An automatic incubation recorder for wildfowl

JOHN HORI

Automatic recording devices which can be buried under ducks' nests to provide records of incubation rhythms have been developed by workers in North America, though no detailed accounts of their construction and use seem to have been published. Such equipment appeared to have obvious application to the nests of Shelduck (*Tadorna tadorna* (L.)), where it could be easily disguised. During the winter of 1962-63 various prototype equipments were constructed and eventually a crude but effective working apparatus was used in North Kent during the 1963 breeding season.

Apart from a wide variety of miscellaneous sites the principal Shelduck nesting places in the area under observation were in rabbit burrows, trees, or hay and straw; all were of roughly equal importance. Hay and straw sites seemed most suitable for recorder experiments and the co-operation of farmers was obtained in arranging interiors of barns and sheds to make them more suitable. Farm buildings chosen all had a previous tradition as breeding sites, and artificial nesting places were constructed in them with bales of straw, meal bags, corrugated iron and other miscellany. Five of these sites were subsequently occupied.

Description of equipment

Basically the equipment comprised three parts : (1) a detecting component in which a contact-making device varied the condition of an electrical circuit according to the female's presence or absence; (2) an electrically operated graphic recorder which responded to the contact; and (3) an interconnecting cable system. In practice none of the components was quite so simple and refinement was necessary to cover other variables.

The simplest system for the detecting component would have been a weight-responsive one in which a sitting bird closed a contact against spring pressure, the spring restoring the contact to its opposite position when the bird left the nest. This would have had obvious disadvantages in matching springs to hypothetical weight conditions and in making running adjustments in the field. It was found that the best results, within my own economic possibility, were obtained with a domestic beam scale on which the pan was replaced by the bottom of a large plastic bowl. In addition to improved accuracy and consistency, such a scale had two major advantages: (a) the movement of the pan to cause beam deflection was very small and (b) balance conditions were adjustable; making it possible to weigh and balance any reasonable clutch. The scale range was 0-14 lb., with adjustment in 1 oz. steps, so that in practice the limiting factor was the physical size of the clutch, not its weight.

An extension arm was fitted to the beam of the scale to operate a totally enclosed micro-switch which thus changed its contact position when there was a change of weight on the scale. Careful attention was necessary to silence the scale movement and all contact faces were treated with foam rubber. The composite scale, beam switch and bowl were placed in a wooden box suitable for burying beneath nests and a layer of straw was stuck over the whole exterior to obviate the possibility of it becoming completely uncovered.

A portable miniature potentiometric recorder was coupled to the detecting equipment; this was a self-contained instrument comprising slide wire, servo-driven wiper combined with the pointer, servo amplifier, battery supply and chart assembly. The unit was transistorized and its small overall dimensions (10 in. × 8 in. × 6 in.) were admirably suited to concealment near the nest, although the original conception was that it should be remotely housed. Various types of 'range unit' are obtainable and in this case temperature measuring circuits were employed. The range and deflecting circuits gave balance conditions when connected to an external thermo-couple; mid-scale deflection corresponding to approximately 27°C at the external location. The copper-constantan thermo-couple was cemented to the beam scale bowl so that it was in the bottom of the nest; it was thought initially that it would be possible to measure incubation temperatures in this way (see below). External circuit connections were such that the micro-switch on the beam connected the thermo-couple to the recorder whenever the beam was deflected by the weight of a sitting bird. Conversely, when the bird left the nest the beam reset; this operated the micro-switch which 'open-circuited' the thermo-couple loop and unbalanced the recorder 'range circuits' which returned the pointer to zero. The pointer reproduced a continuous graphic record on 3 in. wide waxed paper charts. The absence of ink pens and ink reservoirs was an obvious advantage. A chart length of 65 feet was used and driven at 1 in. per hour by the eight-day clockwork drive. This gave a record of just over one month's duration.

Recorder and beam scale were inter-connected with a twin core copper-constantan cable and the whole system was actuated by dry batteries contained within the recorder.

Application and field results

Five of the artificial nest sites were occupied and the recorder was applied to four of these before correct operation was achieved. The initial conception was that the apparatus would be installed towards the end of the laying period when the duck's attachment to the nest had become strong and when the beam scale could be set with accuracy. Approximate weights of birds and eggs had been previously determined, but the size of each particular clutch had to be found out. Setting-up procedure was therefore to involve waiting until the clutch had been completed, or nearly so, and then weighing it on the beam scale. The latter could then be 'calibrated' by adding approximately half the weight of the bird to that of the clutch so that the scale would not be deflected extraneously. The scale and all associated equipment were then to be buried beneath the straw.

The application histories follow, in chronological order.

