

**Welcome to**

**Workshop**

**Above ground and below ground:**

**Decomposer and primary producer interactions.“**

**22. - 23.03.05 in Witzenhausen**

Joint meeting of working groups „Soil Ecology“ (GfÖ), “Ecosystem research” (GfÖ), “Soil Biology” (Comm. III, DBG) and „Soil Ecology“ (DBG)

## **Abstracts**

Oral presentations and posters



## Opening Presentation

### Diversity and activity of autotrophic soil bacteria: combination of classical and molecular techniques.

#### Diversity and activity of bacterial ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO) *cbbL*-genes in agricultural soils

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The diversity of ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO)-genes in terrestrial habitats is not much studied yet. Autotrophic bacteria harboring the calvin cycle enzyme RubisCO may play a significant but not yet understood role in the conversion of carbon dioxide into microbial biomass and organic matter in soils. To gain an insight into the genetic diversity of CO<sub>2</sub>-fixing bacteria in soil habitats we developed PCR-based assays targeting the large subunit gene *cbbL* of the form I RubisCO. Different primer sets were constructed with strong specificity for “red-like” and “green-like” *cbbL*-sequences of selected terrestrial autotrophic bacteria. RFLP and phylogenetic analysis of the amplified *cbbL*-sequences from agricultural soils with different management indicated a high diversity of ‘red-like’ and a low diversity of ‘green-like’ *cbbL*-sequences. Additionally, soil bacteria were isolated in order to build a larger dataset of ‘red-like’ *cbbL*-sequences. Bacterial isolates from the genera *Arthrobacter*, *Bacillus* and *Streptomyces* among others with so far undetected *cbbL*-sequences were obtained. Using RT-PCR analysis, c-DNA of “red-like” *cbbL* messenger RNA could be obtained from these soils after events stimulating the general microbial activity of soils such as after freezing thawing events or and H<sub>2</sub>-treatment like in the vicinity of N<sub>2</sub>-fixing nodules of legumes. A net uptake of CO<sub>2</sub> could be observed under these conditions. Using real-time PCR with *cbbL*-specific primers and probes up to 10<sup>7</sup> copies of *cbbL* were detected in different soils. It was



evident, that agricultural practice had a pronounced influence on the genetic diversity of “red-like” *cbbL*-genes and transcripts in soils.



## Microbial characterization of *Pythium ultimum* suppressive yardwaste compost

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Plant protection by application of different types of compost is a well-known phenomenon and has been made use of as well in agriculture as in horticulture for quite a time nowadays. Recent investigations illustrated that especially municipal solid waste (organic fraction) or yardwaste composting can result in distinct effectiveness of these materials against microbe mediated plant diseases. Besides the nature of organic substance these effects have been assigned to microbial community structure and function lately. As not much is known about which organisms/functions might cause these suppressiveness this study inter alia examined the microbial background of *Pythium ultimum* oppressing yardwaste compost. In windrows of two different sizes (3 x 4 and 3 x 30 m<sup>3</sup>) yardwaste had been composted and composite samples were taken throughout the rotting process and subjected to biocontrol tests and analyses of microbial community characteristics. Samples tested proved to be exceedingly suppressive against *P. ultimum*. Phospholipid fatty acid (PLFA) and random amplified polymorphic DNA (RAPD) fingerprint analyses showed differences in their phenotypic and genotypic profiles, respectively, according to the different windrow sizes and sampling dates indicating changes in community structure and function. Besides RNA of suppressive substrate samples (compost plus commercially available turf substrate) was extracted, 16S/18S rRNA amplified and clone libraries established showing microbial communities in the suppressive substrate being a mixture (e.g.  $\alpha$ -,  $\beta$ -Proteobacteria, Verrumicrobiae; pezizale, 3stereale fungi) of and being altered compared to the original compost sample (e.g.  $\beta$ -,  $\gamma$ -Proteobacteria, Chloroflexi; eurotiale, stereale fungi) and non-suppressive substrate (e.g.  $\delta$ -Proteobacteria, Verrumicrobiae; microascale, pezizale fungi).



