

get his facts straight. In my areas of competence I scoured the text and found no faults of commission and scarcely any of omission. Perhaps some readers may fail to distinguish Galen's and Descartes's ideas from those of Galenists and Cartesians as presented by Frank. Or they may take ideas to be Oxonian which, if they were that, were also Cartesian, Scholastic, Galenic, or Aristotelian. But these are quibbles. What we have in Frank's book if taken as a whole is as enterprising, engaging, and enlightening an example of historical interpretation as this reviewer has recently read.

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Physiological Adaptations

Environmental Physiology of Fishes. Papers from an institute, Lennoxville, Quebec, Aug. 1979. M. A. ALI, Ed. Plenum, New York, 1980. xii, 724 pp., illus. \$69.50. NATO Advanced Study Institutes Series A, vol. 35.

The relationships between structure, physiology, and environmental variables in the largest vertebrate class, the fishes, are explored at length in this collection of 25 papers. Most of the papers (one of which is in French) provide summary reviews of major topics of investigation, such as the effects of gas concentrations; the problems of water, ion, and acid-base regulation; photoperiodic effects on reproduction; physiology of the pineal organ; and circadian rhythmicity. In addition, some responses to factors peculiar to the aquatic environment are treated in various degrees of detail.

One of these factors is the enormous range of hydrostatic pressure found in the oceans. Fishes are known to live to depths of at least 7000 meters, at which there is a pressure of over 700 atmospheres. Fishes furthermore migrate vertically in the water column, and thus may experience pressure fluctuations of 100 atmospheres or more. In a paper by Pequeux, some recent information on the effects of pressure on membrane permeability is reviewed. Pequeux points out that these pressure studies provide new evidence for the independent transport of sodium and chloride ions across membranes and may be a useful way to study the effects of local charge on membranes and the effects of charge on permeability. He also discusses pressure effects on equilibria that involve volume changes and the conse-

quences for biochemical processes other than permeability. In a second paper on pressure, Blaxter reviews some better-known pressure problems, such as swimbladder gas secretion against high gradients and also reviews some very recent literature on how fish prevent oxygen leakage at high swimbladder pressures by the deposition of oriented guanine platelets in the swimbladder wall and by changes in the lipid composition to favor longer-chain components with low permeability. The technical challenge of obtaining animals from the ocean depths in suitable condition for experimentation is formidable and has delayed progress in this fascinating area, so it is satisfying to see these new results collected.

Several papers deal with the sensory systems of the fishes. Below the thin surface layer, fishes exist in a dim blue-green to yellow-green environment in which the detection of contrast, or even of light emitted by photoluminescent fishes, is the prime consideration for visual organization. In reviewing the visual pigment composition and neural integration scheme, Lythgoe emphasizes the often conflicting demands of sensitivity, contrast detection, and detection of movement as well as the differences between land- and sea-dwelling animals. Dale provides some new information as well as a short review of the acoustico-lateralis sensory system, a unique sensory mode in the fishes that serves to detect vibrations in the environment. Popper and Coombs provide a short review and some new ultrastructural information on the ear and its role in sound detection underwater. Conspicuously lacking from the volume is any treatment of the production and detection of electrical information, another unique sensory mode that occurs in at least six taxonomically distant groups of bony and cartilaginous fishes.

Another conspicuous phenomenon among the fishes, and one of some practical importance, is migration behavior. The physiological basis of navigational performance, especially in the open ocean migrants, has been a great puzzle in fish physiology. How is a migration of thousands of miles accomplished with no visual ("landmark") clues? Recent evidence that fish may be able to sense electrical currents induced geomagnetically, either by natural water currents or by the movement of the fishes' bodies through the water, is reviewed by Tesch, along with information on the seasonal movements of some well-known migrant species such as eels, salmon, and tunas.

Overall the book provides timely and

provocative summaries of most of the major areas of investigation in the environmental physiology of fishes. No single volume can hope to be comprehensive—another much-used review now comprises eight full volumes—but within the framework of the possible this volume gets high marks.

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Subsistence in the Tropics

Parmana. Prehistoric Maize and Manioc Subsistence along the Amazon and Orinoco. ANNA CURTENIUS ROOSEVELT. Academic Press, New York, 1980. xvi, 320 pp., illus. \$29.50. Studies in Archaeology.

