By that evening, the young birds could receive food from their parents. Both sexes fed the young. The two original routes of approach were now neglected, and a new one, less well defined, was beginning to be used.

A Marsh Hawk, *Circus cyaneus*, flew over the nest that evening as one of the sparrows was about to feed the nestlings. Immediately the sparrow crouched and froze, uttering three thin calls resembling the syllable '*eek*.' When the hawk had passed, feeding was resumed.

A third egg had hatched the next morning before 8:30, but I was unable to spend much time at the nest that day. The fourth egg failed to hatch but was allowed to remain in the nest until finally destroyed.

Most of the food brought to the nest was small green caterpillars. However, on the third day after the beginning of hatching, a few large, dark caterpillars were brought. The first of these was offered unsuccessfully and finally eaten by the adult sparrow, but an hour later a similar caterpillar was eaten by a nestling.

Until the older nestlings were three days old, their excreta were eaten by the adult birds. However, after that time it was carried beyond my sphere of observation. By that time, the nestlings were able to maintain a begging position for a nearly a minute. The two-day-old bird held his neck fairly rigidly extended upward, but the two older nestlings swayed their heads through a small arc from front to rear, like an inverted pendulum. All were still blind.

Late in the afternoon of June 24, an unknown predator destroyed nest Number 3. Since the other was not as advanced, and I had to leave Algoma five days later, I was unable to observe the later stages of nesting.

SUMMARY

In the District of Algoma, the Clay-colored Sparrow nests in fields overgrown with willows, with aspens suitable for singing perches, and subject to spring floods. Singing occurs until the end of incubation and shows some individual variation. The nests are built a few inches above the ground in willows. Two complete clutches were of four eggs each. Both sexes incubate for 10 or 11 days; each sex uses a distinct approach route to the nest. In two nests, one egg hatched 24 hours after the others. Both adults fed the young. A new approach route was used by the adults after the eggs had hatched.—FREDERICK E. WARBURTON, *Owen Sound, Ontario, Canada.*

Definitions for the Analysis of Survival of Nestlings.—Considerable confusion exists in ornithological literature about the methods of calculating survival of young birds. This confusion results in part from failure to define the survival terms and in part from the problem of altricial birds which, in effect, are "born" twice. This paper attempts to clarify the definitions and gives some examples of their use.

These suggestions omit a discussion of the construction of a conventional life table which is organized to show the number of survivors at successive equal intervals of time. The life table can be easily constructed from data that are systematized according to the recommendations of this note. However, the life table concept is less satisfactory than the following concepts because of the varying duration of the stages of nest-life, monthly variations, and the short lives of most birds.

Mortality rate is commonly used to indicate some sort of a percentage of deaths but is very loosely used. It is suggested that the phrase be omitted to prevent confusion, since there are the following two kinds of mortality rate.

A. The probability of dying (q) is the fraction of the initial population dead at time t. For example, if 100 birds are alive on January 1 and 60 of these birds have

died by December 31, the annual probability of dying is 60/100 or 0.6. The probability of dying cannot be more than one (certainty).

B. The death rate (r) is the number that die divided by the average population during the period of time. Thus if a population of birds declines exponentially, as a result of 60 deaths, from 100 to 40 during the year the average population is 65.5 and the death rate is 60/65.5 = 0.915. But if, although there were 60 deaths, the population remains stationary at 100 birds, then the death rate is 60/100 or 0.6. It must be noted that the death rate can be more than one in species that have short lives and high natality rates. It is possible to have 300 birds die in a population that averaged 100 birds, giving a death rate of 300/100 or 3.0.

The probability of dying (q) is related to the probability of survival (p) by the following equation, $q = 1 - p$. Ornithological work is usually described in terms of survival and hence survival will be used from now on.

The probability of survival (p) is related to the death rate (r) by the following equation:

$$p = e^{-r} \text{ whence, } e^{r} = 1/p \text{ and } r = \log_e (1/p)$$

In addition to the above definitions it is necessary to obtain definitions of the ornithological aspects. For birds it is probably best to omit the calculations of death rates because they imply a constant reproductive rate. Furthermore, the probability calculations are usually adequate. The annual probability values rarely reach one, due to the relation between length of life and reproductive rate. If desired, the death rates can be readily calculated. The following definitions are proposed for the ornithological aspects.

1a. The probability that eggs will hatch is the number of eggs hatched divided by the number laid.

1b. The probability that eggs in successful nests will hatch is the number of eggs that hatch divided by the number of eggs in nests that were successful (*i. e.*, hatched at least one egg).

2a. The probability that eggs will produce fledglings is the number of young that leave the nest divided by the number of eggs laid. This definition usually can be applied only to altricial birds.

2b. The probability that eggs in successful nests will produce fledglings is the number of young that leave the nest divided by the number of eggs laid in successful nests (*i. e.*, fledged at least one young).

3a. The probability that nestlings will fledge is the number of young that are fledged divided by the number of eggs hatched (nestlings). This definition also usually can be applied only to altricial birds.

