

Biological Diversity and Ecosystem Function in Soil

Soil Biodiversity

NERC Thematic Programme



Springtails - National Vegetable Research Station
Horticulture Research International, Wellesbourne

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Modelling Conference at Edinburgh

As a climax to the modelling initiative small grant awarded to Professor Andy Meharg of Aberdeen University and Dr Mark Toal of CEH Monks Wood, nearly thirty people attended a special conference at CEH Edinburgh on 15th September.

Mark Toal summarised the functions of models as descriptive, explanatory and predictive, on an ascending scale of difficulty. A review of extant models for soil systems had revealed none that were instantly transferable to the Sourhope site. The ideal model would, for practical reasons, be executable on a PC and track mass-balanced fluxes of nutrients and carbon linked to the biological components, with abiotic and spatial effects included. He asked the question if biodiversity itself could be factored in. New theories might be needed to support components if the central model, eg quantifying the effects of the functional groups. Real 'dynamic' data were needed urgently from research teams to make sure they were compatible.

Bill Hunt, invited from Colorado to assist with the modelling initiative, explained how his prairie soil model could be simplified into the main trophic groups. The quality of the carbon was determined by the plant sources and by the activity of heterotrophic organisms. Spatial and temporal heterogeneity also needed to be added, to establish the physical scale of the interactions. In the discussion which followed, the need for sub-models for each soil horizon emerged. Mark Toal presented outputs (*Figure 1*) from simulations with and without earthworms, which revealed the need to look at different parameters, eg soil porosity changes as a result of worm activity.

Various research teams presented examples of their results, on ¹³Carbon residence in soil, mycorrhizas and bacterial response to the treatments. Andy Meharg summed up by indicating the mechanisms for including modelling in the final phase of the Programme, either separate models derived by research groups, consortia or a central co-ordinating project. It was agreed that it was desirable that further activities took place before the Warwick meeting at

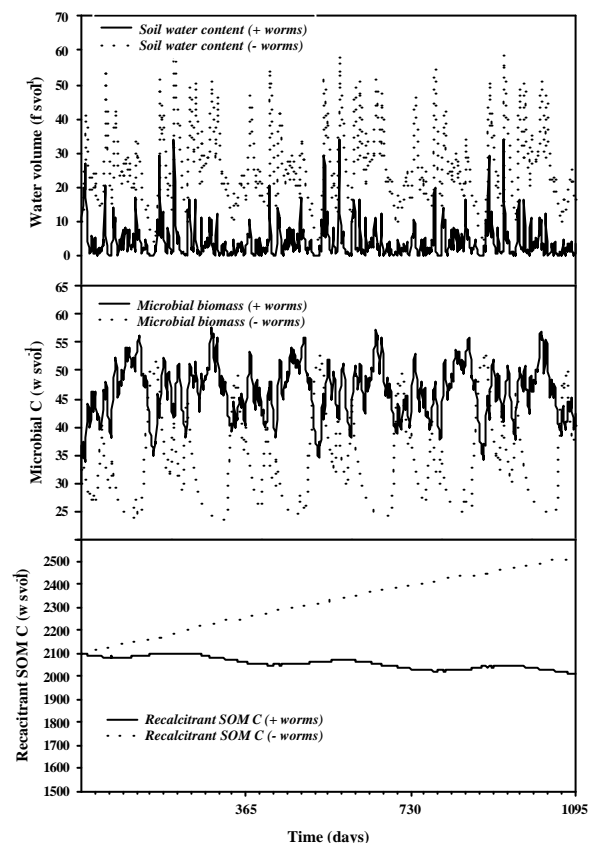


Figure 1: Modelmaker simulation of the interaction of soil water, organic matter quality, and earthworms

which final recommendation would emerge. Meantime the outcomes of the Edinburgh meeting would be circulated widely. A round table vox-pop revealed a spectrum of views on the objectives for a soil biodiversity and function model. Time will tell whether everyone's aspirations can be met, but the Warwick meeting will have to determine how top-down the approach will be.

