Paul Henning Krogh (phk@dmu.dk)
Soil Fauna and Ecotoxicology
Research Group
National Environmental Research Institute
Vejlsøvej 25, 8600 Silkeborg, Denmark

Juliane Filser (filser@gsf.de)
GSF - Forschungszentrum für Umwelt
und Gesundheit
Institute of Soil Ecology
85764 Neuherberg, Germany

The impact of food web complexity and collembolan leagues on nitrogen turnover during barley growth

Fig.1. Mesocosm with barley and mesofauna species added.

INTRODUCTION

We designed a mesocosm experiment with elements of the mesofauna (Fig. 1) to quantify their contribution to nitrogen mineralisation by barley.

The question was: do groups of collembolans differing in their feeding ecology (leagues) exert different effects on N-turnover?

METHODS

Combinations of the species in single treatments are shown in table 1. Clover was grown in the greenhouse and was labelled with ^{15}N-nitrate fertiliser. 2.5 g dried ^{15}N labelled clover (roots and shoots) was mixed into the top 5 cm of the soil column (2,500 g fresh weight; height 24 cm). The isotopic composition of the N was measured by MS. Soil was extracted with KCl and $NH_4^+ + NO_3^-$ was extracted according to Brooks *et al.* 1989, for determination of isotopic content. Roots contained 7.4 % and shoots contained 6.8 % excess ^{15}N when mixed into the soil. The soil was a sandy loam with: Clay (<2µ) 7.5%; silt (2-20µ) 9.5%; fine sand (20-200µ) 45.5%; coarse sand (>200µ) 34.5%; organic carbon 1.6%. The soil originated from arable land (organic farming) and was defaunated by deep-freezing before use. In each column, one spring barley plant was sown and grown until ripeness.

Means of excess % ^{15}N of 4 mesocosms replicates of each treatment with fauna assemblages were compared monthly for 4 months by two-way ANOVA with SAS PROC GLM. Means comparison procedure was Least Significant Difference and statistical requirements were checked using the guided data analysis of SAS/LAB.

	Numbers added		Treatment combinations						
			C	FF	EUE	HEM	EH	EHE	ME
Folsomia fimetaria	35	(5.0)		*	*		*	*	*
Mesaphorura macrochaeta	35	(5.0)			*		*	*	*
Protaphorura armata	7	(1.0)			*		*	*	*
Isotoma anglicana	7	(1.0)				*	*	*	*
Isotoma notabilis	14	(2.0)				*	*	*	*
Hypogastrura assimilis	10	(1.4)				*	*	*	*
Enchytraeus crypticus	90	(13.0)						*	*
Hypoaspis aculeifer	25	(3.6)							*

Table 1. The faunal additions to the mesocosms showing the initial additions in number per microcosm (and in 1,000 m^{-2}) and the different combinations of mesofauna.

RESULTS AND DISCUSSION

Faunal population development

The three euedaphic collembolan populations grew through the experimental period (Fig. 2). *F. fimetaria* increased by 200x10^3 indv. m^{-2} month^{-1} or about by 1,500 indv. mesocosm^{-1} month^{-1} for the first 2-3 months. After the 3rd month the *F. fimetaria* population had crashed. *M. macrochaeta* and *P. armata* increased steadily during the 4 months, exept for *P. armata* when the predator was included.

