

BOOK REVIEWS

Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science. David L. Hull. 1988. The University of Chicago Press, Chicago and London. 586 p. \$39.95.

In *Science as a Process*, Hulls brings systematics (the study of evolutionary pattern) and population biology (the study of evolutionary process) together in a unique way. In the first half of the book he provides a historical narrative of conceptual growth in systematics during the 1960s, '70s and '80s. The emphasis in this account is on phenetics and cladistics (and the less-than-peaceful interactions of their practitioners). In the second half of the book he develops a general model of selection processes which is designed to be applicable to both biological evolution and to the conceptual growth in systematics which he witnessed.

Some of the major observations and regularities that appear in Hull's account of the pheneticists' and cladists' history are the following. Conceptual development is embedded in an historical context. Hull claims that tracing the transmission of ideas from scientist to scientist — identifying a conceptual lineage — is necessary to understand conceptual change. Social relationships among scientists are thus critical to conceptual change, and these are characterized by competition and cooperation. Hull is more impressed by the competitive aspect, claiming that factionalism facilitates the development of science.

Science works because of curiosity, credit (citation and use), and checking (testing). Hull does not deal with the curiosity of scientists beyond noting that it is necessary. He deals at length with the claim that scientists work for credit, the principal currency being citation. Because of the convention of giving credit to the first to publish, scientists are motivated to "share" their results in a public format rather than working secretly. Because opponents of an idea are the most likely ones to test it, scientists are also motivated to produce reliable results and ideas. In all, science works because personal efforts to obtain positive credit also result in the global advancement of scientific knowledge.

However, being right is not enough. Scientists must communicate successfully and persistently. Hull laments several instances of scientists "failing" only because they didn't vigorously and persistently defend and promote their ideas. In the battle of scientists promoting ideas, Hull sees small research groups as a fundamental unit. He likens the research group structure of science to demic structure of biological populations, noting that evolution of concepts and biological populations will be most rapid where such demic structure exists.

In the second half of the book Hull develops a general model of selection processes. The model follows from Hull's previously published work on the analysis of selection in biological populations and relies, for instance, on the distinction between "replicators" and "interactors" and upon construing conceptual lineages, like species, as individuals. A key idea in this is that both biological evolution and conceptual evolution function as examples of the general selection process. As applied to conceptual change, Hull's model puts concepts playing the role of

replicators; they are passed on in replication sequences in which books, journals, lectures, and conversations are the agents used by scientists (the interactors) in competitive contexts. Useful concepts spread, based on the relative success they produce in scientific interactions.

A book of this scope is bound to attract criticism. Probably the most obvious shortcoming is its length. Hull acknowledges this shortcoming but writes: "... I have found myself unable to resist the same forces that I describe in the careers of the scientists whom I have studied." This is unfortunate. The book could have been much more successful if Hull had taken greater pains to limit the repetition, tangential discussion, and overall length.

Another obvious criticism of the book is what Hull calls the "atypicality objection." Perhaps the weight given to factionalism would be different if he had studied an area which was not so thoroughly characterized by acrimonious interaction. Hull's response is not convincing: there is no "typical" science anywhere, so how can one be atypical? There are many counter examples that undermine this justification. For instance, de Vries picked *Oenothera* as his research organism, unaware of its unusual chromosome arrangements, and consequently put undue emphasis on the role of mutation in evolution. The failure of selection in Johannsen's pure lines of *Phaseolus vulgaris* led people to conclude (for a while) that selection was not efficacious. Hull's example may be atypical in the same sense.

There are also some disanalogies between conceptual development and biological evolution that many might find more troubling than does Hull. For instance, unlike most others who have attempted an evolutionary analysis of knowledge growth, Hull does not think that concept acquisition is in any sense Lamarckian. He can hold this view only because he does not require a physical basis for the replication of concepts. So, he sees "... the inheritance of acquired memes, not acquired characteristics." But his failure to have both a physical basis for concepts-as-replicators and a "phenotypic" characteristic which the possession of alternative memes affects, is the reason he sees only "acquired memes." Another oddity of Hull's view is his treatment of cross-lineage borrowing. In biology, the distinction between "vertical" (through reproduction) and "horizontal" (for instance, through viral vectors) transmission of genes is important. In modeling horizontal transfer, it is further important to distinguish between replicative and non-replicative transfer. With replicative transfer, horizontal spread of genes occurs at a high rate. Hull's general model doesn't accommodate this distinction for the same reason that it doesn't deal well with the Lamarckian aspects of cultural transmission; he doesn't have a physical basis for conceptual replication, and he doesn't distinguish between the physical basis of replication and the phenotypes affected by the possession of alternative replicators. Because of these and other problems, the treatment of biological entities and concepts in a common model is less than a complete success.

