Phosphorus Geochemistry in Two Coastal Plain Watersheds with Different Land Management Practives: Processes Involving Organophosphorus Compounds

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Popes Creek, Virginia, is the site of the National Park Service's George Washington Birthplace Monument. The intensity of agricultural activities in this watershed has diminished in this century. The Pocomoke River, Maryland, is the location of major poultry industry where more than 82 million chickens are raised each year. The manure from these chickens is used to fertilize fields in the Pocomoke watershed and water from agricultural fields drains into the upper Pocomoke River. To evaluate the condition of downstream sediments in areas where each stream empties into a larger body of water, box cores were taken of bottom sediment: (1) where Popes Creek empties into the Potomac River, and (2) where the Pocomoke River empties into the Chesapeake Bay.

Box cores were collected in August and November of 1998, and in April 1999, in the Pocomoke River. Box cores were collected in April 1999 in Popes Creek. One to two centimeter intervals of sediment were separated in a nitrogen-filled glove bag. Sediment samples were centrifuged and interstitial water filtered through a 0.2-micrometer membrane. Solids were analyzed for total phosphorus, aluminum, calcium, and iron. Anion analyses of the interstitial water included soluble-reactive phosphate, orthophosphate, chloride, nitrate, and sulfate. Cation analyses of the interstitial water included aluminum, calcium and iron. Concentration gradients from the sediment water-interface to a depth of 20 centimeters show that iron and phosphate concentrations are larger in interstitial water in sediments from Pocomoke River than in interstitial water in sediments from Popes Creek. Because the total phosphorus concentrations in sediments from the two watersheds are similar, a difference in bacterial populations was tested.

The manure of chickens contains phytic acid (inositol hexaphosphoric acid) because chickens can digest less than 30 percent of phytic acid found in the corn in their diets. Microbiological experiments were done to test the response of bacteria in downstream sediments from each watershed to the presence of phosphorus-containing compounds in poultry diets. Incubations of sediment from both watersheds used a medium containing no phosphorus or a medium to which either phytic acid or pyridoxal-5-phosphate, a phosphate-containing compound of the vitamin B-6 complex found in animal feeds, was added as a sole source of phosphorus. Phytic acid or pyridoxal-5-phosphate stimulated the growth of bacteria in sediments from Popes Creek but did not stimulate the growth of bacteria in sediments from the lower Pocomoke River. The sediment from Pocomoke River bacteria were able to grow with, or without, phosphorus in the medium, suggesting that these bacteria are not phosphorus limited.

Similarities and differences in the bacterial population with respect to phosphorus cycling are being investigated. Hypotheses that might explain different responses of the bacterial populations to nutrient adequacy or limitation include: (1) differences in the amount and speciation of phosphorus in the two watersheds, (2) different responses to various nutrient conditions by bacteria in sediments from these two watersheds, (3) differences in redox conditions at sampling sites reflect different bacterial communities, and, (4) antibiotics might be having an affect on microbial populations in the watersheds.

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