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Pollution by Mine Water

from our Microbiology Correspondent

THE influx of acid mine waters into non-acid receiving rivers and lakes can induce considerable ecological changes and can have deleterious effects on all forms of life. Coal deposits frequently contain metal sulphide minerals, especially of iron, and these minerals may be oxidized by thiobacilli and converted to sulphate, ferric and hydrogen ions. It is the accumulation of hydrogen and, to a lesser extent, of sulphate ions that is most detrimental to the development of indigenous heterotrophic micro-organisms. The activities of thiobacilli are undoubtedly significant in the recovery of metals, particularly copper, from low grade or once-extracted ores, but a cyclic operation is necessary to avoid pollution by the resulting acid waters. Recent studies by J. H. Tuttle and his associates (*J. Bact.*, **97**, 594; 1969) have been aimed at understanding the microbial ecology of acid mine drainage systems, and their findings suggest some possibilities for pollution abatement. The ecosystem investigated consisted of an acid drainage stream impeded by a dam of wood dust from saw mill operations: these conditions produced an upper pond, a porous dam and a lower pond which fed an outflow stream. Whereas the original drainage waters were highly acid and rich in iron and sulphate ions, and autotrophic bacteria capable of their oxidation, the lower pond water contained greatly reduced amounts of iron and sulphate and an altered microflora. Numbers of aerobic heterotrophs—predominantly yeasts, filamentous fungi and pseudomonads—increased markedly, and so did certain anaerobic bacteria. These changes in physical environment and in microflora are attributable directly to the influence of the wood dust dam. The reduction of sulphate occurred extensively in the dust pile, the degradation of cellulose and hemicelluloses providing the essential organic substrates for the sulphate reducing bacteria. The activity of the anaerobic bacteria is probably significant at this stage because the substrate requirements of sulphate reducers are principally for organic acids and related fermentation products. The ecological balance of this complex ecosystem is naturally influenced by environmental conditions such as stream flow rate. Thus the colour of the lower pond varied from reddish brown to greenish black depending on the proportion of sulphate reducers and oxidizers, which reflect the inorganic and organic nutrient states of the environment.

Tuttle and his colleagues have analysed this microbial sulphate reduction system in the laboratory (*Appl. Microbiol.*, **17**, 297; 1969) in an attempt to describe the conditions which accelerate the reduction. The effects of temperature and organic supplements on mixed cultures growing on a sulphate–wood dust containing medium were examined. Both the rate and initiation of sulphate reduction were controlled by the rate of digestion of wood dust and there were different optimum conditions for the two activities. Wood degradation had a higher optimum temperature, for example, while the excessive addition of organic substrates lessened the rate of reduction of sulphate. The latter effect itself is complex; for example, it may result from an inhibition of cellulose breakdown and/or from the stimulation of micro-organisms that compete for nutrients with the sulphate reducers. Although further research is needed to define precisely the conditions which might give a reasonable steady state of sulphate reduction in field conditions, Tuttle's group considers that various waste carbon materials as well as wood dust—for example, sewage, waste paper, agricultural wastes—might be used in the conversion. Then acid pollution control might be combined with solid waste disposal and the recovery of FeS or elemental sulphur.