In Vitro "Evolutionary Arms-Races" between Hosts and Parasites in an Artificial RNA Replication System.

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Abstract: Host-parasite relationships are quite universal in nature, where host organisms are exploited by parasitic organisms, viruses, or transposons. Parasites could have been among the major driving forces in the evolution of life through “evolutionary arms-races” [1], but it is still unclear how universal the arms-race phenomenon is, and how the arms-race influences evolution of their hosts.

In this study, we experimentally investigated the host-parasite evolutionary arms-race using a simple artificial host-parasite system established in our laboratory [2]. This system consists of a reconstituted cell-free translation system and two kinds of RNA, Host and Parasite RNAs, both of which are replicated by an RNA replicase encoded only in Host RNA (Fig.1). In this system, both Host and Parasite RNAs are capable of evolution through mutations introduced by replication errors and natural selection processes. We performed coevolution experiments by encapsulating the Host-Parasite RNA replication system in micrometer-sized water droplets and repeating the process of RNA replication and feeding nutrients (Fig. 2).

We found that

1. The number of Host and Parasite RNAs oscillated and itinerated oscillatory competition phase and coexistent phase during the evolution experiments. (Fig. 3)
2. Novel Parasite RNAs with different sequence lengths emerged in the middle of the evolution experiments.
3. Host RNA evolved faster in the presence of Parasite RNAs than in the absence of them.

These results indicate that evolutionary arms-races between Host and Parasite RNA actually occurred, and that parasites can accelerate the evolution of their hosts.

References:

[1] Koonin, Eugene V., and Valerian V. Dolja. "A virocentric perspective on the evolution of life." Current opinion in virology 3.5 (2013): 546-557.

[2] N. Ichihashi, et al. "Darwinian evolution in a translation-coupled RNA replication system within a cell-like compartment." Nature communications 4 (2013).

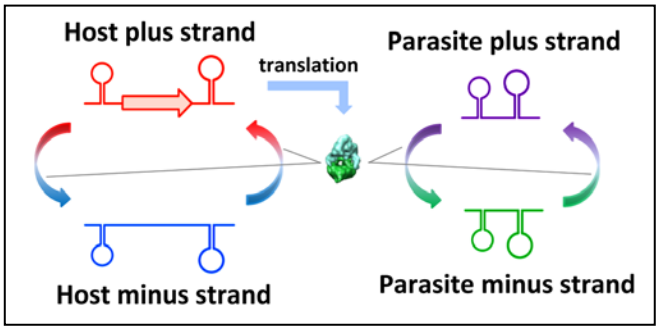

Fig.1 : Host-Parasite RNA replication system

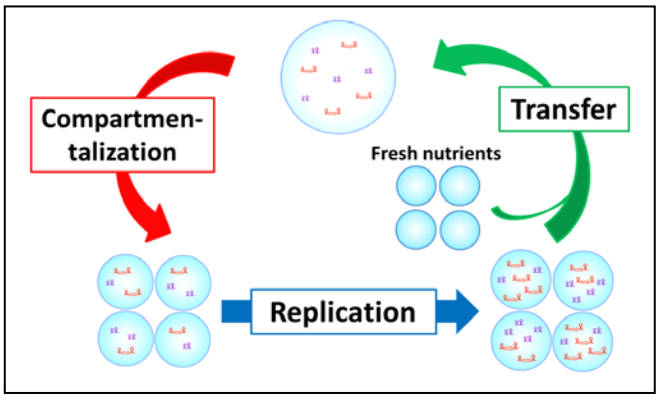

Fig.2 : Schematic of a cycle of coevolution experiment

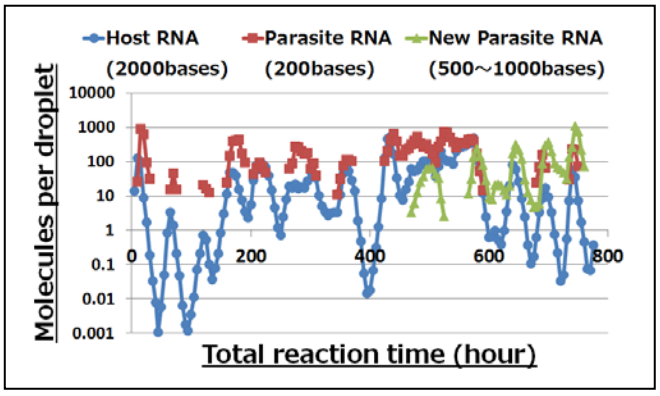

Fig.3 : Population dynamics of Host and Parasite RNA