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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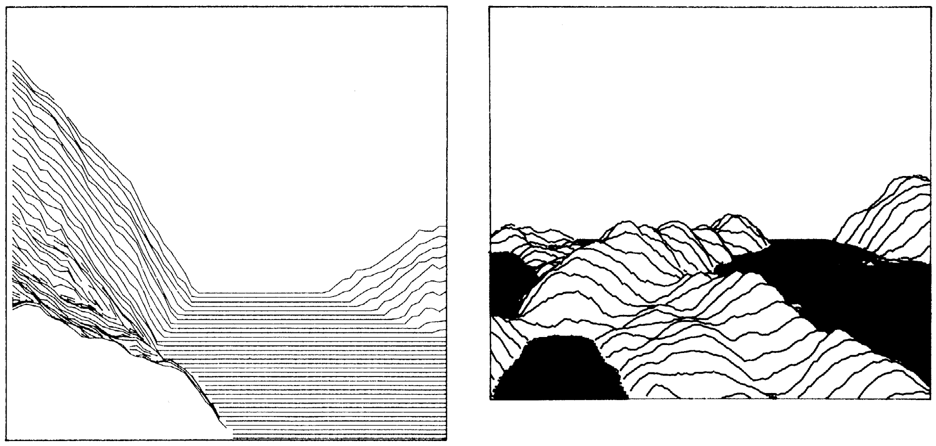
Work with Fractals

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.



Landscapes generated by fractals. "A simulation of the curvature of the earth," as at right, "is needed in coastal landscapes in order to avoid the impression that the landscape is cut off at the horizon," as at left. [From *Fractals*]

Much of the book is concerned with self-similar fractals and self-affine fractal curves and surfaces, the simplest fractals that (so far) have had the broadest range of applications. Feder describes in detail the difference between them, an appropriate topic since indiscriminate application of the simple methods that work well for characterizing self-similar fractals to self-affine fractals appears to be a common error.

Satisfactory procedures for measuring fractal dimensions with these classes of fractal geometry have now been developed. Further advances can be expected, but these parts of the book will have lasting value. For multifractals (fractal measures), practical methods for characterization are just emerging, so the discussion of applications to convection, diffusion-limited aggregation, and viscous fingering should soon be superseded.

In real applications the fractal scaling does not extend over an unlimited range of length scales but is bounded by upper and lower cut-off lengths that depend on the details of the system. In some cases, one type of fractal behavior on one length scale may cross over to a different type on another range of length scales. These issues are discussed when they appear in examples, but it might have been appropriate to discuss them in more detail since difficulties associated with this behavior are commonly encountered in research. Similarly, a more detailed discussion of how to assess both statistical and systematic uncertainties would have been valuable.

The book is concerned primarily with two of the major topics of recent research: the quantitative description of random systems and the phenomenology and kinetics of the growth of fractals. Feder gives little coverage to the third major focus of current research, the physical and chemical processes occurring in, on, and around fractals.

This is a relatively short book, but I believe it is the right length for its purpose. It is well written and careful. The most technically complex topic it covers, multifractals, is described in a clear, direct fashion. Although fractal geometry is a mathematical subject, little mathematical background is required to benefit from this book. I highly recommend it for those who are interested in using fractal geometry but do not want it to become the major focus of their research. It would also provide a sound basis for a course in fractal geometry.

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Contemporary Mechanics

Hamiltonian Systems. Chaos and Quantization. ALFREDO M. OZORIO DE ALMEIDA. Cambridge University Press, New York, 1989. x, 238 pp., illus. $64.50. Cambridge Monographs on Mathematical Physics. Translated from the Portuguese.

Most university students of physical science and engineering must take a course that covers classical mechanics—the study of the motion of material bodies in response to forces. The basic concepts underlying classical mechanics have been known since their enunciation by Isaac Newton and the revealing reformulation by William Rowan Hamilton. It is therefore remarkable that this old field has lately become a "hot" area of research with an explosion in the number of papers, conferences, and new textbooks.

The element stimulating this activity has been the introduction of topological and analytic ideas from the branch of mathematics known as dynamical systems theory. In particular, the concept of chaos has been key to this awakening interest. The word *chaos* is used to describe the time evolution of a deterministic system with very complicated dynamics (complicated in a way that is quantifiable by dynamical systems theory). When viewing chaotic behavior over time, one is very often led to the well-founded thought that its description might best be made statistically. The surprise is that such complicated behavior is common even in very simple Hamiltonian mechanics problems.

This book presents Hamiltonian mechanics from this modern point of view and deals with the implications of chaos for quantum mechanics. The book had its origin in a graduate university course, and it has what I would consider an excellent selection of topics for a graduate course following the standard one in classical mechanics in American universities.

The first part of the book deals with classical mechanics, covering such topics as the Poincaré surface of section technique, the Hartman-Grobman theorem, structural stability, horseshoes, normal forms, bifurcations, and the Kolmogorov-Arnold-Moser theorem. The second part (about one-third of the book) discusses the implications of chaotic dynamics for the solution of a classical problem when quantum mechanical effects are included. The author's treatment of this fascinating topic is very expert, as might be expected from the fact that he has been a major contributor to it.

Since there has been a rapid increase in books on chaotic dynamics, it is fair to ask where the current one fits in. It is not a comprehensive reference, nor does it supply mathematical proofs, extensive illustrative examples, or computer results. However, it successfully (despite some minor errors and obscurities) gives a concise treatment of well-chosen key elements of the field that are suitable for an upper-level graduate physics course.

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Books Received

AIDS and AIDS-Related Infections. Current Strategies for Prevention and Therapy. Adrian J. Bint, John Oxford, and Philip J. Daly, Eds. Academic Press, San Diego, CA, 1989. vi, 137 pp., illus. Paper, $24.95. From a meeting, Stratford-on-Avon, U.K., April 1988.

Atomic Spectra and Collisions in External Fields. K. T. Taylor, M. H. Nayfeh, and C. W. Clark, Eds. Plenum, New York, 1989. xiv, 457 pp., illus. $95. Physics of Atoms and Molecules. From a meeting, Egham, U.K., July 1987.