mechanisms, and the effects on herbivores of the interaction between allelochemics and host nutrients. These 16 chapters share several features. Each is an exceedingly thorough review. Each is concerned primarily with physiological processes such as the biosynthesis and degradation of secondary metabolites and the mechanisms involved in toxicity and repellency to animals. Most provide substantial introductions to the methods used in studying those processes. Though most are also about as stimulating to read as an organic chemistry text, the book succeeds in its primary goal of providing a comprehensive reference and useful source book for students and researchers in the field of plant-herbivore biology.

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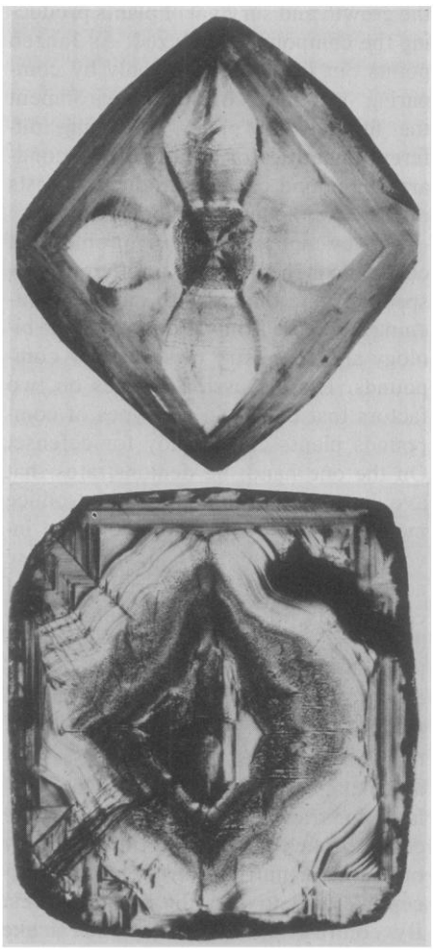
Diamonds

The Properties of Diamond. J. E. FIELD, Ed. Academic Press, New York, 1979. xvi, 674 pp., illus. $67.25.

This book is a natural and timely successor to the 1965 book *Physical Properties of Diamond* edited by R. Berman. The new book is justified by the tremendous amount of research that has been done since 1965. For example, the growth of high-quality single crystals of diamond under controlled chemical conditions has cleared up many of the questions about the elements that can go into the diamond lattice substitutionally and the spectroscopic, electrical, and mechanical effects of the foreign elements. New studies of fluorescence phenomena have brought out significant patterns of layers and domains that suggest that what appears to be an isotropic perfect crystal actually was subjected to different chemical and physical conditions during its growth. New work on strength, friction, and wear characteristics has led to a better understanding of the mechanical properties of diamond. The new book also goes beyond the coverage of the earlier one in including chapters on the geology and the synthesis of diamond and the applications of diamond in science and industry.

The authors of the 20 chapters are associated mainly with universities and research organizations in England and South Africa, and much of the work reported is a result of fruitful cooperation between the DeBeers diamond organizations and various universities in the United Kingdom. Some of the material in the book has already been published in journals.

The chapters of the book are arranged in seven groups. The first group consists of five chapters on thermal, optical, electrical, nuclear, and cathodoluminescence properties of diamond. A chapter on theory deals with attempts to understand the structure and properties of the diamond crystal lattice, both pure and with atomic-scale impurities. Two chapters on the surface properties of diamond deal with adsorbability and with surface profiles and effects. The mechanical properties of diamond are covered in chapters on strength and fracture, adhesion and friction, abrasion and wear, indentation hardness, effects of high temperature, and internal structure. Two chapters on growth cover the physics and chemistry of diamond growth and the technology of diamond synthesis. Two chapters on geology treat the geology of diamond-bearing rocks and the geologic information yielded by the inclusions within natural diamond crystals. The last two chapters of the book deal with industrial abrasive uses of diamond and with the use of diamond in, for example, optical windows, heat sinks, bearings, and electrical devices.



X-ray topographs of crystals that exhibit a center-cross etching pattern. The cross results from "epochs of mixed-habit growth in which normal growth on flat octahedral facets was accompanied by non-faceted growth on hummocky surfaces whose orientation approximated to {100} only in the mean. (The growth surfaces in the latter category are termed 'cuboid'.)" (Top) "Central section of a centre-cross diamond which well exemplifies a smooth variation in ratio of rate of growth on cuboid surfaces to that on {111} facets." The height of the specimen, apex to apex, is 5 mm. (Bottom) "A very complex centre-cross structure with discontinuities in relative rates of growth on cuboid surfaces and on {111} facets." The height of the specimen section is 3.8 mm. [Photographs by Suzuki and Lang, reproduced in *The Properties of Diamond*]

One important form of synthesized diamond, the sintered diamond compact or aggregate, is treated only briefly. Such compacts have been fabricated and marketed since the early 1970's and are used in a wide variety of industrial and scientific tools. More coverage of this kind of diamond would have been appropriate in the book. On the whole, though, the subjects treated in the book have been very well covered, and any person who works with diamond should have the book available.

