hatched, but the chick was not found. The remaining 8 eggs contained fully developed but dead chicks. The chicks had pipped and partially ringed their egg shells and then became "entombed" (Fig. 1). Bobwhite chicks sometimes pip their egg shells but do not hatch due to weakness and/or desiccation (Stoddard, The Bobwhite Quail, C. Scribner's Sons, NY, 1931; Rosene, The Bobwhite Quail, Rutgers Univ. Press, New Brunswick, NJ, 1969; Stanford, Whirring Wings, Missouri Conservation Comm., Jefferson City, MO, 1952).

Stoddard (op. cit.) also said that Bobwhite have a strong nesting instinct and that an incubating hen may remain for a long period of time on eggs that do not hatch. The nesting behavior reported herein is interesting because the hen remained on partially hatched, dead chicks. Perhaps the stimulus of partially opened eggs kept the hen incubating. Also, it has been thought that if only one egg hatches, the nesting instinct would be satisfied (Murray and Frye, The Bobwhite Quail and its Management in Florida, Game Publ. No. 2, Florida Game and Fish Comm., Tallahassee, 1964). The 8 dead chicks had not started to decompose, but rather appeared to be desiccating. The length of time the hen remained on the partially hatched eggs is unknown, but the hatching effort probably occurred several days prior to 3 October.—GEORGE A. HURST, *Dept. of Wildlife & Fisheries, Mississippi State Univ., Mississippi State 39762. Accepted 29 Dec. 1977.*

A Cattle Egret-deer mutualism.—Cattle Egret (*Bubulcus ibis*)-ungulate relationships have been considered commensal (Heatwole, Anim. Behav. 13:79–83, 1965; Jenni, Ecol. Monogr. 39:245–270, 1969). Cattle Egrets feed more efficiently when taking insects flushed by grazing cattle than when hunting apart from cows (Dinsmore, Am. Midl. Nat. 89:242–246, 1973). We observed Cattle Egrets feeding on 3 species of horse flies (Diptera: Tabanidae) on the skin of the Virginia white-tailed deer (*Odocoileus virginianus*) in the Okefenokee Swamp, Stephen Foster State Park, 30 km NE of Fargo, Georgia from 28 May to 2 June 1977. This is the first reported association between Cattle Egrets and any North American nondomestic ungulate.

Observations (ca. 2.5 h) of several egrets and deer were made between 08:30 and 16:30 during the week. Commonly, 1 egret rode on the head or back of a deer and captured the large horse flies feeding on open wounds about the shoulder, head and face of the deer. The deer appeared undisturbed by the presence or feeding activities of the egrets. The species of horse flies observed (*Tabanus petiolatus, Tabanus americanus, Diachlorus ferrugatus*) inflict blood-letting wounds and may vector a variety of ungulate microbial diseases occurring in the southeastern United States (James and Harwood, Medical Entomology, Macmillan Publ. Co., New York, 1969). Thus because both egret and deer received benefits, the relationship was mutualistic. Whether the benefits are significant to the success of the individuals is unknown.

We thank Drs. Roland R. Roth and Richard W. Rust for comments on the manuscript. —MARC R. HALLEY AND WAYNE D. LORD, *Dept. of Entomology and Applied Ecology, Univ. of Delaware, Newark, 19711. Accepted 3 Oct. 1977.*

A test of significance for Mayfield's method of calculating nest success.—Mayfield (Wilson Bull. 87:456–466, 1975) presented further suggestions to simplify his

previously published method (Mayfield, Wilson Bull. 73:255–261, 1961) for combining all available nest data for a species to yield a less biased estimate of nest success than might otherwise be obtained. In his more recent account he included a test of significance that could be used for assessing the difference between estimates of success or, as in his example, the difference between "mortality rates" at separate stages in the nesting cycle, viz. between nest losses during incubation and nestling periods.

