

STUDIES IN THE LIFE HISTORY
OF THE
BLACK-BILLED CUCKOO

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Studies in the Life History of the Black-Billed Cuckoo

Since the black-billed cuckoo (*Coccyzus erythrophthalmus*) is a bird of the Transition zone, ^{an authority} thus breeding primarily in southern Canada and northern United States, the University of Michigan Biological Station located in Cheboygan County, Michigan, has afforded an excellent area for this life history study. During the summers of 1939 and 1941 six nests were kept under daily observation from either the laying of the first egg (in two cases) or the last few days of incubation (four cases) through the nest life of the young, supplemented with data from two additional nests along with observations on two nests of the yellow-billed cuckoo (*Coccyzus americanus americanus*) the habits of which, according to such reliable authorities as Bent (p.70) and Barrows (p.340) are very similar to those of the black-billed.

Observations totalling 94 hours were made from a canvas blind which, because of the shyness of the bird, was placed either on the ground or on a tower depending upon nest height which showed considerable variation, three to five feet from the nest. To overcome the disadvantage of this distance a short range 4X field glass was used to note details of such nestling activities as swallowing and characteristics of food brought into the nest area. While searching daily for nests during a two week period so perfectly hidden they were seldom located except as the adult bird was flushed, information on general habits as well as relationship existing between juvenals and adults was added to that obtained while in the blind.

Grateful acknowledgments are made to Dr. Olin Sewall Pettingill, Jr., Carleton College, Northfield, Minnesota for his many helpful suggestions and advice; to Dr. Theodora Nelson, Hunter College, New York City for her encouragement and to Dr. H. B. Hungerford, University of

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Kansas, Lawrence, Kansas for checking my identification of insect life.

Nests and Nest Building

Although the cuckoo is primarily a bird of the woodlands probably preferring thickets where tree growth is not too great it often builds in scattered clumps of berry bushes or low shrubs, on hillsides, or on a branch of larger trees somewhat secluded by the overhanging branches of the same or neighboring trees. Such a variability of nest location necessitates a corresponding variation in height from a few inches to the unexpected height of 20 feet. Two prime requisites for a successful nesting site is protection and an available food supply. In the Station area the maple was the principal source of food for these birds and the nests were situated either in the tree itself or near clumps of them.

The platform nests, with an inside depth of $3/4$ inch and an inside diameter of $3-3\ 1/2$ inches were made of small twigs loosely interwoven then lined with leaf scraps, pine needles, catkin remains, or empty cocoons, with both bulk material and lining depending upon the availability of material in each specific area. Two nests were selected for counting of nesting material. The bulk of the nest taken from one of the beech trees was made up of a total of 65 twigs - 10 of these varied from 9-4 inches in length, 30 from 6-9 inches and 25 from 3-6 inches. In the second nest which was taken from the hemlock tree there was a total of 76 twigs of more uniform length - 40 twigs were 5-12 inches long and 36 from 3-5 inches long. The lining material for this latter nest was a considerable mat of dead leaves and arbor vitae while in the other nest the lining consisted of a small handful of dry leaf scraps. Data for the six nests kept under observation is given in Table I.

	Nest I	Nest II	Nest III	Nest IV	Nest V	Nest VI
Date found	July 5, 1939	July 22, 1939	July 2, 1941	July 7-'41	July 16	July 18
Habitat	Wooded area	Open 2nd growth aspen area	Open wooded area	Hilltop	Edge low woodland thicket	Roadside bordered by aspen, maple & occasional pines
Nest Site	Lower branch of white pine 3' from trunk	Angle of lower branch of small aspen	Small beech tree where two main branches crossed	Three way fork of one sapling in beech clump	Near top of hemlock $1\frac{1}{2}$ ' from trunk	Near tip of main branch of Acer Saccharum 4-5' from trunk
Height of nest	19 in.	19.5 in.	5.5 ft.	2 ft.	5 ft.	20 ft.
Materials:						
Bulk-	twigs wild cherry, maple & pteris leaf stems	twigs maple wild cherry & aspen	twigs beech Pteris stem & leaf stalks	twigs of beech & aspen	twigs of arbor vitae, aspen, & osier with dead maple & aspen between	aspen & maple twigs
Lin- ing	pine needles & scraps dead aspen leaves	Pteris leaf scraps, moth cocoons & lichen pieces	Scraps dead beech leaves, Pteris leaf scraps & pine needle	Pteris leaves & leaf stalks & aspen leaf scraps	Small pieces of arbor vitae, scraps maple leaves, pistillate willow catkins & few pine needles	Pteris & aspen leaf scraps, pine needles

Measurements

Inside diameter	3.25 in.	3.5 in.	3.75 in.	3.5 in.	3 in.	3.5 in.
Outside diameter	5.5 in.	6 in.	6.5 in.	6.5 in.	7 in.	6.5 in.
Inside depth	.75 in.	.75 in.	1.0 in.	.75 in.	.75 in.	1 in.
Outside depth	1.5 in.	4 in.	3 in.	2.75 in.	3 in.	3 in.
Contents when found	4 eggs	3 eggs	1 egg	1 egg	2 eggs	3 eggs

It is possible that the building of the main part of the nest may be completed in a comparatively short time. Roberts quotes from a writer in Bird-lore (31:190,1929) who stated that a yellow-billed cuckoo gathered all the sticks for its nest by breaking them off with its bill from a nearby dead tree and if any did not break off readily it was abandoned for a more brittle one, thus the rude nest was completed in a few hours. Bent cites Marcia B. Clay (1929) who says the cuckoo did not once descend to the ground for nesting material but selected an apple tree containing a quantity of dead material from which she broke a dead twig with her bill, flew to the nesting site, arranged it, then returned for another. Although it was not my good fortune to observe nest building, my other observations of cuckoo activities would indicate that even the arrangement of the bulk material for the platform nest required considerably more than a few hours as the cuckoo often would sit 30-40 minutes in a dazed, motionless position before the next move. What seems a definite proof that completion of the nest actually extends into the incubation period was the bringing of lining material by the bird when coming to replace the one on the nest. This observation was made three times during the latter portion of the incubation period at one nest, twice the material, pine needles in each case, was carefully worked into the nest though once the needle pair was placed rather indifferently. This bringing of nesting material is a courtship pro-

cedure in the case of some birds but in other groups food is brought with it being closely associated with copulation in some species, the cuckoo belonging in the latter group according to Lack (p.171). At one next the second adult came into the nest area with a larva in its bill and took the usual guarding position. The brooding adult left the nest alighting on a branch just below. In a few minutes the guarding adult hopped down to same branch, ran down it toward the female and stepped on her with the copulatory instinct then immediately flew away with the larva still in his bill but the female remained motionless. At the end of eight minutes the male returned with another larva, alighted on the same branch with the female but as he ran toward her she flew away. In a short while the male ate the larva he had brought but remained on the branch ten minutes before moving out of sight.

