

# Do parasite viruses affect the relationship of parasites with their host?

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Parasite is an organism that lives in association with an organism of different species, the host. The parasite benefits at host expense as a result of this association, the parasite receives an advantage at the host's expense. In the host-parasite relationship, many detrimental effects on the host are produced and the fitness of parasites increases over the host. Accordingly, parasitism is considered as non-mutual symbiotic relationship and many organisms, from viruses to vertebrates are parasites [1]. Inter-specific parasite interactions are one of the biggest challenges of our time for both human and animal health [2]. While understanding of parasite-parasite interactions offers new management perspectives, more experimental and theoretical works should be done to explore their underlying mechanisms and to predicate the potential ecological and evolutionary outcomes of control measures [2–4].

It is well known that parasite's features and host's age, sex and immune status have been accompanied with severity of the clinical manifestation [5, 6]. One of the factors that affect parasite features is parasite viruses. Recently, the role of parasites infected by viruses in modifying host – parasite relationship and their impact on the resulting disease caused is taking a considerable attention as little is known about this issue. Many parasites are infected with viruses. Viruses are considered as the smallest type of infectious organisms

and their genetic material (DNA or RNA) surrounded by a protective protein coat and in some cases, an envelope of lipids. They are able to infect all living organisms including parasites. Viruses of parasites are very specific to them as they cannot infect the host of the parasite. It is known for many years that viruses are able to infect parasites, but new viruses infecting parasites are still discovered nowadays.

Studying the effect on host-parasite is still in its first stage although the presence of viruses in parasites was reported many decades ago [1]. The viruses do not infect the host itself but the host immune system sense by their double-stranded RNA genomes leading to marked complications or severity of the infections. In other cases, the presence of the virus in the parasite might attenuate the disease symptoms caused by the parasite leading to hypo virulence [1]. Viruses infecting parasites are very specific to them, meaning that a virus infecting a parasite cannot infect the human host (of the parasite). Furthermore, viruses are specific to one parasite's species. Therefore, viruses infecting one species of parasite are usually named after it and are numbered according to the sequence of their discovery.

In this regards, the annual incidence of *Trichomonas vaginalis*, a parasitic protozoan infecting the urogenital tract of both women and men is about ~250 million individuals per year. It causes trichomoniasis, the most common sexually transmitted disease resulting in increased susceptibility to immunodeficiency virus and many reproductive complications. *T. vaginalis* is commonly found harboring one or several *T. vaginalis* specific, dsRNA viruses [7, 8]. Exposure of human epithelial cell cultures from the reproductive tract to viruses-negative or positive *T. vaginalis* showed that virus-positive protozoa induced the formation of interferon and proinflammatory cytokines while virus-negative ones did not. These results showed that protozoan viruses can be sensed by human cells, resulting in inflammatory responses and complications related to reproductive system [1, 9]. In contrast, it has been suggested that suggested a decrease of the virulence of the parasite by the virus [10].

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*Leishmania* spp., a parasites transmitted by sand fly to the vertebrate host causing visceral or cutaneous leishmaniasis may is also be infected with viruses (LRV). A dsRNA virus has been associated as partially responsible for complications of the disease produced by parasite [11]. It has been showed that the virus increased the virulence of the parasite in a study done on the murine model of infection with *L. guyanensis* suggesting an association of LRV with the clinical manifestation of mucocutaneous leishmaniasis [11].

*Giardia lamblia*, a causative organism of diarrheal diseases in developing countries, is also infected with viruses. However, a deleterious effect of the virus on the parasite may suggest a decrease in virulence as it is presently not clear if virus infection affects the relationship of this parasite with its host [1]. On the other hand, few studies have investigated the interactions between *Acanthamoeba*, a free-living Amoeba and their infecting giant virus, *Acanthamoeba polyphaga mimivirus*. The encystment stimulation is sufficient to protect *Acanthamoeba* from viral infection, upon infection, the virus is able to interfere with the expression of a serine proteinase related to amoebal encystment and the encystment can no longer be triggered [12, 13].

Accordingly, the interactions between a virus infected parasite and the host of parasite seem to be more complex than expected. For understanding the role of viruses of parasites in this regard, a more relationship should be considered including the virus, the parasite (host of the virus), and the host of the parasite [1]. Hence, future research should focus on relationship between the virus, the parasite and the host and the association between the variation of the pathogenicity symptoms and the presence of virus of parasites.

Another prospects for viruses of parasites, some recent studies also suggest that viruses could be used in treatment of parasites [14]. As viruses infecting parasites are very specific for one parasite species and are usually unable to infect humans. Such viruses could specifically kill parasites inside their hosts [14]. However, more studies are needed to elucidate a mechanism to infect parasites with a virus while inside its host and evaluate potential side effects for the host.

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Maha F. M. Soliman – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

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#### Guarantor

The corresponding author is the guarantor of submission.

#### Conflict of Interest

Authors declare no conflict of interest.

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