

THE MECHANICAL RECORDING OF THE NESTING
ACTIVITIES OF BIRDS.¹

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Plates XV-XVIII.

IN life history studies of birds much has been written by ornithologists concerning the behavior of birds at the nest, the raising of young, methods of feeding, song and call notes, migration, and other activities.

Collections of nests and eggs have determined for most species, the size, structure and make up of nests and the size, number per set, shape, and color of the eggs.

By collection of adult birds not only have birds been accurately described and the names and relationships determined, but much information is on record as to distribution, habitat, sex, migration, and plumage.

Observation or bird-watching in out-door active life, in their natural habits and activities, is a very valuable method of study; and where two or more people coöperate by alternate periods of observation at the nest, continuous records over many daylight hours have been obtained.

The introduction of bird banding has given these methods still greater value, since it is now possible to identify and follow more closely the behavior of the individual bird identified by the band.

Much remains to be learned concerning the life histories of birds. As yet, we do not know the complete life history of a single species. The more readily observed and apparent features of bird behavior have been noted, but the underlying physiological and psychological principles remain for more careful analyses.

One phase of bird activities, that of their attentivity to the duties of reproduction or the amount of time that the two sexes spend on and off the eggs or tending the young, has received considerable attention at this laboratory during the last five years.

¹ Contribution No. 18 of The Baldwin Bird Research Laboratory, Gates Mills, Ohio.



Clock itograph in weather case (closed) and set up below wren box, to which it is connected by wires.

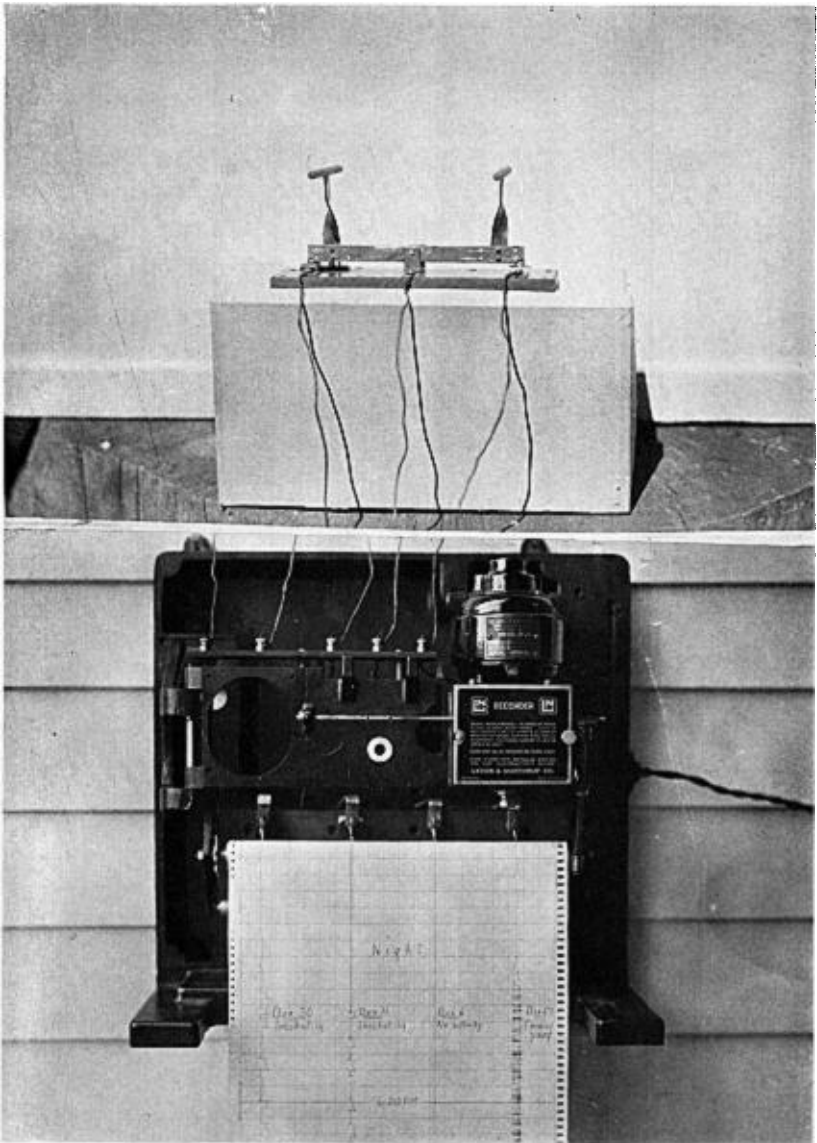
A report on attentive and inattentive periods in the House Wren was published in 'The Auk' (Vol. XLIV, No. 2, pp. 206-216, 1927). In that paper it was shown that the adult birds are not continuously attentive to the eggs, caring for the young, nest-building, or singing. Periods of such attentiveness alternate with periods when the birds are away getting food for themselves. It is obvious that the adult birds must maintain their own vital processes and their own lives as well as look after those of their offspring. From further study on other species, very interesting modifications of the type of attentivity from that found in the House Wren have been discovered, but this must wait till the future to be reported.

