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BOOK REVIEW

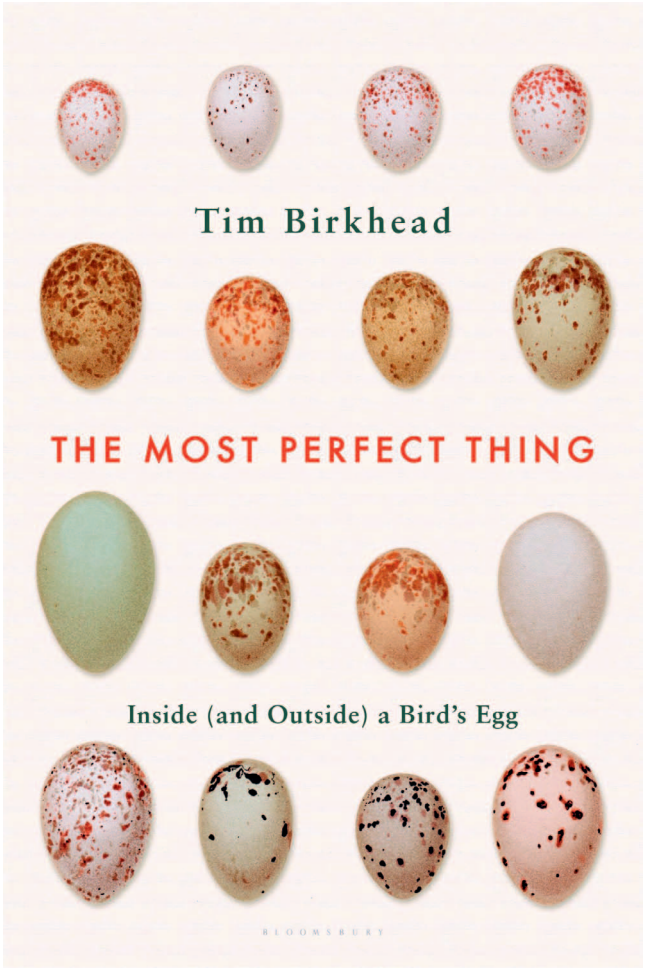
The Most Perfect Thing: Inside (and Outside) a Bird's Egg

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The Most Perfect Thing: Inside (and Outside) a Bird's Egg by Tim Birkhead. 2016. Bloomsbury, New York, NY, USA. xvi + 304 pp., 15 color and 3 black-and-white photographs. $27 (hardcover). ISBN 978-1632863690.



Murres (or guillemots), as their lifelong devotee and steward Tim Birkhead well knows, have phenomenal eggs. Laid precariously on narrow ledges, they are variously multicolored and patterned, decorated with feces, and unusually conical (we'll avoid the term *pyriform*, as Dr. Birkhead has never seen a pear that reminded him of a murre egg). His fascination with these eggs, and a recent desire to understand the function of their shape, eventually led him to write *The Most Perfect Thing*, the latest in a series of books aimed at inspiring a general audience to understand and value birds (e.g., *The Wisdom of Birds* [2008] and *Bird Sense* [2013]). The goal of this book is to open up the bird egg, that "self-contained life support system," to readers, from the outside to the inside, and from the follicle to hatching. As Dr. Birkhead is also a historian of science specializing in ornithology, readers are treated to nearly as much storytelling as scientific explanation, and of course the two sorts of writing are not mutually exclusive. The social circumstances surrounding a discovery, the series of hypotheses and tests that led to a (perhaps still uncertain) conclusion, and the personal narratives that explain why somebody was hanging from a cliff in Bempton grasping for an egg in 1832, all add richness and a human element. This context is especially useful in this age when we frequently must defend our research interest in nature for its own sake. As the author states in the Epilogue, "The study of birds' eggs may seem an indulgence. Who cares about eggs?" Readers of *The Auk* will not need the answer, but of course this book is not primarily for us—it is for the open-minded uninitiated, such as one reader who commented on Amazon.com, "[I] never expected to get enthusiastic about an egg!" This is a colorful manifesto and enthusiastic scientific introduction to the bird egg. We should not expect a full monograph reviewing what is known about eggs (which, by the way, we especially need since the spectacular resurgence of ornithological oology in the past 20 years). *The Most Perfect Thing* is to that imagined tome as Nick Davies's *Cuckoo: Cheating by Nature* (2015) is to Bob Payne's *The Cuckoos* (2005).

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The story begins with the egg-collecting craze of the 19th and early 20th centuries, especially the obsession of a Lancashire lawyer, George Lupton, with murre eggs. He wanted them essentially as a collection of natural art and would pace the tops of cliffs in hopes that his "climmers" would appear with one or two very special ones in their bags among the typical varieties. Since one female lays a distinctive egg in the same spot fortnight after fortnight (if the previous one is removed), and indeed year after year, the egg collectors knew where to get their favorite rare forms. Such egg collecting is illegal today, and for good reason. Nevertheless, Dr. Birkhead still resonates with Lupton in his appreciation of these eggs, imagining the collector beside him as he examines his collection (now at Tring, though it sadly lacks the data that would make it useful to science).

