Homo, a small form different from both *A. africanus* and *H. erectus* occurring about 1.8 million years ago and a large form close to *H. erectus* occurring in the uppermost beds dated at about 1.0 million years ago.

The exciting archeological data from East Rudolf are summarized by Glynn Isaac, J. W. K. Harris, and D. Crader. The oldest known human cultural evidence, dated at about 2.4 million years ago, suggests that some hominids had already developed behavioral patterns that were of fundamental importance for the evolutionary differentiation of modern *Homo sapiens* from other primates. These included tool manufacture and use, meat eating, operation out of a home base, and possibly some form of cooperative division of labor. This evidence is entirely consistent with the fossil data indicating that some early hominids were bipedal, with hands free for tool use.

In summary, this is a valuable volume that brings together more than a decade of research not previously available in such comprehensive form. It will prove extremely useful to anyone interested in geological, paleontological, or archeological problems in Pleistocene Africa, and will certainly be the starting point for all further research in this area.

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Stratigraphy of a Famous Site

Geology of the Olduvai Gorge. A Study of Sedimentation in a Semiarid Basin. RICHARD L. HAY. University of California Press, Berkeley, 1976. xvi, 204 pp., illus. + plates. $22.50.

The Olduvai Gorge, in Tanzania, is probably the world's best-known site in connection with early man, largely through the work of the late L. S. B. Leakey and his wife, Mary, who have received both financial support and publicity through the National Geographic Society. Mammal fossils were first found there by Kattwinkel in 1911, and in 1913 a preliminary geological survey was made by Hans Reck, who recognized five stratigraphic units and numbered them from the base upward. Leakey began his work in the gorge in 1931 and persisted with scanty funds until the discovery in 1959 of the australopithecine skull popularly known as "Zinj," after which money became available for large-scale excavations and detailed study. A turning point in the reconstruction of the history of early man was the 1961 dating by Evernden and Curtis of tuffs in bed I as 1.75 million years old, which gave for the first time a real indication of the antiquity of the human family.

Richard Hay began in 1962 a systematic study of the stratigraphy and sedimentological characters of the deposits, and this volume is the report of some 12 years of investigation. It is a most impressive document and must surely be one of the most detailed and thorough studies of a single small area ever published. Each of the component beds is discussed in detail, including lateral variations and facies changes, and the characteristics are used for environmental interpretations and paleogeographic reconstructions. The Olduvai basin is bordered on the south and east sides by volcanoes that have contributed detrital sediment and pyroclastic debris. Hay has shown that Ngorongoro furnished the volcanic floor but Olmoti supplied much of the tuff material in beds I and II. Within bed II, an eolian tuff known as the Lemuta member forms a striking and useful marker horizon. Widespread faulting caused erosion of bed II so that beds III and IV were deposited in a different setting and are themselves separable only in the eastern part of the basin. The former upper part of bed IV is now separated as the Masek beds, which rest unconformably on the earlier deposits, and the former bed V constitutes two units, the Ndutu beds and the Naisiusiu beds, deposited under conditions of tectonic instability. The unraveling of the complex of lithofacies into half a dozen different types of depositional environments has resulted in a very complete history of events in the gorge, well summarized in chapter 11, and there is evidence for a close association of hominid activities with particular lithofacies that indicate a perennial supply of fresh water.

The volume is very well illustrated, both by clear figures and relevant photographic plates, and there is a glossary that will be useful to the many anthropologists and archeologists who will need to read it; appendixes provide radiocarbon dates and a list of all archeological sites. The size and format match those of the Cambridge University Press volumes *Olduvai Gorge, 1951–1961*, to which Hay's book is an essential companion.

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A New World Culture

The Hohokam: Desert Farmers and Craftsmen. Excavations at Snaketown, 1964–1965. EMIL W. HAURY. Published in collaboration with Southwest Parks and Monuments Association by University of Arizona Press, Tucson, 1976. xii, 412 pp., illus. $19.50.

