although this deficiency is partly allayed by the outlines that precede each chapter.

Many of these topics have been reviewed elsewhere, and in some cases more successfully; the virtue of *The Vertebrate Neuromuscular Junction* is that it assembles within a single volume such a broad range of material related to the endplate. It should prove particularly useful for newcomers to this area of research who might otherwise find the literature overwhelming, but students of the neuromuscular junction should also find it a very good reference work.

STEVE SCHUETZE
Department of Biological Sciences,
Columbia University,
New York, NY 10027

Olfaction and Gustation

Neurobiology of Taste and Smell. THOMAS E. FINGER and WAYNE L. SILVER, Eds. Wiley-Interscience, New York, 1987. xii, 449 pp., illus. $69.95. Wiley Series in Neurobiology.

As has been true for many areas of neuroscience over the past decade, research on the chemical senses—principally olfaction and taste—has benefited enormously from the influx of methods, ideas, and talents from other fields of science and other disciplines of neuroscience. The remarkable advances in visual, auditory, and somatosensory research have served as examples and stimuli for investigations of the organization, mechanisms of function, development, behavioral roles, and diseases of the olfactory and gustatory systems. The invigoration of this important area of sensory neuroscience is evident in the relatively recent spawning of a journal (*Chemical Senses*), professional societies (the Association of Chemoreception Sciences, the European Chemoreception Organization, and the Japanese Association for the Study of Taste and Smell), a regularly scheduled Gordon Research Conference on olfaction and taste, and several organized research groups concerned with the chemical senses.

Olfaction and gustation play key roles in controlling vital behaviors, such as those of feeding and reproduction, and olfaction appears to be profoundly important in the establishment and maintenance of cognitive and emotional states. Moreover, research on the cells, pathways, molecular mechanisms, and psychophysics of chemical-sensory function is contributing to the general progress of neuroscience. There are now marvelous opportunities for advances on problems such as the mechanisms of chemosensory transduction, the genetic and molecular aspects of receptor-cell turnover and target plasticity in the olfactory and gustatory pathways, the cellular basis of information coding and the computational organization of the olfactory system, and the involvement of the chemical-sensory pathways in nutritional and neurological disorders.

As interest and activity in chemical-sensory neuroscience grow, so does the need for an up-to-date introduction to the field. There has been no such single source in recent years, and even otherwise comprehensive textbooks of neuroscience have tended to deal minimally with smell and taste. This compact and particularly welcome new book fills the void at last.

Intending to serve the needs of both students and established neuroscientists requiring an introduction to the area, the editors sought to provide an overview of important issues, ideas, and research findings rather than a collection of comprehensive literature reviews or a treatise on the technical details of research in the chemical senses. The resulting volume is a coherent set of 18 chapters written by leading investigators and clustered under three major topics. The first part, Chemical Sensitivity and Sensibility, deals with chemoreception in unicellular organisms and invertebrates as well as the "common chemical sense" of vertebrates and sets the stage for a second section on olfaction and vomeronasal chemoreception and a third on gustation. Each topic is addressed in an interdisciplinary spirit, with balanced attention to anatomical, physiological, developmental, and psychophysical aspects. Knowledge of basic neurobiology is assumed, but this is not an advanced book.

This book is timely and up-to-date, adequately illustrated, nicely produced, and clearly written. It offers an excellent starting point for both newcomers to the field and cognoscenti who want to broaden their knowledge of the chemical senses.

JOHN G. HILDEBRAND
Arizona Research Laboratories,
Division of Neurobiology,
University of Arizona,
Tucson, AZ 85721

Ontogenetic Changes

Development as an Evolutionary Process. RUDOLPH A. RAFF and ELIZABETH C. RAFF, Eds. Liss, New York, 1987. xiv, 329 pp., illus. $58. MBL Lectures in Biology, vol. 8. From a meeting, Woods Hole, MA, Aug. 1985.

The relationship between development and evolution was one of the great themes of late 19th-century biology. The recent renewal of interest in this subject was sparked in part by R. A. Raff and T. C. Kaufman's *Embryos, Genes, and Evolution*, which appeared in 1983. That book argued that a small number of changes involving regulator genes could easily lead to major ontogenetic changes that could be the basis for macroevolution.

