

EATING HABITS OF FALCONS
WITH SPECIAL REFERENCE TO PELLET ANALYSIS

By RICHARD M. BOND

The following resumé is based on observations on Duck Hawks (*Falco peregrinus anatum*) at 21 eyries in California, Washington and New England, and on 5 young, from various localities, which I raised and partly or completely trained for falconry; on about a dozen eyries of Prairie Falcons (*Falco mexicanus*), and on 4 young which I trained; on about a dozen pairs of Sparrow Hawks (*Falco sparverius sparverius* and *F. s. phalaena*) with their young, 5 of which I raised and partly trained; and on 3 young Eastern Pigeon Hawks (*Falco columbarius columbarius*), of which I also had the training. In addition, I have had the good fortune to observe with considerable care numerous migrating and wintering specimens of all these species in various parts of North America and the West Indies; and in California, wintering examples of the Western Pigeon Hawk (*F. c. bendirei*). To a lesser extent I am in debt to the literature of both ornithology and falconry, and to the observations of others, especially of Captain R. L. Meredith of Boonton, New Jersey, who has been engaged in falconry for twenty-five years, and has at the moment of writing 2 Gyrfalcons, 5 Duck Hawks, and an Eastern Pigeon Hawk, trained or in training.

The falcons included in this treatment tend (except during migration) to have definite hunting ranges, either centering about the nest in the breeding season, or about some favored day and night perch in winter. The winter location may be kept for the whole season (or several consecutive seasons) or may be changed several times in a year.

If there is a plentiful food supply, the hunting area is not commonly changed and tends to be confined to the least possible radius. The Duck Hawk and Prairie Falcon eat once a day if the first quarry captured is large enough to fulfill the day's needs. The Pigeon Hawk has two meals a day, and the Sparrow Hawk feeds more or less irregularly and continuously, at least when preying on insects. One or two extensive soaring flights of from 20 minutes to an hour and a half are made each day, depending in number and duration, apparently, largely on the weather. The hawk spends a large part of each day on a perch, nearly motionless, except that the head is turned constantly so that the eye may follow every moving object that comes within the range of vision.

If food is scarce, the above routine may be very much altered. The soaring flight, if undertaken at all, may be interrupted for hunting at any time, and the perch is frequently changed.

During the nesting season, the feeding behavior shows individual, and to some extent, specific variation. In general, both parents incubate, by turns, and secure their food while off duty. While the young are in the nest, or at least during about the first three-fifths of this time, the male does all the hunting and the female all the feeding and brooding of the young. The male may bring the food to the nesting ledge or hole, or he may transfer it to the female in the air by turning on his back as the female stoops at him from above, thus allowing the female to take the quarry held in his feet.

Birds almost always, and mammals and lizards frequently, are headless when brought to the nest. It appears as though the male (particularly of the Duck Hawk) lives largely, if not exclusively, on heads of the prey animals during this period.

Quarry are carefully plucked (birds) or skinned (mammals and lizards) before being given to the very young nestlings; the latter thus obtain practically no pellet-forming material. The female becomes progressively less careful, and progressively larger species of prey are fed, as the young grow older, but they are not presented with entirely unprepared quarry until they are nearly ready to leave the nest. Thus, pellets found at or below a nest are likely to have been formed in the stomach of the mother, though they may represent also the food of the young, until very near the end of the nesting period. The young continue to obtain at least some food from the parents after leaving the nest, for from two weeks (Pigeon Hawk, Sparrow Hawk) to a month (Prairie Falcon, Duck Hawk) or even six weeks (Duck Hawk).

The adult falcon's diet depends mainly on three factors: (1) availability, (2) species habit, and (3) individual habit.

Availability is always an important factor, but becomes even more so during the nesting season. At that time a very mixed "bag" often results, anything capturable being taken.

The Duck Hawk and the Pigeon Hawk have a specific antipathy to capturing food on the ground, and if not too pressed by hunger will usually attempt to frighten a standing or swimming bird into flight before actually seizing it. The Prairie Falcon, on the other hand, and even more the Sparrow Hawk, seems to prefer to make its capture on or near the ground, and it will usually pass up a bird well on the wing in favor of something still at rest or just getting started. It is only when mammals (insects, in the case of the Sparrow Hawk) are unavailable that birds are taken by these species in large numbers. Tyler (*Condor*, 25, 1923, pp. 90-97) states that in the western San Joaquin Valley the Prairie Falcon much prefers small birds. In this case, however, it was the abundant, ground-living, low-flying forms that were mainly preyed upon, and these I would expect to be the most acceptable avian substitutes for small mammals, if the latter were comparatively scarce. Unfortunately, Tyler does not mention the local mammal fauna in his paper.

It appears to be quite difficult for the very limited mind of a young falcon to grasp the fact that a live bird or mammal may be converted into food. The lesson must be learned over again for every species of prey of very different appearance. It is perhaps as a result of this, at any rate I have found it true, that falcons, both wild and trained are prone to form prey habits, and to confine the food taken to a single species or group as exclusively and as long as may be. When the chosen food gives out, through migration or whatever cause, a new item is selected and followed with the same single-mindedness.