At Nest 1, egg laying was watched to apparent conclusion, *i.e.* down lining, and the apparatus was installed on 21st May, 1963. The beam scale was buried beneath the nest and the recorder placed in a remote part of the barn. Unfortunately this nest turned out to be a multiple one, the work of at least two females, and more eggs were laid until the total reached 25. This necessitated repeatedly re-weighing the clutch and re-setting the beam scale, and it was not altogether surprising that the birds ultimately deserted. The photograph on p. 172 shows this nest 'restored' with the scale buried beneath it.

This first attempt showed that the apparatus was generally satisfactory but the repeated weight increases caused by the laying of additional eggs caused the recorder to incorrectly indicate the continuous presence of the bird. This condition obscured battery drain difficulties which were to arise later.

Nest 2 was in a Dutch barn. The beam scale was buried beneath the nest during laying. The recorder was sited in a hole in the side of the stacked straw. This application quickly illustrated a deficiency in the equipment. As previously described, balance conditions in the range circuits were obtained with the thermo-couple in circuit, *i.e.* with the bird on the nest, and under these conditions the capacity of the internal batteries was some 300 hours. However, when the bird was not on the nest the recorder deflected to zero, driving hard against a stop and consuming much more power than in balance conditions. With continuing deflection to zero, batteries were exhausted in approximately two days.

The apparatus had to be removed from this location when the straw was sold and this opportunity was taken to modify it. Alterations were made to the recorder and its external circuit so that the internal batteries were only utilized when a bird was on the nest. Disconnection of the recorder batteries was effected by an interposing relay to which a capacitor discharge circuit was fitted. The relay was actuated by the beam scale micro-switch and at every relay operation the capacitor discharged into the recorder deflecting circuits causing a definite kick in the trace when the bird left. These modifications necessitated addition of a relay box and a further set of batteries to energise the relay, the latter adding greatly to the weight and bulk: to economise in wiring, the recorder was subsequently placed near to the beam scale. After one further unsuccessful application the apparatus was installed in another hay barn. The modified equipment is shown at p. 172.

At the final nest there was no escape tunnel (see also Hori, 1963). Batteries and relay were buried beneath the straw adjacent to the nest. The equipment was installed on the sixth day of incubation and at first operated perfectly. Further difficulties were soon encountered however when it was found that the drag between the straw of the nest and the stationary straw surrounding it could prevent 'throw off' of the beam scale counter-weight system. This happened particularly after long spells of sitting, presumably as a result of turning, re-settling and lengthy compression of the straw. It was the most difficult problem to eradicate since it involved the small differential between approximately half the weight of the bird and the force necessary to overcome drag and interference of straw. The problem was solved by completely separating the straw of the nest from its surroundings and inserting a stiff paper lining to form a cylinder in which the beam scale bowl and nest moved freely. Some eggs were removed from the nest during these adjustments to avoid removing the whole beam scale for adjustment.

Consistent operation was finally obtained on the ninth day of incubation and a continuous record was plotted from then until the ducklings left the nest. Full details of the results are to be published elsewhere (Hori, in press). The thermo-couple did not give an accurate picture of incubation temperatures and acted merely as a deflecting source for the recorder. This resulted from a decision to 'play safe' by burying the couple beneath a layer of straw and cementing it to the recorder bowl. However, it still seems probable that incubation temperatures could be measured in this way.

This female, AJ87910, was noteworthy as being the first ever to provide such data. Matters were not to end there however; her body was picked up at Niedersachsen on the river Weser near Bremerhaven on 15th October, 1963, so near the Knechtsand as to make it certain that she had been there or intended to go there. She thus went on to prove conclusively that some, if not all, breeding birds from North Kent make the moult migration to Heligoland (Goethe, 1961).

References

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Congenital malformation in birds bred at Slimbridge

JANET KEAR

As in two previous breeding seasons, all young birds and eggs that failed to hatch during 1963 were examined for malformation. The high proportion of abnormality (10 out of 1,767 birds examined) in 1961 (Harrison and Kear 1962; Napier 1963) has not recurred (0 out of 934 in 1962 and 0 out of 2,459 in 1963), suggesting some external factor affecting, for one year only, a number of our breeding ducks. Harrison (1963) has supposed that seed-dressings, of which the three most toxic were voluntarily banned for spring use from January, 1962, might be implicated in congenital deformities in corn-eating birds. It is, of course, impossible to know whether grain fed to the collection in spring 1961 was contaminated, but it is recognised that certain drugs can upset normal embryonic development and the effect of agricultural chemicals in this specific situation might be investigated. The abrupt cessation of abnormality after 1961 makes a further suggestion that radioactive fall-out was a prime cause of the high level of congenital deformity seem less likely, since fall-out continues despite a partial test ban treaty.

References

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