Despite these problems, this is an exciting and thought-provoking book. It is clearly essential reading for students of evolutionary epistemology. Systematists will also find

a great deal of interest. For the more general reader, I suggest reading chapters 1-4, 8, 11, 12 and 14. Excellent chapter summaries are also included.

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Carnivore Behavior, Ecology, and Evolution. Edited by John L. Gittleman. 1989. Cornell University Press, Ithaca, NY. 620 p. \$65.00 hardcover; \$25.00 paperback.

Although they make up only 10% of all mammalian genera and only 2% of all mammalian biomass, man has long been fascinated by carnivores. Perhaps this intrigue was born out of necessity because of the competition with other large carnivores at the top of the food chain. Some anthropologists subscribe to the notion that the advent of hunting large ungulates by hominids began when the lion was first driven from its kill, eventually leading to man's domination of all members of the animal kingdom. Or perhaps the fascination stems from less definable reasons, as in the domestication of the wolf, beginning some 10,000 years ago. It is known that the dog has served man well through the millennia, but the interspecies bond between man and dog is unique within the animal kingdom. For whatever reason, the carnivores represent a well studied order with a collective data that has long been of interest to biologists as well as the armchair naturalist.

In 1973, R. F. Ewer published *The Carnivores*, in which she brought together in a single volume the scattered literature on this order. In this monumental classic she reviewed anatomy, behavior, reproduction, and various aspects of natural history. It soon became a standard reference. Until this present volume, edited by J. L. Gittleman, no attempt had been made to compile recent comparative data in carnivore biology.

The book consists of three sections: (1) Behavior, (2) Ecology, and (3) Evolution. Each part consists of a collection of well selected chapters — 19 in all — contributed by guest authors well known for their contribution to carnivore literature.

Behavior: The first two chapters in this section describe mechanisms of communication that allow carnivores to establish mating systems, modes of parental care, foraging patterns, and other behavioral patterns.

Then, moving from communication to ontogeny, Beckoff critically reviews methodological problems and general trends in carnivore behavioral development. Considering the difficulty in collecting data on ontogeny in the field, most current studies of carnivore development are on captive individuals. In order to eliminate possible biases of captivity, it is necessary to compare this data with that collected in the subject's natural environment. Beckoff suggests how future studies may analyze carnivore development and life histories more thoroughly and why solid developmental data will provide the answers to questions of individual dispersal patterns and subsequent mating strategies.

The remaining chapters in this part address various

mating systems and their ecology and evolution. Mills reviews recent field work comparing diet, reproduction, social organization, communication, and denning of brown (*Hyaena brunnea*) and spotted (*Crocuta crocuta*) hyenas.

Finally the chapters of Sandell and Gittleman compare the evolution of solitary and group living in carnivores by reviewing different forms of solitary living and the ecological factors selecting for these forms. Although most carnivores are solitary, previous discussion has emphasized that large carnivores such as wolves and African lions live in groups to aid in bringing down large prey, whereas the smaller species such as the dwarf mongoose (*Helogale parvula*), and the banded mongoose (*Mungos nugo*) reside in groups to ward off potential predators. Sandell and Gittleman's analysis does not support this size-dependent hypothesis; they argue that anti-predatory factors and dietary characteristics are operating simultaneously to select for group living.

Ecology: This section not only concentrates on the conceptual advances in ecological studies but also mentions some of the new technology available for the study of carnivores permitting more accurate investigations of home range movements, territoriality, denning habits, hunting behavior, social interactions, and other features fundamental to carnivore ecology. This new technology includes improvements in trapping, radio tagging, aerial radiotelemetry, and spotting scopes.

Schaller et al., with his usual thoroughness and eloquence, uses the first comparative study of the giant panda (*Ailuropoda melanoleuca*) and Asiatic black bear (*Ursus thibetanus*) to show the ecological influences of feeding on the nutritionally limited bamboo diet of the panda versus feeding on the more diverse herbivorous diet of the black bear.

In the remaining chapters Estes discusses perception, physiology, locomotion, and behavior of otters, drawing conclusions and raising questions that should encourage other workers to study this "ecologically rich" group of carnivores. King evaluates the unusual niche filled by small carnivores, primarily species of *Mustela*, while McNab, Oftedal and Gittleman dwell on the ever present need of merging physiological and ecological perspectives since all of the present data in this area are from captive animals.

