The Carnivora

Carnivore Behavior, Ecology, and Evolution. JOHN L. GITTLEMAN, Ed. Comstock (Cornell University Press), Ithaca, NY, 1989. xvi, 620 pp., illus. $65; paper, $25.

In 1973, R. F. Ewer provided in *The Carnivores* a marvelous compendium of knowledge of the anatomy, behavior, ecology, and phylogeny of carnivores. Rather than updating Ewer's work in its entirety, the present volume aims to present "critical reviews in rapidly developing and expanding areas of carnivore behavior, ecology and evolution." It succeeds in diverse areas. Since Ewer's book there have been great theoretical advances in behavioral ecology, improvements in radiotelemetric techniques have greatly aided field studies of many species, and new biochemical techniques have revolutionized phylogenetic studies. All these advances are reflected here. The book's 19 chapters are arranged under the three headings indicated by the title. They vary widely in scope, including discussions of general topics across the entire order (acoustic and olfactory communication, behavioral development, locomotor adaptations), discussions of particular taxonomic groups (the advantages and disadvantages of small size to weasels), and detailed comparisons of the ecology of sympatric species (brown and spotted hyenas; giant pandas and Asiatic black bears). Several chapters present original data.

A current subject of interest in behavioral ecology is how ecological factors affect spacing and grouping patterns. This is discussed in several chapters in the behavior section. Gittleman demonstrates positive correlations across the entire order between group size and prey size and between group size and openness of habitat. He suggests that both antipredatory factors (more important in open habitats) and dietary characteristics have operated simultaneously to select for group living, but is unable to partition their relative effects. Gittleman's correlations provide superficial support for the idea that group living among the larger carnivores evolved because of advantages of group hunting of large prey. This idea is now widely questioned, however, because the advantages of increased hunting efficiency often do not offset the disadvantages of sharing the carcasses with companions. In comparing the behavioral ecology of spotted and brown hyenas, Mills doubts that group hunting can be the whole explanation for group living in spotted hyenas. It clearly cannot explain sociality in brown hyenas that live in clans but feed by themselves. Moehlman's chapter on intraspecific variation in canid social systems also casts doubt on the idea that this has been important in the evolution of grouping in any canid species except wild dogs. In coyotes, although there is some correlation between group size and prey size, group size may also grow large at high densities when prey size is small. The importance of density has been pointed out elsewhere by C. Packer, who showed that lions (the only group-living felids) live at higher densities than other large cats and suggested that large prey size may be a permissive rather than a causal factor in the evolution of group living. Models of group territoriality such as those developed by J. L. Brown for birds should also prove useful for mammals. These suggest that the advantages of group territorial defense will more often outweigh the costs of resource depletion by additional group members when population density is high.

Most carnivores are solitary, but, as Sandell shows, mating systems vary with the precise distribution of females. Sandell reviews evidence that females occupy small exclusive ranges when food is abundant and evenly distributed, whereas temporal and spatial variability in food distribution leads to larger overlapping ranges. As expected from sexual selection theory, males tend to occupy larger ranges than those predicted solely on the basis of energy requirements. Males differ greatly in whether they have stable ranges overlapping those of several females but exclusive of males or occupy ranges overlapping those of other males and wander widely in search of females during the mating season. Sandell suggests that there is a threshold density of females below which males will switch from the former to the latter ranging stategy.

A theme that runs through several chapters is the extent to which phylogeny constrains adaptation. By definition, carnivores eat meat, but several families include species that are omnivorous, insectivorous, or even herbivorous. McNab suggests that most variation in basal metabolic rate is explained by body size and diet rather than by phylogeny. Meat eaters in all families have high metabolic rates, whereas omnivorous and herbivorous species have low rates. Oftedal and Gittleman, on the other hand, stress that patterns of energy output during reproduction (energy deposition during pregnancy, postnatal growth rate, milk energy output) are strongly influenced by phylogeny as well as by body size and diet. For example, canids have much higher energy outputs during reproduction than felids. In an admirable but necessarily condensed account of the fossil history of the terrestrial carnivores, Martin shows how the group has been characterized by repeated cycles of radiation and extinction during which a rather small number of "ecomorphs" (such as saber-toothed cats or large bone-crushing pursuit predators) have repeatedly evolved from distantly related ancestral stock. This high degree of convergence greatly complicates the taxonomy of carnivorous mammals, and it is small wonder that this is a controversial area. Wayne *et al.* give a clear account of the phylogenetic trees derived from a variety of biochemical methods, and Wozencraft uses anatomical characters to derive a rather different phylogeny.

Although they hold a particular fascination for us, carnivores are scarce, elusive, and difficult to study. This eclectic volume serves both to highlight the range of adaptations within the order and to underscore the gaps in our knowledge.

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Work with Fractals

Fractals. JENS FEDER. Plenum, New York, 1988. xvi, 283 pp., illus., + plates. $49.50. Physics of Solids and Liquids.

Most structures of importance in nature are neither completely random nor completely ordered. Anyone who attempts to describe such disorderly structures (mountains, coastlines, vascular systems, and lungs, to name a few) with classical Euclidean geometry soon encounters insurmountable difficulties. Important characteristics of these systems can be described quantitatively using fractal geometry, and this development has stimulated interest in many structures and phenomena that only a decade ago were beyond the purview of quantitative scientific investigation. Fractal geometry has been applied to problems as diverse as fluid-fluid displacement in porous media, the growth of nerve cells, the distribution of human populations, the fracture of steels, and the distribution of mass in the universe. Feder's book, in which his aim has been "to write an introduction that may be useful to those who want to use fractals," is most welcome. Such an exposition is urgently needed, and this book is the most complete attempt to satisfy the need.

Feder, a physicist at the University of Oslo, was nudged into starting the book while applying fractal geometry to problems in oil exploration and recovery. The many fascinating examples he gives of its application to real systems come mainly from statistical physics and geophysics. Most are taken from his own research, and these accounts have considerable authority.