Two methods were described in the paper above mentioned, one by observation and the other by the use of thermocouples. These thermocouples, when placed in the nest and connected to a recording potentiometer, give a continuous record not only of every visit of the adult birds to the nest to incubate the eggs but also the duration of these visits and much of the activity while there. This is shown by means of temperature fluctuations in the nest caused by different movements of the adult birds. The advantage of this mechanical method of recording bird behavior is that it is accurate, time-saving, impersonal, and continuous both day and night. Observations alone could not produce such records.

Thermocouples may be inserted in almost any sort of nest, so that the exact amount of time that the adult birds incubate their eggs may be easily obtained. We have acquired such records from fifteen species of birds. This recording potentiometer is operated by electric current which drives about three feet of recording paper per day through the instrument, upon which the pen makes record.

A disadvantage is that the instrument does not record the visits of the adult birds to feed their young, as the adults then do not sit on the nest nor affect the temperature of the thermocouple. If the thermocouple is left in the nest after the eggs hatch, only an erratic record is obtained because of the constant shifting of position of the young.

To get the complete record of visits to the nest not only during incubation, but during the period of feeding young, another



A.—Itograph perches adapted for use on open nests; the two perches swing on a central pivot and make contacts below, the same as in the case of perches arranged for species nesting in boxes.

B.—Multiple itograph; for this the back and motor from a Leeds and Northrup recording potentiometer has been used to operate a wide paper, while the electromagnet and pens have been inserted on a special frame. In the figure, only four pens are shown, each connected to a separate nest, but lately three more pens have been added.

instrument has been devised which will record every visit of the adult bird to the nest from the first inspection of the box until the last young bird leaves and the nest is prepared for a second brood. The duration of these visits is recorded as accurately as before, and some of the bird's activities while at the nest may be interpreted.

Again we called upon our ingenious friend, Dr. Charles Baldwin Sawyer, President of the Brush Laboratories Company of Cleveland, to work out in detail in his shops, the apparatus which we came to call the "Wrenograph," because we used it at first to record the comings and goings of our Wrens.

As this instrument came to be used and adapted to other kinds of birds we have felt that a less facetious but more, descriptive general name should be given to it, and we have called it the "itograph" from the root "it" (from the irregular verb *ire*, to go) as used in the words *exit* and *adit*. The itograph does not record temperature. This instrument in the more simple form, which we call the clock itograph (Pl. XVII, a), is not difficult to construct, and is easily transportable into the woods and fields anywhere, and attached to almost any nest. The only care necessary is a visit each morning to the instrument and sometimes to the nest to make sure that all is working well, and to make a few minor adjustments and notations. The success of the instrument with different species of birds and types of nests demands a little ingenuity.

