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Book Reviews

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Genes, Categories and Species, The Evolutionary and Cognitive Causes of the Species Problem. J. HEY. Oxford University Press. 2001. 217 pages. ISBN 0 19 514477 5. Price £34.95. (hardback).

The forward to this book, from John Maynard Smith, suggests that while, in general, we do not need further books on speciation, we need this one. This is because it considers not the question of what species really are, but rather urges us to think in new ways about our understanding of the evolution of biological diversity, and to make our use of the word ' species ', as a way of categorising that diversity, follow from this understanding. Indeed, Jody Hey takes an unusually thoughtful approach to the difficulties that evolutionary biologists have had with the species problem. Hey has himself made important experimental contributions elucidating patterns in gene trees in closely related species of Drosophila, and he brings to the task of reconsidering the idea of species a profound understanding of evolutionary theory. He considers the various concepts that have been put forward as what the word 'species' ought to mean, and their various shortcomings and domains of inapplicability. However, he rejects the idea that the solution to the species problem is simply one of finding a new simple definition which will fulfill all the goals of earlier failed definitions.

The problem, for Hey, is that our aim in producing a species definition is usually to produce the one which fits most closely with our psychological desire to categorise living things into discrete classes. Our ability to categorise living things has triggered a mindset which makes us think that all of the kinds of living organisms, such as dogs, lions and tigers, are real, indivisible, discrete, and non-overlapping entities. This habit of thought and language causes us to search for a species definition which allows biologists to group living things in ways which are the most congruent with our mental prototypes. For Hey, we should avoid this pitfall created for us by our language, and strive to describe species in ways more consistent with their evolutionary origins.

The approach taken is to consider that there exists real 'evolutionary groups', sharing genetic similarity but defined by competition, and sharpened by recombination (which allows the gene trees of different loci to come into linkage equilibrium within the evolutionary groups). However, there will be loci which don't fit, and populations that are hard to classify into evolutionary groups – the idea that these evolutionary groups constitute 'real species' will not, in itself, allow all problems of species classification to be solved. It will never be possible to produce unambiguous counts of the total number of species, for example, if species are to match these evolutionary groups.

This is undoubtedly a good approach. A new advantageous mutation in a thrush, for example, might be expected to replace completely the pre-existing wild-type allele in this species, but this substitution, and improvement in fitness, will not cause thrushes to replace blackbirds or robins, which compete with thrushes less than thrushes do with each other. The allelic substitution is bounded by the field of competition. Given this concept of an evolutionary group defined by a field of competition, clonal populations can, potentially, be classified into these groups as well. Furthermore, and this is a strength not a weakness, such a vision of the impact of competition may not be empirically true, and thus it suggests an experimental programme to find out how close to the truth it really is.

So there is very little in the book with which I disagree. However, I am not convinced that the species problem is as difficult as evolutionary biologists have made it seem, and I think that evolutionary biology has not been at its best when dealing with this issue. The essence of the 'species problem' is the fact that, while many different authorities have very different ideas as to what species are, there is no set of experiments or observations that can be imagined that can resolve which of these views is the right one. This being so, the 'species problem' is not a scientific problem at all, merely one about choosing and consistently applying a convention about how we use a word. So, we should settle on our favourite definition, use it, and get on with the science. If there are living things, like viruses, where our species concept doesn't work, then that's too bad – viruses don't have species, but we can still describe and categorise them. There is no scientific problem. Clearly, in the popular mind, species are real things – a lion is not a tiger. So there is a pragmatic problem of how scientists explain their discoveries of the nature of biodiversity to those who think that species are always real and unequivocal entities in the world. But this is a presentational problem, not a scientific one.

It is interesting to see a philosophical and psychological approach to the species problem. However, I do not believe that the concept of 'species' is a philosophically tough one to rank with 'time', 'knowledge', 'causality' and so on. For this reason, I didn't find the book to be a good read, and there are undoubtedly too many words chasing too few ideas. Also, I have misgivings about the wider impact of the overselling of the intractability of the species problem in the book. Evolutionary genetics finds itself in a competitive situation, for funding and exposure, with other areas of genetics. It is impossible to deny that in molecular, and particularly, in developmental, genetics, there has been real progress recently. We know much more about how genes control development than we did twenty years ago. Those developmental geneticists looking over the fence at the activity in evolutionary genetics might, with justification, be dismayed to see that the progress on our problems, such as speciation, has not been the finding of solutions to those problems, but rather the production of theories as to why we are so bad at finding the solutions.

JOHN BROOKFIELD
Institute of Genetics
University of Nottingham

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The Mathematical Theory of Selection, Recombination, and Mutation. By R. BÜRGER. J. Wiley & Sons, Ltd. 2000. 409 pages. ISBN 0-471-98653-4. Price £65.00. (hardback).

Genetics is the area of biology which has long attracted the attention of mathematicians, and indeed many fundamental topics of statistics were developed initially as a solution to problems in the study of inheritance, population genetics and evolution. Much of the theory developed by geneticists who lack formal mathematical training or depth is not rigorous, but nevertheless their findings considered important at the time have not usually been wrong. Researchers with a strong mathematical background have themselves made advances of importance in biology, although it has to be said that sometimes little more than polish has been provided. Reinhard Bürger has himself specialised in topics in quantitative genetics, particularly in maintenance of variation, and provided useful results.

This book divides, in effect, into two parts. The earlier and major portion deals formally and rigorously with topics in single and two locus theory, mainly for infinitely large populations; some of these areas are basically quite difficult. These include, for example, conditions for and frequencies at equilibrium in multi-allelic systems and Fisher's Fundamental Theorem of Natural Selection, which can be derived superficially quite simply, but is a minefield when pursued more deeply. For these topics the book is more likely to be useful for the mathematician interested in biology than vice versa.

When considering quantitative traits influenced by multiple loci, for example the amount of variation maintained under stabilising selection, the mathematics can soon become too complex even for someone of Bürger's ability. The book here provides a clear review of the conflicting models, notably the Kimura-Lande Gaussian model, which applies when mutation rates per locus are high, and Turelli's house-of-cards model, which applies at lower mutation rates, and is likely to be more appropriate. Here Bürger reviews information on the biology and adds both mathematical and simulation results of his own. I think this part of the book provides a nice review for quantitative geneticists, and a complement to the texts of, for example, Falconer & Mackay and Lynch & Walsh.

The writing is clear, and some of the more formal mathematical sections (which were quite beyond me) identified for bypassing. The work is indeed rigorous and compreshensive, and represents a major and significant piece of work.

WILLIAM G. HILL
Institute of Cell, Animal and Population Biology
The University of Edinburgh