

REFERENCES CITED

- BRAND, A. R.
1936. Bird song study problems. *Bird Lore*, 38: 187-194.
- DICKEY, D. R.
1922. The mimetic aspect of the Mocker's song. *Condor*, 24: 153-157.
- LASKEY, A. R.
1933. A territory and mating study of Mockingbirds. *Migrant*, 4: 29-35.
1936. Fall and winter behavior of Mockingbirds. *Wilson Bull.*, 48: 241-255.
- MAYFIELD, G. R.
1934. The Mockingbird's imitation of other birds. *Migrant*, 5: 17-19.
- MICHENER, HAROLD AND JOSEPHINE
1935. Mockingbirds, their territories and individualities. *Condor*, 37: 97-140.
- MILLER, LOYE
1938. The singing of the Mockingbird. *Condor*, 40: 216-219.
- NICE, MARGARET M.
1931. Birds of Oklahoma.
1935. Review. *Bird-Banding*, 6: 77.
- VISSCHER, J. PAUL
1928. Notes on the nesting habits and songs of the Mockingbird. *Wilson Bull.*, 40: 209-216.

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NESTING OF THE TURKEY VULTURE IN OHIO CAVES

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Plate 8

ALTHOUGH birds as a whole exhibit distinct differences in nest construction as influenced by their habits and the available material, there is a marked likeness within individual species in the selection of nesting sites regardless of the habitat in which they may be. The Turkey Vulture (*Cathartes aura septentrionalis*), in contrast, presents a diversified selection of nesting sites. One finds it nesting on the sides of steep cliffs as well as down in swamps, and it may be found in rocky caves or rugged hillsides or hidden in salt marshes. It places its nests in forests, shrub thickets, along water courses, in old and odd structures, and in various curious places. In fact, as Burns (1924) expressed it: "The Turkey Vulture nests indifferently in hollow trees, logs, moss crevices, and under thick coverts or in abandoned buildings remote and darkened."

In order to gain intimate knowledge of the nesting habits of the Turkey Vulture, the author spent the spring and summer of 1936, 1937, and 1938 in the central part of Ohio in what is known as the

Sugar Grove Region. From the standpoint of the ornithologist this section is of especial interest because of the great number of vultures which collect there. Furthermore, because of the large number of birds and the rather unique physiography of the country, this spot is a favorable one for a life-history study. The above-mentioned locality comprises the greater portion of Fairfield and Hocking counties, Ohio, the topography of which resembles somewhat that of the hill country found in many parts of southwestern Ohio and much of West Virginia. The Sugar Grove Region is peculiar in that it is crossed by numerous deep ravines, giving a total relief from 200 to 400 feet. These ravines are often V- or U-shaped, being about a quarter to half a mile from the open to the closed end. The mouths of these valleys may also be as much as two or three miles across, but usually not more than several hundred yards. The sides are wooded, sloping up from the bottom to a distance of nearly 500 yards and crowned with erect cliffs of heavy sandstone intermingled with layers of clay rising abruptly from 50 to 200 feet. Due to weathering, the numerous cliffs are cut up with many fissures, varying from a crevice to a small gorge. It is within these recesses or caves that the nests of the Turkey Vulture are to be found.

Many hours were consumed in making a thorough search of every conceivable hollow within the rocks. The importance of securing early nesting dates was realized, together with the desire for definite knowledge of the appearance of the first egg. Sixteen nests in all were discovered in the spring of 1936. During the seasons of 1937 and 1938, all nesting sites previously discovered were closely scrutinized in order to ascertain reoccupancy and consequent egg laying. The additional search revealed four more nests.

