CAPER 2000

11 – 13 April

Birmingham

TUESDAY 11 APRIL

12.30	Lunch and Registration Chamberlain Hall
14.00	ASSEMBLE in meeting room
14.00	Introduction and welcome: Roy M. Harrison , Division of Environmental Health and Risk Management ,birmingham
14.05	Andrew Hart, School of Biosciences *Assessment methodologies for overwintering and establishment potential of exotic arthropods in the UK*
14.30	David Hukin, School of Biosciences *Regulation of transport in the phloem*
14.50	Nick Gould, School of Biosciences *Does sensitivity of water flux to mercury vary along the root growing zone?*
15.10	Rob Kinnersley, Division of Environmental Health and Risk *Management Composition of ambient aerosol using single particle mass spectroscopy*
15.30	Simon Parker, Division of Environmental Health and Risk Management *Optimising the Use of Emergency Monitoring Resources Following Release of a Contaminant to the Atmosphere*
15.50	Tea
16.10	Roy Harrison, Division of Environmental Health and Risk Management *Research on ultrafine particles in the urban atmosphere*
16.30	Nick Blakey, Research Programme Manager ESART *Funding Opportunities from the Land Fill Tax*
18.30	Cafeteria service
20.00	Poster session

WEDNESDAY 12 APRIL

CHAIR – NIGEL BELL

09.00 Who's Who

09.30 Fiona Marshall, Imperial College
Air Pollution Impacts on Urban and Peri-urban Agriculture in India

09.50 Craig Davies, Imperial College
Air Pollution and Agricultural Insect Pests in Urban and Peri-urban Areas of India

10.10 Mike Ashmore, University of Bradford
Modelling of Ozone Flux and Deposition to Vegetation in Europe

10.30 Coffee

CHAIR – JEREMY BARNES

11.00 Emma Clamp, University of Newcastle
Bi-Directional Selection for Visible Injury in Brassica Rapa

11.20 Joe Maddison, University of Newcastle
Is Ascorbate in the Lead Apoplast a Factor Mediating Ozone Resistance?

11.40 Paulina Drogoudi, Imperial College
Effects of Ozone and Fruiting on the distribution of ^{14}C-Labelled Assimilates in Strawberry

12.00 Nigel Paul, Lancaster University
Seasonal Variability in the Sensitivity of Beech (Fagus Sylvatica) to Ozone

12.20 Discussion

12.35 Lunch

CHAIR – ALAN DAVISON

13.45 Keith Goulding, IACR – Rothamsted
Global Nitrogen Enrichment and its Impacts on the Environment and Health

14.15 Chris Barker, Imperial College
The Interaction between Nitrogen Deposition and Heathland Management: The Importance of Below Ground Processes

14.35 Lucy Sheppard, CEH Edinburgh
Early and Late Effects of Simulated Acid Mist on a Commercial Sitka Spruce Plantation approaching Canopy Closure: Significance of Acidified versus Non-acidified N Inputs

15.00 Tea

CHAIR – MIKE ASHMORE

15.30 David Fowler, CEH Edinburgh
NH_3 Deposition to Semi-Natural Vegetation

16.00 Nigel Bell, Imperial College

Reinvasion of Urban Areas by Black Spot and Tar Spot

16.20 John Pearson, University College, London
Exposure to Urban and Rural Pollution and the Lead, Zinc and Nitrogen Content of Mosses

16.40 Ruth Grice, Staffordshire University
Effects of Ozone on Plant/Rhizosphere interactions

17.00 Jonathon Foot, CCW
Air Pollution: Impacts on Nature Conservation – Priority Areas for Air Pollution Research

18.30 Cafeteria

20.00 Professor John Ayres, Birmingham Heartlands Hospital
Urban Pollution and Human Health

THURSDAY 13 APRIL

CHAIR – DAVID FOWLER

09.00 Nigel Turner, University of Aberdeen
Biosensor – based identification and characterisation of pollutants

09.35 Trevor Ashenden, CEH Bangor
Impacts of Vehicle Emissions on Vegetation 0004044 (83157.1)

09.50 Simon Caporn, Manchester Metropolitan
Can we identify impacts of urban pollution on plants?

10.10 David Orr, University of Aberdeen
Pollutant Build-Up on Road Surfaces

10.30 Coffee

11.00 Vincent Gauci, Open University 0004051 (83192.1)
Controls on Suppression of Peatland Methane Fluxes by Sulfate Deposition

11.20 Jeremy Barnes, University of Newcastle
How are the Interactive Effects of Elevated CO_2 and Ozone on Wheat Influenced by Nitrogen Supply?

11.40 Alan Davison, University of Newcastle
Report on GANE

12.00 Discussion

12.30 Lunch

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PAPER ABSTRACTS

METHODOLOGIES FOR ASSESSING THE OVERWINTERING POTENTIAL OF NON-NATIVE ARTHROPODS

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The use of non-native arthropods for the biological control of glasshouse invertebrate pests in the UK is an increasing feature of agricultural and horticultural systems. When such arthropods are introduced into the UK, particularly into glasshouses, there are no effective means of preventing their escape into the wider environment. This could lead to the establishment of such arthropods in the UK, if they were able to survive through winter. If the escaped arthropods were to establish it could result in adverse effects on native populations, such as, for instance, predation and parasitism of prey species of conservation importance, or competition with native natural enemy species for the same prey or hosts.

Our work examines the overwintering ability of a number of non-native arthropods which are under active consideration for licensed release for the control of glasshouse pests, including *Macrolophus caliginosus* Wagner (Heteroptera: Miridae). The further objective is to develop a laboratory protocol for the routine assessment of winter survival, cold tolerance and developmental threshold of non-native arthropods as part of the licensing system.

DOES THE SENSITIVITY OF WATER FLUX TO MERCURY VARY ALONG THE ROOT GROWING ZONE?

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Root elongation occurs as individual cells along the growing zone increase in volume. This increase is caused by water entering the cell, either by moving across the cell membrane from the apoplast via aquaporins, or entering through plasmodesmata that symplastically connect cells to each other or with the sieve element. Growing root cells become increasingly apoplastically isolated during development [1].

In this study, we used mercury - which has been shown to block aquaporins[2] – to manipulate the permeability of the membrane to water. We tested the hypothesis that the half time of water flux into cells in the mature, apoplastic, region will be affected to a greater extent by mercury than in the younger cells, where open plasmodesmata can provide an alternative route for water entry.

20 μ mol $HgCl_2$ reduced root elongation by around 75%, this reduction in growth was greatest in the mature cells, with little effect on the younger cells near the root tip. Pressure probe measurements of water flux ($t_{½}$) indicated that mercury rapidly reduced the half time of all cells in the growing region. The data is consistent with a decrease in symplastic connection and an increase in aquaporin frequency along the growing region.

1. Oparka et al 1994. *Plant Journal* **6** 756-766.
2 Tyreman et al 1999. *Journal of Experimental Botany*. **50**:1055-1071
3 ü

THE ROLE OF THE PHLOEM IN POTASSIUM CIRCULATION

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Potassium is ubiquitous in plants, with a variety of roles both biophysical and biochemical. A lack of available potassium will affect both plant growth and yield.

