Soil Microorganisms and Environment Protection

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Soil microorganisms play a tremendous role in sustaining the equilibrium in the biosphere. They guarantee normal conditions in soils, atmosphere and waters. Microorganisms have sustained an equilibrium in the biosphere for hundreds of millions, or even two billion years. The composition of the atmosphere has remained constant throughout this period in spite of changes in conditions and the fact that plants and animals have arisen. This statement obviously refers to a definite extent to both soils and water. During the past few decades this equilibrium has become disturbed by a broad set of parameters due to the harmful influence of the anthropogenic factor.

The CO_2, CH_4 and N_2O contents of the atmosphere are increasing parallel with a destruction of the ozone layer. Soils and natural waters are becoming polluted by thousands of natural and artificial substances. The humus content of the soils has decreased together with a destruction of the soil structure. The amounts of nitrates, heavy metals, sulphuric acid, etc. in the soils are also on the increase. Soil microbiologists must attempt to develop microbiological methods for the determination of pollution /indication as well as microbiological techniques for equilibrium restoration.

It would seen that a large number and variety of microorganisms, especially soil microorganisms, is the basis of homeostasis. The larger the "pool", the more stable the system is. Investigations which have been carried out by soil microbiologists in recent years /ZVYAGINTSEV, 1987, 1989; ZVYAGINTSEV and GOLIMBET, 1983; LIMAR et al., 1975; ZVYAGINTSEV et al., 1981/ have shown that each hectare of fertile soil contains tens of tons of living microbial biomass. The average value is 20 t/ha. If, for the sake of comparison, this is calculated in terms of animal mass it turns out that the amount of microbial mass on one hectare is equivalent to the mass of 40 cows. One hectare of arable land or meadow can certainly not provide enough food for 40 cows. Nor would it be able to feed 20 tons of microbial biomass if this biomass were not constantly in a state of active metabolism. The present situation is only possible because the microbial biomass consists of dormant forms. The dormant pool makes it possible for the system to return rapidly to the state of homeostasis if this has been disturbed. For example, a mineral nitrogen fertilizer, introduced into the soil, soon undergoes nitrification and denitrification, and the normal, low soil nitrogen content becomes established. The same has been observed when plant or animal remains are introduced into a single soil locus. These quickly become digested by the microbial pool, which is present at any point of the soil where an organic compound has been introduced. Owing to the qualitative diversity at any point of the pool microorganisms occur which are able to utilize proteins, sugars, cellulose, lignine, chitin, etc. The perfect maintenance of homeostasis is possible because of the polyfunctionality of each soil microorganism. Soil microbiologists previously divided all microorganisms into physiological groups and attributed only a narrow function to each microbe. For example, there were nitrogen fixators, nitrificators and denitrificators. It has now been established, however, that a single microorganism often carries out all these functions, but at any given moment the prevalent function will be that which is necessary to revert the system to the homeostatic /equilibrium/ conditions. Homeostasis can also be attained owing to the action of the doubling principle in the soil. Any important natural process is carried out not by one microorganism but by several microorganisms of different types. For example, not only fungi but aerobic and anaerobic bacteria degrade cellulose, and each of these groups is represented by a great variety of genera and species. Thus, this important process is carried out quite effectively under different external conditions. The doubling principle also extends to lignine, chitin and even to hydrocarbons, nitrogen-fixation, denitrification, etc.

The soil microbial system is very well accomodated to the maintenance of homeostasis due to the presence of factors undergoing pronounced changes under natural conditions /all transformations of carbon, nitrogen, phosphorus/. But the maintenance of homeostasis by natural compounds not undergoing significant changes has not often been achieved in nature /heavy metal pollution, sulphuric acid rains/. An especially complicated situation has been created with unnatural compounds, particularly xenobiotics.

In order to increase the stability of the system it is necessary to try to enlarge the microbial pool /as regards both quantity and qualitative diversity/. The pool becomes enlarged as the soil humus content increases. Therefore, highly humous soils are very important for maintaining homeostasis. In spite of the fact that fungi are prevalent in the pool the bacterial pool is characterised by much greater qualitative variety. Bacteria are able to carry out a much wider range of functions than fungi do. In the near future the widespread introduction of microorganisms with different functions, including those obtained by genetic engineering, is likely to become general practice in soil microbiology with the aim of supporting homeostasis.

The microbial pool is characterized by a very high stability in the course of time. It has been shown to survive in peat-bogs for tens of thousands of years and in constantly frozen soils for a million years or more.

The significant complexity is connected with the fact that the pool of soil microorganisms primarily provides homeostasis in the soil itself, which is often attained owing to unfavourable changes in the atmosphere and groundwaters, as in the case of nitrates and nitrogen oxide formation.

The microbiological methods of eliminating pollution include the introduction of microorganisms; and changes in soil conditions to promote the necessary activity of microorganisms.

The introduction of microorganisms will evidently become widespread in the near future, for instance with the use of microbial nitrogen fixators in order to replace harmful mineral nitrogen fertilizers. Microbes which degrade xenobiotics and oil products may also be used as may microbe antagonists. The changes in soil conditions mainly involve the introduction of an organic compound: a co-substrate for the manifestation of microbial co-metabolism, combined with the regulation of air and water regimes. The most advanced microbiological methods are those used in the struggle against oil pollution of the soil. Microbiological methods for the indication of pollution are better developed than the techniques required for the combat against it. Scientists from the Soil Biology Department of the Moscow State University have elaborated methods for the indication of soil pollution with large doses of mineral fertilizers /N, P, K/, heavy metals, nitrification inhibitors, pesticides, oil products, fluorine mutagens and microbial wastes from the microbiological industry.

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