However, in simplifying his general methodology, I fear he may lead readers astray with the test of significance that he proposes. Most statistical texts clearly state that for a chi-square test, the elements in the contingency table must represent the frequencies of discrete, mutually exclusive attributes. This is certainly not the case when "nest-days with losses" are compared with "nest-days without losses" as in Mayfield's Table 1. Nest-days are arbitrary units, not discrete events. And any arbitrary time-interval, providing it is not less than the actual time required for the predation or destruction of a nest, can never have a frequency greater than the actual number of nests lost. Time-intervals without losses are, however, a function of the total time the nest was active.

Mayfield was aware of this problem. After finding that the test yielded a non-significant result, he stated: ". . . the difference may still be real. A larger sample might increase the confidence level. *Changing to a smaller unit* [my italics]—say, nest-hours—might seem to hold out promise of a different result, since it multiplies the sample size without enlarging the losses. . . ." This very suggestion is a clear violation of assumptions underlying the statistical test. Normally, subdivision of the data would increase the calculated significance of the test, because the data in each class should be in equivalent units, e.g., failures versus successes. The caution against using chi-square tests on percentage data, echoed by so many texts (e.g., see discussions in Goldstein, Biostatistics, Macmillan, New York, 1964:102; Snedecor and Cochran, Statistical Methods, 6th ed, Iowa State Univ. Press, Ames, 1967:21; Vann, Fundamentals of Biostatistics, Heath and Co., 1972:156; Woolf, Principles of Biometry, Van Nostrand, Princeton, N.J., 1968:235), is a warning against an analogous procedure. If the total size of a sample were less than 100, then the use of percentages would artificially inflate the values in the contingency table and the analysis would indicate too great a significance. On the other hand, if the sample were greater than 100, the use of percentages would decrease the indicated probability that the difference is significant. Vann (op. cit.:164) indicates that to double the sample size in each cell of a contingency table is to double the chi-square value that will be calculated from it.

By suggesting, as does Mayfield, that "nest-days without losses" be increased by changing to hours [why not minutes? seconds?], while "nest-days with losses" cannot be changed because they are clearly fixed by nest losses, is to reduce the sensitivity of the test. As the denominator of each proportion is increased in this arbitrary manner, the proportions will both tend toward zero. It can be shown that when the sample size in *only one column* of a contingency table is increased, the calculated value of chi-square will increase; but, because the proportions are changing, as the sample size becomes infinitely large, chi-square approaches a finite value. This is quite unlike the situation when the sample size is increased in both columns of the contingency table, for then the proportions are unchanged and as the sample size becomes infinitely large, chi-square approaches infinity as it should. Thus the test proposed by Mayfield is too insensitive to differences between such proportions. In fact, the $\chi^2 = 1.16$ calculated by Mayfield cannot be increased beyond $\chi^2 = 1.20$, *regardless of the increase in data to the column he suggests.*

There seems to be no ready remedy. Although Mayfield's method might yield a less-

TABLE 1

COMPARISON OF MORTALITY DURING INCUBATION AND NESTLING PERIODS OF KIRTLAND'S WARBLER (*DENDROICA KIRTLANDII*)

	Average mortality rate for period*	Calculated no. of nests lost†	Calculated no. of nests succeeded	Total nests found‡
Incubation period	0.44	67.8	86.2	154
Nestling period	0.24	34.6	109.4	144
Totals		102.4	195.6	298

$\chi^2 = 13.20$; df $= 1$; P < 0.0005

* $M = 1 - S$, where S is the average survival rate estimated by Mayfield (1975) for the incubation or nestling period: $S = (1 - P)^n$ and $P = 0.040$ and 0.030, the mortality rate per nest-day; $n = 14$ and 9, the incubation and nestling periods in days.
† Calculated by multiplying 'total nests found' by 'average mortality rate for period.' Number of nests succeeded can then be obtained by subtraction.
‡ Obtained from Mayfield (1960).

