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METHOD FOR CASTING LARGE NUMBERS OF CLAY EGGS FOR USE IN STUDIES OF ARTIFICIAL NESTS

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Abstract—We describe a method for making clay mimics of bird eggs. These eggs can be used in experiments that require many uniform, accurate artificial eggs. We developed methods and made about 1,000 clay eggs at a cost of $0.55 each.

Resumen—Describimos un método para hacer huevos falsos de arcilla que imitan a los huevos de los pájaros. Estos huevos se pueden utilizar en experimentos que requieren muchos huevos artificiales que son copias uniformes y exactas. Desarrollamos los métodos e hicimos cerca de 1,000 huevos de arcilla en $0.55 cada uno.

In the past 20 years, >400 field experiments using artificial bird nests have tested hypotheses of predation on nests (Faaborg, 2004; Moore and Robinson, 2004). Although many aspects of artificial-nest studies have been criticized (Major and Kendal, 1996; Rangen et al., 2000; Burke et al., 2004; Faaborg, 2004; Moore and Robinson, 2004; Thompson and Burhans, 2004; Fontaine et al., 2007), use of artificial nests and eggs is warranted in specific situations. For example, artificial nests and eggs are acknowledged to be effective for studying behavior of nest predators and development of search images by those predators in specific habitats (Faaborg, 2004; Moore and Robinson, 2004). In particular, clay eggs are valuable tools for identification of nest predators (Major and Kendal, 1996; Craig, 1998; Keyser et al., 1998; Rangen et al., 2000; Boulton and Cassey, 2006) because they can preserve impressions of teeth and beaks of predators. Clay eggs also can be useful in revealing the likely distribution of risk of predation in an area (Sutherland, 2000). Moreover, artificial nests and eggs are required to conduct experiments with strong statistical design because variables such as distribution or number of nests and eggs cannot be manipulated practically using natural nests (Rangen et al., 2000; Faaborg, 2004; Moore and Robinson, 2004; Villard and Part, 2004).

In preparation for a behavioral study of predators of eggs on barrier islands along the Atlantic coast of Virginia in 2003, we sought methods for producing large quantities of clay eggs that closely mimic those of shorebirds. Despite the fact that many researchers have used artificial eggs to study predation, we were unable to locate a widely adopted protocol for mass producing clay eggs to a fixed standard. Therefore, we developed a procedure to produce large numbers of clay eggs that were durable in the field, matched appearance of real eggs from a few meters away, and allowed identification of activity of predators.

The overall process involved making a plaster mold of hollow, egg-shaped cavities, filling cavities with melted clay, and then applying final details to the clay eggs after they hardened. We used these techniques to cast multiple eggs of uniform size and shape that we could mark to produce a realistic appearance.

Making the Molds—Mix powdered plaster of Paris with water to get a pourable consistency between heavy cream and honey. Start with 2 times as much dry plaster powder in a plastic bucket as will be needed to fill your mold pan half-way (see below), and add one-half as much water as will be needed for this volume of powder (initially start with ¼ the volume of the plaster). Stir with a stout, preferably square, stick to mix plaster and water. If the mix is too dry and stiff, add more water, a little at a time, and stir. Once all powder is wet, it should have a consistency of 20% liquid and 80% wet lumps before it is well mixed. Let the mix stand for about 1 min before stirring slowly and gently (to avoid getting bubbles in the mix).

Pour plaster into a box, pan, or tray (with tapered sides and lined with plastic food wrap) to a depth of ≥1 cm deeper than one-half the diameter of eggs to be cast. Before mixing plaster, hard-boil enough eggs of an appropriate size to space them 1 cm apart in the tray, and coat them with a lubricant (e.g., petroleum jelly) that will not turn rancid. Press these eggs carefully into the liquid plaster until one-half of each egg is exposed. Also, press a pair of clean, dry marbles into the center axis of the plaster to act as alignment pins. The plaster will heat up as it hardens. When it begins to cool (after about 30–60 min), brush the entire top surface with a thin, even coat of petroleum jelly. If fresh, intact eggs of correct dimensions are not available, blown eggs can be solidified by injecting them with plaster and allowing them to harden. Alternatively, wooden imitations of proper size can be purchased in many hobby and craft shops, and given final form using a wood lathe.