The high mobility of potassium in the phloem leads to a large amount of redistribution between plant cells and tissues. This can occur during periods of low potassium availability, when potassium requirement shifts from an osmotic role to a biochemical role and is translocated to areas of greater need such as the growing shoots .

In this study the distribution and circulation of potassium has been examined in barley grown hydroponically at a number of different external potassium concentrations. Single cells have been sampled, including the phloem sieve elements using aphid stylectomy, under both steady state and during transfer between high and low external potassium.

The results provide direct data on potassium recirculation to the roots via the phloem using the aphid stylectomy sampling technique. The data are discussed in relation to current models of solute recirculation and compared to other methods of sampling the phloem sieve element.

THE REGULATION OF TRANSPORT IN THE PHLOEM

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The phloem is one of two long distance transport pathways in plants. Substances transported include photoassimilates, ions, water, hormones and mRNA to tissues where they are required such as roots and seeds. In addition it is often a route of entry exploited by a variety of plant pests and diseases ranging from viruses to sap feeding insects. An understanding of the phloem function is clearly of important agricultural important.

A mechanism of phloem translocation is described in Munch's pressure-flow hypothesis. If two osmometers with different osmotic pressures are connected, a hydrostatic pressure difference can build up between them. Flow will then occur from the highest hydrostatic pressure (source) to the one with the lowest (sink). The hydrostatic pressure within the source is maintained by the active uptake of solutes causing water to move in.

The phloem is constructed of living cells with functional membranes and is symplastically connected via plasmodesmata to its accompanying companion cells throughout its length. These companion cells 'nurse' the unnucleate sieve tubes and are often the point of solute and water import to the translocation pathway.

Experimental collection of phloem sap can be difficult due to the small size and location of the phloem. In a handful of species, incision into the plant tissue results in phloem exudation due to the positive turgor pressure within the sieve elements. However aphids can be used as a less invasive method of collecting phloem. The aphid is caged onto the area of the plant to be sampled and allowed to feed. A tungsten wire connected to a frequency modulator is then used to cut the stylet off. The positive pressure of the phloem and the natural anticoagulates provided by the aphid can provide up to 24 hours of continuous exudation.

The first project investigates the regulation of potassium ions in the phloem. Potassium is highly mobile within the phloem, almost half of potassium taken up by the roots and sent to the shoots can be recycled back to the roots in the phloem. The majority of this is then sent back to the shoots (Jeschke and Wolf, 1987). Second only to sucrose, potassium is the major osmoticum within the phloem and is also important in balancing charge. Coupled with the observation that sieve element sap is continuous with the cytoplasm this suggests that K^+ is highly regulated within the phloem. This hypothesis was tested on barley (*Hordeum vulgare* L.) grown under a range of K^+ regimes. A decrease in external potassium supply leads to a decrease in phloem potassium concentration. It was concluded that potassium flux to the roots may function as a signal of shoot nutrient status.

In the second project we investigated the transport of water into the root growing zone (RGZ) from the phloem. Water influx provides the turgor pressure necessary for cell expansion. There are two possible routes of water uptake into cells in the RGZ. In symplastically connected cells water and solutes arrive from the phloem. In the absence of plasmodesmal connections water can only enter across the membrane from the apoplast.

We attempted to quantify the proportion of water entering across the membrane by measuring the difference in organic ion concentration of the phloem and the cells it supplied. In the absence of ion uptake from the apoplast the amount by which the cell concentration is reduced below phloem concentration provides an estimate of the dilution of cell composition of apoplastic water. Apoplastic ion uptake was minimised by using a split root system with a single barley root exposed to a growth media with certain ions of interest removed, whilst the remaining roots were fed full nutrient solution. Aphid stylectomy was used to sample the root phloem and single cell sampling was used to obtain sap samples of the growing cells of the same root. The concentration of potassium, sulphur, rubidium and phosphorus present in both compartments was measured using x-ray analysis and the osmotic pressure was measured using picolitre osmometry.

Cell ion concentrations were approximately 15% lower than those of the phloem and we estimate that approximately 15% of the water in the root growing zone is transported through the apoplast. This has implications for the solute relations and growth of the root tip.

References

Jeschke W.D., Pate J.S., Atkins C.A. (1987) Partitioning of K^+, Na^+, Mg^{++}, and Ca^{++} through xylem and phloem to component organs of nodulated white lupin under mild salinity. **Journal of Plant Physiology**, 128: 77-93

SINGLE PARTICLE MASS SPECTROSCOPY OF URBAN AEROSOL DURING THE PUMA URBAN POLLUTION MONITORING CAMPAIGNS

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Detailed knowledge of the composition, and hence the probable source, of ambient aerosol is a prerequisite to effective urban air quality management. A comprehensive series of air pollutant measurements have been made in the West Midlands area of the UK, during two month-long campaigns in summer 1999 and winter 2000, with a view to validating various air quality models (including UAM) for UK conditions. Amongst the pollutants monitored was particulate matter. Particle composition was analysed in real time using a LAMPAS single particle mass spectrometer (Hinz et al 1998), which recorded simultaneous positive and negative mass spectra for the ions produced when aerosol particles in flight were subjected to laser-desorption.

We report the results of measurements which were taken over continuous periods of up to 24 hours, under a range of meteorological conditions and prevailing wind directions, producing a data set with high temporal resolution from which characteristic particle composition profiles could be derived. The large numbers of mass spectra generated are being analysed using software in which fuzzy clustering procedures assign each spectrum to one of a number of categories. To date these have included organic and inorganic carbon, sulphate, nitrate and "crustal" materials such as iron and silicates.

The Ford Mobile Laboratory, in which the LAMPAS instrument was a component part, also allowed simultaneous measurements of particle number, (APS, SMPS), mass (TEOM) and chemical composition by carbon analysis and ion exchange (MOUDI and Partisol filters) to be made throughout the campaign, allowing comparison of the LAMPAS findings with those of more conventional techniques.

Hinze, K.-P, Greweling, M, Iglseder, H, Trimborn, A, and Spengler, B (1998). Source identification of single particles by on-line laser mass spectroscopy. J. Aerosol Sci 29, Suppl.1, pp.S1253-S1254

OPTIMISING THE USE OF EMERGENCY MONITORING RESOURCES FOLLOWING RELEASE OF A CONTAMINANT TO THE ATMOSPHERE

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An "expert system" in the form of a series of questions and procedures has been developed as a decision making aid for planning an emergency sampling strategy. The system aims to optimise the use of finite ground sampling resources within the first hours after a release of contaminant to the atmosphere, on the basis of the minimal amount of information generally available in the first stages of an incident.

The general approach is to start with the simplest case, where a Gaussian plume of airborne contamination is spreading over uniform terrain. Additional information on various parameters related to meteorology, topography and land use leads to sub-division of the area under consideration into different risk categories for deposition. Sampling can then be targeted at areas falling in higher risk categories, these areas being more likely to be significantly contaminated and also having a probable higher level of sample variance than less contaminated areas. A pilot study, using one specified site, has been carried out to test the effectiveness of this approach. The resulting digital maps showed a good level of agreement between predicted and actual areas of high deposition. Current work is using a combination of computational flow modelling, wind tunnel experiments and field measurements to further refine and automate the system, and to address those areas in which the comparison between measured and predicted deposition patterns was less favourable.