3b. The probability that nestlings in successful nests will fledge is the number of young that are fledged divided by the number of eggs hatched in successful nests (*i. e.*, nests that fledged at least one nestling).

4. The probability of survival of young to a specified date is the number alive at that date divided by the number that left the nest, or, in precocial birds, that hatched.

The time interval for the first three definitions is determined by the length of that phase of the life cycle in the particular species. An annual value is biologically meaningless. However, for comparative purposes definition 4 (the probability of survival of young) can be put on an annual basis, if desired, by the formula:

$$p_a = (p_t)^i ,$$

where p_t is probability of survival during time t, p_a is annual probability of survival and i is the number of time units in a year (12 if t is a month; 52 if t is a week, etc.).

From these definitions it is clear that $(p_{1a})\ (p_{3a}) = p_{2a}$, where p_{1a}, p_{2a}, p_{3a} refer to the probability values obtained for the respective definitions. This provides a simple check on the calculations. But the same reasoning cannot be applied to definitions 1b, 2b, and 3b because "successful nest" does not always mean the same thing.

Strictly speaking, infertile eggs should be excluded in these calculations. However, data on infertility are rare and the proportion of such eggs is small, so that no great error is introduced.

It is also necessary to consider the probabilities for survival of a nest, which means that at least one egg will hatch or one young will fledge from a nest.

5. The probability that some eggs in a nest will hatch is the number of nests in which at least one egg hatched divided by the total number of nests with a full clutch.

6. The probability that some fledglings will leave a nest is the number of nests from which at least one young was fledged divided by the number of nests with a full clutch. Obviously this does not apply to precocial birds.

7. The probability that some fledglings will leave a nest in which some eggs hatched is the number of nests from which at least one young was fledged divided by the number of nests that hatched eggs.

Note that, since $(p_5)\ (p_7) = p_6$, a convenient check is available.

It will be noted that in most cases these probabilities are the same as the percentages regularly calculated. The concept of probabilities is suggested because it is a prediction and because it can be more easily manipulated mathematically.

The significance of a difference in probabilities for two species or for the same species in different places or years can be calculated by the usual method as follows:

$$\frac{p_x - p_y}{\sqrt{pq\left(\frac{1}{n_x} + \frac{1}{n_y}\right)}}$$ must be more than two to be significant at the five per cent level of confidence or more than three to be significant at the one per cent level. In the above formula p_x is the probability for one sample and n_x is the number of individuals in the sample. The same notations refer to values for y. p is the total probability of survival in both samples and $q = 1 - p$. This formula assumes that the deaths are independent which is probably rarely true in nature, and hence it gives only an approximation. If the significance is in doubt, more complex methods are required and the data must be recorded according to the number of clutches with 1, 2, 3, etc., eggs and the number of eggs lost for each clutch-size. An indication of the significance of the difference of two samples may be obtained by a consideration of the results of analysis of definition 7.

It is now desirable to cite some examples. The Ruffed Grouse, *Bonasa umbellus*, (Bump, G., R. W. Darrow, F. C. Edminister, and W. F. Crissey, New York State Cons. Dept., 915 pages, 1947) will be used as an example of a precocial species.

Definition 1b. From table 54 (p. 366) 5156 young hatched from 5257 fertile eggs, giving a probability of hatching (in successful nests) of 0.981.

Definition 5. From table 35 (p. 311) 878 of 1431 nests were successful, giving a probability of 0.614 that some eggs in a nest will hatch.

Definition 1a. The data can be utilized from tables 50 and 35 to get a value for this statistic. From table 50, we would expect 100 nests to have 1150 eggs. Total destruction of 49 of these nests (see definition 5) would destroy about 564 eggs. Partial destruction of 0.02 eggs (see definition 1b) in the remaining 51 nests would remove 12 eggs. Hence, the probability of hatching would be $1 - 576/1150 = 0.499$.

Definition 4. The survival of young grouse is given in table 81 as 0.368. The unit of time is not specified, but if we assume that the interval is from April 1 to August 1 (4 months) then:

$p_a = (0.038)^3 = 0.0000549$.

For an altricial bird it is possible to calculate all the statistics defined above. The studies of Nice (Trans. Linn. Soc. N. Y., 4: 1–227, 1937) provide adequate data in her table 16, page 141.

Definition 1a. A total of 510 eggs hatched from 854 eggs laid. Hence, the probability of hatching is 0.597.

Definition 1b. Of a calculated total of eggs in successful nests of 588 (147 times 4), 510 hatched, giving a probability of hatching in successful nests of 0.867. Infertile eggs are included here.

Definition 2a. A total of 306 young were fledged from 854 eggs. The probability that eggs will produce fledglings is therefore 0.358.

Definition 2b. Since 306 young were fledged from 588 eggs (147 times 4.0) in successful nests, the probability of fledging in successful nests is 0.520.

Definition 3a. A total of 306 young were fledged from 510 eggs that hatched. The probability of young fledging is therefore 0.600.

