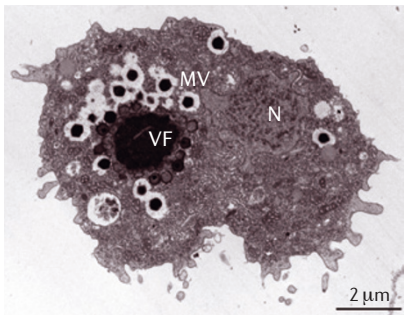
VIROLOGY

Giant viruses — movers and shakers



Transmission electron microscopy image showing *Acanthamoeba polyphaga* infected with Mimivirus. N, nucleus; VF, virus factory; MV, Mimivirus virions. Image reproduced, with permission, from Raoult, D. and Forterre, P. © (2008) Macmillan Publishers Ltd. All rights reserved.

The discovery of giant viruses such as Mimivirus, which can be seen under the light microscope and encodes almost 1,000 proteins, rewrote the rules of virology and sparked a debate on what constitutes a living organism. Reporting in *Proceedings of the National Academy of Sciences USA*, Didier Raoult, Eugene Koonin and colleagues now provide more details about the complement of mobile genetic elements (MGEs) associated with giant viruses.

MGEs mediate the transfer of DNA both within and between species, and include phages, plasmids, transposons and self-splicing elements such as introns and inteins. It was known that giant viruses contain introns and inteins, and support the replication of satellite viruses known as virophages. In this study, a new giant virus, Lentille virus, and its associated virophage, Sputnik 2, were isolated from an amoeba (*Acanthamoeba polyphaga*) that had contaminated the contact lens fluid of a patient with keratitis. Fluorescence *in situ* hybridization (FISH) showed that the virus and virophage colocalized and replicated within virus factories in infected *A. polyphaga* cells. More detailed analysis indicated that Sputnik 2 was integrated into the genome of its giant virus host, and this was confirmed by sequencing viral DNA isolated from cloned Lentille virus particles. High-throughput sequencing also identified an extrachromosomal linear DNA molecule of ~7 kb that resembled a transposable element and which the authors dubbed a transpovirion. FISH analysis showed that the transpovirion was present at high copy number in Lentille virus particles and could replicate in the virus factories in infected *A. polyphaga* cells. Transpovirions were detected in three other giant virus genomes; furthermore, two transpovirion genes had homologues in Sputnik (the virophage associated with Mimivirus), indicating that recombination might have occurred between these two MGEs.

In another recent development, the 3.5 Å near-atomic-resolution structure of Sputnik has been determined by cryo-electron microscopy. The structure showed that the major capsid has a double-jelly-roll structure and, by comparing it with the 3.8 Å resolution structure of an empty capsid, the authors conclude that the mechanism of DNA ejection for Sputnik might be similar to that of adenoviruses.

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ORIGINAL RESEARCH PAPERS Desnues, C. *et al.* Provirophages and transpovirons as the diverse mobilome of giant viruses. *Proc. Natl Acad. Sci USA* **109**, 18078–18083 (2012) | Zhang, X. *et al.* Structure of Sputnik, a virophage, at 3.5-Å resolution. *Proc. Natl Acad. Sci USA* 22 Oct 2012 (doi:10.1073/pnas.1211702109)