) in June, when the parents not only fed them to their young (p. 42) but themselves subsisted largely on them. They dropped to a low in the diet (1.5 percent) in January but even then were found in 29.41 percent of the stomachs.

The greater part of the orthopterous diet was composed of grasshoppers, which were represented chiefly by short-horned Acrididae although many long-horned Tettigoniidae also were identified. Of the 707 adult stomachs examined, 339, or 48 percent, contained 2,435 grasshoppers, an average of more than 7 a bird for those that ate them and of 3.4 a bird for the entire lot. If the data obtained from the nestling stomachs (p. 42) were incorporated, the average would be raised materially. From the figures given it is apparent what a beneficial effect thousands of ravens might have in reducing the grasshopper population.

The monthly grasshopper consumption was greatest in June, as the insects were then at their peak. It dropped off sharply in July, the small percentage for that month being due no doubt to the small number of stomachs available. If a larger series had been studied, the decline would probably have been less abrupt. Quantity variation in the grasshopper part of the diet was brought about also by the development of crops and the early maturing of wild fruits that decoyed the birds from the insects. In September both grasshoppers and fruit were reduced in the diet and the early maturing grain sorghums were compensatingly increased. In October, the month when most of the early grain sorghums are ripe and less palatable than in the dough stage and the early fruits are mostly gone, the birds again ate more grasshoppers.

The role that white-necked ravens play in grasshopper consumption can easily be seen in irrigated areas like that about Fort Stockton, Tex. While the farmers are irrigating their alfalfa fields, the spreading water keeps grasshoppers and other insects moving and there is always a group of white-necked ravens following the flow and catching the insects. Freshly mowed alfalfa fields also are visited by hordes of the birds seeking grasshoppers and other insects that are more easily caught when the vegetation is flat on the ground. In mesquite pastures from June until October it is common to see ravens jumping around in all directions to catch grasshoppers.

That many farmers, however, are not aware of the value of the white-necked ravens in destroying these grasshopper pests, is shown by the common assertion that they know of no good these birds do. One farmer, when informed of the grasshopper-destroying activities of the bird remarked that he was more convinced than ever that ravens were of no value because there were not enough grasshoppers for his turkeys as it was.

Other orthopterons commonly found in the adult raven stomachs were crickets, mantids and their egg cases, and phasmids (walking sticks). The adults of these species were eaten in summer, but the egg cases of the mantids were taken largely in fall and winter.

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As orthopterous insects have wrought more damage to plant life in the range of the white-necked raven than any other insect group, the raven's consumption of them is a definite point in the bird's favor.

Coleoptera.—Beetles were the second most important insect group in the food of the adult ravens, as they contributed 9.55 percent of the total subsistence, or 30.14 percent of the insect food. In all, 16 families were identified.

Weevils (Curculionidae), the most frequently eaten beetle food, furnished 4.49 percent of the entire diet, or 47.02 percent of the coleopterous food, and were noted in 38.61 percent of the stomachs. Remains of 2,835 individuals of 12 genera were found, more than 100 being present in each of 6 stomachs, 1 of which held 268. The four most common genera were *Ophryastes*, *Eupagoderes*, *Thecesternus*, and *Cleonus*.

Scarab beetles (Scarabaeidae), comprising dung beetles, leaf chafers, and others, came next. They supplied nearly 3 percent of the yearly diet, or about 29 percent of the beetle food, and were taken in every month, in greatest quantity in spring. Of the 11 genera represented, *Phyllophaga* (May beetles) and *Canthon* (tumblebugs) were commonest. Adult and larval May beetles occurred in more stomachs (80) and in greater volume than all the other Scarabaeidae present combined; and tumblebugs were found in 41 stomachs, in some of which they were an important part of the contents. Half of one raven's last meal consisted of 17 adult *Phyllophaga* and 10 *Canthon* specimens. Inasmuch as the scarabs as a group are predominantly harmful, the raven's consumption of them is to the bird's credit.

The 14 other beetle families, of which the Carabidae and Tenebrionidae were most prominent, were found in smaller quantities, aggregating only 2.29 percent of the birds' whole food, or 23.98 percent of the coleopterous diet. Of these 14 families, 7 (Anthicidae, Cebrionidae, Tenebrionidae, Cerambycidae, Buprestidae, Chrysomelidae, and Elateridae) are considered detrimental; 5 (Hydrophilidae, Dermestidae, Histeridae, Staphylinidae, and Nitidulidae), of neutral significance; and only 2 (Cicindelidae and Carabidae), beneficial.

Lepidoptera.—Moths and caterpillars ranked next lower than beetles in the adult raven's diet, averaging 6.64 percent of the entire food and being identified in 192, or 27.18 percent, of the stomachs. These insect pests, 6 families of which were identified, were eaten in every month except July and August but were taken most extensively during winter, when cutworms (Phalaenidae) predominated. More than 75 of these were found in each of 8 stomachs taken during February, 275 in 1 of the 8. During December, pupae and larvae of *Datana* sp. (oakworms) of the Notodontidae family were the dominant forms although cutworms also were evident.

Field observations revealed the source of some of these insects and the time of year eaten. During the winter it was common to see a hundred or more white-necked ravens feeding on the ground in cattle pastures. Although their presence there could not at first be explained, it was later noticed that almost every cow chip and small object on the ground had been turned over. A few of the larger chips that the birds could not manipulate were investigated, and beneath at least 75 percent of them cutworms were disclosed; 1 chip harbored 11. A number of farmers have told the writer that on several occasions these ravens have eaten so many cutworms in their young cotton as to obviate the usual necessity of replanting the crop; and many farmers in the irrigated alfalfa areas attest that these birds are a decided benefit in protecting the crop from the alfalfa caterpillar.

Although the cottonworm (*Alabama argillacea*) was not positively identified in the stomachs examined, many digested remains of larvae and adults similar to it were found that probably were that species. Early in September 1934 flocks of ravens were constantly being flushed from cottonfields. At first it was assumed that the birds were resting there, but close scrutiny disclosed that they were walking down the cotton rows looking from side to side, apparently in search of the worms. Moreover, the birds were observed only in cottonfields that were badly worm-infested.

Surely from man's point of view the lepidopterous part of this raven's diet can be listed among the bird's better qualities.

Hemiptera.—Bugs and leafhoppers (included in Other insects, table 3) were found in 171, or 24.19 percent, of the stomachs but formed only 1.51 percent of the entire food. Eaten in small quantities throughout the year, they attained their highest monthly food percentages during May and June. The variety taken was great, as forms of 28 genera were identified. Pentatomidae (stinkbugs), noted in 109 stomachs, were represented by more species than any other family of this order and were taken in greater volume and larger numbers than all the other Hemiptera eaten combined. Leafhoppers (*Stictocephala festina*), of the Membracidae, occurred quite frequently in the fall stomachs, reaching a high in October, when they appeared in 22 of the 31 stomachs that contained hemipterons, in 1 of which 203 leafhoppers constituted 40 percent of the contents. Forms of Cicadidae (harvest flies) and Reduviidae (assassin bugs) were unimportant food items, both in quantity and in frequency of occurrence. The squash bug *Anasa tristis*, of the Coreidae, was identified in a single stomach.

Although some of the Hemiptera eaten are harmful plant feeders, others are useful predators, so that the economic status of the raven is not greatly affected by the mixed diet.

Other insects.—The remaining 5 orders of insects found in the adult stomachs made up only 1.42 percent of the food. They comprised Hymenoptera (bees, wasps, ants, etc.), Diptera (two-winged flies), Isoptera (termites), Neuroptera (lacewing flies, ant lions, etc.), and Odonata (dragonflies and damsel flies). The Hymenoptera taken, of which 11 families and 20 genera were identified, were mostly small ants that were probably eaten accidentally while adhering to other foods or while contained within the stomachs of such foods as lizards and amphibians. The parasite *Brachymeria ovata* was present in every case with pupal specimens of the *Datana* moth, and it, as well as the other Chalcidae and parasitic Ichneumonidae noted, probably was ingested with lepidoterous food items. The Diptera were not all identified beyond the 8 families noted, but 5 genera were recognized, mostly larval and pupal forms that were associated with carrion taken by the birds. The Isoptera consumed were unimportant as food because of their small size. Some of them may have been eaten incidentally with other foods. The Neuroptera were represented by one occurrence of an aphis lion (*Chrysopa*) and the Odonata by a single damsel fly (Zygoptera).

The economic importance of these five insect orders is so varied and the quantity of them taken was so small that their presence in the raven's diet does not greatly affect an estimate of the bird's economic status.

ARACHNIDA

Spiders and their allies (table 5, p. 47) were frequent items in the summer diet of the adult birds but composed less than 2 percent of the food volume for that period. Araneae were found in 7 percent of the stomachs, most of which were collected during the nesting season. As the spiders' soft bodies doubtless hasten the ravens' digestion of them, the record of the frequency of their occurrence may be more informative than that of their volume. Only spiders of the family Lycosidae were recognized; undoubtedly other families were present, but most of the material was in a condition too fragmentary for identification. Harvestmen, or daddy longlegs (Phalangiida), were found in only 7 stomachs and so are not an important food even though 1 bird had eaten 35. Solpugids, which because of their soft bodies were detected mostly by their chelicerae, occurred in 29 stomachs, comprising only a trace of the contents in most of them but forming 10 percent of the volume in 2. Scorpions were identified in 10 stomachs but supplied only a very small part of the contents.

The quantity of Arachnida eaten by the adult birds was so small that very little economic significance can be attached to it. In the nestling diet, however, spiders composed a much larger percentage of the food volume and occurred much more frequently (p. 43).

OTHER INVERTEBRATES

Of the invertebrates eaten exclusive of insects and Arachnida the lowest form recognized in the adult raven stomachs was an earthworm (Oligochaeta). A few snails (Gastropoda) were found, but the remains were mostly fragmentary. Some Myriapoda (both centipedes and millepedes) were noted frequently, but usually in small quantities.

MAMMALS, CHIEFLY CARRION

Mammals, mostly carrion, were the second largest group in volume (13.63 percent) among the animal foods of the adult ravens and occurred in 278, or 39.32 percent, of the stomachs. They were taken in every month, with the 3 highest monthly volumetric percentages being recorded for July, April, and January (table 3; fig. 7). In all, 14 mammalian genera were identified (table 5, p. 47).

