Explaining the Peacock's Tail

Sexual Selection. Testing the Alternatives. J. W. BRADBURY and M. B. ANDERSSON, Eds. Wiley-Interscience, New York, 1987. xii, 308 pp., illus. $81.95. Dahlem Workshop Life Science Research Reports, vol. 39. From a workshop, Berlin, F.R.G., Aug. 1986.

In 1871 Darwin began a controversy that has not abated by suggesting that apparently maladaptive, sexually dimorphic traits, such as the peacock's "tail," have often evolved because they permitted their bearers to attract more mates than less well-endowed competitors. Regarded for many years as the least credible part of the theory of sexual selection, this idea has attracted renewed interest in the last 15 years with proliferation of field studies of social behavior and the development of formal theory on the origin and evolution of mating preferences for sexually selected traits. Vigorous debate has ensued over the merits of rival theories and the nature of the data needed to discriminate between them, raising wider issues of the degree to which social behavior is adaptive and the role of theory in evolutionary biology. In 1986, 48 researchers in the field met in Berlin to discuss the topic and to outline priorities for future research. This well-produced volume records their deliberations in a series of position papers and four group reports.

Perhaps the most complex and contentious issue in sexual selection theory is the role of female choice in the evolution of extravagant male courtship traits. It is the first topic considered, and its influence pervades the entire volume. Extreme sexual dimorphism is most obvious in species in which males provide their mates with neither resources nor assistance in parental care, but in such species females appear unlikely to gain direct benefits from mate choice. If female choice has caused the evolution of dimorphic traits, what forces have propelled it? One solution, proposed by Fisher, relies on a positive genetic correlation between preference and preferred male trait, set up through assortative mating. As a result of the correlation, the preference will evolve simply as a nonadaptive side effect of sexual selection on the male trait. A popular alternative hypothesis is that the preference is selected because chosen traits indicate genetically determined components of male viability that are transmitted to offspring.

Maynard Smith lucidly places these models of female choice within the full range of mechanisms of sexual selection, identifying theoretical problems that others take up. Fisher thought that preferences would originally be favored through the viability-indicator mechanism. For this to occur there must be heritable variation in total fitness among potential mates, but natural selection is expected to eliminate such variation. The genetic data relating to this question are carefully considered by Charlesworth, who concludes that recurrent mutation may maintain some additive genetic variation in fitness; whether it is sufficient to warrant female choice remains open. Kirkpatrick considers a range of alternative origins for mating preferences, including the idea that they arise simply as a consequence of sensory biases. Fisherian models have shown how subsequent evolution of trait and preference are strongly affected by genetic correlations between the preference and the chosen trait or indeed other characters, a theme explored by Kirkpatrick and Lande. Kirkpatrick also shows, in a new model, how the imposition of search costs on choosing females can constrain the broad range of evolutionary equilibria characteristic of Fisherian models to a single outcome.

Although genetic models of the Fisher process have greatly expanded our understanding of how sexual selection could operate, not all field workers are convinced that the peacock's tail is thereby explained. In this vein Andersson suggests that current models are primarily guides to thought rather than prescriptions for detailed empirical study. Borgia reminds us that the formal working out of a theory is no guarantee of its correctness and makes a plea for the study of plausible alternatives. The state of this debate is ably summarized in Heisler's group report, together with suggestions for distinguishing between alternative views. Among the main conclusions are the potential value of comparative studies in testing the past importance of particular mechanisms of selection and the need for genetical studies that examine critical assumptions of the different models in contemporary populations. One overriding impression, however, is that the similarities of Fisherian and viability-indicator models are at least as interesting as their differences. Moreover, the two mechanisms may operate together.

The remaining three sections offer a more varied menu, including discussion of the relative importance of female choice and male competition, the factors that constrain opportunities for sexual selection to occur and curb the elaboration of affected traits, and the nature of inferences that can be drawn from field studies that measure variation in reproductive success in natural populations. Many of the position papers cover familiar ground. Among the exceptions, Hammerstein and Parker explore, using game-theoretic models, the degree to which males and females respectively are expected to search for mates, yield in conflicts of interest over incestuous mating, and provide parental care. Their conclusions include the provocative suggestion that inbreeding avoidance is an unlikely cause of sex-biased breeding dispersal: were it the cause female dispersal would be more prevalent than is actually the case. Queller considers how sexual selection theory applies to flowering plants and finds that opportunities for mate choice differ in important ways from those available to animals. Halliday surveys data (mainly from insects and Amphibia) on physiological costs of male courtship and asks whether elaboration of courtship traits might be limited by physiological trade-offs rather than mortality costs. A recurrent theme of the group reports is the need for more data on all aspects of sexual selection. A lengthy shopping list of projects is provided for the aspiring researcher.