Development as an Evolutionary Process contains further papers on this theme. The volume as a whole has a somewhat diffuse and eclectic flavor, partly because it lacks an introduction that spells out the issues involved (the nearest thing to an introduction is a paper in the middle of the book, "Molecular and developmental correlates of macroevolution," by ten researchers from Raff's laboratory).

About half of the 12 papers in the book are case studies and minireviews of the genetic apparatus of eukaryotes. These include two papers on transposable elements and three papers on gene families. Given this emphasis, the title of the book is surprising. The main point the authors of these papers make is that the element of the genetic apparatus they are discussing could bring about a major regulatory change in gene expression during development. One gets the impression that many of these authors normally do molecular biology using a set of proteins or DNA sequences as markers and that they have incorporated a bit of comparative work into their studies. Their papers appear to be attempts to dress up some of this work after the fact by putting it in an evolutionary context.

The papers I found most interesting start with an evolutionary problem and try to marshal comparative data that bear on it. Valentine and Erwin review the paleontological evidence for the appearance of animal phyla during the early Cambrian and develop a convincing argument that macroevolution was very rapid during this period. Elinson compares the development of aquatic and terrestrial amphibians. There has been an enormous increase in the size of eggs of terrestrial amphibians; Elinson examines some of the consequences of this increase for the pattern of development and compares the extra-embryonic membranes of these anamniotes with those of amniotes. Lord and Hill examine the role of heterochrony in the evolution of higher plants. They make a number of interesting comparisons between plant and animal systems and point out the advantages that plants have for this kind of analysis because of their indeterminate growth pattern. Alberch examines the evolution of developmental pathways responsible for remodeling the hypobranchial apparatus of urodele amphibians during metamorphosis. He discusses the effect these pathways have in constraining the

evolution of different feeding modes in the adult animal. The volume ends with a metaphysical essay by Katz entitled "Is evolution random?" There is a good chance that at least one of these papers will change the way you think about the relationship between development and evolution.

GARY FREEMAN
Department of Zoology, University of Texas, Austin, TX 78712

Social Mammals

Behavioral Biology of Killer Whales. BARBARA C. KIRKEVOLD and JOAN S. LOCKARD, Eds. Liss, New York, 1986. xvi, 457 pp., illus. $79.50. Zoo Biology Monographs, vol. 1.

This is the first volume of the series Zoo Biology Monographs, which is intended to provide "a forum for indepth studies and reviews of diverse taxa and issues within the professional scope of practicing zoo biologists." The series is dedicated to the worldwide movement to preserve biological diversity, a movement in which zoological parks are playing an essential and increasing role. Judging by the first volume, these books, which aim to provide a thorough understanding of animals in their natural habitats as well as in captivity, should become an important resource not only for zoo biologists but also for conservationists and academics concerned with ecology and behavior.

The killer whale, *Orcinus orca*, is an immensely striking animal whether seen in the wild or in captivity. This long-lived, highly social species has provided unique opportunities for long-term research on behavior, ecology, and demography.

The book is divided into three main sections, considering evolution and natural history, behavior and social groupings, and vocalizations and communication. Most of the studies presented were conducted on three wild pods of killer whales found in the region of southern Vancouver Island, British Columbia, and Puget Sound in Washington State.

One of the major questions about killer whales concerns the nature of their mating system. In the first section, Duffield reviews the taxonomy of *Orcinus orca* and discusses chromosomal studies and their implications with respect to the mating system. Chromosomal evolution has been rapid in *Orcinus*, and the species karyotype has diverged radically from the strikingly conservative pattern of other cetaceans. Duffield suggests that this divergence might be caused by a social structure involving some degree of inbreeding.

