J. Field Ornithol., 72(1):124–130

OBTAINING AND STORING HOUSE SPARROW EGGS IN QUANTITY FOR NEST-PREDATION EXPERIMENTS

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Abstract.—House Sparrow (*Passer domesticus*) eggs are useful in artificial nest experiments because they are approximately the same size and shell thickness as those of many forest passerines. House Sparrow eggs can be readily collected in quantity by providing nest boxes in active livestock barns. We collected over 1200 eggs in three years (320–567 per year) from a colony of about 24 breeding pairs by providing 60 nest boxes. Eggs dry-refrigerated at 8–9°C lost mass after 2 weeks, whereas eggs submerged in sodium silicate solution at 8–9°C remained fresh for 2 months until deployment. Eggs stored in sodium silicate solution should be rinsed with clean water before use.

OBTENCIÓN Y ALMACENAMIENTO DE HUEVOS DE *PASSER DOMESTICUS* PARA EXPERIMENTOS DE DEPREDACIÓN

Sinopsis.—Los huevos del gorrión *Passer domesticus* son muy útiles para experimentos de depredación de nidos, porque son aproximadamente del mismo tamaño y su cascarón del mismo grosor que muchos paserinos de bosques. Los huevos de éste gorrión pueden ser coleccionados en lugares como establos. En tres años, coleccionamos 1200 huevos de una colonia de 24 parejas de éstas aves, con tan solo proveerlas de 60 cajas de anidamiento. Los huevos que fueron refrigerados a temperaturas de 8–9°C, perdieron masa luego de dos semanas, mientras los que fueron sumergidos en una solución de silicato de sodio a temperatura de 8–9°C se mantuvieron frescos por dos meses. Los huevos almacenados en la solución de sodio deben ser enjuagados con agua previo a ser utilizados.

Until recently, quail (*Coturnix* spp., *Colinus virginianus*) eggs have commonly been used in artificial nest experiments to study predation rates and predators of forest bird nests (e.g., Wilcove 1985; see reviews by Paton 1994; Major and Kendal 1996). Quail eggs are easily obtained, but are larger and thicker-shelled than those of most forest passerines, and their utility has been questioned (Roper 1992; Haskell 1995) because small-mouthed predators cannot readily open them (but see Craig 1998). Such predators readily open and consume smaller eggs (e.g., Zebra Finch [*Taeniopygia guttata*] eggs; DeGraaf and Maier 1996). Zebra Finch eggs have been used in field experiments (King et al. 1998); however, they are smaller than the eggs of virtually all forest passerines in North America (Haskell 1995), are extremely fragile, and are difficult to obtain in quantity.

House Sparrows (*Passer domesticus*) are introduced to North America and unprotected by state or federal laws. House Sparrow eggs are similar in size to those of many forest passerines, including Neotropical migrants (Table 1). The idea of using House Sparrow eggs in artificial nests is not new (George 1987); they have been employed in field studies in California (Purcell and Verner 1999) and Massachusetts (DeGraaf et al. 1999;

TABLE 1. House Sparrow eggs more closely resemble the eggs of ground- and low-nesting Neotropical passerines than Japanese Quail or Zebra Finch eggs. Physical dimensions of Zebra Finch and Japanese Quail eggs are compared to House Sparrow and six common, northeastern passerine migrants. All values are means, followed by *n* in parentheses, and sorted by mass. Shell thickness was measured by digital caliper.

