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# EFFECT OF NESTING HISTORY ON EGG SIZE IN EASTERN BLUEBIRDS

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Many factors influence egg size in birds (Kendeigh 1975, Parsons 1976). Although variation in egg size within clutches is usually not great (Ricklefs 1977), there may be considerable variation among females (Kendeigh 1975) and female age is sometimes correlated with egg size (Preston 1958, Davis 1975). I previously reported (Pinkowski 1977) that Eastern Bluebirds (*Sialia sialis*) nesting in early summer laid larger clutches if they had not reared a previous spring brood (group NPB) than if they had previously reared a brood (group PRB). It is possible that egg size may also decline after a first brood is reared. In this note I examine the effects of nesting history and two related variables, season and clutch size, on egg size in bluebirds.

During 1969–1977, length (L) and maximum diameter (D) of a sample of eggs from a study area in southeastern Michigan (Pinkowski 1977) were measured to the nearest 0.01 mm with a micrometer. Of 498 eggs measured, 443 (89.0%) were contained in 96 completed clutches, including 3 6-egg clutches, 58 5-egg clutches, 30 4-egg clutches, and 5 3-egg clutches. The remaining 55 eggs were sampled from 31 incomplete clutches in nests that failed before incubation began. The statistical design consisted of a two-level nested analysis of variance (ANOVA) for unequal sample sizes using Satterthwaite's DF approximation (Sokal and Rohlf 1969:274–281). The data were analyzed with respect to: the spring, intermediate, and summer nesting periods (Pinkowski 1977); 4- and 5-egg clutches; and PRB and NPB females nesting in early summer. Individual clutches comprised the ANOVA subgroups, which contributed a significant variance component to the analysis of each group ($P < 0.01$ in each case).

The mean ± SD length × diameter of all eggs measured was 20.9 ± 0.9 × 16.4 ± 0.6 mm. These average values are similar to those (20.7 × 16.3 mm) given by Bent (1949). Range of egg lengths (18.0–24.0 mm) was greater than the range of egg diameters (14.8–17.1 mm), and variance of the length measurement was significantly greater than that of the diameter measurement ($F = 2.35$, $P < 0.01$).

Mean egg size did not differ significantly in the spring (20.9 × 16.4 mm, n = 301 eggs), intermediate (21.0 × 16.3 mm, n = 36), and summer (20.9 × 16.4 mm, n = 161) nesting periods, and it was nearly identical for 4-egg clutches (20.9 × 16.5 mm, n = 120) and 5-egg clutches (21.0 × 16.4 mm, n = 300). Eggs of NPB females averaged larger (21.6 × 16.5 mm, n = 48) than those of PRB females (20.7 × 16.4 mm, n = 86), but only the difference in lengths was significant ($P < 0.02$).

Egg volume can be predicted from linear dimensions and is approximated by the product 0.51 × $LD^2$ (Hoyt, in press). The mean volume of each egg laid by NPB females (0.51 × $LD^2$ = 2999.1 $mm^3$) was 5.6% greater than that of PRB females (2839.4 $mm^3$). Because clutches of NPB females averaged 9.5% greater than those of PRB females (4.36 vs. 3.98 eggs/clutch; Pinkowski 1977), total egg volume was 15.7% greater in NPB females (0.51 × $LD^2$ × 4.36 = 13076.1 $mm^3$) compared with PRB females (11300.8 $mm^3$).

Kendeigh (1941) showed that mean egg size in the House Wren (*Troglodytes aedon*) declines seasonally although in both spring and summer it is closely correlated with temperatures in the pre-laying period. In this study the mean dates of clutch initiation differed little for PRB females (23 June) and NPB females (20 June; Pinkowski 1977), indicating that the observed difference in egg size is almost certainly not attributable to temperature or seasonal effects. Alternatively, smaller eggs may occur if PRB females have less energy available for reproduction after having reared an earlier brood. A reduction in the physiological condition of PRB females has been suggested as an explanation for their smaller clutches (Pinkowski 1977), but it does not necessarily explain their smaller eggs if egg size is not related to egg quality, as suggested by Ricklefs (1977). Bluebirds hatched from proportionately larger eggs, however, are larger (Pinkowski 1975) and presumably have certain growth and competitive advantages over those hatched from smaller eggs. Similar observations have been made in other species (Schifferli 1973), so that it seems likely that the smaller eggs of PRB females indicate a reduction in reproductive effort that may be due to a lowering in the physiological condition of these birds.

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