Evolution: The first three chapters in this part consider ways that morphological or physiological constraints might affect the ability of a carnivore to enter an unused niche, utilize new or varied food resources, or adjust reproductive parameters to meet adverse environmental conditions. Taylor analyzes the five primary locomotor patterns in carnivores and the associated anatomical characteristics. The gist of this is that, even though carnivores have distinct anatomical constraints, most species maintain the flexibility to traverse many habitat types and procure various food resources in spite of these constraints. Van Valkenburgh reviews and quantitatively tests hypotheses related to variation in dental morphology. Mead does a literature review of delayed implantation showing the complexity of carnivore reproduction by focusing on this one aspect, since hormonal, anatomical,

ecological, and evolutionary factors are all involved in the control of delayed implantation. The final three chapters are the most controversial and in some ways the most interesting in that they deal with topics that have been the focus of intense discussion and debate such as: evolutionary divergence of carnivores and pinnipeds, the rate of evolutionary change, and the relative merits of different kinds of information (e.g., molecular versus fossil data) in piecing together evolutionary scenarios of the phylogenetic relationships of remaining carnivore families.

Summary: This book provides students and researchers in animal behavior, behavioral ecology, wildlife ecology, mammalogy, paleontology, systematics, and evolutionary theory with an excellent overview and reference for recent carnivore research and theory. It also defines areas of controversy and suggest numerous areas ripe for future study.

Gittleman precedes each section with an introduction explaining its organization and often showing considerable patience in analyzing its content. This adds to the readability of the text as it prepares the reader for what is to follow and highlights the important issues. There are numerous figures used in the text and the few photos included are generally of high quality. There is a complete appendix that presents classification of the recent Carnivora.

The quick fix of using multiple authors to create scientific volumes has been popular during the past decade. The final outcome has resulted in various degrees of success. In this volume it works because of careful editing and selection by the author. This book would be enjoyed by those only casually interested in the Carnivore order, but should be a required reference for students and researchers.

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Paleoethnobotany: A Handbook of Procedures.
Deborah M. Pearsall. 1989. Academic Press, Inc.,
New York, NY. 470 p. \$59.95 hardcover.

Paleoethnobotany has as its focus the elucidation of the human - plant interrelationship as revealed by study of plant remains recovered from archaeological sites. The subject area is both botanical and archaeological and, as such, holds appeal to students of both disciplines, particularly if adequately trained or at least familiar with some literature of both disciplines. Following a brief historical overview, Pearsall describes the procedures that are currently employed for the recovery, identification, analysis and interpretation of both macroscopic and microscopic plant remains. The book is basically divided into three sections: chapters 2, 3, and 4 are concerned with macroremains, chapter 4 treats pollen while chapter 5 treats phytoliths. Chapter 6 is concerned with integration of paleoethnobotanical data.

This book was evaluated relative to a graduate course in Paleobotany-Paleoecology (including paleoethnobotany) which I taught this past semester. The students in

this class are a mixture of Botany and Quaternary Studies majors, but have all had at least General Botany and usually a course in Plant Taxonomy. Pearsall's description of the methods for recovery, sampling, and analysis for macroremains, pollen, and phytoliths are very good and students generally felt that this book was an essential techniques and reference work for them. Certainly, one of the strongest aspects is the frequent citation of original literature demonstrating the utilization and ethnobotanical materials.

The longest and weakest section is chapter 3 - Identification and Interpretation of Macroremains. Chapter 3 should have been a separate book. It is instead a cursory overview which introduces basic plant parts and some of the potentials and limitations of ethnobotanical applications of macroremains. This chapter supposedly includes basic identification techniques for seeds, fruits, woody stems, underground storage organs (roots and tubers), fibers, leaves, and non-woody stems, as well as specialized identification techniques such as microscopic anatomy, starch grain analysis, electrophoresis, isotopic analysis, and morphometric analysis. Each of these subject areas is admittedly large and perhaps impossible to summarize in a text of this size. However, the readers were left with a feeling of frustration since they could not identify samples of any particular plant part after reading this section unless they had available a previously prepared comparative reference collection of plants and a copy of Delcourt et al. (1979) to undertake a library search for possible illustrations and keys suitable for their particular study area.

We were, perhaps unfairly, anticipating that this section would provide at least some sample illustrated keys for classroom or laboratory use. Omitted, or at least not directly cited, is comparative literature such as Metcalfe and Chalk's (1950) *Anatomy of the Dicotyledons* (Oxford) as well as some of the readily available keys to twigs in Winter condition, cones and fruits, or of grasses and sedges in vegetative condition. In addition, the identification section includes a few errors such as in Fig. 3.20 where an *Achras* seed is identified as fruit (berry). In the same figure "hickory" fruits are identified as nuts when in fact they are drupes. The fruit misidentified as "hickory" in figure 3.20 is however correctly identified on the preceding page as black walnut (*Juglans major*). These deficiencies are minor as they are readily corrected by provision of appropriate keys, illustrations, and comparative material.

