Book Reviews

Wild Canids

Coyotes. Biology, Behavior, and Management. MARC BEKOFF, Ed. Academic Press, New York, 1978. xx, 384 pp., illus. $34.50.

Wolf and Man. Evolution in Parallel. ROBERTA L. HALL and HENRY S. SHARP, Eds. Academic Press, New York, 1978. xiv, 210 pp., illus. $19.50.

Despite popular interest and considerable research effort, much of the biology of both wolves and coyotes remains unknown. In particular, detailed information on the social dynamics of wild populations is not available. We are ignorant of such basic parameters as the role of males in raising pups, the degree to which females may cooperate in breeding, the genetic relationships between members of social groups, and whether sons are more likely than daughters to breed in or close to their parents' territory. The two books under review take different approaches to dealing with the limited information. The book on coyotes summarizes data that do exist, whereas *Wolf and Man* presents a collection of elegant theories without many data to substantiate them.

Coyotes is at its best in those chapters that draw together widely dispersed information; the reviews of parasites and diseases, reproduction, and livestock damage by coyotes, which include large summary tables, are excellent. There are good chapters covering taxonomy, communication, behavioral development, and research on other canids as well as recent ecological studies in the Southwest, Minnesota, Iowa, and New England. The contribution by Camenzind on the coyotes of the National Elk Refuge in Wyoming is of particular interest because it reports the results of the first study in which individual coyote groups were recognized and followed over time. The final three chapters cover, with scrupulous fairness, the emotive issue of coyote damage and control: one article is biased slightly toward a conservationist outlook; one reflects more of a stockman's approach; and the third, a review of computer simulations of coyote populations, can remain aloof. Both the authors and the editor can be complimented on the consistently high standards of clarity and thoroughness maintained in the book.

Wolf and Man is a volume edited by two anthropologists who emphasize the useful cross-fertilization that is possible between biology and anthropology. The book has three sections. The first gives the most extensive treatment to date of "the carnivore analogy." This is the idea that the forces molding human social organization may be illuminated as clearly by studying social carnivores such as wolves, which are ecologically similar to our ancestors, as by studying our phylogenetic relatives among the primates. The most interesting chapter compares the social organization of the Chipewyan people and that of wolves in an area of Alaska where the two populations extensively hunt the same population of caribou. Little is known about the wolves, but it is in dealing with those aspects of social behavior about which the least is known that biologists and anthropologists generally have the most to gain by cooperation.

The second section of the book deals with the evolution of communication and cognition. It includes data on wolf vocalizations and scent marking, together with some speculation that carnivory, which requires accurate knowledge of a larger home range than herbivory, may have prompted the initial increase in the mental capacities of our ancestors. The final portion is devoted to the interesting suggestion that there are valuable insights into human evolution to be gained by comparing the Pleistocene radiation of hominids of different sizes now being unearthed in East Africa with that of the canids that have inhabited North America over the last 500,000 years. The large, extinct dire wolf is compared to the robust australopithecines and coyotes to gracile forms.

With the exception of two chapters by Mech and his co-workers, the book contains few hard data; a 20-page review of coyote biology cites only three references, two of which were published before 1955. It is unfortunate that some of the interesting ideas are not supported even by the data that do exist, such as the known correlations between home range size and relative brain weight; for other ideas, such as the comparison of canid and hominid skulls, insufficient data are presented to allow accurate assessment. At a theoretical level, the book raises interesting questions about the role and meaning of culture in humans and animals, but naive assumptions concerning the nature-nurture dichotomy and group selection arguments flaw the discussion.

Both books serve to emphasize the need for long-term field studies of known individuals. One hopes that the considerable skills that have been acquired in locating both wolf and coyote dens in order to exterminate the occupants can be utilized to allow biologists simply to sit and watch how these two species run their lives.

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The Meeting of a Mathematical Challenge

The Four-Color Problem. Assaults and Conquest. THOMAS L. SAATY and PAUL C. KAINEN. McGraw-Hill, New York, 1977. x, 218 pp., illus. $22. Advanced Book Program.

The four-color problem is to determine whether any map in the plane (or, equivalently, on a sphere) can be colored in four colors so that no two regions with a common boundary receive the same color. It was first posed by F. Guthrie, a student of A. de Morgan, in 1852. A proof that four colors do indeed suffice was published by A. B. Kempe in 1879, but 11 years later P. J. Heawood discovered a fundamental error in Kempe's reasoning. Since then, many attempts have been made to establish the four-color theorem and many false proofs have been proposed. It is not surprising, therefore, that the recent proof by K. I. Appel and W. Haken was greeted with much skepticism when it was announced in 1976. Although a majority of mathematicians are now willing to accept the Appel-Haken proof, an element of doubt remains because the proof relies heavily on the services of a high-speed computer and cannot be checked by hand.

The indispensable role played by the computer in the work of Appel and Ha-

ken is one of the fascinating aspects of their proof. The implications for the future of mathematics are daunting, and in this account of the four-color problem Saaty and Kainen explore them at some length:

> One particularly significant thing which has emerged from this approach is that the computer will play an increasingly fundamental role in mathematical thinking. Here it has been an invaluable aid in generating exhaustive analyses of a problem by cases. From now on mathematicians will dare to use the computer more and more in constructing proofs. As this use becomes more prevalent it would gain greater credibility as a method of approach. This says that we may more often look for constructive analytical existence proofs by working out cases instead of nonconstructive synthetic ones. With this, one would expect that vastly larger and more detailed problems of an abstract nature significant to man's logical view of his thought processes and to his role in the universe will be formulated and solved. Man's imagination creates the domain within which the computer will function.

