I can think of few changes that I would make beyond correcting a few proofreading lapses (Linnaeus's great work was exactly a century after the date given) and minor errors. (Male stag beetles have sexually selected mandibles, not horns, and when will we ever stop hearing about the 'peacock's tail'? The historical contingency of evolution is exemplified by the variety of elongated display feathers among birds, which do include tail feathers in many other species, but also the flank feathers of *Paradisaea* birds of paradise, the secondary wing feathers of the great argus pheasant, head feathers in sage grouse and herons – and the back feathers, i.e. the train, of peacocks.) Coyne is clearly skeptical of most of evolutionary psychology while granting that some human universal characters might well be ancestral evolved traits, but I think one might make more allowance for the possible validity of hypotheses in this field (some of which do seem to make testable, and sometimes supported, predictions). Reassurances that evolutionary interpretations of human behavior are dubious will not allay fears of 'the beast within' if these interpretations prove to be well supported – and the empirical evidence Coyne presents, that we are not condemned by our genes to be unethical or immoral, should make such cautions unnecessary.

Why Evolution is True succeeds in being fully accessible to any reader who has even a vague idea of what DNA is. The publisher should issue an inexpensive paperback edition as soon as possible that should be stocked in every bookstore, sent to friends and relatives, and assigned as supplementary reading in introductory biology courses at both the high-school and university levels. It should also be widely translated. It is a book that needed to be written and needs to be read.

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Book Review

What can function tell us about mechanism?

Tinbergen's Legacy: Function and Mechanism in Behavioral Biology edited by Johan Bolhuis and Simon Verhulst. Cambridge University Press, 2009. £60.00/£24.99 hbk/pbk (262 pages) ISBN-13: 9780521874786/9780521697552

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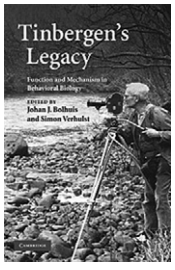

Tinbergen's Legacy comprises eight contributions to a symposium held at Leiden University in 2003 in anticipation of the 40th anniversary of the publication of Niko Tinbergen's classic essay *On the Aims and Methods of Ethology* [1], together with an introduction by Aubrey Manning and a facsimile reprint of Tinbergen's original paper. As anyone with even a passing familiarity with the literature of animal behavior must know, in his *Aims and Methods* article, Tinbergen discusses four questions that he treats as equally important aspects of the investigation of any behavior: What is its cause? What is its function? How does it develop? How did it evolve? For the better part of 40 years, Tinbergen's four questions have been taught in every introductory animal behavior course as the fundamental organizing principle of the field. Twenty years after publication of Tinbergen's classic paper, Marian Dawkins [2] correctly described the field of ethology as a four-legged beast with one leg, the functional one, considerably longer than any of the others. Appropriately, in *Tinbergen's Legacy*, the beast rests, as any self-respecting quadruped should, on legs of roughly equal length.

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As is often the case in a symposium volume, the authors' goals and the relative interest of individual chapters to any reader both vary. Still, anyone curious about either the current state or history of animal behavior will find much of value in this relatively slim volume. Essays range from Aubrey Manning 's insider's view of the history of animal behavior and Innes Cuthill's intriguing blend of history and philosophy in discussing behavioral ecology, to excellent reviews of cutting-edge research on causation, development and evolution by David Sherry, David Crews and Ton Groothius, and Michael Ryan.

A theme that recurs across most of the chapters concerns the appropriate use of information concerning the function of a behavior in the design and interpretation of studies of its development, causation and evolution. There are two quite contradictory positions held by the authors, both supported by their proponents with carefully selected quotes from Tinbergen's classic paper. Sherry, Crews and Groothius, and Ryan all argue that studies of the development, causation and evolution of behaviors should be, and are informed by, consideration of their functions. Indeed, it is hard to argue that the approach that these authors have used to produce such informative research programs is not heuristic. However, Johan Bolhuis and, to a lesser extent, Jerry Hogan writing with Bolhuis, emphasize potential

problems with depending upon information concerning function as a source of hypotheses about mechanisms of behavior.

Hogan and Bolhuis focus on logical and semantic inconsistencies in the use of the terms 'causation' and 'function', and 'proximal' and 'ultimate', and the confusion that can arise if the members of each pair are not treated as a distinct area of inquiry. Bolhuis' chapter provides a detailed critique of studies of correlations between: (i) hippocampal volume and food storing proclivity in crows (Corvidae) and titmice (Paridae); and (ii) the size of specific brain nuclei and song learning and production in birds. His analyses of published data lead him to conclude that there is little empirical support for the 'neuroecological hypothesis of a relationship between. . .brain regions and cognitive mechanisms.' Bolhuis then argues, as he has previously [3], that the use of functional and evolutionary principles in the study of behavioral mechanisms is often misleading and has provided wrong answers as to the neural mechanisms supporting specialization for caching and for song.

This is not the place to attempt to resolve controversies over data interpretation. However, both responses to Bolhuis' critiques [4,5], and recent further analysis of relevant data [6] provide considerably greater support for correlations between hippocampal volume and specialization for seed caching in birds than Bolhuis admits. Furthermore, and perhaps more important, if the neuroecological work described in this volume is exemplary of the approach Bolhuis is criticizing, then he appears to misinterpret the aims of such research. Bolhuis is right that functional research cannot provide causal answers, but it is not then obvious that those he criticizes ever thought that it would. Still, even if, as has been argued, Bolhuis' criticisms are not as devastating as he might wish, he does raise potentially important and interesting issues that give the volume a tension that it would otherwise lack.

In sum, I can warmly recommend *Tinbergen's Legacy* to anyone interested in either contemporary studies of animal behavior or their historical antecedents. It might also serve well as a thought-provoking focus for a graduate-level seminar.

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Book Review

Invasion biology deconstructed

Invasion Biology by Mark A. Davis, Oxford University Press, 2009, US $120.00/$55.00 hbk/pbk (244 pages) ISBN 978 0 19 921875 2/978 0 19 921876 9

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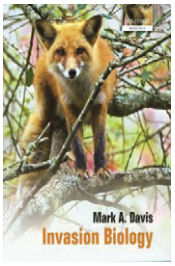

Charles Elton's 1958 book *The Ecology of Invasions by Animals and Plants* [1] is widely acknowledged as having kick-started the systematic scientific study of biological invasions. In the fifty years since Elton's book appeared, the scale and complexity of invasions has escalated to the point that few field ecologists can now avoid considering introduced species in their work, because they are so widespread and their impacts so pervasive. Invasion biology is now a major and rapidly growing subdiscipline of ecology with a growing research agenda [2]. Researchers interested in invasions now also have to battle to keep up with advances in the avalanche of relevant publications. Although several influential books on invasion biology have appeared recently (e.g. Ref. [3]), *Invasion Biology*, a new addition to the canon, from one of the most active and influential researchers in the field, is to be welcomed.

What sets this book apart from others on the study of biological invasions is that it provides not only an authoritative and readable account of the 'nuts and bolts' of the processes that mediate invasions, but also detailed and probing discussions on crucial philosophical underpinnings of attempts to elucidate and manage invasions. Around 60% of the text is devoted to the 'nuts and bolts' of invasions. Davis neatly summarizes key research results under the headings 'Dispersal', 'Establishment', 'Persistence and spread', 'Evolution', and 'Understanding and predicting invasions: an integrated approach'. These sections are lucid, drawing on well-chosen examples to present the best available synthesis of current understanding in the field. Principles are explained with reference to all major taxonomic groups, and with due acknowledgement to research from different parts of the world. Applying the same clear thinking that generated his fluctuating-

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