An Evolutionary Question

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sistent misfortunes such as the unintentional use of the same symbols for paratenial and pretectal nuclei, the latter receiving short shrift as well as confusing and inappropriate designation, but most of the illustrative material is well chosen and clearly explained.

There are a few other items of minor concern, such as failing to refer to some original contributions, but in general such failings can be forgiven because the author's own work has usually been superior to and better illustrated than that of others and the overall level of scholarship in the book is exceptionally high. Even a revisionist history of the posterior group (now a "complex") will serve as a stimulus to work on this subject, but some of the generalizations seem a bit broad. For example, Jones suggests that the spinothalamic tract terminations overlap the cerebellar and medial lemniscus projections and do not stray outside these borders, thereby dismissing the evidence of a more dense medial projection to nucleus submedius. But such oversimplifications, intended to establish general principles, are rare in this insightful and critical survey of the thalamic literature.

A comprehensive work on so expansive a subject cannot cover all bases with equal success. Discussion of the electrophysiological literature on such subjects as inhibition and joint efferent representation might evoke some serious debate, and there is obviously room for further scholarly accounts of the physiological literature or of the vast confusion concerning the nature of "thalamic pain." That said, I have no doubt that the book will stand as one of the great monographs on neuroanatomy of the 20th century. We are indebted to Jones for a superlative achievement in producing a huge reference work that is a joy to read for both its style and its provocative content. The illustrative material sets a standard of excellence that will be hard to match.

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Sexual Selection and Animal Genitalia. WILLIAM G. EBERHARD. Harvard University Press, Cambridge, MA, 1985. xii, 244 pp., illus. $25.

Why are animal genitalia, especially male intromittent organs, so extravagantly variable among species and why do they apparently evolve so rapidly? William Eberhard poses this conundrum and takes a major step toward solving it in *Sexual Selection and Animal Genitalia.*

So inclusive were the original insights of Charles Darwin that it is unusual for modern students of organic evolution to discover genuinely novel applications of sexual selection theory. The relations of epigamic selection and sperm competition to the structure of animal genitalia represent rare exceptions and thus will be a topic of considerable fascination among evolutionary biologists.

Insect systematists, especially, have long recognized the incredible diversity of male genitalia. They have been delighted to find genitalic distinctions among closely related congeners that permit easy taxonomic diagnosis, often in the absence of other useful characters. Taxonomists have typically accepted this gift of morphological diversity with gratitude for its utility in their work but with little thought as to its ultimate cause.

None of the several theories previously put forth to explain the evolutionary lability of male genitalia has been rigorously tested, nor has any been received with such enthusiasm. Hence there is an obvious need for the present work.

Eberhard has meticulously researched and fully conceptualized the extent of the problem. Using the literature (primarily taxonomic) as a data base, he has designed keen tests of the old hypotheses and of his new one. Remarkably, he succeeds in communicating what clearly represents many years of work in less than 200 pages of highly readable, well-illustrated text. He has accomplished this by deft organization, uncluttered prose, and the extensive use of tables to present data summaries complete with all the relevant literature citations.

The book begins with a review of the problem and a survey of taxa in which fertilization is internal and genitalia have evolved rapidly and divergently. These are contrasted with groups with external fertilization, whose genitalia have remained unchanged through time and speciation events.

The illustrations of insect, mammalian, and reptilian genitalia in chapter 1 are truly amazing and should certainly capture the imagination of most readers. Eberhard's book later mentions, among other sexual oddities, hypodermic insemination of certain insects, disposable genitalia, amorous and exploding sperm packets, multipenised flatworms, and chondrichthian contraceptive douches.

Three chapters analyze existing hypotheses including, "lock and key," "genitalic recognition," pleiotropism, and intersexual mechanical "conflict of interest." The author explores the logic of these theses and tests the predictions each would lead to. For example, island animals and parasites are categories presumably transparent to selection for mechanical isolating mechanisms, hence animals in these categories should have relatively uniform genitalia if elaborations are evolved by selection for species isolation. Using this and other, more sophisticated challenges, Eberhard ultimately and convincingly brings the reader to his conclusion that none of the previous hypotheses provides a general explanation.

Chapters 5 and 6 put forth a new hypothesis that sexual selection is the most likely explanation for male genitalic extravagance. Eberhard argues that in addition to transferring sperm, male genitalia function as "internal courtship" and intrasexual competitive devices to insure that the organ's owner's sperm will have a high probability of being used to fertilize the female's eggs.

Subsequent chapters expand the new hypothesis and provide further tests of its predictions. These include female discrimination after genital contact, frequency of remating by females, and the function of male genitalia in the stimulation of females. The penultimate chapter entitled "Specialized nongenitalic male structures," examines an important validation by analogy. If male genitalia have evolved primarily by female choice as a consequence of the stimulation they provide, then nongenitalic male structures that have an intersexual tactile function in courtship should be highly variable as well. The hypothesis is validated. The book concludes with a useful summary chapter.

Woven through the fabric of this treatise is a colorful historical thread that tracks the question, How could sexual selection have been so long ignored as an explanation for ornate genitalia? Eberhard observes that if Darwin had worked on beetles rather than barnacles he likely would have included genitalic elaboration in his listing of the products of sexual selection. Eberhard also notes that the historical pervasiveness of androcentricism in the biology of sex may well have obscured the truth.

The book is a study in academic honesty. Eberhard criticizes his own hypotheses in the course of developing them and presents and analyzes alternative hypotheses whenever appropriate. He also points out occasional deficiencies in the data sets that are used. It is a credit to his scholarship and writing skill that the book's integrity is achieved without tedium for the reader.

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