Egg Laying and Incubation

The height of the nesting season in the Station area occurs during July, according to the official record, with an occasional nest being found the latter part of June or the early part of August. The black-billed cuckoo commonly lays 2 or 3 eggs which are oval in shape (11 mm. x 18 mm.), dull greenish blue in color with one now and then showing a marbled appearance. The egg laying interval was found to be decidedly variable. In one nest found July 2 containing one egg, a second egg was laid July 3 but the third was not laid until July 6, however in another nest containing one egg when found (July 7), the second and third were laid July 8 and July 10 respectively. Several authors, notably Bent (p.72) and Barrows (p.338) state that not infrequently the two species of cuckoos lay their eggs in each others nests, by many considered a relic of the parasitic habit so strongly developed in the old world cuckoos. During my observations a single evidence of this was noted; the egg of a black-billed in the nest of the yellow-billed. Since the 3rd egg of

the yellow-billed remained unhatched that of the black-billed was readily differentiated by its deeper color and smaller size.

Incubation was found to begin following the laying of the first egg but contrary to the generally accepted length of the incubation period (14 days) one egg laid the morning of July 6 hatched the morning of July 16 making the incubation period only 11 days while in another nest the egg laid July 8 hatched July 19, a 12 day interval. In 1937 Wm. H. Elder, in a similar study at the Station records that one egg in the nest under observation had only a 7 day incubation period explained by the abnormal retention of the egg in the oviduct thus taking the place of the first days of incubation normally spent in the nest. While it is very difficult if at all possible to differentiate the cuckoos as to sex, both do take part in incubating the eggs, as proven by the second adult coming into the nest area, giving a low call, then taking the place of the incubating adult as soon as she left the nest. During the period of incubation outside disturbances seemed to interfere more with the natural behavior of the birds than they did after the young were hatched and failure to find more nests in the first few days of use has prevented the obtaining of valuable information for this phase of the life cycle. During the two longest periods of observation on incubation from 1 P.M. to 4 P.M. and again from 7:30 A.M. to 11:30 A.M. each adult was either on the nest or nearby for approximately two hours before the second adult came to replace the one already there. Other times the adult moved out of sight of the blind and I had no way of checking to determine whether the same or a different adult returned to the nest. The morning observation period was on the nest about 10 yards from the main road into the Station area and proved to be a morning of considerable activity, hence very disturbing to the cuckoos. An airplane quite close overhead first drove the adult from the nest. It was

back in twenty minutes only to be driven away shortly after by a group of children, and still a third time driven from the nest by a truck. Each time there was a favorite high branch used as a "lookout" and each time the adult returned to the nest by running up the main limb upon which it was placed, cautiously and deliberately stopping on the smaller branches enroute. As the bird stepped into the nest the bill was used to turn the eggs then they were further turned by the feet as the body was lowered into place. Although other birds, such as red-eyed vireo, oven-bird, cedar waxwings, nighthawks, and crested flycatcher often came into the nest area and two or three times actually alighted in the nest tree the cuckoo paid little attention to them doing no more than turning the head to keep them in sight but chipmunks and spermophile caused very noticeable alarm and concern.

As far as observed the eggs were laid during the early hours of the morning, likewise the hatching except in the case of the younger nestling in Nest V (Table I) which occurred about 3 P.M. July 18. As usual the adult left the nest upon my approach at 2:55 P.M. exposing to view one nestling and the shell of the second egg parted slightly around its lesser circumference so the young bird could be seen moving about inside. Within the next five minutes one half of the shell fell away and the other half was loosened as the young nestling began emitting low cries. This newly hatched nestling was entirely dry as it emerged from the shell.

The egg shells are usually disregarded by the adult except perhaps to be pushed about in the nest with the bill as is proven by the fact that shell scraps are commonly found in the bottom of the nest. Several writers suggest the possibility of the adult eating part of the shells and such proved to be true at one of the nests under observation. The adult returned to the nest with food and after feeding, stepped over the nest to take a brooding position but before doing so reached into

the nest and ate what appeared to be small shell scraps then settled self over the young. In a short while the adult again reached into the nest, brought out the small half of the shell and proceeded to eat it. This large piece afforded considerable difficulty at first as it was too large to be taken into the mouth but the cracking shell attested to the fact that progress was being made and in about two minutes time the entire half was swallowed.

Nestling Stage

The newly hatched cuckoo nestling has a coal black skin the feather tracks of which are made conspicuous by the presence of wiry gray "hairs", the feather-tubes of a rudimentary down which never unfolds, feet and bill are a steel blue-gray with the commissure only slightly lighter in color. By the third day the primitive feather tubes are pushed out by those of the juvenal contour feathers and for the next four or five days are borne upon their tips. The feather-tubes on the anterior portion of the ventral track develop more slowly being only slightly conspicuous until the fourth day though later development practically parallels that of the dorsal area. By the sixth day the feather tubes, ranging in length from 17mm. to 21 mm., give the young nestling the appearance of porcupine but soon the ends of these tubes begin to burst giving the nestling for the first time a somewhat fluffy juvenal plumage. According to Herrick (p.96) about twelve hours is required to complete the opening of the feather tubes although a longer time is required for those on head and neck which are out of reach. * (Pictures if good)

Approximately $1\frac{1}{2}$ -2 hours following hatching, feeding began, the one day old nestling weighing from 7.5 grams to 9 grams. Weight increased quite consistently and noticeably during the first four days but was more gradual during the remainder of nest life, the average weight of the six or seven day old was 23 grams. The weight of the nestlings in Nest I selected as typical, is diagrammed in the graph, Fig. I. All

To be added.

weights were taken daily at approximately 5 P.M.