With such species as the House Wren which almost always nests inside of cavities, or boxes when these are available, the mechanical recording of visits to the nests is not difficult, for each time the bird comes to the nest it must pass through a comparatively narrow entrance hole. Likewise, each time it leaves, it must pass in the reverse direction through the same opening. Thus it is apparent that some device at the entrance which will register the passage of the bird in either direction will record the visits to the nest.

After one or two preliminary unsatisfactory attempts, the following arrangement was found to be a success. As illustrated in the photograph (Pl, XVIII, b), two perches are used, one just outside the entrance hole, the other just within. The two perches

are connected and work in a see-saw manner, like a rocking beam, on a central pivot. By means of a wire spring the beam is in neutral position and the two perches are kept raised above supporting contacts directly beneath when no bird is on. The perches and the supporting contacts below on each side of the entrance are connected with a series of dry-cell batteries and with an electromagnet. On the electromagnet a pen is attached which bears upon a roll of paper unfolding continuously at a uniform rate. The electric connections are shown in fig. 2 (p. 475).

At once it is evident that when the adult bird comes to the nest in the box, it must first alight on the outer perch, pass through the entrance, and step on the inner perch before it reaches the nest. When it alights on the outer perch, its weight is sufficient to press down the perch so that it rests on the support below. This establishes a contact between the two, thereby closing an electric circuit, as is evident in fig. 2. When this electric circuit is closed the arm of the electromagnet with the attached pen moves in one direction—to the right (fig. 1). Then, when the bird leaves the perch, the contact is broken because the wire spring again raises the perch, the electric circuit is opened, and the pen works back to a neutral position. The same thing occurs when the inner perch is pressed down, except that here the electric flow is in the opposite direction due to a different relation of the plus and minus poles of the batteries. This causes the pen to move in the opposite direction—to the left. It is apparent, then, that when the bird enters the box, the recording pen will be pulled first to the right,

