Book Reviews

Plate Tectonics: The Evidence

Geomagnetism in Marine Geology. VICTOR VACQUIER. Elsevier, New York, 1972. viii, 186 pp., illus. $14.75. Elsevier Oceanography Series, 6.

Despite its modest title, this book is essentially an introduction to plate tectonics. The main elements of the new paradigm of the earth sciences are by now well known: The earth's crust is divided by a network of boundary faults into a dozen rigid "plates." Along the plate boundaries earthquakes, volcanoes, geothermal areas, mountain belts, and zones of mineralization are generated as the plates move relative to each other. Like Darwin's paradigm of evolution a century earlier, the new paradigm of plate tectonics has produced a remarkable synthesis among previously diverging scientific disciplines. It would be difficult to exaggerate the impetus given by plate tectonics to both theoretical and applied earth science.

As is generally true in scientific revolutions, the new paradigm did not appear de novo. Half a century earlier, for example, Alfred Wegener had put forward his hypothesis of continental drift. Subsequently Arthur Holmes proposed that convection currents in the earth's mantle are responsible for the movement of the continents and for the formation of ocean basins. As early as 1939, David Griggs suggested that the ocean basins are young because they are swept clean by mantle convection currents which rise beneath the basins and descend beneath island arcs and mountain chains like the Andes, generating deep earthquakes in the process. These ideas have a surprisingly modern ring to them, so much so, in fact, that the question naturally arises, Is there anything new in plate tectonics other than the name?

The answer is yes, there is. The new paradigm of plate tectonics is different from earlier hypotheses in the same way contemporary atomic theory is different from the atomic theory of Democritus. The earlier theories were rather vague and speculative in the sense that they did not point to a critical experiment capable of testing their validity. In the case of continental drift, the result was that most geologists remained tectonic agnostics.

The critical experiment was provided by paleomagnetism, the study of the fossil magnetic record contained in rocks. The first step was to apply this technique to continental rocks to determine whether the continents had been displaced. Movement of North America relative to Europe was demonstrated in this way by Irving and Runcorn in 1956. The next important step was to extend paleomagnetism to the study of the sea floor. Experimentally it was difficult to obtain oriented samples from the sea floor for paleomagnetic analysis because they are covered by 5 kilometers of water. So it was necessary to turn to remote sensing.

In this volume Victor Vacquier presents the basic physics involved in these experiments and the scientific results obtained during a decade of research. Vacquier is in a good position to do this. He developed the fluxgate magnetometer that was used in the first marine magnetic surveys; he was among the first to recognize that magnetic lineations are displaced across transform faults; and he was among the first to use the magnetic anomalies over old seamounts in the Pacific to demonstrate that the Pacific sea floor has moved northward thousands of kilometers relative to the earth's rotation axis. In the present book Vacquier describes all of the mathematical techniques used in analyzing marine magnetic anomalies up to (but not including) the recent use of Fourier transform analysis by Schouten and Blakely. This is done with enough detail to enable a neophyte in the field to get started. The book also gives a fairly complete review of the scientific results obtained from marine paleomagnetism up to (but not including) the recent analysis by Larson, Chase, and Pitman of the older Mesozoic anomaly sequence. It concludes by showing how marine geomagnetism fits into the broad framework of plate tectonics.

In short, this small volume presents a very useful introduction to one of the most exciting episodes in earth science. The story is told by a scientist whose own work was central to the development of marine geomagnetism. And it is told with great modesty: I cannot recall another major review in which the author cites his own work only twice!

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Physiological Ecology

Environmental Physiology of Marine Animals. WINONA B. VERNBERG and F. JOHN VERNBERG. Springer-Verlag, New York, 1972. x, 346 pp., illus. $19.80.

Marine physiologists, like their terrestrial counterparts, measure reactions and tolerances to various parameters such as temperature, salinity, and oxygen. From such data they try to project the organism of interest into the natural setting and see how it "fits." It is now fashionable to call this physiological ecology. Interest, though, centers on the individual rather than the grouping of species in a given place. This latter "community" is treated more by ecologists, frequently even when they don't have data on individuals.

A lot of physiologists have taken a lot of such data. We are currently being inundated by a multiauthor, multivolume work, edited by Kinne, that attempts to treat all this. The Vernbergs have produced a more tractable, small book which should prove worthwhile to students, and as a prelude to Kinne. It is heavily slanted toward the temperate latitude shore, as is their own work. But that is where marine stations and universities are most frequent, and so whence there is the most literature. They have made a commendable effort to cover the literature up to the time of publication.

I confess that I find it hard to make biological sense out of countless curves of oxygen consumption against temperature. Poikilotherms surely use more

oxygen at higher temperatures. But so does a bit of hamburger, and that does not tell much about a cow.