Few topics in archeology have generated as much heated debate as the mode of life of lowland South American peoples in pre-Conquest times. Clearly, theoretical issues broader than the archeology of Greater Amazonia are at stake. What is being debated is nothing less than the "nature" of tropical forest environments and the impact they have had on human cultural developments. Are the tropics capable of sustaining concentrated and complex societies? What are the agricultural productivity, settlement patterns, and carrying capacity of specific tropical habitats? In the context of Amazonia these questions take the form of comparing pre-Conquest demographic densities in the floodplain of the Amazon and Orinoco rivers with population densities in adjacent interfluvial habitats.

The hypothesis proposed by the author of *Parmana* can be stated briefly. Roosevelt suggests that the higher carrying capacity of floodplain habitats vis-à-vis the hinterland is due to the adoption of maize by peoples who grew primarily manioc before. (Other scholars have argued that it was due to better soils or more abundant fish and game.) She contrasts manioc, which grows well in upland soils and is rich in calories but poor in proteins, with maize, which is nutritionally more complete and is better suited to the floodplains. Once maize-growing peoples are released from the need to hunt and fish in order to secure their proteins they can (ergo) grow in numbers, become more sedentary, develop chiefdoms, engage in war, in short evolve a more complex society.

But how does Roosevelt actually reach her conclusions? She begins by criticizing the ideas developed by previ-

ous scholars. Julian Steward failed to explain Amazonian adaptations because he was a diffusionist, Meggers because she is an environmental determinist, Carneiro because he contradicts himself, Lathrap because he does cultural history rather than ecology, and Gross because he is ambivalent about his limiting factors. Unfortunately, Roosevelt does not entertain the possibility that these authors contradict themselves or are confused simply because the same scanty data can be interpreted in a number of different ways. That the information we have at present on the prehistory and ecology of this vast region may be insufficient to make grand generalizations emerges clearly from subsequent discussions. Chapter 3, the longest of the book (78 pages), presents much useful information on Amazonian forest soils versus floodplain soils, on hunting and fishing resources, on the problems of storage of crops and meat, on seasonality of yields, on erosion, and on land availability. However, Roosevelt's statement (p. 89) that tropical forests cannot (anywhere?) be cultivated intensively is by no means a foregone conclusion; certainly, much

of tropical Asia, or even parts of Africa, is cultivated intensively.

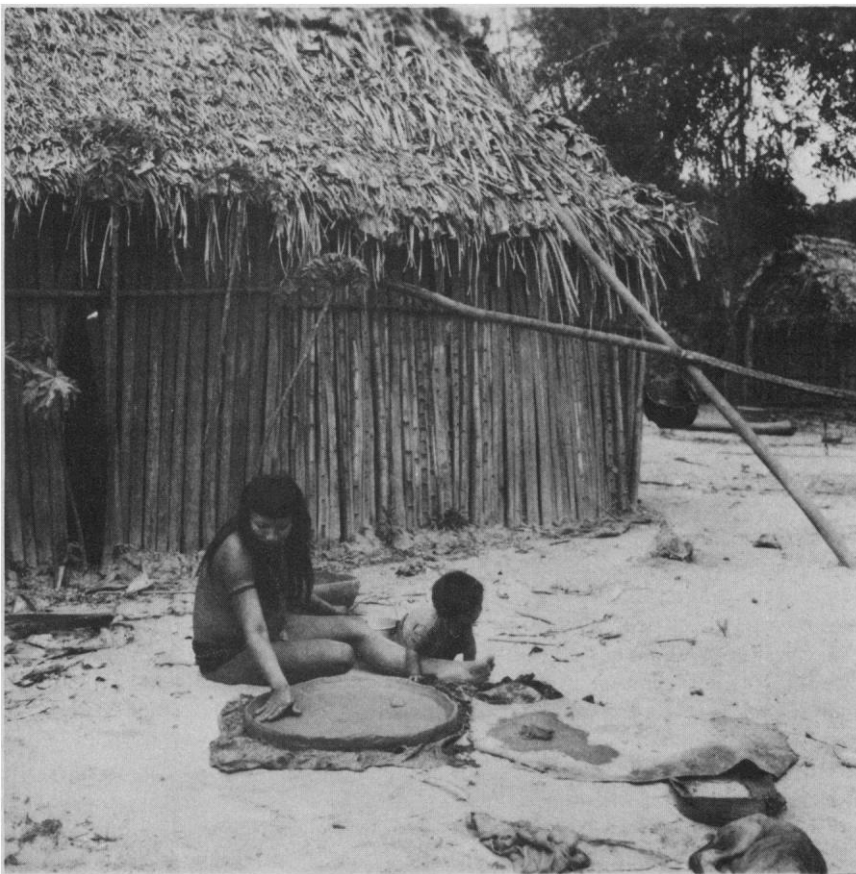
Anyhow, if maize did indeed raise the carrying capacity of Amazonian floodplain habitats then there should, as Roosevelt hypothesizes, be a temporal correlation in the archeological record between the first appearance of maize and increased demographic densities. Only after reaching chapter 4 did this reviewer fully realize where the author goes astray. Although Roosevelt builds up her ecological argument by using data mostly from Upper Amazonia (first 159 pages), the site she worked on, Parmana, is in the middle Orinoco River in Venezuela. (It is like talking about Sicily and Sweden under the rubric of "the European environment.") Are conditions in both immense river systems really comparable? In one sentence (p. 178) the author tells us that aquatic faunas are very similar; in the next sentence we learn that "Orinoco fish have a 60% degree of similarity with Amazonian fish." In fact, Parmana is in the edge of the Venezuelan llanos, in thin gallery forest surrounded by savanna. This would seem to me to be a better environ-

