

This book cannot be criticized for not including recent work demonstrating that after the benzene ring of 3-*O*-methylgallic acid has been opened by an oxygenase, it may close again to form a pyrone ring, with elimination of methanol. The environmental significance of this piece of academic bacterial biochemistry is that the same reaction can expel suitably placed halogen substituents. What was known some years before this book appeared was that oxidative ring-fission may convert the ether bond of methoxyl into an ester bond, so that simple hydrolysis is made feasible and does in fact occur, with release of methanol. The environmental significance of this is that if the benzene ring had borne a halogen in place of the methoxyl, an acyl halide would have been formed, and the odds are that a nucleophilic group on the oxygenase would have become acylated and the enzyme would have "committed suicide." H.-J. Knackmüss and his colleagues have shown that this can happen. Such mechanisms will not get far in degrading haloaromatics.

It is not appropriate in a book review for me to survey enzymic mechanisms available to bacteria for breaking ether linkages in natural products, but I do wish to mention their relevance for biodegradation of detergents and the "builders" that are used with them. R. B. Cain and his colleagues have isolated an enzyme from bacteria that cleaves the ether linkage in the "builder" carboxymethoxyloxysuccinic acid to form fumaric and glycollic acids. This is a reaction entirely analogous to the reaction catalyzed by the enzyme that degrades the natural product polygalacturonic acid, and in fact all of Cain's isolates that grew with this particular "builder" also grew with polygalacturonate as the sole source of carbon. Similar reactions, which are discussed by R. B. Cain (*In: Microbial Degradation of Xenobiotics and Recalcitrant Compounds*, 1981, p. 326. T. Leisinger, A. M. Cook, R. Hütter, and J. Nüesch (eds.) Academic Press: New York) are also available to certain bacteria for use in degrading some polyethylglycols. The environmental significance of this piece of academic microbial biochemistry is that when microbes are faced with an alkylphenol polyethoxylate detergent they may find it relatively easy to degrade the polyethoxylate chain, but not the rest of the molecule. They then accumulate alkylphenols (particularly if the alkyl chain is branched) as well as alkylphenols with short ethoxylate chains. Various authors have claimed that these compounds are more toxic to aquatic organisms than the original detergent. It may be noted that the

polyethoxylate chains in these detergents contain ethylene glycol residues joined through ether linkages. As mentioned, there are precedents for breaking such linkages by eliminating a residue (in this case ethylene glycol) which now contains the oxygen of the ether linkage as a hydroxyl; simultaneously, unsaturation is generated at the carbon that was part of the ether group. Water is now added across the double bond in preparation for the next step, and the overall equation is the same as could be written for hydrolysis; but the reaction is not hydrolysis as usually understood since attack by water does not initiate bond fission.

Many commercial products contain the benzene nucleus, whether they be pesticides, detergents, or simply environmental pollutants. Fortunately, microbes are not strangers to this unit of chemical structure. Next to glucosyl residues, the benzene nucleus is the most common such unit on earth. The aromatic biopolymer lignin, for example, is more abundant than protein, and benzene rings might be described as the daily bread of much of the microbial world. Various degradative pathways are used by aerobic bacteria, the most flexible of which are those described as meta-fission. These were summarized in a general scheme some 20 years ago, so that the fates of substituents of the benzene nucleus could be predicted. No such generalizations for aromatic natural products are mentioned in this book. The special case of degradation of *p*-chlorobiphenyl is given on page 78, as though this type of ring-cleavage had been discovered when investigating chlorinated aromatics. In fact, the sequence given in Figure 3.7 was predictable from the above mentioned generalization, except that errors of structure would not have been made in the figure.

There is one important area of environmental concern where work with pure cultures is not only useful, but is indispensable for obtaining information of undoubted relevance. In certain agricultural areas, some pesticides have become less effective than they once were, due, it seems, to the acquisition of biodegradative mechanisms by microbial populations rather than to increased resistance by target organisms. H.-J. Knackmüss and his colleagues have shown that it is possible to isolate new strains of *Pseudomonas* capable of utilizing 4-chlorobenzoic and 3,5-dichlorobenzoic acids when a chemostat is used. Previously, the organism could not grow at the expense of these compounds. Experiments such as this enable newly acquired enzymes to be examined, and they were found to be plasmid-encoded; this insight could

not be obtained by working with mixed cultures. Indeed the most interesting of degradative plasmids (TOL) carries genes for the catabolism of the aromatic hydrocarbons toluene, *m*-xylene and *p*-xylene. None of these discoveries, which may have important consequences for pesticide use and environmental studies, would have been possible without the painstaking investigations that delineated aromatic degradative pathways and devised enzyme assays; neither of these essential prerequisites for work with plasmids are mentioned in this book, or at any rate are not indexed.

I have focused my observations upon the biodegradation of pesticides because this is, after all, the title of the book. In fact, I enjoyed those chapters most where biodegradation was discussed least. I have mentioned metabolism of pesticides by animals and plants, although I suspect that were I an expert in those areas I would have learned little that was new. The word "biodegradable" is in the title of chapter 8, but most of the material consists of a lively and informative account of Public Health Entomology. J. R. Plimmer's chapter about pesticides for stored products is fascinating. One might summarize the problem in question form: How can products be protected from insects, rodents and microbes over long periods—particularly in climates that favor the proliferation of pests—and retain the minimum of possibly harmful residues before they are presented to humans or animals for consumption?

Probably the most valuable parts of this book are those like chapter 10 where the particular problems of India are described, and the use of pesticides to solve them is discussed. For this reason, I believe that the book will be helpful for all those who are concerned with the problems of agriculture and public health in developing countries. It will depress, rather than stimulate, academic microbiological biochemists who hope that they are engaged in useful work that deserves notice.

Stanley Dagley, Ph.D., is Professor of Biochemistry, University of Minnesota, St. Paul, MN 55108

BOOK RECEIVED

***Biotechnology Made Simple*. PJB Publications ed. Pp. 117. (PJB Publications: 1983) \$150; £75.00**

This large-format paperback is a dictionary of terms used in biology and biochemistry. Figures from basic texts are included. A chronology of the emerging biotechnology industry may be useful to readers who are new to this field.