

*Wilson Bull.*, 95(2), 1983, pp. 283–286

**Incubation period of Ring-billed Gulls and the egg immersion technique.**—Incubation period has been reviewed generally (Drent, pp. 332–340 in *Avian Biology*, Vol. 5 [Farner and King, eds.], Academic Press, New York, New York, 1975), and treated specifically for larids (Parsons, *Ibis* 114:536–541, 1972; Nisbet, *Nature* 241:141–142, 1973; Courtney, *Ibis* 121:207–211, 1979). Intra-clutch differences in incubation period have not been discussed for the Ring-billed Gull (*Larus delawarensis*), although the incubation period for the third egg has been reported (Vermeer, *Can. Wildl. Serv. Rept. Ser. No. 12*, 1970).

Stage of incubation in some birds can be determined by immersing an egg in a beaker of water and measuring the degree of rotation or flotation of the egg. Eggs that have not yet been incubated lie horizontally on the bottom of the beaker. During the course of incubation an egg, upon immersion, will first rotate (i.e., its blunt end gradually rises), then float and break the surface of the water. The degree of rotation or flotation is an index of the egg's specific gravity, which can be used to estimate the laying and/or hatching date of the egg (Westerskov, *J. Wildl. Manage.* 14:56–67, 1950; Schreiber, *Condor* 72:133–140, 1970; Hays and LeCroy, *Wilson Bull.* 83:425–429, 1971). The immersion technique has apparently not been applied to eggs of Ring-billed Gulls. Our objective was to determine the incubation period for each of the three eggs in the clutch of the Ring-billed Gull and to determine the usefulness of the immersion technique as a predictor of laying and/or hatching dates.

We conducted our study in April and May 1980 at the Eastern Headland, Toronto Outer Harbour, Lake Ontario, Toronto, Ontario (for description of the study area see Blokpoel and Fetterolf, *Bird-Banding* 49:59–65, 1978). To determine the sequence of laying and the laying interval, we staked 60 nests, each containing one egg, and checked all nests daily between 10:00 and 12:00 until each contained a complete clutch of three eggs. Eggs were marked A, B, and C to identify first, second, and last egg, respectively, using a felt marker. Chicks were subsequently referred to as A-, B-, and C-chicks, respectively.

We gently released each egg in a beaker of fresh water and measured the degree of egg rotation at the bottom of the beaker using a transparent protractor. Once the eggs floated, we used calipers to measure the diameter of the portion of the egg above the water surface. Once the clutches were complete, each nest was visited every other day. When hatching began, most nests were visited daily. All nests studied were of birds nesting during the first nesting peak in mid-April. All breeding birds in our sample were in full adult plumage (i.e., no brown or black flecking on body, wing, or tail feathers).

As the A- and B-eggs of ring-bills show some development before clutch completion (Ryder and Somppi, *Wilson Bull.* 89:243–252, 1977), and as the adults are known to begin sitting on the eggs immediately after laying the A-egg (P. M. Fetterolf, pers. comm.), we define the incubation period of an egg as the period between laying and hatching of that egg. Eggs could be as much as 24 h old when we first located them.

We measured length and breadth of all eggs to the nearest 0.1 mm to calculate egg volume, using the formula: volume =  $0.489 \times \text{length} \times \text{breadth}^2$  (Ryder, *Wilson Bull.* 87:534–542, 1975). Statistical analysis included 2-way analysis of variance, Duncan's multiple-range test, and linear regression.

**Incubation period.**—Hatching intervals were short compared to laying intervals. The median laying interval between A- and C-eggs was 4 days (N = 58). The median hatching interval between A- and C-eggs was 1 day (N = 46). Incubation periods ( $\pm$ SD) for eggs with respect to their position in the clutch were: A-egg,  $28.1 \pm 1.3$  days (N = 54); B-egg,  $26.3 \pm 1.1$  days (N = 52) and C-egg,  $24.8 \pm 0.9$  days (N = 51).

We tested for intra-clutch differences in volume of eggs. The C-egg was significantly ( $P <$