What I mean is that only an uncertain view can be obtained from conventional respirometry, osmotic, and temperature measurements. From my own experience, the critical factor in the success of an organism can be some unpredictable event such as a hurricane, a cold snap at maximum low tide, or a couple of weeks of cloudy weather just as a spring phytoplankton bloom is starting. These may have their cause in some remote factor such as sunspots. But in the real world one must treat the ensuing results as random.

When we look at the kind of data this book presents, we find most animals sitting in the middle of their tolerance regime. Limiting physiological stresses are usually not apparent. Without considering the unexpected cataclysms one can miss the key.

This is important to understand amid the increasing demand for advice on environmental matters. Usually we don't understand a situation well enough to predict the result of a given action. The proper response of "no comment" is not always forthcoming, particularly when ecologists get into the act with their plausible but unsubstantiated theories.

So the Vernbergs' book, which is presented as an aid in environmental questions, can only give a partial view. They have done a creditable job with what is available. But understanding bits of nature as a unit (ecology) is difficult and we have barely begun to crawl.

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Chemical Attractants

Insect Sex Pheromones. MARTIN JACOBSON. Academic Press, New York, 1972. xii, 382 pp., illus. $22.50.

Insects of many species have evolved visual or sonic signals for communication between potential mating partners. However, the most common means for such transfer of information in the class Insecta is by odors or tastes. The chemicals involved, which may be used to attract individuals of the opposite sex or to stimulate them to copulate, are called sex pheromones.

Scientific man tends to be anthropocentric in assigning research priorities. Thus, insect communication by vision and by sound, with which we can readily identify, has been comparatively well researched. We have little intuitive feel for communication by sex pheromones, and the study of this important aspect of insect life has lagged accordingly.

Developments during the past 15 years, however, have caused a shift in research interests, and this previously neglected subject is now among the most active in biology. One such development has been the realization that manipulation of insect behavior by means of sex pheromones offers an alternative to the use of conventional chemical insecticides. No practical system for insect control based on sex pheromones has yet been developed, but some breakthroughs seem imminent.

The fact that amounts of sex pheromone contained in an individual insect are extremely small, generally less than 1 microgram, has been one of the sources of difficulty. With modern chemical instrumentation, however, it is possible, in some cases, to identify a pheromone when less than 1 milligram has been obtained. The first insect sex pheromone, that of the silkworm moth female, was identified in 1959. Today, such identifications are becoming commonplace.

Martin Jacobson has been prominent among the chemists specializing in the identification of sex pheromones. His earlier book, *Insect Sex Attractants*, published in 1965 by Wiley, was the first monograph surveying the literature in this field. A number of symposium volumes and isolated reviews have appeared since then, but no other monograph on the subject has been published until this new contribution by Jacobson. The work is essentially an expansion and updating of his previous book.

My only disappointment with the book arises from its lack of critical analysis and integration of the information presented. The work consists mainly of a collection of summaries, ranging from a sentence to a paragraph in length, of the findings reported in individual research articles. This lack of criticalness is balanced by the comprehensiveness of the coverage. The bibliography consists of about 1400 entries, and most of them are mentioned in the text. All aspects of the subject are included. Jacobson has reviewed literature on the structure of known sex pheromones and on the means by which they are identified. He has considered the glands that produce the chemicals and the sensory structures that perceive them. He has included the ways in which sex pheromones are used in insect behavior and, finally, the ways in which man might use the pheromones to his advantage, to "outwit" and control the insects. Thus the general reader is given a view of the scope of the field and the specialist is provided with the most complete available entry into its literature.

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Evolutionary Biology

Problemy Evolyutsii (Problems of Evolution). Vol. 2. N. N. VORONTSOV, Ed. Nauka, Novosibirsk, 1972. 300 pp., illus. 2 rubles, 30 kopeks.

This is the second volume (the first was published in 1968) of a Russian equivalent of *Evolutionary Biology* (edited by M. K. Hecht, W. C. Steere, and myself). It contains 23 papers by 18 authors, most of them generalizing reviews of various topics and problems and some of them accounts of original investigations which could as well have been published in specialized journals. Since most biologists are at least to some extent interested in evolutionary problems, and since almost all biological disciplines are of some interest to evolutionists, the series includes a great range of topics: molecular biology, physiology, comparative anatomy, biogeography, variation and natural selection, species formation and reproductive isolation, and (in volume 1) anthropology. Only a few of the highlights of the present volume can be mentioned. V. A. Ratner gives a review of comparative studies of amino acid sequences in proteins of different organisms; O. Y. Orlov discusses the evolution of color vision in vertebrates; Y. I. Novozhenov analyzes the geographic variability of the cockchafer beetle; V. A. Zaslavsky treats of reproductive isolation of closely related species (or semispecies) of weevils; S. D. Matveev gives an interesting but controversial analysis of genetic phenomena observed at the boundaries of distribution areas where closely related forms come together. A serious drawback of the volume is that all pa-