sults. This paper also complements one in section 3 by Wartiovaara and coworkers on "matrix" glycoproteins in early development, which covers expression in early mammalian development of collagens and other glycoproteins as well as fibronectin.

About half the book is taken up by papers on cell surfaces in early development. Three important sets of data, from the laboratories of Vacquier, Shapiro, and Epel, cover fertilization from the first encounter and specific association of gametes to membrane changes in the zygote. Specific molecules for the association of sperm and egg (Vacquier), the persistence of the sperm surface in the developing embryo (Shapiro *et al.*), and the role of calcium in fertilization (Epel) are among the topics covered, but the authors have much to say about events in fertilization and discuss a wide range of subjects concerning membrane changes at fertilization.

Gamete interactions in *Chlamydomonas* and in higher plants are discussed by Goodenough and Adair and by Linskens. Plant development has generally been slighted by experimental embryologists. Contacts between workers on animal development and workers on plant development have been few, and it is good to find the paper by Linskens indicating that some selectivity mechanisms in higher plant fertilization probably involve adhesive specificities familiar to those working in animal cell adhesion. Although its language is somewhat unfamiliar, the paper is worth a careful reading. The paper by Linskens, one in section 3 on lectins and their receptors as determinants of *Rhizobium*-legume associations, and two on lectins of animal cells, those of teratocarcinomas (Martin and co-workers) and those of chick embryos (Barondes), suggest some features of cell adhesive specificity common to many organisms. Though Glaser in his paper suggests that cell adhesion in different systems will proceed via different mechanisms, a theme emerging from the symposium is that lectins and receptors provide specificity of initial recognition.

In conclusion I might mention a paper on the role of the cell cortex in development. Kirschner and co-workers describe experiments on several aspects of early development in *Xenopus*, initiation of the cell cycle and establishment of dorsal-ventral asymmetry in the fertilized egg. The section on the cell cycle documents the waves of surface contraction that sweep over the fertilized egg in a period with a clearly defined relationship to cell cleavage. The authors develop a model in which a master clock controls both division time and frequency of surface waves. Drug treatments, for example with colchicine, can uncouple division and surface waves, allowing study of a simple oscillating system with the goal of understanding the cell cycle oscillator as well. The second portion of the chapter deals with experiments on twinning and the organizing role of the gray crescent in determining embryonic axes of symmetry. Twinning due to rotation of eggs is demonstrated, and it is suggested that the classic experiments of Curtis, in which transplantation of cortex from the gray crescent to the central region of another fertilized egg induced twinning, in fact were demonstrations of the effect of handling the eggs. This paper was for me the most interesting in the book. It approaches old problems and accepted views with both reasoned skepticism and fresh experiments.

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Stone Tools Analyzed

Experimental Determination of Stone Tool Uses. A Microwear Analysis. LAWRENCE H. KEELEY. University of Chicago Press, Chicago, 1980. xiv, 212 pp., illus. + plates. Cloth, $15; paper, $7. Prehistoric Archaeology and Ecology.

Because stone artifacts constitute a high proportion of the material archeologists have to work with, it is not surprising that one of the important frontiers in archeology is the attempt to develop ways in which to increase the information that can be derived from them. Along with ethnographic investigation of the few surviving stone-tool-using peoples, the study of the wear (known as use-wear or microwear) that stone tools sustain in the course of utilization has recently undergone an explosion of interest.

Use-wear comprises various kinds of damage and surface modification including scratches, fracturing, abrasion, and a kind that is loosely termed "polish." Studies of use-wear permit the identification of tool-use activities that were carried on within prehistoric sites and the differentiation of activities carried on at different sites, knowledge that can then be used to reconstruct more general aspects of subsistence behavior. They provide an avenue for seeking information about technological change, and more specifically about manufacturing procedures and techniques.

Lawrence Keeley currently leads the publications stakes in use-wear studies in terms not only of volume of output but of apparent potential of reported findings. This book provides a comprehensive presentation of his Ph.D. work on experimentally produced use-wear, and it incorporates the data on which his previously published summaries are based. With a new wave of graduates (mostly North Americans) entering the field it is timely that these basic data be made available.

Although Keeley points out that the work is a report on a particular research project—the interpretation of use-wear on specific collections of British Lower Paleolithic stone tools—and is therefore neither a textbook nor a general reference book, the results and the methods he employs are of general interest and there is scope for extrapolation to other prehistoric lithic industries. In fact, Keeley's work has already influenced the direction use-wear studies are taking.

