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Editorial

It has been said that without microorganisms animal life on the planet would cease to exist within about five years. Whether or not this is an exaggeration in time-scale, it is clearly true in principle that we depend absolutely on the activities of microorganisms for the replenishment of our environment. Over the years we have built up a shrewd idea of how the major components of the biological world are degraded, though there are still some surprising omissions such as a lack of detail for the breakdown of DNA, RNA and their component nucleotide bases. There is still much to be learnt about the degradation of complex ligno-cellulosic materials, particularly those found in some of the hardwoods, which can be very resistant to decay.

The concept of microroganisms as an essential part of the recycling process is, of course, not new. However, the ability of microorganisms to deal with man-made chemicals – the xenobiotic materials – has, of course, been of more recent occurrence. It was some 30 to 35 years ago that microbiologists first became seriously interested in solving some of the challenges being offered by the molecules produced by synthetic chemists. The ability of microorganisms to break down a relatively large number of synthetic aromatic compounds has been known, at least in principle, for much longer, but the pathways for the degradation of benzenoid or naphthalenic aromatic compounds were obscure. Now, thanks to a sustained effort by many research groups over the past three of four decades, we have an accurate understanding of how the majority of such compounds are degraded.

However, knowing the details of a pathway, or even an array of interlocking pathways, is not sufficient in itself. Knowledge should always be leading us somewhere. The knowledge gained in my example of aromatic compound degradation is now standing us in extremely good stead as it is providing the basis from which we can begin to tackle some of the major outstanding problems of biodegradation, namely the elimination of the persistent recalcitrant molecules which the chemical industry has been manufacturing for a wide variety of activities.

This is not the place to enter into the controversy of whether such compounds do more good than harm: the fact remains that materials are used and some, especially halogenated derivatives, are extremely resistant to microbial (and therefore to all biological) breakdown. Again, I do not want to develop the argument that such compounds, by their very non-degradability, are remarkably unreactive, so that they are not likely to represent a toxicological threat to man, his animals or the environment. Whatever the advantages or disadvantages of using such compounds may be, they do exist and when used, do persist. To deal with them effectively calls for the combined skills of the microbial biochemist and geneticist.

To deal with man-made chemicals it may be necessary to use man-made microorganisms, or at least to produce genetically modified enzymes which can now attack some of the previously recalcitrant molecules. Such a programme, which is exemplified by current activities to deal with the degradation of the poly-chlorobenzenes and biphenyls, can succeed only because we have already acquired the essential knowledge as to how the parent molecules of benzene and biphenyl are themselves degraded. This principle extends to all other types of molecules.

The ability to define the route to biodegradability of a given molecule is now here, and there are many examples of how such knowledge has successfully been applied. Perhaps the best example of this is in the redesigning of the formulation of lubricating oils going into two-stroke outboard motor-boat engines. Knowing what would constitute a biodegradable molecule, it was possible to formulate an entirely biodegradable oil which could be used by boats operating in inland lakes. Build-up of potentially harmful compounds in the lake was prevented and the ecosystem was not then challenged in such a way that it may not have been able to withstand.

Our knowledge of how biodegradation proceeds is vital because biodegradation itself is vital. In this series of contributions, I hope we present sufficient breadth for the reader to see that there are few areas that are escaping the attentions of the microbial physiologist. The coverage which is assembled here is, however, not a complete one and was never intended to be so. It gives a cross-section – and I hope a fairly typical cross-section – of what are some of the major points of microbial research today on this area.

There are many materials which suffer from unwanted biodegradation. Sometimes our knowledge can be used to prevent this happening but it must be said that there are many areas where the basic information about degradative pathways is unknown. For such compounds, degradation is an empirical study. I would though, hope that through these present articles the reader will be able to gather that on many key areas we have moved from empiricism into a rational understanding of the biochemistry of degradation.

I would like to thank all the contributors to this Special Issue for responding, not only as to the initial invitation to contribute but also to meet a very tight deadline by which their contribution had to be completed. We lost only one contribution which was to have covered degradation of fatty acids, as the author, unfortunately for us, moved his laboratory from one continent to another just at the critical time.

To all the contributing authors, I would offer my sincere thanks for their endeavours. I hope that you the reader, will find the chapters illuminating, instructive, but, not least, a justification for believing that microbial biochemistry is indeed the true cornerstone for the understanding of biodegradation.

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