NATURAL ENVIRONMENT RESEARCH COUNCIL

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GLOBAL NITROGEN ENRICHMENT

How atmospheric nitrogen deposition affects mosses, liverworts and lichens in Atlantic oakwoods

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The Atlantic oakwoods on the west coast of Scotland are famous for their rich lichen, moss and liverwort communities and have been called the UK's temperate rainforest. Many of the species found in these woods are rare and found only on the west coast of Britain. Atlantic oakwoods exist in Europe as scattered remnants of an ancient woodland type, but most are found in the UK. The UK has an international obligation to conserve these woods and the species within them.

We monitored seven oakwoods from Loch Maree in Northern Scotland, to Borrowdale in the Lake District. We concentrated on species growing on oak tree trunks (epiphytes). At each site, we measured the amount of nitrogen deposited in the rain, from the atmosphere, and in the water running down tree trunks.

We investigated how nitrogen pollution affected which species occurred, the content of nitrogen in their tissue and how fast they grew. We also wanted to know how well the species could recover from high levels of nitrogen exposure.

Our results show that nitrogen pollution affected which species of mosses, liverworts and lichens grew on the trees. Certain species were more tolerant to nitrogen deposition than others, allowing us to identify indicator species. This is the first time anyone has assessed the impact of nitrogen pollution on these communities.

As the nitrogen concentration increased in the atmosphere, the growth of mosses and liverworts declined and nitrogen in their tissue increased. The reverse occurred when nitrogen levels dropped, and a slow recovery occurred. This is the first time that recovery has been shown to occur.

Nitrogen deposition affects the growth of mosses and liverworts and the species composition of mosses, liverworts and lichens. Thus, even in remote, relatively unpolluted areas, nitrogen deposition is affecting this internationally important habitat.

How atmospheric nitrogen deposition affects mosses, liverworts and lichens in Atlantic oakwoods

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What we wanted to find out

We wanted to assess how the composition of Atlantic oakwood bryophyte (mosses and liverworts) and lichen communities that grow on trees are affected by atmospheric nitrogen deposition. In particular, when nitrogen deposition increases do nitrogen levels in bryophyte tissues increase and growth rates decline? Secondly, do epiphytic bryophytes (those that grow on trees) recover when nitrogen deposition levels are reduced?

Main findings

Nitrogen deposition affects the rate at which bryophytes grow and the amount of nitrogen in their tissue. Nitrogen deposition also affects the composition of lichen and bryophyte communities. Even in remote, relatively unpolluted areas, nitrogen deposition is affecting this internationally important habitat. However, if nitrogen deposition is reduced some species have shown the potential to recover.

How we did it and results

We studied seven Atlantic oakwoods for seven months. We measured the nitrogen the epiphytes received from the rain, the atmosphere, and as water running down tree trunks. Over that time the total wet nitrogen deposition the epiphytes received ranged from 3-12 millimoles of ammonium per tree and 0-5 millimoles of nitrate per tree. The average monthly concentrations of ammonia in the air ranged from 0.002-0.19 microgrammes ammonia per cubic metre. Some species were more tolerant to higher nitrogen levels (eg *Bryoria fuscescens, Usnea subfloridana, Ramalina farinacea, Hypnum cupressiforme* (cypress-leaved plait-moss), *Hypnum andoi* (mamillate plait-moss), *Parmelia saxatilis, Chrysothrix candelaris, Hypogymnia physodes*) than others. Less tolerant species included *Plagiochila atlantica* (western featherwort), *P. spinulosa* (prickly featherwort), *Frullania tamarisci* (tamarisk scalewort), *Lobaria pulmonaria, L. amplissima, Parmelia glabratula subsp glabratula, P. laevigata, Platismatia glauca.* We have a better understanding of which epiphytic lichens and bryophytes act as nitrogen indicators in relatively unpolluted areas of the west coast of northern Britain, in a habitat of high conservation value.

We transplanted epiphytes from a high nitrogen site (43kg nitrogen per hectare per year) to a low nitrogen site (10kg nitrogen per hectare per year) and vice versa. Those moved to the high nitrogen site show significantly reduced growth and significantly higher nitrogen in their tissue. Those transplanted to the low nitrogen site showed increased growth or remained stable, and the nitrogen levels in their tissues declined. Epiphytes respond quicker to increases in atmospheric nitrogen than decreases in atmospheric nitrogen but recovery did occur.

We took ten samples of *Dicranum scoparium* (broom fork-moss), *Isothecium myosuroides* (slender mouse-tail moss), *Thuidium tamariscinum* (common tamarisk moss) from each of the seven sites and analysed their tissue nitrogen. The amount of tissue nitrogen correlated with the total amount of ammonium in the water coming down the tree trunk and with the concentrations of ammonia in the air. Levels of tissue nitrogen in bryophytes do reflect nitrogen deposition levels even in relatively unpolluted sites.

Why this research is important

This work has shown that nitrogen pollution is affecting a rare and internationally important habitat. If nitrogen levels are not reduced we may lose rare lichen and bryophyte species from these woods. This work has provided forest managers with a list of mosses, liverworts and lichens, whose decline will act as an early indicator of increasing atmospheric nitrogen deposition.

For further information contact

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Publications

Mitchell R J, Truscott A-M, Leith I D, Cape J N, Van Dijk N, Tang Y S, Fowler, D & Sutton M A (in press) A study of the epiphytic communities of Atlantic oakwoods along an atmospheric nitrogen deposition gradient. *Journal of Ecology*.

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Mitchell R J, Truscott A-M, Leith I D, Tang Y S, van Dijk N, Smith R I & Sutton M A (2003) Impact of atmospheric nitrogen deposition on epiphytes in Atlantic oakwoods. *Environmental Documentation* No.164 Air. Empirical Critical Loads for Nitrogen. Expert Workshop Berne, 11-13 November 2002. Proceedings pp265-271. Eds B Achermann and R Bobbink.