Richard Scott

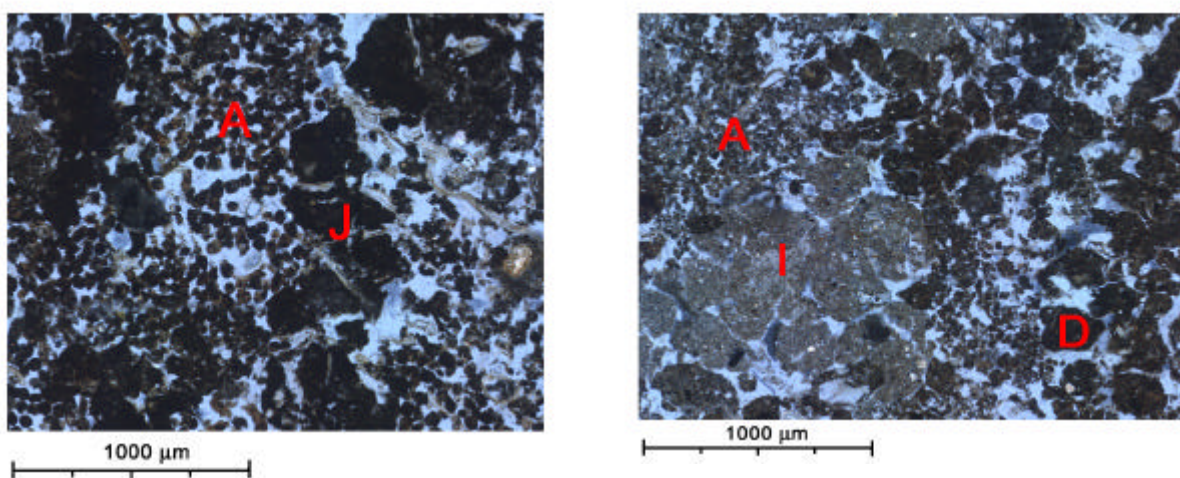
Website: <http://www.nmw.ac.uk/soilbio>

Impacts of soil biodiversity on micromorphology and structure in upland soils

Preliminary results from soil micromorphological analysis (June 1999 sampling) indicate the extent to which fauna affect the soils at Sourhope. Such impacts are expressed in terms of excremental pedofeatures. A typical soil section includes a litter (LF), organic (H) and organo-mineral (Ah) horizon. The organic horizons have gradually formed from the originally homogenized cultivated soil with evidence of an E horizon at the base of the H horizon. The bulk of our soils consists of excremental pedofeatures with four dominant types; enchytraeid (See Fig 1) (type A), earthworm either mammillated (type I) or vermiform (type J) beetle larva excrement (type D) and surface feeder excrements (type F) (not shown).

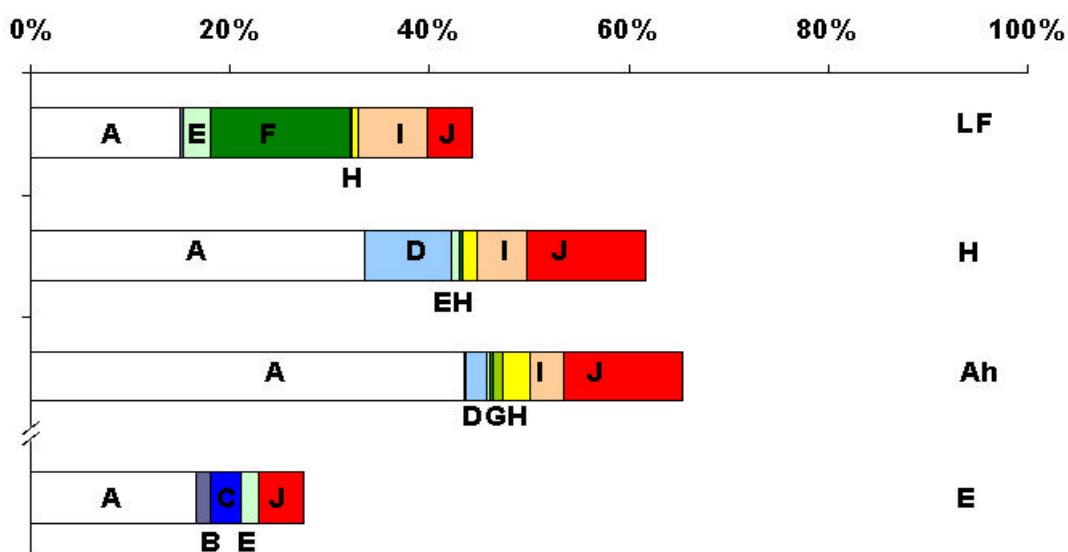
Type A abundance increases with depth from 15% in LF horizon to 40% in Ah horizon. Earthworm excrement is present in all horizons, despite a pH range from 4-5. Type F excrement is mainly present in the LF horizon (c. 15%), whereas the E horizon, where present, has far fewer excremental features (<25% in total).