The cow remains and also many of the unidentified carrion items were found in stomachs collected in August and September 1934, when large numbers of cattle were being slaughtered in the program of drought relief. The carcasses in the fields and the huge bone piles at the emergency canneries attracted large flocks of ravens and so played an important role in reducing raven damage to crops in those areas. Most of the sheep remains were found in stomachs obtained in April and May during the lambing season, the period of greatest natural sheep losses, when the abundant food supply made available by the dead animals draws large numbers of ravens. The single dog and skunk occurrences, as well as many of the rabbit and rodent items were probably highway carrion.

Rabbits.—Rabbits were consumed more frequently than any other mammal. They were identified in 125, or 17.68 percent, of the stomachs as follows: *Sylvilagus* spp., in 11, *Lepus californicus* in 2, and undetermined rabbit in 112. In 8 of the stomachs immature animals were found and in 1 an embryo. The immature specimens may represent kills made by the ravens, but it is doubtful whether mature rabbits often are attacked by the birds. The adult jack rabbits eaten probably all represent carrion, as it is common to see white-necked ravens feeding on rabbits and other animals that have been killed along highways.

Rodents.—The squirrels, kangaroo rats, and other rodents consumed might also have been highway carrion, or they could have been picked up after rodent control campaigns. White-necked ravens commonly flock to prairie dog towns that have been treated with poison grain and feed on the dead animals. They relish the eyes particularly, so that by 10 o'clock the morning after a poison treatment it is almost impossible to find a dead rodent that has not had its eyes pecked out. In all, rodents of seven genera were eaten by the ravens

but by so few that the effect of these birds on control of rodent populations is probably of little consequence.

Raven-sheep relationship.—Serious complaints of raven damage to sheep are confined mostly to Midland, Glasscock, Upton, and Reagan Counties, Tex., for although areas to the east, west, and south of these counties also support many sheep, the ravens there are so scattered that the damage they might do is negligible. These particular counties have a greater raven population and consequently a greater sheep loss because they are just south of one of the bird's heaviest winter concentration areas and because they provide not only splendid nesting sites but also an abundant food supply early in spring when sustenance in the winter home is becoming scarce. The principal food attraction is the large number of dead sheep and lambs.

Early spring is the critical time for sheep, as the ewes, heavy with lamb, may be weakened by the limited food supply. The death rate at that time, ordinarily high, in recent years has been increased by losses from bitterweed poisoning, so that mortality among the ewes and newborn lambs is considerable. Moreover, during delivery the ewes often become partially paralyzed and when this occurs make no attempt to protect themselves, thus becoming subject to raven attack (fig. 8). Although the ravens do eat dead and decaying flesh they prefer fresh meat, and this often leads to their preying upon newborn lambs that are not yet able to get up and defend themselves. However, information obtained from the sheepmen and observations made by the author prove conclusively that the birds attack only the weaker lambs, most of which would have died anyway.

The first objective of attack by the birds is the eyes, and by 10 a. m. scarcely a dead lamb can be found in the pastures that has not at least one eye missing and more than likely both (fig. 8). The tongue, navel, and rectum are also attacked by the birds, but it is the raven's insatiable liking for the eyes that places the bird on the sheepman's black list. At times the birds remove the eyes even before the animals are dead.

The sheepmen have no accurate or uniform method of telling whether the dead lambs with eyes missing were killed by ravens or of determining whether the eyes were removed before or after death. Some sheepmen think that the lambs with blood around the eyes are raven victims; others believe that only those with the eyes out and the body not yet rigid have been killed by the birds; and still others are of the opinion that practically all dead lambs are raven kills.

A cross section of the opinions of the sheepmen regarding ravens was obtained by interviewing 51 individuals in Glasscock and Upton Counties, Tex., in April 1936. These men owned about 114,600 sheep on 366,720 acres of land. Their 85,950 bred ewes were expected

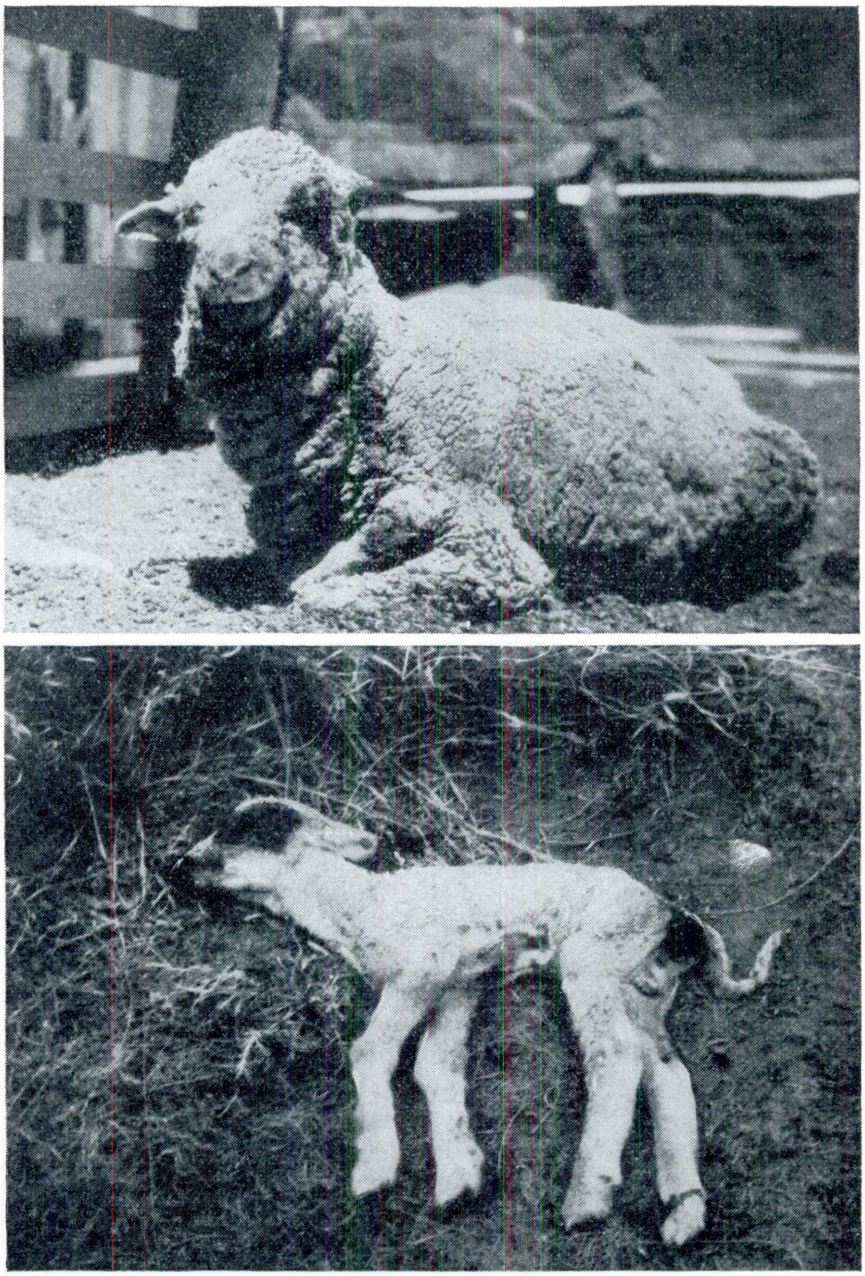

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FIGURE 8.—*Above*, Ewe with one eye pecked out by ravens while she was in labor; *below*, dead lamb from which ravens have removed eyeball, tongue, navel, and rectum.

to drop about 81,650 lambs during the spring, as in the opinion of a number of sheepmen an average of 95 lambs is born to each 100 ewes that are bred.

The 51 estimates of the percentage of lambs that would not otherwise have died that are killed annually by ravens ranged from 0 to 8 and averaged 1.2 percent. Estimates in the area where the more serious losses occurred averaged 2.4 percent, just double that for the whole region studied. Sheepmen in this area report raising between 65 and 75 percent of their annual lamb crop, which means that between 35 and 25 percent of all lambs born are lost from all causes. Even if the larger percentage, 2.4, is deducted as representing the lambs killed by ravens, it still leaves from 32.6 to 22.6 percent of the lamb deaths to be accounted for. The sheepmen all agreed that the principal cause of lamb loss to ravens is adverse weather, as cold spells during spring cause the newborn lambs to "chill down" and thus make them more vulnerable to bird attack.

Many sheep in the area studied die annually from the effects of screwworm infection and bitterweed (*Actinea odorata*) poisoning, and the consensus of the 51 sheepmen was that losses from both these causes were greater than from raven depredations. As an aid in abating screwworm abundance the ranchers are advised to dispose of all dead animals, either by burying or by burning. The sheepmen in the raven territory are extremely lax in this respect, and were it not for the ravens' consumption of carrion much more of it would be left as an inviting home for screwworms. This good that the ravens do may in part compensate the rancher for the losses they inflict.

About half the sheepmen considered their losses from ravens serious enough to justify paying for control; the rest either doubted that control was necessary or objected to paying for it because they thought the losses did not warrant the expense.

The remedies for raven depredations on sheep are: Control of the birds, which can be accomplished by trapping and nest destruction (see Control Measures, p. 53); and improvement in lambing conditions. Many of the sheepmen admitted that their lands were overstocked, a practice that results in weakened ewes that produce lambs of lowered vitality. If the sheepmen would reduce their stock to the proper carrying capacity of the land and increase their personnel during the lambing season so that the newborn could be given more immediate attention, there would be fewer weakened lambs and these would have a better chance of survival.

BIRDS AND THEIR EGGS

Remains of birds and their eggs were found in 52, or 7.36 percent, of the adult raven stomachs (table 5, p. 47) and supplied 1.56 percent

of the entire food (included in Other vertebrates, table 3). Egg remains occurred in 24 stomachs and in some formed a substantial part of the contents—as much as 80 percent in 1. Those in 12 of the stomachs were identified as chicken eggs; those in the other 12 were not determined. In 2 stomachs both a chick and eggshells were found. Remains of domestic chickens were noted in 18 stomachs and of birds of uncertain identity in 14. The scaled quail (*Callipepla squamata*) was identified in 3 stomachs and contributed 35, 5, and 1 percent of their contents, the 5 percent being supplied by a chick. Mourning doves (*Zenaidura macroura*) were eaten by 7 ravens and furnished as much as 33, 48, 50, 60, and 80 percent of the food of 5 of them. As 1 of the doves was eaten in August just 6 days before the dove hunting season opened and the others were consumed in September during the early part of the open season, it is possible that all 7 doves were unretrieved birds that had been killed or crippled by hunters. Passerine birds were noted in 10 stomachs. There were 6 Fringillidae (sparrows, finches), 1 of which furnished 93 percent and another 60 percent of the contents of single stomachs.

