interpretation, geology, pedology, and ethology, these papers served as statements of current research into prehistoric human subsistence and lifeways in general, as parts of specific site reports, and as practical how-to documents on techniques such as sieving, froth flotation, faunal analysis, and site catchment studies. As a summary volume, essentially written by committee, *Early European Agriculture* differs in both structure and function from its antecedents. Rather than a series of disparate papers, it is an integrated volume that attempts to generalize from the prior work of the project rather than to break new ground.

The authors are fully aware of the problems inherent in trying to synthesize a decade of work that at times seemed to be going off in many directions under the general rubric of "economic prehistory." As a central objective they have chosen "to arrive at principles of economic behaviour which are stable in the long term, and which have far-reaching evolutionary importance" (p. viii). Restricted time and resources have forced them both to be selective in the regions covered and to narrow their focus primarily to the relationships between the subsistence base of prehistoric groups and their site locations. Thus European Russia, East Germany, Czechoslovakia, and Yugoslavia are not covered. Moreover, although economic interpretations are given of faunal assemblages, subsistence strategies, and site location preferences, the only attempt made to indicate the societal implications of the economic strategies is in terms of sedentarism or mobility of the group.

Early European Agriculture does not deal primarily with agricultural origins, or with problems of population replacement, culture contact, or diffusion in the spread of agricultural technology into Europe. It is a frankly paleoethological work, which applies principles derived from studies of animal behavior to human groups. Social behavior is seen as dependent on economic behavior, which is considered to be of primary importance among the long-term determinants of human behavior. The economic behavior of human groups is determined through "natural selection": "The economy is the primary adaptation whereby life is maintained and populations survive and grow. It is thus a biological linchpin exposed to the full force of natural selection, and as such it is to be expected that the impact of economic necessity or advantage will be widespread and profound in human behavior" (p. 5). To maintain this evolutionary position, the authors must posit a reason for the "selective advantage" of rational economic behavior. Although admitting the "woefully inadequate" time depth of most ethnographic studies, they assume that "human populations, like those of other animals, frequently exert considerable pressure upon their food resources" (p. 9). This further develops into the assumption that "population pressure has been a constantly repeated factor in human development" and that "it will have conferred a substantial advantage upon those communities with more rather than less productive economies" (p. 11).

This biological evolutionary paradigm structures the argumentation of the book. For example, dietary regimes are studied to assess the constraints and directives they place on economic activities, site locations, population levels, and, "ultimately, on the evolutionary development of the human species" (p. 18). To forestall the charge that they rely too heavily on a "demographic *deus ex machina*" in their insistence on the significance of population pressure, the authors note that at least "it is a conscious and intentional emphasis which we have given, and not merely an oversight" (p. 71). While the explicitness of their commitment is laudable, it does not mitigate the problems of this approach. The biological mechanisms of natural selection and adaptation only loosely fit so cultural a set of behaviors as economics. Without denying the obvious ethological parallels, one nevertheless is hard put to explain the "selective advantage" of one economic system over another in terms of differential reproductive success, viability, or adaptation (as the term is used in population genetics). Using biological evolutionary terms for paleoeconomic behavior produces a Lamarckian, rather than a Darwinian, evolutionary paradigm—intuitively and logically one knows that there is a relationship between the animal form (or cultural economic behavior) and its food sources (or site location choices), but the explanatory mechanisms for that relationship are lacking or based on questionable assumptions such as conscious effort (or rational economic behavior).

As a summary statement, *Early European Agriculture* cannot deal at length with the wealth of recent data pertinent to specific sites and regions. This is most evident in those sections of the book that treat major European physiographic zones (coasts, lowlands, uplands) as study units to delineate the regularities of long-term economic behavior. Heavy reliance is placed on summaries of works published elsewhere (often in the other two volumes from the project), which specialists will find more useful and complete. Those sections that are not summaries suffer from an apparent limitation of the method of analysis: paleoeconomic analysis of site exploitation territories is most useful on the single-site or micro-regional level; above that the regularities fade into obvious generalities. The techniques used to assess subsistence constraints and concomitant environmental interaction seem better suited as guides for framing paleoeconomic hypotheses than as synthetic principles.

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The Physiology of Hibernation

Hibernation and Torpor in Mammals and Birds. CHARLES P. LYMAN, JOHN S. WILLIS, ANDRÉ MALAN, and LAWRENCE C. H. WANG. Academic Press, New York, 1982. xii, 320 pp., illus. $37.50.

This concise yet easy-to-read book is an excellent synopsis of hibernation research, complete enough to provide an entry into the field, extensive enough to provide a useful review for workers in the field, and stimulating enough to suggest many exciting research challenges for future workers.

The first two chapters are an introduction by Lyman to the ecology and evolution of hibernation. Chapter 1 deals with what endothermy is and why and how it evolved and with why hibernation might have evolved as a subsequent adaptation to offset the high energetic cost of endothermy under conditions of limited resources. Chapter 2 surveys the species that hibernate. Hibernation is widely distributed among the various families of birds and mammals and appears to be of polyphyletic origin. We can thus expect species diversity in the physiological and biochemical mechanisms underlying hibernation. Lyman excludes from consideration seasonal dormancy in ectotherms and its possible homologies with mechanisms of hibernation in endotherms.

