of reactions to *The Origin of Species* to argue cogently against the popular idea that older scientists prefer the *status quo* whereas their younger colleagues are more innovative. He provides illuminating discussions of trends within contemporary systematics, taking those trends to illustrate some general processes that occur in the growth of science. This collection also includes an address "on human nature", celebrating the variability of species in general and our own species in particular; three defences of the thesis that species are individuals (of which Hull and Michael Ghiselin are the principal advocates); some essays on sociobiology which hew a characteristically ecumenical line; and some articles about the practice of the history of science.

Although his studies take him into numerous specialized fields, Hull's essays reveal a thorough command of his material. His writing is direct and clear, and he presents interesting and original ideas on a variety of topics. In some instances, he gives us refreshing doses of common sense. "In Defense of Presentism", for example, is a penetrating critique of some fashionable suggestions about the history of science. Recognizing the dangers of distorting the thought of earlier investigators, historians of science sometimes inveigh against any forms of "presentism" or "Whiggism", insisting that historical studies must eschew any categories that would not have been accepted by the historical actors. Hull argues forcefully that this position is both unmotivated and absurd. We can appreciate the danger that our current beliefs might distort historical understanding without yearning for histories that uncritically accept the beliefs of earlier generations. As Hull points out, the historian "has every right to believe that virgin births were no more common two thousand years ago than they are today" (page 217).

Not all of Hull's essays are equally successful. His central argument for the view that species are individuals rather than classes seems to depend on misunderstandings of the notion of a class. Classes (sets) are atemporal entities that do not change over time. How then, Hull asks rhetorically, could a species be a class? The answer is simple: we think of the evolution of species in terms of the differences in the distributions of properties at different temporal cross-sections. The atemporality of classes generates no sound argument for Hull's favoured conclusion, and, in consequence, no rationale for the views about the character of macroevolution that he and others have defended by appealing simply to metaphysics. Many practicing biologists, as well as philosophers, have found inspiration in the idea of the individuality of species. Other biologists and philosophers (including myself) see it as much ado

about very little.

The last two essays in the volume, reflections on human sociobiology and on the sociobiology debate, also seem less well argued. When first published, they struck an admirable tone of mediation: criticisms of sociobiology were to be elaborated, but they should not be allowed to throttle a research programme in its infancy. More than a decade later, the dialectic has unfolded and, in the absence of some rethinking and rewriting, Hull's irenicism is bound to seem flabby and dated.

In the end, however, it is churlish to

complain about a collection offering so many provocative and well-defended ideas about so many topics. Biologists, historians, sociologists and philosophers should be glad to have this convenient synopsis of the ideas of an influential thinker. Hull has done more than his bit to fashion a new stereotype of the philosopher of science, founded on a different trinity of traits: informed, incisive and interesting. □

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Watch the birdie

John R. Krebs

Ornithology. By Frank Gill. Freeman: 1990. Pp. 660. £29.95, \$49.95.

BIRDS impinge on our lives in many and diverse ways. Some people see them as a symbol of the beauty of nature, to be observed and conserved in their natural habitats (the Royal Society for Protection of Birds, I am told, has more paid-up members than either of the main political parties in Britain). Others enjoy their company as talking or singing household pets; as agile quarry viewed down the barrel of a shotgun; or as a convenient snack purveyed by Colonel Saunders. This last group will find little to interest

Kingdom), will find it contains much to inform and enjoy.

Roughly three-quarters of the book is about ecology and behaviour of birds, the rest being concerned with morphology, physiology and evolution. To test the book as a source of ornithological knowledge for students, I looked up the answers to four questions which I have been asked by students in the last year or so. I also compared Gill's answers with those given by the main rival texts: J. Faaborg's *Ornithology: an Ecological Approach* (Prentice Hall, 1988), and the fourth edition of J. C. Welty's and L. Baptista's *The Life of Birds* (Saunders College Publications, 1988).

Here are the questions and answers. (1) How do birds produce sounds? Greenewalt's (1968) theory of the internal tympaniform membranes as the sound source is

Nesting Boobies — a love affair in the Galapagos.

them in Gill's book, but others, as well as the undergraduates for whom it is primarily written (ornithology is still taught as a separate subject in North America although not in the United

Kingdom), simply but accurately summarized by Gill, although Nowicki's important (1987) result showing the effect of helium on the harmonic structure of sounds is not mentioned. Neither of the other two texts get

Oxford Scientific Films

as far as Greenewalt. (2) Why do bird sounds in different habitats have different characteristic time and frequency patterns? Gill presents the two main current hypotheses: sounds are designed by natural selection to overcome habitat-specific attenuation (Morton) or degradation (Wiley). The other two books mention only Morton's hypothesis. (3) Why do birds perform elaborate courtship displays? The accounts of both Welty and Baptista and of Faaborg start from the traditional view that courtship serves to "synchronise sexual arousal" or "maintain the pair bond". Gill, on the other hand, uses a more modern conceptual framework within which males and females are seen to have conflicting interests, so that much of courtship has to do with assessment of partner quality and fidelity. (4) Why do some gamebird populations show regular cyclic fluctuations? The red grouse is taken as a case study by Gill, and he summarizes the Watson-Moss view that cycles are driven by behavioural changes. The alternative view of Hudson, that the gut parasite *Trichostrongylus tenuis* causes the cycles, is not mentioned. But the other two books do not give worked examples and only make very general statements about possible causes of cycles such as food, predators and behaviour.