RESEARCH ON ULTRAFINE PARTICLES IN THE URBAN ATMOSHERE

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There is much current interest in atmospheric ultrafine particles (defined as particles with a diameter less than 100 nanometres) since toxicological studies indicate that airborne particulate matter increases in toxicity per unit mass as particle size decreases. Whilst ultrafine particles contribute only a relatively small proportion of the mass of airborne particles, they make up a large proportion of the atmospheric aerosol by number. These particles originate both from emissions from combustion and other high temperature sources, especially road traffic, and from secondary formation in the atmosphere. The University of Birmingham has a substantial measurement programme of ultrafine particles in the atmosphere relating both to primary emissions and to new particle formation processes. Some examples of this research will be given.

AIR POLLUTION IMPACTS ON URBAN AND PERI-URBAN AGRICULTURE IN INDIA

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A research programme has recently been completed, funded by the UK Department for International Development, investigating the effects of air pollution on the yield and quality of agricultural crops in and around Indian cities. This is a multi-disciplinary study which has assessed the scientific and socio-economic implications of environmental threats to urban and peri-urban agriculture, with emphasis on the livelihood of the poor. The experimental part of the programme involved growing wheat and mustard in winter and moong bean and spinach in summer at locations with different levels of air pollution in and around Delhi and Varanasi, with accompanying pollutant monitoring. All 4 crops showed significant negative correlations between yield and prevailing SO_2 and/or NO_2 concentrations. Furthermore in the case of wheat, measurements of crop quality showed similar relationships between SO_2 and NO_2 concentration and carbohydrate and energy content. Thus there is evidence for ambient levels of air pollution reducing not only yield, but also crop quality in 2 Indian cities, representing a threat to the nutrition of the urban poor, who are major stakeholders.

AIR POLLUTION AND AGRICULTURAL INSECT PESTS IN URBAN AND PERI-URBAN AREAS OF INDIA

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This paper describes the approach to a basic assessment of the nature, extent and significance of air pollution effects on agricultural pests in a location-specific case study in a developing country. One important component of this study was a series of field experiments carried out in urban and peri-urban areas of Varanasi, India, in the winter season of 1998-99. These experiments are discussed in detail.

Mustard (*Brassica junceae*) and cabbage (*Brassica oleraceae*) plants were grown under standardised conditions at three sites with low, moderate and high levels of air pollution, respectively. When the plants had reached an appropriate growth stage, mustard aphid (*Lipaphis erysimi*) nymphs and diamondback moth (*Plutella xylostella*) larvae were introduced onto the mustard and cabbage plants, respectively, and their growth and reproduction were monitored.

At the sites with moderate and high levels of air pollution, the fecundity and r_m of *L.erysimi* were significantly greater than at the low air pollution site. The soluble nitrogen content of the mustard stems was significantly higher at the high pollution site, and a significant correlation was found between stem soluble N content and aphid r_m. Similarly, the developmental rate, pupal weight and fecundity of *P. xylostella* were significantly greater at the high and moderate pollution sites, although no clear pattern emerged from the analysis of the total N content of the cabbage leaves. Differences in daily maximum and minimum temperatures between the three sites were minimal, suggesting that differences in microclimate did not explain the observed differences in insect growth and reproduction.

These results will be used to establish basic air pollution threshold levels for air pollution effects on insect pests, which will then feed into a simple risk assessment of the extent and significance of air pollution-pest interactions. However it is recommended that a greater number of study sites should be used in future experiments, with a wider range of microclimate parameters included in the analysis.

MODELLING OF OZONE FLUX AND DEPOSITION TO VEGETATION IN EUROPE

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Current European assessments of the risk of ozone damage to vegetation are based on the accumulated ozone exposure over a threshold of 40ppb (AOT40) concept. However, it is well established that the impacts of ozone are more closely related to absorbed ozone dose rather than the cumulative external exposure, and that a risk assessment based on this approach would better represent the likely spatial and temporal variation in ozone impacts across the diverse climates and land covers of Europe. This paper describes the development of a model to simulate both stomatal ozone flux and total ozone deposition, for application at the European scale. Predictions of ozone damage based on the AOT40 and flux approach are compared. Comparisons are made between model predictions and field observations of both stomatal flux and total deposition and the key uncertainties in the current formulation of the model are assessed.

BI-DIRECTIONAL SELECTION FOR VISIBLE INJURY IN *BRASSICA RAPA*

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The aim of this study was to select within a population of rapid cycling *Brassica rapa*, individuals which showed low or high levels of visible injury when exposed to an acute ozone dose (circa 150 – 200 nl l-1 6hrs). Selection experiments were conducted over three generations to create resistant and sensitive lines respectively. This approach aimed to determine the presence of additive genetic variance for visible injury in *Brassica rapa*. Wolff & Van Delden demonstrated a strong response to selection for leaf angle in *P. lanceolata* and also genetic correlations between leaf angle and other characters were observed. If lines can be created within a *Brassica rapa* population that differ in their visible injury response, relationships between acute ozone resistance and other coherited traits can be investigated. This will allow further understanding of underlying mechanisms determining ozone resistance and sensitivity.

A comparative experiment was conducted to establish firstly whether the lines were indeed different and secondly to investigate if there was any relationship between chronic and acute ozone injury.

Data are presented which illustrate the significant difference in the lines' response to an acute ozone dose (150 nl l-1 6hrs). Plants were scored estimating the percentage of plant exhibiting visible injury. The sensitive line showed on average 53% injury which was significantly higher ($p<0.001$) than the resistant line (25%). Data will also be shown demonstrating differences between the lines in terms their ascorbate levels, photosynthetic capacity and growth patterns.

K. Wolff & W. Van Delden (1989) Genetic analysis of ecological relevant morphological variability in *Plantago lanceolata* L. IV. Response and correlated response to bidirectional selection for leaf angle. Heredity, 62, 153-160.

IS ASCORBATE IN THE LEAF APOPLAST A FACTOR MEDIATING OZONE RESISTANCE?

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The mechanisms underlying the differential sensitivity of plants to the ubiquitous air pollutant ozone (O_3) are far from fully understood. There is, however, a growing realisation that, following the uptake of the pollutant into the leaf interior, the first reactions take place in the aqueous matrix associated with the leaf cell walls (i.e. the leaf apoplast). This compartment forms the primary boundary between atmosphere and biosphere. The leaf apoplast is known to contain several antioxidants that react readily with O_3 (and/or it's primary dissolution products) to yield ostensibly harmless compounds. There is therefore the possibility that significant amounts of O_3 are scavenged (i.e. detoxified) prior to reaching the primary target - the plasmalemma. If this is the case, antioxidants situated in the leaf apoplast may afford an important first-line of defence against O_3. In this presentation, we focus on the role played by one of these compounds, ascorbate, in screening the plasmalemma from O_3-induced oxidative insult.

