accomplish and what some of the open problems are.

The book is conveniently divided into four quite self-contained parts in such a way that it is not necessary to proceed in the order they are presented in. However, most readers will prefer to attempt part 1, on population dynamics, first, since this is one of the oldest and best-known parts of the subject. Although it is brief, the treatment given should provide the conceptual base for the understanding of much of the recent literature centered around the competition equations.

Parts 2 and 3 are devoted to the spatial patterns in one- and multi-species populations respectively, subjects to which Pielou herself has made significant contributions. Both discrete and continuous populations are treated, and the consequences of various sampling procedures, such as quadrat sampling and distance sampling, are investigated. In all cases assumptions are clearly stated and the limitations of the resulting formulas adequately explained.

Whereas parts 2 and 3 seem to focus on plant ecology, the final part of the book is of wider interest. It contains a good discussion of the mathematics behind species-abundance relations, currently one of the hottest topics in statistical ecology.

One of the characteristics of some recent work in mathematical ecology has been its lack of rigor. Precision has often been sacrificed for generality and realism. The danger in this procedure, of course, is that the conclusions of the subsequent "analysis," which are often qualitative conclusions, are then suspect. With this book, Pielou has attempted, on the whole successfully, to introduce the student to the more rigorous approach.

At times there are anomalies in the degree of sophistication expected of the reader. For example, in the chapter "Patterns resulting from diffusion" the author includes the passage to the Fokker Planck equation from the random walk. But she has chosen to omit the simple and elegant probability-generating function approach to the birth and death processes of chapter 1 in favor of a more messy induction approach. Again, in chapter 5 when the competition equations are dealt with the local stability criterion for ordinary differential equations should have been invoked so that the reader could easily move to more general cases.

A major criticism of the book as a text is that, with few exceptions, the relevant biological situations and data pertaining to the various models are omitted. One may therefore predict that the reader, if a biologist, will find his interest flagging as he proceeds through the calculations without seeing how they tie in with observation. On the other hand, sufficient references are given so that the enthusiastic and diligent reader can correct this deficiency for himself.

Pielou has been successful in conveying to the reader the rationale behind the various statistical definitions and in showing where they are and are not satisfactory. Areas where further research is needed are discussed, and often the direction this research might most fruitfully take is outlined. Mathematical ecology has become a fashionable discipline. This volume should enable graduate students and researchers in ecology to evaluate the work in an area which to some has seemed mysterious and which others have taken on faith.

MARCUS W. FELDMAN
Department of Biological Sciences,
Stanford University,
Stanford, California

Archeology in Eastern Africa

Kalambo Falls Prehistoric Site. Vol. 1, The Geology, Palaeoecology and Detailed Stratigraphy of the Excavations. J. D. CLARK. With contributions by G. H. Cole, E. G. Haldemann, M. R. Kleindienst, and E. M. van Zinderen Bakker. Cambridge University Press, New York, 1969. xvi + 256 pp., illus., + maps and plates. $14.50.

J. Desmond Clark tells us that Kalambo Falls is one of the most interesting sites he has examined. The importance of this "unforgettable" site is evident when one turns to any discussion of African prehistory. The book is an example of an interdisciplinary study in prehistory, an environmental and ecological study, a specialty in which Clark is justly recognized as a leader. The present volume is the backdrop to two forthcoming volumes which will give the archeology and the general significance of this site in African prehistory.

The particularly interesting feature of the site, and the one for which it is most famous, is its well-preserved wood. This wood, dated to a remarkably early age, was painstakingly extracted by means of the simplest kinds of tools, namely hands, water, and fine hair brushes. The wood was found in place with the actual living floors and the archeological remains. To my knowledge, such an occurrence had not been observed before this in Africa, and has been found only very rarely in Europe. This unique preservation is due in the main to the peculiarly favorable conditions of the water-saturated soil. These same conditions unfortunately destroyed all but the most recent bone remains.

The prehistoric cultures represented cut across the known chronology of this part of eastern Africa. We have first, at the top, the Iron Age, followed by the Microlithic, then the Magosian, the Lupemban, followed by the Sangoan, and, at the bottom, the Acheulian. At the base of the Lupemban is a questionable culture horizon which is called "(?) Lupemban." Actually, the very lowest of the remains of the occupations were not reached, because the deposits are below river level, beyond the reach of the excavators at present. By means of several large concrete casings joined together, the excavators were, however, able to probe down into the deposits of the Acheulian age to about 9 feet below the water level.

We have been well prepared for the appearance of this book from the first discovery of the site by Clark in 1953 and his ensuing reports. This book settles some old questions, but raises some new ones in turn. One of the old questions was why this site, occupied from the early Stone Ages, over 60,000 years ago, to the Iron Ages, was selected by its occupants. Eduard G. Haldemann, one of the two field geologists involved in the work, appears to have the answers. The solution is based upon the topography and other local special features of the river and of the site. Judging by the present environment, there is no clear reason why this particular locale would be chosen in preference to other spots on the now sluggish Kalambo River. Haldemann suggests that it must have been a convenient place to cross the river. This makes good sense. It could have been a "staging" area for a crossing, or a point at which people waited for the best time to cross. Haldemann also advances another consideration, of broader significance. The Kalambo River would have become a very important source of fresh water during the times when the level of Lake Tanganyika (at present situated about 3 miles from the falls) was lowered, as it is believed to have been, and the lake water became more saline because of the drier climate. The Kalambo

thus would have been the only permanent river and, moreover, the only freshwater source in the area southeast of the lake.

