

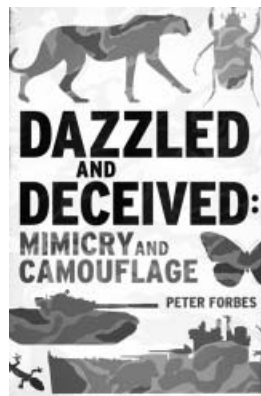
Butterflies and Battleships

Dazzled and Deceived: Mimicry and Camouflage. Peter Forbes. Yale University Press, 2009. 304 pp., illus. \$27.50 (ISBN 9780300125399 cloth).

Coral snakes are so named for their brilliant red, yellow, and black coloration, undoubtedly ranking them among the most beautiful and breathtaking of reptiles. Anyone who has seen a coral snake in a reptile house or field guide would probably side with Hugh Cott's opinion that to suggest such a beast is camouflaged borders on the ludicrous. "If it were true, as Thayer asserts, that crows and coral snakes and Heliconiid butterflies are concealingly coloured, then one surely might as well suggest that snails are swift and earthworms heavily armoured" (Cott 1940). Any organism as brightly colored and dangerous as coral snakes must have evolved distinct and obvious signals so that no potential predator could mistake its identity while inadvertently providing a model for other species to mimic, to gain protection and dupe predators. Many studies and field experiments support this interpretation of coral snake patterns, but I found myself an unexpected supporter of alternative viewpoints one night in Costa Rica while conducting fieldwork. As a snake flushed out of the leaves, I chased the streaking brown body and reached to grab it when it suddenly stopped and the flicker-fusion materialized into the red-yellow-black ringed body of a coral snake. The shock of nearly grabbing a deadly snake stopped me in my tracks and gave the snake all the time it needed to escape its tormenter. The encounter demonstrated to me some fundamental truths at the core of color pattern evolution—function depends on context, moving patterns

are not the same as stationary ones, and dogma can be dangerous.

Dazzled and Deceived: Mimicry and Camouflage explores the personalities, experiences, and dogmas that underlie our current understanding of color pattern evolution. Science writer Peter Forbes blends a historical perspective on the naturalists and geneticists who developed the ideas of mimicry, crypsis, and warning coloration with synopsis of the experimental attempts to reveal the genetic and developmental building blocks of color pattern. Forbes is fascinated with the potential of bioinspired technology and the advances provided from knowledge of functional morphology and bio-



logical engineering principles. (His 2005 book, *The Gecko's Foot*, explored applications from water-repellent nanotechnology derived from lotus leaf structure to adhesives designed from adherent principles of gecko toes.) It is little wonder, then, that a significant portion of this book explores how the understanding of animal color pattern led to the refinement of military camouflage over the course of two world wars.

Forbes's book is not a complete treatise on the science of mimicry or camouflage; it does not follow a linear path tracing the development of ideas, nor does it explain all the details and processes inherent in the evolution of

animal coloration. Instead, the book provides an overview of some significant moments in the development of the field, including modern attempts to uncover the fundamental genetics that determine complex color patterns. The strength of this approach is that Forbes has the opportunity to explore the personalities and conflicts that led to our present dogmas, and in doing so reveals some of the biases present in our thinking. There are fascinating personal stories at the bedrock of the field, from the radical atheist German expatriate Fritz Müller, advocate of the eponymous Müllerian mimicry process that we now understand as the explanation for similarly patterned heliconid butterflies throughout parts of South America, to the neurotic artist cum naturalist Abbott Thayer, who saw every animal as camouflaged and wore a stuffed prongbuck into the crowd at the Smithsonian to demonstrate the importance of countershaded coloration.

The general category of protective coloration includes a number of different illusions and effects, from general invisibility to the deception of mimicking specific objects such as dead leaves, to the startle effects of butterfly eyespots and the coral snake color pattern that gave me pause in Costa Rica. The arguments over the provenance of these ideas and their applications came to a head as World War I broke out. English and American scientists, out of a sense of duty and with a bit of self-aggrandizement, lobbied to help their respective militaries design camouflage that would better protect their troops and equipment. The stories that play out are unsurprising revelations of scientific ego and governmental inertia and obfuscation that nearly prevented the incorporation of scientific principles in the First World War.