White-necked ravens are often accused of destroying the eggs and young of poultry, and other bird life as well, and the results of the stomach analyses substantiate the charge. Several farmers have told of seeing ravens closely watch a turkey during the laying period and then swoop down and eat the freshly laid egg as soon as the turkey left the nest. Two of the birds banded in the course of this study subsequently were killed because they were thought to be catching young chicks.

Merely to state that the ravens feed on poultry and their eggs without explaining the source of the food may lead to erroneous conclusions, however. Rarely have these birds been seen taking eggs from nests close to the hen house; most of the depredations are at nests out in the brush or on strawstacks or in other places away from buildings. Turkeys have the habit of trying to hide their nests, and many farmers think they will not nest unless permitted that freedom. Raven predation on eggs or young birds around the poultry yard is an action to be condemned and controlled, but similar activity at outlying nests should in a measure be condoned as it is due in part to man's carelessness. Egg fragments, too, may come from yet other sources. Ravens commonly feed along highways and around school grounds on lunch scraps that may contain eggshells, and once the writer saw a flock of ravens near Pecos, Tex., feeding on eggs that had been broken in a car wreck.

It is doubtful whether the passerine birds found in the stomachs were killed by the ravens. Most small birds are more agile than the raven and would scarcely be caught unless sick or crippled. The

writer has never seen any signs of ravens being aggressive against adult birds of other species; on the contrary he has commonly seen such birds as the scissor-tailed flycatcher making life miserable for the raven.

Remains of wild birds or their eggs in the raven's food are indicative of objectionable habits only when the raven has killed young birds or has pilfered nests. When the eggs have been gleaned from deserted nests or when infertile unhatched eggs and dead birds have been fed upon, the acts must be considered of neutral significance.

REPTILES, AMPHIBIANS, AND FISHES

Reptiles, amphibians, and fishes together made up only slightly more than 1 percent of the food of the adult ravens (included in Other vertebrates, table 3), but they occurred in almost 10 percent of the stomachs. The largest quantity was taken in May, but if to the number consumed in June, the month when the adults started feeding the young, were added the number fed to the nestlings during the month, the total destroyed by the adults would be about the same as in May.

The forms identified in this lower vertebrate food are listed in table 5 (p. 47). Reptiles, including lizards, snakes, and turtles, predominated. Lizards were taken most frequently, and of the 5 genera represented, *Phrynosoma* (horn-toads) was by far the most important. Amphibians, consisting of salamanders, toads, and frogs, were noted in 15 stomachs. The single fish eaten was a small minnow, probably found dead.

The insect-destroying activities of amphibians and reptiles, of the smaller lizards particularly, make the presence of these vertebrates in the raven's diet a point in the bird's disfavor; but the quantity taken was so small that the economic significance is slight.

PLANT FOOD

Vegetable material occurred in 608, or 86 percent, of the adult stomachs and formed 50.33 percent of the total food. It was eaten in every month and formed as high as 76.69 percent of the food volume in November and 72.5 percent in August. The plants consumed most commonly and in greatest quantity were the grain sorghums, but wild fruits and corn were relished also. It is the raven's great liking for certain cultivated crops that makes it so serious a problem to the farmers. The plants noted in the stomachs are listed in systematic order in table 5 (p. 47).

GRAIN SORGHUMS

Slightly more than half the vegetable diet of the adult ravens consisted of grain sorghums. They supplied 25.66 percent of the yearly

food; were eaten by 375, or 53.04 percent, of the birds; and were taken in every month except June and July. The varieties with softer kernels, such as milo, hegari, and kafir, were preferred to the harder Sumac (Red Top) sorgo.

The quantity eaten fluctuated from month to month, as is shown in table 3 and figure 7. This may be due in part to too small a series of stomachs, but it may also represent definite trends in the bird's habits that can be explained only by knowledge of conditions in the field. After the nesting season is over the ravens move into the farming areas and as soon as the grain sorghums have developed to the dough stage start eating them. This is generally in August, and in that month these grains were found in 30.77 percent of the stomachs examined and formed 2.58 percent of the food. That the volume consumed rose abruptly in September, increased in October, and reached its high in November (48.19 percent) reflects the stages of development and availability of the grain during these months. Not only does the late crop far exceed the early one in acreage, but most of it matures in November. The large quantity eaten during January may represent a loss of some grain still in the shock, but it is made up chiefly of waste grain gleaned from the fields. The decline in February and March is brought about by the small quantity of sorghums then available and by the increase of insect and mammalian food in the diet. The rise in April is due to the fact that, other foods being scarcer, many stockmen feed bundles of the grain to the cattle in the pastures and that ravens eat the part that is shelled out—which would otherwise be wasted—and pick out the undigested kernels from cow dung. The sharp drop in May is because choicer foods then become more available and tempt the birds to a more varied diet.

The losses inflicted by white-necked ravens on grain sorghums in general and on milo, hegari, and kafir in particular—because of the great acreages of these grown and the long period of their availability—are greater than on all other crops. The birds prefer the sorghums in the late dough stage but readily take ripe seed also. Maturing grain can be found from August until late November, and ripe grain is available in shocks and stacks from that time on until late spring.

In the areas of more concentrated raven populations it is not uncommon to find fields of grain sorghums that have been severely damaged by the birds, as flocks of 50 to 500 may alight in a field and inflict heavy losses if left undisturbed. Whenever the birds band together, particularly during drought years when food is scarce, they present a much greater problem than normally. Such a situation calls for continual vigilance with a shotgun and a quick harvest as soon as the grain matures. In late winter and in spring, again especially in

years when drought has drastically reduced the food supply, considerable trouble is experienced with the ravens eating the grain from stacks and ricks. At such times close minding the grain or covering it is necessary.

Texas is the leading State in the production of these grains, which are grown mainly in the western half of the State in an area that coincides closely with that of heavy raven concentrations. There are large acreages of the crop in the Panhandle of Texas, too, but the ravens are relatively scarce there, principally because the plains country does not afford the brush necessary for roosting.

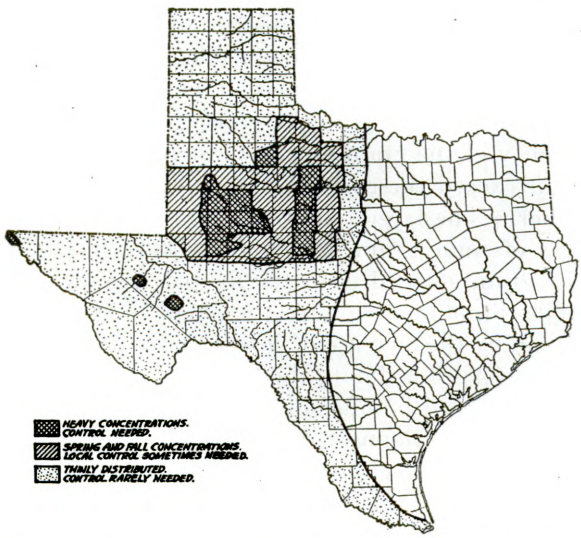

FIGURE 9.—Distribution of the white-necked raven in Texas, with the eastern limit indicated by the heavy line between the stippled and white areas.

The raven's distribution in Texas is shown roughly in figure 9. In the areas of heavy concentrations (cross-hatching) control activities are justified; in those of only spring and fall populations (hatching) some local control at times may be needed, but because of an abundance of choice food it is usually impracticable and frightening devices are more useful; and in the areas where the birds are scattered (stippling) control is very seldom necessary, as only small local aggregations are possible and in most instances are comprised of so few birds that the damage inflicted is slight.

There is enough migratory movement among the ravens for damage to be wholly seasonal in some parts of their range. Along the northern part of Texas adjoining Oklahoma, in extreme western Texas, and in eastern New Mexico most of the birds retire from agricultural to range lands for nesting. In August, the young birds, able by that time to fly, accompany the adults to the nearest farming areas, where they all sojourn until about November. Then they move into more southern agricultural districts for the winter, dispersing again early in March for nesting.

Other birds, particularly blackbirds and lark buntings, also feed

heavily on grain sorghums, and often the ravens are blamed for the injury they do. Raven attack can easily be distinguished from that of smaller birds, however. The latter pick out the individual kernels and seldom leave any waste, whereas the ravens in an attempt to get several kernels at once eat the grain with a chopping action of the beak that results in many broken and cut kernels on the head and considerable waste on the ground. Recumbent grain heads that have been fed on by rodents and rabbits may resemble those worked on by ravens, but in such instances droppings or tracks may serve to identify the pilferer.

CORN

Corn is a minor crop in the raven territory, where, except for parts of Terry, Yoakum, and Gaines Counties, Tex., and eastern Lea County, N. Mex., it is raised only in small patches for home consumption. In the counties named it is grown on a commercial scale and so suffers proportionately greater loss from ravens.

The most frequent criticism of the ravens in relation to the corn crop is that they damage the grain while it is in the milk, or roasting-ear, stage. After they have torn open the husks and eaten some of the succulent kernels, water and spores may enter and ear rot result. This type of injury is pernicious, as consumption of only a few kernels may result in loss of an entire ear. No corn was found, however, in any of the stomachs collected during the 4 months June through September, the main roasting-ear season. This does not mean that the damage cited is mythical; rather it reflects the small quantity of corn grown in the raven territory and the fact that a very small consumption by many birds may mean severe loss locally.

Very little complaint is voiced against the raven for pulling planted corn. The explanation is threefold: (1) The patches of corn are small and widely scattered; (2) at this period the insect supply, which is preferred to corn, is bountiful; and (3) the ravens are engaged in nesting activities, largely in pastures many miles distant from the farming sections.