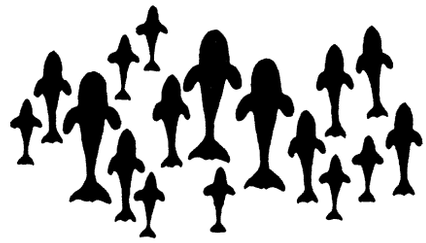
Matkin and Leatherwood review the literature on killer whale distribution, abundance, and social behavior. Their chapter and one on demography by Balcomb and Bigg show that killer whale pods are extremely stable social units with practically no dispersal of individuals between them. The integrity of pods is also indicated by the existence of pod-specific dialects, discussed later in this volume by Hoelzel and Osborne and elsewhere by J. K. Ford and H. D. Fisher (*Rep. Int. Whaling Commission* **32**, 671 [1982]). Sara Heimlich-Boran suggests that the males, traditionally assumed to be the breeding bulls in a pod, may be siblings or offspring of the pod's breeding females, residing permanently in their natal pod.

These studies suggest an unusual mammalian social system in which dispersal by either sex is rare or nonexistent and males breed either with close relatives in their own family pod or with females in other pods during social interactions between pods. More data are needed on this intriguing question.

The second section begins with a descriptive chapter by Jacobsen with interesting information on natural history, daily patterns, and foraging behavior of northern Vancouver Island pods. A chapter by Ray *et al.* presents data on social and respiratory synchrony of captive killer whales that will be of use in assessing the health of captive animals. A chapter by Osborne quantifies the time budgets of Puget Sound killer whales and gives particularly interesting descriptions of complex greeting ceremonies when pods meet and discussion of behavioral differences between these and the northern Vancouver Island pods.

The most intriguing chapter is by Sara Heimlich-Boran, who quantifies the frequencies of association between individual members of J-pod, one of the best-studied killer whale groups. Young calves prefer to associate with their own mothers, but after a few years, particularly when a younger sibling is born, they shift allegiance to a nonbreeding female, who is usually a close associate of their mother. This "aunting" behavior is particularly interesting, but, disappointingly, few data on the age and status of the "barren" females who act as "aunts" are presented here. Heimlich-Boran concludes that J-pod is composed of four subunits centered around breeding females and their offspring. This chapter is well complemented by a chapter by Haenel in which a clear qualitative description of calf behavior is given.

Two chapters on vocalization and communication by Morton *et al.* and Bain offer complementary approaches to studying the context of killer whale vocalizations in captivity and relating findings to the excellent earlier studies by Ford and Fisher in the wild.



Aerial diagram of killer whale tight resting formation. Pod size and age-sex composition are modeled after J-pod. [From R. Osborne's chapter in *Behavioral Biology of Killer Whales*]

In the final chapter Lockard summarizes the information presented in the book with reference to primate behavior. This one comparative chapter is disappointing because killer whale social behavior is as likely to converge with that of other carnivores, which are barely mentioned in the book, as it is with that of primates. The comparative analysis that is done is too brief and in a section entitled "are killer whales cannibalistic?" confusing. The book lacks an exhaustive comparative discussion of killer whale mating systems, which could have helped in formulation of hypotheses for future research.

Although few conclusions are drawn by the contributors, a wide variety of basic data are presented that will provide grist for the mills of marine mammalogists and those interested in mammalian social systems. In keeping with the goals of the series to which the book belongs, the information will also be of use to zoo professionals concerned with sound captive management of killer whales.

PETER O. THOMAS
Animal Behavior Graduate Group, Division of Environmental Studies, University of California, Davis, CA 95616

Books Received

Astrophysical Radiation Hydrodynamics. Karl-Heinz A. Winkler and Michael L. Norman, Eds. Reidel, Dordrecht, 1986. viii, 590 pp., illus. $98. NATO Advanced Science Institutes Series c, vol. 188. From a workshop, Garching, F.R.G., Aug. 1982.

Asymptotic Theory of Statistical Inference. B. L. S. Prakasa Rao. Wiley, New York, 1987. xvi, 438 pp. $49.95. Wiley Series in Probability and Mathematical Statistics.

Atlas of Selected Oil and Gas Reservoir Rocks from North America. A Color Guidebook to the Petrology of Selected Oil and Gas Reservoir Rocks from the United States and Canada. Edwin W. Biederman, Jr. Wiley-Interscience, New York, 1986. xx, 399 pp., illus. $125.