The section following basic identification techniques in Chapter 3 provides an excellent overview of the presentation and interpretation of macroscopic remains; but, in my opinion, it would have been strengthened by more frequent reference to Gilbert and Mielke (1985), *The Analysis of Prehistoric Diets* and Wing and Brown (1979), *Paleonutrition*, two other books in the "Studies in Archaeology" series by Academic Press. Surprisingly, these references are missing in the special section on Reconstruction Prehistoric Diet near the end of the text. It also seems to me that one aspect of the interpretation of macroscopic remains which might have been included at this point is how such material might be used to recon-

struct prehistoric environments. Surprisingly, even in the special topic section, *Reconstructing Paleoenvironment*, I found no mention of tree-ring studies. These deficiencies like those of the basic identification techniques are likewise easily remedied and do not detract significantly from the overall purpose of the chapter.

The book has a good presentation of palynological approaches to paleoethnobotany, discussing such critical topics as the production, dispersal (transport) and preservation of pollen, sampling, extraction and numerous references for pollen identification, analysis, and interpretation. Pollen analysis often provides data on plants not represented in the macroscopic plant record and may even permit analysis of human behavior relative to plants (e.g. diet, medicinal or ceremonial practices, and room or implement utilization).

Pollen types are rarely identified to the level of species. However, the recently developed technique of phytolith (plant opal) analysis is providing a valuable adjunct to pollen analysis as discussed by Pearsall. Phytoliths often occur in situations where pollen is not preserved and, in other instances, documents the occurrence of plants not revealed by either pollen or macroscopic remains.

In final analysis, Deborah Pearsall has provided us with a comprehensive, authoritative and indispensable textbook to modern procedures of paleoethnobotany. This book provides the reader with much food for thought in the interpretation of archaeological plant remains. It also works in the classroom, laboratory and office or wherever one attempts to understand the interactions of humans, plants and their environment.

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The Challenge of Global Warming. Edited by Dean E. Abrahamson. 1989. Island Press, Washington, D.C. 358 p. \$34.95 cloth; \$19.95 paper.

This book is a collection of proceedings from several meetings and discussions by individual authors on the implications and policies concerning the effects of global warming. Topics include world wide atmospheric alterations, impacts on biological and physical systems, levels of greenhouse gases, and policy making.

The preface and introduction give a good overview of topics to be discussed. The book is divided into five main sections, each containing chapters addressing different subjects pertinent to that section. Each chapter is detailed and thorough with most concluding with specific notes. Section 1 points out the catastrophic consequences of increased global warming, debates whether adaptation or prevention is better, describes why we should be concerned, and offers a basic scientific understanding with recommended actions. Atmospheric sensitivity and future perturbations are stressed. Section 2 relates biotic changes to global warming. Deforestation, reforestation, respiration, species range, and policies addressing these changes are presented. Section 3 elaborates on climate projections, agriculture and energy use, water use effi-

ciency and runoff, sea level rise, the loss of wetlands and how earth's biotic and abiotic systems may have to be reorganized. Section 4 discusses the sources and sinks of various greenhouse gases, and section 5 deals with international policies.

As with any book, there are strong and weak aspects of this volume. Although it is written for the nonscientist, there are certain passages that require some scientific understanding. Perhaps a glossary of terms would be helpful. It does an excellent job in stating what we do and do not know concerning global warming and how we should alter our actions accordingly. Although global warming may not be a firmly proven fact, the adjustments proposed remain beneficial. This book makes one well aware of the immense planetary alterations caused by man. I am pleased to have read this book and it should be read by anyone concerned with environmental changes.

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The Complete Guide to Environmental Careers: The CEIP Fund. Lee P. DeAngelis, Project Director, Stephen C. Basler, Staff Writer, and Loren E. Yeager, Researcher. 1989. Island Press, 1718 Connecticut Avenue N.W., Washington D.C. 328 p. \$24.95 cloth; \$14.95 paper.

The Complete Guide to Environmental Careers has grown out of the work of the CEIP (Center for Environmental Interns) Fund established in 1972. The CEIP Fund currently operates from regional offices in Cleveland, Boston, Seattle and San Francisco. It claims to be the largest on-the-job trainer for environmental careers in the country and places college students and recent graduates (called CEIP associates) in short-term, paid professional-level positions with corporations, consultants, government agencies and nonprofit organizations.