EFFECTS OF OZONE AND FRUITING ON THE DISTRIBUTION OF ^{14}C-LABELED ASSIMILATES IN STRAWBERRY.

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The impact of ozone on the partitioning of carbon in crop plants by direct assessment of carbon distribution rather than in the differences in growth between plant parts has received little attention. Fruiting and deblossomed strawberry plants (*Fragariax ananassa* Duch. cv. Cambridge Favorite) were treated with 92 ppb O_3 or filtered air in open top chambers for 69 days. The first (leaf 1) or third (leaf 3) most recent fully expanded leaf were labeled with $^{14}CO_2$ and the sink strength (% allocation) and relative specific uptake (RSU) (% allocation/% dry matter) of the different sinks, and the amount of assimilates allocated to the sinks were determined.

A decrease ($P<0.1$) in the relative specific uptake of total fruits was found when leaf 1 was labeled, but not when leaf 3 was labeled. The fact that the assimilates from leaf 3 were distributed mostly to the fruit, suggests that the amount of assimilates distributed to the fruits was probably governed by changes in the photosynthetic rate, rather than an alteration in the allocation pattern of assimilates.

The ^{14}C assimilate concentration (RSU) in the leaves above the source leaf 1 was significantly ($P<0.05$) greater at 24 h but not 48 h post labeling period, suggesting that assimilates were distributed earlier to the younger leaves in ozone treated plants. Furthermore, a greater ($P<0.1$) distribution of assimilates (sink strength) in the leaves above the source leaves 1 or 3 was found.

In contrast to fruiting plants, ozone significantly increased ($P<0.05$) the sink strength and RSU of the petioles of the crown containing the source leaf in deblossomed plants. In addition, the amount of carbon allocated to the roots significantly decreased ($P<0.05$); this was controlled more by photosynthesis than the proportional allocation of assimilates.

SEASONAL VARIABILITY IN THE SENSITIVITY OF BEECH (*FAGUS SYLVATICA*) TO OZONE

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Two year old saplings of beech (*Fagus sylvatica* L.) were grown in Solardome glasshouses were exposed to ozone treatments early in the growing season (mid-May to mid July) and/or late in the season (mid July- mid September). Responses were quantified using *in situ* gas analysis, and destructive harvests for plant morphology and biomass. Ozone pollution early in the season (May-July) significantly reduced net photosynthesis, transpiration and stomatal conductance in beech but comparable pollution later in the season (July-September) had no significant effects. The mechanism of this response is not yet known, but seems likely to reflect a direct effect of ozone on stomata. The early season response occurs at cumulative ozone concentrations well below the current critical AOT40 of 10 ppmh. In plants exposed to ozone throughout the season, photosynthesis during August and September was significantly inhibited compared with controls. This response was associated with a significant increase in internal CO_2 concentration, but not with any change in stomatal conductance. However, photosynthetic rates late in the season were low compared with those in June and July, suggesting that the significant reduction in late-season carbon fixation due to long-term ozone fumigation may not have major effects on biomass production. Although confirmation in terms of biomass data is required, these gas exchange data suggest that the current critical level criteria might be improved by "weighting" ozone episodes according to season, with greater weight being given to episodes early in the year.

GLOBAL NITROGEN ENRICHMENT AND ITS IMPACTS ON THE ENVIRONMENT AND HEALTH

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More 'reactive' N (N_2O, NO, NO_2, NO_2^-, NO_3^-, NH_3 and NH_4^+) is now produced by human-driven than by natural processes. World-wide 20 Tg N yr^{-1} is emitted from energy production, 80 Tg N yr^{-1} fixed in fertilizer production, and 40 Tg N yr^{-1} fixed by the cultivation of legumes and other crops; a total of 140 Tg N yr^{-1}. This compares with 90-130 Tg N yr^{-1} by natural processes (lightning and biological fixation). In addition N is being mobilised from long-term storage pools through biomass burning, land clearance and conversion, and the drainage of wetlands. Reactive N is readily transported in solution or *via* the atmosphere and spread regionally and globally. It is accumulating in the atmosphere, soils, groundwater, land vegetation, oceans and marine sediments.

Soils both produce reactive N and are impacted on by reactive N. Agricultural soils are a major source of N_2O but non-agricultural land may be too. Some woodlands have become saturated with N from atmospheric deposition, greatly increasing N_2O flux rates. The denitrification of nitrate leached to rivers and estuaries from agricultural land and of nitrified, deposited ammonia, is also a major source of N_2O. The ability of soil to oxidise CH_4 is impaired by N inputs and N deposition is likely to have reduced the soil sink strength. Soils play a very important role in the balance of CO_2 fluxes and in the sequestration of C. The cycling of N and C are closely linked and N deposition may increase the sequestration of C in soil, reducing global change. Reactive N contributes to acid deposition and soil acidification. Legumes and ammonium-based fertilisers, applied in excess of requirements and leached, rapidly acidify soils and can lead to the leaching of Al and toxic metals into waters.

NO_2 increases aphid and pest damage to plants and plays an essential role in photochemical smog reactions and thus in the formation of O_3, the main phytotoxic element in smog. There are synergistic and antagonistic interactions between NO_2, O_3 and SO_2 and their effects on plants. However, soils make only a small contribution to the production of NO_2 and O_3, the main sources being combustion especially vehicles and home heating. Deposited N can increase crop yields (it has maintained a wheat yield of *ca.* 1 t ha^{-1} on a completely unfertilised plot of the Broadbalk Experiment since 1843), but it can cause eutrophication and change the species composition in natural and semi-natural ecosystems.

'Air pollution' generally increases human mortality and lung and heart conditions and exacerbates asthma and hay-fever, although particulates and ozone are the main health-affecting pollutants. Specifically, exposure to NO_2 irritates the respiratory tract and may exacerbate asthma attacks. Agricultural soils are a major source of nitrate in potable waters, considered to be a health hazard for many years. The current EU Limit of 50 mg nitrate l^{-1} was set to protect against methaemoglobinaemia (Blue Baby Syndrome) and stomach cancer, but recent research has questioned both of these effects.

Mansfield TM, Goulding KWT & Shepherd LJ. 1998. *Disturbance of the nitrogen cycle.* (3rd New Phytologist Symposium, *New Phytologist* **139**, No 1), Cambridge University Press.

THE INTERACTION BETWEEN NITROGEN DEPOSITION AND HEATHLAND MANAGEMENT: THE IMPORTANCE OF BELOW GROUND PROCESSES

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Increased nitrogen deposition is believed to be responsible for the recent change in dominance at many of Europe's lowland heaths from the original heath community to one that is dominated by one or two grass species. In the light of enhanced nitrogen deposition, management of heathlands becomes an important area of research. Whilst a lot of information exists about individual management practices, very little is known about the interaction between management and enhanced nitrogen deposition. Management may alter the impact of additional nitrogen on heathlands. Research has been carried out on a lowland heath site in Surrey investigating the effects of three management regimes and (simulated) accidental heath fires on the impact of additional nitrogen.