Species	Mass (g)	Length (mm)	Width (mm)	Shell thickness (mm)
Zebra Finch (*Taeniopygia guttata*)	1.0 (147)[a]	15.1 (286)[a]	9.6 (286)[a]	0.065 (4)[b]
Black-throated Blue Warbler (*Dendroica caerulescens*)	1.4 (4)[d]	16.9 (50)[e]	12.8 (50)[c]	0.061 (2)[c]
Black-and-white Warbler (*Mniotilta varia*)	unavailable	16.9 (99)[e]	13.4 (99)[c]	unavailable
Ovenbird (*Seiurus aurocapillus*)	2.5 (4)[d]	20.2 (345)[e]	15.6 (345)[c]	0.073 (2)[c]
House Sparrow (*Passer domesticus*)	2.8 (7816)[e]	21.6 (4573)[c]	15.6 (4573)[c]	0.102 (11)[c]
Veery (*Catharus fuscescens*)	3.0 (4)[e]	22.9 (78)[e]	16.9 (78)[e]	0.093 (2)[c]
Hermit Thrush (*Catharus guttatus*)	3.7 (7)[e]	22.8 (72)[e]	17.0 (72)[e]	0.092 (2)[c]
Eastern Towhee (*Pipilo erythrophthalmus*)	3.8 (3)[e]	23.1 (50)[e]	17.0 (50)[e]	0.116 (2)[c]
Japanese Quail (*Coturnix japonica*)	9.4 (12)[f]	33.0 (2)[f]	23.0 (2)[f]	0.187 (2)[b]

[a] Zann 1996.

[b] Measurements taken from freshly broken, then dried, shell fragments.

[c] Measurements taken from University of Massachusetts Museum of Zoology collection shell fragments.

[d] Estimated mass; museum specimen clutches completely filled with distilled water to compensate for greater specific gravity of natural egg contents, i.e., 1.03 g/ml (Burley and Vadehra 1989).

[e] Species accounts from The birds of North America, A. Poole and F. Gill, eds., Academy of Natural Sciences, Philadelphia, Pennsylvania and American Ornithologists' Union, Washington, DC.

[f] Measurements taken from fresh specimens.

Maier and DeGraaf 2000). Their use has been limited, however, apparently due to their limited availability (i.e., they must be recovered from accessible nests). We have employed House Sparrow eggs in large-scale experiments and have developed a method to reliably obtain and store them in quantity.

METHODS

Egg collection.—We placed 60 newly constructed Eastern Bluebird (*Sialia sialis*) nest boxes in (54) and outside (6) of three active livestock barns at a single site at the University of Massachusetts, Amherst, in February 1997. Nest boxes were fastened to the sides of interior horizontal beams at least 3 m above the floor or to barn siding outside at the same heights (North 1972). Boxes were spaced a minimum of 1 m apart (Summers-Smith 1988:144) where there was easy ladder access. We blocked off areas of the barns from which it would be difficult to collect eggs. Boxes were constructed of untreated 2-cm thick pine to specifications recommended by the North American Bluebird Society (see Berner 1995). We used a 3.8-cm round hole and increased nest box depth 15% beyond that recommended to decrease the probability of depredation by European Starlings (*Sturnus vulgaris*) or Norway rats (*Rattus norvegicus*), because both species were present at our collection site.

Egg laying at our site's latitude generally commences in late March (Summers-Smith 1988:fig. 50); however, we delayed first collection by approximately two weeks to increase egg yield per collection effort. Thereafter, collections were made every 3–4 d after 0700 EST (Anderson 1995). We collected all eggs found (including those found in easily accessible sparrow nests not built in nest boxes) and recorded total number, noting the number broken during handling, plus the location of active nest boxes. The average collection, plus egg processing, took 2–3 h.

Nest boxes were emptied but not disinfected in February or early March, prior to the next egg-laying season.

Egg processing.—Immediately after collection, eggs were completely submerged in "water glass" (a 10:1 solution of potable water and sodium silicate solution [approx. 27% SiO_2 in 14% NaOH], available from Sigma Chemical Co., St. Louis, Missouri) and refrigerated at 8–9°C (Romanoff and Romanoff 1949:700). Eggs that were obviously bad (i.e., dark discoloration on blunt end) were culled. Good eggs were stored in dated, sealed 1.9-l Dynalon® specimen containers (available from Carolina Biological Supply Co., Burlington, North Carolina). A piece of Dynalon® lid material, fitted to the interior circumference of the container, was used to fully submerge those eggs that floated high enough in solution to break the surface. (Trade names and commercial products are mentioned for information only; no endorsement by the U.S. Dept. of Agriculture is implied).

