Climate change and coevolution: We've done the math

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When scientists attempt to understand how climate change might reshape our environment, they must grapple with the seemingly endless complexity of interacting systems.

For those considering the likely fate of particular species, there is now a relatively simple rule of thumb to help calculate the likely effect of climate change where species interact.

"A lot of the discussion about climate change focuses on the fate of individual, iconic species, but to evaluate the effects of future environmental changes we need to account for interactions between species," James Cook University evolutionary ecologist Tobin Northfield said.

"We need to consider how species co-evolve – how they are adapting in response to each other, as well as in response to climate change. In addition, as difficult as it may seem, we need to account for changing interactions, as the species evolve."

Research published this week in *PLOS Biology* argues that where species have conflicting interests (for example where one species becomes very aggressive towards the species it competes with for food) their coevolving relationship is likely to reduce the effects of climate change on both species.

Where species interact in a non-conflicting way (for example where one

species simply avoids the other species it competes with for food, rather than becoming aggressive) the effects of climate change are likely to be greater.

Dr Northfield, now at James Cook University in Cairns, worked at the University of Wisconsin with Dr Anthony Ives to develop a rule of thumb to help scientists calculate how co-evolving species might change over time.

"When evaluating the effects of climate change, there is already so much to consider, we were hoping to find some simple answers," Dr Northfield said.

Drs Northfield and Ives have developed modeling tools and guidelines to help scientists extrapolate from the short to longer term.

"Many earlier studies have looked at how climate change might affect the evolution of particular species, and more recently there has been some investigation of how interacting species might change in the short term."

"We used simple models of competition, predation and mutualism to consider how these interactions might change over longer time periods, and how that, in turn will affect each species," Dr Northfield said.

"The nature of climate change means that we don't have years and centuries to observe changes in nature. Mathematical modeling gives us a way to calculate what the future might look like," he said.

The study began, with funding from the United States Department of Agriculture, as an investigation of how pest insect population densities might change in cropping regions.

"One of our findings is that when predators attack crop pests and benefit agriculture, such as lady beetles eating aphids, the predator and prey will both evolve in response to climate change and will reduce the effect of climate change on crop damage," Dr Northfield said.

The researchers have suggested ways to evaluate their rule of thumb.

"Insect populations are a good testing ground for our theory, because it is relatively easy to include many insects in an experiment, and they reproduce quickly, allowing faster evolution," Dr Northfield said.

"For example, by looking at insect/plant interactions at different latitudes, it is possible to observe how coevolving species, and their interactions, vary in different climatic conditions.

"If you know what type of coevolution drives the interaction, you can make predictions of how it will affect the species densities across the different latitudes."

The paper also suggests ways for researchers to determine which type of coevolution (conflicting or non-conflicting) drives a particular species interaction.

"This is not as clear and straightforward as you might think," Dr Northfield said. "In some plant–insect relationships, for example, some insects that pollinate flowers can also evolve to steal from the flower without providing the flower with the benefits. Of course, this conflicts with what is best for the plant. So we've also developed some guidelines for classifying species interactions."

More information: Coevolution and the Effects of Climate Change on Interacting Species is online at: www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1001685