Fig 1:
Thin sections showing excremental pedofeatures, type A (enchytraeids) and I, J (earthworms)



The distribution of excremental features is linked to variation in the thickness (see Fig 2) of the H horizon across the site. Soil with a shallower H has a greater diversity of excrement types and between 1.5 and 2 times more type A excrement. Earthworm features are mainly vermiform (Type J) in soil with thicker H horizons, whereas type I and J are equally represented elsewhere. These results highlight the importance of soil horizon in terms of faunal activity.

Figure 2: Distribution of excremental pedofeatures in horizons



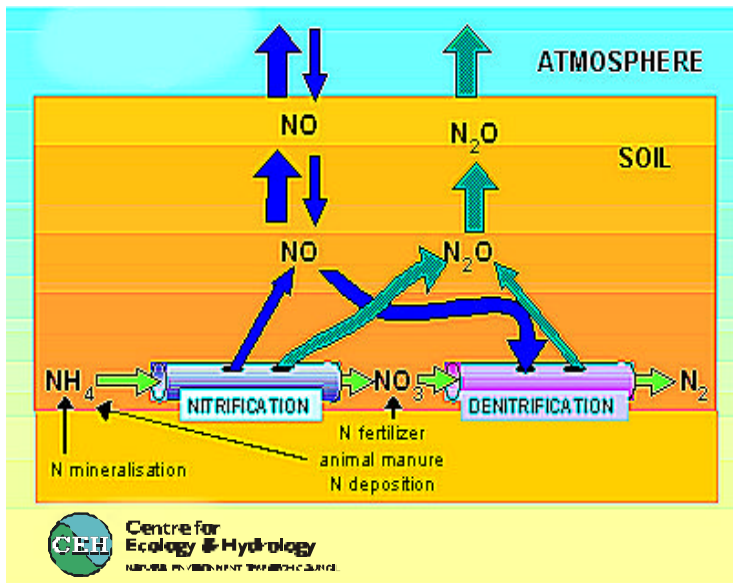
Nitrogen transformations at Sourhope

At CEH and SAC Edinburgh we (Ute Skiba, Bob Rees and Chris Davies) study the nitrogen transformations from the Sourhope main plots. This work is part of the project lead by Jim Prosser (2118) which will link the function with the diversity of nitrite oxidisers. We measured nitrification and denitrification rates, both in the field and in our controlled environment laboratory at CEH Edinburgh. Both processes produce the atmospheric pollutants NO (nitric oxide) and N₂O (nitrous oxide). NO is a precursor of tropospheric ozone and acid rain and N₂O is a greenhouse gas and contributes to ozone depletion in the stratosphere.

Our laboratory experiments support the general understanding that NO is mainly a product of nitrification, whereas N₂O emission fluxes are largest from wet denitrifying soils. In the field, largest emission rates were measured from the nitrogen & lime plots. This is not surprising. What is interesting is that all our field and

laboratory fluxes are very small compared with those we and colleagues have measured from agricultural grasslands that have received N fertilisers for many years. This implies that the N cycle at Sourhope is not leaky and the N added is being immobilised, rather than leached as NO₃ or emitted as NO and N₂O.