## Impact of cycloheximide addition on adenylates in soil.

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Cycloheximide inhibits specifically the ribosomal protein synthesis of eukaryotic cells, i.e. the metabolism of soil fungi. We measured cycloheximide effects on adenylates in 20 different soils (0-10 cm depth) from arable, grass and forest land with a large variety of soil properties. The aims were (1) to assess the interactions between cycloheximide effects and soil properties and (2) to prove the relationship between cycloheximide effects on ATP and the ergosterol-to-microbial biomass C ratio, which is an indicator for the fungal proportion of the total microbial biomass. The adenylates ATP, ADP and AMP were measured 6 h after adding either 10 mg cycloheximide g<sup>-1</sup> soil in combination with 24 mg talcum g<sup>-1</sup> soil or 24 mg talcum g<sup>-1</sup> soil solely. The medians of the relative increases in AMP and ADP were 45% and 25% and the medians of the relative decreases in ATP and adenylates were -36% and -12%. These changes in adenylate composition lead to a cycloheximide-induced relative decrease in AEC level of 15%. The relative decrease in ATP content after cycloheximide addition was significantly correlated with the ATP-to-microbial biomass C ratio, but not with the ergosterol-to-microbial biomass C ratio. The absolute increase in ADP and the absolute decrease in ATP were affected by the clay content according to principal component analysis. The reduction of the ATP-to-microbial biomass C ratio indicates that this ratio had the potential of being an important ecotoxicological indicator of direct toxic effects of organic pollutants on soil microorganisms. 6



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## Abstract

The responses of three decomposer groups, (earthworms, springtails and microorganisms, to manipulations in plant species diversity (1, 2, 4, 8), plant functional group diversity (1, 2, 3, 4) and functional group identity (grasses, legumes, small herbs, tall herbs) were studied in a microcosm experiment. Separate and combined treatments with earthworms and springtails were set up. Two earthworm species representing major functional groups of earthworms in grasslands were investigated, the endogeic species *Aporrectodea caliginosa* and the anecic species *Lumbricus terrestris*. In springtails three species were investigated, the hemiedaphic species *Heteromurus nitidus*, *Folsomia candida* and the euedaphic species *Protaphorura fimata*. Plant species and functional group diversity beneficially affected *A. caliginosa* (increase in body weight and incorporation of <sup>15</sup>N from labelled litter) and *P. fimata* (density), presumably by changing the quality of belowground resources. For *H. nitidus* and *F. candida* the identity of plant functional groups was more important than plant species diversity per se. Also, the response of the latter springtail species depended on earthworms. Microbial respiration was reduced by earthworms in more diverse plant communities, which correlated with root biomass. The results suggest that belowground resource inputs from plant roots strongly modify decomposer performance and emphasise that the quality of the resources that enter the belowground subsystem are more important than their quantity. The responses of decomposers generally were not correlated with below- or aboveground productivity. In addition, the results document that effects of plant community composition on the performance of decomposer species depend on the presence of other decomposers.



**Interactions between microbi-detritivorous soil fauna, ectomycorrhiza  
and red oak seedlings.**

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In the Lusatian mining district a considerable portion of sandy mine spoils have been afforested with red oak (*Quercus rubra* L.) since 1960. However, the structure and function of the microbi-detritivorous soil fauna at these sites have been little explored. In addition, few studies have investigated the interactions between the soil fauna, the ectomycorrhizal performance and plant growth [1]. These interactions might be of considerable importance for ecosystem productivity and, hence, for the restoration success of these plantations in the long run [2].

Therefore, we analyse the structure of several representatives of the soil fauna and investigate their impact on decomposition at red oak plantations on mine spoils and at unmined reference sites. Moreover, we establish laboratory experiments on the interactions of collembola and enchytraeidae and several ectomycorrhizal-fungi and their impact on production on red oak. Here the project design and preliminary results are presented.

[1] SETÄLÄ, H. 2000 Reciprocal interactions between Scots pine and soil food web structure in the presence and absence of ectomycorrhiza. *Oecologia* 125: 109-118

[2] WARDLE, D.A. 2002 Communities and ecosystems - linking the aboveground and belowground components. *Monogr. Pop. Biol.* 34: 392p



## Invasion of European earthworms into a North American aspen forest: Effects on soil chemistry, microflora, fauna, and vegetation

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After the last glaciation earthworms, which had taken refuge in the southern parts of the continent, did not recolonize North America. They have invaded the region which today is Canada since 1500 AD when European settlers colonized the continent and were distributed by inadvertent or intentional human activities.

Earthworms are known to alter soil structure, nutrient cycling and the complex interactions between soil fauna and microflora and therefore likely affect aboveground plant communities. However, the impact of these ecosystem engineers on soil microbial and soil mesofauna communities has only been studied recently.

