meaning of differential mortality by sex is neglected. Here and there bizarre statements appear—for example, "Where no biparental family exists, the female is just as well off being fertilized by one male as another" (p. 153).

The eighth chapter discusses social theory. Contentious and negative throughout, it distinguishes itself by a sustained and misguided attack on the kinship theory of W. D. Hamilton. The final chapter gives some parting thoughts on humans. We learn, for example, that "any learning that goes on during play is quite incidental" (p. 259). And the book closes by stating, "That the brain is destitute of purpose does not imply that it cannot be used" (p. 263).

Throughout the book, Ghiselin's evolutionary arguments are presented in a casual manner, bordering on the sloppy. From this book the student will learn little about the logic of evolutionary theory or about the way in which scientific evidence should be organized. This weakness can be illustrated by the treatment of three key topics that recur through the book.

1) *Kinship theory*. The best Ghiselin can say of Hamilton's kinship theory is that "something appears fallacious about many of the explanations cast in such language" (p. 137). He goes on to ask rhetorical questions. "Would we say that a sperm cell benefits from being small, since it thereby allows the existence of more individuals like it?" (Under certain conditions, yes.) "If a worker bee sacrifices herself in behalf of bees with similar DNA, should we not argue that cells that die in forming hair are doing the same thing?" (Not exactly, because cells within a body are identically related whereas bees within a hive are not.) "Where a society or an organism constitutes an integrated whole, which reproduces as a unit, such reasoning [that is, kinship theory] is both superfluous and misleading." (Quite the contrary; only a society of identically related individuals is expected to reproduce as an "integrated whole"; in all other societies, conflict and disagreement are expected—even if only one individual per society reproduces.) Ghiselin's main attack is reserved for the application of kinship theory to the social insects, a singularly unwise choice. Because in his original paper Hamilton made several mistakes in calculating degrees of relatedness for haplodiploid species, Ghiselin claims that such degrees of relatedness depend on "arbitrary decisions as to how one slices the metaphysical pie" (p. 228). This is nonsense. Hamilton's errors were corrected by himself and others, and by reference to a nonarbitrary criterion built into the original theory. Most of Ghiselin's other objections evaporate on inspection, and his entire attack is a case of substituting criticism for understanding.

2) *The meaning of sex*. Ghiselin argues (I believe correctly) that natural selection favors sexual reproduction because individuals with genetically variable offspring out-reproduce those without. But he does not mention J. Maynard Smith's observation that sexual reproduction has an immediate 50 percent selective cost (due to meiosis) in all species in which males invest little or nothing in their offspring. Understanding this cost is vital to understanding sexual reproduction. For one thing, it means that the advantage of genetic variability must be very high in almost every generation. This, in turn, implies that the correlation between what is genetically ideal in one generation and what is genetically ideal in the next must be very low. These and other implications have been developed by G. C. Williams (most recently in *Sex and Evolution*, Princeton University Press, in press).

3) *The concept of parental manipulation*. That parents might mold their offspring in the interest of themselves rather than of the offspring is an idea that is not new with Ghiselin. Like some others, he believes that this idea will explain such phenomena as sterile castes in the social insects. The problem is that offspring are expected to resist such molding, and the resulting conflict requires kinship theory for its analysis (because parent and offspring are related). An instructive example of Ghiselin's difficulties is his suggestion that sex-linked mimicry in butterflies (where females are mimetic and males cryptic) can be explained as a maternal device to reduce predation on daughters (the less frequent the mimics, the less intense the predation on them). But how would a mother force her sons to be nonmimetic? Assume that a non–sex-linked mutation for mimicry occurs in a population. Is Ghiselin imagining that the mother can make sure that this allele does not get passed on to her sons? This would be an extraordinary ability, requiring the capacity to spot a mimicry allele on whatever chromosome it appeared on and to suppress its reproduction except where it was appropriately sex-linked. These and other difficulties never surface because Ghiselin employs an imprecise, nongenetical language. Although Ghiselin mentions the hypothesis that female choice has maintained male crypticity, he dismisses it without referring to the striking fact that, in general, butterflies with visual courtship cues show sex-linked mimicry and butterflies with olfactory cues do not. This omission is especially ironic because female preference for cryptic males is the only plausible mechanism by which a female could influence the percentage of her sons who are mimetic.

One final feature of this book, its unremitting negative tone, deserves comment. Ghiselin cannot resist criticizing others. Indeed, he is as happy attacking a footnote or a sentence fragment as he is attacking an entire discipline, and his book reads like a compendium of marginal comments on the work of others. In compiling these criticisms, he is certainly no respecter of persons: the mighty and the meek, the rigorous and the befuddled, the living and the dead all must taste the terrible justice of Ghiselin's swift sword. Mayr is cut to pieces for some unwise comments on seals, Wynne-Edwards is flayed on page after page, Lorenz's musings on aggression engender several pages of criticism, Guthrie is chided for publishing a paper lacking references prior to 1937, primatologists are lined up en masse and dispatched, and the embryologist Driesch is resurrected from the turn of the century and given a good drubbing. One could go on and on. The best that can be said for this performance is that Ghiselin shows a certain fascination and talent for ferreting out the errors of others.

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Anatomy in Action

Biomechanics. An Approach to Vertebrate Biology. CARL GANS. Lippincott, Philadelphia, 1974. x, 262 pp., illus. Cloth, $12.50; paper, $5.95.