The search for the various nests brought to light two paramount facts: first, that there are certain types of cavities selected by the birds; secondly, the birds recognize a distinct territory in which the nest is located. Regardless of the length of the valley, not more than one nest on any one side of a valley was ever discovered. Should the valley be U-shaped or should it be large and contain several apparently ideal sites, it is then possible that one nest may be found on each side of the valley or one at one side and one at one end. Intensive search in all valleys in the seasons of 1936, 1937, and 1938 failed to reveal any deviation from this rule. Thus it is apparent that, at least in this region, there is not only a total lack of gregarious nesting, but a well established territory surrounding each nest.

TYPES OF NESTING CAVES AT SUGAR GROVE

Type I.—Type I seems to be most frequently sought by the bird and such sites are rarely unoccupied. It is in a cave within the rocks from 100 to 200 feet above the floor of the valley and about ten to twenty feet up in the rocky sides. The better-constructed caves have two entrances, one used by the old birds as an easy entrance and a quick exit and the other used by the young to pass out to a platform or to the top of the cliff to be fed, to stretch, to preen, and eventually to take off into the air. The opening used by the adults is about four feet square, seldom less, while that used by the young is much smaller. The interior of the cave is dry. Oftentimes a large rock, perhaps dislodged from above, serves as a windbreak and a shelter from the rain. At times, the floor of the cave may be heavily lined with leaves, chestnut and oak predominating. Frequently the roof of the cave touches the incubating bird. At this place, far removed from the heat and light of the sun, the temperature will be as low as 15.5 degrees Centigrade (60 degrees Fahrenheit). The light intensity at high noon seldom exceeds three candlepower.

Type II.—Type II may assume a variety of forms but it will always be found within the cliffs. Sometimes the nest is located in a long, narrow fissure so small that one can scarcely wedge one's way back to the eggs. These recesses are dark, damp, and forbidding places where the air is stale. Such nests are less desirable, perhaps, because they have but one opening, thereby preventing rapid escape in time of danger.

Type III.—Type III is frequently encountered under the shelves of rock from which the soil has been removed by weathering or by rodents. Although the eggs are usually not more than two feet from the entrance, the hollow itself may extend back several feet. So small are these sites when measured vertically that as the bird sits upon the eggs the roof of rock touches its body. There is an abundance of such sites and many nests are found in such positions.

From the viewpoint of inaccessibility and isolation, Type I is more desirable but less frequently encountered. Photographs of these sites are shown on Plate 8.

TEMPERATURE AND LIGHT RATINGS WITHIN NESTS

Below are shown the temperature and light ratings within six nests. It will be seen that the average high temperature was 17.6° C. and the low, 15.7° C. The average light intensity was 2.3 candlepower as measured by a Weston meter. It is, perhaps, this low temperature

within the caves that is in part responsible for the long incubation period of forty days common to the birds of the Sugar Grove Region.

TABLE 1
MEASUREMENTS OF TEMPERATURE AND LIGHT WITHIN NESTS

	Temperature		Light
	High	Low	Candlepower
	15.5° C.	15.0° C.	4
	18.8	15.5	2
	15.5	13.3	2
	16.1	15.5	2
	16.2	14.4	2
	23.8	20.5	3
Average	17.6	15.7	2.5

NEST MAKING

In the selection of a nesting site the Turkey Vulture exhibits more care than it shows in nest making. A mere depression among leaves, crumbling bark, dirt, or rubbish serves to form a repository for the two handsome eggs. At the sixteen nests under observation during the spring and summer of 1936, 1937, and 1938 the writer never saw any indication of nest building. In all the nesting sites there was always some material covering the bare sandstone rock. In most cases this was dead, dry leaves which had drifted down from the trees above or had been swirled in by the rushing winds of the past years. In the early part of the nesting season there may not have been even a slight depression to suggest a proper nest, but during successive days of incubation, the weight of the bird's body tended to press or push aside the debris until a shallow, bowl-like depression was made within the leaves.