Chapters 3, 4, 5, and 7, by Lyman, and chapter 6, by Willis, are an excellent review of the studies that have characterized the systems physiology of hibernation. The authors emphasize cardiovascular controls and thermoregulation. They convincingly demonstrate that hibernation is not a failure or abandonment of normal homeostasis but an adaptive extension of the range over which the

animal's physiological control systems can operate. These chapters synthesize the old and new literature. The authors point out many questions that remain to be answered, such as those concerning periodic arousals from hibernation, the mechanisms inducing hibernation, the responsiveness of the hibernating animal to external stimuli, circadian rhythmicity during torpor, and the control of thermogenesis and the distribution of heat during arousal. Important literature on circadian rhythmicity during torpor has been overlooked in these chapters, and there is no treatment of circannual rhythmicity. All in all, however, the chapters provide an excellent overview of major issues in the physiology of hibernation.

Chapters 8 and 9, by Willis, cover an enormous literature on cellular and biochemical adaptations associated with hibernation, and they reveal the lack of general and unchallenged conclusions on the subject. Perhaps broad generalizations are the exception rather than the rule at the cellular and biochemical level, for very different solutions to the problems of functioning at low temperature may have evolved in different species. However, some variability in experimental observations may result from technical difficulties in isolating components of the integrated hibernation physiology in vitro. It is difficult to interpret which differences in results are a consequence of culture and assay and which are true evolutionary differences. Willis comments that in interpreting the results of in vitro work "one must erect a framework in the context of which the isolated observations may achieve relevance, hoping meanwhile that the structure thus erected does not turn out to be a hanging scaffold." The control of brown fat metabolism, a subject on which major progress has been made in recent years, is not discussed.

In chapters 10 and 11 Lyman presents some interesting but more peripheral and seldom reviewed literature on cell cycles, aging, and resistance of the tissues of hibernating animals to disease, parasites, radiation, and malignancy.

In chapter 12 Wang comprehensively reviews endocrine mechanisms associated with hibernation. The hypothalamic-pituitary axis is very much involved in hibernation physiology and should be studied in detail. It is remarkable that so little study has been devoted to the relationship between reproductive endocrinology and hibernation, for the reproductive cycle and the hibernation cycle appear to be tightly linked.

Chapter 13, on respiration and acid-base state in hibernation, is a wonderfully clear treatment by Malan of a difficult subject. In addition to reviewing the literature Malan clearly and convincingly relates his hypothesis that a self-induced acidosis may play an important role in the inhibition of cellular metabolism during hibernation and a direct role in resetting the thermoregulatory system.

The concluding chapter, on recent theories of hibernation, is a provocative and critical discussion by Lyman of various attempts to synthesize explanations of the evolution and the mechanisms of hibernation. The exciting and controversial work on hibernation "trigger" is examined closely.

This book is an excellent progress report on hibernation research and sets before us a future agenda. But it makes one realize that at least another generation of researchers will have to match the wide-ranging contributions of Lyman before the conclusive book on mechanisms of hibernation can be written.

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Cloud Processes

Cloud Dynamics. Proceedings of a symposium, Hamburg, Aug. 1981. E. M. AGEE and T. ASAI, Eds. Terra Scientific Publishing, Tokyo, and Reidel, Boston, 1982 (distributor, Kluwer Boston, Hingham, Mass.). viii, 424 pp., illus. $49.50. Advances in Earth and Planetary Sciences.

This book is intended to serve "as a brief introduction to the study of cloud dynamics with primary emphasis on current international research efforts," and despite the drawbacks of such multiauthored volumes one must regard it as meeting this somewhat limited goal pretty well.

The book is divided into two sections, on shallow convection and deep convection, and each section has an introduction by Agee. In the section on shallow convection, he reviews the classical results of the laboratory experiments of Benard and the subsequent theoretical treatment of Rayleigh and some of its more modern refinements. Agee then illustrates various types of shallow convection in the atmosphere with radar and satellite observations. The review will probably be difficult for the nonmeteorologist because it contains a lot of jargon, but it should serve as a useful primer or refresher for those with some background. It could perhaps have been improved by putting greater emphasis on physical insight (explaining the physical reasons for a critical Rayleigh number for the onset of convection, for example, and discussing why the circulation pattern for convective cells in gases is expected to reverse from that in liquids) than on listing of results.

Subsequent papers considerably expand this introductory material with both observational and theoretical treatments of the distribution, structure, and convective instability of horizontal rolls, cloud streets, and bands. Two papers treat the effects of long-wave radiation on layer clouds (where radiative cooling can profoundly affect the upper few hundred meters of the cloud) and on trade wind cumuli (where radiative interaction appears to produce a noticeable though generally small enhancement of the cloud energetics).

Two papers not particularly specific to shallow convection are included in the first section of the book. The first, by Emanuel, is a highly readable treatment of his application of similarity theory to small-scale downdrafts within cumulus clouds. Recent observational studies have given clear evidence that air is entrained into some clouds through the top, rather than the sides, and is subsequently mixed through the cloud by penetrative downdrafts. Such mixing has important microphysical as well as dynamical implications, and Emanuel's analysis is probably the most successful application of similarity principles to cumulus convection. In the second paper, Betts summarizes a new concept, the saturation point. In unsaturated air the saturation point is the familiar lifting condensation level. However, with cloudy air Betts shows how a generalization that includes the idea of a sinking evaporation level can be useful in studying the thermodynamics of cloudy air, mixing of cloud with the environment, and thermodynamic equilibrium structure and instability. Like most of the papers in the book, Betts's paper is a summary of published or soon-to-be published journal articles. In the present case, though one can get the gist of things from the version in the book, the more complete discussion in the original journal article is quite a bit easier to follow.

The section on deep convection starts off with an introduction on thunderstorm structure and geographic distribution. Severe storms are given the most emphasis, with results from the Thunderstorm Project and the work of Newton and of