In this study the effect of invasion of earthworm species (*Dendrobaena octaedra*, *Lumbricus terrestris* and *Octolasion tyrtaeum*) into a western Canadian aspen forest on soil fauna, microbial and plant community and soil chemistry were investigated.

Along three transects (200 m) starting at the edge of the forest, densities of earthworm species were determined. Plants were harvested, and separated into three plant functional groups (herbs, grasses, legumes) and the dry weight was measured. In addition, soil cores were taken to investigate the effects of burrows of *L. terrestris* on soil fauna, microflora and soil chemistry.

In general, the presence of *L. terrestris* and *O. tyrtaeum* reduced forest floor material dramatically and mixed soil layers completely. The presence of *L. terrestris* burrows had no effect on the distribution of plant functional groups but on the density of legumes. Further analyses are in progress.



## Interactions between two collembolan species and their density-dependent effect on the performance of a grassland plant community

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Although there is much evidence that soil invertebrates as an important part of the decomposer community have a strong impact on plant growth, little is known about the specific contribution of Collembola so far.

The major effects of Collembola are supposed to be indirect via grazing on the microbial community and thus improving plant performance by promoting nutrient remineralisation, nutrient uptake or reducing the number of plant pathogens. We suggest this grazing effect to be highly density-dependent, and expect the plants to benefit most from intermediate numbers of Collembola. At high densities even a negative influence might occur due to over-exploitation or feeding on living plant tissues. Besides that we are also interested in the interactions between two collembolan species and hypothesize that two species have a more favourable influence than one species due to synergy effects.

To test these hypotheses we set up a laboratory experiment with four different Collembola densities and a grassland plant community consisting of four plants from different functional groups (*Bellis perennis*, *Taraxacum officinale*, *Trifolium repens* and *Lolium perenne*). The experiment is conducted with two collembolan species (*Folsomia candida* and *Protaphorura fimata*) whose exclusive and combined effects will be examined in microcosms that are kept in a climatic chamber with controlled air humidity, temperature and light-dark-circle.

Increase in plant growth is measured once a week and after 40 days plant biomass, shoot-root-ratio and nutrient content of the plants as well as Collembola numbers are ascertained to estimate population development.

First results of Collembola effects on germination and seedling survival will be presented.



## Quadtrophic interaction in a soil food web – chemical signalling and plant growth

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Above ground tritrophic interactions by herbivore induced plant volatiles are known since many years and are well studied. However, the role of volatile organic compounds in soil food webs has only recently deserved some attention. There is no reason to assume that a complex signalling system has not evolved below ground. The rhizosphere is an ideal study system, because many organisms dwell in a limited space and establish mutual or competitive interactions. Plant roots, mycorrhizal and saprotrophic fungi, fungivorous and predatory microarthropods represent four trophic levels in the rhizosphere.

We have developed a laboratory system to study chemical communication between different components within the soil food web. We found that mycorrhizal fungi without tree roots were most attractive for collembola. They preferred neither naked tree roots nor mycorrhizal roots. Accordingly, grazed fungus was most attractive for predatory mites. Grazed fungus in symbiosis with tree roots or tree roots with collembola did not emit volatiles that were attractive for predators. The mycorrhizal symbiosis seems to hide itself chemically. In another experiment we could show that a pine seedling could benefit slightly from grazing collembola in the rhizosphere. The biomass and nitrogen content of the seedling were highest at an intermediate grazing pressure for the mycorrhiza. We discuss the evolutionary constraints of the fungus for not emitting signalling compounds.



## **Interaction of grassland diversity and faunal decomposer diversity on trophic interactions.**

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Decomposer animals influence soil structure and nutrient mineralisation, and therefore likely affect plant performance and plant competition. To study the effect of decomposer animals, Lumbricidae and Collembola, on plant performance, a model grassland community was constructed in a greenhouse. Microcosms contained grassland soil, including  $^{15}\text{N}$  labeled litter to trace N fluxes. Common plant species of Central European Arrhenatherion grasslands were transplanted into microcosms with plant species numbers varying from 1 to 8 and plant functional groups varying from 1 to 4. Earthworms and collembolans were added to microcosms in a two factorial design.