ment for maize than most of Amazonia (aside from the floodplains). At any rate, even by the loosest of standards, Greater Amazonia barely stretches to the Orinoco.

Chapter 5 presents the archeological test of the hypothesis. To reiterate, Roosevelt suggests that the replacement of manioc by maize in the Parmana, Corozal I phase (800 to 400 B.C.) is correlated with an increase in human population densities. Unfortunately, the evidence she presents is provisional. In a footnote (p. 193), we learn that the details of fieldwork and the analysis of the materials recovered from Parmana are being prepared for a subsequent publication. The obvious question to ask is why publish tentative radiocarbon dates, unanalyzed plant remains, approximate site size calculations, premature ceramic sequences, and so on just now? Why not wait until the analysis is further along?

In the final sections (summary and conclusions) we do learn, with some relief, that Roosevelt herself believes more work might be necessary before the maize hypothesis is confirmed and that patterns of change in subsistence and demography could be the result of other factors besides the ones mentioned. Here, she also hints that the evidence from the Orinoco might not be applicable to the Amazonian floodplain and that the whole argument may be only a rough sketch that ignores a great deal of complexity. The author seems to be her best critic.

In short, it seems necessary to point out that there is no single tropical forest subsistence system, no single lowland cultural development, no single floodplain habitat, no single chiefdom level of sociopolitical complexity, not even a single plant called manioc or a single race of maize. There are, instead, a multitude of tropical forest adaptations, an enormous variety of lowland developments, innumerable and highly localized microhabitats, many different kinds of chiefdoms, many manioc plants, ranging from highly toxic to sweet, and many races of maize, with extremely variable tolerances, yields, and methods of processing. Recent ethnographic studies conducted near the Orinoco and elsewhere in South America also suggest a great deal of local complexity in the kinds of plants that were used by prehistoric peoples, in the role played by vegetable proteins, and in the flexibility of swidden systems and their potential for increased yields. What resources are used by a tropical forest society may, in fact, depend less on supposed environmental factors than on



"Chacobo woman making a pottery griddle for baking manioc, Beni river, Beni Province, Bolivia. By Borys Malkin (1960). Many of the griddles that have been found in archaeological deposits bear the impressions of the cloth or matting on which they were modeled." [Negative No. 32375. Courtesy of the Museum of the American Indian. Reproduced in *Parmana*]

how successfully people, individually or in groups, concentrate resources and manipulate productivity (N. Irvine, personal communication). Moreover, both productivity and population densities may have fluctuated wildly in prehistoric times, as they do now. Until we can gain a better understanding of the mechanisms of demographic change in "natural" and human communities within the tropics, through detailed studies of particular interactions, there may be little to be gained from another speculative re-treatment of the same data.

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Tropical Storms

The Hurricane and Its Impact. ROBERT H. SIMPSON and HERBERT RIEHL. Louisiana State University Press, Baton Rouge, 1981. xxviii, 398 pp., illus. \$20.

The frequency of hurricanes affecting the United States has diminished over the past 20 years, and catastrophic losses of life have not occurred recently in this country. Even so, an up-to-date, general book on hurricanes is more relevant than ever owing to the unprecedented expansion of the population into coastal areas threatened by hurricanes. *The Hurricane and Its Impact*, written by pioneers in tropical meteorology and hurricane prediction, is therefore a welcome addition to the limited number of books on this topic. It should find a wide audience among scientists, engineers, and members of the general public who wish a comprehensive introduction to the scientific aspects and the social, economic, and political consequences of hurricanes.