Corn was found in 12.16 percent of the adult raven stomachs, comprised 5.28 percent of the food, and reached its high in the monthly diet (22.07 percent) in March.

The chief source of the corn eaten in November, when it formed about a tenth of the food, was unharvested grain (fig. 10). Unless the crop is closely minded while in the field the ravens will damage it severely. The writer has seen many fields where they have removed more than 50 percent of the grain from the ears. Because the acreages of corn grown are small it is easier to keep the ravens out of this crop than out of crops grown in larger acreages.

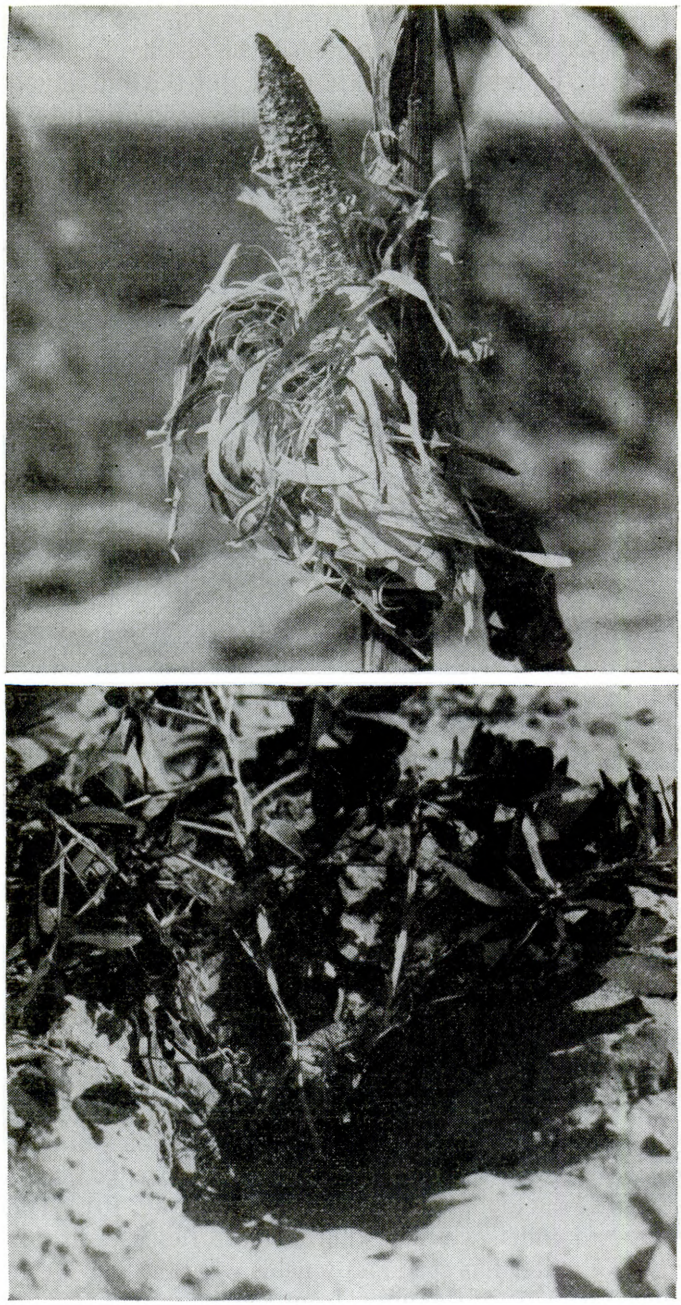

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FIGURE 10.—White-necked raven damage to crops: *Above*, to mature corn; *below*, to peanuts, showing that the nuts have been removed from the soil beneath the vine.

The mere presence of these birds in a cornfield, however, does not always prove that they are eating the grain. In September 1934 the writer flushed about 25 ravens from a cornfield in Terry County, Tex., and fully expected to find that they had done serious damage. Examination of the corn showed, however, that it was very wormy and that the worms and plant lice had practically ruined the tassels and young ears. The ravens had been tearing open the husks and eating the worms. The ears thus exposed likely would have developed rot, but this damage would have been no greater than the injury the worms would have caused.

Most of the corn eaten during late winter and early spring was gleaned from feed lots, hogpens, and poultry yards. At this time of year the available food supply is lowest and the birds forage over wide areas They are attracted to the environs of small towns and to farmyards and stock-feeding lots, and when they feed in these places corn is likely to form an important part of their diet. One series of March birds that was collected near a feeding pen had partaken freely of corn.

For the most part then the corn in the raven's food must be classed as a direct loss to man, inasmuch as most of it represents either destruction of the crop or consumption of poultry and livestock feed and very little of it indicates utilization of waste grain.

OTHER GRAINS

The other grains in the raven diet, including oats, wheat, barley and rye, were taken in small quantities in every month but July, oats more often than all the others. This food was derived mainly from harvest waste, grain distributed in rodent-control campaigns, poultry and stock feed, and dung. The greatest monthly consumption (11.15 percent), which was for August, represented mostly waste grain; and the oats contained in one small series of winter stomachs had been cooked, showing the source to have been hog or poultry feed. Relatively little complaint about the ravens eating small grains is made, however, as in the raven territory most of these mature in June when insects are so abundant as to decoy the birds away from the less palatable grain food.

OTHER CULTIVATED CROPS

Under this caption are grouped peanuts, watermelons, cantaloups, honeydew melons, tomatoes, castor-beans, sunflower seeds, and pears. These aggregated 7.27 percent of the adult annual food, with peanuts forming slightly more than 2 percent, melons a little more than 4, and the others a little less than 1.

Peanuts.—The total peanut acreage within the raven belt is not large, being confined principally to a few sandy areas in northern Taylor, southern Jones, and Eastland, Callahan, and Comanche Counties. When raven damage to peanuts occurs it is usually severe, and as the birds are adept at digging out the nuts without disturbing the vines it is often inflicted before the farmer is aware of what is happening. The birds begin to dig the nuts when they start forming in August and continue to feed on them until the crop is taken from the field, usually early in October (fig. 10).

Peanuts occurred in greatest quantities in the stomachs collected during December, January, and February, when they represented either waste from the field or livestock feed. About half those found in the February stomachs came from chicken or hog feed composed of cooked peanuts, milo, and oats. Peanuts were unimportant in the food during August, September, and October, the months when there is most trouble with the birds in this crop. This is because they are only very locally cultivated and few of the stomachs were collected in the vicinity of peanut fields.

Scaring devices are the only means by which the birds can be kept out of peanut fields (p. 52), as the abundance of food at the time damage is done makes the use of traps or poison very ineffective. It is desirable and practicable to stack the peanuts around a pole with the nuts to the center to reduce losses during the curing period and then to speedily remove the whole crop from the field as soon as it is cured.

Melons.—Evidences of watermelons and cantaloups were found in 115, or about one-sixth, of the stomachs examined. Seeds chiefly were noted; rarely was any flesh discernible. Melons were eaten to a greater extent following rather than during the main melon season. During July, August, and September the melons are at their best, but of the birds examined only 3 had eaten them in August and 8 in September. The probable reason for this is that the farmers of Texas are very fond of their watermelons and cantaloups and make special efforts to keep the birds away from them until their own desires are satisfied or the main part of the crop has been harvested. When prices drop or when most of the good melons have been eaten, the strict guard over the crop is relaxed and the birds start feeding in the fields in large numbers. During October and November, ravens could almost invariably be found in or near unprotected melon fields, and many of the stomachs representing those months were collected from such fields.

The real loss from raven damage to melons is not in the bulk actually consumed but in the large number of melons pecked and left with holes through which bacteria and fungi enter and ruin the fruit. If the birds would confine their feeding to one melon until it was completely eaten before pecking into others, less fruit would be injured

and the loss would not be great; but by their procedure in a very short time they often cause a very great many melons to spoil. It is extremely disappointing to a farmer and his family to go through the hot, dry summer anticipating melon feasts, only to find that the ravens have been in the patches first. It is this disappointment more than the economic loss that creates the antiraven feeling among farmers, many of whom have told the writer that they would rather lose 5 or 10 acres of grain sorghums than their little melon patch.

Where melons are grown on a commercial scale, if the crop were not protected the loss per acre from ravens would undoubtedly exceed that resulting from all other raven depredations combined.

Prevention of damage rather than control of the birds is suggested during the melon season. This can best be accomplished by the use of frightening devices (discussed on pp. 52 and 53) and by having the home melon patch close to the house so that it may be better guarded. Protection is often afforded, too, by sprinkling the melons with lime or whitewashing their tops or by covering them with sacks when they are about full grown. It is appreciated that the type of soil near the farmhouse is not always favorable to melon production and that the ravens may visit the patch while the family is away; nevertheless, planting near the house is one of the most effective ways of getting the melons through the season without undue loss.

The wild "pie melon," or citrus melon, is common in parts of the raven territory and is eaten by the raven as well as by rabbits, rodents, and cattle. The birds' consumption of this food can hardly be considered detrimental, as the melons have little economic value, even though a few are used for preserves.

WILD FRUITS

Wild fruits were important in the diet, as they formed 7 percent of the yearly food, were eaten by 19.66 percent of the birds, and were taken in every month. In January and November they supplied only a small part of the food, less than 1 percent, but in the other months were eaten in larger quantities, furnishing more than a tenth of the food in December, about a fourth in May, and nearly half in July and August (table 3; fig. 7). Such a high consumption of wild fruits during the latter 2 months naturally helps keep the birds out of the watermelons and early grain sorghums, which are maturing at that time.

The species identified numbered 22. The pulp and seeds of "cactus apples," or pricklypears (*Opuntia*), which were eaten more often than any other wild fruit, formed their greatest bulk in the diet in July and August. Practically every raven shot in those months had fed on these deep red fruits, as evidenced by red stains on their

feet and vents. Fruit of buckthorn (*Condalia*) was important in May and June, and hackberry (*Celtis*) was the dominant wild fruit food in the fall and winter months. The remaining species were eaten so infrequently that little significance can be attached to their presence in the diet.

MISCELLANEOUS SEEDS

Seeds of weeds, grasses, and other plants formed a minor part of the adult ravens' food but were found in stomachs collected in every month except June. They embraced 41 genera, of which 9 were wild grasses and 1 a sedge. Seeds of the unicornplant (*Martynia louisiana*) and sunflower (*Helianthus*) predominated. Many of the smaller seeds were no doubt taken accidentally with other foods. The effect these birds have on the control of weeds is slight and does not contribute much to their credit.

