Interpreting Micromorphology

Scanning Electron Microscopy. Systematic and Evolutionary Applications. Proceedings of a symposium, Reading, England, Apr. 1970. V. H. HEYWOOD, Ed. Published for the Systematics Association by Academic Press, New York, 1971. x, 332 pp., illus. $19. Systematics Association Special Volume No. 4.

A significant technological development often elicits waves of excitement that generate crisp, clear books extolling its virtues. The scanning electron microscope (SEM) is such an instrument, and this is such a book. The SEM now has applications in both molecular biology (see *Philosophical Transactions* of the Royal Society of London, series B, **261**, 1–230 [1971]) and evolutionary studies. In the context of systematics, as Heywood points out in the book under review, the SEM is best considered as extending the range and quality of the light microscope rather than as an adjunct of the transmission electron microscope.

The familiar premise of each of the 16 chapters in *Scanning Electron Microscopy* is that morphology is a fundamental clue to deriving phylogenetic relationships. The novel theme is that micromorphology can be critically important to developing evolutionary lineages. The variety of new "microhabitats" also reactivates interest in functional morphology, since biological roles and selective advantages remain to be discovered in this new world where spines, setae, hairs, warts, ridges, flanges, reticulations, pores, pegs, striations, buttresses, and cavities assume the appearance of the Andes next to the Peru-Chile trench.

Three chapters especially consider techniques and broader implications of the SEM for increasing the quantity and quality of information about small objects (P. C. Sylvester-Bradley, using ostracods; W. W. Hay, using planktonic Foraminifera; and P. Echlin, using nonmineralized cells and tissues). For example, photographs dramatically show recrystallization of calcite caused by ultrasonic cleaning. Future atlases of stereoscopic plates illustrating morphologies are promoted and promised.

Thirteen chapters (three in French with English summaries) are dominantly case histories of particular interest to specialists. Ten of these, several of which show the wealth of information in fossils, are based on microorganisms and plants. These include chapters on bacteria (Actinomycetales) and Cretaceous and Recent fungi (S. T. Williams and C. J. Veltkamp; L. E. Hawker; R. Heim and J. Perreau; K. L. Alvin), Recent diatoms (R. Ross and P. A. Sims), Recent and fossil calcareous pelagic algae, especially coccolithophorids (D. Noël; A. J. S. Ramsay), Mesozoic gymnosperm pollen grains (Y. Reyre), fossil and Recent conifer leaf cuticles (M. C. Boulter), and fruit (Heywood). Three chapters investigate animal morphology and evolution. These are based on Cambrian to Recent brachiopod skeletons (A. Williams), insect eggshells (H. E. Hinton), and mite surfaces (D. A. Griffiths and J. G. Sheals).

A major cause of the interest in the SEM results from its fantastic ease of use by the thousands of systematists already accustomed to interpreting external morphology, and *un*accustomed to doing serology, protein sequencing, or electrophoresis. Whether the SEM is *the* instrument for evolutionary studies is a moot point. However, it will certainly be routinely used as a source of information that will revolutionize the way in which evolutionary relationships are derived for many groups—as is already clear from this beautifully produced book.

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Figure and Vision

Visual Perception of Form. LEONARD ZUSNE. Academic Press, New York, 1971. xii, 548 pp., illus. $19.50.

This book is a remarkable *catalogue raisonné* of work on the perception of two-dimensional form. The author's knowledge is prodigious. There are over 2500 references arranged according to topic; for example, there are 500 on visual illusions and 200 on figural aftereffects. The bibliography is reasonably complete up to the end of 1966, is less full thereafter, and in effect stops with 1968, but the book is worth possessing for the bibliography alone. The text, which constitutes only two-thirds of the book, is a valiant effort to digest the mass of material assembled in the references. The author summarizes the different theories accurately and fairly, though for reasons of space many topics have to be dealt with in a rather cursory fashion. It is for example not possible to give an adequate account of the theoretical issues surrounding the problem of figural aftereffects in the six pages allocated to it, let alone to summarize the experimental evidence. The author passes few value judgments and makes little attempt to reconcile divergent viewpoints.

Insofar as Zusne presents a point of view of his own, he appears to have faith in listing the parameters of visual forms and systematically manipulating them to measure their effects on behavior. He writes,

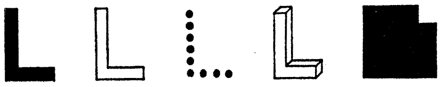
> It would appear from the above studies that in 30 or so years of studying form-identification thresholds for foveal vision we have learned very little that can be stated with any degree of certainty. Experimental designs involving large random samples of shapes, more subjects and due consideration of the manifold factors that influence form thresholds are clearly called for [p. 307].

It would be equally possible to conclude that this approach to the problem is misguided and that what is really needed is some hard thinking about the mechanisms underlying form vision, before plunging into experiments. The idea that in order to understand form perception all we have to do is measure a large number of parameters of visual form (such as the first, second, and third moments of area), and study the effects on behavior of varying such parameters, is one with which I am out of sympathy. The increases in understanding brought about by this method do not seem to me commensurate with the time and effort devoted to it.

Zusne also believes that the use of information theory will bring order out of chaos:

> The precision that the Gestalt notions of simplicity, good form, and other principles of organization lacked was provided by information theory. Better still, it furnished the means by which to quantify the even more fundamental notion of organization. . . . Organization and redundancy are approximately the same. Since redundancy is the complement of uncertainty and uncertainty can be quantified, so can organization [p. 62].

