of the structures, even for the most discussed operant, hippocampal theta rhythm.

Theoretically the behaviorist view is again the most strongly represented; nowhere is any more complex a view of conscious awareness presented than that it is an internal response. The most extreme of these papers is that by McGuigan, who argues for a modified version of the motor theory of thought, maintaining that one cannot think well without the involvement of the musculature, particularly that concerned with speech. It is unfortunate that no clinical neuropsychologist pointed out in the discussion of this paper that peripheral dysarthria, which prevents speech, leaves thought totally unaffected.

A few of the papers do move well away from a behaviorist orientation. Chapman relates evoked potential and information-processing tasks in the style of Posner and Sutton. Paivio discusses the psychophysiological correlates of imagery. Unfortunately these studies of his seem much less successful than his better known studies using orthodox experimental-psychological methods. Sperry discusses what has been learned from split-brain patients about the neuropsychology of cognition. This is an excellent survey of the field, but split-brain work has by now been surveyed a number of times and it is not clear that this particular disconnection syndrome provides so much more information than other neurological syndromes as to merit its greater popularity among researchers. One major lacuna of the book is the absence of any discussion of frontal lobe and aphasic syndromes, obviously directly relevant to its theme.

One paper that stands out is that by the McNeilages on the central processes controlling speech production. Almost alone, it begins from a theoretical perspective, outlining alternative models of the speech production process. The models, which are of considerable complexity, are then compared with reference to a number of different types of evidence, from the peripheral physiology of the speech musculature to the nature of speech errors. This theoretical orientation enables different types of evidence to be related through a structural model of a subsystem which may reasonably be conceptually isolated within a total model of brain function. This procedure contrasts with the methodology common among the other papers, a relatively atheoretical correlating of different types of measure. The McNeilage approach is much more similar to that used successfully in relating different levels of explanation in other areas of science and thus seems more appropriate for relating conscious experience with neurophysiology and information processing.

TIM SHALLICE
National Hospital for Nervous Diseases, Queen Square, London, England

Cell Movement

Locomotion of Tissue Cells. Proceedings of a symposium, London, Aug. 1972. Associated Scientific Publishers (Elsevier, Excerpta Medica, North-Holland), New York, 1973. viii, 382 pp., illus. $20. Ciba Foundation Symposium 14.

This symposium was prompted, as Michael Abercrombie, the chairman, points out in his introductory remarks, by the knowledge of how widespread actin and myosin are in metazoan cells, the recent advances in understanding muscle contraction at the molecular level, and the recent refinements of experiments on living cells that are converting into functional terms the steadily improving picture of the microarchitecture of the cell. The content of the symposium extends beyond an attempt to understand the locomotory machinery per se and provides an evaluation of many factors that regulate cell movement in culture and during development.

The overall role of microfilaments and microtubules in cell locomotion is soundly evaluated. In addition, a diverse range of motile phenomena expressed by the cell surface are dealt with. An attempt is made to integrate into a coherent picture of cell movement such properties and phenomena as membrane fluidity, surface particle movement, formation and behavior of lamellipodia and microspikes, and exo- and endocytosis. Opposing mechanistic viewpoints emerge to account for these phenomena, but the approach is highly successful in that it draws attention to potential mechanisms whereby the cell surface transmits the translational forces of cell movement to the substrate and receives environmental cues that modulate cell movement.

The contact behavior of cultured cells is reevaluated in the light of a large input of new information. The factors underlying monolayering and the phenomenon of contact inhibition and its role in establishing and maintaining supracellular organization are clarified as a result of a series of incisive and spirited discussions.

Of considerable significance are two papers that take a pharmacological approach to such diverse phenomena as cell movement in the developing sea urchin and exo- and endocytosis. The papers emphasize the need to extend this approach to the regulation of cell movement in the intact organism. A single paper deals with the relationship between cell adhesiveness and movement and puts forward the theory that cells can adjust their motile processes to compensate for changes in cell adhesion. Although it is criticized in the ensuing discussion, the theory is highly attractive if only because this possibility has been largely overlooked in studies of cell movement.

As a whole the symposium will serve as a sound introduction to the subject and as a powerful reminder for the expert of the many phenomena that are directly involved in, or that profoundly modulate, the locomotion of tissue cells.

COLIN S. IZZARD
Department of Biological Sciences, State University of New York, Albany

Relations among Invertebrates

Embryology and Phylogeny in Annelids and Arthropods. D. T. ANDERSON. Pergamon, New York, 1973. xiv, 496 pp., illus. $24. International Series of Monographs in Pure and Applied Biology: Zoology, vol. 50.

During the past century a large number of descriptive studies of the development of representatives of the annelids and arthropods have accumulated. The embryologists involved have for the most part limited their attention to a restricted group, or at best to no more than one major one, and, not surprisingly, a variety of terminologies, points of emphasis, and interpretations have emerged. Communication among these embryologists and synthesis of their findings by others has proven difficult if not impossible.

D. T. Anderson is exceptional in this field in that he has carried out extensive studies on representatives of many of the major groups of segmented invertebrates. This publication is an attempt on his part to bring order to the complicated and confusing situation in an effort to utilize the facts of

development in an interpretation of phylogenetic relationships. Drawing on his own experience and the extensive literature he presents a new basis for phylogenetic analysis of annelids and arthropods, emphasizing the similarities and dissimilarities of the formation and fate of presumptive areas of the blastulas or blastoderms.

