LIPID BIOMARKERS AND MICROBIAL DIVERSITY SYSTEMATICALLY ASSOCIATED WITH APHOTIC EUXINIC CHEMOCLINES IN A SALINE LAKE

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During the first half of Earth history, oceans remained anoxic and dominated by prokaryotic microbial communities. In this context, shallow-water lake Dziani Dzaha (mean depth of 4 meters), located in the tropical Mayotte island (France), has recently been identified, based on its biogeochemical characteristics, as one of the best contemporary analogues of Paleoproterozoic oceans. Lake Dziani has permanent anoxia under 1.5m, permanent euxinia, ^{13}C-enriched carbonates precipitation and prokaryotic dominance. The biogeochemistry of this type of aquatic ecosystems as well as the structure of microbial communities thriving in such lakes remain poorly explored.

In this study, we characterized the molecular and isotopic compositions of the organic matter along with the structure of the microbial community in the different compartments of the water column. This was performed during two contrasted periods (each representative of *ca*. 6 months of the year): a stratified period (corresponding to a humid climate) when strong euxinic conditions prevail in most of the water column, and a mixed period (corresponding to a dry climate) when euxinia is limited to the deepest part of the lake (18 m). During both periods, however, only the upper part (from 0.75 to 1 m maximum) of the water column is oxygenated due to the tremendous cyanobacterial productivity (Leboulanger et al., 2017) occurring all year long. The vertical distribution of lipid biomarkers was compared with the abundance and diversity of prokaryotic microorganisms (i.e. *Bacteria* and *Archaea*).

The results show that the presence of chemoclines (one for the mixed period and two for the stratified period) plays a prime role in structuring microbial communities throughout the water column and in the recycling the cyanobacterial organic matter. This latter appears to be more intense during the stratified period as evidenced by lipid biomarkers, pigments and cell counting data. Whatever the period being considered, an increase in bacterial and archaeal biomass and in several bacterial and archaeal biomarker concentrations occurs below the aphotic and euxinic chemocline(s) (Figure 1), suggesting the existence of specific anaerobic and halophilic microbial populations involved (directly or indirectly) in the sulfur cycle. This was supported by DNA sequencing of *Bacteria* and *Archaea*, which demonstrated a seasonal and chemocline-dependent structuration of the microbial community along the water column, with sulfur-dependent communities of *Bacteria* and *Archaea* systematically associated with the bottom compartment of the water column.

The biological origin of several biomarkers (such as wax esters and tetrahymanol, Figure 1) associated with the non-photic and euxinic chemoclines is questioned, as it likely relies on other sources than those classically assumed for these lipids. The stable carbon isotopic composition of some archaeal biomarkers ($\delta^{13}C \approx$-21‰) compared to that of Dissolved Inorganic Carbon suggests the development of methanogenic populations specifically adapted to the extreme conditions (hypersalinity, high concentrations of sulfides) prevailing under the chemoclines.

Our data highlight the complexity and dynamism of such highly productive and anoxic aquatic ecosystems, that deserve to be further investigated to better characterize the origin and fate of organic matter under conditions resembling those of the Proterozoic Oceans.

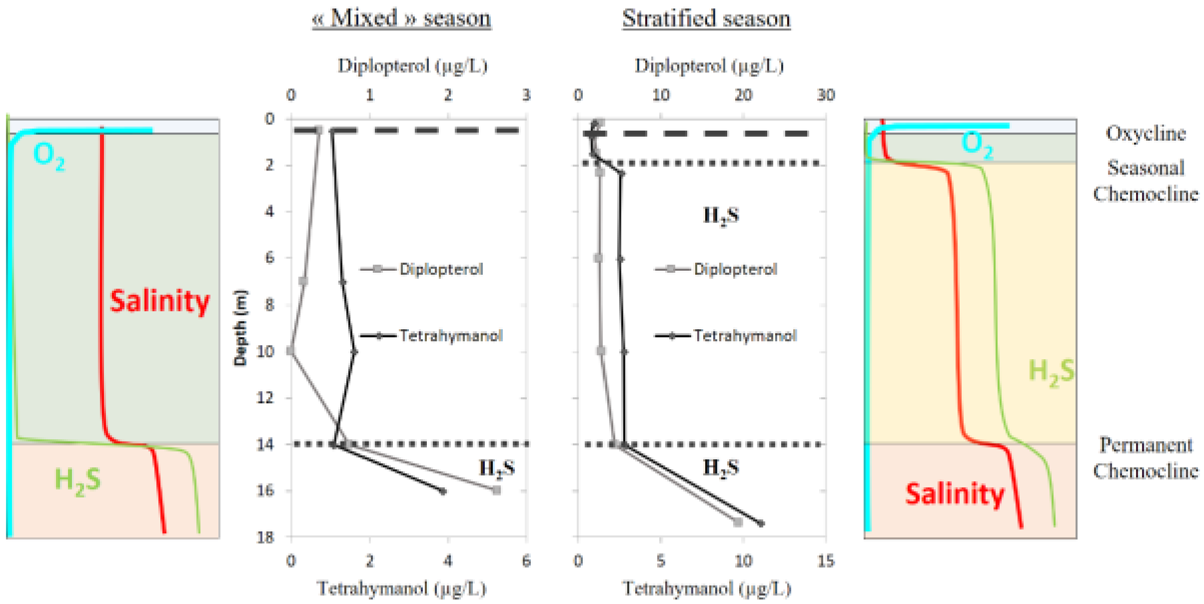

Figure 1 *Concentration of diplopterol and tetrahymanol for the "mixed" and the stratified season and associated stratification of the water column*

References

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