structures, the earliest of which date from the Mousterian. These houses are mostly constructed from mammoth bone, an animal which forms the bulk of the economy, and whose bones (skulls, long-bones, scapulae and tusks) in a region with a timber shortage, made good building material. In addition to hut plans and their reconstruction, the author reproduces some of the archaeological material, but unfortunately, though being quite generous with his illustrations of the bone objects, gives no useful illustrations of the flint assemblages.

When one looks at the list of references at the back one can only be very grateful for the mass of material that the author has condensed. This is a very useful book and most prehistorians, not excluding Russians, will be glad of it.

J. D'A. WAECHTER

Statistics for biologists

Biostatistical Analysis. By Jerrold H. Zar. Pp. xiv+620. (Prentice-Hall Biological Sciences Series.) (Prentice-Hall: Englewood Cliffs, NJ, 1974.) \$25.95.

WHETHER or not statisticians regard the practice as desirable, many biologists choose to be responsible for their own statistical analyses. To aid them, they have a great many bad and a few good cookery books. Professor Zar's thorough presentation of detailed formulae and abundance of worked examples places him firmly in the second category. Those who are prepared to handle a rather heavily formalised symbolism should welcome this well-produced text. The descriptions of analysis of variance calculations and their associated tests of significance are particularly clear. Perhaps the chief weaknesses are the lack of critical guidance on choice between methods (when should a non-parametric technique be adopted for analysis of a continuous variate?) and the unfortunate habit of presenting the scaffolding of tests of significance without summary tables of means.

More than 200 pages of tables of statistical functions are included. Today's computer facilities, and the availability of keys for standard functions on relatively cheap desk calculators, could have allowed substantial omissions and condensations here, with consequent reduction in the high cost of the book. The attitude to computing, indeed, is surprisingly old-fashioned. Little is said about any sophisticated programming. Such uses of computers as are described are concerned merely with performing the heavy arithmetic and with the barbarity of floating point output.

The book evidently originated in a concern for statistical analysis of observational data rather than planned experiments. This emphasis is valuable,

though it could usefully have been supported by more discussion of sampling of biological populations and materials, selection of observations and measurement procedures. Particularly interesting is the chapter on distributions of angular directions, a topic rarely mentioned in elementary texts.

D. J. FINNEY

Wobble in the glance

Eye-Movements and Visual Perception. by R. W. Ditchburn. Pp. xv+421. (Clarendon: Oxford; Oxford University: London, December 1973.) £9.50.

WHEN we wish to scrutinise an object and look at it in great detail we point our eyes towards the thing and hold them quite stationary—or so one might think. But even during periods of concentrated fixation, the eyes are never really still. They move constantly with three components of motion: a slight tremor (about 50 Hz, amplitude about 20 arc s) probably originating in the intrinsic noise of the extraocular muscles; slow drift (velocity up to 20 arc min s⁻¹); and intermittent, tiny, fast flicks (usually one or two per second, mean amplitude 5 arc min).

Our normal persistent perception of the visual world must depend on one or more of these apparently involuntary movements because if an optical device is used to hold an image more or less fixed on the retina, despite eye movements, the pattern seems to fade virtually completely within a few seconds. Isaac Newton was perhaps the first to recognise this necessity for a moving retinal stimulus. He noticed that pressing the side of the eyeball with a finger stimulates the retina mechanically, producing a coloured blob superimposed on the visual field; however "if the eye and the finger remain quiet these colours vanish in a second minute of time, but if the finger be moved with a quavering motion they appear again"¹.

Since Newton's time there has been more than a little research on the small eye movements of fixation and the curious phenomena that occur when the retinal image is stabilised. Ditchburn's book is a critical catalogue of this work, invaluable to the researcher in this area and of interest to every student of vision. This book, then, has a place as a companion (but not a complete successor) to the highly personal account of eye movements and visual perception by A. L. Yarbus².

Ditchburn begins with a general introduction to visual optics and the problems introduced by movements of the eye. He then provides a most useful review of all the methods of recording eye movements and evaluates them critically.

This section, together with an appendix containing many technical details, is of great value to anyone intending to work in this field where instrumentation is so varied in scope and quality and where the recording apparatus itself imposes severe restrictions on the kinds of movements that can be accurately monitored.

Next comes a survey of the results of these recording experiments with a wealth of quantitative data from many different workers. Ditchburn then discusses the various kinds of apparatus used for producing a more or less stationary retinal image despite movements of the eye. Most involve the wearing of a closely fitting contact lens with various appendages such as a sucker, to hold the lens tightly to the cornea, a mirror on a long stalk or even a miniature projection system complete with lens and light bulb. Some of these devices would have made the Spanish Inquisition green with envy. Unfortunately not all these methods are equally efficient in holding the retinal image stationary: consequently the various introspective reports on changes in colour, brightness and clarity of stabilised images are not all equally valid and it is sometimes difficult to know how to evaluate them.

Before considering the causes of perceptual fading of a stabilised image and the function and control of small eye movements, Ditchburn reviews briefly the relevant physiology of the visual system. But let me be clear: this is not the place to learn about the latest advances in visual physiology. This is perhaps the weakest section of the book, but is adequate for the question in hand.

Ditchburn concludes that no single type of small eye movement (tremor, drift or saccade) is adequate to maintain the normal visibility of the image. He believes that both drifts and saccades are essential. It is worth mentioning that not everyone agrees. Steinman and his colleagues³, for instance, have found that some observers can learn to suppress small saccades completely, without decreasing the accuracy of fixation or the visibility of the target.

Finally, a word about the index. The book is organised into numbered subsections of each chapter and these are used (rather than page numbers) in the index. No doubt this is a great economy in editing and layout but it is a very clumsy system to use. I hope that any future edition of this book may have a real index as well as answering many of the unsolved questions in this fascinating field.

COLIN BLAKEMORE

¹ Newton, I., *Opticks*, (Bell, London, 1730).

² Yarbus, A. L., *Eye Movements and Vision*, (Plenum, New York, 1967).

³ Steinman, R. M., Haddad, G. M., and Skavenski, A. A., *Science*, **181**, 810 (1973).