
Analysing active interactions between autotrophs and viruses in soil by following transfer of assimilated carbon

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Résumé

While we have substantial knowledge of the complexity of prokaryotic communities and their contribution to functional processes in soil, we are currently ignorant on the role of viruses in influencing their ecology. In particular, difficulties remain in identifying the frequency of active interactions between host and virus populations in situ, largely due to a lack of tools to study interactions within this highly diverse and heterogeneous environment. To examine discrete, active interactions between individual host and virus populations in situ, this study focused on the transfer of assimilated carbon from autotrophic hosts to viruses. Microcosms containing pH 4.5 or 7.5 soil were amended with ¹³C methane or carbon dioxide and subjected to short-term incubations. Using DNA stable-isotope probing combined with metagenomic analyses, microbial networks were characterised, with primary and secondary utilisers of carbon identified, together with the transfer of host-fixed carbon to viruses. In methane incubated soils, 63% of ¹³C-enriched viral contigs were associated with methylotrophic bacteria with viruses non-methanotrophic methylotrophs and predator bacteria also identified. Active interactions and history of virus interactions with individual hosts were also characterised via analysis of ¹³C-enriched virus protospacer sequences in host CRISPR arrays. In soils incubated with carbon dioxide under nitrifying conditions, active viruses of ammonia oxidising archaea and nitrite oxidising bacteria were identified. Putative viruses of both methane oxidisers and ammonia oxidising archaea contained auxiliary metabolic genes involved in central metabolic pathways, and analysis of viral genes (e.g. integrases, tail and capsid proteins) revealed that they were distinct from previously cultivated viruses. These results demonstrate that following carbon flow facilitates identification of discrete host-virus interactions within the complex soil environment.

Mots-Clés: Soil viruses, DNA, stable isotope probing, metagenomics

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