

SOME EARLY SUMMER FOOD PREFERENCES OF THE AMERICAN RAVEN IN SOUTHEASTERN OREGON

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No comprehensive study has ever been made to determine the economic status of the American Raven (*Corvus corax sinuatus*), although there is, apparently, a general belief among sportsmen that any beneficial habits possessed by the raven are nullified by its depredations upon nestling birds and birds' eggs. It is not questioned that depredations are made on both nestlings and eggs; but the extent of this destruction, and the percentage relationship between these items and other foods, have not been sufficiently studied. Before any general condemnation or laudation of the raven is to be taken seriously, laboratory analyses must be made of the contents of a large number of stomachs collected at all seasons and from all parts of the range. These analyses must be supplemented by intensive field studies during the months of May and June, when damage to birds' nests is likely to be greatest.

The data presented in this report are based on examination of the stomach contents of 18 adult and 66 nestling birds, the latter representing 18 broods. The series was collected in the vicinity of Lake Malheur Reservation in southeastern Oregon from June 1 to 23 by Messrs. George M. Benson, Reservation Protector, and Alvah M. Springer. The number of stomachs examined is ample to reveal food preferences of ravens in this general locality for the month of June. Particular consideration is given here to those items in the diet upon which the apparent ill reputation of the raven chiefly rests, namely, birds and birds' eggs.

Birds.—Bird remains, occurring in 21 stomachs, represented only a little more than 6½ percent of the total food. They amounted to only a small part of the contents of any one stomach, as a rule less than 10 percent. In but 3 stomachs was the proportion of bird remains in excess of 50 percent, two of these being stomachs of adult birds. Identification was possible of only a few of the bird fragments in this series. In one stomach, feathers and bone fragments of a coot were distinguished, and in another, those of a sparrow. Nestling birds were represented in 7 stomachs, but the fragments were not sufficiently diagnostic to permit positive identification. In some stomachs the remains were in an advanced state of digestion, and in others they consisted of only a trace of feather fragments, presenting in either case no adequate basis for identification. Bird remains occurred approximately 2½ times more frequently in the diet of nestlings than in that of adults, being found 19 times in stomachs of the former, and twice in those of the latter. The bulk percentage of bird remains, however, is less in the nestling diet, the percentage amounting to 6.37 for nestlings and 7.72 for adults.

Birds' eggs.—Shell fragments of birds' eggs were noted in 14 stomachs, forming by volume 2.03 percent of the bulk. Four of the occurrences were in stomachs of adult birds and the remaining ten in those of nestlings, nine of which were accounted for by two broods, every bird in each brood having some shell in its stomach. The fragments in each of the latter cases were all small, of similar thickness, and uniform whitish in color; it is not unlikely that each brood had been fed from a single egg. In one stomach, the fragments were fairly large, and it was possible to identify them as those of a coot's egg. Another stomach contained fragments of eggs of two species of birds, neither definitely identified, although one set of fragments might possibly have been from the egg of a thrush, and the other set from that of a sparrow. In still another stomach, the fragments may possibly have been from the egg of a duck. Specific determination of eggs from fragments of shells is almost impossible in most

cases. Too much caution cannot be exercised in the interpretation of the above data, chiefly because 29 of the 35 occurrences of bird remains and egg shell fragments were from stomachs of nestlings.

Comparison of the stomach contents of nestlings within a brood often disclosed the fact that repeated occurrences of an item meant division of a single catch among young birds, rather than the making of many separate kills. For that reason, since 19 of the bird occurrences were from stomachs of nestlings of nine different broods, and only two from those of adults, the 21 occurrences of bird remains are not to be interpreted as 21 different kills. The actual number of birds taken by all ravens could not be definitely ascertained, because it was not always possible to determine whether the fragments in different stomachs from the same brood were those of a single bird. If the occurrences of bird remains in the stomachs of nestlings within a brood are the result of the division of one catch, the minimum number of depredations involved in the feeding of the nestlings would be nine; and the total number of ravens involved in all depredations upon birds would be eleven, indicating that the minimum of one raven out of every 8 had resorted to such activities. This minimum ratio, while possibly underestimated, is much more accurate than one which would result from the assumption that the number of occurrences represented the number of kills.

The interpretation of the data on egg-shell fragments in stomachs offers additional problems. The bulk percentage of this item is not an accurate indicator of the amount of egg material consumed, since the shell alone, and in many cases only a part of it, enters into the percentage. In lieu of this weakness, it will be advantageous to determine how frequently the ravens indulged in the taking of eggs. Granted that repeated occurrences of egg shells in stomachs of a brood represent the division of a single egg, that is, when structural characters point to the fact that the fragments of shell could have come from the same egg, we can conclude that a total of six ravens, five of them parents, had made such depredations. This means that a minimum of at least one bird in every fifteen was guilty of nest plundering. Regardless of the raven's technique in getting the contents of an egg, whether by swallowing the whole egg, or by piercing it and then sucking out the contents, at least part of the shell would unavoidably be taken, and since a mere trace of shell can readily be detected in stomachs, very few, if any, occurrences of eggs would pass unnoticed in examining stomach contents. The frequency ratio, however, also has its limitations in giving an understanding of this complex problem.