My test shows that Gill's book, although superficial in places, is more up-to-date and incisive than its rivals. It is also most attractively produced. I would recommend it as the preferred text for an ornithology class, unless it was essential to have the sections in the other two texts on "Birds and Man" — dealing with applied problems not covered as a separate issue by Gill.

Let me end by telling an historical anecdote. On page 9 of his introduction, Gill asserts that "Albert Szent-Georgy (*sic*) won a Nobel Prize for the elucidation of the Krebs cycle from studies of pigeon breast muscle". The crucial discovery for the cycle (conversion of oxaloacetate and pyruvate (via acetyl CoA) into citrate) was reported by H. A. Krebs (in a paper famously rejected by *Nature* on 14 June 1937). Szent-Györgyi discovered that several 4-carbon dicarboxylic acids are readily oxidized in suspensions of minced pigeon muscle and that these dicarboxylic acids can act 'catalytically' to accelerate the combustion of substances in the muscle suspension.

I remember once, as an undergraduate, hearing Szent-Györgyi in a lecture at Woods Hole claiming that the citric-acid cycle should have been named after him, not Krebs. I wonder if Frank Gill was in the same audience? □

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The science of queens

Donald H. Feener Jr, Diane W. Davidson and Jon Seger

The Ants. By Bert Hölldobler and Edward O. Wilson. *The Belknap Press of Harvard University Press*: 1990. Pp.732. \$65. Distributed in the United Kingdom by Springer-Verlag, £70.50.

INDIVIDUALLY, ants are small and unremarkable; collectively, they rule the terrestrial world. They live almost every-

field guide, and we hope that the authors will do this. (At more than 2.5 kilograms, *The Ants* is not portable.) Other chapters include extensive tables summarizing biogeographical distributions, regional faunistic studies, modes of colony formation, pheromone chemistry, and many other subjects. There is a glossary of several hundred terms, and some chapters have what amount to mini-glossaries of their own. The bibliography (65 pages) contains 3,000 references. We doubt that any major taxon has ever received such a thorough and synthetic review.

With uninhibited enthusiasm (and flashes of humour), Hölldobler and Wilson begin *The Ants* with brief accounts of

The Argentine ant.

where and eat almost everything. They make up only 0.1–1 per cent of all animal species but 10–25 per cent of the animal biomass in many places. Ants have pushed insect sociality to its limits in several different respects, and this is in large part the key to their ecological success. Yet they are hardly mentioned in many ecology textbooks, and "not one biologist in a hundred can describe the life cycle of any species". This state of relative neglect should soon end, because Bert Hölldobler and Edward Wilson have put most of myrmecology between covers.

The Ants is a stunningly attractive volume that belongs as much on the coffee table as it does on the lab bench. It contains nearly 1,000 illustrations, including 24 spectacular colour plates that vividly portray the lives of various species. (How many children will slowly turn the pages of this book, and years later take up the study of ants?) The 20 chapters are organized thematically, and they are written in a clear, accessible and engaging style. The chapter on classification is a book within a book; it includes anatomical drawings and definitions, a genus-level taxonomy, keys to the 11 subfamilies and the 292 currently recognized genera (50 pages), and habitus drawings of every genus (60 pages). With this extraordinary tool, even a novice will be able to identify any ant to genus; the chapter could be made into a splendid

the ecological and scientific importance of these and other social insects. Insiders will be thrilled, and even the most sceptical should be convinced that "the modern insect fauna has become predominantly social". In chapter 2, on classification and origins, the authors estimate that only about half of the world's ant species have been formally described. The vast majority of unknown species are confined to rapidly disappearing tropical rain forests — Wilson recently collected 42 species in 26 genera from a single tree in the Peruvian Amazon, for example. Although the taxonomy of ants is in better shape than that of many other insect groups, many phylogenetic relationships remain unclear, including those of the 11 subfamilies. These gaps in our understanding should soon yield to rigorous phylogenetic analyses applied to both morphological and molecular data.

Chapters 3 to 9 review what is known about colony life cycles and interactions among colony members; the topics include altruism and the origin of workers; differentiation and division of labour among worker castes; colony odor and kin recognition; communication; and colony homeostasis. Chapter 10, on foraging strategies, territory and population regulation, illustrates the authors' focus on general biological principles. In arguing for the importance of competition in ant communities, they draw on more different