16th Nov 2007

Evolution slide show

Sediments at the bottom of the ***Oude Meren*** pond in Belgium have provided a snapshot of evolution in action, says S.Ananthanarayanan.

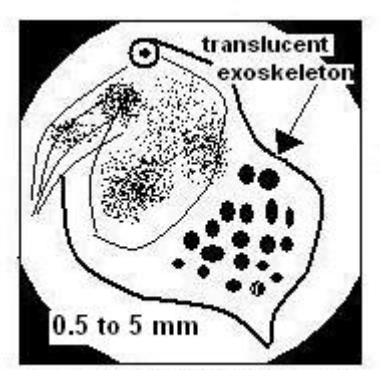
Many generations of the miniscule organisms, ***Daphnia***, and their predator, ***pasteuria ramosa***, preserved in the slime, have documented the evolution of the parasite to keep pace with the Daphnia as it changes form to become resistive. Ellen Decaestecker and colleagues in Belgium, Switzerland and France report in this week's ***Nature*** that the ***Red Queen Hypothesis***, a pattern of co-evolution of species, is borne out by the mud encased time-line.

The Red Queen

In Lewis Carol's Alice Through the Looking Glass, the Red Queen says, "It takes all the running you can do, to keep in the same place", to express the irony that efforts are naught because the context changes before the effort is over. The Red Queen Effect in the dynamics of co-evolving biological systems is that species need to keep developing, not to get ahead and dominate, but just to maintain 'fitness' relative to the environment.

The race between hosts and parasites, the effort of the former to develop resistance and of the latter to change track and catch up, is a key force that structures the populations of such pairs of species. But direct evidence of the process is rare and data that has been available does not reveal the dynamics of the mechanism.

Daphnia and Pasteuria

Daphnia are tiny, crustaceans, or animals with an outer shell, commonly called *water fleas,* because they swim in leaps, like fleas. The interesting thing about Daphnia is that the shell is translucent and allows many vital body functions to be viewed using a microscope. Apart from their use in the laboratory, Daphia are an important source of food for many species and can also be used to clear fish tanks of algae, so long as they are not eaten by the fish	 Daphnia magna with eggs

Pasteuria Ramosa is a bacterium that infects the Daphnia with the effect of making the crustacean incapable of reproducing, before it kills the host. But Pastueria shows great selection of which subset of hosts it will infect and this effect is a direct result of some strains of the host being resistant to the parasite. This kind of specificity and the shift of the genetic structure of

Daphnia populations during epidemics are indicators of clear co-evolutionary dynamics. But it has not been able to identify and trace development of Daphnia/Pasteuria species in a natural setting over time.

Records of development

A fortunate circumstance is that both the species produce parts of themselves that are useful for propagation and these lie dormant for long periods in pond beds. As layers of mud form at the bed, these remains are entrapped and become records of the genetic varieties that existed over time.

The scientists therefore studied the sediment cores from a shallow pond in Belgium, where the Daphnia co-exist with the Paseuria Ramosa, the parasite. From different sediment layers, they hatched Daphnia clones from dormant eggs and picked up fragments of Pasteuria. Each depth represents a snapshot of the continuing dog fight of the host and parasite in evasion and pursuit.

The results showed that the parasites caught up with evolving hosts in a time-scale of 2-4 years, which was the closest intervals the mud layers could reveal. In cross-infection experiments, it was found that Daphnia were most prone to contemporary parasites, could resist parasites from earlier layers and were also less vulnerable to parasites from future layers. This last indicates that the parasite lost its present effectiveness when it changed on the trail of the evolving host

This historical reconstruction of the interaction of the host and parasite, in the ‘wild’, has demonstrated co-evolution of the two species – each responding to the ‘moves’ of the other. ‘Red Queen’ dynamics may then be the reason for development of many biological phenomena, like sexual reproduction, where two individuals contribute different genetic raw material, as opposed to asexual reproduction. The study shows in frozen frames the game of tag that has led to biodiversity itself.