Mix slightly more plaster than the first time and pour it over the embedded eggs. Use bristles of a small brush or a fingertip to lightly touch, and thereby break, any air bubbles around the perimeter and over the top of each egg. Let the mold solidify and cool for about 30 min. Remove it from the tray and use a sharp tool to wedge halves of the mold apart and remove eggs from the mold.

Mold 1 (Fig. 1a)—Remove eggs and use an 8-mm (5/16-inch) drill-bit to drill a fill hole toward the center of each egg depression in one half of the mold. The hole must match the outside

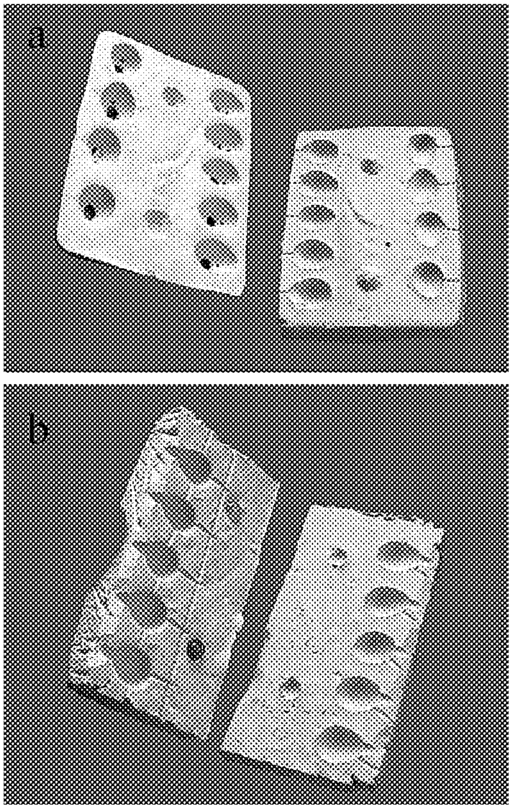

Fig. 1—Types of molds used to produce clay mimics of eggs of the American oystercatcher (*Haematopus palliatus*): a) mold 1; b) mold 2.

diameter of a turkey-baster tip (see below). These holes must go all the way through the half of the mold. To allow air to escape the mold during the casting step (below), drill a 3-mm (1/8-inch) hole about 3 mm (1/8-inch) away from each fill hole. The additional holes should be positioned to one side of each fill hole and along the wide circumference of each egg depression, and angled away from fill holes to the outer surface of the mold. All fill holes should be aligned along the same axis of the mold-half, and all smaller holes should be angled toward the same side of the mold. The smaller holes will allow air to escape the mold during the casting step (see below) without need to reposition the mold.

Mold 2 (Fig. 1b)—An alternate method of making fill holes in plaster is to drill into egg voids along the seam between halves of the mold. Air channels can then be gouged to the egg voids at angles with the fill holes using a sharp instrument. If molds are made this way, the halves must be held tightly together with a bungee cord or clamp during casting.

Melting the Clay—Several brands of plasticine modeling clay are commercially available; we chose Van Aken Plastalina (Van Aken International, Rancho Cucamonga, California) because of a reliable local supplier. Melt about 0.45 kg (1 pound) of clay in a 1.9-L (2-quart) double-boiler over medium heat. Stir occasionally with a wooden paddle and heat clay until all lumps are melted. Using three double-boilers at a time provides a pot of melted, pourable clay, a pot of clay that is in the process of melting, and a pot of dipping clay for the final finish (see below). Keep a pot of boiling water nearby to replenish the double boilers.

Different colors of clay have different melting characteristics, especially when purchased in 2.7-kg (5-pound) blocks. This probably is due to variations in physical characteristics of solids that give color and body to the clay. White clay tended to remain lumpy, making it difficult to cast. Up to 10% paraffin can be added to thin the white clay, but eggs are best cast from other colors, such as brown or gray, because they have better melting characteristics. Combinations of white and other colors can then be used as the final finish (see below).

