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Abstractions

FIRST AUTHOR

About 85% of all plant species, most notably trees, depend on partnerships with soil fungi to thrive. The resulting mycorrhizal fungi scavenge hard-to-access nutrients and pass them on to the trees in exchange for the plants' store of carbon-rich sugar. On page 88, a team of international researchers reports some of the secrets of the genome of the mycorrhizal *Laccaria bicolor*. Francis Martin, a microbiologist at the French National Institute of Agricultural Research in Nancy tells *Nature* how the genome sequence reveals an underground molecular dialogue that controls important ecosystem functions.

Was it difficult to get funding to sequence the genome of a mycorrhizal fungus?

I've worked with mycorrhizae for 25 years, but I wouldn't have bet a penny that we could get the €5-million worth of funding needed to sequence this genome. I worked on a collaborative effort, funded by the California-based Joint Genome Institute (JGI), to sequence the poplar tree's genome. After that, we were able to convince the JGI that sequencing *Laccaria* would provide a better understanding of ecosystem function.

Was this your first choice of species?

Yes. We wanted an ecologically relevant species that interacts with seedlings as well as mature trees found in Europe and North America. There were only a handful of such species with the minimal set of genetic resources required for sequencing, such as cDNA libraries. *Laccaria* is also economically relevant because it is used to promote the growth of conifer seedlings in nurseries.

Did the genome generate new hypotheses?

Many. For example, the genome has some features that are common to saprotrophs — organisms that consume dead organic matter — as well as genes required for symbiotic interactions, so we speculate that *Laccaria* may be an ancestral species of both groups. We also found genes encoding hundreds of small peptides, which we suspect the fungi may use to manipulate plant gene expression.

Are there any other mycorrhizal genome sequences on the horizon?

Yes, we are sequencing the genome of the black truffle mushroom, another mycorrhizal fungus. There are two main evolutionary branches of fungi, and the black truffle and *Laccaria* belong to different ones. By comparing the two genome sequences, we can see whether the two fungal kingdoms used the same tools to develop mycorrhizal symbioses with trees during evolution. We hope to get that paper out before Christmas — when truffles will reach the market. ■

MAKING THE PAPER

Anthony Ives

A mathematical model reveals the fragility of ecosystems.

The midges of Lake Myvatn — literal translation, 'Midge Lake' — in northern Iceland make up two-thirds of the lake's biomass, and often form swarms that hover like clouds over the surface of the water. Anthony Ives, a theoretical ecologist at the University of Wisconsin–Madison, puts their abundance into perspective by describing it as being "like going into prairie grasslands and having the majority of the animals there be a single species of grasshopper". But despite their dominance, the numbers of these tiny insects fluctuate wildly. And a mathematical model Ives developed to explain the population dynamics of the lake's midges suggests that they are extremely sensitive to both natural and human-induced change.

Ives began collaborating with Árni Einarsson and Arnthor Gardarsson at the University of Iceland in Reykjavik 10 years ago. Since 1977, these researchers had been gathering data on the population density of the midges, *Tanytarsus gracilentus*, living in Lake Myvatn. The data showed that the abundance of these midges, which feed on algae, fluctuates by almost six orders of magnitude. "The thing that really struck me was not just the extent of these fluctuations, but the fact that they're not random, nor are they regular. They're something in between," says Ives. Although some other animals also show dramatic population outbreaks, these typically occur in a regular fashion; outbreaks and crashes of Lake Myvatn's midges occur irregularly, 4 to 7 years apart.

To understand the phenomenon, Ives cobbled together statistical tools normally used to monitor stock-market activity or the trajectories of interplanetary satellites, and applied them to Einarsson and Gardarsson's field data. The model showed unusual mathematical properties, so they enlisted Vincent Jansen at Royal Holloway, University of London, Epsom, to help interpret what these meant. In the model they designed, which is described on page 84, population abundance shifts between a constant state and one that is cyclical.

"It's this shifting from one type of dynamic [constant] to another type [cyclical] that can produce high-amplitude cycles and make the frequency of these cycles unpredictable or irregular," says Ives. Even small changes in the weather, or other environmental events, including those caused by human activities, may result in wild fluctuations in population density, he adds.

Ives's model also helps to explain the impact that historical dredging for the mineral diatomite may have had on the lake. The operation, which started in 1967, was abandoned in 2004 after becoming what Ives describes as "an environmental cause célèbre" when the fish populations started to diminish drastically. His mathematical model suggests that such dredging could have increased the size of the fluctuations in the midge population. Because these organisms are the main source of food for Lake Myvatn's fish, a crash in the midge population would have left fish with nothing to eat.

Ives hopes to continue this collaboration, and expand it to include other researchers, allowing them to gather further basic ecological information about the midges and the entire ecosystem that they affect. ■

FROM THE BLOGOSPHERE

With more than 100 members, the neuroscience group (http://tinyurl.com/2s356r) is one of the fastest growing areas of Nature Network. It recently started an online journal club for neuroscientists to discuss the latest research and trends.

As with a traditional journal club, interesting papers from any journal are featured, beginning with an account of the paper by a student or postdoc in the neuroscience discipline concerned who was not involved in the work being discussed.

This journal club is designed to teach non-specialists about certain neuroscience subfields that may be of interest to them, as well as to highlight important findings for specialists. Participants ask questions about data and conclusions, or the implementation of particular methodologies; discuss why additional data would help solidify conclusions; and suggest next steps.

It is almost two months since the journal club began, and five papers have already been discussed. Topics range from delivering anaesthesia to manufacturing hair cells, as well as controversial debate about glia, flies and sexual preference. ■

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