We know from our other ongoing trace gas work at CEH Edinburgh, that eventually the tight N cycle at Sourhope will become leaky. How long this will take will depend on the rate and magnitude of the N applied. We will carry out some simple experiment to investigate the time scale of this.



Ute Skiba, CEH Edinburgh

Soil Biodiversity in press - Ecology goes Underground

Publications are beginning to appear. Finlay et al were the first with a peer-reviewed paper, describing abundance of protozoa at the Sourhope site, on size/abundance relationships. Abundance is universally related to organism size, consistent with spaces in the fractal soil structure. (*Finlay, B J et al. 2000 Protist, 151, 69-80*).

Nick Ostle followed with a paper describing the first trials of the isotope pulsing system. The York-based carbon cycling team quickly found in their 1999 campaign that the ¹³CO₂ pulse resided for a relatively short time in the plants. (*Ostle, N et al. 2000. Rapid Commun Mass Spectrom, 14, 1345-1350*).

nature

3 August 2000 Vol 406/issue no. 6795 www.nature.com

NERC freelance writer Jon Copley talked to Programme members and the resultant article appeared in Nature in August this year (*Copley, J 2000. Nature, 406, 452-454*), describing the novel aspects of current research into soil biodiversity and carbon flux, under the title 'Ecology goes Underground'.

Richard Scott

Soil Bio Newsletters on the WEB

We still hold stocks of Programme Newsletters, for which there is a steady demand. Should you want to run off your own copies we have now installed Acrobat Reader copies on the Programme Website. Just click on...

www.nmw.ac.uk/soilbio/outputs

FINAL ROUND ANNOUNCEMENT

Steering Committee requested that the opportunity announcement is made in December, leading to a late January deadline for submission of bids. Bidders should start writing now especially if they wish to include collaboration from user organisations.

NB: Data Protection Act

Under the Data Protection Act, we are obliged by law to ask you if you still wish to receive your copies of the Soil Bio Newsletter, and that we have your permission to keep your name and address details on file. If you **want to continue** receiving copies of the Newsletter you **must** complete the tear-off slip enclosed with this Newsletter. If you do not return this slip we have no option but to remove your name and address details from all of our mailing lists.

Rebecca Pinder

Sourhope Joint Sampling Event 27th July 2000

An enthusiastic core of project representatives braved the Sourhope weather over two days to extract a sample from each of the four general sampling plots in the 25 main plots currently in use. In addition, the Sourhope team of Sarah Buckland, Claire Cornish and Nick Ray did plant species lists and measured soil pH for each sample point, 100 in total. A 20x20 cm sample block was then subdivided for distribution to groups requesting samples, generating 1000 subsamples. Results are still being processed. Some archived soil material is available from CEH Merlewood if any groups are interested. Preliminary data have been posted on the new Extranet pages.



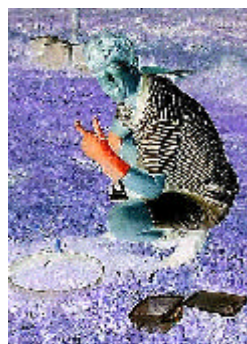
Botanist Claire Cornish lists the plant species



Extracted soil block showing horizons

Richard Scott

Ostle's Competition time!



Crikey ! Name this scientist and send us a caption. You could win a top of the range scarf made from genuine 'Sourhope Cashmere'. Entries via email to:-

soilbio@ceh.ac.uk

LOST PROPERTY



If anyone recognises either of these jolly motifs as theirs' please contact 'Biffa' Ostle and 'Knuckles' Ineson who presently have them perched in a safe place.

Nick Ostle, CEH Merlewood

Apologies

Finally, we apologise for referring to David Hopkins as David Hopinks in Sweethope feature in our last edition of the Soil Biodiversity Newsletter. Also Mark Pawlett is from UEL and not UCL as stated in the same article on worm transplants at Sweethope.

Dates for the Diary

2nd AWARD HOLDERS MEETING
8th and 9th November 2000
Scarman House, Warwick University site

January 2001 Submission of bids for final funding round.

July 2001 Announcement of successful bids.

March 2003 British Ecological Society Symposium on Soil Biodiversity at University of Lancaster



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