Casting the Eggs—Coat the contact face of each half of the mold with a thin layer of petroleum jelly to act as a release agent. Use a heat-resistant plastic or metal turkey baster with an outside diameter at the tip of 8 mm (5/16 inch) to inject liquid clay into molds. When melting clay reaches a syrup-like consistency, insert tip of baster into the liquid without filling it, and then allow the tip to heat. Failure to heat the tip will result in clay solidifying in the baster; thus, clogging it or drastically reducing its capacity. Condition the baster with melted clay by drawing about 7.5 cm (3 inches) of clay into the baster and squirting it back into the pot. Repeat this procedure several times, using a little more clay each time, to heat the baster to approximate temperature of the clay.

To cast a set of eggs, begin by drawing clay into the baster (about 7 cm = 3 inches of clay will be needed for eggs the size of those of Japanese quail, *Coturnix japonica*). Hold the mold over the double-boiler with air holes tilted slightly upward, and inject clay into the first fill hole until it comes out the air hole. Squirt the remainder of the clay back into the pot, and then refill the baster before filling the next cavity to prevent clogging the baster. Use this procedure to fill each cavity in turn, and then set the mold aside to cool. Clean the tip of the baster immediately after casting by removing the bulb, extruding clay through the tip with a 6-mm (¼-inch) dowel rod, and then scraping the barrel with a stick.

When the mold has cooled to room temperature, pry the halves apart with a thin putty knife or knifepoint. Eggs that are stuck to the sprue side of the mold (side with pouring holes) can be dislodged easily by poking a dowel rod into the pouring hole. Set eggs aside for smoothing. Clay left in air holes can be pushed out using the blunt end of a thin bamboo skewer. Eggs stuck in the bottom of the mold can be dislodged by gently rocking and lifting using thumbs and index fingers of both hands. If this is not effective, place a smooth piece of cloth over the egg and use a little more force. Doing this quickly rather than slowly will minimize distortion of eggs. If neither of these methods dislodge the egg(s), put the mold in a −20°C freezer for 30 min, and then carefully insert the tip of a putty knife along the side of the egg and pry it out. Cuts in eggs can be smoothed over easily at room temp. To make eggs easier to remove, lightly coat contact faces of molds with petroleum jelly before each pour.

Many eggs will have casting defects such as voids, sprue extensions, and seams. These defects can be repaired and smoothed using a small knife.

Final Finish—Melt a mixture of white clay and other colors in a separate double- boiler. Insert a bamboo skewer 1 cm into the small end of each egg, and dip the egg into the pot of melted clay. Remove the egg, but hold it above the pot for 10 s until the clay stops dripping. Insert the bare end of the skewer into a bucket of sand to support the egg until it cools. After eggs have cooled and outer coatings of clay have hardened, remove eggs from the skewers. Cut the drip-end off each egg with a sharp blade and use this clay to fill and smooth the skewer hole in the other end. Apply final markings such as spots or stippling using waterproof markers or acrylic paint. This procedure produces clay eggs with an eggshell-smooth finish that are slightly heavier than real eggs.

We used water-proof markers to apply patterns that mimicked eggs of the American oystercatcher (*Haematopus palliatus*). Other researchers have used poster paints (Sodhi et al., 2004), varnish (Zanette and Jenkins, 2000), champagne beige automobile paint (Sutherland, 2000), and unspecified paints (Møller, 1987; Burke et al., 2004) to give eggs their final color, and to reduce melting and sticking to nests.

Our approach produced about 1,000 eggs at a cost of $0.55/egg, including materials ($250) and labor (30 h @ $10.00/h). This expense could be reduced somewhat by bulk purchase of clay, and use of several molds to increase rate of production. Although eggs of Japanese quail cost from about $0.10 (from an Asian food store) to about $1.00/egg (from a scientific supplier), our procedure can be tailored to any type of egg. Among other advantages, clay eggs can preserve impressions of teeth and beaks of predators and are, therefore, useful in identifying nest predators (Major and Kendal, 1996; Craig, 1998; Keyser et al., 1998; Rangen et al., 2000; Boulton and Cassey, 2006). Clay eggs also avoid problems of spoilage and undesirable odors that are common to real eggs during field trials under warmer conditions (ambient temperatures ≥35°C).