biased estimate of nest failure than obtained by ignoring nests other than those found before eggs had been laid, the fact remains that the only independent units available for statistical analysis are not nest-days or nest-hours but nests. The mortality rate that his method attempts to estimate is that which would be obtained if all nests could have been found and followed through the season, viz. failed nests/all nests. Thus, the only reasonable units for the marginal totals of the contingency table are the actual numbers of nests involved. I suggest *calculating* the frequencies within the table from the estimate obtained by Mayfield's method; this ensures the retaining of the accuracy of his method, while using only the total number of nests in the chi-square analysis ensures the satisfying of an important underlying assumption. This assumption is set out unequivocally by Siegel (Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill, New York, 1956:44): "To use χ^2 in testing a hypothesis . . . cast each observation into one of k cells. The total number of such observations should be N, the number of cases in your sample. That is, each observation must be independent of every other; thus one may not make several observations on the same person and count each as independent [read nest for person]. To do so produces an inflated 'N'." And on p. 109: "N is the sum of each group of marginal totals. It represents the total number of *independent* observations. Inflated N's invalidate the test."

The test I suggest is illustrated with Mayfield's data in Table 1. Basically it can be seen to be an extension of Mayfield's estimate of nest success itself. As he points out, to ignore incomplete records of nests is to bias results towards understating mortality and overstating success. He argues that his method brings mortality estimates to a more realistic level. My test makes use of these presumably more accurate estimates of mortality and survival to calculate the actual number of nests that should have failed or succeeded in a given sample of nests found at all stages. The data used by Mayfield in his Table 1 were based on 154 nests in the incubation period and 144 in the nestling period (Mayfield, The Kirtland's Warbler, Cranbrook Inst. Sci., 1960:193, 198). From the estimate that he calculated, the actual number of nests lost in the incubation period must have been closer to 67.8 than the 35 that he observed. Likewise, losses during the nestling period must have been closer to 34.6 than to the 22 he noted. The chi-square test in Table 1 shows that the difference between mortality rate during incubation and

nestling periods is in fact highly significant ($\chi^2 = 13.20$; P < 0.0005), not non-significant as Mayfield concluded. Thus there would seem little justification for lumping the 2 stages to obtain a single rate. Mayfield stressed that the observer should state reasons for electing to lump or not to lump data from these 2 sources. The method that I have described provides an objective test of the homogeneity of the samples and thus a criterion to aid the decision to lump or not.

It may concern some readers that my test does not make use of "observed" and "expected" values as usually seen in a standard contingency table to be analysed by chi-square. They may prefer to think of the observations being made indirectly through Mayfield's method; the marginal totals are in fact observed. However, it is important to realize that these values are established prior to and quite separately from the "expected" values in the standard chi-square analysis, and from the point of view of that analysis are indeed "observed" values.

Doubtless, more sophisticated analyses could be developed for data of this kind, but I think that chi-square still provides the easiest test and one that fits nicely with Mayfield's desire to simplify the procedure as much as possible. As presented here, it has the advantage of being no more biased by sample size than Mayfield's estimate of nest success might be, for the cell frequencies in the contingency table are based on that estimate. A possible source of bias, in some tests, lies in the fact that many nests from the nestling period are the same nests as those included in the incubation period, i.e., the rows of Table 1 may not be entirely independent. However, this will probably be of little importance and, in any case, will tend to make the test more conservative. Although not discussed by Mayfield, Yates' correction for continuity (see any of the above references to statistical works) is sometimes applied to such 2×2 contingency tables. But retention of the decimal part of the estimated numbers of nests will render this correction less important, although it will change the calculated chi-square value considerably if the sample size is small.

The method can be extended readily to tables with more than 2 rows and to other situations where tests of homogeneity are appropriate. The hypotheses under test, in any event, relate to differences between or among the estimates for incubation, nestling, or other periods obtained by Mayfield's method.