The effect of additional nitrogen and management on the result of competition between *Calluna* and invading grass species will be mediated by below ground processes. Microbial parameters will determine the availability of nitrogen and the effect it has on competition. Both nitrogen additions and management will alter these microbial parameters. We present results investigating below ground responses of our heathland site (decomposition rate, litter nitrogen release and mineralisation rates) to management and nitrogen additions. We also describe an experiment currently underway that aims to investigate how the effect of management on the available organic nitrogen may alter the outcome of *Calluna* and grass competition with enhanced nitrogen deposition.

EARLY AND LATE EFFECTS OF SIMULATED ACID MIST ON A COMMERCIAL SITKA SPRUCE PLANTATION APPROACHING CANOPY CLOSURE: SIGNIFICANCE OF ACIDIFIED VERSUS NON-ACIDIFIED N INPUTS

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Abstract

Since 1996 a Sitka spruce plantation in southern Scotland, planted in 1986 with a mixture of provenances, on a drained, deep peat has been treated with simulated acid mist in 4 replicated blocks each containing 6 treatment plots (2 rows of 5 trees). Spray booms were mounted on an extendable tubular scaffolding framework at canopy height. Treatments provided N and S in equimolar concentrations (1.6 mol m^{-3}) supplying ~ 50 kg S and N ha^{-1} yr^{-1} as: N (NH_4NO_3), S (Na_2SO_4), NS Acid (NH_4NO_3 + H_2SO_4 at pH 2.5), 2NS Acid (double dose applied at twice frequency) plus an unsprayed and sprayed control. Early effects have been seen on stemwood growth and the vitality of groundflora, indicating significant differential effects of acidified versus non-acidified N. In the longer-term significant effects on the soil and below-ground processes indicate non-acidified N is suppressing above- and below-ground growth in addition to mycorrhizal fructification. This talk will summarise the main treatment effects with respect to changes in stem growth, foliar chemistry, litter chemistry, root growth, mycorrhizal infection and soilwater chemistry, eluding to the important role of S in N chemistry.

NH_3 DEPOSITION TO SEMI-NATURAL VEGETATION

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Abstract

Many point sources of NH_3 emission (intensive livestock units) in the UK are in close proximity to areas of N sensitive moorland vegetation. Long-term measurements of NH_3 deposition at low ambient NH_3 concentrations (< 2 μg m^{-3}) have shown a decline in NH_3 deposition velocity with increasing ambient NH_3 concentration to semi-natural vegetation, however, no data exists for this moorland community at higher ambient NH_3 concentrations. To determine the potential impact of these high N inputs on semi-natural vegetation it is necessary to quantify the dependence of NH_3 deposition velocity and canopy resistance on ambient NH_3 concentrations at range of ambient NH_3 concentrations.

NH_3 flux measurements were carried out on semi-natural vegetation in an open-top chamber study using a flux chamber system with NH_3 injection at a range of NH_3 concentrations (1-42 μg m^{-3}) and conditions. NH_3 deposition to the vegetation surface was found throughout the range of NH_3 concentrations, with no NH_3 emission even at low ambient concentrations. Deposition velocity to wet canopy surfaces was high compared to deposition to dry surfaces. Deposition velocity (V_g) to both wet and dry vegetation canopies decreased as ambient NH_3 concentrations increased. Canopy resistance (dry vegetation) increased with increasing ambient NH_3 concentration.

Implications of these results for quantifying N deposition to semi-natural plant communities are discussed.

REINVASION OF URBAN AREAS BY BLACK SPOT AND TAR SPOT

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Field surveys involving lichens have revealed that in ameliorating air quality, these organisms can re-colonise areas from which they were previously absent. Sometimes, this reinvasion is submitted to a time-lag, often termed "memory effect", which may be caused by poor dispersal ability.

In this study, the response of two fungal pathogens, previously absent from many urban areas, to decreasing SO_2 levels in the UK is examined. The first pathogen was *Rhytisma acerinum*, causing tar-spot of sycamore (*Acer pseudoplatanus*). The second pathogen was *Diplocarpon rosae*, causing blackspot of rose (*Rosa* spp.). *R. acerinum* had previously been incorporated into a biomonitoring survey along with lichens in the 1970's in South Yorkshire. It was therefore decided to revisit these sites to see if the fungus could now be found where it was previously absent when SO_2 levels were higher. As for *D. rosae*, Saunders (1965) had collected data concerning the amount of infection of rose plants in major cities of the UK. These cities were also revisited, with the aim of examining any signs of re-colonisation by the pathogen.

For both pathogens, it was found that with one exception, all the sites from which they were previously absent had been re-colonised. There was no evidence for a memory effect and there was no correlation between present-day SO_2 levels and the infection indices. The conclusion was that present day concentrations of the pollutant had no significant effect on the pathogens, although the concentrations in the 1960's and 1970's had a negative impact on both diseases at the time.

EXPOSURE TO URBAN AND RURAL POLLUTION AND THE LEAD, ZINC AND NITROGEN CONTENT OF MOSSES.

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Most mosses are perceived to be sensitive to atmospheric pollution, however a certain number are very common in urban environments. These species are commonly epilithic mosses found on walls, often next to very busy main roads, and include *Tortula muralis, Grimmia pulvinata* and *Bryum capillare*. In urban areas these species are likely to be exposed to high levels of NO_x derived from traffic exhausts. We could find very little in the literature on the nitrogen content of such species and we wondered whether the N content of the moss shoots would somehow reflect the degree of exposure to traffic and be useful for assessing urban traffic pollution. From 105 samples collected around the UK we found that there was no correlation between traffic flow (road use) and the total N content of moss shoots. However, when the shoots were measured for stable isotope variation ($\delta^{15}N$) there was a very marked correlation, with mosses from busy urban roads and motorways being c. + 3.0 ‰ and those from quiet rural areas being c -7 ‰. Lead and zinc content of moss shoots was measured to assess the amount of traffic exposure and correlated with $\delta^{15}N$ but not the total N of shoots. Using this evidence, plus a transect downwind from a motorway and that from the literature, we present a revised hypothetical model for atmospheric NO_x fractionation and deposition as gas/particle/wet phases.

THE EFFECTS OF OZONE ON PLANT/RHIZOSPHERE INTERACTIONS

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Tropospheric ozone is regarded as one of the most potent phytotoxic air pollutants[1]. Ozone affects plants by causing an initial phase of stress reactions leading to a reduced photosynthetic rate. This is often followed by a second phase where cell damage occurs and visible symptoms such as necrotic areas may appear [2]. Ambient ozone concentrations are typically between 20 and 60 nl l^{-1} [2], however resistance to ozone damage in wild populations of *Plantago major* changed over time depending on previous exposure levels [3].

The plant *Pisum sativum L.* is a leguminous plant and is thus involved in a symbiotic association with the *Rhizobium leguminosarum* biovar *viciae* bacteria. The plant fixes carbon from photosynthesis (source), and allocates it to areas within its system, as required by the sink. Much of the carbon is required by the plant roots, where the bacteria are housed in special nodules, and into the soil through rhizodeposition[4].

