CHAPTER 5

SUMMARY AND CONCLUSION

Pollutants in the environment are exposed to various degradative forces. Among them biotic degradation, or metabolic processes, are known to play a vital role in deciding overall fates of organic pollutants. They not only contribute to the disappearance of the original form of pollutants, but also change their physicochemical properties, and thus affect their transport and distribution behaviour among various compartments in the environments.

Most forms of living organisms are capable of directly interacting with pollutants, and some of them are capable of metabolizing even very recalcitrant pollutants. Metabolic processes found in microorganisms, plants, and animals are, however, qualitatively different.

Microorganisms are known to play major roles in metabolizing chemicals in the environment (Hill and Wright 1978; Matsumura and Krishna Murti, 1982). Their contributions to the metabolic alteration of pollutants in the environment are aided by the phenomenon that the bulk of pollutants are found in soil and aquatic sediment (excluding open ocean floors) loaded with microorganisms.
In animals, particularly the mammalian species, as studies on microbial metabolism of pesticides were lagging far behind comparable studies in mammalian species. However, as knowledge on microbial degradation has advanced, it has become apparent that in many cases the patterns of degradation in these two different groups of organisms are often very different. First of all, the purpose of all metabolic reactions on xenobiotics in higher animals is to eventually convert them into polar and, therefore, excretable forms. Second, in higher animals the processes of primary metabolism of xenobiotics are centralized in a few specialized organs. In the case of the liver, its metabolic pattern is largely determined by the activity of an oxidative detoxification system, generally termed mixed-function oxidase. On the contrary, the predominant metabolic activities in the microbial world are meant for production of energy. In this respect, it is not even possible to define xenobiotics here, since most organic materials can serve as the source of energy to at least some microorganisms. Hence only a few groups of chemicals may be regarded as foreign to microorganisms. Among insecticidal compounds, halogen-containing chemicals, particularly halogenated aromatics, must be regarded as generally foreign (or unusable) material to microorganisms.

Another characteristic of microbial metabolism is the adaptability of microorganisms to changing environments through mutation and induction, particularly toward chemicals that are initially toxic to them. The
case of penicillin resistance in bacteria through induction of penicillinase is well known. The metabolic activities of microorganisms encompass many different types of biological processes not found in any other organism. They include fermentation, some anaerobic metabolism, chemolithotrophic metabolism, and metabolism through exoenzymes. In general, microbial contributions to metabolic alteration of insecticides may be classified in several categories. It must be stressed that the main purpose of such a classification effort is to present clearly the types of microbial degradation according to their final manifestations. They are not classified according to the intrinsic mechanisms by which they degrade pesticides. Various reactions which involve different enzymatic mechanisms and yet are known to behave in similar patterns have been grouped together.

Many environmental factors are known to affect the rate of metabolic conversion of pollutants. In the case of soil microbial activities, water content of soil greatly affects and in extreme cases limits the type of microbial activities. Waterlogged conditions in combination with high nutrients could promote growth of anaerobic microbial species. Extremely dry conditions limit microbial activities. The tendency is greatest with sandy soil, with least water-holding capacity among various soil types. In very dry conditions *Aspergillus* and *Penicillium* species show abilities to persist, while streptomycetes show moderate degrees of tolerance to dryness.
Bacteria in general require high moisture, though some (e.g. *Bacillus* spp.) are capable of surviving dry periods in the form of spores.

Acidity also affects soil fauna. In general, acidity depresses the growth of bacteria more than that of fungi. For instance, below pH 5, bacterial activities are usually very low. Soil is generally considered to be nutrient deficient as a normal state (with some exceptions, such as forest soil). Therefore, addition of exogenous nutrients causes a sudden burst of microbial activities. Yet, increase in total microbial activities alone may not result immediately in increased metabolism of pollutants as will be explained later.

Temperature is the major contributing factor in deciding the characteristics of soil biota. Each microbial species has a definite range of temperature preference for significant activity. Thus composition of active microbial species varies in a given soil as temperature changes. For instance, Okafor (1966) has found that chitin metabolizing organisms in tropical soil at 28-30°C were predominantly actinomycetes, nematodes, and protozoans, while at 2-15°C, fungi and bacteria were more important. It must be emphasized, however, that higher temperature does not automatically guarantee higher microbial populations and activities. Certain microorganisms are well adapted to colder climates and as such would flourish even at seemingly low temperatures. In temperate zones with
moderate to severe seasonal variations, for instance, it is common to observe maximum microbial activities in spring and fall rather than.

During the summer, even where adequate moisture is maintained throughout the year. Other determinants, such as redox potential, nutrients, and physico-chemical characteristics of soil, also play very important roles. However, they play similar roles both in the tropics and temperate zones. Among these factors there are certain known joint actions. For example, the availability of nutrients with water often creates low redox potential, and at the same time, in those environments where nutrients and water are constantly available, the soil characteristics become organic. In arid environments microbial activities are naturally low, even with irrigation, since soil lacks organic constituents. Under such conditions organic pollutants tend to vertically migrate to lower layers because of low holding capacity of sandy soil, where microbial activities are low, causing groundwater contamination where there is little microbial action.

A methyl-parathion degrading consortium of bacteria was isolated from the Cauvery River Basin agricultural soils using methyl-parathion as the only carbon source. The ability of the consortium to degrade methyl-parathion, was assessed with a mineral medium containing pesticide; Different colonies were chosen from the consortium obtained, depending on their color, growth shape, morphology, consistency, borders and surface. As
much as eleven different genera of bacteria were found in the consortium, which were tested for enzymatic activity by measuring change in absorbance at 410 nm, when methyl-parathion was exposed to an extract containing the enzyme (a phosphotriesterase), to produce dimethylthiophosphoric acid and p-nitrophenol. From the tested species, only four of them showed phosphotriesterase activity on the methyl-parathion. Because most of the isolated bacteria are pathogens it becomes difficult to establish recommendations towards the extensive use of one of these strains in natural environments. However, these bacteria could be considered as a potential source of enzymes to reduce environmental contamination by methyl-parathion and its residues.

Total heterotrophic and Methyl parathion degrading bacterial counts of Cauvery river bed, near Erode, Bhavani and Tiruppur were analyzed. The samples were taken from the river sediment on monthly basis from October 2007 to November 2008. The total heterotrophic bacterial count was in the range of 12-20 x 10^4 CFU/gm and the total pesticide degrading bacterial count in the range of 50-90x10^3 CFU/gm. The pesticide degradation was found to be maximum at a concentration of 5µl of pesticide / ml of medium. Among the pesticide degrading bacterial population Bacillus Sp., was found to be dominant followed by Pseudomonas Sp., Micrococcus Sp. and Yersinia Sp.
Methyl parathion is the most commonly used pesticide for pest control in rice fields. As there was less significant quantitative variation between total heterotrophic and pesticide degrading microflora, this observation indicates that the bacterial genera are native microflora and are better adapted metabolitically to degrade the non-recalcitrant pesticides for their sole source of carbon and energy and it indirectly reduces the risk of pesticide leaching and dissipating into the reverine system. It is concluded that the proper bioremediation in the soil can easily eliminate the ill effects caused by accumulated toxic pesticides.