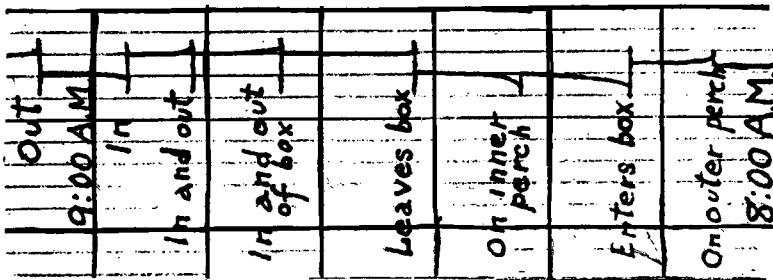
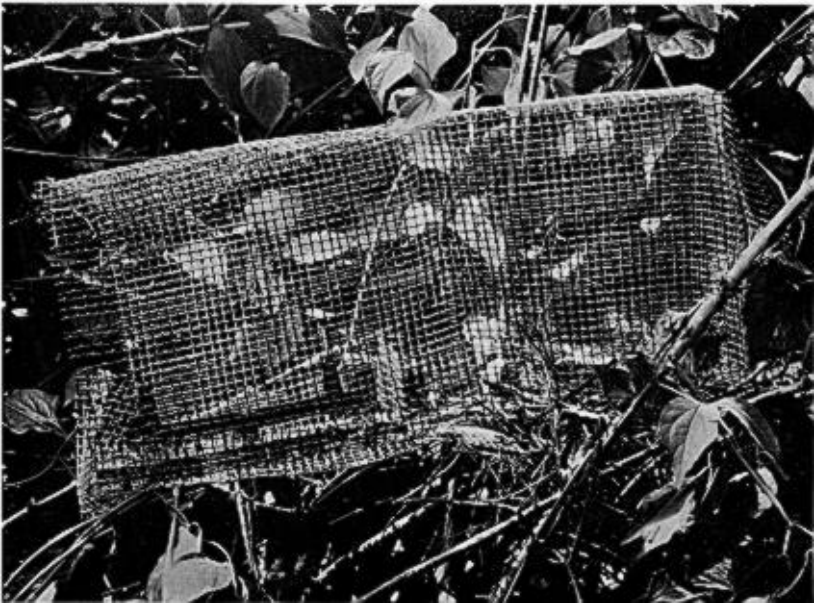
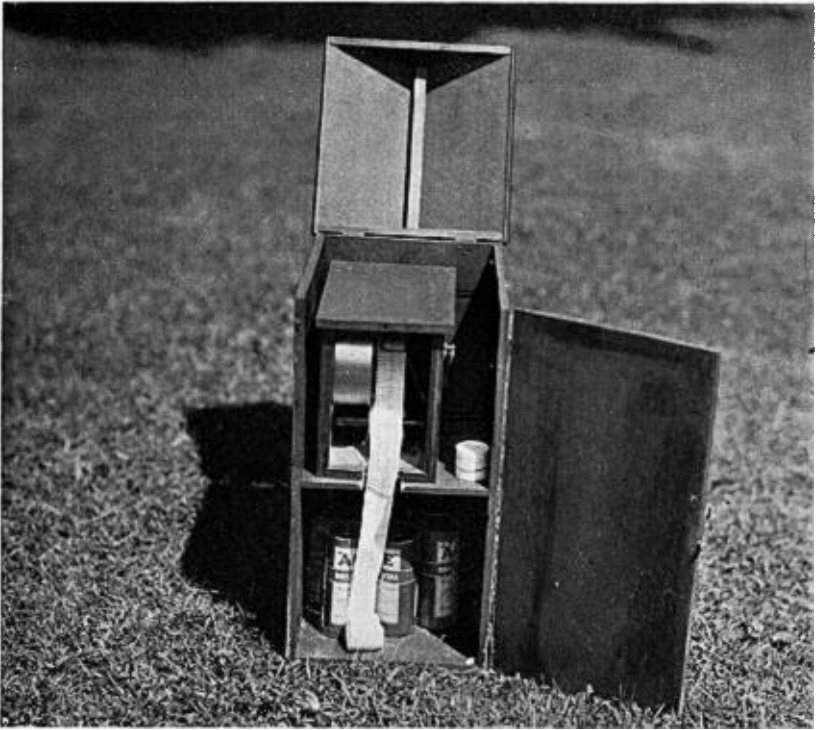


Fig. 1. Detail of record from clock itograph with interpretation of each movement of the pen.



A.—Clock itograph, complete, included in weatherproof outer box.

B.—Itograph perches arranged at an open nest (Catbird) showing position in short tunnel of wire mesh at left leading to enclosed nest at right. Adult birds enter and leave nest through tunnel alighting each time on two perches in turn.