Shoot biomass increased with plant species and plant functional group diversity. Presence of legumes increased total plant biomass and shoot biomass whereas presence of grasses and tall herbs decreased plant biomass. Presence of decomposers strongly increased total plant biomass and shoot biomass. Root biomass decreased in presence of collembolans and even stronger in presence of earthworms. However, it increased when both animal groups were present. Presence of earthworms increased mean individual weight of grasses per pot, whereas presence of collembolans increased mean individual weight of tall herbs. Also, presence of decomposers increased total N content and  $^{15}\text{N}$  content of plants, being at a maximum in the combined treatment with earthworms and collembolans.

It is concluded that decomposers increase plant productivity by stimulating litter decomposition and nutrient mineralisation resulting in increased plant nutrient uptake. The non-uniform effects of collembolans and earthworms suggest that diversity of soil decomposer animals is an important structuring force for aboveground plant community composition.



## **Influence of Collembola on seed survival – a project outline**

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A particularly critical phase in the life of a plant is the seed stage. Especially in seed banks the seeds are exposed to a number of mortality factors such as attack by fungi. Because of the interactions between seeds and the surrounding soil containing a multitude of soil organisms it may be of interest to find out whether fungus-feeding soil animals such as Collembola have an influence on the losses of seeds caused by fungal attack. Although soil fungi are likely to be a major cause of mortality for seeds, few studies have examined this aspect.

In an experimental approach under controlled conditions, we investigate to which extent Collembola affect the germination potential of seeds. We hypothesise that seed germination potential in presence of Collembola will be higher than in their absence. Second, germination rates should be higher in fungicide than in Collembola treatments. Third, we assume that fungicide + Collembola treatment will result in maximum germination rates.

To test these hypotheses, 4 different treatments (control, + Collembola, + seeds treated with fungicide, + Collembola and + seeds treated with fungicide) are set up with seeds of selected grassland species. After a certain storage period of the seeds in the soil their viability will be checked. Analysis of variance (ANOVA) will be used to test whether there are differences in seed survival among the different treatments. As a pilot experiment, we are presently conducting studies on fungal attack on seeds of different plant species. The results will be included in this presentation.



### **Trophic interactions in a North-German agro-ecosystem.**

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In the framework of the Braunschweig Carbon Project the trophic chain of a typical North-German agro-ecosystem cropped in a three-year crop rotation (winter barley, sugar beet, winter wheat) was analysed. The study site is located within the experimental area of the Federal Agricultural Research Centre, Braunschweig, and was managed according to local farming practices. The soil is an eutric luvisol of loamy sand texture (pH 6.5,  $C_{org}$  1.2 %).  $CO_2$  concentrations in the atmosphere of the study sites were elevated to 550 ppm during daylight hours ( $T > 5^\circ C$ , wind speed  $< 6.5 m s^{-1}$ ), and the  $CO_2$  applied to the site was depleted of  $^{13}C$ .

Investigations in the experiment covered above ground biomass production, root growth and canopy  $CO_2$ -exchange throughout the whole three year period of the crop rotation. Carbon turnover in soil was investigated by means of soil respiration measurements as well as determination of soil microbial biomass, microbial respiration coefficient, soil carbon  $^{13}C$  composition and enchytraeid abundances. Soil  $CO_2$  efflux determined by soil respiration measurements was closely related to above ground biomass production. Management practices and climatic conditions were driving factors with regard to the dynamics of the system. The presentation will give an overview over trophic interactions in the agro-ecosystem studied with particular emphasis on relationships between the variables on different temporal levels.



**The community structure of soil mites in four different management systems with different types of vegetation composition in agroecosystems of the subhumid Pampa (Argentina).**

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Above and belowground communities influence each other through a variety of interactions. Aboveground manipulations, such as a reduction in plant biomass and diversity, are expected to have important effects on soil mesofaunal diversity, manifested largely through alteration of microclimatic conditions and resource availability. The aim of the study was to evaluate if the species richness and diversity of the different suborders of edaphic mites are equally affected by changes in the vegetation composition in four different management systems in agroecosystems of the subhumid Pampa. We evaluated these parameters in a naturally developed plant community of native grassland and three managed sites along a gradient of disturbance and land-use intensification: a cattle-raising, a mixed and an agricultural management system. Diversity was measured by Alpha, Shannon, Simpson, and Evenness indices. Species richness and diversity of the four suborders of mites were differently affected by the four different management systems. The ratio Oribatid/Astigmatid species richness in the natural vegetation plot and in the lower input systems was almost three times higher than in the high input agricultural plot. But in general it was not possible to clearly identify a direct relationship between community structure and the associated vegetation diversity. Therefore we conclude that other factors are involved. The factors (e.g. fertilizer, soil compaction, pesticides) to explain the differences in community composition between different sites are discussed.