MISCELLANEOUS ITEMS

Cheese occured in a single stomach and paper and rubber bands in two and three stomachs, respectively. The cheese and paper doubtless were taken from luncheon debris along the highway. The elastic bands merely illustrate the curious nature of these ravens. Glass marbles and rubber bands were found among the pellets at roosts on several occasions.

FOOD OF NESTLINGS

Inasmuch as each pair of ravens produces an average of four young annually, the nature of the food consumed by the nestlings is of importance in an economic appraisal of the species. Young in nests can be found from late May until the latter part of July, so that their food habits are of consquence over a 2-month period. The nestlings are fed by the parents for 3 or 4 weeks, after which they forage for themselves.

The interpretation of items in the diet of nestlings is somewhat different from that of like items in the food of adults. For instance, mouse remains in the stomach of an adult usually indicate an entire individual eaten but in the stomach of a nestling may mean only part of a mouse consumed, as a single victim often is divided among a brood and so at times may account for as many as six occurrences.

In all, 120 nestling stomachs were examined, 8 of which were collected during May and 112 in June. It is regretted that no stomachs were available for July, but doubtless the food for that month would not have differed much from that for June. Probably the only item that would have shown an increase is wild fruits. The volumetric and occurence percentages of the principal food groups are presented in order of volumetric importance in table 4, and the

volumetric food percentages are illustrated graphically in figure 11. The food items are listed systematically in table 5 (p. 47).

The thin and delicate nature of the nestling's digestive tract makes it imperative that the young bird be fed easily digested foods almost exclusively; thus it is not surprising that animal matter formed about 99 percent and vegetable matter only a little more than 1 percent of the food of the 120 nestlings. The stomachs of even the older nestlings were thinner walled than those of adults and were also larger and so of greater capacity.

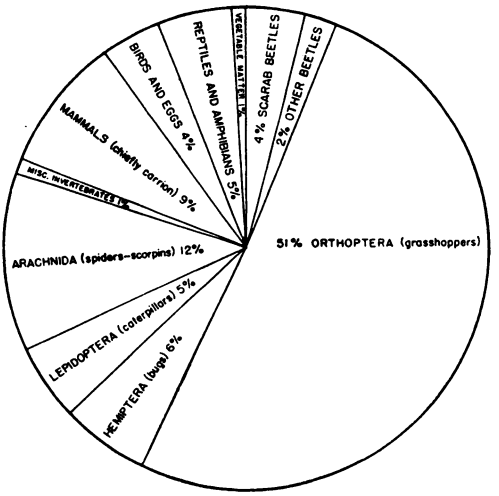

FIGURE 11.—Food of 120 nestling white-necked ravens. Each sector represents the volumetric percentage of the food named. Table 4 presents both volume and occurrence percentages.

TABLE 4.—*Volume and occurrence percentages of principal food groups in the diet of 120 nestling white-necked ravens in May and June*

[Volume percentages are presented graphically in fig. 11]

Food group	Percentage	
	Volume	Occurrence
ANIMAL FOOD		
Insects:		
Grasshoppers and allies (Orthoptera)	51.21	99.17
Beetles and weevils (Coleoptera):		
Scarab beetles (Scarabaeidae)	3.98	49.17
Ground beetles (Carabidae)	1.52	32.50
Darkling beetles (Tenebrionidae)	.45	3.33
Weevils (Curculionidae)	.03	10.83
Other beetles [1]	.18	20.83
Total Coleoptera	6.16	
Bugs (Hemiptera)	5.83	58.33
Caterpillars (Lepidoptera)	4.74	38.33
Other insects (Diptera and Hymenoptera)	.28	15.83
Total insects	68.22	
Spiders and allies (Arachnida)	11.59	75.00
Mammals, chiefly carrion	8.82	36.67
Reptiles and amphibians	5.52	20.83
Birds and their eggs	3.78	15.83
Miscellaneous invertebrates (centipedes, millepedes, and snails)	.75	12.50
Total animal food	98.68	
PLANT FOOD		
Vegetable fibers, milo, weed seeds, and wild fruit	1.32	15.83

[1] Cicindelidae, Silphidae, Histeridae, Elateridae, Buprestidae, Phalacridae, Cerambycidae, and Chrysomelidae.

ANIMAL FOOD

The animal part of the nestling food was composed of a variety of forms from arthropods and snails to reptiles, birds, and mammals; but most of it consisted of insects, which contributed more than two-thirds (68.22 percent) of the entire food.

INSECTS

Orthoptera.—Grasshoppers and their allies supplied more than half (51.21 percent) the nestling diet and were present in 99.17 percent of the stomachs. Mantids (Mantidae) were found in 5 stomachs and crickets (Gryllidae and Stenopelmatinae) in 3, but practically all the orthopterous food was composed of grasshoppers of the families Acrididae and Tettigoniidae. These made up 50 percent or more of the contents in 69 stomachs and 90 percent or more in 12.

In all, the remains of 1,803 grasshoppers were found in the 120 nestling stomachs, an average of 15 a stomach. The average number eaten by each adult in June was 12. Considering the raven brood to be 4, then at each feeding period during June each nesting pair of ravens destroys at least 84 grasshoppers. As the adult stomachs usually are filled and emptied twice during the day and the nestling stomachs, being larger, undoubtedly oftener, to compute the number of grasshoppers destroyed by a nesting pair daily the 84 may be doubled at least, giving 168—a conservative figure.

The economic importance of these insects in the June diet can better be shown by some hypothetical figures based on counts made at a few of the raven roosts known to be in existence, the population of which was conservatively estimated at 106,400 birds. Assuming an equal distribution of sexes and 80 percent of the birds breeding, there would be 42,560 pairs of ravens each raising an average of 4 young. Applying the above figure of 168, the total number of grasshoppers eaten daily during the month would be 7,150,080.

The number of grasshoppers found in the individual stomachs of a brood of nestlings gives indication that the young are afforded nearly uniform care, as in numerous broods each nestling had received the same or nearly the same number of these insects. It makes one wonder whether ravens can count or can recognize the young individually.

Coleoptera.—Beetles (6.16 percent) ranked second in volume in the insect food of the nestlings as they did in the adult diet. Scarabs (3.98 percent) were the most important; and of these May beetles (*Phyllophaga*) furnished the greatest percentage and a limited variety of both plant-feeding and coprophagous forms made up the remainder. Next in importance were the carabids (1.52 percent), both plant-feeding and predaceous species. Other beetles, representing at least

10 families of varying economic worth, constituted an unimportant part of the diet, even in the aggregate (0.66 percent).

Hemiptera.—The true bugs were the next most important order (5.83 percent) in the insect diet. The families represented most frequently were the Pentatomidae (stinkbugs) and Cicadidae (harvest flies). Apparently stinkbugs, though obnoxious to the human sense of smell, are not particularly distasteful to ravens.

Lepidoptera.—Moths and caterpillars (4.74 percent) were found in 46 nestling stomachs but in only 6 contributed 25 percent or more of the food, the largest percentage being 58. The order was represented primarily by larval forms (caterpillars), which occurred in a third of the stomachs; but a few adults and one cocoon were noted. The larvae were not identified beyond the order, but undoubtedly a good many were Sphingidae (sphinx or hummingbird moths) and Phalaenidae (cutworms).

Other insects.—All the other insects eaten by the nestlings made up only 0.28 percent of the diet. They comprised undetermined forms, noted in one stomach, and three orders: Hymenoptera, represented by a wasp (Vespidae), a spider wasp (Psammocharidae), and a bee (Panurgidae); Diptera, consisting of a midge (*Cricotopus*), an ox warble (*Cuterebra*), and Muscidae of the species *Chrysomia;* and Mallophaga (bird lice).

ARACHNIDA

Spiders and their relatives are important sources of food for the nestlings and because of their soft bodies are especially suitable for the newly hatched birds. These eight-legged animals formed 11.59 percent of the nestling diet and were found in three-fourths of the stomachs. The adults during the same period that the nestling stomachs represent (May and June) obtained less than 3 percent of their diet from this source. Spiders formed the greatest bulk of the arachnid food and occurred more frequently than other members of the group, but as their soft bodies made identification difficult only a few families were recognized. The number of spiders consumed by individual nestlings was small, usually from one to three. Inasmuch as the Arachnida are largely insect predators, their presence in the raven's diet can only be to the bird's discredit.

OTHER INVERTEBRATES

All other invertebrates eaten, including centipedes, millepedes, and snails, together formed only 0.75 percent of the nestling food.

MAMMALS, CHIEFLY CARRION

Mammal items were found in a few more than a third of the nestling stomachs and made up 8.82 percent of the food. Such forms of

carrion of larger animals as bone, hair, and flesh were found in 7 stomachs; and remains of rabbits, probably also of carrion origin, in 10. Pocket mice (*Perognathus*) remains were noted in 27 stomachs; but this figure does not represent that many mice killed, because 1 individual was usually divided among a brood. Remains of a white-footed mouse (*Peromyscus*) and of a harvest mouse (*Reithrodontomys*) were found in a single stomach each.

REPTILES AND AMPHIBIANS

The reptiles and amphibians (5.52 percent) eaten by the young ravens consisted mostly of lizards, although toads, a box turtle, and the burrowing snake *Tantilla nigriceps* were taken by a few nestlings.

BIRDS AMD THEIR EGGS

Birds, including domestic poultry, and their eggs formed 3.78 percent of the young ravens' food. In all, 13 stomachs contained fragments of eggshells, including those of domestic chicken, prairie chicken, a mourning dove (possibly), and other birds not identified. The prairie chicken eggs were eaten in Oklahoma in the heart of an area well suited to these game birds, but the person who collected the ravens involved did not feel that the ravens were a serious menace to the prairie chickens.[4]

PLANT FOOD

The vegetable part of the nestlings' food was composed largely of plant fibers ingested incidentally with such foods as grasshoppers and spiders, but there was also at least one occurrence of each of the following fruits: Buckthorn (*Condalia*), cherry (*Prunus*), blackberry (*Rubus*), and mulberry (*Morus*).