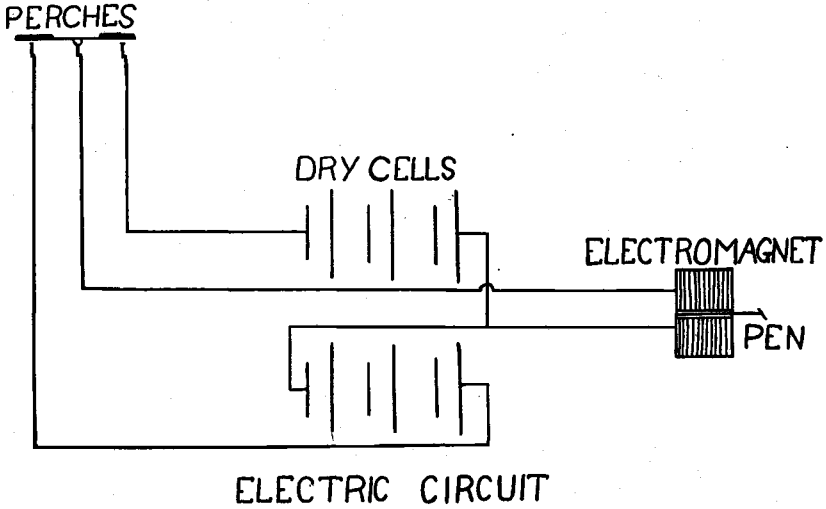


Fig. 2. Electrical connections between perches and itograph. The circuit is closed only when the weight of the bird depresses one or the other perch. The two perches close different circuits, thus drawing the pen to the right or left.

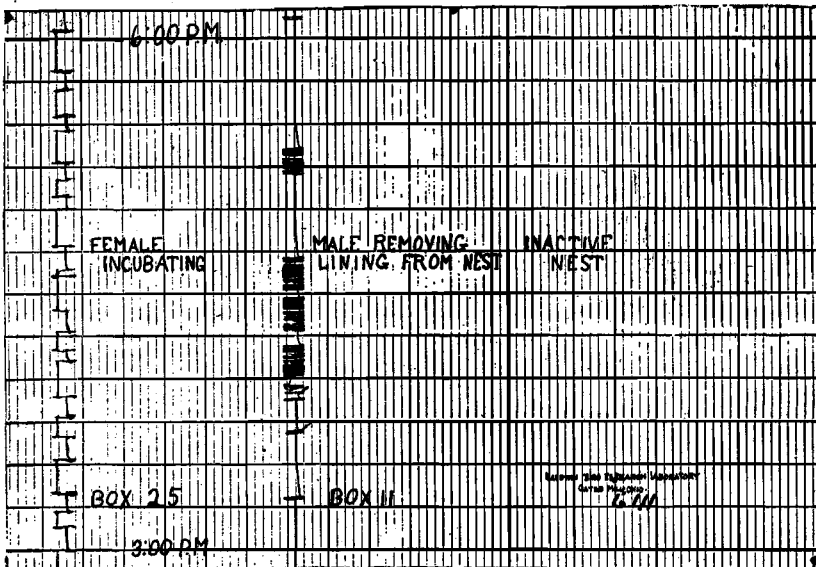


Fig. 3. Record from multiple itograph showing very characteristic record obtained when male wren actively removing lining at the completion of a first nesting—in anticipation of remating for a second time.