Some of the nesting sites serve as the winter home of the wood rat (*Neotoma pennsylvanica*). These animals frequently carry into the cave vast quantities of materials such as twigs, leaves, bits of bark, husks of corn, chestnut burrs, string, and paper to serve as food, nesting material, and as a windbreak. Even when such an aggregation of rubbish is present the bird does not use the debris on which to lay its eggs, but will deposit them on a spot where accumulated materials are thin and scant. Two nests were found where the only substance separating the eggs from the stone was a very slight layer of what could be classed as humus. It was undoubtedly the remains of plant material reduced to soil through successive years. In both these nesting caves bare, loose rocks of various sizes dotted the floor. In the

spring of 1934, a nest was located in a secluded and darkened corner of a barn loft. In this case, although some twenty feet off the ground, the bird had chosen the floor boards as a repository for the eggs rather than some of the numerous elevations within easy reach, such as piles of hay, platforms, and coils of rope.

Thus, it is apparent that, although nest-building material may be available in unlimited quantities and varieties, the Turkey Vulture builds no nest. However, the word 'nest' will be used in this discussion, hereafter, to designate the repository of the eggs.

EGGS

Position of the eggs within the nest.—In my investigations I found the eggs of the Turkey Vulture deposited in the darkest part of the cave, which was nearly always behind a rock or under an overhanging shelf or at a point where there was just enough room into which the bird could squeeze. The eggs were deposited from two to six feet within the cave. The original position of the eggs was changed from time to time, and due to the movements of the bird the eggs would become rather deeply embedded among the leaves. However, the next day would again find them on the surface. There was at no time any evidence of an attempt on the part of the bird to conceal the eggs when it left the nest.

Number of eggs.—The usual number of eggs deposited in the nest of the Turkey Vulture is two, sometimes one, and as a survey of the literature discloses, at rare times three eggs have been found.

Time of egg laying.—My earliest record in Central Ohio for the laying of the eggs is April 8. This is in accord with Jones (1886) who stated that in Ohio the eggs are laid about the first week of April to the fifteenth day.

Time between laying of two eggs.—In all nests which the writer observed, the interval between the laying of the first and second eggs was one day; but only in three cases was it possible to observe this. Presumably, incubation began as soon as the set of eggs was complete.

Description of eggs.—The eggs vary in shape from ovate to elliptical and from ovate to elongate ovate. The shell is smooth, dull, and grayish white, and sometimes has a faint bluish or greenish tinge. The eggs are blotched, splashed, and smeared with shades of deep chocolate brown which colors usually predominate over the larger end. Pale lilac markings are discernible over the egg and likewise are more numerous at the larger end. There is always a distinct difference in the color patterns of the two eggs in a set. Usually the first one laid

is the more heavily figured with brown, while the other is more evenly speckled with smaller splashes of chocolate.

In my experience there was no great change in the color of these eggs during incubation; however, they seemed to become dull and lose their luster at this time, due perhaps to the deposit of oil from the brooding bird's breast.

