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On 6 May 1983, while examining nest boxes in conjunction with a project at the Carnegie Museum of Natural History's field research station, Powdermill Nature Reserve (3 miles south of Rector, Westmoreland Co., PA), I found an undersized egg of an Eastern Bluebird (*Sialia sialis*) in a partial clutch in nest box P-2. This "runt" or "dwarf" egg was one of three eggs present in the nest at the time of the examination. It was slightly duller, both in color and finish than the two normal-sized eggs but was similarly shaped.

The runt egg measured 11.0 × 9.0 mm and weighed 0.46g. Subsequent to the first examination, two additional eggs were laid in box P-2. The four normal-sized eggs in the completed clutch of five measured as follows: 22.0 × 17.0 mm; 21.0 × 16.0 mm; 22.0 × 16.5 mm; 21.5 × 16.5 mm. The average of these egg measurements, 21.6 ×16.5 mm, compares well with that given by Bent (1949) for the species ($\bar{x}$ = 20.7 × 16.3 mm, n = 50). The average weight of Eastern Bluebird eggs reported by Wetherbee and Wetherbee (1961) is 2.92 g, with a range of 2.56 to 3.21 g (n = 12). The runt egg being reported on here, then, is less than 16% of the average weight of a bluebird egg, or just 18% of the weight of the smallest egg recorded by Wetherbee and Wetherbee (*op. cit.*). This may be the proportionately smallest runt egg ever reported for a wild bird. Such extremely small runt eggs contain little or no yolk and are consequently infertile.

Runt eggs vary in size, but they are usually noticeably smaller than the smallest extreme expected by normal variation within a clutch. In this sense they should be considered abnormal occurrences, unlike the usual, terminal "runt" eggs reported by Preston and Preston (1953) for the Laughing Gull (*Larus atricilla*). The last eggs laid in clutches of this species, and probably other gulls as well, differs significantly and predictably from all others in the clutch with respect to maximum width and ovateness, being narrower and less ovate (see Preston, 1953).

Koenig (1980a) provides two methods, one based on absolute size and the other on relative volume, by which abnormal runt eggs can be reliably distinguished. These methods may have to be employed in order to recognize larger runt eggs (i.e., those approaching 75% of the average weight or volume of the other eggs in the clutch). Rothstein (1973) suggests that very small runt eggs may result in either a bimodal distribution for all eggs, at least, of a species or a discontinuous frequency distribution as related to the sizes of all other eggs. Lloyd Kiff (pers. comm.) has indicated that Rothstein's criteria may not apply in cases of scaled-down egg size within a clutch, as has been recorded for several woodpecker species.

Runt eggs are known, though not well-documented, for Eastern Bluebirds (Ralph Bell, William Highhouse and Lewis Kibler, pers. comm.). In fact, they are known for most avian taxa; there are more than 1,000 runt egg specimens in the collection of the Western Foundation of Vertebrate Zoology, including several in bluebird sets (Kiff, pers. comm.). In domestic fowl, and probably wild birds as well, runt eggs are perhaps the most common egg abnormality (Romanoff and Romanoff, 1949).

Runt eggs were encountered and occasionally reported by egg collectors around the turn of the century (Jacobs, 1898; Ingersoll, 1910). It was not then uncommon for commercial dealers to furnish catalogues of abnormal specimens to prospective buyers (Kiff, pers. comm.). During the temporal gap between the cessation of widespread egg collecting and the initiation of comprehensive avian field studies which once again brought workers into contact with large numbers of egg sets of various species, a generation of bird students was born (the author included) which is largely unfamiliar with the precedent of knowledge (much of it unpublished) regarding runt eggs. Contemporary workers, as a result, have begun documenting a phenomenon which is not at all unique or even unexpected (Rothstein, 1973; Ricklefs, 1975; Manning and Carter, 1977; Dring, 1980; Ritchison, 1984; Bartel, 1986). The purpose of this paper, then, is not simply to document another in a long line of runt egg discoveries, but rather to address what is not well known or documented about the phenomenon.

The causes of runt egg production are relatively unknown, though they are almost certainly various. The phenomenon is not precisely correlated with the age of the laying female, although in domestic fowl there appears to be a greater tendency for young birds to lay runt eggs than older birds (Pearl and Curtis, 1916). Nor are runt eggs predictably the first or last eggs laid in a clutch (Kendeigh, 1956; Koenig, 1980b). Similarly, there seems to be no greater likelihood of runt eggs in later clutches of multiple-brooded birds, although experiments with unnaturally induced over production of eggs has produced runt eggs in some cases (Jacobs, *op. cit.*). It is worth noting that the bluebird runt egg being reported on here was part of the first clutch of a normally double-brooded species and was certainly not the last egg laid in that clutch.

