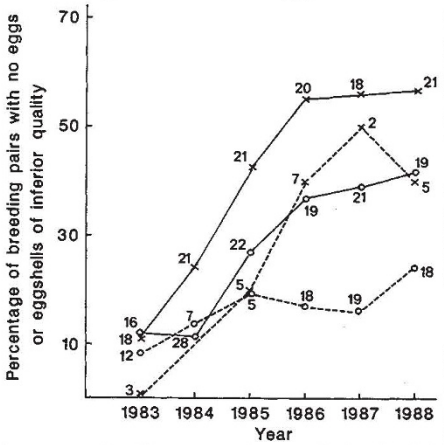
# Acid rain and eggshells

SIR—The Netherlands has the highest forest decline due to acid precipitation in Europe[1]. Studies on the effects of acid rain have concentrated on soil acidification in relation to changes in soil nutrient status, tree growth, disappearance of ectomycorrhizal fungi and leaching of nitrate. Little information is available on the effects on higher trophic levels in forest ecosystems and there have been few studies on the effects of acid precipitation on bird life[2–4].

Our long-term study on population processes in the great tit and other hole-nesting bird species, carried out in deciduous and coniferous forests on both nutrient-rich and nutrient-poor soils, provides an opportunity to analyse the effects of acid precipitation on parameters related to reproduction. In Buunderkamp forest, which is representative of the coniferous and mixed deciduous forests on poor sandy soils in the eastern part of the country, we ringed all resident great tits. Between 1983 and 1988, we collected detailed demographic data in a poor and a relatively rich part of the forest[5]. We found there had been a sharp increase in the proportion of eggs with no shell at all or with shells of such a poor quality that the embryo dried up during incubation because of excessive evaporation (see figure). The occurrence of this phenomenon increased in up to 57 per cent of territorial birds in the poor part and up to 40 per cent in the relatively rich part. The increase for non-territorial birds, which normally have a relatively short period of local residence, was smaller. Blue tit, coal tit, nuthatch and great spotted woodpecker also had problems with eggshell formation, in contrast to the pied flycatcher, a migrant species, the female of which starts egg laying shortly after arrival.

We found strong indications for a similar increase in other forests on poor podzolic soil. On the other hand, we observed no increase in the percentage of breeding pairs with eggshells of insufficient quality in woods of clay or loam soil.




Increase in the percentage of territorial breeding pairs of the great tit with no eggs or eggshells of inferior quality. The data were collected in a poor part and a relatively rich part of the Buunderkamp mixed forest. Key: x — x territorial birds, poor part, x – – x non-territorial birds, poor part (in 1984 this category was absent); o — o territorial birds, relatively rich part; o – – o non-territorial birds, relatively rich part.

The inferior quality of eggshells — very thin, granular, porous, fragile and without coloured spots — is related to an insufficient deposition of calcium. As a consequence of acid precipitation, $Ca^{2+}$ in the soil is replaced at the adsorption complex by hydrogen ions and the $Al^{3+}$ levels increase as the pH of the soil decreases, and at ratios of $Ca^{2+}/Al^{3+}$ smaller than 1 the uptake of calcium is impaired[6]. In the podzolic soils where the birds were observed, we found ratios of 0.3. The reduced supply resulted in low $Ca^{2+}$ levels in the leaves of several tree species (see table). The relatively few data on $Ca^{2+}$ content of caterpillars — in spring and summer an important food source for hole-nesting species — that could be collected in 1988 on leaves of pedunculate oak and red oak, suggest a close relationship between the $Ca^{2+}$ concentrations of leaves and caterpillars (data not shown).

From the data on the $Ca^{2+}$ status at various trophic levels (soil, tree leaves, caterpillars, eggshells) of the forest ecosystem on poor sandy soils in the Netherlands, a direct relationship with the acid rain seems very likely. The data do not suggest that the numbers of great tits in poor forests are already declining because there is a large surplus in the production of young birds in the rich areas which by migration may compensate for an eventual shortage in poor forests. But our results imply that the effects of acid precipitation are becoming apparent at all trophic levels of forest communities.

Calcium-ion concentrations in leaves and needles of various tree species

| Tree species | Soil | | | | |
|---|---|---|---|---|---|
| | Poor ($n = 7$) | | Rich ($n = 5$) | | |
| | $\bar{x}$ | s.e. | $\bar{x}$ | s.e. | |
| Birch (*Betula alba*) | 118 | 4.7 | 132 | 24.8 | NS |
| Beech (*Fagus silvatica*) | 75 | 8.0 | 134 | 14.2 | * |
| Scots pine (*Pinus silvestris*) | 67 | 7.0 | 105 | 7.2 | * |
| Pedunculate oak (*Quercus robur*) | 67 | 7.0 | 106 | 7.0 | * |
| Red oak (*Quercus rubra*) | 64 | 8.5 | 87 | 15.2 | NS |

Calcium-ion concentration in mmol per kg dry matter. (Test: Wilcoxon,* $P \leq 0.01$).

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# Mummy DNA fragment identified

SIR—The isolation of DNA fragments from a 2,400-year-old Egyptian mummy was reported by Pääbo[1]. One clone, pMUM2:9, carried a segment of 3,400 base pairs (bp) — of which a 919-nucleotide fragment was sequenced — encompassing two members of the *Alu* family of repeats. We now report that 382 bp of the 5′-end of the first intron of HLA-DQA1 (DQα), a human major histocompatibility complex (MHC) class II gene, is almost identical to a non-repetitive region of the mummy DNA. A very similar region also occurs in HLA-DQA2 (DXα). The MHC class II α- and β-chain genes encode heterodimeric surface proteins involved in the immune response. Genes encoding β-subunits are highly polymorphic, whereas α-chain genes exhibit much less variability, with the exception of the HLA-DQA1 gene. We have analysed dq–7 (Fig. 1), an *Eco*RI/*Bam*HI subclone derived from H11A, a cosmid carrying the HLA-DQA1 and B1 genes[2]. We characterized dq-7 by restriction mapping, hybridization and sequencing. A major transcription start site for the HLA-DQA1 gene[3] has also been demonstrated.

At its 5′-end, dq-7 contains a repetitive


FIG. 1 Structure of the dq-7 subclone, with restriction sites. Vertical lines, *Alu* repeat; diagonal shading, A-rich; spotted region has 97% identity to a portion of mummy DNA (see text). The 5′- untranslated region/signal peptide (UT/SP) exon is also shown. Arrow, direction of transcription of the HLA-DQA1 gene; A and BA1 regulatory signals conserved among MHC class II genes.