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SEDIMENTARY PIGMENT DISTRIBUTIONS SUGGEST TEMPORAL CHANGES IN THE CHEMOCLINE DEPTH OF A MEROMICTIC LAKE

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Anoxygenic, phototrophic green and purple sulfur bacteria (GSB and PSB) inhabit water bodies characterized by photic zone euxinia, where sulfidic waters receive enough light to support photosynthesis. Some species of GSB can produce pigments that allow them to adapt to low light conditions, enabling them to inhabit environments even where sulfidic waters are found solely at deeper depths. At shallower depths PSB and associated sulfate reducing bacteria tend to form a dense bacterial plate at the upper surface of the anoxic zone. For this study we extracted pigments from the water column and sediments of a euxinic lake and analyzed them using reversed phase high performance liquid chromatography (RP-HPLC) with photo diode array detection and atmospheric pressure chemical ionization liquid chromatography-multistage mass spectrometry (APCI LC-MS^n) (Airs et al. 2001). We examined the variability in distributions of bacterial pigments from depths within and below the bacterial plate and related those findings to distributions of pigments extracted from the lake sediments to evaluate how the chemocline depth responded to environmental changes around the lake.

Fayetteville Green Lake, New York, maintains persistent density stratification, allowing water below a chemocline, at ~20 meters depth, to remain anoxic year-round. Density stratification is controlled by two main factors: (1) the influx of dense, relatively saline groundwater and (2) the lake's setting in a wooded, steep-sided topographical depression which reduces wind mixing of the lake. The depth of the chemocline, currently at the base of a 4-meter thick pycnocline, is controlled both by the pycnocline depth and productivity of the bacterial plate, which oxidizes sulfide that diffuses upward from the bottom waters, thus causing the sharp transition from reducing to oxidizing conditions. Our sample from within the bacterial plate contained high concentrations of chlorophyll *a* (Chl *a*) related to cyanobacteria (*Synechococcus*) living at the top of the chemocline, bacteriochlorophyll *a* (Bchl *a*) from PSB (*Chromatium*), and several forms of Bchl *e* from GSB (*Chlorobium*). A sample from 5 meters below the chemocline contained lower concentrations of Chl *a* and Bchl *a* and a different distribution of Bchl *e* forms with a higher proportion having *n*-propyl and *iso*-butyl groups at the C-8 position. Extended alkylation at C-8 has been hypothesized as an adaptation to low light conditions (e.g. Bobe et al., 1990).

We also extracted pigments from gravity core sediment samples collected at Green Lake. Previous studies suggest that deforestation of Green Lake's drainage basin in the early 19th century stimulated higher rates of organic matter production in the lake due to increased nutrient flux. Primary productivity increased both below and above the chemocline, shown by increased accumulation rates of bulk organic matter (Hilfinger et al., 2001) as well as Chl *a*, Bchl *a*, and Bchl *e* from our work. For 2000 years prior to deforestation the Bchl e C-8 position shows a high degree of extended alkylation (*iso*-butyl:*n*-proply:ethyl = 2.2:2.4:1.0, n=3) At the time of deforestation the Bchl *e* distribution shifts toward C-8 ethyl groups (1.1:1.1:1.0) suggesting GSB were living at a shallower depth with greater light availability. Sediments for the ~180 years since deforestation have trended back toward increased extended alkylation with surface sediments at (1.4:1.5:1.0). Thus, the sediments of Green Lake suggest that a temporary shallow chemocline resulted from deforestation, either due to increased productivity in the mixolimnion and bacterial plate, expansion of the monimolimnion due to changes in ground water flux to the lake, or greater wind mixing directly from deforestation. Similar use of bacterial pigment distributions in other permanently meromictic settings could also help constrain variability in chemocline depth.

REFERENCES

Airs R.L., Atkinson J.E., Keely B.J., 2001. Development and application of a high resolution liquid chromatographic method for the analysis of complex pigment distributions. Journal of Chromatography 917, 167-177.

Bobe F.W., Pfennig N., Swanson K.L., Smith K.M., 1990. Red shift of absorption maxima in Chlorobineae through enzymic methylation of their antenna bacteriochlorophylls. Biochemistry 29, 4340-4347.

Hilfinger M.F., Mullins H.T., Burnett A., Kirby M.E., 2001. A 2500 year sediment record from Fayetteville Green Lake, New York: evidence for anthropogenic impacts and historic isotope shift. Journal of Paleolimnology 26, 293-305.