Generally speaking, the falcons eat perched, either where the prey is captured, or on some convenient vantage point to which it is carried. An insect or other very small quarry may be consumed in flight, or a feeding bird may finish a meal in the air if frightened from its perch. After each third or fourth mouthful the falcon raises its head and looks around, often watching for a minute or more before going on with its meal.

Unlike an owl, a falcon seldom eats anything whole, no matter how small or soft it may be. Small creatures are grasped in one foot and held up toward the beak. Not infrequently the upper end of the tarsus is rested on the perch, the effect being much like that of a man resting his elbow on the table while he grasps a banana. Larger quarry is stood on, being held especially by the inner claw of one foot or of both. Small morsels are bitten or pulled off by the beak, and bones are usually broken (by the bird twisting its head) while they are still attached to the body. If a large piece of bone comes off with a morsel, it is rolled with the tongue and frequently

bitten with the edge of the beak until broken up. If it can not be thus broken, it is grasped with the foot again, if of convenient size and shape, or it is at once discarded.

A large piece of meat is likely to be impaled on the point of the beak and give the eater much trouble. Small morsels are carried on the upper surface of the tongue to about the middle of the beak, and there stick to the "roof of the mouth." The next stroke of the tongue passes under the morsel until the back of the tongue, just anterior to the glottis, can catch it and carry it back into the throat. The morsels may pass one by one into the crop, or become jammed in the upper esophagus. Feeding is then temporarily stopped while the bird hunches its shoulders, stretches and retracts its neck, and swallows hard.

Insects are, of course, known to be of some importance to the Pigeon Hawk and Prairie Falcon as well as to the Sparrow Hawk. I have seen even Duck Hawks, especially young birds just learning to fly, catch grasshoppers and perhaps other forms. The insect is seized in one foot and held up. If the bird wishes to adjust the position of the insect, it transfers the latter to the beak and back to the foot with great quickness. The head of an insect may be swallowed whole by the larger birds, but the thorax and abdomen are much crushed. Insect wings and legs may be eaten, but are perhaps more often discarded. It is surprising to see with what dexterity so large a bird as a Duck Hawk or Prairie Falcon can catch and handle an insect not much over an inch long.

I have not observed a Duck Hawk or Pigeon Hawk feeding on a reptile, but the Prairie Falcon and Sparrow Hawk ordinarily seize a lizard about the middle, or just behind the forelegs, and crush the head with the beak. The head is usually partly or entirely eaten. More or less of the body skin is pulled off and discarded, and the body is eaten in small sections from before backward. The feet are commonly eaten unskinned. The tail, if not already autotomized by the lizard, is often discarded.

Birds are handled variously, depending largely on their size in relation to that of the falcon. A very small bird is seized in the air or on the ground and killed, as are all birds, by biting through the neck vertebrae. The head and part of the neck is well crushed and then eaten, feathers, beak and all. The two smaller falcons often reject the beak of even the smallest quarry. The hawk then plucks its prey with considerable care, attempting to reject all the feathers as they are removed. Primaries, tail and other large feathers are usually successfully discarded, but the breast feathers and to some extent other body feathers, especially if they are wet, stick to the beak, and if there is not a stiff wind blowing to carry them away, are, after much head shaking, swallowed. A falcon which is exceptionally hungry, or a captive bird which has had no pellet-forming material for some days will be much less careful in this respect and will even appear to eat some of the feathers on purpose. A Duck Hawk seems to pay little heed to the position of a sparrow's body and will begin to feed on whatever side is up when the plucking is finished. The whole bird is usually eaten, including the tarsi, which are broken in several places, and the feet. Rarely is part of the gut rejected.

Birds somewhat larger—more than a meal for the falcon—may be seized in the air and killed in the same manner as the smaller birds, or they may be struck with such force that, because of their greater inertia, the claws of the hawk rip right through them and fail to hold. In the latter case, the quarry is often killed outright by the blow and is caught as it falls or after it reaches the ground. Even though the quarry is already dead the neck is usually broken, perhaps through habit. The breast, most of the sternum, the lungs, the heart, the liver and some of the gut of a fair-sized bird are often eaten. It is not unusual for the breast and belly alone to be plucked.

A bird too big to carry is almost never plucked entirely, though such prey is rather infrequently killed except by the Pigeon Hawk. The beaks of medium to large avian quarry ordinarily are rejected unless unusually small and soft, but one or both feet of birds up to about one-half the weight of the hawk are swallowed with surprising frequency.

Small mammals are seized much as are small birds, though killing is perhaps more often effected by crushing the skull rather than by biting through the neck. The head is eaten first and then the rest of the animal. If the creature is tender-skinned, the skin is torn off in strips. If the strip of skin happens to have the fur side against the bird's tongue it is usually rejected; if the flesh side, it is often swallowed. Most of the gut ordinarily is discarded. The tail of a mouse is usually swallowed, often still attached to one of the hind legs. Tough-skinned small mammals usually have the skin peeled back from the severed neck in one piece. This appears not to be a planned action, but to result from aimless pulling at the resistant skin, and purposeful attack on the exposed flesh.