Eventually, it was the power of data from the field in World War II that finally proved the value of bioinspired

doi:10.1525/bio.2010.60.10.12

design, as a photo of two British anti-aircraft guns so clearly reveals. In an image taken from the perspective of an overflying plane, two guns are present—one with traditional military green-and-brown blotched camo, the other painted with countershading patterns as directed by the naturalist Hugh Cott. The standard 1940s camo gun is a clear target, whereas Cott's gun is utterly invisible in the photograph. This evidence convinced the British military to incorporate basic biological principles of concealment throughout their operations. Critical biological details, from the perception of the viewer (planes photographed targets in black and white, rendering color camouflage useless) to the context of the surrounding environment (camo netting laced with strips of color was not so effective in the desert), began to be incorporated into the military realm.

The balance of *Dazzled and Deceived* focuses on the genetics and development of mimetic patterns, as revealed mostly through work with butterflies. The problems here are huge for evolutionary biologists. How does natural selection build a complex organism with all its integrated parts through fixation of random mutations? Butterfly mimicry has been a classic arena in which to tackle this problem precisely because the gambit is so obvious: To be a good mimic of another species requires many pattern elements of bars, lines, colors, and even wing shapes to change at once. Moreover, how can this process produce females that are perfect mimics and males that look nothing of the sort within a single species? These genetic requirements are seemingly at odds with our understanding of gradual evolutionary change and genes of small effect. Forbes takes us through the emergence of E. B. Ford's school of ecological genetics and the basement-made butterfly crosses that eventually began to illuminate the problem of linked-gene complexes ("supergenes"), sex-linked inheritance, and modifier genes. The answers to the mimicry paradox, preliminary as they are still, inform modern evolutionary-developmental studies in all species and have launched the

current effort to map a number of butterfly genomes. These genomic excursions promise to uncover the genetic architecture of mimetic patterns in a variety of species and in doing so uncover the fundamental basis of adaptation and speciation.

Forbes has succeeded in producing a book with a novel perspective on an oft-visited topic. There is not much in the biological thread that will be new to anyone with a current grounding in evolutionary biology, but the historical vignettes and insights into the naturalists' battles to aid the military machine provide a strong example of how practical applications come from unlikely subjects. The account of the postwar eclosion of the field of ecological genetics provides a view to the social influences that underscore all scientific interpretations. To the more general reader, *Dazzled and Deceived* will prove an engrossing narrative of evolutionary biology as exemplified through the colors of animals, a topic that captivated the founders of the field and remains at the forward edge of genetics, evolution, and development today.

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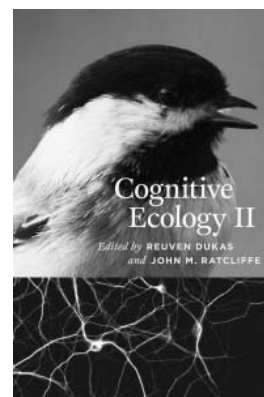
COGNITIVE ECOLOGY COMES OF AGE

Cognitive Ecology II. Reuven Dukas and John M. Ratcliffe, eds. University of Chicago Press, 2009. 384 pp., illus. \$40.00 (ISBN 9780226169361 paper).

In the 17 years since Les Real (1993) coined the term "cognitive ecology"

to describe the integration of cognitive science and behavioral ecology, Reuven Dukas (1998) has published an edited collection, Victoria Healy and John Braithwaite (2000) have asked whether cognitive ecology represents a field of substance, Dukas (2004) has published the evolutionary biology of animal cognition, and in 2007 the Animal Behavior Society sponsored a symposium, "The Evolutionary Ecology of Learning, Memory, and Information Use." This volume, *Cognitive Ecology II*, is a product of that 2007 symposium.

Dukas, an associate professor of psychology, neuroscience, and behavior, and a member of the Animal Behavior Group at McMaster University, and John M. Ratcliffe, assistant professor at the Center for Sound Communication



at the Institute of Biology of the University of Southern Denmark, present a new attempt to analyze the ecology and evolution of animal cognition. The book's 23 contributors cover the mechanisms, ecology, and evolution of learning, memory, decisionmaking, and social cognition in a variety of invertebrate and vertebrate model systems. Contrary to its title, this collection is not a second edition of the 1998 version (Dukas 1998), but is a new compilation of topics. In this sense, the book follows the tradition established by Krebs and Davies (1997) in their four editions of *Behavioural Ecology: An Evolutionary Approach*.

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