## Increase of bacterial activity through effluent irrigation practise in Israel

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Treated wastewater effluents are an important water source for irrigation in arid and semiarid regions. Especially in Israel recycled wastewater is used for irrigation of agricultural land since more than ten years. Wastewater contains organic matter together with various more or less environmentally hazardous substances, e.g. heavy metals and PAHs.

The activity of microorganism in agricultural soils contributes to the maintenance of fertility for food production. Therefore changes in microbial activity due to treated wastewater as alternative irrigation water would have an important effect for agriculture.

An experiment was performed to evaluate the effects on sandy soils from a grapefruit orchard and typical loamy soil from the Israel Valley. Over a period of 4 month the soil was crosswise irrigated with freshwater and effluent water in the lab. Respiration, microbial biomass and direct bacterial counts were determined. Also the FISH method was used for activity measurements in the soil samples.

Differences could be ascertained between freshwater and effluent irrigation in both soil types. Mainly it is indicated that microbial activity is enhanced by effluent water which is shown by an increase in respiration and bacterial counts.



## Structural and functional analyses of microbial communities in an integrated managed arable soil

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Despite great progress in the development of arable farming practices, there is a steady decrease of fertile agricultural land along with a decrease of crop yield on the global scale. However, it is necessary to employ high productive cropping systems to provide food for a steadily growing human population. Apart from crop/food production sustainable farming practices must encompass conservation of finite resources and protection of the natural environment as well, so that the needs of people living today can be met without compromising the ability of future generations to meet their own needs. One principle within integrated farming systems which are more widespread in industrialized countries than organic farming practices is the enhancement and maintenance of soil organic matter. From the farming's perspective this is achieved by means such as site-adapted crop rotations, minimum tillage techniques, green cover crops and organic fertilisation. From the soil's perspective, this is achieved by versatile soil microbial communities involved in the various transformation processes of soil organic matter to serve as a structural stabilizer, as an energy and nutrient store and as a chemical buffer for introduced xenobiotics. For a holistic view and a sustainable management of arable cropping systems it is necessary to understand the underlying processes in soil organic matter transformation and the role of the respective microbial communities.

Thanks to the advent of molecular methods during the last decade, the soil microflora (= microbial biomass) is no longer considered as a black box. It has been shown that a soil is dwelled by complex microbial communities constituted by members of all three domains of life: bacteria, eukarya, archaea. Although the knowledge on the abundance and diversity of soil microorganisms has increased dramatically, there is little knowledge about the interplay between organic matter, its turnover and the regulation of microbial *in situ* function in cropping systems under integrated management and their dynamic in time and horizontal/vertical space)

In this study we show how the structure and enzymatic activity of microbial communities is influenced by integrated crop production and how this is driven by the quantity and quality of dissolved organic matter over a years period in different soil depth etc.



**Plant growth and microbial activity in a tropical soil amended with faecal pellets from millipedes and woodlice.**

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**Abstract**

The effect of soil fauna-mediated leaf litter (faecal pellets) versus mechanically fragmented (ground) leaf litter on biomass production of rice (*Oryza sativa*, var. Primavera) was assessed in pot tests. Rice plants were either grown in soil samples amended with faecal pellets of diplopods and isopods fed on leaf litter of a legume cover crop (*Pueraria phaseoloides* (Roxb.) Benth) and a peach palm (*Bactris gasipaes*) or in soil amended with finely ground leaf litter. The addition of faecal pellets caused a significant and dose related increase in plant biomass compared to pure soil. Ground leaf litter induced a much smaller positive effect on plant biomass development with *Pueraria* litter > *Bactris* litter > mixed primary forest litter. In contrast, microbial biomass development during the four weeks plant test was higher in the soil amended with ground litter as compared to soil amended with faecal pellets. The results show a clear positive effect of the soil fauna on soil fertility and indicate a different availability of nutrients from the organic substrates for plants and the soil microflora.



