

published, which enables us to investigate the biogeochemical, physiological, and ecological differences in microbial responses to the ambient environmental conditions.

Results: Three aspects related to the application of proxies were proposed to be deciphered, including the cross-check of multiple proxies due to the various biogeochemical processes, the sensitivity and the linear range of the proxies resulting from physiological responses, and the spatial heterogeneity of the proxies arising from the ecological difference. Biogeochemically, microbes can show responses to the ambient environmental conditions via several molecular patterns and pathways, providing a unique chance for the cross-check of multiple proxies. Physiologically, microbes are found to show a linear response to the environmental conditions only in certain range. The linear physiological response thus determines the sensitivity of the proxies for paleoenvironmental reconstruction. Ecologically, microbes might show responses to different environmental factors in different regions. The heterogeneity of ecological responses could affect the proxies used in different regions. Microbial activities in a specific environment might be restricted by a specific factor, such as the aridity in arid region, which in turn leads to the molecular proxies in a sensitive response to this particular factor instead of other factors.

Conclusions: Application of microbial molecular proxies awaits the systematic investigations on all the biogeochemical, physiological and ecological responses. Care should be taken when we use these proxies without any knowledge of physiology and ecology of the corresponding microbes.

Keywords: Geomicrobes; lipids; geobiology; ecology; global change; paleoclimate

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