Quibblers will perhaps object to the principal title of this book, which is primarily a report of the results of a year's excavations carried out at one site in southern Arizona. But in reality these excavations together with the excavations Haury carried out at the same site in 1934–35 do indeed constitute the major study of the Hohokam culture.

Rarely does an archeologist have the opportunity that Haury had of returning after 30 years to reexcavate a major site employing an array of new methods and techniques. He and his colleagues have made excellent use of this opportunity. The importance of the Snaketown excavation—and the Hohokam—is well illustrated by the storm of contention regarding chronology, internal development, and extent of Mesoamerican affiliations that followed publication of the original Snaketown report in 1937. For example, in the present report Haury charts (fig. 16.1) no fewer than six greatly differing chronologies for the Hohokam—the one he and his colleagues advanced in 1937, two others by one of the original authors, and three proposed by other outstanding Southwestern archeologists.

The stated objectives of the new research included clarification of chronology (using new dating techniques and methods); expansion of knowledge regarding the earliest Hohokam periods and their presumed origin in the preceding Cochise culture; evaluation of the nature, extent, and time of Mesoamerican influence on the Hohokam; and finally, concentration on the history of irrigation agriculture as developed at Snaketown.

The various chapters and appendixes of the book demonstrate the thoroughness, skill, and craftsmanship of the field and the laboratory studies and the soundness of Haury's conceptualization and interpretation of the data, both new and old. The "new archeology" dedicated to processual studies notwithstanding, Haury states without apology that he has utilized the "historico-cultural approach," noting that processual studies will come in due time—following, as they must, studies such as this.

The new excavations at Snaketown verified the phase sequence established

in the earlier excavations. However, many developments previously thought to have occurred in the Colonial period, or later, were traced back into the earlier Pioneer period, some to its very beginning. Among these was canal irrigation, originally thought to have been invented locally in the Colonial period. Large-scale and ingenious excavation of the network of overlapping and intersecting canals led to the location and tracing of a shallow Pioneer period canal of simple construction. Fill in older levels of this canal produced only ceramics diagnostic of the Vahki phase, representing the earliest occupation of the site. Haury concludes, with reason, that the concept and techniques of canal irrigation were brought to Snaketown by its first settlers, a conclusion of great importance in determining Hohokam origins.

Traits attributed to the earliest settlers ("forming a constellation of attributes for which there are no local antecedents") include a highly developed system of water control and an associated tillage economy involving new races of maize, cotton, beans, and squash; well digging; large, squarish, sunken-floored houses; presumable extended-family living in established villages; cremation of the dead; well-established pottery making, producing especially gray-brown and red-slipped wares lacking painted decoration. In addition there was a human clay figurine complex, a specialization in use of marine shell jewelry and shell carving, stone sculpturing, use of full-troughed and exteriorly shaped metates, use of incised bone tubes, probably skill in textile arts, and, significantly, use of turquoise mosaics. Haury believes that social and political leadership, though adequate to guide development and maintenance of the water control system, was "at best . . . no more complex than that of a simple peasant society."

Haury concludes that this block of traits was sufficiently large and complex to be considered a cultural unit; the simultaneity of appearance of the traits and the absence of local prototypes indicate that they were carried into the Southwest by a migrant group. Thus Haury's previous view that early Hohokam evolved locally from the antecedent Cochise culture is reversed. He now believes that "such a migration could have come from Mexico probably as early as 300 B.C. and that after having 'settled in' the society enjoyed a long local development, though nudged to greater cultural heights from time to time by infusions from Mesoamerica."

The place of origin in Mexico of the migrants cannot yet be specified, but Haury speculates that the original Hohokam departed from some place in the Mesoamerican frontier region, perhaps an arid area, during the Preclassic horizon before 300 B.C. He suggests northern Michoacan, Guanajuato, southern Zacatecas, or an adjacent coastal area as possibilities.