**Relevance of microbial colonisation for root decomposition after removing of  
above ground biomass. University of Kassel, Witzenhausen**

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Amino sugars make a significant contribution to soil organic N and are mainly of microbial origin. The most important amino sugars in soil are glucosamine, galactosamine, muramic acid and mannosamine. A method was developed for the simultaneous determination of these 4 amino sugars by high-performance reverse-phase liquid chromatography in standard solutions, soil and root hydrolysates. Pre-column derivatisation with o-phthalaldehyde (OPA) was used in an automated sample injector with thermostatic regulation of the reagent at 4 °C. The separation of the 4 amino sugars was fully satisfactory and was not disturbed by other fluorescent components in the soil and root hydrolysates.



**The response of decomposers (earthworms, springtails and microorganisms)  
to variations in species and functional group diversity of plants**

“Honeydew application and positive and negative C and N priming effects within the organic layer and the mineral soil of a Rendzina”

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The effects of low amounts of honeydew (obtained from *Phyllaphis fagi*) applied to the organic layer and the mineral soil of a Rendzina soil type developed under beech were studied over three months with regard to potential C and N priming effects. The study was carried out in microcosms encompassing three different soil materials (1. organic layer, 2. calcareous Ah horizon and 3. organic layer plus Ah horizon) and two different treatments (25 mg honeydew TOC per week and a control treatment).

Preliminary results supply evidence for a different response to low inputs of honeydew TOC depending on the soil material and the C and N fraction studied. Within the organic layer the input/output budgets showed that the low input of readily available organic C caused a positive C and N priming effect enhancing CO<sub>2</sub> production as well as DOC, DIC (dissolved organic and inorganic C) and total N and NO<sub>3</sub>-N output fluxes with leachate compared to the control. However, in the Ah horizon set-ups, the honeydew input caused increased C output fluxes as DIC (plus 33%) and DOC (plus 13%) but decreased CO<sub>2</sub> fluxes (minus 11%) compared to the control, resulting in a net negative C priming effect. A negative priming effect was also observed for N, where the honeydew input led to significantly lower NO<sub>3</sub>-N fluxes (- 43%), pointing to a microbial N immobilisation. In the combined set-ups (organic layer plus Ah horizon) the honeydew application induced a negative C priming effect and a nearly balanced N budget.



## Selective enrichment of Uranium in soils and sediments depends on primary production and soil development

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### Abstract

Uran ist fern von den Quellen (z.B. „Tailings“ des Erzbergbaus) bis weit in die Einzugsgebiete nachweisbar. Im Gegensatz zu den meisten Schwermetallen ist U unter aeroben Bedingungen nicht nur in sauren, sondern auch in neutralen, alkalischen und relativ harten Wässern sehr löslich. Es ist schon lange bekannt, dass U an organischer Substanz und insbesondere mit Huminstoffen komplexiert. Zwangsläufig bilden unterirdische Kompartimente, wie der Wurzelraum, Böden und Sedimente lokale Senken. Wir haben solche Senken auf Halden mit unterschiedlicher Vegetationsentwicklung und im Abstrom in Feuchtgebieten kompartimentspezifisch analysiert. Mittels Isotopenanalysen (Zerfallsreihen der Uran- und Thoriumisotope sowie  $^{137}\text{Cs}$ ) und mit organischer Substanz bzw. Kohlenstoff als Bezugsgröße kann die Verlagerung von Uran und weiterer Elemente verfolgt werden.

Es zeigte sich, dass auf offenen Halden und in frühen Sukzessionsstadien, entsprechend der prognostizierten chemischen Spezifizierung von U (PhreeQC Modellierung), das Element selektiv angereichert wird. Das Isotopengleichgewicht von  $^{238}\text{U}/^{226}\text{Ra}$ , wird durch Verwitterung und Auswaschung von U auf Werte  $< 0,5$  vermindert. Im Wurzelraum und insbesondere in der Wurzelrinde wird U aber angereichert. Im Zuge des Kohlenstoffumsatzes im System Baum-Boden wird U im Verlaufe der Bodenentwicklung auf Halden im Of- und Oh-Horizont angereichert. In diesen Bodenhorizonten nähert sich das Isotopenverhältnis von  $^{238}\text{U}/^{226}\text{Ra}$  wieder dem natürlichen Gleichgewichtsverhältnis von 1 an. In den Sedimenten von Feuchtgebieten kann U im Verlaufe von wenigen Jahrzehnten selektiv aufkonzentriert werden ( $0,4\text{-}1,6 \text{ g}\cdot\text{kg}^{-1}$  dry matter, Dudel et al. 2004). Dies entspricht der U-Konzentration in „high grade ores“. Das  $^{238}\text{U}/^{226}\text{Ra}$ -Verhältnis weicht hier aber vom radioaktiven Gleichgewicht ab ( $>4!$ ). Aus den Isotopenverhältnissen der Zerfallsreihen kann abgeleitet werden, dass das Uran aus der gelösten Phase in die allochthone oder authochthone organische Substanz aufgenommen wurde. Es wird abschließend ein Prozessmodell des Uran-Transfers und primärproduktionsabhängigen Festlegung zur Diskussion gestellt.



