for petroleum, an exercise which most petroleum geochemists have periodically gone through. Kartsev's approach is refreshing in that he cites several examples of Soviet oil accumulations which effectively put to rest the theories of inorganic origins.

The main hypothesis of the Russian authors is that petroleum starts out as a heavy dispersion of mobile, hydrocarbon-like compounds which are then transformed during diagenesis at increasingly greater depths of burial into lighter hydrocarbons with a corresponding hydrogen deficient residue. Thus shelf oils which have not been subjected to very great depths of burial or regional metamorphism tend to be heavy as compared to oils accumulating in highly folded regions.

The phenomenon of the metamorphism of petroleum with age and depth of burial is handled rather interestingly by Kartsev in terms of the "geotectokhronobat," a factor which takes into consideration the depth of a petroleum accumulation, the absolute age of containing sediments, and a parameter characterizing the degree of metamorphism of the particular region. Geotectokhronobats are calculated for about 60 petroleums, mostly Russian but including a few from foreign fields. Kartsev also uses a vector diagram adapted from Vassoevich for visual representation of the effect of geological factors on petroleum properties.

Andreev presents several effective arguments for applying thermodynamic processes to the analysis of the formation and change of petroleum under natural conditions in two central chapters of the book. He demonstrates that the disproportionation of hydrogen from the very large molecules to the very small molecules leads ultimately to the formation of very light gases and pure methane plus graphite in the last stages of metamorphism. In general, the thermodynamic probability of redistribution of hydrogen increases with the complexity of the molecule. Andreev's chapters constitute the most detailed discussion of hydrocarbon transformation at low temperature available in the geochemical literature.

Mechanisms of oxidation of accumulated oils by meteoric waters are discussed in some detail by Kartsev and Andreev, with the latter providing thermodynamic data on the reactions.

The phenomenon of migration of a mobile hydrocarbon phase from source to reservoir rock is treated very lightly with the admission that we just don't understand it. The authors consider vertical migration through a basin as negligible, and vali l reasons are given for ways in which migration cannot occur. Most Western geochemists would agree with the Russians' statement, "The migration of petroleum from clays is a very complicated and debatable question and is one of the weakest aspects in the theory of the formation of petroleum from dispersed organic material."

Bogomolov contributes most of the data on the thermocatalytic conversion of both hydrocarbons and nonhydrocarbons to low-molecular-weight fractions of crude oil. A host of specific examples are given of the thermocatalytic conversion of aromatic, naphthenic, and paraffinic hydrocarbons. Bogomolov arrives at several important generalizations concerning the composition of the products as a result of these experiments.

Although a book like this does not become outdated in terms of the experimental data, it is unfortunate that all of the experiments cited and most of the references are prior to about 1958. This was recognized by the authors when the translation was planned, and both Bogomolov and Kartsev requested that some of their more recent papers through 1962 be cited. Nevertheless, the rapid advance made during the last decade in gas chromatography and mass spectrometry methods would make it possible to detect reaction products with a precision at least an order of magnitude higher than at the time this book was written. For example, Dobryanskii points out in the closing chapters that "experimental verification of the hypothesis concerning the transformation of petroleum aims at reproducing in the laboratory the natural process to which petroleum is subjected in the depths of the earth. Experiments with various hydrocarbons and their mixtures are carried out at the lowest temperatures at which the changes susceptible to analysis could still be reliably noted." The temperature range at which most of the Soviet experiments were carried out was about 150° to 450°C. Similar types of experiments are being carried out today in the ranges of 75° to 125°C, from which one can make more realistic extrapolations to natural conditions. Dobryanskii recognizes the problem and discusses it in some detail. It may be that even now the Russians are supplementing their previous work with lower-temperature studies.

The final chapter by Dobryanskii contains a useful set of nine conclusions regarding the transformation of petroleum in nature. Of particular interest is a diagram showing the hypothetical group composition of petroleum as a function of degree of conversion as it goes through the entire process of metamorphism.

The book is more readable than many Russian translations, thanks largely to the efforts of the translation editors, E. Barghoorn and S. Silverman. Both editors are thoroughly familiar with the subject, and their comments at various places add to the usefulness of the text. The book is highly recommended to anyone having an interest in petroleum geochemistry.

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Plant Ecology

Principles of Dispersal in Higher Plants. L. VAN DER PIJL. Springer-Verlag, New York, 1969. viii + 156 pp., illus. $9.

Intended as a companion volume to *The Principles of Pollination Ecology* (1966) by K. Faegri and L. van der Pijl [reviewed in *Science* **155**, 65 (1967)], the present work is an invaluable addition to the literature on reproductive biology of plants. Dispersal and pollination biology, long in disrepute, is only now coming back into vogue. Van der Pijl's slim, compact volume is the first comprehensive treatment of the subject in English since H. N. Ridley's monumental, and still indispensable, classic *The Dispersal of Plants throughout the World* (1930).

Few botanists today are better qualified than van der Pijl to write on dispersal (and pollination) biology. A treatise of high caliber would be expected, and this latest effort is no disappointment. The author has an intimate knowledge of tropical phenomena in general and of tropical reproductive biology in particular. This book is markedly free of the north temperate bias that characterizes so many of the European works. Tropical examples of dispersal are used extensively throughout the text.