SUMMARY OF FOOD HABITS

Laboratory examinations of 707 adult and 120 nestling stomachs of the white-necked raven and field examinations covering almost every month show the bird to be an omnivorous and resourceful feeder and demonstrate that its seasonal food is governed largely by the factor of availability. In all, 288 different items (214 of animal and 74 of vegetable origin) were identified (table 5, p. 47), and if all material found in the stomachs could have been specifically identified no doubt the number would have been increased. Although the animal items far outnumbered the vegetable, the total volumes of the two kinds of food were about equal in the adult diet. The nestlings, though, were almost entirely carnivorous.

[4] Davison, Verne, and McAtee, Waldo Lee: Report on the Arnett, Oklahoma, experimental quail and prairie chicken management project. U. S. Bur. Biol. Survey Wildlife Res. and Mgt. Leaflet BS-39, 6 pp. [Processed.]

Insects as a class contributed the greatest bulk of food, as they supplied nearly a third of the adult and more than two-thirds of the nestling diet. The injurious forms eaten outnumbered the beneficial.

Grasshoppers (Orthoptera) were consumed in greater quantity than any other insect group. They made up more than half (51.21 percent) of the nestling and about an eighth (12.56 percent) of the adult food, although in the latter they reached a high of 60.32 percent in June. The raven's untiring war on grasshopper pests during the warmer months appreciably offsets the damage the bird inflicts at other seasons.

Beetles (Coleoptera) were second in volume in the insect diet of both adults and young. For the adults, weevils ranked first in this group and scarabs second; for the nestlings, scarabs first and ground beetles next. The other coleopteran families represented in the food furnished such small percentages that they are of little significance in the bird's economic status. As weevils and scarabs are among the most injurious beetles, the raven's consumption of them in large quantities is definitely a point in the bird's favor.

Lepidoptera ranked third in quantity in the insect diet of the adults and fourth in that of the nestlings. Those taken were almost all injurious forms, such as cutworms, sphingid larvae, and adults of a *Datana* moth. This part of the diet is without question entirely to the bird's credit.

Hemipterous forms of insects, consumed in small quantities, were of more importance to the nestlings than to the adults. They consisted largely of stinkbugs and leafhoppers. Again this part of the insect diet refects beneficial activities on the part of the raven.

Several other insect orders were represented in the food, but in quantities and numbers so small that little economic significance can be attributed to their consumption.

Spiders were unimportant in the adult food but formed more than a tenth of that of the nestlings, their soft, easily digested bodies being especially suitable for the thin and delicate digestive tracts of the young birds. The fact that spiders are generally considered beneficial places this item of the diet against the raven, but the total quantity consumed was so small that it has little effect on the bird's economic status.

Earthworms, myriapods, and snails were eaten so sparingly that their presence in the diet is of no significance.

Mammalian food was important in the diet, ranking second in the animal food of the adults and third in quantity in the nestling food. Most of it consisted of carrion, which was obtained chiefly from carcasses of horses, cows, sheep, and rabbits. The presence of dead animals annually attracts many ravens to the sheep country, where the

birds occasionally prey on weak lambs and ewes. This damage, while pernicious and highly criticized, is somewhat compensated for by the raven's destruction of carrion on the same range. The carrion-eating habit is commendable also in that it reduces breeding places for flies and aids in general sanitation of the range. Small rodents were eaten sparingly. Their presence in the diet indicates beneficial predation on the part of the raven.

Birds, including domestic poultry, and their eggs were found in but a small proportion of the stomachs. It is an established fact, though, that ravens will pilfer nests and destroy young of other birds when these are not well guarded or concealed. It is questionable whether they ever destroy normal adult birds, because most of these are fully able to protect themselves against the ravens. Poultry losses from ravens, a large percentage of which are inflicted at nests and on young in areas distant from the farmyard, can largely be prevented by providing suitable enclosed nesting facilities.

Reptiles and amphibians formed about 6 percent of the food of the nestlings but only slighty more than 2 percent of that of the adults. The greatest bulk of this food was lizards, which were eaten mainly in summer. The insect-destroying activities of reptiles and amphibians make their presence in the diet a point of some discredit to the raven.

Cultivated crops offer the greatest supply of food to the white-necked ravens and so are somewhat responsible for the sporadic concentrations of these birds. Grain sorghums were the most im-important plant food item found in the stomachs examined and made up more than a fourth of the adult birds' subsistence. The varieties with softer kernels were preferred; and all kinds were eaten more readily during the late dough stage, although the mature seeds also were relished. Because of the large acreages of grain sorghums grown and the concentrations of ravens attracted to them, raven damage to these grains is greater than to any other crop. If undue losses are to be avoided, close minding of the sorghums during maturing and harvesting is usually essential. Actual control of the ravens or reduction in their numbers during the crop-growing season is impracticable because of the bounteous food supply available at that time of year. Cultivated crops of less importance that are attacked by the raven and may be severely damaged locally are corn, peanuts, melons, tomatoes, castor-beans, sunflower seeds, and pears. The acreages involved are so small, though, that the economic significance is not great. Vigilant guarding with firearms and frightening devices must be resorted to where the ravens are numerous. Wheat, oats, barley, and rye are minor crops in the raven territory and were not fed on excessively by the birds examined.

Wild fruits were consumed in large quantities during the summer and early fall and therefore played an important part in helping reduce the amount of feeding done in cultivated crops at that time.

ITEMS IDENTIFIED IN THE STOMACHS

Table 5 lists all the items found in the 827 white-necked raven stomachs examined. The arrangement of the foods identified is systematic through families and alphabetic for genera and species.

TABLE 5.—*Items identified in the stomachs of 827 white-necked ravens (707 adults and 120 nestlings) and number of stomachs in which they occurred*

ANIMAL FOOD

Food item	Number of stomachs in which found	
	Adult	Nestling
OLIGOCHAETA		
Earthworm	1	
ARACHNOIDEA: ARACHNIDA		
Scorpionida:		
Centruridae:		
Centrurus carolinianus	1	4
Species undetermined	5	10
Undetermined	4	24
Solpugida:		
Solpugidae:		
Eremobates sp	1	
Undetermined	28	2
Phalangiida	7	15
Araneae:		
Lycosidae	2	13
Salticidae		2
Undetermined	49	37
Acarina:		
Parasitidae:		
Uropoda sp		1
MYRIAPODA		
Diplopoda	20	6
Chilopoda:		
Scolopendra sp		1
Undetermined	5	
INSECTA		
Orthoptera:		
Mantidae:		
Stagmomantis sp	76	5
Phasmidae	17	
Tettigoniidae:		
Eremopedes sp		1
Neoconocephalus sp	1	
Undetermined	21	75
Stenopelmatinae	1	1
Gryllidae:		
Anurogryllus sp	1	
Undetermined	8	2
Acrididae:		
Brachystola sp	3	
Chortophaga sp		1
Hippiscus sp	1	5
Melanoplus sp	7	6
Orphuella sp		1
Undetermined	326	118
Undetermined	3	
Isoptera:		
Termitidae:		
Amitermes tubiformes	1	
Undetermined	10	

Food item	Number of stomachs in which found	
	Adult	Nestling
INSECTA—continued		
Neuroptera:		
Chrysopidae:		
Chrysopa sp	1	
Odonata: Zygoptera	1	
Mallophaga		1
Hemiptera:		
Cydnidae:		
Aethus sp	1	
Galgupha sp	1	1
Pentatomidae:		
Aelia americana	2	
Banasa sp	1	
Brochymenia sp	8	
Coenus delius	1	
Euschistus sp	3	
Hymenarcys nervosa	2	
Species undetermined	17	
Nezara sp	22	
Peribalus limbolarius	1	
Podisus acutissimus	1	
Solubea pugnax	1	
Thyanta sp	3	
Undetermined	49	29
Coreidae:		
Anasa tristis	1	
Archimerus sp	9	
Aufeis impressicollis	4	
Chariesterus sp	1	
Coriscus sp	1	
Harmostes sp	2	
Lygaeidae:		
Geocoris sp	2	
Lygaeus kalmii	1	
Reduviidae:		
Rocconota sp	1	
Sinea confusa	3	
Species undetermined	2	
Undetermined	4	1
Nabidae:		
Nabis sp	1	
Miridae	1	
Cicadidae:		
Cacama sp	3	
Tibicen sp	1	
Undetermined	3	32
Membracidae:		
Ceresa sp	1	
Stictocephala festina	29	
Cicadellidae	1	
Coccidae	1	
Undetermined	9	1

TABLE 5.—*Items identified in the stomachs of 827 white-necked ravens (707 adults and 120 nestlings) and number of stomachs in which they occurred*—Continued

ANIMAL FOOD

Food item	Number of stomachs in which found	
	Adult	Nestling
INSECTA—continued		
Coleoptera:		
Cicindelidae:		
Cicindela sp.	8	3
Carabidae:		
Amara sp.	1	
Anaferonia sp.	4	1
Anisotarsus sp.		5
Calosoma lugubre	3	3
triste	1	
Species undetermined	38	8
Chlaenius orbus	1	
tomentosus		2
Cratacanthus dubius	1	
Species undetermined	1	
Evarthrus sp.	1	1
Geopinus incrassatus	3	
Harpalus gravis	1	
pennsylvanicus	1	
Species undetermined	8	1
Nothopus sp.	1	2
Pasimachus depressus	1	
Species undetermined	10	4
Philophuga viridicollis	1	
Species undetermined	2	
Piosoma setosa	3	
Poecilus sp.	1	
Pterostichus sp.	1	
Selenophorus sp.	4	
Triplectrus rusticus	1	
Hydrophilidae:		
Sphaeridium scarabaeoides	1	
Silphidae:		
Necrophorus sp.		1
Staphylinidae	3	
Histeridae	4	1
Anthicidae:		
Notoxus sp.	1	
Cebrionidae:		
Scaptolenus estriatus	1	
Elateridae:		
Aeolus dorsalis	1	
Species undetermined	1	
Lacon rectangularis	3	
Undetermined	6	2
Buprestidae:		
Acmaeodera sp.	4	
Chrysobothris sp.	1	1
Hippomelas obliterata	1	
Undetermined	10	3
Dermestidae:		
Dermestes sp.	8	
Undetermined	2	
Nitidulidae:		
Pallodes silaceus	1	
Stelidota sp.	1	
Phalacridae		1
Tenebrionidae:		
Astrotus sp.	4	
Bothrotes canaliculatus	6	
Species undetermined	16	
Eleodes tricostata	2	
Species undetermined	11	
Undetermined		4
Scarabaeidae:		
Aphodius sp.	4	
Bolbocerosoma sp.	4	19
Canthon laevis	10	1
praticola	3	
puncticollis	3	
Species undetermined	30	14

