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Exploring virus dynamics in a Nanobdellati Co-culture system

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Archaea are infected by structurally diverse viruses that are important drivers of microbial evolution. However, archaeal virus infections are typically studied in binary host-virus systems, while the influence of additional microbial partners on infection dynamics remains poorly understood. The archaeal kingdom *Nanobdellati* (formerly DPANN) comprises ultra-small symbionts with reduced genomes and cell sizes, yet their ecology and interactions with viruses remain largely unexplored because of limited cultivability.
In this study, we explored the interactions between the ultra-small archaeon YN4 of the order *Nanobdellales*, its archaeal host *Metallosphaera hakonensis* YN4HA, and the virus Metallosphaera Turreted Icosahedral Virus 4 (MTIV4), using a newly established, stable tripartite co-culture system. We combined physiological, genomic, transcriptomic, glycoproteomic, cryo-electron tomographic, and live-cell imaging approaches to characterise the three partners. Cryo-electron tomography revealed that the *Nanobdellales* ectosymbiont forms a direct connection with its host through a cone-shaped attachment organelle. Although MTIV4 infects only YN4HA and impairs host growth, the presence of the YN4 symbiont substantially mitigated this virus-induced growth inhibition. Our results show that an obligate symbiont can confer protection against viral infection, suggesting that the host-symbiont relationship may shift from a parasitic interaction towards a defensive partnership. Glycoanalysis further suggests that remodelling of host cell-surface glycans, triggered by the YN4 symbiont, may contribute to this protection.
This study provides the first in-depth exploration of a tripartite host-symbiont-virus system in archaea and highlights the importance of considering microbial communities when studying viral ecology and evolution.

Reference #1

`A Tripartite Co-culture System Reveals Defensive Mutualism Between a Nanobdellati Symbiont and Its Host`

Hiroyuki D Sakai, Sabine Schwarzer, Satoshi Nakagawa, Milad Reyhani, Shigeru Shimamura, Matthew D Johnson, Yuya Tsukamoto, Michiru Shimizu, Ken Takai, Takuro Nunoura, Norio Kurosawa, Moriya Ohkuma, Thomas Hackl, Debnath Ghosal, Tessa Quax
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Reference #2

Reference #3

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