Useful introductory chapters on general terminology, on dispersal units, and on relationships between the various

reproductive structures of the seed plants follow a very sketchy historical survey. The treatment of the time-honored ecological dispersal classes (such as wind dispersal, water dispersal, and animal dispersal and their subdivisions) comprises nearly half of the book. A general set of characteristics (the "syndrome") is provided for most of the dispersal classes. Algae, fungi, and the vascular cryptogams are not considered, as is clearly indicated in the title. The author chooses his examples from both tropical and temperate areas, largely avoiding the rote cataloguing of dispersal types in which so many of the earlier workers on dispersal biology indulged. Recent work is stressed. Some readers may be annoyed by van der Pijl's frequent and eager speculation about presumed evolutionary significances of various dispersal phenomena. A unique feature of this part of the book is the author's repeated discussion of correlations, or lack of them, between various aspects of pollination and dispersal. For example, wind pollination (anemophily) and wind dispersal (anemochory) generally have evolved independently in various plant groups. The sections on dispersal by reptiles (saurochory), birds (ornithochory), bats (chiropterochory), and ants (myrmecochory) are particularly complete.

Van der Pijl covers less well trodden ground in the last third of the book. A section on synecology very briefly summarizes our knowledge of dispersal phenomena and relationships in deserts, in tropical rain forests, and on islands. The chapter on establishment, dealing in part with vivipary and germination, is rather brief, although it does serve as a guide to the more extensive literature. A very long and theoretical chapter, based largely on a 1966 paper by the author, treats the evolution of dispersal organs of the ferns, seed ferns, gymnosperms, and, most extensively, the angiosperms. The concepts of E. J. H. Corner, especially his controversial durian theory, are treated at length, though in a somewhat disjointed manner. Chapters on the leguminous fruit and on man and his plants conclude the book.

The bibliography of 200 entries is up to date and reasonably complete through 1966 (there are only six references for 1967 and 1968). Eighty-one of the entries are for works written in languages other than English; 158 of the references were published after Ridley's tome appeared. A glossary is lacking. The three indices (general subject matter, scientific plant names, and scientific animal names) are adequate. Sixteen excellent photographs and ten sets of diagrams are sprinkled throughout the text.

This book is well written in a lively, metaphoric style, frequently revealing, however, that the author's native tongue is not English. Van der Pijl's penchant for rather esoteric scientific (and nonscientific!) words is evident on most pages. Not all terms are defined, or clearly defined, in the text. The repeated omission from the bibliography of works referred to in the text is the most frustrating and annoying feature of the book; for example, 12 workers cited in the first six pages of the book are not listed in the bibliography. Unfortunately, the author even fails to give bibliographic information for many recent works cited in the text; these, of course, cannot be found in bibliographies of the older publications on dispersal biology. Inclusion of the omitted titles would have expanded the seven-page bibliography to at least nine.

Better editing would have corrected the bibliographic omissions, the numerous misspellings and typographical errors, and the grammatical and stylistic ambiguities. In spite of these shortcomings, however, this work is an excellent, up-to-date treatment of a long-neglected subject. I wholeheartedly recommend this summary of our knowledge of dispersal biology to all field biologists, particularly those who desire a greater acquaintance with tropical phenomena. This splendid volume is unlikely to be surpassed for quite some time.

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Epizootiology

Diseases in Free-Living Wild Animals. Proceedings of a symposium, London, 1968. A. MCDIARMID, Ed. Published for the Zoological Society of London by Academic Press, New York, 1969. xxiv + 336 pp., illus. $14.50. Symposia of the Zoological Society of London, No. 24.

The reports in this symposium volume present the work of biologists who seem motivated by interest in the diseases of wild animals as biological problems to be solved for their own sake, rather than as an adjunct to some aspect of public health or veterinary medicine. This does not reduce the value of the book for readers interested in the human and economic aspects of wild animal diseases, and it enhances its value for biologists specializing in other areas. Most of the papers include sufficient introductory material to allow the nonspecialist to pick up the main thread of the problem without difficulty.

It is good to be reminded that there are intriguing biological problems to solve which have only indirect dependence on the current biochemical revolution. For example, the reports by Wells and Lumsden and by Baker on trypanosome infections point out the dearth of sound behavioral and ecological information concerning the vectors and hosts of several important animal diseases transmissible to man or his domestic animals. I hope this will be encouraging to students who may have been made to feel that investigations at levels above the macromolecular are somehow second-rate. Here are problems to solve which lie close to the heart of biology—the functioning of the intact organism in its environment.

The epizootiology of myxomatosis continues to be a prime example of the consequences of the introduction of a disease into a new geographic area under known, if not fully controlled, conditions. The history of this intercontinental experiment, involving South America, Australia, and Europe, is briefly but clearly brought up to date in the report by Vaughan and Vaughan. This, as well as several other papers in the volume, should be of special interest to evolutionary and population biologists concerned with problems of introduction, mutual adaptation of host and parasite, and the role of disease in population control.

Repeated comments point up the significance of environmental factors in the course of disease in populations—as well as our lack of specific knowledge of these "factors" and how they influence disease patterns. It is reported that some environmental or physiological "stress" brings about a change from a carrier state to a disease state. Something must have changed, and whatever changed constitutes the stress. Used in such a general way, the concept of stress loses its meaning.

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