Food item	Number of stomachs in which found	
	Adult	Nestling
INSECTA—continued		
Coleoptera—Continued.		
Scarabaeidae—Continued.		
Cotinis texana	1	
Species undetermined	1	
Cremastocheilus sp.	1	
Diplotaxis sp.	2	
Euphoria kernii	4	
Ligyrus gibbosus	3	
Species undetermined	4	
Phanaeus vindex	10	6
Phyllophaga cribrosa	34	4
lanceolata	9	2
Species undetermined	54	17
Rhysseumus sp.	1	
Cerambycidae:		
Prionus sp.		1
Sphaenothecus suturalis	1	
Undetermined	4	1
Crysomelidae:		
Chrysomela sp.		1
Cryptocephalus sp.		1
Gratiana pallidula	2	
Lema trilineata	1	
Metachroma quercatum		1
Monoxia sp.	1	
Nodonota sp.	8	
Pachybrachys sp.		2
Phyllotreta sp.	1	
Undetermined	4	3
Curculionidae:		
Cleonus sp.	35	1
Dichoxenus setiger	1	
Eupagoderes decipiens	2	
speciosus	1	
Species undetermined	72	
Graphorhinus vadosus	2	
Lixus sp.	3	1
Ophryastes latirostris	5	
tuberosus	4	
vittatus	12	
Species undetermined	193	
Otidocephalus sp.	1	
Pantomorus tesselatus pallidus		2
Species undetermined	1	
Peritaxia perforata		1
Sphenophorus sp.	9	
Tanymecus sp.	1	
Thecesturnus humeralis	7	
Species undetermined	36	
Tyloderma sp.	1	
Undetermined	25	9
Lepidoptera:		
Psychidae	1	
Geometridae	3	
Sphingidae	6	1
Notodontidae:		
Datana sp.	22	
Phalaenidae:		
Chorizagrotis inconcinna	1	
Undetermined	94	3
Hesperiidae	1	
Undetermined	77	45
Diptera:		
Chironomidae:		
Cricotopus sp.		1
Tabanidae	1	
Therevidae	1	
Asilidae:		
Asilus sp.	1	

TABLE 5.—*Items identified in the stomachs of 827 white-necked ravens (707 adults and 120 nestlings) and number of stomachs in which they occurred*—Continued

ANIMAL FOOD

Food item	Number of stomachs in which found	
	Adult	Nestling
INSECTA—continued		
Diptera—Continued.		
Asilidae—Continued.		
Undetermined	2	
Oestridae	1	
Cuterebridae:		
Cuterebra sp.		2
Tachinidae	1	
Sarcophagidae	30	
Muscidae:		
Chrysomia macellaria	1	1
Species undetermined		1
Musca domestica	1	
Stomoxys calcitrans	1	
Undetermined	2	
Chloropidae:		
Elachiptera sp.	1	
Hymenoptera:		
Braconidae:		
Chelonus sp.	1	
Ichneumonidae:		
Ichneumon sp.	2	
Ophion sp.	1	
Chalcididae:		
Brachymeria ovata	5	
Species undetermined	12	
Psammocharidae	1	1
Tiphiidae:		
Elis sp.	1	
Tiphia sp.	1	
Scoliidae	1	
Formicidae:		
Camponotus sp.	8	
Formica sp.	1	
Lasius niger	1	
Species undetermined		3
Leptothorax sp.	1	3
Monomorium sp.	1	1
Pogonomyrmex sp.	4	
Solenopsis sp.	1	8
Undetermined	36	9
Vespidae:		
Polistes sp.	2	1
Sphecidae:		
Bembex sp.	2	
Cerceris sp.	1	
Andrenidae:		
Andrena sp.	2	
Halictus sp.	2	
Melissodes sp.	2	
Panurgidae		1
Bombidae:		
Bremus sp.	2	
Undetermined	53	5
Undetermined Insecta	6	1
GASTROPODA		
Undetermined fragments	6	11
PISCES		
Cyprinidae	1	
AMPHIBIA		
Caudata	2	
Salienta:		
Bufo sp.	2	2
Rana sp.	4	
Undetermined	4	
Undetermined Amphibia	3	
REPTILIA		
Squamata:		
Iguanidae:		
Anolis sp.	1	
Crotaphytus wislizenii	1	
Species undetermined	1	
Holbrookia sp.	1	2
Phrynosoma cornutum	5	
Sceloporus undulatus thayerii		1
Species undetermined	5	15
Undetermined	29	3
Colubridae:		
Elaphe sp.	1	
Tantilla nigriceps	1	3
Undetermined	5	
Undetermined	1	
Testudinata:		
Testudinidae:		
Terrapene ornata		2
Undetermined Reptilia	2	
AVES		
Galliformes:		
Tetraonidae:		
Tympanuchus pallidicinctus		4
Perdicidae:		
Callipepla squamata	3	
Phasianidae:		
Gallus sp. (domestic fowl)	18	2
Undetermined		3
Columbiformes:		
Columbidae:		
Zenaidura macroura	7	2
Undetermined		2
Passeriformes:		
Turdidae:		
Turdus migratorious	1	
Icteridae:		
Icterus bullocki	1	
Fringillidae:		
Callomospiza melanocorys	1	
Pooecetes sp.	1	
Spizella sp.	1	
Undetermined	3	
Undetermined	2	
Underermined Aves	14	13
MAMMALIA		
Carnivora:		
Mustelidae:		
Mephitis sp.	1	
Canidae:		
Canis familiaris (dog, carrion)	1	
Rodentia:		
Sciuridae:		
Citellus mexicanus	1	
Species undetermined	2	
Cynomys ludovicianus	2	
Heteromyidae:		
Perognathus flavus	1	
hispidus		4
Species undetermined	15	23
Dipodomys ordii	2	
Cricetidae:		
Neotoma sp.	3	
Peromyscus sp.	6	1
Reithrodontomys sp.		1
Simodon hispidus	3	
Undetermined	5	
Undetermined	6	2

TABLE 5.—*Items identified in the stomachs of 827 white-necked ravens (707 adults and 120 nestlings) and number of stomachs in which they occurred*—Continued

ANIMAL FOOD

Food item	Number of stomachs in which found		Food item	Number of stomachs in which found	
	Adult	Nestling		Adult	Nestling
MAMMALIA—continued			MAMMALIA—continued		
Lagomorpha:			Artiodactyla—Continued.		
Leporidae:			Bovidae—Continued.		
Lepus californicus	2	4	Undetermined	4	
Sylvilagus floridanus	1		Undetermined	1	
Species undetermined	10	1	Perissodactyla:		
Undetermined	112	5	Equidae:		
Artiodactyla:			*Equus* sp. (horse, carrion)	2	
Bovidae:			Unidentified carrion	72	2
Bos sp. (cow, carrion)	5	1	Undetermined Mammalia	34	4
Ovis sp. (sheep, carrion)	23	1			

PLANT FOOD [1]

Pinaceae:			Leguminosae:		
Pinus edulis	1		*Acacia* sp	1	
Ephedraceae:			*Arachis hypogaea* (cultivated peanuts	26	
Ephedra sp	16		*Prosopis glandulosa*	1	
Gramineae:			Geraniaceae:		
Avena sp. (cultivated oats)	50		*Erodium* sp	1	2
Buchloe dactyloides	11		*Geranium* sp	1	
Cenchrus sp	2		Zygophyllaceae:		
Eriochloa sp	2		*Kallstroemia hirsutissima*	2	
Festuca octoflora	1	5	Species undermined	5	
Species undetermined		2	Koeberlinaceae:		
Hordeum sp. (cultivated barley)	10		*Koeberlinia spinosa*	4	
Panicum fasciculatum	1		Euphorbiaceae:		
Species undetermined	1	1	*Croton* sp	3	
Paspalum sp	1	3	*Euphorbia* sp	1	
Secale sp	3		*Phyllanthus polygonoides*	1	
Setaria spp	8		*Ricinus* sp	2	
Sorghum halepense vulgare (milo; kafir; hegari; Sumac, or Red Top, sorgo)	375	1	Anacardiaceae:		
Triticum sp. (cultivated wheat)	27		*Rhus* canadensis		2
Zea mays (cultivated corn)	86		Species undetermined	5	
Cyperaceae:			Sapindaceae:		
Cyperus sp	2		*Sapindus drummondii*	3	
Liliaceae:			Rhamnaceae:		
Smilax sp	5		*Condalia obovata*	10	1
Fagaceae:			Species undetermined	20	
Quercus sp	1		Vitaceae:		
Ulmaceae:			*Vitis* sp	2	
Celtis reticulata	21		Malvaceae:		
Species undetermined	4		*Malva* sp	6	
Moraceae:			*Malvastrum* sp	1	
Morus rubra	1	4	Cactaceae:		
Polygoniaceae:			*Echinocereus* sp	1	
Polygonum sp		1	*Mammillaria missouriensis*	1	
Chenopodiaceae:			*Opuntia engelmannii*	26	
Atriplex sp	1		Onagraceae:		
Undetermined	1		*Gaura* sp	1	
Amaranthaceae:			Umbelliferae:		
Amaranthus sp	8	1	*Carum carvi*	3	
Aizoaceae:			*Cicuta* sp	1	
Mollugo verticillata	2		Cornaceae:		
Menispermaceae:			*Cornus* sp	11	
Cocculus carolinus	4		Sapotaceae:		
Berberidaceae:			*Bumelia lanuginosa*	2	
Berberis trifoliata	4		Species undetermined	1	
Species undetermined	2		Boraginaceae:		
Papaveraceae:			*Lithospermum* sp		7
Argemone sp	1		Verbenaceae:		
Resedaceae:			*Verbena (bipinnatifida?)*	1	
Reseda sp	1		Labiatae	1	
Rosaceae:			Solanaceae:		
Prunus sp		1	*Lycium* sp	33	
Pyrus sp	1		*Lycopersicon esculentum* (tomato)	4	
Rubus sp	2	1			

See footnote at end of table.