The broader concern of this book is not British Lower Paleolithic tools as such (although certainly some very interesting conclusions are reached in that regard) but the identification at magnifications of about 200 of forms of use-polish that resulted from the experimental working of materials known to have been utilized by early humans, such as wood, antler, animal hide, meat, and fresh bone. The degree of success reported by Keeley in matching particular types of use-polish to type of material worked has not been approached by any other use-wear researcher.

Until about the time Keeley completed the research embodied in this book the major—and largely unrecognized—problem besetting use-wear studies was the isolation in which most of the researchers worked. With the convening in Vancouver of the first international conference on lithic use-wear in early 1977 channels of communication and interaction were opened. Despite the series editor's claim in the foreword that Keeley has "revised and updated his methodologically rigorous studies," there is no detectable cognizance taken of the papers or the discussions from that conference (whose proceedings were published as *Lithic Use-Wear Analysis*, B. Hayden, Ed., Academic Press, 1979). Keeley's book is essentially the same as his Ph.D. thesis, even retaining the more unorthodox terminology. For instance, how many of the uninitiated will know that Keeley's term "1/2 Moon breakage" refers to that well-known fracture me-

chanics category "bending fracture"?

It is unfortunate that Keeley persists in characterizing use-wear studies as fundamentally divided according to technical approach. In his words, "One approach concentrated on the low magnification study of edge damage, while the other employed a more catholic approach but nevertheless concentrated on the high magnification study of microwear polishes and striations." Seeing himself as the major exponent of the latter approach, Keeley derides low-magnification studies because those who have worked with a maximum magnification of about 50 have so far failed to discriminate the diagnostic use-polishes he has identified. The promotion of this view by such an influential researcher will surely inhibit flexibility on the part of novices to the field. There are researchers, including myself, who have obtained excellent results by employing high- and low-magnification microscopy in combination. Furthermore, as Keeley himself takes pains to point out, his use-polishes have so far been identified only on specific types of fine-textured siliceous stone. The vast majority of stone tools recovered from archeological sites are made of other types of stone that appear to sustain different wear patterns. These can be best identified at low magnification. Keeley also states that use-wear researchers who primarily employ low-magnification microscopes concentrate on use-fracturing (he uses the less precise terms "use-damage") at the expense of other forms of use-wear. This is misleading, as anyone can see by glancing through the publication resulting from the Vancouver conference.

Without a doubt one of the most problematic matters in use-wear research is the control of variables, there being as yet no generally agreed upon minimum standards of experimental design. Keeley rightly claims that the experiments carried out by other researchers lacked "methodological rigour." Certainly this has led to poor comparability between sets of data. But Keeley's condemnation applies as much to his own work. In carrying out his experiments he had in mind that they should be performed in a "natural" work environment:

> As many of the experiments as possible were conducted outdoors, on the ground, in case the amount of grit introduced between the implement edge and the worked material should be artifically reduced by experimenting indoors on clean floors or countertops. Many of the experiments were done with dirty hands, since the ancient users of these tools were unlikely to wash their hands once a week, let alone several times a day.

By doing the experiments this way he has failed to adequately control the variable that according to his own account, and the results of other workers, is of paramount importance in the formation of use-polish, abrasion and striation. Keeley's interest is centered on the end result of wearing processes, and he sees the formation of use-polishes as a tangential issue, questioning whether a proper understanding of it is obtainable. Yet if he had controlled the introduction of abrasive particles in the tool-use operations he would have been able to elucidate the role of foreign particles in the development of his polishes. As it is, Keeley, and the readers of the book, can only speculate about why the use-polishes appear to be different.

Another problem with Keeley's experimental procedure is the use of dilute hydrochloric and nitric acids as cleaning agents for the experimental tools before examination for use-wear. He reports no demonstration that the use-wear was not altered by the acids.

It is also unfortunate that Keeley did not fully appreciate the value of the scanning electron microscope, with its broad magnification range and good depth of field. The book is liberally illustrated with 115 microphotographs taken through a metallographic microscope, but their resolution and depth of field are comparatively poor.

This book is destined to be a basic source of information on lithic use-wear. Its problems reflect the difficulties that are experienced in the early growth of any field of study. In the next few years we will undoubtedly see transformations.

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Feeding Strategy for the High Yielding Dairy

(*Continued on page 100*)