Concealing Coloration in Animals

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Source: Copeia, 2013(4):782-783. 2013.
Published By: The American Society of Ichthyologists and Herpetologists
DOI: http://dx.doi.org/10.1643/OT-13-073.1
URL: http://www.bioone.org/doi/full/10.1643/OT-13-073.1

Concealing Coloration in Animals. J. Diamond and A. B. Bond. 2013. Belknap Press of Harvard University Press. ISBN 9780674052352. 288 p. $29.95 (hardcover).—I once asked my Australian Wildlife Biology class the question, ''Why are the vast majority of Australian lizards brown?'' The obvious answer is that Australia is a dry, brown continent and that lizards have evolved concealing coloration. Both the question and answer belie a fascinating complexity and diversity of animal color patterns and the evolutionary processes generating and maintaining them. Nevertheless, the implication is that concealing coloration is both ubiquitous and central to understanding animal diversity, a view eloquently argued by Judy Diamond and Alan Bond in their new book.

Diamond and Bond provide a compelling overview of the evolution of concealing coloration, from the molecular structure of pigments to frequency-dependent selection and predator cognition. The book is structured in four parts: the first describes forms of concealment; the second explains mechanisms of color production and predator visual perception; the third explores evolutionary processes acting on concealing coloration; and the fourth examines predator psychology and prey detection. Key concepts within each section are communicated through the use of historical and contemporary vignettes on the important thinkers, events, phenomena, and experiments that have shaped the way we think about concealing coloration today.

The book begins with the cases for and against the view that concealing coloration is the product of natural selection. The affirmative case was championed by the likes of Alfred Russel Wallace, while the champion of the case against was none other than Theodore Roosevelt. Roosevelt believed that there was little evidence to suggest that background resemblance actually prevented an animal from being detected and eaten—and if it did, why didn't all animals have concealing coloration? Through the course of the book, Diamond and Bond build an unassailable case that concealing coloration, when considered in relation to the behavior of both predators and prey, does increase an animal's chances of survival, even if only slightly, which is all that is needed for it to evolve in response to natural selection.

The examples of organisms, researchers, and experiments have been carefully chosen to exemplify each key component of the case for the adaptive significance of concealing coloration. For instance, some impressive examples of concealing coloration can be found in creatures inhabiting the giant mats of floating kelp called sargassum, the largest of which is the Sargasso Sea of the North Atlantic. Diamond and Bond take the reader on a journey beginning with the initial discoveries of creatures of the Sargasso Sea (including the spectacular sargassum fish, *Histrio histrio*) by Peter Osbeck, a disciple of Carl Linneaus, in the 1750s and Alexander Agassiz's subsequent surveys in 1877 and observations suggesting background choice. The journey culminates in Hacker and Madin's series of elegant experiments in the 1990s confirming Agassiz's observations. These experiments showed that in two species of sargassum shrimp, individuals chose backgrounds and adopted postures that maximized concealment (Hacker and Madin, 1991). The story of the creatures of the Sargasso Sea highlights the importance of behavior for enhancing background and object resemblance.

In a similar way, Diamond and Bond compellingly describe the debate and controversy surrounding industrial melanism of peppered moths (*Biston betularia*), arguably one of the best known and clearest examples of the evolution of concealing coloration and adaptive evolution more generally. They tell the story of the controversial painter Abbott Thayer's principle of disruptive coloration (Thayer and Thayer, 1909) and his hotly debated contention that all animals, when viewed in the right environment, are concealingly colored (as in his famous painting of a peacock, reproduced on page 44). Somewhat in contrast to ''colorful'' stories of discovery and debate in the earlier part of the book, the latter part becomes a little more technical, covering challenging topics such as the physics of light and the structure of pigment molecules, animal vision, predator cognition, and the role of gene flow in adaptive divergence. Despite the complexity of these topics, Diamond and Bond manage to convey concepts clearly and, for the most part, with a minimum of jargon, without sacrificing accuracy.

The book is written in a style that is accessible to a lay audience and is punctuated by striking color photos, many of which were taken by Judy Diamond. However, the depth and breadth of information is such that even an expert is likely to learn something new. Reading this book stimulated me to think about aspects of my own work in new ways and I would

recommend it to all those interested in animal coloration. There is no book that I am aware of that competes with this one. Since Hugh Cott's (1940) classic monograph on adaptive coloration in animals, there has been no comprehensive monograph on the topic targeted to a broad audience. Graeme Ruxton and coauthors' (2004) superb book on the evolutionary ecology of crypsis, warning signals, and mimicry is specifically targeted at an academic audience, as is Stevens and Merilaita's (2011) book on the mechanisms and function of animal camouflage. The latter is a collection of empirical and review articles for a scientific audience rather than a broad or comprehensive overview of the field.

Although *Concealing Coloration in Animals* is targeted for a very broad audience, the scholarship reflects the depth of knowledge of the authors, being both thorough and up to date. For example, the book features the recent work of Bree Rosenblum and colleagues on the genetic basis of the remarkable convergent evolution of blanched coloration in lizards from the White Sands National Monument, New Mexico (Manceau et al., 2010; Rosenblum et al., 2010). Diamond and Bond use this example to explain differing degrees of concealing coloration among co-occurring species, resulting from the species-specific balance between local adaptation and gene flow. The lizards of the Tularosa (including White Sands) exemplify a broad range of important concepts including divergent mate preferences and incipient speciation, the role of behavior in limiting gene flow between geographically contiguous populations, and the functional genetic basis of changes in coloration.

One aspect of this book that distinguishes it from others is the focus on, and insight into, the role of predator cognition in the evolution of concealing coloration. Alan Bond has no equal in this field. The fourth and final part of the book focuses specifically on detection, presenting evidence for Niko Tinbergen's four adaptive behavior strategies that prey use to avoid detection: immobility, background selection, adoption of postures to enhance object resemblance, and being locally uncommon. Diamond and Bond elegantly explore these strategies in the context of predator psychology, search images, and visual attention and show how predator cognition is central to understanding phenomena such as the massive color polymorphism in species such as banded grove snails (*Cepea nemoralis*), beach clams (*Donax variabilis*), and guppies (*Poecilia reticulata*).

Overall, the book is a short and very enjoyable read, of interest to both an academic and general, scientifically interested audience. It covers all important aspects of concealing coloration, from mechanisms of color production and color vision, prey behavior and predator cognition, to evolutionary processes. It is beautifully written and illustrated, and well worth the very modest price.

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