This choice of a date of 300 B.C. for the appearance of the earliest Hohokam raises once again the controversial question of Hohokam chronology. In this new study, Haury utilizes dendrochronology, cross-dating through the evidence of intrusive pottery, archeomagnetic dating, obsidian hydration dating, and alpha-recoil track dating. Regrettably, some of the dates obtained were based on insufficient material or were contradictory, some of the techniques used are still experimental, and some of the results obtained permitted alternative interpretations. Helpful as they are, the dating techniques supplied by other sciences remain subject to error from many sources, some inherent in the techniques and others resulting from the nature of the archeological record. Haury, like other archeologists, has had to choose among his options, utilizing his own archeological experience and insight. Dates after A.D. 700 are reasonably firm. The problem lies with dates for Snaketown phases preceding the Santa Cruz phase, especially the critical beginning dates for the earliest Vahki phase. Haury relies on general archeological reasoning plus three archeomagnetic dates of 300, 250, and 200 B.C., not coincidentally repeating his estimate of earlier years, to derive the initial date of 300 B.C. for the Vahki phase.

Haury rejects the hypothesis of Charles DiPeso that there was an earlier "Ootam" occupation followed by an advanced "Hohokam" intrusion from Mesoamerica in the late Pioneer period, or after A.D. 900 in DiPeso's chronology. He agrees that Hohokam culture enjoyed an efflorescence during the Colonial period, accompanied by the introduction of some new Mesoamerican elements, but believes that this efflorescence was essentially a climax of Hohokam cultural evolution. A number of archeologists working in northwestern

Excavators in the well area of Snaketown, attempting to delineate early Hohokam efforts to reach the water table. "About 2 m down, a hard, more or less flat caliche layer was encountered. . . . This capped a sand layer . . . , which in turn rested on another caliche layer. . . . In places, the top caliche layer was missing. Where its edge could be detected, the pattern described [suggested] removal . . . by man. . . . We may assume, on the basis of all evidence available, that the sand layer was the aquifer and that tapping the water supply was the motive for the digging. Although no groundwater was encountered in our search, enough moisture existed to produce cauliflower-like crystallization of salts on the surface of the lower caliche layer during a single night's exposure to air." [From *The Hohokam: Desert Farmers and Craftsmen*]

Mesoamerica (including the reviewer) and some Southwestern archeologists will certainly challenge this conclusion, at least with respect to the intensity of Mesoamerican influence at that time.

Haury's book—including the several appendixes—is a veritable encyclopedia of archeological data. Its great value lies not only in its data and in the major conclusions it draws but equally in the careful and mature consideration of every question arising from the discoveries made. Haury once again has demonstrated his superb mastery of the archeologist's skills, techniques, and methods. The book is thoroughly illustrated with maps, drawings, photographs, and charts, carefully chosen to clarify the descriptions and discussions. Best of all, there emerges from the archeological record presented a clear view—no matter what the outside influences were—of the evolution in situ, in a somewhat grim environment, of the culture of one people over a span of some 15 or more centuries. Historians as well as archeologists will find the book a rich source of data, and the data are so well presented that the "new archeologists" will be able to live on them for many years.

The Hohokam is a fitting testimony to Emil Haury's prominence in his field. It is a rich contribution to archeological knowledge and a scholarly demonstration that the "historico-cultural" approach is still viable and productive.

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Brain-Behavior Relationships

The Hippocampus. ROBERT L. ISAACSON and KARL H. PRIBRAM, Eds. Plenum, New York, 1975. Two volumes. Vol. 1, Structure and Development. xviii, 418 pp., illus. $24.50. Vol. 2, Neurophysiology and Behavior. xviii, 446 pp., illus. $24.50.

The need for a comprehensive review of hippocampal anatomy and function has been mounting for more than a decade, and the appearance of the present two-volume work on this formidable subject is therefore an event of considerable importance in neurology.

