Eastern Deciduous Forest Biome
Memo Report 73-76

Synthesis Process Report

Aquatic Decomposition and Mineral Cycling

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Research supported in part by the Eastern Deciduous Forest Biome, U.S. International Biological Program, funded by the National Science Foundation under Interagency Agreement AG 199, 40-193-69, with the Atomic Energy Commission - Oak Ridge National Laboratory.

1973

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FWI Report #73-28

Abstract

The results of IBP-EDFB research in aquatic decompositon and mineral cycling at Lake George and Lake Wingra are reported for the interval Sept. 72 - Aug. 73. Some preliminary syntheses between the processes are given. The status of the pertinent models is discussed.

Keywords: aquatic, microorganisms, phosphorus, carbon, nitrogen, nutrients, decomposition, growth rate

Early attempts at synthesizing the activities of the decompositon process and the mineral cycling process were made for the AAAS symposium held in Washington, D.C. in December 1972.

Comparisons between sites (Lake George and Lake Wingra) for specific processes and between processes for specific sites were made. These comparisons resulted in some preliminary syntheses that will be explored and extended substantially in the current fiscal year as one of the major objectives of IBP research by this process coordinator.

The investigators involved in the two processes met in a joint workshop at the 2nd Annual EDFB Meeting in March 1973. A more extensive concept of the role of the decomposer emerged from the discussions of this workshop in which the influence of the decomposers on abiotic as well as other biotic compartments was considered. On the other hand, the immediate reaction of the microbial population to sudden chemical and physical changes makes the microbial compartment particularly sensitive to the environment as was seen in a perturbation study conducted at Lake George.

Lake Wingra's phosphorus studies have shown that dissolved inorganic phosphorus reaches a miximum level in the autumn and the spring, and that total phosphorus during any specific runoff is highest at the beginning of runoff. Characterization of settling velocities of the phosphorus input was made. The rates of change as well as quantity of interchange between compartments (six) of total phosphorus were studied at Lake Wingra. Wide fluctuations in total phosphorus and particulate organic phosphorus seem to be attributable to fluctuations in biomass.

Phosphorus levels in the surface waters of Lake George and Lake Wingra are quite different (L. George = 8 μg total P/l; L Wingra = 100 μg total P/l). Mean values for total phosphorus and suluble phosphorus in the water column show a South to North gradient in Lake George. These data correlate with other observations on the influence of human population density. NH_3-N, NO_3-N as well as the organic content of the sediments and decomposer activity reflect this gradient. Little variation in water inorganic chemistry occurs with depth at Lake George.

Nitrification is considered to be mostly heterotrophic in Lake Wingra. Levels of ammonia are too low in either lake for autotrophic oxidation. Neither lake reports significant levels of NO_2-N.

$^{15}NH_4Cl$-N turnover rate in Lake Wingra surface waters are rapid whereas the rate in bottom waters and adjacent sediments is extremely slow. In contrast, $K^{15}NO_3$-N was denitrified and assimilated rapidly in Lake Wingra sediments, yet minimal turnover occurred in the water column.

Dissolved and particulate organic carbon were measured at Lake George and Lake Wingra at various stations and depths throughout the year. In addition, the humic content of the DOC was determined at Lake George.

Uptake of isotopically labelled substrates by the microbial population in the water columns of the two lakes reflects similarity indicating the same rate of microbial biomass production. However, higher levels of cells are maintained in Lake Wingra suggesting that a more rapid turnover of microbial biomass occurs in Lake George. This implies that the detrital food chain may, in fact, have different significance with regard to the energetics of the two lake systems. This point should be explored further.

Decomposer activity in the sediments is dependent on temperature when an unacclimated microflora is exposed to different temperatures. However a similar dependence is not observed in the field data as the temperature of the sediment increased over the summer indicating the influence of adaptation to gradual change or the greater influence of differences in nutrient levels. The data obtained when phosphorus (5 - 50 μg/1) and nitrogen (50 - 500 μg/1) were added to the standard assay for decomposer activity showed different effects. In all systems, P depressed activity whereas N stimulated activity.

A correlation between heterotrophic microbial growth rates and the DNA content of the sample has been shown. Evidence exists that varying extraction procedures can be used to differentiate between classes of organisms eg. fungi, bacteria, eukaryotic algae.

Studies on methane production were done at Lake Wingra. Substantial amounts of methane are released from below the water-sediment interface in the summer months. Most of the methane activity was found to reside in the top 5 cm of sediment. Once can correlate the methane formation with the organic content of the sediment.

The constructs of the decomposition model at Lake George have been changed so as to become more realistic and to include cycling of nutrients. It has been coupled with certain other submodels of CLEAN to form an open water model.

At Lake Wingra an empirical model has been developed for total nitrogen. A model for microdynamics of phosphorus is being developed at Lake Wingra.