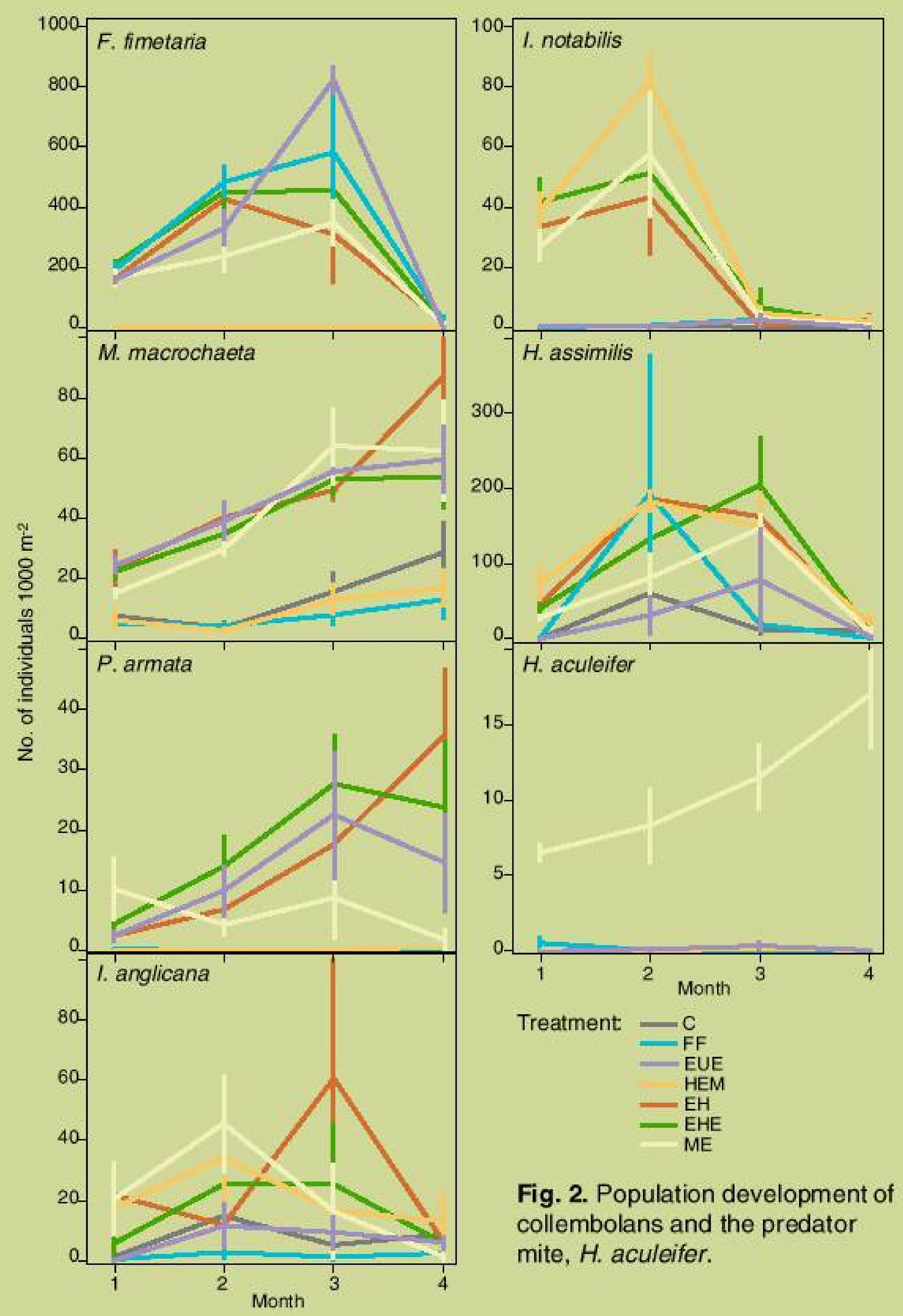

Fig. 2. Population development of collembolans and the predator mite, *H. aculeifer*.

Influence on ^{15}N

We found small effects of the fauna on excess ^{15}N content in the soil (Fig. 3a). The euedaphic collembolans decreased the nutrient pool of clover derived N (^{15}N) in the soil extract. The hemiedaphon seemed to have no effect on N, but the enchytraeid and the gamasid mite increased the soil extract ^{15}N by 15%.