The book is composed of 29 reviews and an editorial introduction and summary written by authors noted for their contributions to hippocampal morphology or physiology. The first volume is devoted to cellular organization and development, neurochemical aspects, and endocrine involvements of the hippocampus. The first of these topics is dealt with in seven chapters, five of which are morphological and cover cytoarchitecture and extrinsic and intrinsic fiber connections of the hippocampus (R. B. Chronister and L. E. White, Jr.; E. W. Powell and G. Hines), prenatal cytogenesis and phylogeny of the hippocampus (J. B. Angevine, Jr.), postnatal cytogenesis (J. Altman and S. Bayer), and the rearrangements of synaptic territories that follow experimental interventions on various afferent connections (G. Lynch and C. W. Cotman). Two further chapters deal with the neurophysiological aspects of the same general subject: P. Andersen's with the observations that have led him and his colleagues to a concept of a lamellar form of hippocampal segmentation, and P. D. MacLean's with the exteroceptive and interoceptive inputs to the limbic cortices adjoining the hippocampus. Neurochemical aspects of hippocampal afferentation are reviewed comprehensively by D. W. Straughan, and R. Y. Moore and M. J. Kuhar deal especially with monoamine and acetylcholine afferents, respectively. On the endocrine side, B. S. McEwen *et al.* review the evidence regarding glucocorticoid receptors in the hippocampus, B. Bohus and C. Van Hartesveldt the modulating influence of the hippocampus upon the pituitary-adrenal axis, and B. K. McGowan-Sass and P. S. Timiras the reciprocal involvement of the hippocampus in the cyclical release of ovarian and adrenocortical hormones. Somewhat out of context in this volume is its last chapter, in which S. Nakajima deals with memory impairments elicited by puromycin and actinomycin D and by experimentally induced abnormal neuronal-discharge patterns in the hippocampus.

The physiological and behavioral chapters composing volume 2 deal more explicitly with the general functional significance of the hippocampus. O. S. Vinogradova concludes an extensive review of single-unit recordings with the suggestion that, within the grouping of limbic structures, the hippocampus acts as "the active filter of information, participating in the process of suppression of reactions when the environment is stable." P. J. Livesey concludes that the hippocampus facilitates the attentional processes essential in determining clue relevance; R. J. Douglas attributes to the hippocampus a function in inhibiting emotional reactivity; and D. P. Kimble suggests that it has a role in enabling the behavior of animals to be flexible rather than rigidly determined by reinforcement. The hippocampal slow-wave or theta rhythm, discussed in six chapters dealing with the electrical activity of the hippocampus, is variously linked to attentive attitudes (T. L. Bennett) or to particular forms of active voluntary behavior (C. H. Vanderwolf *et al.*; A. H. Black), but it is also reported to have different behavioral corollaries in different animal species (J. Winson; D. P. Crowne and D. D. Radcliffe). J. B. Ranck, Jr., correlates the theta rhythm with activation of a small number (5 percent of the total) of neurons widely distributed in the hippocampus. On the subject of the role of the hippocampus in memory processes, E. A. Serafetinides *et al.* link ictal impairments of memory and orientation to electroencephalographic abnormalities in the temporal lobe, especially of the speech-dominant hemisphere, and N. Butters and L. Cermak find the hippocampus of that side involved in retention of verbal materials, that of the opposite side in nonverbal memories. In a scholarly final chapter L. Weiskrantz and E. K. Warrington emphasize in particular the growing evidence that the memory impairments following temporal-lobe lesions cannot be attributed simply to a failure of "consolidation" or long-term storage. Each volume of this generally well-written book has a useful subject index, but many readers will find the absence of an author index inconvenient in a publication of this size and scope.

As a synopsis of knowledge concerning its complex subject in the mid-1970's this book is a unique contribution to the neurological literature. With few exceptions, its individual chapters are well worth reading and provide the fair coverage needed to make publications of such scope optimally useful to both beginning students and established investigators.

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Books Received

Admissible Sets and Structures. An Approach to Definability Theory. Jon Barwise. Springer-Verlag, New York, 1975. xiv, 394 pp., illus. $29.60. Perspectives in Mathematical Logic.

Analytical Aspects of Mercury and Other Heavy Metals in the Environment. R. W. Frei and O. Hutzinger, Eds. Gordon and Breach, New York, 1975. viii, 196 pp., illus. $19.50. Current Topics in Environmental and Toxicological Chemistry, vol. 1. Reprinted from *International Journal of Environmental Ana-*

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