Lying in one of the least known parts of Africa, the Kalambo Falls area is but sparsely inhabited by either man or animal. However, it lies in one of the crossroads of eastern Africa, in the Tanganyika-Nyasa corridor between Lakes Tanganyika and Malawi. We have here something like an hourglass constriction, connecting northeast Africa and the interior of southern Africa.

When this site was first discovered it was thought that its inhabitants had been a group of prehistoric lake dwellers. That interpretation was abandoned following the detailed investigation in 1959 and 1963, which showed that the deposits were largely fluviatile in origin. There is abundant evidence for this—alignment of the pebbles in the deposits, tree trunks (in the older deposits) with their heads pointing downstream, and the numerous channel cuttings and aggradation of sediments. Having once accepted the reports that this was a lakeside occupation, with all that that means for prehistoric adaptation to environment, one finds it a wrench to adjust one's thinking to a riverine situation. Fortunate is the archeologist who can correct his interpretations in the course of the fieldwork, and credit is certainly due to Clark and his associates for their masterly presentation of the evidence supporting the new line. Fundamentally, in the mind of this reviewer at least, the whole prehistoric occupation revolved about the proximity of the water at the Kalambo Falls site.

As Kleindienst points out, because of the work of the water in ancient times, none of the sediments and deposits from the key site A could be duplicated in exact detail at the other three locales. In order to get their correlations, the investigators had to do some involved sleuthing, based on lithology, organic remains, carbon-14 dating, elevation, and artifact contexts. With regard to the geology, it is curious that the standard Munsell color chart was not used here.

Probably the single most interesting bit of research involves the paleoclimatological aspect. E. M. van Zinderen Bakker discovered from his pollen studies that there were considerable changes in vegetation at the site during the Pleistocene. The results of his work are presented graphically in fig. 17, in which he illustrates the striking similarities between Woldstedt's temperature curve for the last 70,000 years in Europe (the Last Glaciation) and the results he obtained at Kalambo Falls. One could argue that the graph for Kalambo Falls shows more dots off the curve than on it, indicating a certain amount of supposition, but we have no reason to believe the situation was other than as Bakker depicts it.

After having been conditioned to the traditional chronological divisions, the "Earlier," "Middle," and "Later" Stone Ages, which Clark helped propagate in his book *The Prehistory of Southern Africa* (see table 3 there), published 10 years before the present work, we find these terms conspicuous by their absence in the report on Kalambo Falls. Actually, Clark used this nomenclature in connection with Kalambo Falls through the middle '60's. Heavy doubts concerning the inflexible nature of this arbitrary framework were raised in the Wenner-Gren Foundation for Anthropological Research symposium on Africa in 1965 (see *Background to Evolution in Africa*, 1967, edited by Walter W. Bishop and Clark). Regardless of the merits of abandoning a given system of nomenclature, the fact is that discarding something already fossilized in the literature takes a little time to get used to.

The archeologist who is trained neither as a botanist nor as a geologist will probably get most use out of appendix K. This appendix gives us a welcome summation of the finds from localities A, B, C, and D at Kalambo Falls by archeological horizons. Appendix J will also be frequently referred to by researchers. It is a detailed summary of the radiocarbon dates for the archeological industries.

As Clark says, admitting all of the lacks in the record at the Kalambo Falls site, the unaccounted-for gaps in the chronological record, and the problems in the archeology and geology, it is transparently evident that here we have the most complete record available for this span of time in sub-Saharan Africa. As a backdrop to the forthcoming publications on the same site, Clark and his associates have demonstrated the kind of habitat and the biome against which were interplayed man and his culture. Actually, Clark might be accused of being a kind of "environmental determinist," which were once almost fighting words. Writing on Kalambo Falls in the *Scientific American* in 1958, Clark suggested that by the end of the Pleistocene, about 10,000 years ago, the stream of human progress had shifted out of Africa to the Near East and Europe. By then, lower Africa had become a "backwater" because life in Africa was "easy" compared with the rigors offered by the elements in the newer parts of the occupied world. We do not know if Clark will dwell on this theme in the other books on Kalambo Falls, but it is something that goes vastly beyond our present reach.

RALPH S. SOLECKI
Department of Anthropology, Columbia University, New York City

Island Faunas

Mammals in Hawaii. A Synopsis and Notational Bibliography. P. QUENTIN TOMICH. Bishop Museum Press, Honolulu, 1969. viii + 240 pp., illus. $5. Bernice P. Bishop Museum Special Publication 57.

Like most remote lands, the Hawaiian Islands possess a sparse fauna of endemic mammals. Aside from a rich variety of whales and dolphins (17 species) in the surrounding waters, the indigenous mammals include only a species of monk seal and a subspecies of the hoary bat, both of which presumably reached here under their own powers. But the list of other mammals that have populated the area now includes 26 exotic species of eight orders. Here indeed is a natural laboratory for studying the ecology of introduced forms, and this volume provides a firm foundation on which to build.

Polynesian settlers, possibly as early as the 2nd century A.D., brought with them the pig, dog, and Polynesian rat. Following Captain James Cook's first arrival in 1778, European explorers and traders introduced cats, dogs, and mice and other rodents, many of which later assumed considerable economic and public health importance. With the development of agriculture, the mongoose and two species of bats (which failed to survive) were imported for the control of pests. Interest in sport hunting led to the introduction of such ungulates as the axis and mule deer, pronghorn, and mouflon. At various times the wallaby, rabbit, and guinea pig were released or escaped. There now are 19 free-ranging, established terrestrial species, including (in both feral and domestic states) the horse, donkey, sheep, goat, cow, and water buffalo, that reached the islands through the agency of man.