This intrusion of the computer will undoubtedly change the face of mathematics, and the transformation, from an art to a science, will be unwelcome to some.

The book is divided into two parts. The first discusses the early history of the four-color problem, its reformulation in terms of planar graphs, the basic theory of maps and colorings, and the methodology that enabled Appel and Haken to settle the problem. It is probably this part that will be of greatest interest to the general reader. The important concepts of reducibility, discharging, and unavoidability are clearly explained, and the heuristic reasoning that encouraged Appel and Haken to pursue their goal for several years is described in some detail.

The second part of the book is concerned with the many other approaches to the problem that have been developed over the years. As the authors note, "These variations are a testimony to man's tremendous breadth and imagination in his assaults on a difficult problem." Thirty-five equivalent formulations of the conjecture are described, relating the four-color problem to Diophantine equations, Galois fields, sequences, polynomials, trigonometric functions, and finite projective geometries, as well as to a variety of seemingly disparate graph-theoretic notions.

To conclude, there is an appendix in which certain technical results quoted earlier in the text are proved, and several related avenues of graph theory are briefly explored. It should be noted that the "metaconjecture" at the end of the appendix is equivalent to a well-known conjecture of G. Hajós that dates back to 1953 and was recently disproved by P. A. Catlin.

Although the material is quite well organized and is written so as to be accessible to readers with a modicum of mathematical training, it suffers from a number of defects that may well confuse the nonspecialist. It is not uncommon to find terms and symbols used before they are defined, if indeed they are defined at all; a list of symbols would certainly have helped. There are inconsistencies in notation, with different symbols denoting the same concept and different concepts denoted by the same symbol. Several proofs in the second half of the book are incomplete. Facts that have already been noted are inexplicably repeated; for instance, one may find the following three sentences in quick succession (on pp. 12, 13, and 19 respectively): "It is easy to find a graph, some of whose edges always cross at a point that is not a vertex no matter how we draw them," "Note also that not every graph is planar," "Let us observe that not every graph is planar." And once or twice the authors go out of their way to remark that a certain planar graph is four-colorable, having seemingly forgotten that the purpose of their book is to explain why all such graphs are four-colorable.

Despite these imperfections, *The Four-Color Problem* does provide a stimulating and instructive account of the decline and fall of a major mathematical problem. It also serves as a good introduction to the developing field of graph theory, complete with historical motivation.

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Opiatelike Substances

The Endorphins. Papers from a symposium, Brescia, Italy, Aug. 1977. ERMINIO COSTA and MARCO TRABUCCHI, Eds. Raven, New York, 1978. xviii, 380 pp., illus. $28. Advances in Biochemical Psychopharmacology, vol. 18.

When comparing the contents of this volume with the most recent prior review of the subject (*Opiates and Endogenous Opioid Peptides*, H. W. Kosterlitz, Ed., Elsevier/North-Holland, 1976), it is apparent that there is a wealth of new information, especially on the interaction of endorphins with other neuronal systems and the role of endorphin in the regulation of pituitary hormone secretion. Save for an introductory paper by Zetlar that discusses pharmacologically active peptides present in the nervous system and one by Kosterlitz and Hughes that reviews the development of the concepts of opiate receptors and their ligands, the present volume is designed more for those actively working in the field and related fields than for those who want an overview of the state of the art. For the active investigator, as well as for the beginner, it would also have been helpful to have a critique and a more detailed description of the various methodologies employed; in many instances reported results rely heavily on immunochemical characterization, which does not provide sufficient specificity for the substance being measured, or on extraction procedures that may generate artifactual results with regard to compounds that might not have been present in vivo prior to extraction.

There is general agreement that the anatomical distribution of enkephalinergic neuron systems is more diffuse than that of endorphin, as determined by both immunocytochemistry and radioimmunoassay. The enkephalin neurons are present in brain areas assumed to be related to pain and analgesia (periaqueductal gray, medullary raphe nuclei, spinal trigeminal nucleus, and spinal cord), behavior (globus pallidus, stria terminalis), and neuroendocrine effects (median eminence). Little (Bloom *et al.*) or no (Johansson *et al.* and Cox *et al.*) enkephalin is present in the pituitary. Immunological methods alone are not precise enough to fully distinguish between leucine- and methionine-enkephalin, although this has been accomplished by the use of radioimmunoassay after the separation of the two enkephalins under high pressure liquid chromatography (Meek and Bohan). The distribution of enkephalin follows but is not completely parallel to that of opiate receptors. In contrast, the distribution of endorphin cell bodies, fibers, or both appears to be restricted to the hypothalamus, midbrain, and pituitary, chiefly the intermediate lobe. Endorphin (and enkephalin) content in the hypothalamus is unaffected by hypophysectomy, raising questions about the source of such endorphin and the physiological significance of pituitary endorphin. Although the amino acid sequences of endorphin and Met-enkephalin are found within the β-lipotropin molecule (and β-lipotropin has been shown to be present in the central nervous system), there is no evidence that Met-enkephalin is derived via lipotropin degradation. The source of the Leu-enkephalin in the brain is even less clear, for only the sequence