In eight chapters Anderson reviews the development of presumptive areas and presents fate maps for representatives of the polychaetes, the oligochaetes and leeches, the onychophorans, the myriapods, the apterygote and the pterygote insects, the crustaceans, and the chelicerates. These chapters are clearly and simply illustrated to present a basis for comparison and interpretation.

The final chapter is an attempt at an interpretation and synthesis of the evidence, in which Anderson presents his conclusions. The patterns of development in the Onychophora include all the developmental diversity and specialization exhibited within the Myriapoda and the Hexapoda. Anderson suggests that the onychophoran-myriapod-hexapod assemblage is a unitary phylogenetic group, the Uniramia. On the basis of embryological evidence none of these is regarded as ancestral to the others but each as having diverged independently from a common lobopod ancestor. The Crustacea form a second unitary group of arthropods, with the evidence suggesting a more distinct unity in their embryonic development than in that of the Uniramia. Comparison and analysis of developmental patterns of the Crustacea, Annelida, and Uniramia bring Anderson to the conclusion that these three groups are unrelated except insofar as all are members of a larger assemblage of invertebrates with a basic pattern of spiral cleavage.

The Chelicerata emerge for Anderson as a third unitary group of arthropods with a distinctive developmental pattern. Their total cleavage and the details of the arrangement of presumptive areas make difficult a linkage with the other groups. Anderson concludes that analysis of such features rules out any association with the Uniramia. A relationship of the Chelicerata to the Annelida or the Crustacea can be neither confirmed nor denied on the basis of his analyses. The absence of any evidence of spiral cleavage in the Chelicerata may suggest a phylogenetic origin independent of the other arthropod groups and the annelids.

Anderson concludes on the basis of studies in comparative embryology reviewed here that the arthropods constitute a polyphyletic assemblage, as previously suggested by Manton. He recommends that at least three phyla (Uniramia, Crustacea, and Chelicerata) should replace the currently accepted phylum Arthropoda. We may be sure that the last word is not yet in on this controversy of long standing.

This volume is a welcome addition to the literature. It is of importance as an effort to bring order and understanding to the chaotic literature of descriptive embryology of these segmented invertebrates. The emphasis which Anderson has given to the development and presentation of clear diagrammatic maps of the presumptive areas and to their use as a basis for interpretation and speculation is to be commended.

ROBERT L. FERNALD
Department of Zoology,
University of Washington, Seattle

Life under Pressure

Barobiology and the Experimental Biology of the Deep Sea. Proceedings of a symposium. RALPH W. BRAUER, Ed. North Carolina Sea Grant Program, University of North Carolina, Chapel Hill, 1972. xiv, 428 pp., illus. Paper, $10.

No marine biologist can resist comparing the volume of the oceans with that of the terrestrial biosphere. Leaving aside the actual biomass and its importance to man, the comparison shows that more than 99 percent of the globe's animated envelope is oceanic. Most of this impressive figure stands for an environment that is subjected to biologically effective hydrostatic pressure. With the *Challenger* expedition, it became known that life exists at all depths in the oceans, and this may be considered the start of pressure biology. Originally limited to morphological and ecological observations, "barobiology" gained new momentum as physiological effects of pressure became of interest during World War II. These studies were last summarized in the mid-1950's (F. H. Johnson, H. Eyring, and M. J. Polissar, *The Kinetic Basis of Molecular Biology*, Wiley, 1954).

Almost two decades' lack of comprehensive literature on pressure effects on organisms and life processes has been ended in the last few years by an outburst of three books. A collection of review articles, *High Pressure Effects on Cellular Processes* (A. M. Zimmerman, Ed., Academic Press, 1970), was followed by two symposium proceedings, *The Effects of Pressure on Organisms* (M. A. Sleigh and A. G. Macdonald, Eds., Academic Press, 1972), resulting from a September 1971 symposium, and the book under review here, resulting from a symposium held some months earlier. These three treatises cover almost identical ground, and there is an obvious overlap of authors (ten) and topics, which results in a certain amount of overkill.

Of the two proceedings volumes, *The Effects of Pressure* holds a definite advantage in representing the more recent meeting. Because of its predominantly British authorship it has less duplication of coverage. It includes useful complementary information, especially in chemistry, enzymology, microbiology, and animal behavior.

Although Brauer's book is less professional in format, it makes one wish to have been a participant in the workshop. The papers are too numerous for individual discussion. They are grouped under five general headings: Biological and Oceanographic Problems Requiring High Pressure Aquaria; Observations on Deep Ocean Fauna, *In Situ* Experiments, Methods of Retrieving Deep Ocean Fauna and Choice of Potential Biological Materials for Study in High Pressure Aquaria; Chemical Aspects—Sensors, Properties of Solutions and of Macromolecules; High Pressure Aquaria, General Design Characteristics; and Design and Performance Characteristics of Currently Existing High Pressure Aquarium Systems. This strong emphasis on high pressure aquaria is, fortunately, largely limited to the headings. The symposium is actually much broader in scope and comprises studies, or summaries of studies, on the physicochemical, biochemical, cellular, and ecological levels.

The highlights in the transcribed discussions have to be found by patient reading, but they are there. One of them has to do with the observation of an intriguing similarity between the narcotic effect of metabolically inactive gases at normal pressure and that of highly inert gases at elevated pressures. Corresponding similarities are not necessarily found on the molecular level, and it is interesting to note that more information is available from experiments on the physiological effects of hydrostatic pressure on higher forms