Violence Against Young

Infanticide. Comparative and Evolutionary Perspectives. GLENN HAUSFATER and SARAH BLAFFER HRDY, Eds. Aldine, New York, 1984. xl, 598 pp., illus. $34.95. From a conference, Ithaca, N.Y., 1982.

Prior to pupation, the larvae of some species of tree–hole-dwelling mosquitoes eat all the smaller larvae occupying the same hole in order to prevent themselves being eaten by those larvae on entering the quiescent pupal stage. Bluegill sunfish fathers caring for a small clutch of eggs frequently consume the eggs and then seek opportunities to sire larger broods. Female poison-arrow frogs crush the eggs being brooded by males for other females, thereby freeing the males to care for their own eggs. The first-hatched, and therefore older and larger, chick in a black eagle nest repeatedly attacks its newly hatched sibling, preventing it from feeding and ensuring its death. Male house mice (CF-1 strain) rarely kill neonates between 12 and 50 days after copulating with a female, whereas they often do before and after this period. As a result of harassment by the dominant female, subordinate mother brown hyenas are unable to care for their cubs, and they suckle the dominant female's litter following the death of their own young. When a male red howler monkey replaces the current dominant male in a troop, frequently he attacks and kills infants and then mates with the mothers when they resume estrus. Ayoreo mothers less than 25 years old frequently bury newborn infants when they know or suspect their social relationship with the father is unstable. Such is the rich diversity of material covered in this book, a product of a Wenner-Gren Foundation conference

The survey of infanticide provided in the 25 chapters and four sectional introductions in this volume amply demonstrates that infanticide is neither a rare nor an aberrant behavior. It is also not a unitary phenomenon across taxonomic groups; depending on the species, death of immature conspecifics can be caused by parents, other kin, or non-kin, by males or females, by adults or other immatures, and it may or may not involve consumption of the victim. Furthermore, death can be either the direct or the indirect result of overt aggression or may be caused by neglect. Whereas the sex of the perpetrator is highly predictable in many species, the sex of the victim is usually predictable only in some human societies. Despite the taxonomic variety in expression of infanticide, this book rests upon a unitary concept for interpreting and understanding the causes and consequences of infanticide, namely that individuals responsible for infanticide, on average, are behaving in a manner that increases their individual survival and reproductive success.

The book is eloquent testimony to the invigorating effect that Hrdy's (*Ethol. Sociobiol.* **1**, 13 [1979]) classification of infanticide according to natural selectionist principles has had on the study of a phenomenon that previously had been primarily considered as the pathological consequence of overcrowding or other disturbing influences. Thus most of the 41 authors contributing to the book consider ultimate explanations for infanticide in terms of (i) exploitation of the immature as a food source, (ii) sexual selection that increases reproductive opportunities by eliminating the dependent offspring of a prospective mate, (iii) parental manipulation that maximizes lifetime reproductive success by selective elimination of offspring, and (iv) removal of a potential competitor for resources. These explanatory hypotheses for infanticide permit specific predictions as to the age, sex, and social status of the killer, the degree of genetic relatedness between infant and killer, and the benefits that accrue to the killer. Thus, under the sexual selection hypothesis, primate perpetrators of infanticide are expected to be adult males that have recently changed social or breeding status; such a male should rarely kill his own offspring, and he should usually gain rapid sexual access to the mother of the killed infant such that, on average, he will sire more offspring during his lifetime than if he had not killed infants. A second set of hypotheses can be constructed concerning counterstrategies of females to prevent or reduce infanticidal loss of their offspring.

Although Hrdy's ideas on the adaptive significance of infanticidal behavior form the framework for the book, they are not unquestioningly accepted. In the opinion of Boggess, the adaptive value of killing infants as a way of increasing reproductive opportunities has not yet been demonstrated for Hanuman langurs, the species that inspired Hrdy's development of the sexual selection hypothesis. Rebuttals to Boggess's chapter by Sugiyama and by Hrdy indicate the sensitivity of the issue and reveal the differences and biases in interpretation that occur even among qualified and dedicated researchers. One aspect of the dispute about the significance of infanticide in langurs arises from differing perceptions as to whether the sexual selection hypothesis requires that males always or only "on average" behave in a manner consistent with predictions of the hypothesis. A larger aspect of the dispute concerns the types of evidence admissible for establishing that infanticide has occurred and for establishing that males gain reproductive benefits. Must the death actually be witnessed, or can strong circumstantial evidence be accepted? Must the interbirth interval be known for each female, or can averages be used? The chapter by Crockett and Sekulic demonstrates the role that appropriate statistical analysis of demographic data can play in establishing the correlation between male take-over of a troop and infant mortality even if direct observations of infanticide are few. The chapter by Vogel and Loch demonstrates the value of longitudinal studies for correct assessment of critical demographic parameters not available from cross-sectional studies. As a result of such longitudinal studies, Hausfater has refined his calculations for the expected reproductive success of infanticidal and noninfanticidal males.

Surprisingly, not all authors define what they mean by infanticide. Some give general definitions, such as "the killing of conspecific young," which leaves to the reader what the author intends as the lower and upper age limits of "young" and whether only attacks that are immediately fatal to the young qualify. Others address the difficulties of defining infanticide in various taxonomic groups. Hayssen places weaning as the upper age limit for infanticide in mammals, whereas Hrdy and Hausfater, Charnov, Fossey, and Packer and Pusey propose termination of dependence on parents as the critical factor. Brooks, however, considers sexual maturity the upper age limit for infanticide. Weaning and dependence on parents are meaningless concepts in the case of the many species of invertebrates and lower vertebrates that lack parental care. Simon

uses "propagule mortality" to refer to the deaths of amphibian eggs and larvae, and Dominey and Blumer, noting that killing of eggs, larvae, and juveniles in fish is always accompanied by consumption, use "cannibalism" in preference to "infanticide." Dickemann proposes that, since the term "infanticide" is imbued with Western thought and societal values, "pedicide" may be a more biologically meaningful and broadly useful term. As with debates over such terms as "cuckoldry" and "rape," perhaps the essential issue is not what term is used but the need for researchers to define in detail what they mean by it and what evidence they consider imperative for establishing its occurrence.