The presence of shell fragments in stomachs may not always indicate damage to other species of birds. Some of the shell fragments might have been broken bits of hatched eggs picked up as grit. It is not inconceivable that ravens may occasionally rifle nests of their own kind. In addition, eggs may be taken from nests that have been deserted owing to some cause other than interference by a raven. In these cases, on the basis of stomach analysis alone, the raven would unknowingly be accused of depredations that were not actualities. Another similar, but probably rare, possibility is that unhatched eggs may be taken from a nest after incubation has been completed. In this case no damage would be incurred; although, again, on the basis of stomach analysis, it would unavoidably be so considered.

In estimating actual damage caused by nest or egg destruction, there must be taken into consideration the innate ability of a species to nullify at least partly the effect of these depredations. For instance, if a raven causes the destruction of a nest containing 10 eggs, and a second attempt at nesting is successful in the rearing of five young, then the actual damage would be not more than half so great as at

first indicated. (This would be true only if the rearing of a single brood were the rule.) Damage may similarly be offset if the raid occurs before incubation begins, in which case there is a possibility of stolen eggs being replaced. Better understanding of these important problems will require many hours of observation in the field. In the final analysis, the damage which the raven inflicts on various species of birds by nest plundering must not be determined alone by the number of eggs taken, or by the number of nests destroyed, but by the effect of these raids on the final and total hatch for the season.

Mammals.—Juvenile rabbits fall easy prey to a wide variety of predators, and it appears that the American Raven is fully capable of taking a significant toll of the yearly increase. In this study, rabbits occurred in no fewer than 43 stomachs, or in approximately 51 percent of those examined. Juvenile rabbits, probably less than $\frac{1}{3}$ grown, were taken most frequently, with fragments of as many as four being found in a single stomach. Mr. Benson reports that ravens often feed on rabbits that are killed on the highways, and no doubt some of the occurrences reported in this study had their origin from this source. Rabbit remains formed a larger part of the diet of nestling birds than that of adults. Examination showed that thirty-five of the sixty-six nestlings, or 53 percent, were fed on rabbits, while eight of the eighteen adults, or 44 percent, had fed on these animals. In the nestling stomachs, rabbits comprised 37.07 percent by bulk of all the food taken, while in those of the adults they amounted to 23.88 percent of the total food. The average percentage for adults and nestlings combined was 34.26, which is the largest percentage revealed in this study for any single food item.

Other rodents, represented by fragments of pocket gopher (*Thomomys* sp.) and chipmunk (*Eutamias* sp.), comprised less than 1 percent of the bulk food. Chipmunk fragments were found in the stomachs of two nestlings of the same brood, but undoubtedly represented only one kill.

Amphibians and reptiles.—From the standpoint of bulk percentage amphibians stand fifth on the list of food items, with a percentage of 6.59. With the exception of one occurrence of a true toad (*Bufo* sp.), spadefoot toads (*Scaphiopus hammondi*) made up the entire amphibian portion of the diet. These toads occurred in thirteen stomachs, and no fewer than forty-three individuals were noted, most of them being young, probably only recently transformed from the larval state. The bones of as many as sixteen individuals were found in a single stomach. The nestlings had a greater percentage of amphibian food than the adults, the figures being 7.40 percent for the former, and 3.62 percent for the latter.

Lizards were only slightly less important than toads in the diet of these eighty-four ravens. They were present in twenty stomachs, eighteen of which were from nestlings and two from adults. The total percentage of reptile food for nestlings amounted to 6.43, for adults 0.84, and for all birds 5.23. The majority of lizards recorded were of the genus *Sceloporus*, although in one stomach fragments of a horned toad (*Phrynosoma* sp.) were noted. In stomachs that contained only a few bone fragments it was impossible to make even generic identification.

A few bone fragments and scales of an undetermined snake were found in a nestling stomach, amounting to only 1 percent of the stomach contents of that bird, and to an insignificant fraction of the total food of the group.

Fish.—The scales of an undetermined fish made up 3 percent of the contents of one stomach, but represented an insignificant percentage of the bulk. This item is likely to be of carrion origin.