TABLE 5.—*Items identified in the stomachs of 827 white-necked ravens (707 adults and 120 nestlings) and number of stomachs in which they occurred*—Continued

PLANT FOOD[1]—Continued

Food item	Number of stomachs in which found	
	Adult	Nestling
Solanaceae—Continued.		
Solanum rostratum	1	
tuberosum (potato peeling)	1	
Species undetermined	1	
Martyniaceae:		
Martynia fragrans	1	
louisiania	28	
Species undetermined	5	
Plantaginaceae:		
Plantago sp.	3	
Rubiaceae:		
Diodia teres	1	
Cucurbitaceae:		
Citrullus vulgaris ("pie melon," watermelon)	38	
Cucurbitaceae—Continued.		
Cucumis melo (cantaloup, honeydew)	81	
Species undetermined (wild gourd)	5	
Ibervillea sp.	5	
Compositae:		
Ambrosia elatior	1	
Species undetermined	4	
Helianthus sp.	25	
Verbesina sp.	1	
Undetermined	3	

MISCELLANEOUS ITEMS

Cheese	1		Rubber band	3	
Paper	2				

[1] In general, nomenclature and systematic arrangement of plants is according to Cory, V. L., and Parks, H. B.: Catalogue of the flora of Texas. Texas Agr. Expt. Sta. Bull. 550. 130 pp. 1937.

ECONOMIC STATUS

It is extremely difficult to arrive at a generally applicable verdict with respect to a bird with such varied habits and such an adaptable nature as the white-necked raven. The occurrence of ravens in large numbers makes them potentially capable of doing either severe damage or much good, and during the season their habits may vary from one extreme to the other. If the birds were evenly distributed throughout the year and did not congregate they probably would be more beneficial than detrimental. In judging the economic status of the ravens examined in this study their yearly food habits may be segregated roughly into beneficial, 37 percent; detrimental, 33 percent; and of neutral significance, 30 percent.

Under the varying conditions that exist in the field, however, the status of the ravens will have to be determined locally and seasonally and the birds dealt with accordingly. Where the birds can be kept out of the cultivated crops without too much expense, the farmer will reap considerable benefit from their insect-eating habits and the rancher from their consumption of both insects and carrion; but where large raven concentrations occur during fall and winter and cause heavy crop losses, it is justifiable or even necessary to reduce their numbers by some method of control (p. 53).

CROP PROTECTION

Farmers in raven territory should learn to consider the bird a problem variable in importance and to be dealt with as circumstances warrant. Much can be done to protect certain crops by altering farm practices. The loss of chicken and turkey eggs can largely be eliminated by providing suitable enclosed nesting facilities. Small melon, peanut, and corn patches can be planted close to the farmyard, if soil conditions permit, a practice that will more than pay for itself if raven pressure is severe. Often melons can be protected by being sprinkled with lime or having their tops whitewashed or by being covered with sacks when about full grown.

When it does become necessary to adopt some means of protecting crops from raven attack, the urgency of the need and the permanency of the relief desired should dictate the method. If protection must be immediate, the most satisfactory plan is to use frightening devices, which often will prove sufficient when the raven pressure is for only a short period or when natural foods are abundant and control methods impracticable. If more lasting relief is desired, a control program aimed to reduce numbers is required, but this is usually slow in affording relief.

FRIGHTENING DEVICES

The shotgun is without question the best single device for frightening ravens from crops. During the molting season in August and September the birds are particularly shy and consequently easily frightened. It is not necessary to kill the birds; the noise is the chief deterring factor. Shooting with guns as a means of control or of significantly reducing the number of birds, particularly at the roosts, is likely to prove both uncertain and expensive, however.

Carbide exploders (automatic flashguns), so far as is known, have never been tried with ravens. Their use at commercial melon or peanut patches may be worth while, but the regularity and harmlessness of the explosions would soon be detected by the birds.

The traditional scarecrow may give protection for a few days; but unless backed up by some actual destruction, its usefulness is likely to be of short duration. Indeed it must be remembered that most frightening devices are of only temporary value and that it is up to the farmer to outwit the raven.

Numerous other crop-protection practices have been employed by farmers with varied success. In small fields the best results have been produced by stretching wires or strings around and over the fields. This method is usually improved by attaching to the wires or strings bright bits of paper and rags or shining cans, bottles, or mirrors. One farmer reported the successful use of a few posts 10

feet high, each with a 6-foot cross arm at the top from which clear, narrow-necked bottles were suspended. The glistening of the glass and the whistling of the wind over the bottle tops were believed to be the frightening features.

CONTROL MEASURES

When frightening devices fail or when the ravens become so abundant that their numbers must be reduced, there are several control measures that may be used. Those advocated are discussed below.

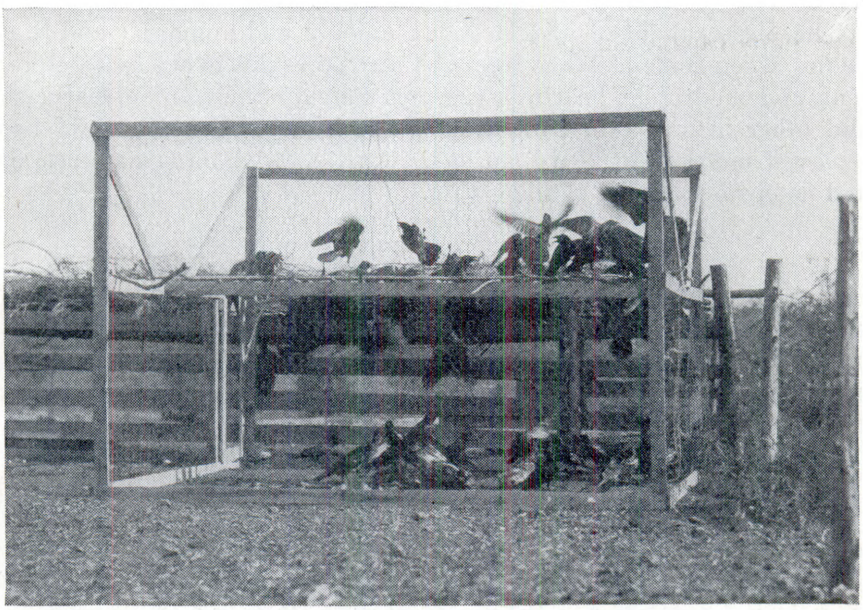

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FIGURE 12.—One night's catch of white-necked ravens (151 in all) in a cage trap.

Intensive and widespread control campaigns cannot be recommended; not only are they unnecessary, but they may reduce the beneficial activities of the birds in sections where they are needed. In practicing control it is well to remember that cruelty is not necessary and adds nothing to the effectiveness of the method.

TRAPPING

Trapping, supplemented under some conditions by patrol with the shotgun, can be recommended as a safe and satisfactory method of control that if properly practiced will provide all the repression necessary. It is most effective during the colder months, after the crops have been harvested and when food is scarce.

LIVE TRAPPING

The most selective and safest means of reducing the numbers of white-necked ravens is by catching them alive in large cage traps [5] of the type known as the Australian crow trap that have demonstrated their efficiency on various occasions (fig. 12). One trap that was operated for 12 days in November caught 512 white-necked ravens; and 4 traps, used at one place from September 1934 until the following spring, caught 10,000. Success depends largely on the proper placement of the traps and on keeping them freshly baited, as well as on removing excess birds at regular intervals.

The birds caught should be killed quickly and humanely and the bodies taken some distance from the trap so as not to act as a deterrent, and the trap and surrounding area should be kept free of feathers and other litter. When the trap is not in use, all bait should be removed and the door tied open, so that any entering birds may escape and not be held to die of starvation.

STEEL TRAPS

Steel traps with heavily padded jaws, set on posts where the ravens regularly perch or placed near carcasses, may be used to catch a few birds and thus have a deterrent effect on others. If the traps are put on posts, the attached chain should be long enough to reach the ground. Such traps should be visited several times daily.

DESTROYING NESTS, EGGS, AND YOUNG

Destroying the nests, eggs, and young of ravens is an effective control procedure that may be employed by stockmen in extensive pastures where the birds are nesting. Inasmuch as the destruction of nests and eggs early in the season may affect only a small proportion of the raven population, it is desirable to wait until most of the nests contain young birds. Consequently June and July are the months best suited for the work. This method can be made very selective by employing operators who will refrain from destroying the nests of beneficial hawks, owls, and smaller birds.

POISONING

Investigations have shown that where control of white-necked ravens is necessary it can be practiced most effectively and humanely by the use of the cage trap. However, to satisfy the many inquiries made about poison a few remarks regarding its use will not be amiss. Poison as an instrument in bird control should be considered only for

[5] For details of construction and operation, see Aldous, Shaler Eugene: A cage trap useful in the control of white-necked ravens. U. S. Bur. Biol. Survey Wildlife Res. and Mgt. Leaflet BS-27, rev., 4 pp., illus. 1938. [Processed.] Free on request from the Fish and Wildlife Service, Washington, D. C.

species that are seriously destructive and then only as a last resort when all other means have failed.

Poisons that can be used for raven control are not selective in their action, and because of the raven's habit of moving from place to place it is difficult to place the poisons in the field so that ravens only will get them. Extreme care, therefore, must be exercised in their distribution lest desirable species meet the fate intended for the undesirable or lest various legally protected birds be killed and penalties incurred.

Thus, although trained operators have obtained satisfying results with poison in experimental bird control, because of the hazard to beneficial forms of wildlife and domestic stock, as well as to inexperienced operators themselves, its use against ravens cannot be recommended for the general public and poison formulas have purposely been omitted from this report. Should it ever become necessary to resort to the use of poison in raven control, it is imperative that the poison be distributed only under the direct supervision of trained personnel.

EXPLOSIVES

Dynamite has been successfully employed in Oklahoma and a few other States in bombing crow roosts and probably could be used with equal efficacy in roosts of white-necked ravens. Roosts that harbor ravens exclusively, though, are most commonly found in mesquite groves, and the effectiveness of bombs under such conditions has yet to be demonstrated. For this reason and because bombing is a hazardous process that should be carried out only by experienced operators, the details of procedure are not included in this report.

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