A microcosm containing *Pisum sativum* variety Feltenham first, in a soil mixture of 75% John Innes and 25% Agricultural sand (which had previously been shown to be the best growth medium under these experimental conditions), was used as a model system to evaluate the direct effects of ozone fumigation on the plant, using physiological data. The indirect effects of ozone fumigation on the soil microbial community was studied using microbiological techniques and fluorescent microscopy [5].

The stress caused by ozone at 70 nl l^{-1} 12h d^{-1} affected plant growth and also the structure of the soil microbial community when compared to a similar ambient air situation. This was probably due to alterations in plant carbon allocation and thus to nutritional status of the rhizosphere caused by ozone exposure.

1. T. Reichenauer, H.R. Bolhar-Nordenkampf, U. Ehrlich, G. Soja, W.F. Posth, & F. Halbaracks (1997). The influence of ambient and elevated ozone concentrations on photosynthesis in *Populus nigra*. Plant Cell and Environment, 20, 1061-1069.

2. H. Sanderman Jr (1996). Ozone and plant health. Annual Review Phytopathology, 34, 347-366

3. A.W. Davison, K. Reiling (1995). A rapid change in ozone resistance of *Plantago major* after summers with high ozone concentrations. New Phytologist, 131, 337-344

4. M.C. Hawes, L.A. Brigham, F. Wen, H.H. Woo & Y. Zhu (1992). Impact of root border cells on microbial populations in the rhizosphere. Advanced Plant Pathology, 8, 119-148.

5. J.R. Anderson & J.M. Slinger (1975). Europium Chelate and fluorescent brightener staining of soil propagules and their Photomicrographic counting-11. Efficiency. Soil Biology and Biochemistry, 7, 211-215.

AIR POLLUTION: IMPACTS ON NATURE CONSERVATION- PRIORITY AREAS FOR AIR POLLUTION RESEARCH

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The statutory UK conservation agencies (CCW, EN, SNH) have been heavily involved in the assessment and quantification of acidification and eutrophication impacts. The work has ranged from evidence to input into the second sulphur protocol, assessing the impacts of nitrogen and grazing in the uplands, through evaluation of power station contribution to critical load exceedance on Sites of Special Scientific Interest (SSSIs) down to comments on individual plant performance via IPC/IPPC consultation processes.

Overwhelming evidence exists that acidification, eutrophication and photochemical oxidants are still major threats to nature conservation interests in the UK and will remain so until at least the middle of the next century. However; even with proposed cuts in place by 2000 a number of internationally protected habitats will still be receiving acid deposition, NOx, NH3 and O_3 in excess of their critical loads. To protect these areas further cuts in emissions from European and UK sources will be required.

The Priority areas for air pollution research in the UK will be discussed in relation to the role of the Countryside Agencies and the newly formed Air Pollution Lead Co-ordination Network (APLCN).

BIOSENSOR-BASED IDENTIFICATION AND CHARACTERISATION OF POLLUTANTS.

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There is a growing need for both regulators and industry to find improved methods of rapidly, accurately and cost-effectively monitoring the environment for toxic pollutants (single and mixed) and identifying their nature and source. Biosensor technology has the potential for rapid assessment of bioavailability of pollutants without the need for costly chemical analytical methods. The purpose of this research was to use a *lux*-marked bacterial biosensor (with *lux* reporter genes downstream of a strong constitutive promoter) to characterise kinetic responses of target pollutants (e.g. heavy metals and chlorinated organics) to enable pollutant identification and discrimination and to assess modes of pollutant interaction. The biosensor was employed in a continuous, luminescence-based monitoring mode such that dynamic response to pollutants was assessed every second for 360 seconds and a computer program was designed to enable dose response curves of known pollutants to be compared with unknown samples. The interpretation of modelled results enabled a much fuller understanding of dose response behaviour to pollutants than that associated with traditional single value end-points (e.g. NOEC or EC) and suggests a powerful technology is emerging for rapid and reliable pollutant fingerprinting.

Impacts of Vehicle Emissions on Vegetation

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CEH Bangor, Newcastle University, Imperial College London, CEH Edinburgh, Bradford University and Manchester Metropolitan University

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Pollutants derived from vehicle emissions now pose a major threat to human health and urban ecology. This project group aims to evaluate the impacts of urban pollutants on vegetation and plant-insect interactions to provide generic information for the future remediation and conservation of vegetation in urban areas. Studies will be conducted in a wildlife garden at the Natural History Museum in central London and at roadside sites in and around Newcastle and Manchester. Complementary studies will be conducted under more controlled conditions in a Solardome exposure system developed in a previous feasibility study at CEH Bangor.

Specific objectives of the project are i) to evaluate the impacts of urban air pollution climates on a range of plant species of differing morphology/functional types and their insect herbivores ii) to study the effects of these pollutants on leaf function, leaf chemistry and plant-herbivore interactions iii) to identify abiotic stresses in urban environments that affect pollutant uptake and plant responses iv) to evaluate the importance of vehicle pollutants as a limiting factor for lichen recolonisation of urban areas v) to derive initial estimates of critical levels of pollutants for urban ecosystems and vi) to identify which types of plant species are tolerant of urban pollution climates and thus useful for urban planting.

CAN WE IDENTIFY IMPACTS OF URBAN POLLUTION ON PLANTS?

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Vegetation provides numerous benefits in the urban and highway. Obvious benefits include aesthetic value, visual screens, ecological habitat and food chain functions contributing to enhanced biodiversity. A further key potential function is a sink for pollutant emissions from vehicles. The capacity to fulfil effectively the varied roles of vegetation requires good plant health with vigorous rates of growth and leaf area production.

Despite the importance of roadside and urban plants we have little detailed understanding of how they grow and perform in the face of modern traffic pollution. By reference to critical levels and other empirical information we should expect that trees in urban and roadside sites are adversely affected by current air quality in many urban sites. Identifying such injury is difficult and air pollution problems for urban trees are often not recognised by local authorities and other agencies.

This presentation will review some important aspects of pollution impacts where knowledge is missing. This will be supported by data from recent studies using ryegrass, birch and scots pine along transects in the Manchester region.

TALK CONTRIBUTION

POLLUTANT BUILD-UP ON ROAD SURFACES

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The objective of this study was to collect and analyse sediment from a small area of impervious urban road and investigate relationships between the sediment itself, attached pollutants and various climatic parameters. Sediment loading rates, particle size distribution and pollutant characteristics, such as heavy metals (Zn, Cu, Pb, Cd) in each fraction were determined. A novel 'wet' method was used to collect the smallest particle fraction, which is the fraction normally left behind by dry vacuuming. Over one year, samples were collected from two positions alternately on the road surface. Three sets of samples were taken along a cross section of the road surface. Standard statistical methods, including multiple regression, were used to determine relationships amongst the data. Sediment loading rates were highest in the winter months, especially when snow was present on the road surface. Concentrations of heavy metals were highest in the smallest particle size fraction analysed (2 – 63 μm). the antecedent dry weather period had no significant influence on either sediment loading rates or pollutant concentration.

Controls on suppression of peatland methane fluxes by sulfate deposition.