The food of the cuckoo consisted almost entirely of insects, 90% of which was in the larval form, the remaining 10% was made up of grasshoppers, small moths, mayflies, robber flies, and an occasional spider. The larva of the rosy maple moth, Anisota rubicunda, was the most abundant one in the Station area and explains why 81% of the larvae fed were of this variety.

Feeding is done by both sexes with the approach to and departure from the nest showing the cuculine habit. of running along a branch. As the adult approached the nest the young cuckoo almost invariably gave a food response- open mouth, stretched neck, and flapping wings. The wide open mouth displayed a very conspicuous group of snow-white disks of variable size symmetrically arranged on the palate.

? Some observers believe these disks to be sucking pads used to hold to the adult bill during feeding. In watching 75 feedings only three times was there close contact between the upper mandible of the nestling and the bill of the adult but rather the adult appeared to make an effort to push the bill against the lower mandible of the young thus placing the live food more nearly in contact with the disks on the upper mandible. Since the lower edge of the larger disks was decidedly irregular it seems that they may be an aid in holding the ^{live} food rather than holding to the bill of the parent.

The food was carried crosswise in the bill and since the adult made one or two stops before feeding the young, opportunity was given for

identification of the food brought. Occasionally the food had been macerated before being brought into the nest area but more often this was done after alighting on the nest edge. Most of the food was inserted far down in the throat then when necessary additional thrusts were given to hasten the swallowing response. With the younger nestlings the larva was thrust into the open mouth, then a motionless position held by both adult and young sometimes for as long as eight or ten seconds before swallowing occurred. If this first attempt did not bring results, the larva was withdrawn, macerated, and reinserted in the throat, then perhaps repeated a third time. With the older nestlings swallowing was more likely to be immediate or within a few seconds.

Food was generally brought by the adult when the exchange in brooding periods was made, the adult leaving the nest not returning for a considerable period. One notable exception to this took place about 10:30 A.M. July 24, 1941. The brooding adult left the nest as the second adult came up the nest limb with a grasshopper nymph in its bill. This nymph was fed to the one day old nestling then the adult turned and ran down the nest limb out of sight. In less than three minutes was back again with a good sized larva (about 1" long and correspondingly thick) which she proceeded to feed to the same nestling. Just as the larva was inserted into the open mouth the second adult returned, coming from the opposite direction and alighting directly on nest edge, with a well-developed larva of the rosy maple moth. The first larva which had not been swallowed was withdrawn as both adults gave the low call to the young often given at the nest. The food response was instantaneous by both nestlings and both adults started to feed the younger, however the female (?) succeeded in replacing her larva and the male turned about to place the larva he was carrying in the wide open mouth of the older nestling. Both nestlings gave a retarded swallowing response but

the older one swallowed first, the fecal sac was taken, and the adult flew away again leaving the female to assume her brooding duties.

Feeding intervals varied considerably, apparently not depending upon either the age of the nestlings or the weather conditions (except in the case of actual heavy rain) however the longer the brooding time the more consecutive trips were made for food with usually a shorter interval between trips. Nestlings were usually fed according to their insistence for food and more often than not the same individual was fed twice or even three times in succession. *(Frequency graph - ?)*

Following feedings, fecal sacs were voided but were immediately picked up and swallowed by the adult. At one nest with three young, where the feeding was very rapid only the first fecal sacs were swallowed, the others being carried away from the nest. Toward the end of nest life the young nestlings made an effort to help in keeping the nest clean - they backed to the edge of the nest before voiding the excretory sac though the adult always picked it up and either swallowed it or carried it away.

During the first two days in the life of the nestling any interruption to the silence, such as moving leaves in nest area, resulted in an evident food response which would be repeated several times, each time accompanied by a sound similar to the buzzing of a bee. This buzzing gradually gave way to a low grating call which took on true cuckoo characteristics about the sixth or seventh day. The fifth day appeared to be a crucial time in the nest life of the cuckoo for it was then that fear manifested itself in loud, explosive calls, in being especially reluctant to be taken from the nest, and in voiding a brown sticky excreta rather than that normally enclosed within a sac if it became nervously unsettled before weighing. At no time in any of the nests was this brown waste voided following a feeding but only when dis-

turbed before releasing its firm grasp on nest materials for weighing. Corresponding to the changes in the calls of the nestling were noted other behavior developments; these have been summarized in Table II.

Table showing progressive development of nestlings.

Age	Sight & Hearing	Calls	Instincts	Activities
1st day	Hearing keen-food response given when leaves rustled	Similar to bee buzzing	Grasping-continual opening & closing of toes when taken from nest	Slight wing shivering during food response.
2nd day	Eyes beginning to open	Buzzing sound changes to a mewling		Wings moved more forcefully
3rd day	Eyes wide open for short periods		Grasping well developed	Yawning and stretching of wings
4th day	Eyes open and did some looking around	Call becomes raspy "bark"		Stretching of both wings & legs
5th day	Definite turning of head to see--hearing well developed	Loud calls given when taken from nest	Fear manifested; climbing instinct good	Picked at moving ants or flies; changed nest position
6th day	Still more alert to sound & sight	Call quite cuckoo-like		Showed evidences of nest leaving

Even though the cuckoo is normally a shy, retiring bird ~~it~~ it becomes quite courageous in defense of its young. During the early period of incubation when flushed from the nest the adult left very quietly though she lingered on a nearby branch and watched. Toward the end of this period the adult did not leave the nest so readily and when she did, it was with a mewling sound and perhaps open bill but once the young were hatched the climax of adult objection to an intruder was reached. During the first three or four days of nestling life the adult

left the nest with a mewling sound and open mouth but ^{when} ~~if~~ the young were lifted from the nest, ^{if} they ~~often~~ emitted the raspy call commonly made at this age, the adult became definitely courageous, returned nearer the nest with wide open mouth, spread tail and drooping wings- this protestation was accentuated by a loud bill clapping. Upon retreating to a nearby branch the demonstration ~~was~~ gradually decreased until the adult ~~was~~ once again a silent onlooker.

