Maths experts question key ecological theory

June 20 2012

Mathematicians at the University of York in the UK and the University of Canterbury in New Zealand say they have disproved a widely accepted theory underpinning the operation of complex networks of interactions in the natural world.

Networks are a powerful way to describe ecological communities, which typically involve large numbers of species that can exhibit both negative (e.g. competition or predation) and positive (e.g. mutualism) interactions with one another. Recent mathematical and computational analysis suggested that nestedness -- the tendency for ecological specialists to interact with a subset of the species that also interact with more generalist species -- increases species richness.

But the researchers from the York Centre for Complex Systems Analysis (YCCSA) and the Biomathematics Research Centre at Canterbury say they have proved the reverse is true, using mathematical models based on plant-pollinator networks observed in the wild. The data span the globe, ranging from tropical rainforests to the high Arctic, and include species such as birds of paradise and hummingbirds as well as insect pollinators such as bees, wasps and butterflies.

The research is published in the latest edition of *Nature*.

By carefully examining previous analytic results, and applying computational and statistical methods to 59 empirical datasets representing mutualistic plant-pollinator networks, they say they disprove the accepted theory of nestedness. Instead, they contend that the number of mutualistic partners a species has is a much better predictor of individual species survival and community persistence.

Co-author Dr Jon Pitchford, who is also a member of the Departments of Biology and Mathematics at York, said: "We know that real mutualistic communities are nested -- they have sets of interactions-within-interactions, rather like Russian dolls. We are trying to understand how this is related to their biodiversity and stability. This will enable us to better understand the way ecological networks are affected by environmental fluctuation and climate change."

Co-author Dr Alex James, of the Department of Mathematics and Statistics at Canterbury, said: "It is a well-used phrase but correlation does not imply causation. Although a cursory glance at real networks can make it appear that nestedness is correlated with survival, you need to delve deeper to realise this is a secondary correlation. The stronger and more causal relationship is between the number of mutualistic partners a species has and its survival."

Co-author Dr Michael Plank, also of the Department of Mathematics and Statistics at Canterbury, added: "Real-life networks, whether they are from ecology, economics, or Facebook, can be large and complex. This makes it difficult to tease apart causal relationships from confounding factors. This is where mathematical models come into their own. They allow us to systematically change one network attribute, such as nestedness, whilst controlling for other variables."

More information: The paper ‘Disentangling nestedness from models of ecological complexity’ is published in that latest issue of *Nature*.
DOI10.1038/nature11214

Provided by University of York