Glimpses of Creatures in Their Physical Worlds

Author: Bennet-Clark, Henry

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Relative hindlimb length in anoles is an ideal trait with which to examine form and function because of its correlation with microhabitat use. As a result, macroevolutionary forces can be examined by tying phenotypic variation to ecological causes; basically, the phenotype → performance → fitness paradigm.

The discussion of island and mainland anoles in Chapter 16 ("The Five Faunas Reconsidered") especially caught my attention because it is both speculative and thought provoking. The compelling argument is that differences in density and diversity of predators on island and mainland habitats affected the course that evolution may have taken. Alternatively, one might wonder whether frequent (evolutionarily speaking) catastrophic events (such as hurricanes) on West Indian islands have repeatedly affected anole populations such that the ability to rapidly respond to habitat change in itself has been favored. "Evolvability" is addressed in the last chapter. Anoles show greater variability in morphology and thermal physiology than other lizard clades. It might be instructive to conduct laboratory experiments to determine whether island and mainland anoles differ in their ability to change limb length or thermal physiology in response to habitat characteristics. A long history of predictably high predator diversity and abundance may have had a lesser impact on evolutionary rates in mainland anoles than a long history of catastrophic events has had on island anoles.

The overall layout of the book, with a single column of text on each page, is appealing. I particularly like the creative use of annotations, which allows the text to flow while giving the interested reader additional detailed information (and some very entertaining anecdotes). Color photographs and graphics throughout complement the presentation. Only one rather minor inconsistency in the text comes to mind: Following a convincing defense of the phylogenetic species concept, Losos emphasizes "reproductive isolation as an appropriate framework for consideration of the nature of anole species" (p. 22). Yet the entire book emphasizes a phylogenetic approach to understanding the evolution and diversity of anoles. That aside, errors are rare (e.g., listing "Pianka and Vitt 2003" as "Vitt and Pianka 2003" in the literature cited).

Although Losos targets the book to "those deeply interested in anoles and those interested in general questions of biodiversity, evolutionary biology and ecology" (p. 8), I would broaden that to include all students of the natural sciences interested in discerning how inquisitive scientists reconstruct the history of life. A good reading of *Lizards in an Evolutionary Tree* will most likely result in "field envy" by laboratory experimentalists. For Jonathan Losos, the laboratory is the West Indies, his Petri dishes are the many islands teeming with *Anolis* lizards, and his experiments are real-world demonstrations that natural selection has produced an astounding diversity of life on Earth.

LAURIE J. VITT

Laurie J. Vitt (vitt@ou.edu) is a George Lynn Cross Research Professor and curator of reptiles at the Sam Noble Museum, University of Oklahoma, in Norman.

HOW CREATURES WORK

Glimpses of Creatures in Their Physical Worlds. Steven Vogel. Princeton University Press, 2009. 328 pp., illus. $35.00 (ISBN 9780691138077 paper).

Steven Vogel has written a number of books on biomechanics, from the diverting and amusing *Life's Devices* (1988) and *Cats' Paws and Catapults* (1998) to the scholarly, insightful, and amazingly useful *Comparative Biomechanics* (2003). The success of these works has been so great that Vogel has been largely immune from the rat race of the research grants system, and instead has been able to pursue his interests in such areas as the flow-induced ventilation of sponges and prairie-dog burrows, or the responses of leaves and trees to wind.

Vogel is part of the school of physiology and biomechanics, fostered by the legendary Knut Schmidt-Nielsen, at Duke University, and his eclecticism and inventiveness are remarkable. He has a good knowledge of both the animal and plant kingdoms, plus a knowledge of physics, engineering, and physical chemistry, and thus is able to apply principles used in, for example, commercial chemical engineering to the problems of gaseous exchange or water loss by leaves. He also has the ability to sense a problem and an enviable knack for explaining what is happening.

Glimpses of Creatures in Their Physical Worlds is a reworking of essays published in the *Journal of Biosciences* between 2004 and 2007 that approximately form the chapters of this book. In the reworking, these articles have been edited to allow cross-referencing, and the older material has been updated to account for more recent findings. Vogel admits to retreating from optics or acoustics and toward an abiding interest in the behavior of fluids and solids. What we have then are 12 chapters, loosely interrelated, covering topics in physical chemistry, fluid dynamics, the dynamic and static behavior of structures, and the solutions of living organisms to everyday physical problems.