The variation in reluctance to leave the nest indicates a corresponding variation in brooding with the climax being reached when the young were three or four days old. For the first four days of nestling life the male was on guard on a nearby branch during most of the brooding periods of the female but during the last few days was observed guarding only occasionally and at three nests not at all from the fifth day. Weather conditions had an evident bearing upon brooding. During the entire life of the nestlings in one nest weather was consistently cool and windy with brooding being maintained quite definitely through the first five days while at another nest when the temperature was quite high with only an occasional breeze there was very little brooding even though the nestlings were one and two days old respectively.

During the summer of 1939 when two nests were kept under daily observation both were brought to fruition except for a single egg which did not hatch but during 1941 only a single nest was entirely successful. In one nest the second nestling hatched when the first was four days old (the second egg laid never did develop) and probably because of the difference in age the younger was crowded from the nest and was found the next morning hanging on the outer end of the twigs making up the platform nest. In another nest one of the three eggs was pushed out of the nest and although it was replaced before many hours had passed it was again missing the next morning with no evidence of it on the ground under the nest. The younger of the two nestlings (3 days) was likewise

gone the morning following the disappearance of the egg. In a third nest which was in progress during a period of high temperatures (90°-96°) a very short exposure to the direct sunlight killed the two nestlings and although the adults stayed near the nest for several hours following, they deserted before the next day. The high mortality of the nests observed is given in Table II and explains in part why although the cuckoo may be designated as a common bird of a given area it never becomes plentiful.

	Eggs	No. hatched	Nestlings
1939			
Nest I	4	3	All developed
Nest II	3	3	All developed
1941			
Nest III	3	2	(1 developed (1 crowded from nest
Nest IV	3	2 (1 pushed out)	(1 developed (1 crowded from nest
Nest V	2	2	2 developed
Nest VI	3	2	2 died--result of exposure to sun

Due to the fact that the cuckoo nestlings are in reality precocial altricial young the duration of their nest life was quite short. Of the nestlings observed two left the nest at the age of six days, the other at seven days. My single observation of nest leaving was made during the summer of 1939 and occurred the evening of the seventh day following weighing. When returning the third nestling I noted that the one previously weighed (7days old) had climbed out on the supporting branch. Its grasp was loosened with difficulty and the nestling put back into the nest. This was no sooner done than it ran out of the nest again to the end of the nest branch and in its haste to escape lost its balance and while hanging by its toes gave loud cuckoo-like calls that brought the parent from its watching perch on a near-by tree. The young lost

its hold and still giving its calls ran thru the Pteris for several yards before I succeeded in catching it. It was returned to the nest but remained quiet only a short while before repeating the attempt to escape. Once again it was returned to the nest but when I left the nest area this seven day nestling was standing in a climbing position on the supporting Pteris stem and nest edge while the adult cuckoo was just a couple branches above giving a low coaxing call.

Juvenals

Although it was impossible to locate and follow the young cuckoos after they left the nest, during the two weeks spent afield in search of nests there was opportunity to make observations on juvenals from earlier nests. The juvenal plumage was noted to be very similar to that of the adult as to color except more brownish with the feathers of the scapulars and interscapulars tipped with grayish white and the underparts more decidedly buffy. One juvenal had a tail ~~about~~ two inches long and another four inches in length. In one case an adult was nearby on guard, being detected only when the young gave a low call as I happened upon it. The other young was detected in a clump of red maples (*Acer rubrum*) and because of its longer tail it was first thought to be an adult but the buffy edge to the feathers and the lack of the conspicuous red skin surrounding the eye typical of the black-billed proved that it was a juvenal. This bird was in the process of feeding and though it lacked the ease and grace of movement of its parents yet it jumped from limb to limb and ran up each branch with true cuculine instinct. In feeding, six *Anisota rubicunda* larvae were eaten in close succession indicating that the food following nest life very closely parallels that taken while in the nest. Another proof of this was the stomach contents of a somewhat older juvenal (tail full length but other characteristics those of the juvenal) which contained ten apparently

full grown larvae of the *Anisota rubicunda* and six of a more medium size. The diet probably becomes more varied following the height of the larva season and up to the time of migration which begins in late August or September.

Summary

1. The black-billed cuckoo is the common species of northern Michigan, nesting either in woodlands or more open areas.
2. Nest height varies from a few inches to twenty feet, with the majority at the lower levels.
3. The egg laying interval is irregular, varying from one to three days.
4. Incubation, in the two cases definitely checked, was found to be 11 and 12 days respectively.
5. Both sexes share the incubating and brooding duties. The female assumes the greater part, however, with the male standing guard during the first 4 or 5 days of nestling life.
6. Feeding intervals were observed to be more influenced by disturbances in the nest area than by either nestling age or weather conditions.
7. Larvae is the principal food throughout the life of the cuckoo.
8. Nestlings show a very evident progressive behavior development.
9. Mortality in the nests observed during July 1941, was found to be high.
10. Adult cuckoos become quite courageous in defense of their young.

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NESTING HABITS OF THE BLACK-BILLED CUCKOO¹

BY O. RUTH SPENCER

DURING the summers of 1939 and 1941, I carried on studies on the nesting habits of the Black-billed Cuckoo (*Coccyzus erythrophthalmus*) at the University of Michigan Biological Station in Cheboygan County, Michigan. I kept six nests under daily observation, two from the laying of the first egg, and four from the last few days of incubation, through the nestling stage. I supplemented information obtained from these nests with data from five additional nests of the Black-bill and from two nests of the Yellow-billed Cuckoo (*Coccyzus americanus*), which has similar habits (Barrows, 1912: 338; Bent, 1940: 54).

To note details of nestling activities and kinds of food brought into the nesting area by the adults, observations totalling 94 hours were made from canvas blinds three to five feet from the nests; depending upon the nest height, these blinds were placed on the ground or on a tower. A 4x field glass was used. Additional observations, particularly on general habits, were made without a blind.

The information presented in this paper is based, except when otherwise indicated, upon data obtained from the six nests under observation. Table 1 is a summation of these data.

Grateful acknowledgments are made to Dr. Olin Sewall Pettingill, Jr., for guidance given in this study; to Dr. Theodora Nelson and Mrs. Margaret Nice for valuable help and critical reading of the manuscript; and to Dr. H. B. Hungerford for checking my identifications of insects.