For individual studies that used eggs collected immediately before their deployment (i.e., less than 2 wk), we stored eggs in closed, plastic food storage containers, refrigerated at 8–9°C, with layers of eggs separated by

clean cotton batting. Randomly selected eggs from the first collections in 1997 were stored in this manner and periodically weighed to measure moisture loss.

Storing eggs in water glass could possibly influence nest predation. The solution is astringent and could repel some potential predators if not completely rinsed off prior to deployment of eggs. To address this treatment as a potential bias, we examined 1998 data from two separate field studies (performed simultaneously in adjacent, similar habitat) to see if treated House Sparrow eggs (DeGraaf, unpubl. data) had a different predation rate than untreated House Sparrow eggs (Maier, unpubl. data). All eggs were exposed for 12 d in artificial ground nests, were at least 70 m apart, and were not monitored by cameras (see DeGraaf et al. 1999 for additional detail). We used a 2×2 contingency table setup for a binomial comparative trial to compare proportions of predation between treated and untreated eggs (Zar 1996:489) with a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

We collected over 1200 House Sparrow eggs in 3 yr, ranging from 320–567 eggs per year. Because our collection efforts were not of the same duration or intensity each year, we cannot say if our efforts lead to a decline of the House Sparrow population at our collection site; however, a thriving population still existed after three years of egg collection. We estimate that at least 24 breeding pairs occupied our site. Each female, as a removal indeterminate layer, is capable of laying up to 18 eggs per season while maintaining normal body reserves (Anderson 1995).

Egg collection at our site peaked in mid to late May in all years. We observed that eggs collected later in the laying season broke more readily during collection and subsequent handling. Our data on broken eggs indicated a slight increase in the percentage of those broken per collection as the season advanced past mid-May. Our observation was in accordance with Romanoff and Romanoff (1949:fig. 93) who correlated a decrease in shell thickness with increases in environmental temperature and humidity. These thinner-shelled eggs may more closely resemble those of similar-sized Neotropical passerines who are laying at the same time under similar environmental conditions.

Of the 60 nest boxes installed, over 50% were used by nesting House Sparrows over the three years of collection. After the first year, the majority of eggs were collected from nest boxes versus other nests. Although pairs are thought to be faithful to their nest sites for life (Summers-Smith 1988:143), our reduction of other less-accessible nest sites may have coerced breeding pairs to switch sites. Monitoring active nest boxes for this period revealed a House Sparrow preference during early season for southeasterly-situated boxes, with a general preference for nest boxes just inside large barn doors as the egg laying season progressed. The number of nest boxes provided should exceed the estimated number of breeding pairs because pairs may change nest sites between successive broods and

disturbance (i.e., removing eggs) may also result in nest site abandonment (Summers-Smith 1988 and references therein).

Although Norway rats, European Starlings, and domestic cats (*Felis catus*) were present, we did not observe any nest predation within our nest boxes, but did witness nest predation (i.e., egg destruction) in nests built outside of nest boxes. We did observe, however, that nest boxes that were attached within 0–20 cm of intersecting beams were used less often. This may suggest that House Sparrows, if given a suitable choice, prefer nest boxes that do not provide ready access for potential predators.

The water glass preservation technique retards the deterioration of eggs, imparts no detectable taste to egg contents, prevents eggs from picking up undesirable odors, and prevents desiccation over long periods of time (Romanoff and Romanoff 1949:700). We have inspected eggs thus preserved over a year after their collection and have found them to be in good condition.

In our test of whether storage in water glass affected predation, the combined results of two field studies showed little difference in 12-d predation rates ($\chi^2_1 = 1.37$, $P > 0.2$) between House Sparrow eggs stored in water glass (84%, $n = 70$) and dry refrigerated eggs (73%, $n = 41$). These results are similar to those from laboratory experiments in which Zebra Finch eggs stored in water glass were exposed to captive, white-footed mice (*Peromyscus leucopus*). During two separate trials, Zebra Finch eggs, refrigerated at 8–9°C for 2 and 8 months in water glass, were respectively depredated 72% ($n = 29$) and 73% ($n = 26$) by 55 individual mice within a 12-h period (Maier and DeGraaf, unpubl. data). These results are comparable to those obtained when dry-refrigerated Zebra Finch eggs were exposed to captive white-footed mice (DeGraaf and Maier 1996).

