One to ovoid? Using 3-D printing, researchers can study what causes birds to reject eggs with greater precision

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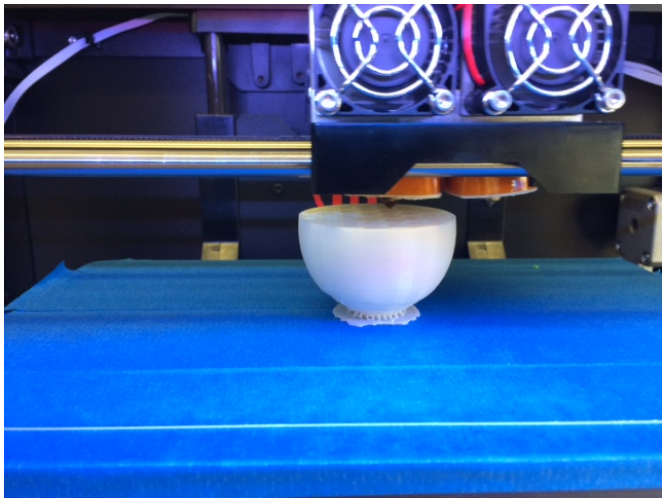


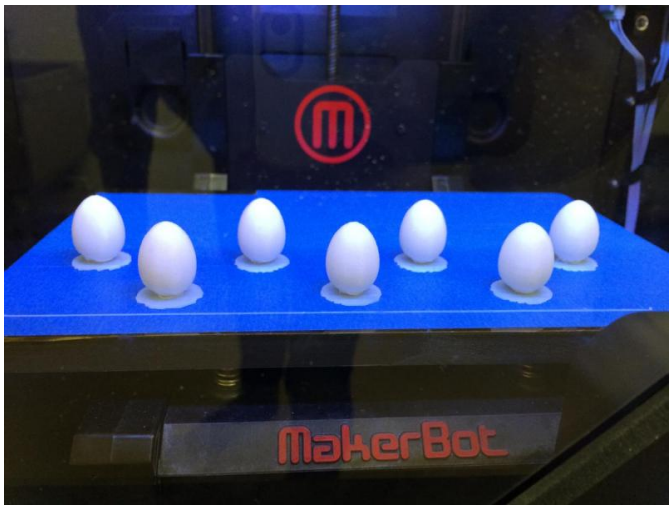
A partially manufactured egg. Credit: Miri Dainson and Robert Pecchia. CC BY 4.0

Old-school field work meets cutting-edge technology! For decades, researchers have been making artificial eggs out of plaster, wood, and other materials to test how birds identify and reject the eggs that invading "brood parasites" sometimes sneak into their nests. But these methods have many limitations, and a new study published in the open-access journal *PeerJ* is the first to test the usefulness of 3D printed eggs for research on egg rejection.

Brood parasites are birds that don't build nests of their own. Instead, they slip their eggs into the nests of other species, where oblivious parents may raise these invading chicks even at the expense of their own. In some species, this has led to an evolutionary arms race in which host parents get better and better at identifying and rejecting eggs that aren't theirs, using cues including egg size, shape, color, and pattern, while brood parasites have become increasingly adept at mimicking the eggs of their host species. To study egg rejection behavior and figure out how bird parents identify impostor eggs, ornithologists have long been doing experiments which involve adding artificial eggs to nests and observing what the parents do.

The problem is that making convincing, uniform artificial eggs out of traditional materials like plastic, wood, and plaster-of-Paris is surprisingly challenging. The fake eggs can be time-consuming to produce, prone to human error, and hard for other researchers to replicate exactly, which is important in confirming scientific findings. To get around these limitations, researchers created digital models of the eggs of Brown-headed Cowbirds (a North American brood parasite) and created them using 3D printers. 3D printing also allowed for the creation of hollow eggs that could be filled with water or gel, closely mimicking not just the weight but even the thermodynamic properties of real eggs.

Painted beige to match real cowbird eggs or blue-green to match the eggs of the host American robins, the 3D printed eggs were placed in robin nests, which were then monitored for six days to see how the parents reacted. Robins accepted 100% of the blue-green eggs but rejected 79% of the eggs which were painted to resemble those of cowbirds. Reassuringly, this is similar to the results of past studies using traditionally-produced plaster eggs, however 3D printed eggs now have the advantage of being less variable and more able to reproduce a desired size and shape. In addition, the digital models used to produce them can be shared among researchers so that experiments can be replicated more precisely than was possible in the past.



The manufacturing process of 3-D cowbird eggs. Credit: Mark Hauber. CC BY 4.0

"Hosts of brood parasites vary widely in how they respond to parasitic eggs, and this raises lots of cool questions about egg mimicry, the visual system of birds, the ability to count, cognitive rules about similarity, and the biomechanics of picking things up," says Prof. Don Dearborn, chair of the Biology Department at Bates College, a brood parasitism expert who was not involved in the 3D printing study. "For decades, tackling these questions has meant making your own fake eggs—something we all find to be slow, inexact, and frustrating. This study uses 3D printing for a more nuanced and repeatable egg-making process, which in turn will allow more refined experiments on host-parasite coevolution. I'm also hopeful that this method can be extended to making thin-shelled, puncturable eggs, which would overcome another one of the constraints on these kinds of behavioral experiments."

"3D printing technology is not just in our future—it has already revolutionized medical and basic sciences," says Prof. Mark Hauber, an animal behaviorist at Hunter College of the City University of New York, the study's senior author. "Now it steps out into the world of wild birds, allowing standardized egg rejection experiments to be conducted throughout the world."

More information: Igic B, Nunez V, Voss HU, Croston R, Aidala Z, Lopez AV, Van Tatenhove A, Holford ME, Shawkey MD, Hauber ME (2015) Using 3D printed eggs to examine the egg-rejection behaviour of wild birds. *PeerJ* 3:e965 dx.doi.org/10.7717/peerj.965

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