New study supports Darwin's hypothesis on competition between species

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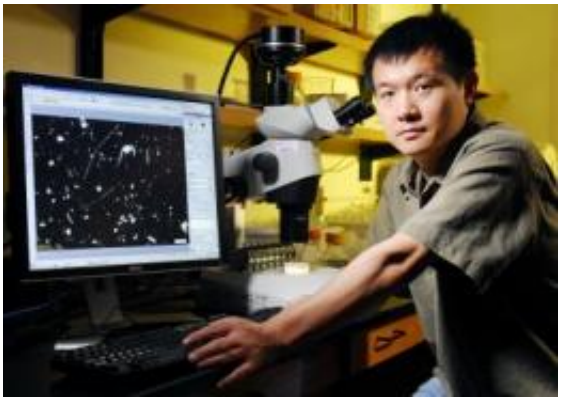

Georgia Tech School of Biology assistant professor Lin Jiang displays a microscopic image of a protist species he used to support Darwin's hypothesis that the struggle for existence is stronger between more closely related species than those distantly related. Credit: Georgia Tech/Gary Meek

A new study provides support for Darwin's hypothesis that the struggle for existence is stronger between more closely related species than those distantly related. While ecologists generally accept the premise, this new study contains the strongest direct experimental evidence yet to support its validity.

"We found that species extinction occurred more frequently and more rapidly between species of microorganisms that were more closely related, providing strong support for Darwin's theory, which we call the phylogenetic limiting similarity hypothesis," said Lin Jiang, an assistant

professor in the School of Biology at Georgia Tech.

The study was published online on June 14, 2011 in the journal Ecology Letters. The work was supported by the National Science Foundation.

Jiang and his team -- Cyrille Violle, formerly a postdoctoral fellow at Georgia Tech currently at the Centre d'Ecologie Fonctionnelle et Evolutive in Montpellier, France, and Georgia Tech biology graduate student Zhichao Pu -- conducted experiments with 10 common ciliated protist species in artificial, simplified ecosystems called microcosms. Diana Nemergut, an assistant professor in the Institute of Arctic and Alpine Research and the Environmental Studies Program at the University of Colorado at Boulder, helped the team generate a family tree of the 10 microorganisms to determine how closely related the species were.

"We selected bacterivorous ciliated protist microorganisms for this study because they rapidly reproduce, allowing us to examine species co-existence over multiple generations in a closed system during a period of a few weeks, which wouldn't be possible if we were testing the hypothesis with plants or animals," said Jiang.

The researchers set up 165 microcosms that contained either an individual protist species or a pairing of two species, along with three types of bacteria for the organisms to eat. They collected weekly samples from each microcosm and examined them under a microscope, recording the presence or absence of species. After 10 weeks, the researchers estimated the density of the protist species in each microcosm.

The study results showed that all species survived until the end of the experiment when alone in a microcosm. However, in more than half of the experiments in which protists were paired together, one of the two

species dominated, leading to the extinction of the other species.

The researchers found that the frequency and speed of this extinction process -- called competitive exclusion -- was significantly greater between species that were more closely related. In addition, in microcosms where both competitors coexisted for the duration of the experiment, the abundance of the inferior competitor was reduced more as the phylogenetic relatedness between the two competitors increased.

The study also showed that the frequency of competitive exclusion was significantly greater between species that had similar mouth sizes.

"We documented the mouth size of each species because there is some evidence that this morphological trait affects the selectivity and uptake rate of prey particles, and we thought that similarity in mouth size might translate into the exploitation of similar bacterial resources and result in competitive exclusion," said Jiang.

While they found that phylogenetic relatedness predicted the likelihood of coexistence better than mouth size, the results suggest that other traits involved in resource uptake may also be important predictors of the outcomes of competitive interactions in ecological communities.

"This study is one step toward a better understanding of how phylogenetic relatedness influences species interactions," said Jiang. "We hope our experimental validation of the phylogenetic limiting similarity hypothesis in microorganisms will encourage other ecologists to conduct additional studies with other types of organisms to further validate Darwin's hypothesis."

The phylogenetic limiting similarity hypothesis is just one of the many ideas Darwin published in his 1859 book called "The Origin of Species." In this book, Darwin introduced his scientific theory that populations

evolve over the course of generations through a process of natural selection. The book presented a body of evidence that the diversity of life arose by common descent through a branching pattern of evolution.

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