In keeping with the goal of the conference on which it is based, this book emphasizes conceptual issues and unsolved problems. Readers hoping for a tidy summary of all that is known about sexual selection may be disappointed. But for anyone who wants to know why Darwin's views still raise hackles after more than a century, as well as for those attempting to find out whether he was correct, it will be an essential reference.

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From Cabot to Shelton

The Cold Light of Dawn. A History of Canadian Astronomy. RICHARD A. JARRELL. University of Toronto Press, Toronto, 1988. xii, 251 pp. + plates. $35.

This history begins with explorer John Cabot's arrival in Newfoundland in 1497 and extends down to Ian Shelton's discovery of supernova 1987A in the Large Magellanic Cloud with the University of Toronto's

telescope at the Las Campanas Observatory in Chile. The book's scope includes navigators and observers, amateurs and professionals, teachers and researchers, students and observatory directors, optical and radio astronomy, observation and theory, people and places.

One main theme of the book is the gradual shift, over the last century and a half, of the center of action from English astronomers in Canada to Canadian astronomers with strong ties to the United States. A second theme is the shift from part-time practitioners to fully committed, professional astronomers, and from practical navigation and time-keeping to "pure" research on the nature of stars and the universe.

The book is well written. There are a few minor errors of fact (the United States entered World War I in 1917, not 1914; Andrew McKellar did his graduate work and earned his Ph.D. at Berkeley in physics, not at Lick Observatory or in astronomy), but in the main it is well researched, with copious references to original sources. The author has a good grasp of the whole field of astronomy, though a few of his explanations of observational results are somewhat lacking in focus. However, his description of J. S. Plaskett and J. A. Pearce's observational confirmation of the picture of differential galactic rotation, one of the great triumphs of Canadian astronomy, is particularly clear and vivid.

The Dominion Astrophysical Observatory and its 72-inch reflector with which Plaskett and Pearce did this work were conceived and brought into existence by Plaskett. He and his successor as its director, W. E. Harper, are described by Jarrell as straitlaced, hard-working perfectionists, near caricatures of Victorian, small-town Ontario Protestants. C. A. Chant, who created modern astronomical education in Canada at the Univerity of Toronto and set up its David Dunlap Observatory, was another. Not surprisingly, they forged close links with W. W. Campbell, the longtime director of the Lick Observatory, who shared all these attributes except that he had been born and raised in northern Ohio and educated in Michigan, less than a hundred miles from the Ontario border. Many of their younger associates and students, starting with R. K. Young and with Pearce (who died only this September at the age of 96), served part of their apprenticeships at Mount Hamilton, learning American research methods. All this is well described in *The Cold Light of Dawn*.

Canada has a small population, and its climate is not particularly well suited for astronomy. (Indeed, a third theme of the book, not directly stated by the author, is that its recent most conspicuous successes have come from its new observatories in Chile and Hawaii.) To date it has produced no Galileo, or closer to our own time no Henry Norris Russell or Edwin Hubble, though present work by Canadian astronomers with the Canada–France–Hawaii telescope is at the forefront of world observational research. Hence the book's main interest must be seen in its Canadian context, as only a part of the wider world of science. Overall it is a good book, whose single weakness is that it covers so wide a field that its author cannot explore the most important episodes in real depth. *The Cold Light of Dawn* should be read by Canadian scientists and historians of science, and by everyone with an interest in the history of science in Canada.

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"Visual meteor observers, National Research Council [of Canada], Metcalfe Road, c. 1950." [From *The Cold Light of Dawn*]

String Theory

Superstrings. A Theory of Everything? P. C. W. DAVIES and JULIAN BROWN, Eds. Cambridge University Press, New York, 1988. viii, 234 pp., illus. $39.50; paper, $10.95. Based on a BBC radio broadcast.

In the preface, Davies and Brown state that the intention of their book is to "give both physicists and interested non-physicists an insight into the essential ideas of string theory." They go on to say that they hope "the book offers a useful glimpse of how leading physicists talk and argue about a subject of contemporary importance." These are remarkable aspirations for a relatively short book that avoids using any mathematics or too much technical jargon. What is more remarkable is that the effort succeeds. *Superstrings: A Theory of Everything?* does present the essential ideas of string theory in a manner that is enjoyable for the expert and easily accessible for anyone else. More important, the book contains a series of interviews about string theory with some of the world's leading theoretical physicists. These physicists were asked to discuss the reasons for their optimism, or pessimism, about the role of superstrings as a unified theory of nature. Their answers are profound, sometimes electrifying, and offer a rare and important glimpse of the differing philosophies that guide some of the best scientific minds. There is controversy here, and it is fascinating.

The book divides naturally into two parts. It begins with an introduction that discusses, in a logical order, most of the important topics in theoretical physics that must be contained in a theory of everything. To say the least, this is not easy. A theory of everything must encompass special relativ-