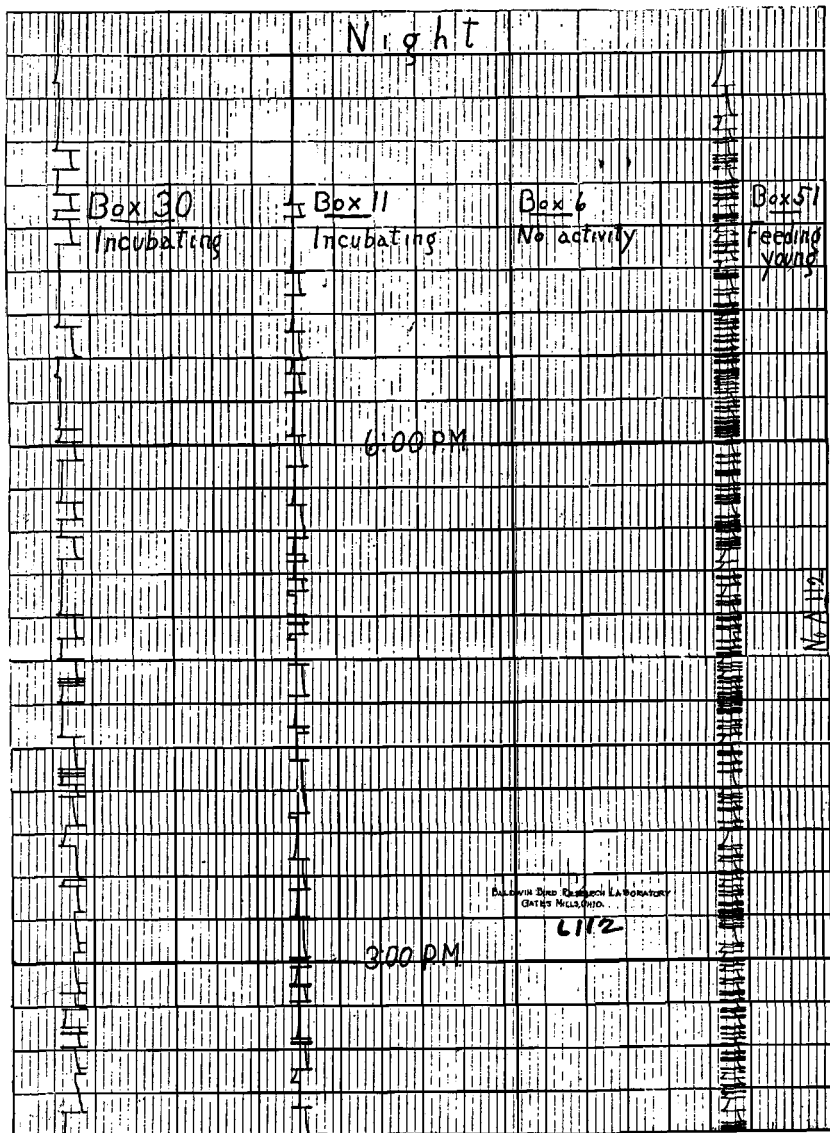
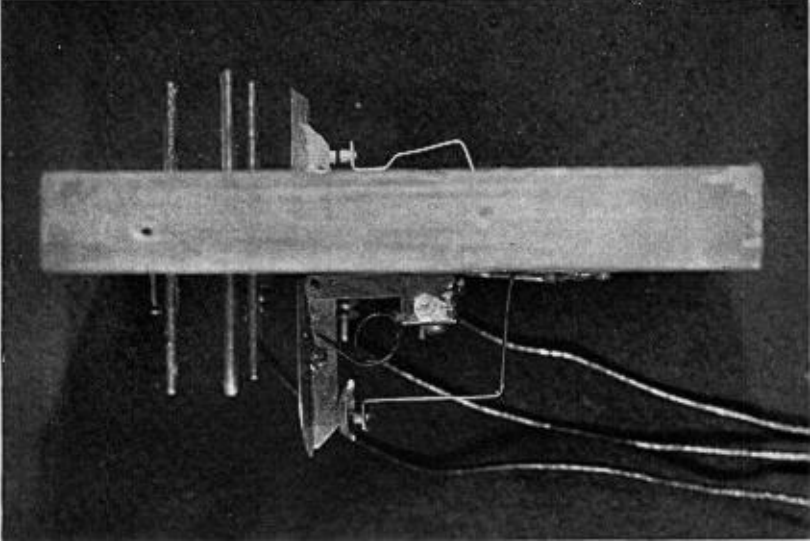
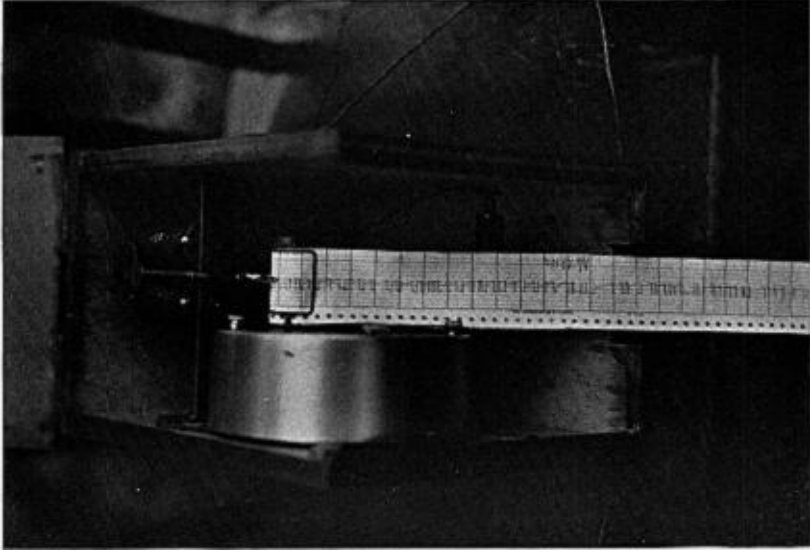