Readers using Mayfield's method should appreciate that the nest-day selected by him as the unit for analysis, although perhaps the most defensible on biological grounds because it provides a complete cycle for all possible predation, is an arbitrary choice. Mayfield does not discuss the selection of this unit, but his implication (1975 op. cit.) that nest-hours might be useful suggests that he is unaware of the difficulty. To change the unit of time also changes the success estimated for the overall period. For example, had his calculation of nest survival during incubation (from 35 nests lost in 878 nest-days of observation; daily mortality $P = 0.040$) been based on nest-minutes, he would have concluded that 57.23% rather than 56.58% of nests succeeded. At the other extreme, nest-fortnights (14 days is after all the incubation period of the species in his example) would yield a success rate of 44.19%. Other than through faith in the importance of circadian periodicity, it seems difficult to justify why the nest-day should yield the success rate closest to the actual one.

Although Mayfield devised his method ostensibly to reduce the bias of the conventional one, Green (Wilson Bull. 89:173–175, 1977) has shown that if a breeding population contains birds that can be categorized according to the vulnerability of their nests, Mayfield's method will yield a biased result. Thus, when nests can be separated on any basis (e.g., habitat difference, age of owner, height, time in the season, first or

second clutch), it would appear advisable to use Green's modification of Mayfield's method. When such separation of data cannot be made, the dilemma of the researcher will be in not knowing whether the bias of Mayfield's method towards understating success is greater or less than the bias of the conventional method in overstating it.— DOUGLAS D. DOW, *Dept. of Zoology, Univ. of Queensland, Brisbane, Australia, 4067. Accepted 20 Jan. 1977.*

Mirror image versus conspecific stimulation in adult male Zebra Finches.— Mirror image stimulation (M.I.S.) has been used to study social responses in a variety of animals (Kaufman and Hinde, Anim. Behav. 9:197–204, 1961; Svendsen and Armitage, Ecology 54:623–627, 1973). The advantage of this technique over direct visual contact with a conspecific is control of the stimulus by the experimenter. While this procedure has been conducted with several species, only chimps have so far shown the ability to recognize their own image (Gallup, Science 167:86–87, 1970).

Siamese fighting fish (*Betta splendens*) exhibit a preference for M.I.S. over visual access to a conspecific (Baenninger, Psychon. Sci. 4:241–242, 1966). This phenomenon also has been shown to exist in House Sparrows (*Passer domesticus*) and parakeets (*Melopsittacus undulatus*) (Gallup and Capper, Anim. Behav. 18:621–624, 1970). I examined this phenomenon in Zebra Finches (*Poephilo guttata*).

Ten adult male Zebra Finches were tested in a continuous choice situation of M.I.S. and visual access to a conspecific. The testing apparatus was modified after the plan of Gallup and Capper (op. cit.). It consisted of a plywood box 72 cm long, 42 cm wide and 38 cm high. The ceiling had an opening 43 cm long and 26 cm wide covered by fine screen.

Two perches, 17 cm long, were placed 8 cm above the floor and centrally located on each side of the cage. One perch was associated with an 8 × 5 cm mirror; the opposite perch was placed in front of a plexiglass window of the same size. This window allowed visual access to a 14 cm long, 14 cm wide and 18 cm high target cage. The target cage contained one adult male conspecific. A cardboard partition in the test cage kept the test bird from seeing the stimulus associated with the opposite perch. A continuous supply of food and water was available in the target cage and on each side of the experimental cage.

Testing was initiated by placing one bird in the experimental cage and a conspecific in the target cage. A photoperiod of 12 h was controlled by a light source placed 40 cm above the testing apparatus. Time spent on each perch was electrically quantified. The weight of the bird on the perch triggered a microswitch hooked up to an electric timer. Timers were reset at the end of each 24 h period; this procedure was continued for a period of 9 days.

Figure 1 shows the amount of time spent on the perch associated with the mirror and the amount of time spent on the perch associated with the target cage. Day 1 was not included in the graph as this was considered an adjustment period. The data show an overwhelming preference for interaction with the conspecific compared to the almost total absence of time spent on the perch associated with the mirror. The preference for conspecific visual access continued until day 6 after which preference for M.I.S. took place. Preference for M.I.S. continued through the final 3 days of testing.

All of the 10 individuals tested showed an overwhelming initial preference for visual access to the conspecific and later exhibited a preference for M.I.S. which continued