

THE BREEDING SUCCESS OF VARIOUS PASSERINE BIRDS UNDER CHRONIC GAMMA IRRADIATION STRESS

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IN November, 1961, a 9,500 curie source of Cs¹³⁷ was set up in a scrub pine-oak forest on the Brookhaven National Laboratory site in central Long Island, New York (Woodwell, 1963). Since that time the forest has been continually subjected to gamma irradiation 20 hours a day. Because the forest is not rich floristically and provides few ecologic niches, both the species diversity and number of breeding pairs of birds are rather low. However, in the late spring and summer of 1965 we noticed a greater number and variety of breeding birds than usual in the irradiated forest. This stimulated some detailed observations on the location of the nests, their distance from the radiation source, the probable exposure rate at the nest, estimated by using LiF dosimeters, and finally the success or failure of the breeding attempt.

This research was carried out at Brookhaven National Laboratory under the auspices of the U. S. Atomic Energy Commission.

OBSERVATIONS

In the spring and summer of 1961, before installation of the radiation source, the proposed experimental forest was examined by John Greenlaw, who recorded 29 species of birds in or around the area. Only 12 species actually nested in an experimental plot (91,317 sq. yds.) set up at that time: Ruffed Grouse (*Bonasa umbellus*), Yellow-shafted Flicker (*Colaptes auratus*), Hairy Woodpecker (*Dendrocopos villosus*), Downy Woodpecker (*D. pubescens*), Great Crested Flycatcher (*Myiarchus crinitus*), Blue Jay (*Cyanocitta cristata*), Black-capped Chickadee (*Parus atricapillus*), White-breasted Nuthatch (*Sitta carolinensis*), Brown Thrasher (*Toxostoma rufum*), Hermit Thrush (*Hylocichla guttata*), Baltimore Oriole (*Icterus galbula*), and Rufous-sided Towhee (*Pipilo erythrophthalmus*).

In 1965 the area studied was only one-tenth the size of the original study area. The chronic dose rate was presumed to have a negligible effect over the 30-day nesting period beyond 66 yards from the source (11 Roentgens/day or 330 R for the nesting period). The area within the first 66 yards around the source was carefully watched and the presence of singing males noted, to locate territories and nesting sites. In this way the nests of five species of birds were located in the irradiated forest: Tree Swallow (*Iridoprocne bicolor*), Rufous-sided Towhee, Brown Thrasher, Baltimore Oriole, and Eastern Bluebird (*Sialia sialis*).

The Tree Swallow nest was in a woodpecker hole 57 yards from the

source. The birds were first observed on 28 May 1965, bringing nest material to the tree and, later, spending some time in the nest incubating. Three young were seen to leave the nest 28 June. Assuming there were eggs present on 28 May, the eggs and young were exposed to 558 R at a rate of 18 R/day. This was measured by LiF dosimeters placed in the nest so the shielding effect of the tree is included. After the young left the nest, an egg with no sign of an embryo was discovered buried in the nest material.

The first towhee nest was found 14 June, at 37 yards. Between 19 and 22 June four eggs were laid. On 12 July one egg, removed for examination, had no embryo. The nest was deserted on 15 July almost 30 days after the beginning of incubation and the remaining three eggs disappeared within four days. At a rate of 21.6 R/day the eggs received 497 R for the period 22 June to 15 July.

A second towhee nest was found at the base of a tree in a thick clump of *Carex pensylvanica* on 20 July at 42 yards. In all probability the eggs had been incubated by that time for several weeks, at a dose rate of 39 R/day. By 27 July the nest had apparently been deserted and by 30 July all eggs had disappeared.

On 18 June a Brown Thrasher nest containing four eggs was located at 57 yards. By 29 June only one young nestling was still in the nest. This disappeared between 5 and 9 July before it was fully feathered. The young were exposed between 18 June and 5 July to 252 R at a rate of 14.8 R/day.

A Baltimore Oriole nest was found in the top of a scarlet oak (*Quercus coccinea*) 19 June, 93 yards from the source at a dose rate of 6 R/day. Although it was not possible to examine the nest or to keep it under frequent observation, the adults were seen on 9 July carrying food to the nest, indicating, at least, a successful hatching.

On 14 July a dead female bluebird was found 24 yards from the source, close to an abandoned nest. The bird was well decayed when discovered and an unlaidd egg was clearly visible in the body cavity. The abandoned nest contained two eggs, neither of which contained embryos, and the eggs showed distinct signs of dessication. The daily dose rate at the nest was 130 R. The minimum dose probably received by the female, allowing four days for nest building and two days for eggs laid one per day would have been 780 R.

DISCUSSION

Willard (1963) showed that the LD100 (i.e., a dose that is 100 per cent lethal) for wild bluebirds is about 3,000 R when given as an acute dose to the nestlings. The LD100 for eggs is 600 R acute dose (Willard, 1963; Norris, 1958). Willard also stated that the morphological development

TABLE 1
EFFECT OF CHRONIC RADIATION ON THE NESTS OF SIX BIRDS

<i>Dose rate/day</i> ¹	<i>Total dose over 13 days</i>	<i>Nesting results</i>
6	78	nestlings observed
14	182	fledglings observed
18	234	nestling observed
21	273	eggs lacking embryos
39	507	eggs lacking embryos
130	1690	eggs lacking embryos

¹ Dose in Roentgens.

of acutely irradiated bluebirds is slower than that of their non-irradiated siblings but that the behavioral development of the two occurs at the same rate. Irradiated fledglings tend to leave the nest at the same time as non-irradiated fledglings (Willard, 1963) but usually lack fully developed flight feathers. Willard also suggested the use in ecological studies of an LD50 of 500–600 R, since this would take into account the mortality occurring in birds which leave the nest before they are able to fly.

If the incubation time for the five species irradiated is arbitrarily set at about 13 days, then an accumulated dose can be calculated (Table 1). Here the LD100 for irradiated eggs is rather lower than that reported by Norris (1958). Generally an accumulated dose of chronic irradiation has less effect than an equivalent acute dose. The two examples which seem to contradict this general observation are provided by abandoned towhee nests. Examination of an egg from one nest showed no embryo, so it is certainly possible that the eggs were never fertilized rather than being inhibited in their development as a result of irradiation. Since the male towhees return north in advance of the females and set up and defend territories before the nests are actually built or the eggs laid, it is quite possible that the males accumulated enough radiation prior to mating to sterilize but not enough to kill them. The resulting eggs would be sterile and would not hatch. By overlong incubation (up to 15 days over the normal 13) one towhee female may have been exposed to 630 R and the other to 1,170 R without apparent ill effect. The female bluebird received a minimum of 780 R prior to death although this individual could have received far more than this by perching very close to the source. In view of the location of the nest 24 yards from the source it seems quite probable that this female accumulated rather more than the total calculated from nesting activities, enough to place the exposure well over the LD100 of 1,000 R.

From these observations, then, it seems likely that the LD100 for the eggs of wild passerines is between 500 and 1,000 R at a dose rate up to 50 R/day and that the LD100 for adults may be as high as 2,000 R at a dose rate of up to 150 R/day.

LITERATURE CITED

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