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Methane (CH_4) is an important greenhouse gas, contributing an estimated 15 to 20% of the present greenhouse effect. Anaerobic decomposition in soils from both natural wetlands and rice paddies constitute the largest source of atmospheric methane. After much work over the last 20 years driving variables controlling size and temporal variability of emissions from these systems are now well understood and has lead to the construction of predictive numerical models.

However, these models generally assume that alternate electron acceptors (species that in these systems permit decomposition of organic matter to CO_2 as the terminal product rather than CH_4) have been removed from the system by microorganisms that can out-compete methane producing bacteria for substrates (e.g. sulfate reducers). The fact that the consumption of such alternate electron acceptors as sulfate provides a more energetically productive way by which organic matter can be degraded means that these systems are often rapidly depleted of these species. However sulfate is a major constituent of acid rain which, while on the decline in Europe and north America is a growing problem in Asia. Over two years I examined the hypothesis that sulfate derived from acid deposition (a growing problem in many parts of the world) would provide a sufficient, continuous supply of sulfate that would enable the maintenance of a competitive population of sulfate reducing bacteria thereby suppressing CH_4 fluxes. Results of a manipulation experiment in a peatland in northern Scotland support this hypothesis. Furthermore, results indicate that the degree of suppression may be influenced by climate.

HOW ARE THE INTERACTIVE EFFECTS OF ELEVATED CO_2 AND OZONE ON WHEAT INFLUENCED BY NITROGEN SUPPLY?

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Spring wheat (*Triticum aestivum* L. cv. Hanno) was grown in duplicate controlled environment chambers under a factorial combination of ambient/elevated CO_2 and CFA/ozone at three contrasting levels of nitrogen supply (High N-14 mM NO_3; Medium N-4 mM NO_3 and Low N-1.5 mM NO_3). Nitrogen limitation was found to reduce the growth stimulation under elevated CO_2, but appeared to afford protection against O_3. The extent of the amelioration of ozone injury under elevated CO_2 was found not to be dependent on N supply. The importance of exclusion *versus* detoxification (*via* ascorbate) in the amelioration of ozone injury under elevated CO_2 will be discussed in relation to plant ontogeny.

POSTER ABSTRACTS

The Effects of Elevated Nitrogen and Imposed Drought on the Plant Community Dynamics of a Lowland Heath

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To investigate the effects of elevated nitrogen on semi-natural vegetation, experimental field trial plots were established at a lowland heath site in Cheshire in 1996. The plots have received NH_4NO_3, in aqueous solution, applied at 14 day intervals to provide a dose equivalent to: 0, 20, 60, 120kg ha^{-1} yr^{-1}. During the summer of 1997 the plots were split beneath rain shelters, one half receiving the average weekly summer rainfall for the site, the other half was droughted. Nitrogen applications continued throughout the six months of imposed drought.

Infestation of *Lochmaea suturalis* and resulting herbivorous damage was recorded in 1998 and 1999 - there was an increased proportion of shoot damage in the high N plots. Annual vegetation surveys have shown a reduction in canopy cover of *Calluna vulgaris* and an acceleration of the *Calluna* cycle. Associated with these phenomena has been the marked formation of canopy 'gaps' in the 60 and 120kg ha^{-1} yr^{-1} treatments. These plots have shown major fluctuations in the plant community dynamics of *Deschampsia flexuosa* and moss species.

New plots have been established, creating artificial 'gaps' in the heather canopy. The treatments include nitrogen application and seeding with *Deschampsia flexuosa*. These plots have been established to investigate the relationship between *Deschampsia flexuosa*, gap formation and nitrogen addition.

Poster contribution

IMPACT OF AIR POLLUTANTS ON ROADSIDE AND URBAN VEGETATION

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Plants in the urban and roadside environment are exposed to complex mixtures of gaseous and particulate pollutants with the additional impact of other factors such as roadside salt, oil and heavy metals. All of these have important interactions with plants, but their combined effects have not been adequately investigated.

The aim of the investigations presented here has been to obtain a clearer understanding of both the "stress profile" to which roadside plants are exposed, and the impact of roadside plantings on the spread of pollutants away from "point" sources such as motorways. Transects have been established across two conifer belts adjacent to the M6 with the intention of monitoring the spread of both particulate and gaseous pollutants away from the motorway and studying the interaction of these pollutants with leaf surfaces. Experimental material has also been established close to existing monitoring-stations at clean (Bangor), suburban (South Manchester) and polluted (M62 embankement - Junction 17) sites. Results will be presented on the possible effects of pollutant gases and particulate loading on cuticular erosion, levels of endophytic fungal infection and needle transpiration rates.

POSTER CONTRIBUTION

THE APPLICATION OF A NOVEL SODIUM BASE CATION DOMINANCE WEATHERING INDEX FROM A REGIONAL TO NATIONAL SCALE

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Key to the determination of catchment susceptibility to acidification is the accurate quantification of mineral dissolution rates and release of base cations. Mineral weathering reactions consume protons, buffering soils. This is fundamental to Critical Loads methodology. Critical Loads are used to assess the risk of acidification of soils and surface waters from atmospheric pollution. This approach underpins international pollution abatement strategies[1]. Considerable discrepancies in values have been reported between the different methods of calculating mineral weathering rates currently used[2]. Increasingly complicated modelling approaches often require difficult to attain site specific input data.

In Scotland, in catchments where parent materials and soils have low mineral weathering rates, the contribution of atmospherically derived base cations to the total soil exchangeable base cations is known to be substantial. The maritime origin of this deposition results in the base cations of soils and surface waters in such catchments being sodium (Na^+) dominated. In catchments underlain by parent materials where biogeochemical weathering processes contribute more base cations, the degree of Na^+ dominance is decreased. This effect has been exploited to allow a quantitative index of weathering in catchment surface waters, where the Na^+ dominance of the base cations reflects the weathering rates upstream of the sampling point[3].

Using data from a year long study of the River Dee catchment in Northeast Scotland, the index has been calibrated on a regional level using input-output budget derived weathering rates across catchments exhibiting a wide range of parent materials. A consideration of the sensitivity of the index to variations in atmospheric Na^+ deposition loads and concentrations is required to allow its application on a national basis. This is investigated using data from the Acid Waters Monitoring Network sites across Britain.

The potential use of this Na^+ dominance index for the direct quantification of catchment susceptibility to acidification at fine spatial resolution, using cost effective field measurements and analysis is highlighted.

1. J. Nilsson & P. Grennfelt. (Eds.), Critical Loads for Sulphur and Nitrogen, Report from a Workshop held at Skökloster, Sweden, 19-24 March, 1988, Nordic Council of Ministers, Copenhagen, 1988, pp. 8-79.

2. M.E. Hodson & S.J. Langan (1999) Considerations of uncertainty in setting critical loads of acidity of soils: the role of weathering rate determination. Environmental Pollution, 106, 73-81.

3. C.C. White, R.P. Smart & M.S. Cresser (1998). Atmospheric sea–salt deposition effects on soils and freshwaters in N.E. Scotland. Water Air and Soil Pollution, 105, 83–94.

Impacts of tropospheric ozone on natural plant communities.

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Year 1 Ph.D. findings.

A) The costs of evolving ozone tolerance..

