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News

New species evolve in bursts

Red Queen hypothesis of gradual evolution undermined.

Kerri Smith


Alice and the Red Queen had to run as fast as they could to stay in the same place - just like evolving species, according to the eponymous hypothesis.*Through the Looking Glass/John Tenniel*

New species might arise as a result of single rare events, rather than through the gradual accumulation of many small changes over time, according to a study of thousands of species and their evolutionary family trees.

This contradicts a widely accepted theory of how speciation occurs: that species are continually changing to keep pace with their environment, and that new species emerge as these changes accrue. Known as the 'Red Queen' hypothesis, it is named after the character in Lewis Carroll's book *Through the Looking-Glass, and What Alice Found There* who tells a surprised Alice: "Here, you see, it takes all the running you can do, to keep in the same place."

The Red Queen hypothesis rests on the idea that species must continuously evolve just to hang on to their ecological niche. That gradual evolution is driven by the constant genetic churn of sexual selection.

A consequence of this is that all of the species in a particular family, or genus, gradually evolve to form new species at the same rate.

But Mark Pagel and his team at the University of Reading, UK, challenge this idea. In a paper published today in *Nature*, they compared four models of speciation — one of which was the Red Queen hypothesis — to see which best explains the rate of speciation in more than 100 species groups from the animal and plant kingdoms, including bumblebees, turtles, foxes and roses.

They looked at the lengths of branches in thousands of species' evolutionary trees contained within these groups to estimate the time periods between speciation events.

When the team compared how well the four models fitted the groups' evolutionary histories, the Red Queen idea that species form through a catalogue of incremental changes fitted no more than 8% of the family trees.

Conversely, almost 80% of the trees fitted a model in which new species emerge from single rare evolutionary events. The Red Queen, it seems, is not running to keep up, but jumping a longer distance and then pausing for a while[1].

"What we've shown is that speciation is about happy accidents — rare events that happen in the environment that cause a species to speciate," says Pagel. These events could include a mountain range being thrust up or a shift in climate, he says.

The team's findings might stir things up in the world of evolutionary biology. "It really goes against the grain because most of us have this Darwinian view of speciation," says Pagel. "What we're saying is that to think about natural selection as the cause of speciation is perhaps wrong."

Mike Benton, a palaeontologist at the University of Bristol, UK, agrees that the work might ruffle a few feathers, adding that it could also shift attention to how groups of species evolve, rather than the minutiae of competition or predation effects that affect a single species. Where speciation is concerned, at least, "maybe all of this squabbling in the undergrowth is quite irrelevant".

Evolutionary biologists will also "look closely at the methods", Benton predicts. The paper's heavily computational approach, crunching large amounts of data from phylogenetic trees, has not traditionally been applied to evolutionary theories.

But Pagel thinks they will be able to convince others that their approach is useful. "We think people will come around because it will start to unravel some mysteries about speciation," he says.

- **References**

1. Venditti, C., Meade, A. & Pagel, M. *Nature* advance online publication doi:10.1038/nature08630 (2009).

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