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Roots

The Soil-Root Interface. Proceedings of a symposium, Oxford, England, Mar. 1978. J. L. HARLEY and R. SCOTT RUSSELL, Eds. Published for the *New Phytologist* by Academic Press, New York, 1979. xx, 448 pp., illus. $32.50.

Increasing interest in roots is not confined to genealogists and their sort. Plant and soil scientists have made plant root systems a major subject of research, as the number of recent books and conference reports on the subject attests. The papers in this volume were presented at a symposium attended by 122 participants from 13 countries. The volume contains 32 papers read in full as well as abstracts of 34 additional papers offered by participants.

The book has something for almost everyone and much too much information for any single individual to assimilate. The root-soil interface is a complex region that has a structure and function all its own but that cannot be studied independently of the soil or of the plant. It

is not possible to infer all the important physical, chemical, and biological processes in this zone from studies of the bulk soil or of plants in nutrient solution. The physical and chemical properties and biological population of the root-soil interface can change rapidly over short times and short distances, and almost all methods of study are of necessity indirect and remote. Nevertheless, the studies reported in the book are more than sufficient to make a convincing argument for the importance of this interfacial region. The uncertainty principle appears to be applicable to such studies in that almost any technique for studying the properties and processes in this microsystem introduces first-order perturbations that often overshadow the effect being studied. Scanning electron microscopy, fluorescence microscopy, soil psychrometry, and electron paramagnetic resonance as well as radioisotopic and chemical measurements have provided a fascinating quantity of experimental observations. The use of a fiber-optic duodenoscope offers what appears to be the least disturbing method of direct visual observation.

In reading the book one is struck by the need to quantify many qualitative observations that have obvious significance. Good progress has been made in the quantification of water flow, ion transport by mass flow, and diffusion. In other cases, however, quantification is more difficult. For example, though the contribution of mycorrhiza activity to phosphorus availability is demonstrable, it is far from clear how to build it into the quantitative theories. It is difficult enough to try to quantify the contribution of microflora to nutrient availability through decomposition of plant residues. When one must also take into account the grazing on these microflora by protozoans such as amoebae the task becomes formidable, yet soils containing amoebae along with bacteria may exhibit 100 percent more mineralization of NH_4^+-N than those with bacteria alone.

The question whether there is an air gap or other form of poor mechanical contact between root and soil still seems unanswered. Time-lapse photographs of roots visible in a rhizotron have been previously taken as evidence of appreciable diurnal shrinkage and swelling of roots, suggesting a substantially reduced contact during the day, when transpiration is at a maximun. In the book there is also evidence of a substantial drop in soil-water potential between the bulk soil and the root xylem. Whether this evidence reflects poor root-soil contact, overestimates of the number of absorbing roots, or some yet unidentified factor is not clear.

Symptomatic of the uncertainty concerning the nature of the root-soil interface are the many roles attributed to mucigel in various contributions to this volume. Mucigel is an elixir concocted of plant mucilages, bacterial cells, and their metabolic products (polysaccharides, peptides, lipids, and so on) that serves as sort of rhizobial Maxwell's demon. Mucigel binds cations and is thus presumed to retard penetration by heavy metal cations in the vicinity of the apical meristem. It provides a measure of selectivity for other ions such as potassium, and it serves as a source of protons at the root surface, acidifying the adjoining region sufficiently to enhance the dissolution of inorganic compounds. It may reduce the friction between the growing root tip and the soil. Its constituent molecules contribute to the glue with which soil aggregates are stabilized. Most of all, mucigel is purported to enhance the contact between soil and root. If it is a true gel, as is often averred, it can clearly provide a hydrated pathway for ion transport by diffusion. It is more difficult to see how a gel can contribute significantly to water transport, since the hydraulic conductivity of a gel is relatively low. Even in the sol form the large molecules may increase the viscosity of the soil solution and could, theoretically, lead to a nonlinear flow equation. If one accepts the estimates sometimes made that as much as 18 percent of the carbon fixed by photosynthesis ends up as organic matter released into soils by cereal plant roots, the yield of mucilage and other compounds approaches that of the grain. While most crop models take root growth into account, few deal with this metabolic sink explicitly.

Many of the names that one would hope and expect to see are to be found in the list of authors, and the volume provides a wealth of authoritative information about root-soil interactions. It also provides its share of conventional wisdom for which the actual evidence is never produced. It is obvious that the contribution of the book to communication between representatives of diverse scientific disciplines is only a beginning. Many of the most difficult problems will be solved not by interdisciplinary teams but by individuals who are equally at home with the jargon, the concepts, and the experimental techniques of chemistry, physics, and biology.

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Books Received

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