Although researchers in many studies mention using plasticine clay (e.g., Bayne and Hobson, 1999; Estrada et al., 2002; Rosemier and Flaspohler, 2006), most investigators (e.g., Estrada et al., 2002; Boulton and Cassey, 2006) provide scant details of methods used to manufacture their artificial eggs, or documentation of appearance and consistency of the final product. Most studies only report that appropriate-sized mimics were made by hand using clay, and then painted to resemble eggs of a particular species (e.g., Rangen et al., 2000). Maier and Degraaf (2001) and Rosemier and Flaspohler (2006) mention rolling eggs by hand. Matthews et al. (1999) and Langmore et al. (2005) used silicone molds. Burke et al. (2004) mentioned casting eggs in plastic molds of unknown origin. D. Liley (Sutherland, 2000) sought to standardize size of egg by forming a suitable model egg, and then weighing out that same amount of clay for each of the other eggs, which he shaped by hand. Lack of a standardized technique for making clay eggs, and apparent variability in appearance of artificial eggs, make replication of previously reported studies difficult. As a result of this ambiguity, Villard and Part (2004) considered realism of mimics often to be in question.

Few experiments have addressed sensory cues and development of search images relating to how predators locate bird nests (Rangen et al., 2000; Santisteban et al., 2002). Even so, most avian predators, as well as diurnal mammalian predators, are believed to rely on visual cues to locate nests and eggs (Rangen et al., 2000; Santisteban et al., 2002). This would necessitate closely matching the appearance of real eggs, including characteristics of shape and color.

Perception of color by humans is different from that of many other animals. For example, birds perceive color in the ultraviolet (UV) to near-ultraviolet range (Odeen and Hastad, 2003). Thus, researchers who use artificial eggs to test behavior of birds would be prudent to ascertain spectral sensitivities of their target species as well as the reflectance spectrum of the egg model(s) in their study. If necessary, clay mimics manufactured using our method can be painted to produce colors at wavelengths that match those of eggs being mimicked.

Although our procedure addresses some problems related to visual cues, it does not resolve the issue of olfactory cues. Our eggs released a subtle, but detectable (to humans), odor of clay. Rangen et al. (2000) suggested that clay eggs are more susceptible than real eggs to predation by mammals that use olfaction for locating food. They documented higher rates of predation on artificial nests that contained clay eggs than on artificial nests that contained eggs of Japanese quail or domestic finches. In contrast, Berry and Lill (2003) documented no difference in rates of predation on clay versus canary (*Serinus canarius*) eggs in a study area inhabited by several rodents (*Rattus* and *Mus*), taxa that use olfaction in locating food (Hermer-Vazquez et al., 2007). Bayne and Hobson (1999) also concluded that clay odor did not attract nest predators (including North American deermice, *Peromyscus maniculatus*) in their study. Thus, importance of olfaction remains an open question with respect to mammalian predation on clay eggs.

A drawback other than odor of the clay eggs we produced was that they sometimes became coated with sand when rolled excessively, as by ghost crabs (*Ocypode quadrata*). Painting eggs with a thin coat of clear shellac would solve this problem and, perhaps, also reduce the clay odor. Water-based acrylic paint might accomplish the same purpose.

This is the first detailed description of a method that uses real eggs to create a plaster mold for casting large numbers of clay eggs that can be marked easily to mimic real eggs. Another apparent innovation in our methods is use of a thin layer of colored clay to achieve desired color and finish. Our procedure creates uniform clay eggs that are durable in the field and closely match the appearance of real eggs.

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Literature Cited

Bayne, E. M., and K. A. Hobson. 1999. Do clay eggs attract predators to artificial nests? Journal of Field Ornithology 70:1–7.

Berry, L., and A. Lill. 2003. Do predation rates on artificial nests accurately predict predation rates on natural nests? The effects of nest type, egg type, and nest-site characteristics. Emu 103:207–214.

Boulton, R. B., and P. Cassey. 2006. An inexpensive method for identifying predators of passerine nests using tethered eggs. New Zealand Journal of Ecology 30:377–385.

Burke, D. M., K. Elliot, L. Moore, W. Dunford, E. Nol, J. Phillips, S. Holmes, and K. Freemark. 2004. Patterns of nest predation on artificial and natural nests in forests. Conservation Biology 18:381–388.