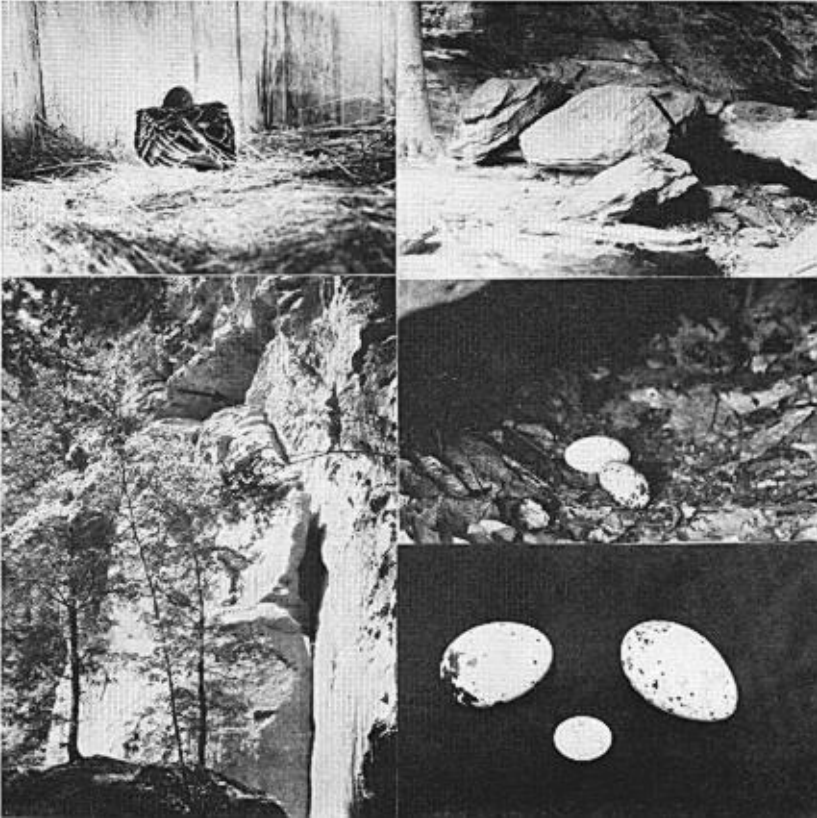
TABLE 2
WEIGHTS AND MEASUREMENTS OF TURKEY VULTURE EGGS
(SUGAR GROVE REGION)

<i>Weight</i>	<i>Length</i>	<i>Circumference</i>
67.6 grams	68.65 mm.	44.84 mm.
74.4	71.43	44.84
92.6	71.83	49.21
89.1	73.42	49.60
87.3	73.81	48.02
86.6	71.83	46.83
86.4	75.40	48.41
87.5	72.23	49.21
81.1	69.05	48.41
80.8	70.24	48.41
83.0	68.65	47.22
80.7	67.07	47.62
85.4	71.43	48.02
71.2	66.67	46.83
77.7	74.21	46.83
Average	82.1	70.06
		47.62

INCUBATION

Beginning and duration.—There is a considerable variance in the estimation of the length of the incubation period. The shortest number of days revealed in the literature was twenty-two days, as reported by Gentry (1882). Thirty-two days was recorded by Audubon (1835). Thirty days was mentioned by Burns (1915), Jackson (1903), and Kempton (1927). Pennock in writing to Bent (1937) estimated the incubating period to be forty-one days.

It is interesting to note that, although the first two nests located by the writer in the season of 1936 had their full complement of two eggs at the time of discovery, these eggs did not hatch out until thirty-nine days later. During the season of 1937 the beginning of the incubation period was noted in four nests. In order to get further data upon this, the second egg was taken and placed beneath a hen. Since this egg failed to hatch in forty-five days, it was opened and found to be infertile. The nest from which this egg was taken was deserted,



(Upper left), TURKEY VULTURE INCUBATING IN A BARN. (Lower left), "TYPE I" NESTING SITE. (Upper right), "TYPE II" NESTING SITE. (Middle right), TURKEY VULTURE NEST IN CAVE AT SUGAR GROVE, OHIO. (Lower right), TURKEY VULTURE EGGS, SHOWING PATTERN AND SIZE (COMPARED TO A HALF-DOLLAR).

as also was another of the four nests I discovered. The eggs in the third nest, unfortunately, found their way into the hands of a collector. One egg in the fourth nest proved to be infertile while the other egg hatched in thirty-nine days. It is the opinion of the writer, therefore, that the incubation period of the Turkey Vulture is between thirty-eight and forty days in this region of Ohio.

Sex of incubating bird.—Opinions differ regarding the part played by both birds in incubation. Audubon (1835) believed that both birds shared this duty. Kempton (1927), Maslowski (1934), and Gentry (1882) agreed with him in this belief. Horsfall (1932), nevertheless, stated that only the female sat upon the eggs. The writer succeeded in banding eight birds at four nests and proved conclusively that both birds aided in the incubation. Sufficient observation to determine how much time was spent by each bird upon the nest was prevented by the extreme timidity of the birds as well as by the placement of the nest so high above the ground and so far back in the cave. In two nests the adult birds were marked in the hope that this would prove helpful in securing the desired information. The expected results did not materialize as both nests were at once deserted.