NESTS AND NEST BUILDING

The Black-billed Cuckoo generally nests in low trees or bushes (Chapman, 1937: 331), but nest-sites in the Biological Station area varied. The vegetation chosen for nests ranged from clumps of beech saplings (*Fagus grandifolia*) to coniferous trees (*P. strobus* and *Tsuga canadensis*) and tall deciduous trees (*Acer saccharum* and *Populus sp.*), and sites varied in elevation from 19 inches to 20 feet, with an average elevation of 5.9 feet.

The nests were always well concealed by overhanging branches and leaf-clusters. Made of small twigs loosely interwoven, and lined with leaf scraps, pine needles, catkin remains, or empty cocoons, they were comparatively frail platforms, with uniform $\frac{3}{4}$ -inch inside depth and 3- to $3\frac{1}{2}$ -inch inside diameter. Apparently the material was gathered largely in the vicinity of the nest, both bulk and lining materials being chosen from those readily available. Two nests, No. 3 and No. 5, were selected for detailed examination of nesting material. The bulk of nest No. 3 gave a total of 65 twigs, 10 varying from 9 to 14 inches in length,

¹Contribution from the University of Michigan Biological Station.

TABLE 1
SIX NESTS OF THE BLACK-BILLED CUCKOO

	Nest 1	Nest 2	Nest 3	Nest 4	Nest 5	Nest 6
Date found:	July 5, 1939	July 22, 1939	July 2, 1941	July 7, 1941	July 16, 1941	July 18, 1941
Habitat:	Wooded area	Open 2nd-growth aspen area	Open wooded area	Hilltop with aspen, beech, and bracken cover	Edge of low woodland thicket	Roadside bordered by aspen, maple, and occasional pines
Nest site:	Lower branch of white pine, 3 ft. from trunk	Angle of lower branch of small aspen	Small beech tree where two main branches crossed	Three-way fork of a sapling in a beech clump	Near top of hemlock, 1½ in. from trunk	Near tip of main branch of sugar-maple, 4-5 in. from trunk
Elevation of nest:	19. in.	19.5 in.	5.5 ft.	2 ft.	5 ft.	20 ft.
Bulk of nest:	Twigs of wild cherry and maple and bracken leaf-stems	Twigs of maple, wild cherry, and aspen	Twigs of beech, bracken stem, and leaf-stalks	Twigs of beech and aspen	Twigs of arbor vitae, aspen, & osier, with dead maple- and aspen- leaves between	Aspen and maple twigs
Lining of nest:	Pine-needles and scraps of dead aspen leaves	Bracken leaf-scrap, moth cocoons, and lichen fragments	Scraps of dead beech & bracken leaves, pine-needles	Bracken leaves, leaf-stalks and aspen - leaf scraps	Small pieces of arbor vitae, scraps of maple leaves, pistillate willow-catkins, and pine-needles	Bracken, aspen-leaf scraps, pine-needles
Inside diameter:	3.25 in.	3.5 in.	3.75 in.	3.5 in.	3 in.	3.5 in.
Outside diam.:	5.5 in.	6.0 in.	6.5 in.	6.5 in.	7 in.	6.5 in.
Inside depth:	0.75 in.	0.75 in.	0.75 in.	0.75 in.	0.75 in.	0.75 in.
Outside depth:	1.5 in.	4.0 in.	3.0 in.	2.75 in.	3 in.	3 in.
Contents when found:	4 eggs	3 eggs	1 egg	1 egg	2 eggs	3 eggs

30 from 6 to 9 inches, and 25 from 3 to 6 inches. Nest No. 5 gave a total of 76 twigs of more uniform length, 40 varying from 5 to 12 inches, and 36 from 3 to 5 inches. The lining of the first nest was a small handful of dry leaf scraps, and of the second, a considerable mat of dead leaves, pieces of arbor vitae, willow catkins, and pine-needles.

I was not able to make observations during the nest-building period, but there is evidence that nest-building is prolonged into the incubation period. Three times at nest No. 6, an adult brought pine needles as lining material when coming to replace its mate on the nest. Twice the material was carefully worked into the nest.

COURTSHIP FEEDING

During my observations at nest No. 1 on July 12, 1939, the eighth day of incubation, one of the adults (presumably the female) was on a branch above the nest when the other (presumably the male) came into the nest area with a green larva in his bill. Within a few minutes he swallowed the larva and several times gave a loud call. Immediately the female began flirting her wide-spread tail, while making a low mewling sound. This display went on intermittently for fifteen minutes before she flew to the top branch of a nearby aspen. The male remained silent and motionless.

Again, two days later, one of the adults (presumably the male) came into the nest area with a larva in his bill and took the usual guarding position above the nest on a branch of a near-by tree. The female left the nest and alighted on a branch just below. In a few minutes the male hopped down to the same branch, ran down it toward the female and mounted her. However, copulation did not take place. The male immediately flew away with the larva still in his bill, and the female remained motionless. After eight minutes the male returned with another larva and alighted on the same branch with the female, but this time as he ran toward her she flew away. In a short while the male ate the larva he had brought, then remained on the branch ten minutes before moving out of sight. This behavior, though merely inceptive, can presumably be taken as illustrating courtship feeding (Lack, 1940).

EGG LAYING, INCUBATION, AND HATCHING

The Black-billed Cuckoos laid from 2 to 4 eggs, with an average of 3 eggs per nest. The eggs were oval in shape and dull greenish blue in color, and some had a marbled appearance after three or four days' incubation.

The egg-laying interval was variable. The nests were checked daily at approximately 9 A.M. Each new egg was marked and recorded. Nest No. 3, when discovered July 2, contained one egg. A second egg was

laid July 3 and a third July 6. Nest No. 4 contained one egg when found July 7. A second was laid July 8 and a third July 10.

Several authors (e.g. Barrows, 1912: 340; Bent, 1940: 56, 73; and Herrick, 1910: 229-232) state that not infrequently Black-billed and Yellow-billed Cuckoos lay their eggs in each other's nests as well as in the nests of other birds. During my observations I noted only one case of parasitism, finding a Black-bill's egg in a Yellow-bill's nest with two young and two eggs of the Yellow-bill. It was readily distinguished from the other eggs by its deeper color and smaller size.

