Abstractions

SECOND AUTHOR
Ecological food webs are undeniably complex, but whether they are also chaotic has been a matter of debate for ecologists for more than 30 years. Chaotic systems are governed by physical laws so convoluted that long-term predictions of their behaviour are impossible. On page 822, Jef Huisman at the University of Amsterdam in the Netherlands and his colleagues present evidence that plankton food webs are chaotic. He tells *Nature* why ecology may never be able to make long-term predictions.

There are very few empirical examples of chaos in ecosystems. Why is that?
Because we need long-term studies to prove that ecosystems are chaotic. My co-author Reinhard Heerkloss monitored the abundance of plankton species and nutrient fluxes under controlled temperature and light conditions for 2,300 days. He said it looked as if the system behaved chaotically, but he didn't know how to prove it, so he gave me the data. Plankton have short generation times, so the data covered thousands of generations.

Did you find evidence of the 'butterfly effect'?
Yes. This classic example of chaos theory — that the flap of a butterfly's wings can cause tiny atmospheric changes that result in a tornado elsewhere — describes how slight differences in the initial conditions of a system can change subsequent interactions in that system, leading to large-scale variation. Initially, our plankton species behaved as predicted, but then the abundances of species slowly diverged until, after 15–30 days, we could no longer predict their behaviour. We found the same limit to predictability for all plankton species in the food web — strong evidence that interactions among species cause the ecosystem to behave chaotically.

Did your work resolve any other questions?
Yes. Plankton species compete for several limiting resources. Classical ecological theory suggests that only a handful of species should survive in one place. Yet sampling studies routinely find 60–100 species in a single millilitre of water. Our data show that chaotic fluctuations in species abundance, resulting from species interactions, may create temporal 'windows' for more species to invade and survive in the system.

Will ecology ever be a predictive science?
Predictions in ecology will be similar to those for the weather — short-term predictability is high, whereas long-term forecasts are all but impossible. That said, we need long-term studies to understand all the mechanisms at work when species interact with each other or the environment. ■

MAKING THE PAPER

Rasmus Voss

Archived X-ray data reveal the secrets of a supernova's formation.

A trip to see friends and give an informal talk about his graduate work turned out to be much more fruitful than Rasmus Voss had anticipated. The visit, to Radboud University in Nijmegen, the Netherlands, led to work that takes astronomers a step closer to establishing how one type of supernova forms.

At Radboud, Voss, now a fellow at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany, spoke about his work analysing X-ray telescope data. Gijs Nelemans, a theoretical astronomer at Radboud, and the adviser of one of Voss's friends, attended the talk. He realized that with his knowledge of theoretical models and Voss's expertise, the two of them could tackle a model which suggested that the presence of X-ray signals could precede a type Ia supernova — an exploding star astronomers use to measure the expansion of the Universe.

At the time, two schools of thought prevailed about the origins of these supernovae. One theory was that supernovae result from the merging of two white dwarfs, which are small, dense stars. Such a merger would not be expected to be preceded by any X-ray data. The other possibility was that a white dwarf slowly accretes material from a companion star, producing X-ray signals in the process. If Voss and Nelemans found X-ray signals in positions at which type Ia supernovae later occurred, this would lend credence to the accretion model.

The origins of supernovae are difficult to study, because by the time researchers detect an explosion, the object that led to it has gone. So Voss and Nelemans decided to hit the archives in search of optical telescope data that showed supernova activity. Voss then trawled through earlier archival data from the Chandra X-ray Observatory, which can detect the most distant X-ray sources, to look for X-ray signals in locations at which supernovae had occurred. Their attempts, which focused on three supernovae that had occurred in 2002, 2004 and 2006, did not yield conclusive results.

The two decided to put the project on the back burner and wait for a new supernova to occur. "Not many of these events happen within a distance where they can actually be seen," says Voss. "So we basically sat for half a year. Then a nearby supernova exploded." But Voss didn't immediately scramble to the Chandra X-ray data archives, thinking that his chances of finding X-ray data to validate the accretion model were slim. "I had been working on another project," he says, "So I delayed looking at the data."

But when he did go back to the archives, he found the X-ray signatures that had eluded him on the other three supernovae. His reaction, he says, was a mixture of being "very embarrassed" for not immediately jumping on the data and "very excited" because the presence of X-ray signals preceding the supernova demonstrated the feasibility of their approach.

Their findings (see page 802), Voss says, do not exclude the merger model, because type Ia supernovae may occur by multiple means. But a likely outcome of the work is that more supernova specialists will start looking at X-ray data in their studies. And, as far as Voss is concerned, the next time he sees any supernova activity, he'll attack the X-ray data immediately. ■

FROM THE BLOGOSPHERE

A new web-based application aims to help scientists determine the journal most appropriate for publishing their results and select appropriate peer reviewers. The application, called Jane (journal/author name estimator), is described in the Nautilus post "What's in a Jane?" (http://blogs.nature.com/nautilus/2008/01/whats_in_a_jane.html).

Jane works by comparing sample text input by the aspiring author with that of published journal articles. At present, Jane has some teething troubles, as demonstrated by a trial run, but could an automatic selector ever be the best method of selecting the journal in which to publish one's results?

Suggestions and advice are readily available from scientists in the field, who hear about work at talks or read about it in a preprint. And journals provide author guidance on their websites about editorial scope, impact factor and so on. *Nature*, for example, is looking for novel results, not something similar to work that has just been published. It will be a sad day, according to Nautilus, when science journals publish articles selected for them by computer. ■

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