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Y. Cohen: SULFUR TRANSFORMATIONS AT THE HYDROGEN SULFIDE/OXYGEN INTERFACE IN STRATIFIED WATERS AND IN CYANOBACTERIAL MATS

Stratified water bodies allow the development of several microbial plates along the water column. The microbial plates develop in relation to nutrient availability, light penetration, and the distribution of oxygen and sulfide. Sulfide is initially produced in the sediment by sulfate-reducing bacteria. It diffuses along the water column creating a zone of hydrogen sulfide/oxygen interface. In the chemocline of Solar Lake (Sinai) oxygen and sulfide coexist in a 0-10 cm layer that moves up and down during a diurnal cycle. The microbial plate at the chemocline is exposed to oxygen and hydrogen sulfide, alternating on a diurnal basis. The cyanobacteria occupying the interface switch from anoxygenic photosynthesis in the morning to oxygenic photosynthesis during the rest of the day. This activity results in a temporal build up of elemental sulfur during the day which disappears at night due to both oxidation to thiosulfate and sulfate by thiobacilli, and reduction to hydrogen sulfide by *Desulfuromonas* sp. and anaerobically respiring cyanobacteria.

High dark CO_2 fixation, which can be stimulated by sulfide, elemental sulfur, and thiosulfate in the presence of oxygen or nitrate, is found in the chemocline. Over 90 percent of the primary production in the stratified Solar Lake occurs under sulfide conditions because of the activities of several cyanobacteria, plates of *Chromatium* sp., and *Prosthecochloris* sp.. These sulfur bacteria exist above the major cyanobacterial plate of *Oscillatoria limnetica* which is found at the deepest part of the hypolimnion. The relative contribution of anoxygenic photosynthesis to overall primary productivity is a function of light penetration to the hydrogen sulfide/oxygen interface layer. When only 1 percent of surface light reaches this layer, anoxygenic photosynthesis accounts for about 5 percent of the overall primary productivity whereas if 20 percent of the surface light reaches the chemocline (the case in Solar Lake), anoxygenic photosynthesis accounts for more than 90 percent of the photosynthetic carbon dioxide assimilation.

The study of the hydrogen sulfide/oxygen interface in sediments requires the use of microelectrodes for pO_2, pH, pS^{2-}, pH_2, and pCO_2. These electrodes, now used in several laboratories, were introduced to microbial ecology by N.P. Revsbech of Aarhus University in Denmark. Sharp gradients of all measured parameters are observed in microscale (the top 1-10 mm of the sediment column). These result from intense microbial activities in this thin photic zone.

Diurnal fluctuations at the hydrogen sulfide/oxygen interface in sediment are much more pronounced than those of stratified water bodies, since the established gradients in sediment are very steep and diffusion in these dimensions is very fast. Because of this close proximity, the diurnal fluctuations expose cyanobacteria to sulfide at night and sulfate-reducing bacteria to high concentrations of oxygen during the day.

The cyanobacteria cope with exposure to sulfide either by carrying out facultative anoxygenic photosynthesis or by performing oxygenic photosynthesis in the presence of sulfide. When pH_2 electrodes were introduced to the Pmax zone, a transient peak of H_2 was observed upon turning on the light, possibly indicating photolysis of water by cyanobacteria under these conditions. *Oscillatoria limnetica* were shown to produce H_2 in a CO_2 limited environment under both aerobic and anaerobic conditions.

Sulfate reduction was found to be enhanced in the light at the surface of the cyanobacterial mats. Microsulfate reduction measurements showed enhanced activity of sulfate reduction even under high oxygen concentrations of 300 800 μM. Apparent aerobic SO_4 reduction activity can be explained by the co-occurence of H_2. The physiology of this apparent sulfate reduction activity is currentl. being studied.

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