Incubation began after the laying of the first egg, but was three to four days shorter than the 14-day period given by Burns (1915: 283). In nest No. 3 one egg, laid and marked the morning of July 6, hatched the morning of July 16. In nest No. 4, the egg laid July 8 hatched July 19. The shortest period of sitting was 15 minutes, the longest 115 minutes, with an average period of 90 minutes. The shortest interval the eggs were left uncovered was 5 minutes, the longest 56 minutes, with an average interval of 28 minutes. The eggs were incubated 68 per cent of the time (calculated on the basis of 15 hours' observation, exclusive of the 4-hour period of unusual activity described later).

The sexes were not distinguishable, but I was able to corroborate the statement by Herrick (1910: 195) that both sexes take part in incubating the eggs. Several times a second adult came into the nest area, gave a low call, and took the place of the incubating bird as soon as the latter left the nest. In 17 hours of observation during the incubation period, I observed the second adult take over this duty three times.

During both incubation and brooding, the adult sat very quietly, turning the head from time to time, and moving the eyes more or less continuously. Contrary to the observation made by Herrick (1910: 197), the adults varied their position on the nest, but four birds seemed to have a favorite position, which they assumed more often than others. The birds had also a favorite path to the nest, but it was not invariably used.

Ordinarily the cuckoo remained close on its nest and was not readily flushed during the last few days of incubation. A striking exception to this was noted during an observation period the day before the first egg was hatched. Nest No. 6, containing 3 eggs, was about ten yards from the main road into the Station area. Three times the bird was frightened from the nest—by a low-flying airplane overhead, by a passing group of children, and by a passing truck. With each disturbance the bird flew to a favorite high branch above the nest, which it used as lookout, and then returned to the nest by flying down to the nest branch, and running along it, stopping cautiously and deliberately on the smaller branches on the way. The adult appeared continuously uneasy throughout the four hours of the morning-observation.

As far as I observed, egg-laying and hatching took place during the early morning hours, except in one case, when the younger nestling in nest No. 5 appeared about 3 P.M., July 18. This very exceptional case of afternoon hatching gave me the opportunity to watch hatching procedure. The adult left the nest upon my approach at 2:55 P.M., exposing one nestling and the second egg, whose shell was cracked and slightly parted around its lesser circumference, showing the young bird moving about inside. Within the next five minutes, half of the shell fell away. The young nestling began emitting low cries, and emerged from the remaining half-shell *entirely dry*. The adult, meanwhile, remained on a branch of an adjacent tree and called softly at irregular intervals.

The egg shells were usually disregarded by most of the adults, though they were sometimes pushed about in the nest with the bill. That they were not consistently removed was proved by the fact that many shell scraps were found in the bottom of the nests. However, at nest No. 6, an adult ate the larger pieces of shell. About four hours after the young hatched and after they were fed, the adult stepped over the nest, but before taking the brooding position reached into the nest and devoured what appeared to be small shell scraps. After a short period of brooding, the adult again reached into the nest and brought out the entire smaller half of the shell. It was too large to be taken into the mouth whole, so that it was necessary to crack the shell first between the mandibles. In about two minutes' time the bird had swallowed the entire half.

NESTLING STAGE

The newly hatched Black-billed Cuckoo nestling has a coal-black skin, whose feather tracts are made conspicuous by wiry gray "hairs"—the feather tubes of a vestigial down that never unfolds (Herrick, 1910: 198). The feet and bill are a steel-blue, the commissure very slightly lighter in color. By the third day the down-feather tubes are pushed out on the tips of the juvenal contour-feather tubes, and remain attached to these for four or five days. The feather tubes on the anterior portion of the ventral tract at first develop more slowly than the others, being barely visible until the fourth day, but in their later development they practically parallel those on the dorsal area. By the sixth day the juvenal contour-feather tubes, ranging in length from 17 mm. to 21 mm., give the young nestling the appearance of a porcupine, but on the seventh day the ends of these tubes begin to burst, and the nestling for the first time has a somewhat fluffy plumage. According to Herrick (1910: 206) the opening of the feather tubes (except those on the head and neck, which require longer) is completed in about 12 hours.

The day-old nestlings weighed from 7.5 grams to 9 grams, giving an average for 7 nestlings of 8.5 grams. Weight increased quite uniformly during the first four days, the average daily gain of 9 nestlings

being 4.7 grams; but the increase was more gradual during the remainder of nestling life, the average daily gain of 9 nestlings being 2.8 grams. The average weight of the 9 nestlings on the last day of nest life was 28.5 grams.

FEEDING, CALL NOTES, BROODING OF YOUNG

Feeding began 1½ to 2 hours after hatching. The food consisted almost entirely of insects, 90 per cent of which were in the larval form. The remaining 10 per cent was made up of grasshoppers, small moths, mayflies, and robber flies, with an occasional spider. The larvae of the rosy maple moth (*Anisota rubicunda*) were extremely abundant in the Station area. This abundance probably explains why 81 per cent of the larvae fed to the young cuckoos were of this variety. Herrick (1910: 212) found that smooth larvae made up 44 per cent of the total food of Black-billed Cuckoos, hairy caterpillars 5 per cent, adult lepidoptera 5 per cent, and grasshoppers 27 per cent.

Feeding was done by both sexes. The adult approached the nest by running along the nest branch, and the resulting vibrations excited the food-response in the young: open mouth, stretched neck and flapping wings, accompanied by a sound like the buzzing of bees. As mentioned by Herrick (1910: 214), whenever this food-response was not given by the time the adult stepped on the nest edge, the parent immediately gave a peculiar low mewing sound, and this invariably excited a vigorous response.

The wide-open mouth of the begging young bird displayed a very conspicuous group of snow-white disks of variable size symmetrically arranged on the bright red palate. (Herrick, 1910: 201). Some observers (e.g. Herrick, 1935: 99; Roberts, 1932: 593) believe these disks to be sucking pads used by the young to hold the adult's bill while feeding. However, in 75 feedings, I noticed close contact between the maxilla of the nestling and the bill of the parent only three times. Since the lower or inner edges of the larger disks were decidedly rough, the disks may be an aid in grasping the live food. Another possible function of these disks may be as a food target, since they greatly increase the conspicuousness of the palate.