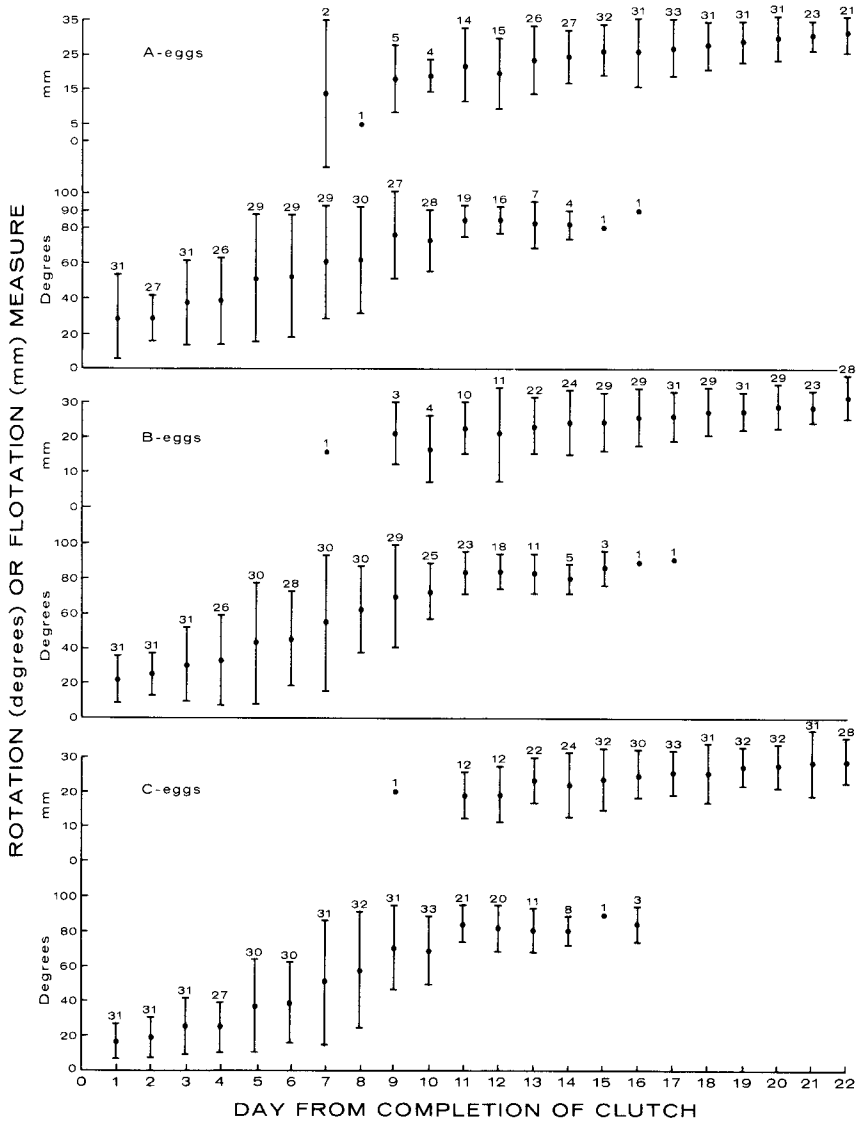


FIG. 1. Rotation and flotation measures of A-, B-, and C-eggs of Ring-billed Gulls during 22 days of incubation after clutch completion. Vertical lines indicate 95% confidence intervals. Sample sizes are shown above the vertical lines.

0.01) smaller than the A- and B-eggs (Duncan's multiple range test). Mean volumes ( $\pm$ SD) were as follows: A-egg, 50.4 ( $\pm$ 3.7) cm<sup>3</sup>; B-egg, 50.0 ( $\pm$ 3.8) cm<sup>3</sup>; and C-egg, 47.2 ( $\pm$ 3.7) cm<sup>3</sup>.

To test whether there was a correlation between incubation period and egg volume, we calculated correlation coefficients between these two variables using volumes of A-, B-, and C-eggs separately, as well as the pooled values of the A-, B-, and C-eggs. In the latter case an average incubation period was used as the dependent variable. The resulting relationships in all four correlations were positive but weak ( $r < 0.10$  in each case).

In early-nesting Ring-billed Gulls incubation begins after laying the A-egg, but occurs only during the daytime (Fetterolf, Can. J. Zool. 57:1190-1195, 1979). During the night, until about day 8, the birds desert the colony resulting in cooling of the eggs. Despite that nocturnal desertion, the A-embryo, as judged from egg immersion measurements, has developed to some extent by the time the C-egg is laid.

How then does the C-embryo effectively catch up in its development resulting in a high degree of hatching synchrony within the clutch? The A-egg is significantly larger (as measured by volume) than the C-egg. Smaller eggs develop faster with the same application of heat (Skoglund et al., Poultry Sci. 27:709-712, 1948) which suggests that the C-egg may catch up solely because of its smaller size. The lack of strong correlation between egg size and incubation period in our sample might be explained by assuming that (1) larger eggs were laid by larger females and (2) larger females apply more heat to their eggs. Parsons (Ibis 114:536-541, 1972) found that an increase of 20% (11 cm<sup>3</sup>) in the volume of Herring Gull (*L. argentatus*) A-eggs resulted in an increase of about 16 h in the incubation period. In Ring-billed Gulls the difference in volume between the A- and C-eggs is only 6% (3 cm<sup>3</sup>) but the resulting increase in incubation period is about 36 h. The difference between the two species may be caused by differences in the amount of time spent incubating during the laying period and in the effectiveness of incubation during that period.