The costs associated with the evolution of ozone resistance have been examined using NC-S and NC-R clover. Mixtures of NC-S (ultra-sensitive) and NC-R (ultra-resistant) were established and placed into two treatments, charcoal-Purafil^R filtered air (CFA) and CFA+ 75 ppb ozone. Harvests were made every 28 days and shifts in the ratio of NC-S:NC-R calculated. Findings indicated that NC-S outcompeted NC-R in CFA but NC-R had the advantage in the ozone treatment. This indicates that competitive viability in clean air is compromised when ozone tolerance has evolved.

B) The role of ascorbate in mediating ozone tolerance.

One of the major aims of this Ph.D. project is to assess the role played by ascorbate in mediating ozone tolerance. As a first step, we have investigated the correlation between leaf ascorbate content and ozone tolerance with age and shade treatment. Leaf ascorbate content showed no marked changes over the leaf-life span and appeared not to be correlated with the timing of O_3 injury or O_3-induced depression of leaf gas exchange. Shading on the other hand, decreased leaf ascorbate and increased sensitivity to ozone.

These data will be employed in understanding the effects of elevated O_3 concentration on grass/clover swards in OTC-based experiments in the field.

Epilobium hirsutum (Great Willowherb) Displays Inter-Population Variation in Response to Elevated Levels of Ozone.

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The poster presented will show that five wild-collected populations of *Epilobium hirsutum*, a common wetland species, display variation in the level of response to both acute and chronic ozone episodes.

COMPARISON OF THREE OZONE ANTIOXIDANTS ON *Trifolium alexandrinum*.

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EDU has been known for many years to act as an ozone antioxidant. On the other hand, carbendazim and benomyl, common fungicides, are known to be antioxidants but are not used in the field. *Trifolium alexandrinum* was used to study the protection from three different ozone antioxidants. *T.alexandrinum* was tested for ozone sensitivity in the preliminary experiment which showed severe leaf injury, growth loss and biomass reduction at concentration of 70 ppb 7 hd^{-1}. It was given three chemicals; ethylenediurea (EDU) 500 ppm, benomyl and carbendazim (600 ppm) and distilled water for control by both foliar spray and soil drench three days before exposing to ozone. After three weeks in ozone, EDU showed full protection by retaining the total biomass, chlorophyll content, growth and less leaf injury (< 2% and 0.03 by percentage and 5 scale scoring). Benomyl and carbendazim protected total biomass, chlorophyll content and growth. However, leaf injury still remained (51-54 % and 1.3-1.5 by percetage and 5 scale scoring). The fumigated ozone plants which were given distilled water showed obvious effects of total biomass, chlorophyll content (19% and 17%) and leaf injury (65% and 2.6 by percentage and 5 scale scoring). Ozone reduced stomatal conductance significantly but this was not affected by any of the antioxidant, demonstrating that protection was not by reduction of ozone flux.

HEALTH RISK ASSESSMENT OF LEAD POLLUTION IN EGYPTIAN ENVIRONMENT USING A MULTIMEDIA SIMULATION MODEL

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Egypt has developed many industrial activities, over the last four decades, to meet its own demands for economic growth, which has been accompanied by a vast expansion in urbaniziation mainly around greater Cairo and other big cities in Delta region. Urbaniziation, industrialization, high vehicular traffic density and poor control means have resulted in increased contamination of environment by lead pollution. Elevated levels of lead have been recorded in air, soil, crops and River Nile (the main source for drinking and irrigation water) during the last two decades[1]. Consequently, exposure to these contaminated media poses a potential risk to human health in Egypt and quantitative analysis of human health risk has become increasingly important.

By the use of a multimedia - multiple - pathway risk assessment model, using data on lead concentrations in the Egyptian environment, this study aims to examine the contribution of atmospheric deposition of lead to human lead intake levels through all potentially hazardous media. The contribution to adult blood lead levels of inhalation, food and dust ingestion, water ingestion and dermal contact pathways have been estimated.

This poster describes the designed simulation model which written in a spreadsheet format (Microsoft Excel). This model calculates both the steady state and dynamic (time dependant) numerical solutions for the soil and plant components. The exposure pathway equations[2] that describe the lead intake and give the contributions of different exposure media - pathways to mean blood lead at the steady state, are also presented.

1. WHO/UNEP (1992). *Urban Air Pollution in Megacities of the World.* Blackwell, Oxford
2. Carlisle, J.C. & Wade, M.J. (1992). Predicting blood lead concentrations from environmental concentrations. Regulatory Toxicology & Pharmacology, 16(3): 280-289.

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THE ECOLOGY AND PHYSIOLOGY OF THE POLLUTION-TOLERANT LICHEN, *LECANORA CONIZAEOIDES*.

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The SO_2 tolerant, crustose lichen *Lecanora conizaeoides* has been declining rapidly in the London area in recent years. There has been much documented evidence of its abundance and correlation to atmospheric levels of SO_2 over the past few decades[1,2,3]. It has also recently been discovered to be declining in rural areas, but remaining in other urban areas of Great Britain where there are still elevated sulphur dioxide levels[4] In the Liphook Forest Fumigation Project evidence was obtained suggesting that *Lecanora conizaeoides* benefits directly from levels of SO_2 that other lichen species cannot tolerate[5] This suggests an elevated physiological requirement for sulphur, rather than the ability to 'out-compete' other less resistant species. This would offer an explanation as to why *L. conizaeoides* has diminished in recent years, given that levels of atmospheric SO_2 have also decreased. Other factors like fungal attack and interspecific competition with the epiphytic alga *Desmococcus viridis* may also be contributing to its decline, particularly as the decline of *L. conizaeoides* is occurring at a time when levels of nitrogenous pollutants have been rising[6].

The poster will present results of experiments illustrating the decline of *Lecanora conizaeoides* and will describe new research being carried out, using pollutant/nutrient enrichment treatment, that hopes to determine whether or not a sulphur requirement is the cause for the observed decrease of this lichen species.

1. J.W. Bates, J.N.B. Bell & A.R. Farmer (1990) Epiphyte recolonisation of oaks along a gradient of Air pollution in SE England, 1979-1990. Environmental Pollution 6, 81-99.
2. O.L. Gilbert (1970a) Further studies on the effects if sulphur dioxide on lichens and bryophytes. New Phytologist 69, 605-627.
3. D. Hawksworth & F. Rose (1970) Qualitative scale for estimating the sulphur dioxide air pollution in England and Wales using epiphytic lichens. Nature 227, 145-148.
4. S. Boreham (1993) Changes in the lichen flora on birch *Betula pendula* in northern Epping Forest. The London Naturalist 72, 25-30.
5. J.W. Bates, P.J. McNee & A. McLeod (1996) Effects of sulphur dioxide and ozone on lichen colonization of conifers in the Liphook Forest Fumigation Project. New Phytologist 132, 653-660.
6. J. Poikolainen, H. Lippo, M. Hongisto, E. Kubin, K. Mikkola, M. Lindgren (1998) On the abundance of epiphytic green algae in relation to the nitrogen concentrations of biomonitors and nitrogen deposition in Finland. Environmental Polhution 102, 85-92.