Fig. 4. Record from multiple itograph showing type of records obtained when birds (house wrens) incubating and feeding young. The distance between any two consecutive horizontal lines represents fifteen minutes.



A.—Clock itograph; inside on the left, a round casing enclosing a forty-eight hour clock which operates a spindle by which the paper is rolled off at the rate of about four feet per day; the pen is mounted on an arm controlled by an electromagnet operated by dry cells.

B.—Front of wren box; on the left side is shown the outer perch and the electric connections on the outer side of the box; to the right, the inner perch, which is protected from contact with the nest material when in use by a metal cover. The projecting pegs above the perches are to prevent the bird from going into the opening without touching the perch.

and then to the left and then gradually work back to a neutral position. It is important that the pen should not jump back to neutral, but rather drag gradually back as in that way it shows which is the last perch used by the bird. Likewise, when the bird leaves the box, it steps first on the inner perch, then the outer, so that the pen moves, in this case, first to the left, then to the right. Thus in the record obtained, it is evident at once whether the bird has just entered or left the box.

Portable Itograph.—In the portable itograph, as shown in the photographs, everything is compact. A 48-hour clock is used to unwind a narrow strip of paper and on this the pen works (Pl. XVIII, a). As the paper is unrolled, a continuous record is formed of all visits which the adult birds make to the nest. The recording instrument is placed on a shelf in a small protective weather-proof box (Pl. XVII, a). The set of batteries is directly below, and the strip of paper runs down the front of the box through a slit in the shelf into an empty space in front of the batteries. When finally set up, the front of the box is closed, the roof is lowered, and thus left ready to operate (Pl. XV). Since no human being is around and the birds soon become accustomed to the presence of the box and perches, as natural a record as is probably possible to obtain results.

When it is reasonably certain that a pair of birds will nest at a certain box, the instrument may be adjusted before nest-building is begun and left as long as desired so that a complete record running all through the nesting life is obtained. Where large numbers of boxes are under observation and many are in use at the same time, it is usually practicable to wait until nesting has begun, then take down the box, transfer the nest and its contents to an itograph box with the connections already arranged, and fasten the new box in the position of the old. Adult Wrens come back within a few minutes and accept the new box with very little hesitancy.

Multiple Itograph.—The type of itograph described above is portable, a feature we have gone to some trouble to obtain. However, it records the activities at but one nest at a time. Another instrument records from seven different nests simultaneously on a wide strip of paper (Pl. XVI, b and figs. 3 and 4, pp. 475-476). The principle of its operation is much the same except that instead

of but one electromagnet and one pen, there are seven electromagnets set up in the same supporting case. Also, instead of a clock to unroll the paper, it has an electric motor. This fact, in addition to its size, weight and cumbersomeness, does not permit ready movability. However, the distance from the nests to the instrument may be of any desired length, so that the instrument may be set up in the center of the field of activities at the beginning of the season and several nests connected to it at various times. This instrument we have called our *multiple* or *stationary itograph*.