If the C-egg in Ring-billed Gulls is smaller partly to facilitate synchronous hatching of the clutch, then the disadvantages resulting from a smaller C-chick at hatching apparently do not outweigh the advantages accrued by hatching synchrony. A slightly smaller C-chick, hatched shortly after the A- and B-chick, may be an adaptation to fluctuations in availability of food during the chick-rearing period (Parsons 1972). If food is abundant the C-chick could easily be raised to fledging; if food is scarce, the C-chick would soon die after hatching because of a disadvantage in competing for food with its older, larger siblings. In situations of intermediate food abundance, being small might be advantageous to the C-chick in that it could survive on a relatively small amount of food.

*The egg immersion technique.*—Some of the eggs, upon immersion, began to break the water's surface by day 7, whereas others did not do so until day 17. The A-egg showed signs of hatching (starred or pipped) on day 19, and the C-egg on day 27. With respect to laying sequence of the eggs, confidence limits of flotation measures were widest for the A-eggs and narrowest for the C-eggs, particularly from day 1 to day 9 (Fig. 1). In all eggs, variability was greatest during the period of complete submersion and smallest during the period when the egg broke the water surface. On average, the A-eggs rotated and floated higher than the C-eggs, while the B-eggs were intermediate (Fig. 1).

The egg immersion technique gave highly variable results for eggs incubated for equal lengths of time after clutch completion. Thus, the method is not adequate for determining the stage of incubation, unless the age categories are divided into groups as large as 1 week.

Schreiber (Condor 72:133-140, 1970), using the egg immersion technique for eggs of Western Gulls (*L. occidentalis*) reported little variation in rotation and flotation in eggs of the same age and suggested that it "would be valuable to compare egg flotation characteristics of other species in order to develop a workable flotation scale for various incubation periods."

Schreiber checked only two clutches from laying to hatching (floating the eggs five times), but he also floated 100 other eggs whose hatching dates were known (27 of these eggs were floated four times). Schreiber presented no data on incubation periods for individual eggs (A, B, and C), but he reported that incubation periods for completed clutches varied from 25–29 days. Because Schreiber's methods differed from ours and because it is not clear what incubation period he used for the 100 eggs of known hatching date, his results and our findings cannot be properly compared.

Hays and LeCroy (Wilson Bull. 83:425–429, 1971), using the egg immersion technique for Common Terns (*Sterna hirundo*), concluded that the stage of incubation of eggs can be estimated within approximately 2 days. The difference in their findings and ours with respect to the usefulness of the technique is probably due to: (1) small, non-representative variability in flotation measures as a result of their small sample size ( $N = 2$  for each of nine categories of embryo development), (2) their use of C-eggs only, resulting in lower variability than that when all three eggs are used, and (3) possible inter-species differences.

Variability among adults with respect to time spent incubating and efficiency of heat transfer from the body to the eggs may result in differences in the rate of development of the embryo, and hence in differences in the rate of change in specific gravity. These then result in differences in rotation and flotation measures at similar stages of incubation.

We thank the Toronto Harbour Commissioners for allowing us to work at the Eastern Headland. P. M. Fetterolf and G. D. Tessier helped in the field. P. M. Fetterolf provided unpublished information. G. E. J. Smith provided statistical advice. J. E. Bryant, S. G. Curtis, R. W. Schreiber, and an anonymous referee commented on earlier versions of the manuscript. Financial support to the senior author was provided by contracts from the Canadian Wildlife Service.—ERICA NOL, *Dept. Zoology, Univ. Toronto, Toronto, Ontario M5S 1A1, Canada*; AND HANS BLOKPOEL, *Canadian Wildlife Service, 1725 Woodward Dr., Ottawa, Ontario K1A 0E7, Canada. Accepted 29 Oct. 1982.*

*Wilson Bull.*, 95(2), 1983, pp. 286–287

**Communal harvesting of a transient food resource in the Mexican Jay.**—Increased efficiency in locating and harvesting transient food resources has been implied as a possible advantage to members of communal groups (Brown, *Ann. Rev. Ecol. Syst.* 9:123–135, 1978), but descriptions of such events do not seem to have been recorded for communal species. The following incident was observed in the Chiricahua Mts., Arizona, 6 June 1979. At 09:45 a banded female Mexican Jay (*Aphelocoma ultramarina*), MOOMXO, which had been singing quietly 3 m from me, flew to a patch of sunny, bare ground and began picking up and swallowing winged reproductive ants as they emerged from their nest, paused in the sun, and flew away. She took 18 ants in about as many seconds, and flew to a tree. A few seconds later BOXR, a 1-year-old bird, flew to the spot and took 50 reproductives before I had to look away, again at about one per second. Within 2 min a total of nine jays, most of the flock of 13, arrived and rapidly consumed the ants. By 09:55 the emergence was over, and no reproductives remained at the site. In about 10 min a transient food source had been discovered and shared among nine birds.

It is not clear how the recruits learned of the presence of the food, but Mexican Jays typically watch each other when foraging and are quick to go to the site of a discovery by another jay. Soft calls are continually given by members of a foraging group, and these might have been involved. More conspicuous as signals of food, however, are the swift, direct glides to the spot. Although it is possible that all nine birds would have found this resource