Subject matter in the book deals with the essential elements of environmental careers, including basic information on job outlook, salary level, entry requirements and procedures to enter the job market. Chapters are devoted to careers and issues, education for an environmental career, volunteer programs and internships, entering the environmental job field, the planning profession and environmental education and communication. In addition, there are subject chapters covering such topics as solid waste management, hazardous waste management, air quality, water quality, land and water conservation, fishery and wildlife management, parks and outdoor recreation and forestry. Each chapter has a section on key issues, trends, developments, and their relationship to careers in the field.

One of the highlights of the book is the inclusion of case studies of agencies, businesses or organizations in each chapter, along with a profile of an active worker in the area being discussed.

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Antarctic Comrades: An American with the Russians in Antarctica. Gilbert Dewart. 1989. The Ohio State University Press, Columbus, OH. 194 p. \$25.00 hardcover.

The interests and talents of scientists are often a surprise to their colleagues and to non-scientists. Dewart has captured the essence of the polar plateau, Russians, Antarctic research, Antarctic exploration, and his position as an exchange scientist in a timely, exciting and quite readable book. Several quotes illustrate his talents and the topics: "With the summer sun slanting its weak rays across the still-frozen snowscape, death changes the color of its shrouds from black to white, but it is no less dead." "I learned many things about these contradictory and sometimes maddening people, but the most important is the most obvious—that they are indeed people like ourselves, in some ways very much like ourselves." "The seismic shooting turned out to be very difficult here, as the wind had kicked up again and there was a great deal of blowing snow..., not to mention the usual frostbitten hands and faces." "The ghostly tide of white powder was still running ankle deep, softening the outlines of the rocks, drifts, and buildings, wiping out the footprints of the homeward bound with its currents and eddies." And "In Antarctica, my companions and I were in the deceptively quiet eye of this political hurricane..."

This book chronicles life in East Antarctica with a Soviet research team in 1960, during the height of the Cold War. The detail and insight to Soviet science (many dedicated and honest scientists), life in the USSR (through the microcosm that existed at Mirny, Antarctica), and research in remote and harsh environments make for good reading by historians, research administrators, scientists, teachers and those who enjoy accounts of polar exploration. Comprehensive, with interesting observations and facts about Antarctica that even those who have been there will appreciate (such things as blue-outs and green moats), the book holds one's attention with accounts of a difficult traverse to the coldest research station on earth (Vostok), a major fire that claimed the lives of "exemplary men, possessed of that special spirit of comradeship and self-denial that makes an expedition really work" (understandably the shortest chapter), the reaction of Dewart's comrades to the shooting down of Francis Gary Powers' U-2 spy plane, and analysis of the similarities and differences between the Americans and the Soviets. The Soviets have unusual approaches to safety, preventive maintenance, and use of equipment (if it works well, don't use it). The availability of tools, the comfort of workers, ability

to party and drink, and variation in quality of food also make interesting reading.

One gets the impression that Dewart knew much more about the Russian people than many diplomats during the Cold War, and that he was one of only a few people who was able to develop close ties to Russians at many levels. We learn about the lives of the working people, the nature of Soviet society (which the author believes has many analogies to a feudal society), the impact of the Second World War (veterans estimate that one-sixth of prewar Soviets perished) and Stalin, and the idea that in some areas the war did not really end until 1952, when martial law was lifted. We learn how they accepted Gil Dewart as a scientist and a friend, and the impact that he had on the Soviet station with his bright clothes ("In Russia, men do not wear such bright colors"), his beard (beards became acceptable and a contest was held), his music (jazz became a regular component of the music from the Communications Center), and his Sunday issue of *The New York Times*.

In addition to what we learn about life in Antarctica and the USSR, we also learn about the life of a geoscientist, including his association with Cal Tech and MIT, work with Big Oil in Louisiana, research at Wilkes Station and the International Geophysical Year, and jobs and experiences of a world-wide traveler. We get a sense of his patience and tolerance in the face of "Murphy's Law" and its Russian counterpart ("Law of Universal Contrariness") and understand the need for these qualities in polar exploration and research. There is no hint of frustration with the delays associated with weather, vehicle breakdowns (is repair the most common word in the Russian language?), and difficulty in taking gravity readings on snow that is perturbed by wind load on nearby tractors. His nicknames also reveal the character of the Soviets and the author: Gil was known as the "Finger Doctor" because he had Band-aids (new to them), the "Corporal" because of his military experience, and "Dyadya Gil" because of the bond developed with a young sled dog.

Although the Cold War appears to be over, many of Dewart's observations will be of much interest as we learn more about the USSR and we attempt to understand the Soviets. The book is a highly recommended addition for personal and professional libraries; it is good reading even without buttered tea or vodka.

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