Behavior of incubating birds.—The attitude of the adult birds, when approached during incubation, differs with individual birds and types of caves selected. In the larger caves where the exit is easy and where there is a double entrance, the adult usually makes its escape. This is almost universally so at the beginning of the incubation period. In the case of the smaller caves, there is little chance for the bird to take to the air when an intruder has reached the entrance; consequently it may retire to the deeper, darker recesses of the cave, blundering off with the head lowered, mouth open, and feathers ruffled. Or the bird may remain on the nest, slowly lift its wings, emit a prolonged, deep guttural hiss and, at the same time, vomit. There is either a slow discharge in the form of a solid mass of food or a steady drivel of colored liquids. This method of slow regurgitation is probably the result of the crouched, sitting position of the bird where lack of room prevents it from throwing the head forward, then sideways, and lifting the body, which is the normal action in the vomiting process. This discharged material never remains in the nest but is re-eaten after the intruder disappears.

Food is sometimes regurgitated as the birds fly from the nests when disturbed. This usually occurs a few seconds after the bird is in the air, due perhaps to the rapid contraction of the muscles as the bird hastily escapes. This discharged material is always merely dropped and at no time ever directed at an intruder.

There is a total lack of pugnacity on the part of the brooding vultures. Repeatedly, when I entered the caves, taking with me the equipment necessary to band and make measurements of eggs and birds, I have met with no interference on the part of the incubating bird or its mate. I have found, however, that after the birds have once been handled while upon the nest, considerable scheming is required to catch them on the eggs again. When a Turkey Vulture's nest is being inspected, the mate of the incubating bird will often be perched on some high, dead tree nearby, commanding a view of the nesting site. I could not ascertain if any signal or warning, vocal or otherwise, was exchanged between the birds. At times I observed that it was impossible to catch the bird on the nest if its mate was soaring overhead. When the mate was not seen, it was easier to approach the nest and handle the bird.

Even when incubation was at its height there were two periods of the day when both birds usually were absent from the vicinity of the nest. The first was in the morning about the time when the vulture population of the valley was engaged in sunning itself or taking exercise flight preparatory to the morning search for food. The second period was in the afternoon when the day's hunt was over and the birds were preening and sunning themselves before entering the roosting area. Not infrequently I have seen birds approach the nesting territory just before dark, after they had apparently been engaged in these activities.

Conditions at the nest while incubating.—Oftentimes the only indications of a Turkey Vulture's nest is the slight evidence of excrement on some prominent rock at the entrance of the cave. Since the adult frequently pauses upon a rocky platform when leaving the nest, such platforms can usually be detected from above by traces of excrement which is in no case abundant. At times, however, it is possible to detect the presence of a nest by the peculiar odor of the vulture. This must not be confused with the odor of carrion or filth, for the bird has definitely a musty smell which is not altogether unpleasant. Even birds reared in captivity and fed on strictly fresh meat emit the same odor.

In most of the nests located, interior conditions depended much on the type of the cave. The very nature and construction of the recesses, which were large and roomlike and well ventilated, aided much in their sanitation; the circulation of air tended to carry off any disagreeable odors present. In contrast to this, there were small, narrow, lengthy, fissured caves where interchange of air was infrequent and in consequence such places were stale and musty.

I have seldom encountered excrement or or near Turkey Vulture eggs. Occasionally, feathers or down from the adults may be found within the caves. No refuse, no bones, nor any animal remains were ever discovered inside the nesting caves. Generally speaking, when one considers the feeding habits of these birds as well as their size, together with the fact that caves as a whole are dark, forbidding places, Turkey Vultures' nests in caves before and after the arrival of the young are by no means objectionable. The nests which I have seen in logs or stumps exhibit the same sanitary conditions.