The taxonomic groups receiving the most detailed treatment in this volume are rodents and primates. For rodents, field evidence of infanticide is sparse, in part because unweaned young are rarely seen and killers are likely to be quick and cryptic in their action. However, extensive laboratory data focusing on the effects of age, sex, strain, social status, reproductive status, copulatory experience, hormonal levels, and intrauterine environment for species such as house mice and Mongolian gerbils are reported in the five chapters covering rodents. All nine chapters on nonhuman primates discuss field evidence for infanticide, albeit circumstantial in many instances. Thus, even though primate infants are visible to observers from birth and infanticidal males appear not to be especially surreptitious in their behavior, observers rarely witness a complete infanticidal event. Human infanticide can also be difficult to document even in societies in which the behavior is not legally proscribed; authors of the four chapters on humans indicate how statistical evidence, such as sex differentials in mortality, provide an indirect indication of the occurrence of infanticide.

This book provides a valuable review of the evidence and ultimate explanations for infanticide across a spectrum of taxonomic groups. Two matters that I consider needed more treatment are the potential detrimental effects on lifetime reproductive success for males that kill female infants that might be future mates and the adaptive significance of female mammals' terminating investment in their own neonates by means of infanticide. No doubt other readers will find matters of interest to them that are neglected. However, overall such omissions are small compared with the wealth of information and ideas contained in the book. I consider this book essential reading for behavioral ecologists, sociologists, psychologists, demographers, and anthropologists interested in the evolutionary origins and proximate causation of infanticide in animals, including humans. It will enrich the reader's understanding of the types of infanticide that occur across a range of taxonomic groups and the contexts in which infanticide occurs; most of all it should convince even the most doubtful that, in most instances, infanticide is a natural behavior that can be interpreted in the context of modern evolutionary theory.

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De revolutionibus Analyzed

Mathematical Astronomy in Copernicus's De Revolutionibus. N. M. SWERDLOW and O. NEUGEBAUER. Springer-Verlag, New York, 1984. In two volumes. xxiv, 711 pp., illus. $78. Studies in the History of Mathematics and Physical Sciences, vol. 10.

The great work from which historians date the beginning of modern science, Copernicus's *De revolutionibus*, has been republished six times in its original Latin and translated more times than that into at least five modern languages. Yet for all this attention, nothing has been produced that can be termed a critical edition, or even a satisfactory translation, because none of the enterprises has been based upon the detailed technical understanding and extensive recomputation necessarily involved in comparing *De revolutionibus* with its great predecessor, Ptolemy's *Almagest*. Years ago, long before the appearance of the spate of new editions and translations in connection with the 500th anniversary of the birth of Copernicus in 1973, Otto Neugebauer envisioned an extensive commentary on Copernicus, as the final phase of a study of the entire tradition of Greek astronomy. The project proved too ambitious even for the venerable Neugebauer, however, and it has only now been completed by one of his disciples. The result is some 400 pages of analysis, accompanied by well over 200 diagrams and some 20 graphs, covering every aspect of Copernicus's mathematical astronomy.

This book is not for tyros. It is not that either the mathematics or the astronomy is severe; in fact, the closest I can come to criticizing Swerdlow's study is to express the opinion that many readers will wish for analytical expressions of some of the interminable geometry. But the historical discussion has to assume some background and sophistication in order to be useful to the professionals to whom it is directed, and most nonprofessionals will, accordingly, find a fair number of bewildering allusions and even apparent gaps in the presentation. For those who persevere, however, Swerdlow has a number of interesting general points to make, amid the mass of detail of individual calculations. What all of these points convey, in various ways, is that science was no easier to do in the 16th century than it is now. If the rules for doing science were so much looser as to allow Copernicus to indulge in shortcuts that will be viewed variously as tragic or comical, the methods available for coping with the task "legitimately" were correspondingly feebler. Four passages from Swerdlow's introductory summary should suffice to illustrate the problems:

> This [procedure] would be difficult enough if the parameters were correct, but mostly they were not, resulting as they did from very sensitive derivations from less-than-accurate observations [p. 74].
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> Nevertheless, it is one of the most confusing sections of *De revolutionibus*, containing many errors and internal contradictions, due to an inconsistent revision of an originally flawed exposition [p. 75].
>
> The agreement between the observation and computation comes out perfectly, but only because Copernicus first altered the time of the observation by 40^m and the longitude of the star by $10'$ [p. 76].
>
> . . . the analysis required to discover these consequences was very difficult and required observations of a sort that it never even occurred to Copernicus to make [p. 77].

Inevitably, a commentary such as this is Monday morning quarterbacking. Yet Swerdlow never allows the reader to forget that Copernicus was not always even trying to do as much as modern readers might presume he was and that even what he was trying to do was very difficult. And, though Swerdlow's analysis is probably more pointed than what most historians of science indulge in, it is probably gentler than most people without historical training will find comfortable. Most controversial for scientists will probably be the fundamental chain of assumption underlying the analysis: (i) Copernicus truly seems to have assumed (more or less correctly) that Ptolemy's models were mathematically correct representations of the phenomena, but physically impossible ones; so (ii) all he (Copernicus) had to do was find physically reasonable models (without equants) that were mathematically equivalent to Ptolemy's; therefore (iii)