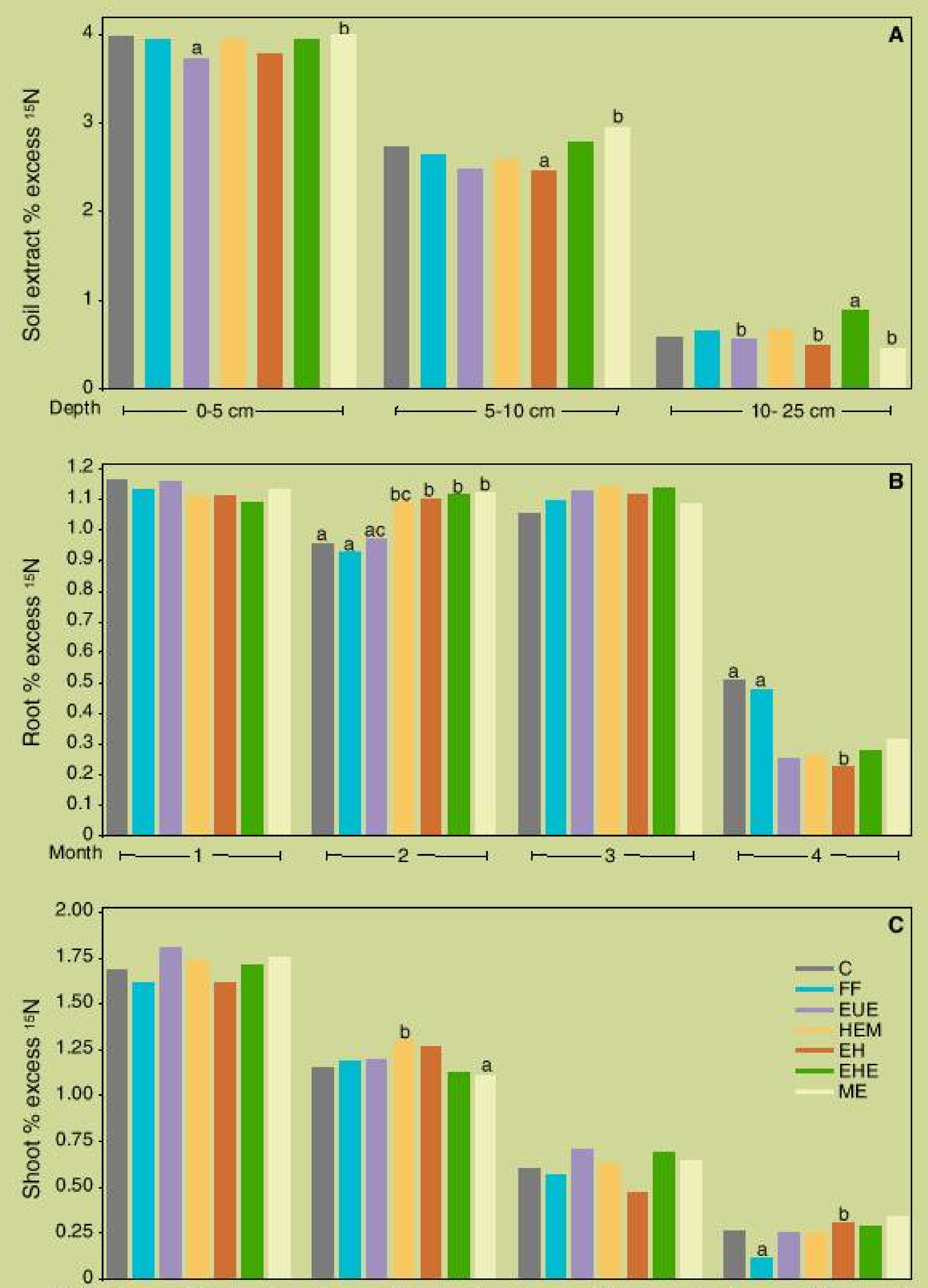

Fig. 3. Excess ^{15}N in soil after 1 month (A), and monthly for roots (B) and shoots (C). Horizontal axis: fauna treatments with legend as Table 1.

Roots contained less ^{15}N from the labelled clover after 2 months, when only euedaphic or no Collembola were added (Fig. 3b). Thus, during plant growth ^{15}N uptake was enhanced by 15% due to the presence of hemiedaphon and the more complex mesofauna assemblages. This is in agreement with observations by Setälä *et al.* 1996, and Nagel *et al.* 1995, when using similar methods.

After 4 months when barley growth had ceased, more ^{15}N was present in the roots without fauna then with fauna (Fig. 3b). *F. fimetaria* was no longer present at the fourth month and therefore this treatment was similar to the control. At this stage, which corresponds to harvest, as the barley was now ripe, all fauna additions apparently decreased the ^{15}N-content of the roots.

The hemiedaphon have increased the ^{15}N isotopic content of the shoot (Fig. 3c), but the two most complex assemblages counteracted this effect. Again complexity indeed seems to affect the nutrient uptake from the decomposing clover.

CONCLUSIONS

- All the added species increased their population abundances during the beginning of the experiment. The euedaphic collembolans were most successful
- *I. anglicana* and *H. assimilis* needs to be prevented from migrating between mesocosm containers
- The hemiedaphic league increased N derived from decomposing clover in both roots and shoots
- The euedaphic league decreased soil mineral N derived from decomposing clover
- Increasing the complexity increased the ^{15}N in soil and roots, but depleted the content in shoots

To get an even clearer picture of the potential of soil mesofauna to mediate nutrient uptake we propose to

- Test effects of soil mesofauna in soils with low content of plant-available nutrients.
- Use N-poor litter
- Involve interactions with macrofauna