## Poster

### Effects of inoculation with saprotrophic basidiomycetes on decomposition of wheat straw in a pot experiment

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Near-surface accumulation of undecomposed straw caused by conservation tillage complicates sowing and supports the outspread of soil-borne pathogens. We investigated if inoculation with the saprotrophic basidiomycetes *Coprinus comatus*, *Cyathus striatus* and *Trametes versicolor* accelerate wheat straw decomposition and had positive effects on the growth and yield of wheat. Wheat straw was added in litter bags to a loamy sand in a pot experiment, and weight losses, chemical and morphological changes were measured after 90 and 180 days. Straw and grain weights of harvested test plants were determined after 180 days.

Inoculation with all three fungi significantly enhanced the wheat straw decomposition and increased wheat grain yields. The effects of inoculation with *Coprinus comatus* and *Trametes versicolor* on straw decomposition were restricted to the first 90 days. Inoculation with *Cyathus striatus* enhanced straw decomposition until 180 days and increased grain yield most successfully. We conclude, that selected strains of saprotrophic basidiomycetes have capabilities to accelerate wheat straw decomposition in soil and improve soil properties for plant growth. In current experiments we are testing the long-lasting inoculation effects under field conditions.



## Microbial Litter Decomposition in Soils of Secondary Forest of the Mata Atlântica

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### Abstract

The metabolic activity of micro-organisms in soil from areas of different stages of regeneration in the Brazilian Mata Atlântica was assessed via respiration measurements. The stages were pasture, very young, advanced and old secondary forests and. The aim of the study was to assess the ability of the soil microflora to decompose the organic material from the natural litter layer and to use it as a nutrient source to build up microbial biomass.

Soil (Cambisol, 0-5 cm) was collected at four study areas situated in the coastal plain of the Serra do Mar near the town of Antonina (25°25' S, 48°40' W) in the "Área de Proteção Ambiental Guaraqueçaba ("Reserva Natural do Rio Cachoeira"). The stages were pasture (P), and three stages of secondary forest: very young (H), advanced (A) and old, near primary (F). From three sites (P, H and F) also leaf litter material was collected.

The litter was ground and mixed as a powder separately with the soil of each site and incubated for four weeks in the laboratory. Basal (BR) and glucose-induced respiration rates (SIR) were determined on day 1, 7, 14 and 28. Measurements of CO<sub>2</sub> production were performed at the Universidade Federal do Paraná with a soil respiration device based on infra red gas analysis (IRGA) under continuous flow conditions.

Addition of ground leaf litter increased microbial respiration depending on the incubation time, the origin of the soil (stage of regeneration) and the litter type.

The observed differences in the reaction of the soils to litter amendment indicate that the sites differ with regard to the nutrient status of the different litter types, the nutrient status of the respective soil and perhaps have site specific microbial communities with different metabolic diversity and versatility. To answer this questions analysed of the nutrient status of soils and litter will be performed and the microbial metabolic diversity will be assessed by applying the BIOLOG method using ECOplates.

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## Plants control microbial activity and carbon channels below ground

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Plants are the most important primary producers in the soil food web. They provide carbon by root exudates and by litter on the soil surface. Soil organic matter is processed recalcitrant remnants of dead plant tissue incorporated in the soil. Therefore all three energy channels in soils originate in plants. But moreover, plants interact with microorganisms which in turn are influenced by the activity of soil animals. These interaction in turn control decomposition and in the end plant growth. We studied the influence of living plants on the usage of the three energy channels by microorganisms and soil fauna and the feedback on plant growth. In a laboratory experiment, three energy channels were labelled with three carbon isotopes (<sup>12</sup>C, <sup>13</sup>C, <sup>14</sup>C). We had treatments with plants (corn), with different soil fauna complexity, and with litter added. The results were that all three treatments influenced microbial respiration, and that shoot biomass is elevated in the litter treatment and the treatment with anecic earthworms. The presence of plants enhance litter respiration, soil fauna immobilise litter borne carbon, and root derived carbon was passed to the predator level of the food web. We conclude that plants control the activity of rhizosphere and litter decomposing microbes and that a major carbon channel for the soil food web originates in root exudates.