Once again we have the idea that quantification is the panacea. Yet, as Zusne hints elsewhere, the application of information theory has singularly failed to quantify figural goodness partly because there is no alphabet of elements out of which a form is made up. The thorny problems surrounding the ap-



plication of information theory to visual patterns tend to be glossed over, and we are left with such statements as that "in a polygon, information measurement thus reduces to counting the number of its turns. . . . it would be convenient to measure the information content of a form in terms of bits, i.e. the binary logarithm of the number of turns." Even if there were ways of measuring the information in a form that corresponded to judged figural goodness, this would not answer the fundamental question of how the brain processes pictures in such a way that we can recognize them and describe them in the ways that we do.

Zusne has perhaps been slightly unlucky in the timing of his book in that the approach to form perception has been transformed over the last few years partly as the result of work in artificial intelligence, which psychologists ignore at their peril. The key problem is surely how we are able to map the input picture into its elements and make explicit the relations between these elements. We see a piece of a jigsaw puzzle as a number of blobs related in highly specific ways: how such segmentation is achieved is not known. Although no existing computer program can produce the sort of description of this simple type of pictorial material that we do, work in artificial intelligence has called attention to the importance of problems of this kind and is beginning to suggest how they may be solved. How is it that we see the first four figures shown in the illustration (above) all as L's made up of a vertical and a horizontal bar despite the great difference in the ways a bar is depicted in them, while we see the fifth figure as a square with a nick in it although topologically it is very similar to the first? Zusne makes no mention of such problems, nor does he refer to the set of problems that arise from the fact that the image on our retina is usually extremely "noisy": for example, in looking at the real world the boundaries of surfaces are often not represented by any brightness differential in the retinal image, yet we are still able correctly to map the input picture onto structures that represent the surfaces actually present in the real world and the relations between them. This sort of problem does not arise with the nonrepresentational, two-dimensional patterns drawn in high-contrast India ink with which Zusne's book largely deals.

Moreover, the experimental approach to form perception has also undergone marked changes recently. There is no description in the text of work on visual search and visual matching or of research on visual short-term memory. The names of Neisser, Sternberg, Posner, and Sperling are conspicuous largely by their absence.

In his introduction Zusne shows himself aware of the changes that are coming about, and he may indeed have been fortunate not to have had to cope with them. He writes:

> It therefore seems likely that because the concept of visual form will crumble of its own weight, it will not be possible to write a volume quite like the present one in the future. . . . At a time when the field of visual perception of form appears to be approaching a crossroads, this reference volume is offered to those students and researchers who have a need for a systematic source of information on all aspects of perception of static, two-dimensional visual form as it has been conceptualized historically and until the recent past.

This is an excellent statement of the book's provenance, and it is worth adding that, although nothing like it may be written again, nothing like it has been written before; we should be grateful for Zusne's industry and scholarship which have enabled him to provide such a comprehensive and useful guide to the literature.

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On Hooke

Robert Hooke's Contributions to Mechanics. A Study in Seventeenth Century Natural Philosophy. F. F. CENTORE. Nijhoff, The Hague, 1970. xvi, 136 pp., illus. Paper.

In his preface, Centore states that "there is no scholarly study available of Hooke's actual place in the history of science and philosophy with respect to his doctrines and accomplishments within the area of mechanics." It is my unhappy duty to state that in my opinion Centore's book has not altered this situation. The opening sentence, an assertion that the history of science has ignored Hooke, aroused my apprehension that the author belonged to the Hooke cult. In this I was certainly mistaken. While Centore obviously admires Hooke, the book does not argue intemperately or unreasonably for Hooke's contribution to 17th-century science. Its faults lie not in partisanship but in simplification and in imprecision. As to the first, Centore devotes passages of tedious length to the detailed exposition of elementary issues such as uniformly accelerated motion and Hooke's argument for the indefinite extension upward of the earth's atmosphere. As to imprecision, he does not seem wholly to comprehend the questions in mechanics with which he is basically concerned. He wants to see Hooke's intuitive (and commonplace) idea of the "force" or "strength" of a body in motion as a step toward Newton's second law, which replaced this intuitive view of the force *of* a body with a precise quantitative measure of the force acting *on* a body to change its inertial state. In a passage that wholly bewilders me (pp. 84–85), he argues that Hooke developed Galileo's work on falling bodies by showing that the velocity or momentum of a body falling a constant height increases in proportion to the square root of its weight. He cumbersomely derives the inverse square relation from Huygens's formula for centrifugal force and Kepler's third law in order to illustrate the difference between Newton and Hooke. It is apparently true that Hooke never understood this relation, but one can hardly cite so elementary a substitution of one formula in another as a measure of Newton's mathematical capacity. What counted was the ability to demonstrate that an elliptical orbit entails an inverse square force to one focus.

Centore compounds the shortcomings of his book by failing even to mention Hooke's most important effort in rational mechanics, his investigation of simple harmonic motion. Mechanics was already a sophisticated mathematical science by the age of Hooke. Centore's interpretative framework, which seeks to contrast Newton's mathematical abstractions with Hooke's Baconian experimentalism, is incapable of shedding serious light on his book's announced topic, Hooke's contribution to mechanics.

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