

Metagenomic Identification of Cave Microorganisms in Lascaux and Other Périgord Caves

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Abstract : The Lascaux Cave in South-Est France is an archeological landmark renowned for its Paleolithic paintings dating back c.18.000 years. Extensive touristic frequenting and repeated chemical treatments have resulted in the development of microbial stains on cave walls, which is a major issue in terms of art conservation. Therefore, it is of prime importance to better understand the microbiology specific to the Lascaux Cave, in comparison to regional situations. To this end, we compared the microbial community (i.e. both prokaryotic and eukaryotic microbial populations) of Lascaux Cave with three other anthropized Périgord caves as well as three pristine caves from the same area. We used state-of-the-art metagenomic analyses of cave wall samples to obtain a global view of the composition of the microbial community colonizing cave walls. We measured the relative abundance and diversity of four DNA markers targeting different fractions of the ribosomal genes of bacteria (i.e. eubacteria), archaea (i.e. archeobacteria), fungi and other micro-eukaryotes. All groups were highly abundant and diverse in all Périgord caves, as several hundred genera of microorganisms were identified in each. However, Lascaux Cave displayed a specific microbial community, which differed from those of both pristine and anthropized caves. Comparison of stains versus non-stained samples from the Passage area of the Lascaux Cave indicated that a few taxa (e.g. the Sordiaromycetes amongst fungi) were more prevalent within than outside stains, yet the main difference was in the relative proportion of the different microbial taxonomic groups and genera, which supposedly supports the biological origin of the stains. Overall, metagenomic sequencing of cave wall samples was effective to evidence the large colonization of caves by a diversified range of microorganisms. It also showed that Lascaux Cave represented a very particular situation in comparison with neighboring caves, probably in relation to the extent of disturbance it had undergone. Our results provide key baseline information to guide conservation efforts in anthropized caves such as Lascaux and pave the way to modern monitoring of ornamented caves.

Keywords : cave conservation, Lascaux cave, microbes, paleolithic paintings

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