Itograph on Open Nests.—When one comes to record the visits of adult birds to open nests, as those of Catbirds, such a box arrangement as is used with the House Wren will not work. The same principle of having two perches, making two different electric contacts when the bird comes to the nest or leaves, is still practicable, however. All that is necessary, is to adapt the perches. One such adaptation which has proved very successful is illustrated (Pl. XVI, a). To use this perch it is necessary to train the birds to approach and leave the nest each time by the same route. The adoption of a single route to the nest is quite normal with birds even when there is no human interference. To aid this, all sides of the nest except one are enclosed in wire mesh. Then it is also advisable to build a short tunnel on the open side so that the bird cannot possibly avoid this route to and from the nest. The perches are then placed in this tunnel in such a position that the bird must alight on them as it visits the nest (Pl. XVII, b).

One may think that so much structure may frighten the birds and that the normal nesting behavior will be disturbed. So far, we have used this perch arrangement on three different open nests of three species—Catbird, Robin, Phoebe—and each attempt has been successful—in fact even more successful than was at first hoped. The records obtained on both portable and stationary itographs have been excellent, and from all appearances the behavior has been normal. The young in every case left the nest normally, the feeding of the young by the adults was regular, and the birds became quite accustomed to the perches. So far, we have not attempted this set-up on open nests until the eggs have hatched. Also the set-up is not arranged all at once, but a step at a time. For instance, with the Catbird, the wire mesh enclosure open only

on one side was placed at the nest on the day that all the eggs hatched, the tunnel was made on the open side the next day, while it was not until the third day that the perches were placed in and the final connections established. It was made certain at each step that the birds were behaving normally before the next addition was made. Also, from observations beforehand it was determined which side of the nest the birds approached most frequently. After the final adjustment had been made, the adult birds returned within ten minutes and a normal record was obtained for the rest of the nesting period.

It has been generally assumed by most ornithologists hitherto, that birds will not permit visits to their nests or interference in their nesting activities without desertion. This is not entirely justified. It is the regular practice at this laboratory to visit and work with the available nests of all species occurring on the premises. In a few cases, it is true, this has caused the birds to desert, but in the great majority of cases not. There is a difference between species in the amount of interference which they will tolerate. With the House Wren, almost anything can be done with the birds or nests at any stage with the assurance that not over ten per cent of the experiments will be unsuccessful by reason of desertion of the birds. The House Wren is an exceptionally easy species with which to work.

Nevertheless, we have been successful in obtaining good temperature records and records of attentivity by placing thermocouples in the nests of the following species of birds:

Number of Nests	Number of Nests
House Wren 20	Flicker 1
Robin 4	Mourning Dove 4
Bluebird 2	Killdeer 2
Catbird 2	Cardinal 1
Purple Martin 1	Goldfinch 1
Song Sparrow 4	Phoebe 1
Yellow Warbler 1	Domestic turkey (wild nest) . . 1
Crested Flycatcher 1	

Itograph box perches have been successful as follows:

House Wren	35 nests
Bluebird	3 nests

Open nest itograph perches have been successfully arranged for:

Robin	1 nest
Phoebe	1 nest
Catbird	1 nest

Birds are undoubtedly most sensitive to interference during the nest-building and egg-laying periods. At this time they will sometimes desert at the slightest provocation so that discretion must be used. As incubation proceeds they become more faithful to their nests, and after the eggs are hatched, considerable disturbance, is necessary to make them desert.

The Chipping Sparrow and Cedar Waxwing are the only two species with which we have found it difficult to work and desertions in these species are frequent.

Birds also differ individually in the extent of interference which they will stand. Even some individual House Wren will endure more than others.

It has been the common experience of ornithologists that when birds desert their nests for whatever reason, they begin a new one in the immediate vicinity within a very short time. The normal amount of reproduction for the season is therefore maintained, although for these particular birds, the nesting period is slightly prolonged. An occasional unsuccessful attempt at nest experiments is no cause for alarm or discouragement, and the information obtained from these more intensive studies of life history is of considerable value. It is from this point of view that the use of the instruments described above has been suggested. It is hoped that they will be of some interest to bird students.

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