Definition 3b. The data are not given directly in table 16 but can be calculated as follows. Eggs hatched in 147 nests and young were fledged in 100 nests, giving 0.68 successful in fledging young. Then, 0.68 times 510 eggs that hatched gives the number of eggs (347) that hatched in nests that successfully fledged young. The probability of nestlings fledging in successful nests is 306/347 = 0.882.

Definition 4. Data are not available for this statistic, but we can calculate the "probability of returning" as follows. From table 26 (p. 180) 40 birds returned from 317 banded as fledglings. If we assume that the mean date of fledging was about June 15 (see table 12, p. 132) and that the mean date of return was about March 15 see chart 6, p. 44) then the "probability of return" is 40/317 = 0.126 for 9/12 of a year. The annual probability, therefore, is 0.126 raised to the 12/9 power, which is 0.0632

Definition 5. The probability of a nest successfully hatching is 0.697, since eggs hatched in 147 of 211 nests.

Definition 6. The probability of a nest successfully producing young is 0.474, since 100 of 211 nests produced young.

Definition 7. The probability of a nest, in which young hatched, producing young is 0.680, since 100 nests produced young out of 147 nests in which young hatched.

For comparison the results may be tabulated as follows:

Definition (*see text*)	*Song Sparrow* (*Nice*)	*Ruffed Grouse* (*Bump et al.*)
1. a.	0.597	0.499
b.	0.867	0.981
2. a.	0.358	—
b.	0.520	—
3. a.	0.600	—
b.	0.882	—
4.	0.0632	0.0000549
5.	0.697	0.614
6.	0.474	—
7.	0.680	—

It may be worthwhile to calculate the significance of a difference. Nice (*op. cit.*, p. 141) states that the probability of fledging was far less in 1933 than in 1932. In 1933, 27 (19.0%) of 142 eggs fledged; in 1932, 76 (36.8%) of 206 eggs fledged. Utilizing the formula given above the calculations are:

$$\frac{.368 - .190}{\sqrt{(.296)\,(.704)\left(\frac{1}{206} + \frac{1}{142}\right)}} = \frac{.178}{\sqrt{.00232}} = 3.8$$

This result is statistically significant, if we can assume that the deaths are independent. If, however, most of the deaths are dependent, then the difference probably is not significant and needs further analysis.

It is hoped that this systematization of data will permit more uniformity of analysis and stimulate the collection of more adequate data.

I am indebted to D. F. Farner, R. V. Rider, and C. A. Bachrach for criticism of the manuscript at various phases of its development.—David E. Davis, *Division of Vertebrate Ecology, Johns Hopkins School of Hygiene and Public Health, Baltimore, Maryland.*

Notes on Birds of Jamaica.—This note concerns some observations made in the winter of 1946–47 on transient or winter visitant birds of Jamaica. I wish to point out that I made my records available to James Bond, of the Philadelphia Academy of Natural Sciences, for use in his 'Field Guide to Birds of the West Indies' (1947) and his 'Check-list of Birds of the West Indies' (1950). Thus, it will be noted that all species here recorded as new to the Jamaican avifauna have already been listed by Bond for the island. However, lack of space prevented Bond from giving details of the records here presented.

For aid in many ways I am indebted to Mr. Bond, to Mr. C. Bernard Lewis, Curator of the Science Museum of the Institute of Jamaica, Kingston, to Dr. Bernard Williams of Greenwood, Salt Marsh P. O., Jamaica, to the Hon. Theodore R. Williams of Kew Park, Westmoreland Parish, Jamaica, and to many other Jamaican friends. Dr. George M. Sutton of the University of Michigan helped me secure some essential supplies. I also owe my thanks to Mr. Lewis, Dr. Williams, and other members of the Natural History Society of Jamaica for permitting me to publish here some of their notes from the Society's mimeographed 'Natural History Notes' (see literature cited).

All specimens taken are in the collection of the Science Museum of the Institute of Jamaica.

Plegadis falcinellus, Glossy Ibis, and *Guara alba*, White Ibis.—I saw two Glossy Ibises and two flocks of about 12 birds each of White Ibises on November 29, 1946, in the Dawkin's pond area, Port Henderson, St. Catherine Parish. May Jeffrey-Smith (1947: 116) reports 15 White Ibises at the mouth of the Martha Brae River, Trelawney Parish, on June 22, 1947. C. B. Lewis (1948: 142) reports an unverified observation of "dozens of Glossy Ibis and a lesser number of White Ibis . . . feeding at the mouth of the Duhaney River." Bond (1950: 12–13) gives no other Jamaican records for the Glossy Ibis. Concerning the White Ibis, he writes (*loc. cit.*) "apparently rare in Jamaica, though formerly a not uncommon resident." Jamaican observers would do well to obtain specimens to serve as concrete evidence of the present day occurrence of these two ibises on the island.

Coccyzus erythrophthalmus, Black-billed Cuckoo.—According to Bond (1950: 71) this cuckoo is casual in the West Indies on migration, being recorded from Cuba,