Insects.—Insects, as a group, stand next in importance to the rabbit as a food item, amounting to about 33 percent of the total. The adults had a greater per-

centage of insects in their diet than did the nestlings, the percentage for the former being 48.56, and for the latter 29.74. This is a departure from the usual rule in birds, but in this case the deficiency of insects in the nestling diet was made up by the greater percentage of rabbit, the capture of which may have been less time consuming than the collection of a sufficient number of insects to satisfy the ever hungry broods.

In the order of their importance in the diet, from the percentage standpoint, representatives of the following seven orders of insects were identified: Homoptera, Diptera, Hymenoptera, Coleoptera, Lepidoptera, Orthoptera, and Heteroptera. The orders Orthoptera and Heteroptera were so sparsely represented as to be insignificant, together amounting to less than $\frac{1}{4}$ of 1 percent of the total diet. The insect groups will be separately discussed.

Some difficulty is encountered in determining which insects represent primary or first-hand food and which represent secondary food, that is, insects that were contained in the stomachs of lizards, toads, or insectivorous birds that may have been eaten. In some cases, the stomachs of lizards and toads were still sufficiently intact to make quite certain which insects should be considered as of secondary incidence. For instance, in the case of the raven that had eaten a horned toad, the stomach of this lizard was partly intact and was observed to be gorged with ants, many of which were also mingled with the general stomach contents of the raven. Consequently all the ants, whether in the horned toad's partially intact stomach or found with the other food material, were reckoned in the lizard percentage. The presence of small insects in raven stomachs when remains of lizards, toads, or insectivorous birds are absent from the contents leaves no choice but to consider them primary food, although they may seem to be items that would be beneath the raven's attention. The percentage of insects of questionable origin, however, is small, probably being less than 1 percent.

Homoptera.—From the standpoint both of quantity taken and of frequency of occurrence, cicadas stand out as the most important kind of insect taken by this group of ravens. They aggregated no less than 18.70 percent of the total food, which is about 56 percent of the whole insect diet. They occurred more frequently in nestlings than in adults, having been present in twenty-four stomachs of nestlings for a frequency percentage of 36, while they occurred in four stomachs of adults for a frequency percentage of 22. The bulk percentage of cicadas in the nestling diet amounted to 21.08, and in the adult diet 10.10. In sixteen stomachs the percentage for these insects was above 70 percent of the total contents. At least 550 individual cicadas, predominantly adults, were present in the contents of twenty-eight stomachs, this being the total number of stomachs in which they occurred. The genera *Okanagana* and *Platypedia* were represented; one stomach alone contained as many as 101 individuals of the latter genus. These insects are of good size and no doubt their bodies contain a great deal of nutritious material. They emerge from the soil in large numbers from more or less localized areas and so, probably, can readily be captured in good numbers; all things considered, they seem to make an ideal nestling food.

Diptera.—Diptera were present in this series of stomachs chiefly in the form of sarcophagid, or "flesh fly", larvae and pupae. They were usually associated with carrion, although this does not mean that they were accidentally taken when feeding on carrion. In some cases, they were present without a sign of carrion, indicating that the bird had probably visited some carcass especially to pick them out. The larvae and pupae together occurred in eleven stomachs, four of which were of adult and seven of nestling birds, and made an aggregate percentage of 2.76. Other

Diptera taken included the larvae of Stratiomyiidae, or "soldier flies", of the genus *Odcntomyia*. They were present in the stomachs of two young from the same brood, the parents of which were not collected. One of these stomachs contained 220 of these larvae to the exclusion of all other food; the other contained 27 individuals, which made up 92 percent of the contents. These soldier-fly larvae aggregated 2.28 percent, and Diptera of all kinds 5.04 percent, of the total food.

Hymenoptera.—Hymenoptera stand third in importance in the insect diet by virtue of the presence of saw-flies of the genera *Atomacera* and *Sterictiphora* in three stomachs of adult birds, in each of which they were present to the extent of 90 to 100 percent. In these three stomachs, there were more than 8,200 individuals of these insects present. Not knowing the circumstances under which they were taken, it seems remarkable that such great numbers of these small insects could be collected by a raven. They were all in about the same state of digestion, and so must all have been taken within a short period of time. The presence of these saw-flies in a swarm seems to be the only way to account for their being captured in large numbers. One of the above three stomachs contained also eleven individuals of a parasitic wasp of the genus *Tiphia*, which represented 6 percent of the contents of that stomach. These three genera together made up 16.06 percent of the food of adult birds, and together with one undetermined Hymenoptera in the stomach of a young bird constituted 3.47 percent of the food of all birds.