Mammals too large to seize safely are usually killed, at least by the Duck Hawk and Prairie Falcon, by a series of stoops at the head and neck, made at such speed that the claws do not hold. These stoops are repeated until the quarry is stunned or blinded, or until the skull is fractured or the neck dislocated. So far as I know, no species of falcon habitually hunts prey necessitating such tactics when smaller game is available.

The pellet-forming material consists of chitin and keratin and related substances, and also of seeds and other non-protein crop and gut contents of the prey. The following are included: The exoskeleton of insects and other invertebrates; the scales and claws of reptiles; the beak, feathers, tarsal and foot scales, claws, and gizzard-lining of birds; and the hair and claws of mammals. Bones and teeth are usually completely digested. An adult captive falcon fed an artificially high proportion of bone for some days may regurgitate a little, but this is rare, and must be still rarer in wild birds. I have not been able to get a growing falcon to regurgitate any bone, no matter how much it has been fed.

Regurgitation of a pellet by a wild falcon under normal conditions occurs every morning, ordinarily shortly after dawn, and in winter usually at the place where the bird spent the night. In summer, with daylight coming early, and with the young needing food, hunting may begin before regurgitation. I have seen pellets produced by Duck Hawks twice, and by a Prairie Falcon once, while the birds were on the wing. In addition, the Sparrow Hawk and Pigeon Hawk may regurgitate a second pellet in the middle of the afternoon if the morning's meal was eaten sufficiently early.

In analysing collected pellets of falcons, those containing any appreciable quantity of bone should be discarded, especially if whole bones are present, unless there is absolute certainty of origin.

Mammal-containing pellets may be determined, at least to species, by the usual methods of hair examination; but a knowledge of the local, small, diurnal mammals will greatly lighten the work, since the most common available forms in the immediate vicinity will account for the great majority of the pellets. If there is accurate knowledge of locally occurring subspecies, it will usually be possible to name the pellet contents with considerable certainty, for it must be extremely rare for a resident bird to hunt far enough afield to capture other than the local form.

Many published records of falcon pellets simply say "small birds," "large birds," or even "feathers." Where bird species are very numerous around a nesting site, or where a dozen species and subspecies of small finches are wintering together, it may

often be impossible to go further, but in many winter or summer falcon ranges, accurate identification of pellet material, at least to family or genus may be made, and not rarely to species or even subspecies. The bulk of the feathers in a pellet are usually from head, neck and breast. These feathers may be slightly altered in color, but apparently not in pattern, if any exists. Frequently the beak or claws or both are present and are useful in identification. A knowledge of local distribution and habitat will help narrow the field, as in mammals, and it should be remembered that cover-haunting birds are not ordinarily available to any falcon. Finally, at a given site there may be a dozen or so pellets of exactly the same color, size, and consistency. Two or three of these may be positively identifiable through beak, claws, primaries, etc. Since falcons so habitually pursue one species of prey at a time, there is an extremely strong likelihood that the beakless and clawless pellets of the lot represent the same species as the others, especially if from state of dryness and weathering they seem to form a compact age series.

Similar deductions may often be made from the scales of reptiles, especially since the skin of one or more feet of a lizard may often be floated out of a pellet almost entire. Insects may be counted, and at least partly identified, by the very resistant mandibles, even if the rest of the head is broken beyond use. Other parts of insects in recognizable condition are of irregular occurrence in falcon pellets.

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STATUS OF THE CORMORANTS OF GREAT SALT LAKE

WITH TWO ILLUSTRATIONS

By WILLIAM H. BEHLE

In a recent article dealing with the history of the bird colonies of Great Salt Lake (Behle, 1935, p. 32) attention was called to the fact that the fourth edition of the A. O. U. Check-list (1931, p. 23) indicates that the cormorants of Great Salt Lake belong to the race *Phalacrocorax auritus albociliatus*, while elsewhere they are found designated as *P. a. auritus* (see Lewis, 1929, pp. 7, 9, 10, and Peters, 1931, p. 86). In order to test out this matter of subspecific status, I have sought some breeding cormorants with nuptial plumes. At my request, Mr. Milton T. Rees of Salt Lake City obtained several specimens from Egg Island, Great Salt Lake. Three of these, taken on April 19, 1935, were sent to the Museum of Vertebrate Zoology, at Berkeley, and three reached the Department of Zoology at the University of Utah. These six breeding examples have now been examined by me.

The Pacific coast race, *albociliatus*, as the name indicates is characterized by having white nuptial plumes, these in groups or "crests" on the sides of the head above and behind the eyes—at least plumes in which white predominates. In the eastern race, *auritus*, these plumes are predominantly black. I find that the black plumes predominate in the birds from Great Salt Lake. A great amount of variation, however, is observed in these specimens as to color and number of plumes.

These diagnostically important nuptial plumes are of course "ornaments" of the breeding season and are acquired anew each year in the spring, starting to appear in March. They are worn by both sexes but are larger on the males than on females. According to Lewis (*op. cit.*, p. 58) they do not appear until a bird is nearly three years old, and there is usually not a marked development of crests until the fourth