The water glass solution must be completely rinsed off the eggs with clean water prior to their deployment to minimize any possible effect on predation. Washing eggs has been shown to temporarily weaken shell strength, but strength is regained upon drying (Burley and Vadehra 1989: 53).

Storing dry House Sparrow eggs in sealed, refrigerated containers is advisable only if the eggs are to be used within 2 wk. Eggs stored in this manner lost mass at the rate of about 1.4% per week (Fig. 1).

Artificial nests continue to be useful when their differences from natural nests are minimized (Wilson et al. 1998). The object depredated (i.e., the egg) should simulate that of the species in question. Factors such as nest appearance (Martin 1987) and scent (Whelan et al. 1994) are important, but only relatively recently has egg size come under scrutiny. Comparison of predation rates on artificial nests to those on real nests would be most reliable, other factors being equal, if the eggs are of comparable size. Also, the predators of real nests would more likely be indicated if appropriately-sized eggs were used in artificial nests.

We believe that House Sparrow eggs are of appropriate size to simulate eggs of forest passerines, especially those of many Neotropical migrants, often the species of most concern. Use of nest boxes in active livestock

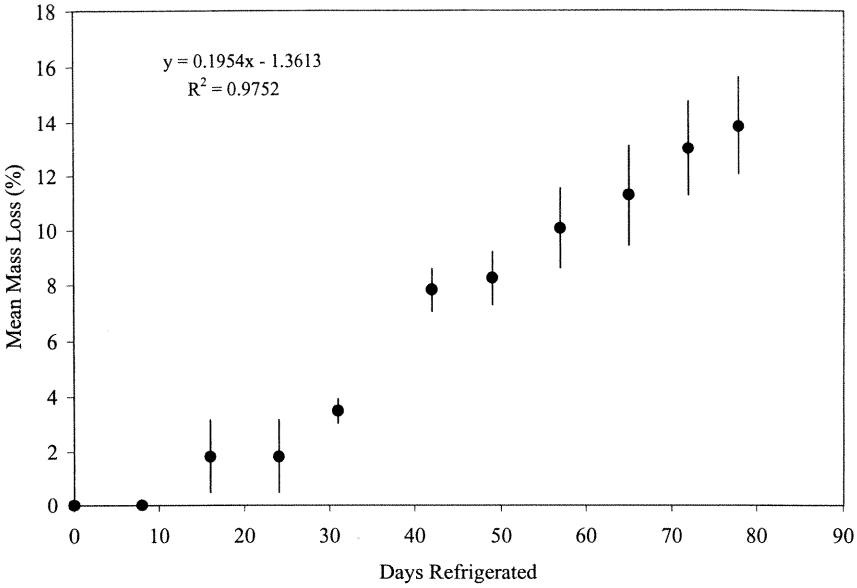

FIGURE 1. Mass lost by dry-refrigerated (8–9°C) House Sparrow eggs (n = 5). Data are mean percent fresh mass (g) ± 2 (SD), after arcsine transformation (Zar 1996:282).

barns provides a reliable supply of House Sparrow eggs, and storing them in sodium silicate solution preserves them in fresh condition until deployment.

ACKNOWLEDGMENTS

We thank B. Hanlon and D. Freeman for allowing us to use the livestock barns at the University of Massachusetts for egg collection, M. Stoddard and N. Perry for assistance in collecting eggs, David Haskell, William M. Healy, and Matthew Vander Haegen for their reviews of the manuscript, K. Doyle for Neotropical egg specimens from the University of Massachusetts, Amherst Museum of Zoology, and M. Sheremeta for typing the manuscript.

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Received 26 October 1999; accepted 16 March 2000.