Heredity apparently plays no role in most instances of runt egg laying; runt eggs are thought to be isolated occurrences resulting from some temporary disturbance (e.g. infection or injury) to the reproductive system of the laying bird (Romanoff and Romanoff, *op. cit.*) A possible exception to this may be the unusual runt egg record reported by Zeleny (1983). In that case the same bluebird (identified by band number) laid four runt eggs in three separate partial clutches in the same season. Each of the clutches, consisting of only one or two runt eggs each, was incubated for the full term before being abandoned for the next attempt. Such an instance as this suggests a congenital defect or at least a permanent injury to the bird's reproductive system. Another account of a complete clutch of runt eggs laid by a Song Thrush (*Turdus philomelos*) (M'Williams, 1927) may have a similar explanation. Collection and dissection of chronic runt egg layers might well provide insight into the proximate physical causes of runt egg production in wild birds. For now, though, the causes and correlates of this phenomenon are practically unknown.

Also unknown is the rate at which runt eggs are produced in populations of free-living birds. It can be argued that museum collections are somewhat biased in favor of anomalies, and most field records of runt eggs are of one example out of so many eggs seen. The inherent error in calculating frequencies from these sources, taken separately or together, is obvious. With the exception of domestic fowl, only one study has begun to make inroads into the frequency of runt egg production in birds. Koenig (1980a, 1980b) has discovered an unusually high incidence of runt eggs in the Acorn Woodpecker (*Melanerpes formicivorus*), about 40 per 1,000, and he tentatively suggests that the hole-nesting habit, communal nesting or both, may account for the unusual frequency he has observed. In support of the hole-nesting connection, he cites higher than average frequencies of runt eggs in museum sets of several species of woodpeckers (a range of 4.8 to 8 per 1,000 for the five species for which he has records of more than two runt eggs), though none approaches that which he has recorded for the Acorn Woodpecker.

Contrary to the hole-nesting hypothesis, Koenig (*op. cit.*) cites Kendeigh (*op. cit.*) and Ricklefs (*op. cit.*) whose accounts for the cavity-nesting House Wren (*Troglodytes aedon*) and European Starling (*Sturnus vulgaris*), respectively, report relatively low runt egg frequencies of 1.5 and 1.0 per 1,000. These frequencies, however, were calculated on the basis of just two runt eggs each, fewer than Koenig (*op. cit.*) required when making his comparisons among woodpecker species. In addition, I would suggest that the combination of bird size, egg size, clutch size, and cavity size might operate to produce considerably different frequencies of runt egg production in hole-nesting species.

The need for reliable frequencies based on large samples of runt and normal eggs from wild bird populations for analysis of interspecific differences and intraspecific patterns, as well as the possible illumination of the proximate causes of runt egg production, is clear. Among birds, those species which are readily attracted to artificial nest sites are especially suitable for investigation into the frequency of runt egg production. One limitation of this approach is the more or less fixed cavity size of species-specific nest boxes, which eliminates one possibly important variable. On the other hand, control of this variable may lead to a clearer understanding of the effects of others.

Bluebirds (*Sialia sialis, S. mexicana* and *S. curricoides*), given the frequency and convenience with which they are studied, might make particularly good subjects for the study of runt egg production by wild birds. Unparalleled information on the runt egg phenomenon could be gained through the cooperation of bluebird workers over the course of just a few nesting seasons. Data could be pooled at the end of each season and analyzed for overall frequency of runt eggs within the genus, for each species, with respect to clutch sequence and size and the laying sequence within each clutch. Other rarer egg anomalies could likewise be reported, including oversized and misshapen eggs.

Many bluebird workers have undoubtedly encountered runt eggs. Little can be reliably concluded, however, from undocumented accounts of isolated examples. A cooperative effort, on the other hand, could add substantially to our understanding of the runt egg phenomenon. Since many of us have large numbers of Tree Swallows (*Tachycineta bicolor*) or Violet-green Swallows (*T. thalassina*) utilizing our bluebird trails, these species, too, could be monitored for runt and other abnormal egg information.

The most basic information that cooperators could provide would be the total number of eggs seen in a season for each species and the number of runt or other abnormal eggs noted. Of course, incalculating frequencies, the absence of abnormal eggs in a sample is of equal interest.

When abnormal eggs are found, details such as the size and weight of the egg (also the sizes and weights of any normal eggs in the clutch), position of the abnormal egg in the laying sequence, the position (i.e. first clutch, second clutch, . . .) and size of the clutches containing abnormal eggs, and the age of females laying such eggs, would improve the overall analysis.

I have prepared a data sheet on which can be recorded information pertaining to anomalous egg production. Those interested in joining in this study may write to me for a supply of these sheets.

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