The first half of the book consists of a survey of the structure and life cycle of hurricanes, from their genesis over warm tropical oceans to their eventual decay over land or colder water. The discussion of the life cycle and structure of hurricanes includes an introduction to hurricane climatology and to physical processes such as evaporation from the ocean and release of the latent heat of condensation. These aspects of hurricanes are dramatized by the description of individual storms such as Hurricane Camille in 1969 and by scenarios involving the reactions of people to hurricanes.

The second half of the book treats the important topic of the effect of hurricanes on human activities near the coast.

This half treats such practical aspects as the variation of the mean wind speed with height from the ground, the turbulent component of the wind, and the effect of wind on shoreline structures. Because most of the coastal damage caused by hurricanes is associated with water, considerable attention is also devoted to the effect of hurricanes on the ocean through the generation of storm surges and breaking waves.

A unique and valuable portion of the book assesses the hurricane threat and discusses ways to reduce hurricane risk. For example, return periods in years for hurricane strikes are given for 80-kilometer sections of the Gulf and Atlantic coasts and cumulative probabilities for the occurrence of hurricanes of varying intensity are presented. The prediction of hurricanes and systems for warning of them are covered in a comprehensive, understandable way.

Two aspects of the book could be strengthened. Portions of the discussion of the physical mechanisms of hurricane formation and movement are somewhat vague or insufficiently supported by references. Examples include the discussions of the role of sinking cold air in cyclogenesis and of the mechanism by which conservation of absolute vorticity in the ocean enhances the storm surge, the statement that hurricanes tend to avoid landfall, and the use of the concept of efficiency in various contexts without precise definitions.

The book also gives cursory treatment to two important aspects of tropical cyclones: the interactions between the small-scale cumulus clouds and the large-scale vortex and the rapidly expanding use of numerical simulation and prediction models. The latter neglect is unfortunate in view of the success of such models in simulating hurricanes and quantifying physical processes such as latent heat release, radiation, and boundary layer processes and their potential for isolating the physical mechanisms leading to hurricane formation and for testing hurricane modification hypotheses. A particularly frustrating statement concerns the slow, erratic motion of Hurricane Dora in 1964: "Clearly the atmosphere was indeterminate in this situation, precluding any valid forecasting method other than persistence" (pp. 174-175). In fact, the atmosphere is a deterministic system and therefore primitive equation models are entirely capable of forecasting the stalling of hurricanes when the environmental data, particularly the steering flow, are well resolved.

In spite of the criticisms, the book is an excellent summary of hurricanes for general readers as well as meteorologists. It is technically very well done, with numerous clear figures and supporting photographs from aircraft and satellites to illustrate the cloud structure of hurricanes. It is a worthy successor to Dunn and Miller's *Atlantic Hurricanes*, issued in 1960 by the same publisher.

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Atmospheric Motions

Dynamics of the Upper Atmosphere. SUSUMU KATO. Center for Academic Publications Japan, Tokyo, and Reidel, Boston, 1980 (distributor, Kluwer Boston, Hingham, Mass.). xiv, 234 pp., illus. \$29.95. Developments in Earth and Planetary Sciences, 01.

Susumu Kato's *Dynamics of the Upper Atmosphere* is an introduction to the theory of acoustic-gravity and tidal waves and their ionospheric effects, as well as a review of recent developments in these subjects. The upper atmosphere in this context refers to the region above about 90 kilometers, or the E and F regions in ionospheric parlance. Kato presents a nice balance between theoretical developments in upper atmosphere dynamics and the interpretation of ionospheric observations that contain signatures of neutral atmosphere dynamic processes. An instructional virtue of the book is that fundamental analog problems are utilized to illustrate and clarify the basic physics of upper atmospheric dynamical processes and to interpret results from theoretical (numerical) models and radar observations.

Following an introductory chapter on basic atmospheric properties and structure and the fluid dynamical equations governing atmospheric motions, a chapter on acoustic gravity waves adequately introduces the physics of acoustic waves and gravity waves by deriving and discussing the wave dispersion relation for an isothermal atmosphere and then qualitatively addressing the effects of temperature gradients, background winds, and molecular dissipation in modifying the propagation of these waves. In addition, several analytic solutions of wave propagation characteristics for particular excitations (infinite and finite-line harmonic oscillators and uniformly moving point and line sources) are obtained that represent analogs of realistic problems in