As the subtitle of this book suggests, biomechanics is less a discipline with a subject matter of its own than a style of approaching comparative and functional anatomy through the principles of elementary physics. Instead of writing yet another elementary physics textbook using biological examples, Gans

has given us a handsomely illustrated demonstration of how he and other 20th-century herpetologists have relied on physical principles in seeking explanations of feeding, locomotor, and respiratory adaptations of amphibians and reptiles.

Gans restricts himself to four topics: egg eating in snakes, locomotion in snakes and other limbless vertebrates, burrowing adaptations in the amphisbaenians (a group of mostly limbless Squamata traditionally classified as lizards), and respiration in frogs. Superimposed on these four sections is a sequence of short expositions of basic physical principles, set off in boxes from the text but topically related to it. Thus, an introductory description of egg ingestion is used as an occasion for a boxed introduction to vector addition, illustrated by the forces that a snake's teeth exert on the egg's surface; a description of vertebral specializations for puncturing ingested eggs prompts a boxed disquisition on strength of materials; and so on. Sometimes the highly simplified treatments that result are not very happy from either a mechanical or a biological standpoint. The analysis of egg-biting neglects the frictional forces and cranial kinematics that characterize the real situation and so winds up giving the mistaken impression that forces exerted against a surface are always normal to it. A later analysis of a fingertip resting on a ledge, used to introduce concepts of couples and moments, is almost incomprehensible because some forces have been diagrammed as vectors and others as torques (and others not at all) and the distal interphalangeal joint has been treated as if it were immobile.

So, despite the title, this is not a book to go to for an introduction to vector addition or beam theory. What it does provide is an excellent introduction to the way in which a first-rate functional morphologist tries to figure out how animals do the things they do and why they are constructed the way they are. Gans tries to articulate some general principles of functional morphology in an introductory chapter condensed from another book in progress, but he need not have bothered; the care, clarity, and honesty with which he builds up the case for each of his interpretations of reptile morphology and the obvious pleasure he takes in defining unanswered questions communicate these principles much more impressively.

The longest and most fascinating section of the book is the analysis of burrowing in amphisbaenians. Four modal head shapes among amphisbaenians are described. By the end of the chapter, Gans's biomechanical analysis of anatomical and behavioral data has established that the most common head shape is associated with a tunneling mechanism in which soil is displaced by use of the head and trunk as a ramming piston sliding back and forth within a looser sleeve of scales so that friction is in effect eliminated during the acceleration of the piston. The other three head shapes correspond to burrowing patterns in which the head is rotated back and forth around one of its three principal axes. Gans's path to these conclusions takes him through expositions of moisture balance and energetics in subterranean animals, growth mechanisms and biomechanics of bone, pinnateness and length-tension relationships in muscle, deformed-coordinates analysis, the mechanical properties of soils, predatory behavior, the mechanics of cranial sutures, masticatory stresses in vertebrate skulls, and cochlear microphonics. These and other diverse themes are brought together into an ingenious set of postulated relationships between digging behavior, cranial shapes, auditory mechanisms, prey detection, and vertical and horizontal distribution in the Amphisbaenia. In the process, Gans draws some unobtrusive morals concerning the opportunistic nature of evolution and the folly of taking any animal as a typological representative of any of the groups it belongs to. Here and elsewhere, the book is both exciting and chastening. It is well worth the price of admission for any student of evolutionary morphology.

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Insect Endocrinology

Insect Hormones and Bioanalogues. K. SLÁMA, M. ROMAŇUK, and F. ŠORM. Springer-Verlag, New York, 1974. x, 478 pp., illus. $45.90.

Until publication of *Insect Hormones and Bioanalogues*, collaborations between biologists and chemists on this subject had resulted in mere anthologies, disjointed in theme and perspective. Sláma, Romaňuk, and Šorm have at last produced a comprehensive monograph to which researchers in the natural sciences at large, as well as specialists in insect endocrinology, can turn with relief. More than 20 years of research are integrated into 470 pages of text.

A pioneer in insect endocrinology, Sláma appears to have masterminded the project, since two thirds of the book is under his authorship, including surveys of insect neurosecretory mechanisms and general endocrinology. Romaňuk and Šorm review the chemistry of juvenile hormones, ecdysones, and many bioanalogues and offer in detail the published synthetic routes for their preparation. Extensive tables and bibliographies support each chapter and are characteristic of the tone of the book, which is documentative, rather than evaluative.

The description of insect endocrine anatomy and morphology is worthy of special notice, even though these topics have been covered by other recent publications; and readers will find the chapters on hormone physiology and bioassay evaluation to be equally instructive.

Yet, despite its significant merits as a repository of information, *Insect Hormones and Bioanalogues* must be cited also for its perhaps unavoidable shortcomings. For example, sections pertaining to endocrinology gloss over the behavioral and ethological implications of insect neuroendocrine functions, which are of pressing interest to insect physiologists and population biologists alike. More extensive coverage of the molecular and gross genetic foundations of insect endocrine action would also have been welcome.

Moreover, the presentations of developments in the study of hormone biosynthesis, distribution, metabolism, and mode of action are largely out of date. A similar criticism can be leveled at the sections on hormone structure-activity correlations for failing to focus on the alkyl 2,4-dodecadienoates—so-called "Entocons" introduced by Zoecon Corporation—novel bioanalogues that have shed more light on the practicability of insect control with hormones than any other set of analogues studied in the last 10 years.

This is a commendable book, in short, if it is approached by discerning readers as a guide to classical work in insect endocrinology or as an annotated glossary of the many obsolete bioanalogues prepared in the still unresolved quest for "third generation pesticides."

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