Craig, D. P. 1998. Chipmunks use leverage to eat oversized eggs: support for the use of quail eggs in artificial nest studies. Auk 115:486–489.

Estrada, A., A. Rivera, and R. Coates-Estrada. 2002. Predation of artificial nests in a fragmented landscape in the tropical region of Los Tuxtlas, Mexico. Biological Conservation 106:199–209.

Faaborg, J. 2004. Truly artificial nest studies. Conservation Biology 18:369–370.
Fontaine, J. J., M. Martel, H. M. Markland, A. M. Niklison, K. L. Decker, and T. E. Martin. 2007. Testing ecological and behavioral correlates of nest predation. Oikos 116:1887–1894.
Hermer-Vazquez, L., R. Hermer-Vazquez, and J. K. Chapin. 2007. The reach-to-grasp-food task for rats: a rare case of modularity in animal behavior? Behavioural Brain Research 177:322–328.
Keyser, A. J., G. E. Hill, and E. C. Soehren. 1998. Effects of forest fragment size, nest density, and proximity to edge on the risk of predation to ground-nesting passerine birds. Conservation Biology 12:986–994.
Langmore, N. E., R. M. Kilner, S. H. M. Butchart, G. Maurer, N. B. Davies, A. Cockburn, N. A. Macgregor, A. Peters, M. J. L. Magrath, and D. K. Dowling. 2005. The evolution of egg rejection by cuckoo hosts in Australia and Europe. Behavioral Ecology 16:686–692.
Maier, T. J., and R. M. Degraaf. 2001. Differences in depredation by small predators limit the use of plasticine and zebra finch eggs in artificial-nest studies. Condor 103:180–183.
Major, R. E., and C. E. Kendal. 1996. The contribution of artificial nest experiments to understanding avian reproductive success: a review of methods and conclusions. Ibis 138:298–307.
Matthews, A., C. R. Dickman, and R. E. Major. 1999. The influence of fragment edge and size on nest predation in urban bushland. Ecography 22:349–356.
Møller, A. P. 1987. Egg predation as a selective factor for nest design: an experiment. Oikos 50:91–94.
Moore, R. P., and W. D. Robinson. 2004. Artificial bird nests, external validity, and bias in ecological field studies. Ecology 85:1562–1567.
Odeen, A., and O. Hastad. 2003. Complex distribution of avian color vision systems revealed by sequencing the SWS1 opsin from total DNA. Molecular Biology and Evolution 20:855–861.
Rangen, S. A., R. G. Clark, and K. A. Hobson. 2000. Visual and olfactory attributes of artificial nests. Auk 117:136–146.
Rosemier, J. N., and D. J. Flaspohler. 2006. Island-specific ecological release of small mammals in Lake Michigan and potential consequences for ground-nesting birds: the importance of American beech (*Fagus grandifolia*) in structuring small-mammal communities. George Wright Forum 23: 24–32.
Santisteban, L., K. E. Sieving, and M. L. Avery. 2002. Use of sensory cues by fish crows *Corvus ossifragus* preying on artificial bird nests. Journal of Avian Biology 33:245–252.
Sodhi, N. S., M. Castelleta, W. Z. Loh, B. P. Y-H. Lee, and R. Subaraj. 2004. Tropical lowland rainforest birds on a highly urbanized island: monitoring, losses and lessons. Pages 78–83 in Proceedings of the fourth international symposium on urban wildlife conservation (W. W. Shaw, L. K. Harris, and L. VanDruff, editors). School of Natural Resources, University of Arizona, Tuscon.
Sutherland, W. J. 2000. The conservation handbook: research, management and policy. Blackwell Publishing, Malden, Massachusetts.
Thompson, F. R., III, and D. E. Burhans. 2004. Differences in predators of artificial and real songbird nests: evidence of bias in artificial nest studies. Conservation Biology 18:373–380.
Villard, M.-A., and T. Part. 2004. Don't put all your eggs in real nests: a sequel to Faaborg. Conservation Biology 18:371–372.
Zanette, L., and B. Jenkins. 2000. Nesting success and nest predators in forest fragments: a study using real and artificial nests. Auk 117:445–454.

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