Coleoptera.—Beetles, as a group, although usually present in small numbers and representing only small percentages of individual stomach contents, occurred most frequently of all insects, and were present also in the greatest variety of forms. In all, twenty-eight genera of beetles representing eleven families were found in this series of stomachs. Species from the families Tenebrionidae, Scarabaeidae, Dermestidae, Carabidae, Curculionidae, and Silphidae were most common. The genera *Sphaeriontis*, *Eleodes*, *Coniontellus*, *Pccalta*, *Dermestes*, *Calosoma*, and *Necrophorus* made up 72 percent or nearly $\frac{3}{4}$ of the beetle content. Considering all stomachs together, beetles occurred in approximately 30 percent of them, having been found in 34 of the entire 84. In the adult ravens, beetles were present in nine stomachs, or in an even 50 percent, while in the nestlings they were present in twenty-five, or in about 37 percent. The total percentage of beetles in the diet of adults was 8.17, and in that of nestlings 2.12, a proportion of almost 4 to 1. The bulk percentage of beetles in the food of all birds was 3.42.

Lepidoptera.—Only one stomach of the adult ravens contained Lepidoptera; at least 78 fragmentary chrysalids of an undetermined butterfly were present in this one stomach to the exclusion of all other food. They were in an advanced stage of digestion, but the number was easily determined by counting the cremasters or terminal hooks. Of the nestlings, four had been fed caterpillars, one stomach containing twenty individuals, and another as many as 30. These larvae were probably all from the family Noctuidae, commonly known as cutworms. Lepidoptera amounted to 2.13 percent of all the food.

Orthoptera.—Grasshoppers and their allies were taken uncommonly by the ravens during the breeding period. The adult ravens had not taken any grasshoppers, and they were recorded for the young birds in only three stomachs, the maximum percentage for one stomach being 5. The grasshoppers noted were species of the family Acrididae, or short-horned locusts. Two stomachs contained sand crickets (*Stenopelmatus* sp.), fragments of a single individual being present in each stomach, and amounting to 1 percent of the contents of each. The total aggregate percentage for this group was only 0.15. Undoubtedly, these insects enter into the

diet of ravens to a much greater extent at other seasons. A number of raven pellets collected by Smith Riley from the Malheur Lake area during July in 1923, and examined by E. R. Kalmbach, revealed that the birds were taking large numbers of grasshoppers.

Heteroptera.—These insects, the true bugs, were taken so rarely as to be insignificant in the food column. Stink-bug (Pentatomidae) fragments were recorded in two adult stomachs, comprising 2 percent of the contents in each case. The percentage of Heteroptera for all birds amounted to only 0.06.

Scorpions.—Scorpions were occasionally taken by these ravens, being present in three adult and seven nestling stomachs. In the adults the bulk percentage amounted to 2.22, and in nestlings to 0.41, making a combined total percentage of 0.80. The highest number of individuals recorded for any one stomach was four, these being present in a nestling stomach, and identified as *Vejovis boreas*.

Vegetable matter.—Very little in the way of vegetable matter was consumed by these ravens. The only vegetable item taken by adults was corn. It was present in two stomachs, being recorded to the extent of 35 percent in one and 2 percent in the other. Of the nestlings, eight stomachs contained vegetable material, two stomachs containing corn to the extent of 42 and 33 percent, respectively, and three, containing oats in percentages of 62, 15, and 8, respectively. In addition, three stomachs contained fibrous, bark-like material that may have been picked up as débris. The determined vegetable material, corn and oats, amounted to 2.35 percent of the total diet; and the undetermined vegetable fiber, some of which may have been accidentally taken, amounted to 0.89 percent.

Carrion.—The natural association of certain insects, such as sarcophagids, dermestids, silphids, and others, with dead and decaying flesh is of valuable assistance in establishing the carrion origin of certain vertebrate items in stomachs. It is certain, however, that at times the use of these insects as carrion indicators will lead to erroneous interpretation; because, in some cases, the indicators will be present in the stomach almost to the exclusion of other food, showing that ravens sometimes visit carcasses to feed on the scavenger insects, without necessarily partaking of the carrion itself. To illustrate the difficulty, let us suppose that a juvenile rabbit may be captured and devoured by a raven, and, before the rabbit has been completely digested, the bird visits a dead animal and eats a number of dermestids and sarcophagids. It is obvious that the diagnosis of rabbit as carrion in such an instance would be a misinterpretation. Carrion was present in thirteen stomachs of this present collection (eight of them containing sarcophagid larvae or dermestids), and represented 7.52 percent of the total food.

Extraneous matter and gravel.—Occasionally, small sticks, pieces of bark, and other débris were found in stomachs. This was particularly noticed in the case of nestlings and for those adults which had fed upon carrion. Gravel, in small amounts, occurred in the raven stomachs frequently, some of which, no doubt, was taken accidentally, and some probably intentionally as grit.

Pellet analysis.—One nest pellet was collected and upon examination yielded bone fragments of 1 *Scaphiopus hammondi* and some undetermined egg-shell fragments. The bones of the toad had not been affected to any great extent by digestion.

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