## Fate of nitrogen derived from wheat and rape residues - clean plowing vs chisel plowing -

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### Abstract

Crop residue derived nitrogen amounts up to 30 and 50 kg ha<sup>-1</sup> a<sup>-1</sup> for winter wheat and winter rape, respectively. The contribution of this nitrogen to the nutrition of subsequent crops and its contribution to soil-N-pools were investigated in two different cropping systems in the field using cylinders from polyethylene (30 cm in diameter). Cylinders were placed vertically in the soil to a depth of 40 cm. In the encircled areas all litter was removed and exchanged with <sup>15</sup>N labelled wheat or rape straw. In the “clean plow” treatment the litter was burrowed to a depth of 20 cm while litter in the “chisel plow” treatment was slightly mixed into the upper 10 cm leaving a certain portion on the surface.

“Clean plowing” represented a three crop rotation starting with winter rape before summer barley that was followed by winter wheat. “Chisel plowing” represented a 4-year low input system starting with winter rape before oats that was followed by winter wheat. In the fourth year fields were left set aside before the rotation started again with rape. Therefore we investigated wheat straw decomposition in barley growings vs. set aside vegetation and rape straw decomposition in wheat growings vs. oats.

After 12 month (September to September) cylinders were removed from the field and soil and plant materials were analyzed for residue derived nitrogen.

65 to 80 % of residue derived N were recovered. The rest was lost due to leaching and/or denitrification. Up to two thirds of recovered residue-N was obtained as organic soil N. 3 to 10 % of residue derived N was recovered in successive vegetation. However, the specific enrichment of residue-N in the plant biomass turned out to be a function of treatment rather than that it was a function of primary production. The enrichment of set-aside-vegetation in the chisel plow treatment after winter wheat clearly exceeded that of all other treatments. This indicates that chisel plowing and wide C/N ratios of residue straw both are factors supporting the re-utilisation of residue-N due to a shift of larger N-releases from residues into spring. It is likely that the sowing of catch crops would make the set-aside-year in the low input system much more effective for saving residue nitrogen for the nutrition of following crops.



## Mineralisation and sorption of the steroidhormones 17 $\beta$ -estradiol and testosterone in different soils

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Natural steroidhormones like 17 $\beta$ -estradiol and testosterone through the use of animal manure, sewage sludge and wastewater. Those hormones can effect fish at extremely low aquatic concentrations which has resulted in an increased interest regarding the mobility and persistence of these compounds in the environment. Today there exists limited research on the behaviour of those hormones in soils.

The work which will be presented here examines the mobility and degradation of 17 $\beta$ -estradiol and testosterone in four agricultural topsoils with different treatments and in one forest topsoil. One of the agricultural soils received applications of wastewater over a period of four decades and another got applications of sewage sludge over the past 30 years. The other two agricultural soils were the corresponding untreated control soils.

Batch experiments and laboratory microcosm incubations with [4-<sup>14</sup>C]- 17 $\beta$ -estradiol and [4-<sup>14</sup>C]-testosterone were conducted to analyse the sorption and mineralisation of these compounds.

In the incubation study a difference in the mineralisation rate of 17 $\beta$ -estradiol and testosterone was observed in all of the five soils. After three days more than 50 % of testosterone was mineralized. In contrast 17 $\beta$ -estradiol was mineralised slowly suggesting that its bioavailability was low. No statistically significant differences were observed between the degradation of one hormone in the treated and the corresponding untreated agricultural soil.

Batch experiments demonstrate that an apparent sorption equilibrium is reached within 48 hours. Measured sorption isothermes for both hormones were generally linear. Large log  $K_{oc}$  values (3.05-3.46) suggest that leaching from soils will be limited for estradiol. Lower log  $K_{oc}$  values (2.9-3.29) for testosterone show that this compound leached all five soils more rapidly. After application of wastewater supplemented with hormones less estradiol was sorbed on the solid phase which indicates that constituent parts of DOC act as solubly sorbents.