SUMMARY

This paper has attempted to reveal certain facts hitherto not generally known concerning the Turkey Vulture. No evidence of gregarious nesting was found in the Sugar Grove Region of Ohio. A distinct territory surrounded each nest. Characteristic nesting sites in caves are described. Both male and female birds took part in incubation while the length of the incubation period was thirty-eight to forty days. One day elapsed between the laying of the first and second eggs. The low temperature within the caves no doubt increased the length of the incubation period. Conditions of comparative cleanliness surrounded the nests which made working with these birds a pleasure rather than an obnoxious task.

LITERATURE CITED

- AUDUBON, J. J.
1835. *Ornithological Biography*. 3: 32-35. (Adams and Chas. Black, Edinboro.)
- BENT, A. C.
1937. *Life Histories of North American Birds of Prey, Order Falconiformes*. U. S. Nat. Mus., Bull. 167: 12-44.
- BURNS, F. L.
1915. *Comparative Periods of Deposition and Incubation of Some North American Birds*. *Wilson Bull.*, 22: 279.
- BURNS, F. L.
1924. *The Philosophy of Birds' Nests and Comparative Calology in Consideration of Some Local Nidicolous Birds*. *Wilson Bull.*, 36 (3): 122, Sept., 1924.
- GENTRY, T. G.
1882. *Nests and Eggs of the Birds of U. S.*: 281-288, pl. XLVIII (J. Wagnerseller, Phila.)
- HORSFALL, BRUCE
1932. *Nature Magazine*, 19: 34, no. 1.
- JACKSON, T. H.
1903. *The Turkey Vulture and Its Young*. *Bird-Lore*, 5: 184.
- JONES, HOWARD
1886. *Illustrations of the Nests and Eggs of Birds of Ohio with Text*: 137. (Clarke and Co., Circleville.)

KEMPTON, R. M.

1927. Notes on the Home Life of the Turkey Vulture. *Wilson Bull.*, 38: 142-145.

MASLOWSKI, K. H.

1934. An Aerial Nest of the Turkey Vulture. *Auk*, 51: 229-230.

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SEXUAL DIMORPHISM IN THE FALCONIFORMES

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It has been known for a long time that the males of certain species of Falconiformes are smaller, sometimes much smaller, than the females. This fact has been common knowledge but apparently there has never been any careful work to determine in which species and to what degree this dimorphism is exhibited. The present work is intended to fill this gap in ornithological information.

Sexual dimorphism is exhibited in a majority of orders of birds, and in most cases the male sex is the larger. This is the case in all groups for which data are available, except the Falconiformes, the Strigiformes, and the Superfamily Charadriodea (Shore-birds) of the Charadriiformes, where the opposite is true. The similarity of the Strigiformes to the Falconiformes in this respect might have been developed because of the similarity of habits, but this theory cannot be carried too far because the equally predacious Laniidae (Shrikes) of the Passeriformes show the opposite dimorphism. The presence of the Charadriodea here is harder to explain; perhaps they are following the pattern of the rest of the Charadriiformes in which the sex most concerned with incubating and brooding is the smaller, for in this superfamily, the males take on most of the nest duties,¹ a habit most highly developed in the Phalaropodidae.

The amount of size difference between the sexes in birds can be demonstrated most easily by the ratio of the size of one sex to that of the other. This gives a series of percentages showing the size differential. From the percentages, more information may be deduced.

The most accurate measurement of the 'size' of a bird is, most naturally, that of weight. However, there are practically no data on weights of hawks. What exist are taken largely from birds which have been in captivity for considerable lengths of time for the purpose

¹ This statement is open to question. There is much evidence that in most of the shorebirds, both sexes incubate. Cf. Ticehurst, *Ibis*, (13) 1: 582-583, 1931.—Ed.