MICROBIAL BIOMASS AND CARBON METABOLISM IN SOILS

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A thesis submitted for the degree of
Doctor of Philosophy

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February 1981
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SUMMARY

Studies on the decomposition of organic substances in soil have been reviewed with particular emphasis on organic fractions defined biologically rather than chemically. Methods available for the determination of microbial biomass in soil were also reviewed. The fumigation technique and the determination of ATP appear to be most suitable for estimating microbial biomass, especially in studies concerning the dynamics of organic carbon in soil. However, the application of the above two methods is limited by the conditions which prevail in the field, and during sampling and handling in the laboratory.

Seven soil samples collected fresh from the field were examined after various pretreatments in terms of content of ATP and biomass carbon. The ATP extracted was markedly and rapidly reduced by air-drying. However, a short wetting phase prior to freeze-drying of air-dried soils increased the ATP content significantly. The increase in the content of ATP extracted during wetting of air-dried soils occurred in the presence of dinitrophenol and therefore was not due to synthesis but to other reactions. The net effect of freeze-drying on the extraction of ATP depended on the physiological state of the organisms. However, the nature of the changes associated with freeze-drying of the soils and their influence on the extraction of ATP was not fully understood. Storage of the freeze-dried soils at 25°C and -15°C led to substantial losses of ATP.

The effects of various pretreatments on the biomass carbon content of the soils were compared based on the amounts of CO₂ evolved from the fumigated and unfumigated soils during the 0-10 day incubation period. Biomass carbon content of the soils decreased after air-drying. The concentration of ATP in the biomass of the field moist, air-dried, freeze-dried, and soils incubated with water did not change significantly and were similar to the values reported by Jenkinson and coworkers. The
wide biomass C/ATP ratios in the air-dried soils were thought to be due to incomplete extraction of ATP. By contrast the ratios of biomass C/ATP in the biomass of the field moist and the soils incubated with water after freeze-drying were much lower because more ATP was extracted.

Two soils, viz. the Urrbrae fine sandy loam and the Northfield clay were fractionated based on particle size and density after dispersions using a Spex shaker or an ultrasonic probe. The content of organic carbon, nitrogen, ATP and the monosaccharide composition of the soil fractions were determined. The recovery of ATP from the soil fractions obtained after dispersion using the Spex mixer was poor and ATP was evenly distributed amongst the soil fractions. By contrast after ultrasonic dispersion the concentration of ATP was high for fractions of diameter 5-2 μm and <1 μm in the Urrbrae silt and silt size particles of the Northfield clay. Determination of the ratios of the galactose + mannose/ arabinose + xylose indicated relative enrichment of microbial materials but not necessarily the living organisms in these fractions. A fractionation scheme was formulated based on the amounts of ATP and the organic material contained in the soil fractions obtained by physical means only and was used to study the decomposition of 14C glucose in the two soils.

After incubation of 14C-glucose the proportion of 14C present as biomass was much higher in the Northfield clay than the Urrbrae fine sandy loam. A range of biomass C/ATP ratios for the labelled microbial population in the soils incubated with 14C glucose is reported. Most of the 14C and ATP in the Urrbrae soil was located in the <0.5 μm fraction during early stages of the incubation but subsequently there appeared to be a transfer of ATP and 14C, presumably as microbial biomass, to the 5.0-0.5 μm fraction. The non-biomass-14C present in the <0.5 μm and the 20-5 μm fraction was largely responsible for the disappearance of 14C from the Urrbrae silt as compared to the rapid losses of biomass-14C from the 5.0-0.5 μm and the 20-5 μm fractions of the Northfield clay. Although
the retention of $^{14}C$ in the two soils was similar, considerable differences were observed in the dynamics of biomass and non-biomass materials.