The food was always carried to the young crosswise in the bill. Occasionally the adult crushed the food before bringing it into the nest area, but more often not until after alighting on the nest edge. Usually the food was thrust far down in the throat. When necessary, additional thrusts were given to hasten the swallowing response. With the younger nestlings the larva was put into the open mouth, then a motionless position was held by both adult and young for many seconds—often for as long as two or three minutes—before swallowing occurred. Herrick (1910: 218) records an instance in which five minutes were required to awaken the swallowing reflex. If the first attempt failed, the larva

was withdrawn, further crushed, and put again into the throat. Occasionally this procedure had to be gone through a third time. With the older nestlings swallowing took place either immediately, or within a few seconds after the food was inserted into their mouths.

Food was generally brought by the adult when coming to take its turn on the nest, the other adult leaving the nest and not returning for a considerable period. A notable exception occurred about 10:30 A.M., July 24, 1941, at nest No. 6, which contained two nestlings. The brooding adult left the nest as the relief adult came up the nest-limb with a grasshopper nymph in its bill, which it fed to the day-old nestling and then ran down the nest limb out of sight. In less than three minutes it was back again with a larva about one inch long and correspondingly thick, which it fed to the same nestling. Just as the larva was inserted into the open mouth, the mate returned and alighted on the nest edge, carrying a well-developed larva of the rosy maple moth. The first adult withdrew the unswallowed larva just fed the nestling, and both parents gave the low food-call. Response was instantaneous, and both adults now tried to feed the younger bird. The first adult succeeded in replacing the same larva, and the mate turned about and placed the larva it was carrying in the wide-open mouth of the older nestling. The swallowing response of both nestlings was retarded because of the size of the larvae, the older one swallowing first. The second adult took the fecal sac and flew away again, leaving the other to assume brooding duties.

Feeding intervals varied considerably. At nest No. 1, containing three young (3-, 5-, 6-day age) intervals ranged from 1.5 minutes to 80 minutes; the average was 18.5 minutes during a 4-hour observation made in the morning. At nest No. 6, with two young (2-day, 3-day age), the feeding intervals varied from 3 minutes to 65 minutes over a five-hour morning-period, and averaged 25 minutes. Herrick (1910: 222) cites two extreme observations. For a 53-hour period at two nests containing six young (ages varying from one to six days), the feeding rate was once every 25 minutes. For an entire day at a nest containing three young (4-, 5-, 6-day), the feeding rate was once every 4 minutes. Herrick explained this high rate by lack of fear, abundant food, favorable weather, and no other young, already fledged, to divert the attentions of the parents.

After feedings on the first five days, fecal sacs were voided and were picked up by the adult. They were either swallowed immediately or carried away. During a four-hour period at nest No. 1 (containing 3 young), when 27 feedings took place, the fecal sacs were carried away after 17 feedings and swallowed after the other 10. On seven occasions after swallowing the sac, the adult settled on the nest, and on the three other occasions it again fed the nestlings several times. It thus appears that at this stage of nest life the manner of fecal disposal is determined

by the adult's next activity: if the bird is disposed to brood or feed again, it swallows the sacs; if not, it carries them away. Herrick (1910: 220) stated that the disposition of the fecal sacs was dependent upon various circumstances in which must be included the hunger of the old bird at the moment.

From the age of 5 days the nestlings backed to the edge of the nest before voiding the fecal sacs. Occasionally the sacs fell to the ground, but more often they fell on the edge of the nest and were picked up by the adult and either swallowed or carried away.

An unusually strong grasping-reflex appeared during the first five hours out of the shell, allowing the bird to cling to the nest. At one-day-old a very rapid opening and closing of the toes was noticed. On succeeding days the toes were opened and closed with greater force.

I noted a very slight shivering of the wings during the food response in all 14 nestlings at one-day-old. This movement became more forceful in the 2-day young. Four 3-day nestlings (nests Nos. 1, 2, and 4) were seen to stretch one wing after the other, sidewise, during prolonged absences of the adult. Grasping at this age was so well-developed that, unless I took great care when removing the young for weighing, the nest was pulled apart. Ten nestlings at 4 days (nests Nos. 1, 2, 3, and 4) stretched the wing on each side downward while extending the corresponding leg. This was done regularly during an adult's absence of an hour and fifteen minutes at nest No. 2, the leg-wing stretching occurring on the average every 8 or 10 minutes, with a maximum interval of 16 minutes.

I saw no evidence of the preening instinct which Herrick (1910: 205) says becomes very active on the sixth day. During the last two days of nestling life (6 and 7 days), with a very few quill tips on dorsal and ventral tracts opened, the young cuckoos were quick to pick at ants or flies on themselves. At no time could this action be mistaken for the combing action as described by Herrick (1910: 205).

During the first two days of nestling life the sound accompanying the feeding response had been similar to the buzzing of a bee. This buzzing gradually gave way to a "bark," a low grating call that took on true cuckoo characteristics about the sixth or seventh day. At the five-day age fear manifested itself in loud, explosive calls, and the young became especially reluctant to be taken from the nest for weighing. Either just before or at the time of removal they voided a brown, sticky excretion, whereas after feeding they invariably voided white fecal sacs.

Accompanying the changes in the grasping-reflex and wing-movements, and in the call of the nestlings, was the development of sight and hearing. The eyes began to open at two days and were wide open for short periods by the third day. At four days the nestling followed moving objects with its eyes, and at five days turned its head from side to

side in an attempt to see moving objects in the nest area. At one day of age the rustling of leaves excited the food response, which indicated an already keen sense of hearing. At five days the breaking of a twig several feet from the nest caused the nestling to turn its head in that direction. Both sight and hearing were well-developed by the six-day age.

At my approach to the nest during brooding the behavior of the adult very closely paralleled that described by Herrick (1910: 197). At first, the adult moved its head to keep me within view, but as I came nearer the nest (within 4 or 5 feet), the head began to rise and continued until the bill pointed to the zenith. Rapid movements of the eyelids and fast breathing movements were very noticeable.