Our tour of the bird egg from the outside to the inside starts, of course, with the shell. This unique structure serves a vital role in protecting the developing embryo from environmental insults such as microbes, while still allowing gas exchange. The author focuses on mothers' dietary strategies for building up enough calcium to produce the shell; ways in which anthropogenic pollutants, in the form of acid rain and pesticides such as DDT, have led to calcium-related problems in eggs; and basic work on shell microstructure.

The shell is what gives bird eggs their shape, the feature that is presented as the most understudied aspect of bird eggs (although it is not quite as understudied as it is portrayed). Shape is probably the closest egg trait to Dr. Birkhead's own heart, as he begins and ends the book with a controversy over whether the conical shape of murre eggs functions primarily to decrease their likelihood of falling off ledges, which has long been the standard hypothesis. He believes this shape mostly does nothing of the sort but rather "keeps the blunt end out of the muck." In a note, he promises a future publication on this hypothesis, which has indeed recently come out (Birkhead et al. 2017). Also emphasized in that paper, but not in this book, is another hypothesis: that a conical egg shape allows for a greater range of contact with the substrate, which strengthens the egg's resistance to impact as birds land on their eggs or on other incubating birds in a dense colonial situation.

Egg coloration is dealt with next, emphasizing physiology in one chapter and function in another. The author admits that despite great interest and plausible hypotheses, the empirical studies do not yet permit definitive answers. Certainly, many egg background colors and markings appear to camouflage them from predators; some within-species variation has evolved in coevolution between brood parasites and their hosts; and in other cases variation allows individuals to distinguish their eggs from those of neighbors. Why some birds lay conspicuous eggs is less well known, and Dr. Birkhead offers a sample of the going hypotheses. One point that might not be clear from this chapter is that this area of research is precisely that which has resurged in the past two decades, owing largely to the importance of egg appearance in the boom of brood parasitism research initiated by Payne, Rothstein, and Davies in the 1970s and '80s, combined with methodological developments in the measurement of color in the evolutionary ecology of birds (especially UV-VIS spectrophotometry).

The physiology and function of the inner parts of the egg are the reader's next stop. The apparent nothingness of albumen belies its importance not only as a source of water and protein to support embryonic development, but also as a second line of defense against microbial infection, further isolating the nutritious yolk from contamination. As for the yolk, the author decribes its function as a repository for hormones and discusses foundational research on adaptive adjustment of testosterone.

So far, morphology has provided the landmarks on this tour, while the developmental process is described here and there along the way. In the penultimate chapter, the ontogenetic gaps are filled: The egg is fertilized, laid, incubated, and hatched. We are introduced to the reasons for failures of fertilization (usually a male problem) and hatchability (usually a female problem or else due to genetic incompatibilities). Nonpredatory embryonic deaths during incubation are generally related to temperature, humidity, or insufficient turning. Advancements in this area are salient reminders of the enormous debt we owe to poultry researchers, whose funding dwarfs that of ornithologists. The book ends with a return to George Lupton, the shape of murre eggs, and a plea to conserve birds and maintain funding for basic ornithological research.

The length and depth of the book are, considering its aim and audience, ideal. Covering so much about eggs, plenty must be left out, and there are many ways this could have been done. Here, genetics and evolutionary history are largely excluded to provide more room for physiology and function. Most (two thirds) of the examples are from the nonpasserines, especially Charadriiformes. Historical work is sometimes given equal or even higher billing in comparison to recent work. For instance, for the color of tinamou eggs, the book presents a 1916 hypothesis (aposematism; Swynnerton 1916) but not a 1973 hypothesis (signal to incubating males or co-laying females; Weeks 1973; see also Brennan 2010), and it summarizes foundational work in pigment and yolk biochemistry and shell ultrastructure but not more recent work. Areas of intensive recent research, such as egg color and incubation, are represented by thumbnail sketches and focal case studies rather than by a broader review, a strategy that may well ensure reader interest. Occasionally the book seems to represent itself as comprehensive where it is not, for

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instance when it refers to camouflage–conspicuousness, individual recognition, and avoidance of brood parasites as "overall . . . [the] three broad categories of evolutionary explanation for the colour of eggs." Taking note of these limitations amounts really to a reiteration of the general audience and inspirational focus of the book. *The Most Perfect Thing* excels especially in its stories (including those egg-collecting yarns), Dr. Birkhead's own observations and impromptu tests, cameos by devoted egg curators and sharp field biologists, and various tangents ranging from viper semelparity to women incubating eggs in their cleavage.

Despite this book's popular appeal, oophilic ornithologists can learn from it in ways that inform our research. The historical perspective can be enlightening and can remind us of neglected hypotheses. Many of us will be delighted by Dr. Birkhead's yen for finding the *locus classicus*—the first time an idea or observation was presented to the community; these citations are often surprising. Likewise, he highlights open questions and exceptions to generalities, some of which could seed future research. And, of course, some of us who work exclusively on one aspect of eggs can benefit from basic information on other aspects. Those who think routinely about pigmentation might not know about the four sorts of albumen. Those who study the effects of pollutants on egg quality might not have encountered the variety of ways in which the egg exits the reproductive tract. Still, we come away from this book with the impression that its success should rather be gauged by its tendency to convince people that Thomas Wentworth Higginson's 1862 statement is not entirely unreasonable: "I think that, if required on pain of death to name instantly the most perfect thing in the universe, I should risk my fate on a bird's egg."

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