In his earlier works, Vogel has shown a fondness for alliteration, double entendre, and puns, but in this

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book he is curiously restrained. One chapter, however, titled "Getting Up to Speed," is subtitled "Leaping, Launching and Lurching." This lovely chapter is about biological projectiles: spores, seeds, fleas, and even kangaroos. Here Vogel relates acceleration to the size of the projectile: Mulberry pollen is shot out with an acceleration of nearly one million times that of gravity (g), whereas a kangaroo achieves only 6.7 g of acceleration. He then goes on to discuss the limitations of muscle as a source of mechanical work and power, and the widespread use of elastic materials to store muscle energy in jumping insects, showing that these are far less regularly used by mammals. The real winners in the ballistics record book are plants and fungi, which eject seeds or spores by wonderful osmotic engines in reproduction-bound self-destructive devices, but these single-shot mechanisms are too diverse to detail here.

One area of interest to Vogel's mentor Schmidt Nielsen was the thermal relations of organisms in their environments. On this topic, not surprisingly, Vogel starts with a comparatively conventional look at the ways by which heat is transferred—some very familiar to biologists (and in everyday life), such as radiation and convection—but he moves on to surprising areas such as infrared radiation from seaweeds into the sky. He explores how animals can adjust their rates of heat transfer by balancing internal forced convection using the blood system with natural convection or conduction at the body surface. (A nice example is the seaweed-munching Galápagos iguana, which balances solar heating while on land with conductive and convective cooling while foraging underwater.)

On the topics of water and water-based biological fluids, such as sap or blood, the reader finds studies of the effects of ice crystals on cells and on biological antifreezes, as well as the effects of temperature and solutes such as salt on the amount of gas that dissolves in water. There is a delightful account of how water can be condensed from seemingly arid desert sand and how a similar process might be exploited by a desert-living tunnel spider. And then there is a discussion of cryptobiosis: Life without water as a trick for survival in one sort of extreme environment. I could go on, picking out more plums from a rich pie, but I shall leave the rest for the reader to find.

Glimpses of Creatures in Their Physical Worlds does not profess to have a "target"; rather, Vogel looks at a particular area of physics or mechanics and wonders (or is it wanders?) on paper whither it will lead. The wandering often goes in unexpected directions, such as the observation that it is rare to find gliding seeds that weigh less than one gram, or the trajectories of fungal spores, or that there are both mechanical and fluid-dynamic constraints on the height of trees.

Vogel also has a liking for dimensionless numbers. Some of these are familiar: the Reynolds number and its use in describing the relative importance of viscous and inertial effects in fluid dynamics; and the Froude number describing the relationhip between size, velocity, and the acceleration due to gravity in the walk-to-gallop transitions in quadrupeds. Others, such as the Péclet number, describing the relationship between velocity and distance on the rate of diffusion in a system, or the Grashof number, describing the intensity of free convection, are less familiar. I did sometimes find myself wondering about the importance of a particular number and seeking an everyday explanation of its relevance. And yet curious omissions exist, such as the Strouhal number, which describes the relationship between size, velocity, and the frequency of vortex shedding in, for example, fish swimming, but this is an area into which Vogel does not enter in this book.

The bibliography is commendable for three reasons: First, it covers 24 pages and lists some 500 references; second, it extends from the early 19th century (amusingly including the overture to Rossini's opera *William Tell*) up to 2008; and third—and I wish more authors did this—it provides the pages on which the reference is cited in the text. There is also a list of the symbols used in the text—vital both as a space saver and as a ready cross-reference.

Overall, I found *Glimpses of Creatures in Their Physical Worlds* to be rather less accessible than some of Vogel's earlier, and more popular, books. I think this is because of the welter of equations that require serious concentration and are sometimes unsupported by examples. As ever, Vogel is inspiring and his insights are remarkable—but this time it's harder work.

HENRY BENNET-CLARK

Henry Bennet-Clark (henry.bennet-clark@zoo.ox.ac.uk) is a reader emeritus in invertebrate zoology with the Department of Zoology at University of Oxford, United Kingdom.

LIFE AT ALTITUDE

The Biology of Alpine Habitats. Laszlo Nagy and Georg Grabherr. Oxford University Press. 2009. 376 pp. $125.00 hardback, $55.00 paperback.

This book, *The Biology of Alpine Habitats*, is the 14th in the series *The Biology of Habitats* (excluding four second editions), published by Oxford University Press with the goal of "providing an integrated overview of the design, physiology, and ecology of the biota, set in the context of the physical environment." The series is aimed mainly at senior undergraduates and graduates taking courses in ecology or environmental science, as well as interested professionals. The authors, Laszlo Nagy and Georg Grabherr, both of the Department of Conservation Biology of the University of Vienna,

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