Genes drive ecosystem evolution

Dorothy Bonn

The genes of one dominant species can drive the structure of the whole community of living organisms in which it lives, new research shows. Genetic variation – in cottonwood trees in this instance – also influences the evolution of the entire ecosystem. "This has major implications for conservation", says research team leader Tom Whitham, Regents' Professor of Biological Sciences at Northern Arizona University (Flagstaff, AZ).

By studying variations in a gene that controls tannin levels in cottonwood (poplar) trees (*Populus* spp) that grow along rivers in the western US, Whitham and a team of US, Canadian, and Australian scientists have found that tannin levels in the trees have predictable effects on the population density of diverse organisms – from endophytic fungi to aquatic invertebrates to insects and the birds that feed on them. Variations in tannin levels also explained 63% of variation in the rate of decomposition of cottonwood leaves and 65% of variation in N mineralization in the soil.

Courtesy of T Whitham

Cottonwood trees lining a riverbank in Utah.

In breeding experiments the team crossed and back-crossed two species of cottonwood, *P fremontii* and *P angustifolia*, which hybridize naturally in the wild. They are the dominant organisms in the endangered riparian ecosystems of the southwestern US. "This habitat is especially important to conserve because it is a biodiversity hotspot", Whitham explains.

Cottonwoods themselves are subject to selection pressures. Beavers, which fell cottonwoods for food and to build dams, avoid those with high tannin levels. After 5 years of selective felling by beavers, cross types high in tannins (*P angustifolia* and backcross hybrids) had become three times as abundant as the low-tannin *P fremontii*. "The interactions of cottonwoods and beavers can change the species composition of a whole ecosystem", says Whitham. "Because of such genetic interactions we now know that it is important to conserve genetic variation, even in very common species. Previously, the emphasis was on doing so only in rare and endangered species."

"Conservation biologists have a growing appreciation that the genetic variability within managed populations can influence the health and viability of those target populations", comments Jeff Mitton (University of Colorado, CO). "Whitham and colleagues show that the genes in some species produce phenotypes whose impacts ripple through the community."

The US Bureau of Reclamation is already putting Whitham's findings into practice in restoring native riparian habitats along the Colorado River. Says bureau biologist Gregg Garnett, "We are focusing on finding out more about the function of these different riparian genotypes and how they can help our restoration program". ■

Anoxic conditions plague the Gulf of Finland

Nancy Bazilchuk

Scientists with the Finnish Institute of Marine Research (FIMR; Helsinki) report that bottom waters in the Gulf of Finland are the most anoxic ever recorded in 42 years of observations. The problem is mirrored in the northern and central parts of the Baltic Sea basin, where nearly all water below 60–70 m is either anoxic or has an oxygen content that is too low to support macroscopic life, says Juha Flinkman, senior scientist at FIMR.

According to Seppo Knuuttila, a researcher with the Finnish Environment Institute's Research Programme for the Protection of the Baltic Sea (Helsinki), just four of 47 observation sites measured during an August research vessel cruise had abundant bottom fauna. Thirty-seven sites were completely devoid of such species – more than in any other of the 7 years that bottom fauna have been studied. Knuuttila believes that "the missing zoobenthos may have contributed to the collapse of the [Baltic] herring catch", which has dramatically declined in the past decade. Cod numbers have also dropped, says Flinkman, because they can't reproduce in the anoxic waters.

The southern arm of the Baltic Sea is formed by the Gulf of Finland, and is linked to the North Sea by way of a sound pinched between Sweden and Denmark. The FIMR describes the Baltic as one of the most polluted waterbodies in the world. It is fed by a large drainage area, which supplies a correspondingly huge influx of nutrient-laden freshwater. This, combined with the restricted circulation, tends to cause the sea to stratify, trapping saltwater under a layer of freshwater and preventing the mixing of lower, anoxic layers with the oxygen-rich upper layers. The resulting anoxic conditions also contribute to the release of phosphorus, which has been accumulating for decades in bottom sediments, further exacerbating algal growth problems.

The Finnish Government has undertaken a number of projects to curb eutrophication in the Baltic including the improvement of wastewater treatment in northwest Russia, particularly in St Petersburg, which lies at the head of the Gulf of Finland. ■