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Two Hosts or One? Viruses are More Complex than Previously Thought

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Editorial

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Editorial

Viruses are categorized as eukaryotic, archaeal, and bacterial, explaining the presence of eukaryotic genes in eukaryotic viruses, and bacterial genes in bacterial viruses (phages). An eukaryotic virus infects eukaryotes, and can incorporate host genes into its genome that help the virus escape the host cell and evade the immune system. Phages often incorporate bacterial genes that enhance the fitness of the virus. Eukaryotic viruses do not seem to infect bacteria, and up until last year, there was not any evidence of phages infecting eukaryotes.

WO is a phage that infects the *Wolbachia*, a group of obligate intracellular bacteria that infect over half of all insect species. The genome of WO phage contains a eukaryotic association module, enriched with eukaryotic like domains, including latrotoxin-CTD from widow species (*Latrodectus sp.*) [1]. The CTD most likely incorporated into the virus genome during lysis from a spider cell. Since the virus must exit both *Wolbacchia* cells and arthropod host cells in order to find more bacteria to invade, the virus may need to incorporate genes from the arthropod genome to survive the lysis from bacterial cells. While this seems reasonable, it is the first evidence of a virus infecting organisms from multiple domains of life. The mechanism of horizontal gene transfer from eukaryote to phage is unknown, but it is likely that phages of other species of obligate intracellular bacteria contain eukaryotic domains in their genome [1].

Many eukaryotic parasites are obligate intracellular parasites, and could have viruses that contain genes from the vertebrate hosts of the parasites. These viruses face the same challenge that WO phage face, having to escape the parasite cell and the host cell in order to find additional hosts. However, the evidence of lateral gene transfer between eukaryotic viruses and eukaryotic organisms is overwhelming [2]. Viruses of *Plasmodium sp.*, *Trichinella sp.*, and other obligate intracellular parasites require more study to determine the extent and mechanism of lateral gene between the host and the virus.

Phages likely pick up material from eukaryotic viruses and other intermediates between the eukaryotic hosts and the obligate intracellular bacteria [1]. Eukaryotic viruses of obligate intracellular parasites could pick up host genes in a similar mechanism. Phages and eukaryotic viruses may also incorporate DNA directly from eukaryotic hosts, and transfer this DNA laterally into the bacterial and eukaryotic parasite genomes [2]. From there, the genes could transfer to other viral individuals and to any other hosts of the virus, thus forming a complex network of transfer from one individual to another. As an example, stinkbugs contain homologues of latrotoxin-CTD that likely came from WO phages in the *Wolbachia* that infect the stink bugs [1]. Considering that eukaryotic parasites can contain many viruses, this could account for large amounts of lateral transfer. We need to

better characterize and describe viral genomes, and determine the extent of host material transferred to viruses.

References

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