Even though the adult cuckoo was normally a shy, retiring bird it became quite courageous and bold in defending its young. Early in the period of incubation, when flushed from the nest by my approach to within five feet of the nest, the adult flew very quietly to a nearby branch and watched. Toward the end of the incubation period (8 to 9 days) the adult did not leave the nest so readily, but remained motionless until I was within two or three feet of the nest. When it did leave, it was with a mewling sound and perhaps open bill. At the time of hatching, the adult was more reluctant to leave and more vigorous in its calls; it stayed closer to the nest than before—within two or three feet—while uttering kuk-kuks of protest. It continued to behave in this manner for the first three or four days of nestling life. Later, whenever the young emitted the raspy bark commonly made by them when disturbed, the adult became strikingly bold, and a number of times flew directly at my face with wide-open mouth, spread tail, and drooping wings, sometimes clapping the bill loudly. Each attack was usually short, and it quickly decreased in intensity, the adult finally perching on a nearby branch and quietly looking on.

Observations on the attendance of the adult were made for 10-hour periods at 2-day and 5-day ages of nestlings. In each case the data were obtained during ten hours' observation, during which the weather was clear and the temperature mild (78° F and 81° F). The periods of attendance were longest during the middle of the day. The shortest periods were in late afternoon, when feeding activity increased. For the 2-day nestling the maximum attendance period was 120 minutes, the minimum 45 minutes, giving an average of 87.5 minutes. For the 5-day nestling the maximum attendance period was 105 minutes, the minimum 10 minutes, giving an average of 43.3 minutes.

Weather conditions had an evident bearing upon brooding. During the entire life of the nestlings in nest No. 4, the weather was windy and cool (65° F: five-day average); brooding was maintained quite steadily through the first five days. The average length of the brooding period (based on 19 hours of observation) was 80 minutes, and the young

were brooded 54 per cent of the time. In contrast with this, at nest No. 6, when the temperature was quite high (93° F: three day average) with just an occasional breeze, the young were brooded only 26 per cent of the time. The average brooding period (based on 11 hours of observation) was 20 minutes, and the parent would often shade the young from the sun for an equivalent period.

During the approach and duration of a storm, brooding at nest No. 1 was maintained for a two-hour period. The adult apparently sensed the storm's approach, for although the second bird called from a nearby branch, the brooding one did not leave. Three times during the hour preceding the storm the adult used its bill and body in an attempt to push the nestlings deeper into the nest. As the storm broke, the bird noticeably lowered its body, at the same time spreading the wings over the nest edge and lowering the tail. With each additional down-pour the body was pulled more tightly to the nest, tail lowered further, and bill pointed higher. For 45 minutes following the storm the only change the brooding bird made in her position was to lower her head. Herrick (1910: 225) watched a nesting adult during a 1½-hour rain. He noted that it left as soon as the rain was about over. He also noted that the bird raised her body two or three times during the rain to examine the young, whereas the one I observed did not raise the body until shortly before leaving the nest even though it was evident that the nestlings were decidedly restless.

NESTING SUCCESS

During the summer of 1939, when I kept two nests under daily observation, both were brought to successful completion except for a single egg, which did not hatch; but during 1941 only one out of the four nests was entirely successful. In one nest (No. 3), two out of three eggs hatched, the second four days after the first. The younger nestling was found dead at two days of age, hanging on the outer edge of the nest, from which it had probably been crowded. In another nest (No. 4), one of the three eggs was pushed out of the nest and, although I returned it before many hours had passed, it was again missing the next morning with no evidence of it on the ground under the nest. The younger of the two nestlings (three days of age) was also gone the following morning. In a third nest (No. 6), where brooding was in progress during a period of high temperatures (93°-99°), a 15-minute exposure to direct sunlight for purposes of photography killed the two nestlings. (The adults stayed near the nest for several hours afterwards, but deserted before the next day.)

Of the 18 eggs laid in the two seasons, 14 (87.4 per cent) hatched. Ten of the young (71 per cent) left the nest, giving a total for surviving young of 55 per cent from the six nests.

5-day-old stages of nestling life. During cool windy weather, length of attendance-periods increased.

The young left the nest at the age of 6 or 7 days, with the juvenal-feather tubes just beginning to open.

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NEST LEAVING

Herrick (1910: 199) says the cuckoo nestling, in proportion to its size, is probably the strongest and most enterprising altricial young on the North American continent. This, in part, explains the shortness of its nest life. Of the ten nestlings known to leave the nest, two left at the age of six days, and eight at seven days.

My single observation of a young bird leaving the nest was made during the summer of 1939 and occurred after I weighed the birds the evening of the seventh day. When I was returning one young to the nest, I noted that the one previously weighed had climbed out on the supporting branch, where it stood erect with upward pointed bill, suggesting the pose characteristic of a bittern. I loosened its grasp with difficulty and put it back into the nest. It immediately ran out again to the end of the nest-branch but, in its haste to escape, lost its balance and, while hanging by its toes, gave loud calls that brought the parent, in a spectacular display of courage, from its watching perch on a nearby tree. The young lost its hold, fell, and, still giving its calls, ran with amazing speed through the bracken (*Pteris*) for several yards before being caught. It was returned to the nest but remained quiet only a short while before repeating the attempt to escape, performing several climbing-feats with skill and speed. Once again the nestling was returned to the nest, but when I left the nest area it was standing in a climbing position on the supporting bracken stem and nest edge. The adult cuckoo, perched just a couple of branches above, was giving a low coaxing call.

SUMMARY

In northern Michigan the Black-billed Cuckoo was found to nest usually in woodlands but occasionally in more open areas. A total of six nests were observed during the summers of 1939 and 1941.

Nest elevation varied from 19 inches to 20 feet, the average being 5.9 feet.

Possible cases of courtship feeding were observed.

The egg-laying interval varied from one to three days. Both sexes took part in incubating the eggs, one adult apparently assuming the greater responsibility. The incubation period, determined in two cases by marking the eggs, was found to be 10 and 11 days respectively.

Insect larvae made up 90 per cent of the food brought to the nestlings; the remaining 10 per cent consisted of miscellaneous insects.

The Black-billed Cuckoo nestling is exceptionally precocious. The most outstanding reactions displayed upon hatching or shortly thereafter are its grasping-reflex, call-notes, and enthusiastic food-responses.

Observations showed the average attendance-period of the parents to decrease somewhat less than 50 per cent between the 2-day-old and