

Host-parasite Red Queen dynamics archived in pond sediment

In coevolution, hosts and parasites can engage in a kind of arms race. One side adapts and evolves; the other side adapts and evolves to keep up. In the end, neither side is necessarily better than the other, as is reflected in Red Queen dynamics, called after the character in 'Through the Looking-Glass' who tells Alice that all the running she does will only leave her in the same place. The phenomenon helps to illustrate why sexual reproduction is important: by producing genetically varied offspring, a slower evolving organism can defend itself against a faster-evolving one.

Although the principle is well known, these Red Queen dynamics are hard to detect in nature because many generations are needed and the changes from one generation to the next may be slight. In this study, we reconstructed the coevolutionary interaction between the water flea *Daphnia magna* and its bacterial parasite *Pasteuria ramosa*, using what amounts to a time machine in the sediments of a shallow pond in the Belgian town of Heverlee (Abdij van 't Park). The layered sediments of this pond contain *Daphnia* eggs and spores of the bacterial parasite, both surviving for many years in a dormant condition and by such reflecting an archive of past evolutionary changes. By reviving the *Daphnia* eggs and producing active bacteria from different layers that correspond to different times, we were able to test how the organisms evolved in relation to each other.

We found that the bacteria infected the water fleas at a higher rate when both were from the same time period than the bacteria were from an earlier time. That showed that the bacteria had adapted to become more effective. But when the same generation of eggs was exposed to bacteria from a later period, the infection rate declined. By adapting to their contemporary hosts, these 'future' bacteria had lost their advantage against the earlier hosts. Year-to-year infection rates among contemporary hosts and parasites remained stable. For all the evolutionary running around, the species were running in place relative to each other. In addition to pure Red Queen dynamics for infectivity, this study also reports a steady increase in virulence (damage to the host) of the parasite over time from the moment the parasite was first found in the sediments.

(text is based on H. Fountain, 'The New York Times', 20/11/2007 and K. De Rijck, 'De Standaard', 15/11/2007)