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Abstract

In this study the influence of initial elemental stoichiometry of beech (*Fagus sylvatica* L.) litter on microbial decomposition was investigated. Litter from four different Austrian sites with different elemental stoichiometry was examined. A detailed perspective on early litter decomposition was provided: Sixty litter microcosms were sampled over eight weeks in total. Decomposition rates found in our laboratory experiment were in the range of literature values and consistent with in situ litter bag studies. In addition to decomposition in terms of CO_2 respiration and litter mass loss the focus laid on microbial nitrogen uptake and microbial interactions. The results showed, that the chemical nature of mineral nitrogen was more important than initial total nitrogen concentrations. Sites with higher amounts of initial ammonium were less active than sites with more initial nitrate. Microbial community analysis (Phospholipid Fatty Acids) revealed contrasting behaviour of fungi and actinomycetes during litter decomposition. Additionally the potassium and possibly also the manganese content of the litter affected the decomposition dynamics. Microbial biomass increased and the inorganic nitrogen pools decreased in the very beginning of the experiment. Respiration was also highest in the beginning, indicating highest activity at the start of the experiment. Not only the amount but also the form of nitrogen release strongly influenced the decomposition process.

Introduction

Litter decomposition is one of the key processes in nutrient recycling (Moore et al. 2006) and litter mineralization is a major source of CO_2 output of soils, which make up a huge carbon reservoir on a global scale (Couteaux et al. 1995). The gaseous composition of the atmosphere is already changing dramatically due to anthropogenic material transport and energy consumption (Ojima et al. 1994; Olofsson and Hickler 2008). Therefore it is of major importance to evaluate and predict the amount of CO_2-release from the soil-litter system into the atmosphere. Climate and substrate quality are regarded as the main drivers influencing decomposition rates of leaf litter (Meentemeyer 1978; Prescott 1995). To assess litter decomposition rates two basic methods are used: the litter bag-technique or microcosm studies (Salamanca et al. 1998). Climatic factors were reduced to a minimum by the usage of microcosms (Taylor et al. 1989), to study exclusively the impact of substrate quality and initial stoichiometry on decomposition. So far almost all terrestrial litter decomposition studies with microcosms contained both litter and soil e.g. (Jonasson et al. 2004; Teuben 1991). To gain a deeper insight into the microbial processes occurring in the litter itself, microcosms filled with litter only were used to exclude soil-litter interactions. It is well known, that litter chemistry, lignin-content and N-content affect decomposition rates (Melillo et al. 1982), therefore the focus laid mainly on litter stoichiometry. That high lignin-content reduces decomposition rates is well defined by now (Berg et al. 1993). The impact of nitrogen on decomposition is more controversial. Nitrogen seems to accelerate decomposition in earlier stages, whereas in later stages it slows it down (Gallo et al. 2004), this issue has been addressed as “microbial mining theory” (Craine et al. 2007). According to this theory microbes degrade highly recalcitrant substrates to get access to the nutrients that are bound within the substrate.

I hypothesized that

(i) litter with higher initial nitrogen content would accelerate the early stage decomposition of rather lignin-rich (Melillo et al. 1982) and thus recalcitrant beech litter (Mungai and Motavalli 2006).

(ii) k-strategists would catch up on primary dominating r-strategists over time when easily accessible nutrients are decreasing.

Additionally the time course of the early-stage decomposition was closely examined, mainly in terms of microbial biomass, inorganic nitrogen and respiration.

Material and Methods

Sample Sites

In autumn 2006 beech (*Fagus sylvatica* L. (1753)) litter was collected from four different sites in Austria: Achenkirch, Tyrol (**A**), Klausen-Leopoldsdorf, Lower Austria (**K**), Perg, Upper Austria (**P**) and Orth, Gmunden, Upper Austria (**O**), which were different in bench mark nutrient stoichiometry. Achenkirch was a Tyrolean Spruce-Beech (*Picea abies* L., H.KARST. (1881)) forest on loam with a pH of 7.0. The coordinates of **A** were 47°35' N and 11°39' E (Ambus et al. 2006). Kl ausen-Leopoldsdorf was situated in the Vienna Woods, with the coordinates 48°07' N and 16° 03' E. The soil was a loam – loamy clay with a pH of 4.6 (Kitzler et al. 2006b). The coordinates of Orth were 47°51' N and 13°42' E. The site was elevated about 700 m above sea level and northeast orientated. The forest consisted mostly of beech but also of Norway spruce and fir (*Abies alba* MILL. (1768)) and it had an average slope angle of 34 %. The soil was a brown loam on carbonate rock. The coordinates of **P** were 14°54' N and 48° 21' E. The exposition was so uthwest. The site was dominated by beech, but also contained conifers. The litter was immediately air-dried and put into microcosm-chambers in July 2008. Prior to the start of the experiment an elemental analysis of the collected litter was done. C- and N-content were analyzed with a Leco CN2000 (LECO corp. St Joseph, MI, USA).

Experimental setup

In total 60 Microcosms were established. Each microcosm consisted mainly of a PVC cylinder (Ø 10 x 10 cm height). Two cm above the bottom a grate was fixed, upon which 38 g of moist litter was introduced. To prevent strong evaporation, the cylinder was covered and a moist sponge cloth was laid below (**Fig. 1a**). The cover was composed of a PE-foil fixed to a two cm ring of drainage pipe. The foil was perforated to allow atmospheric gas exchange. Two airtight covers for the gas sampling were built (**Fig. 1b**). A hole was drilled into the top cover and a septum was put into the borehole and sealed with silicone (Baysilone medium viscous; Bayer corp.,

Leverkusen, Germany). Additionally a 2 mm polyurethane band was adjusted inside the covers for air-tight sealing.

Purified beech litter was shred into pieces to simulate soil-fauna activities and sieved: the fraction from 1 mm to 1 cm was used. The experiment was conducted under stable conditions. Average temperature was about 20 ± 1 °C and the water content of the leaves was 60 %. The water content was adjusted on bulk material. After two days of equilibration the microcosms were filled with moist litter. The water content was adjusted weekly by weighing the microcosms and the missing amount of deionised water was supplemented with a syringe. At the first time point samples were gathered from the original litter pool and not out of the microcosms.

The decomposition experiment ran over a time period of eight weeks and weekly litter samples were analysed. For homogenization the litter was chopped into small pieces with a two-bladed mincing knife. Fifteen microcosms were provided per site. Each week one microcosm per site was harvested and four subsamples were taken for analysis. In order to check for possible underestimation of sample variability due to the harvest procedure a side experiment was conducted and microbial biomass, nitrate and ammonium concentrations within and between microcosms from two sites was compared. The results confirmed that variability within microcosms was equal or higher than between microcosms (**Table 1**). In week five, the midterm of the experiment, three extra microcosms per site offered an additional source for replicates. The remaining four microcosms of each site were mounted for the last sampling time. Gas measurements were conducted weekly with these four respective microcosms.

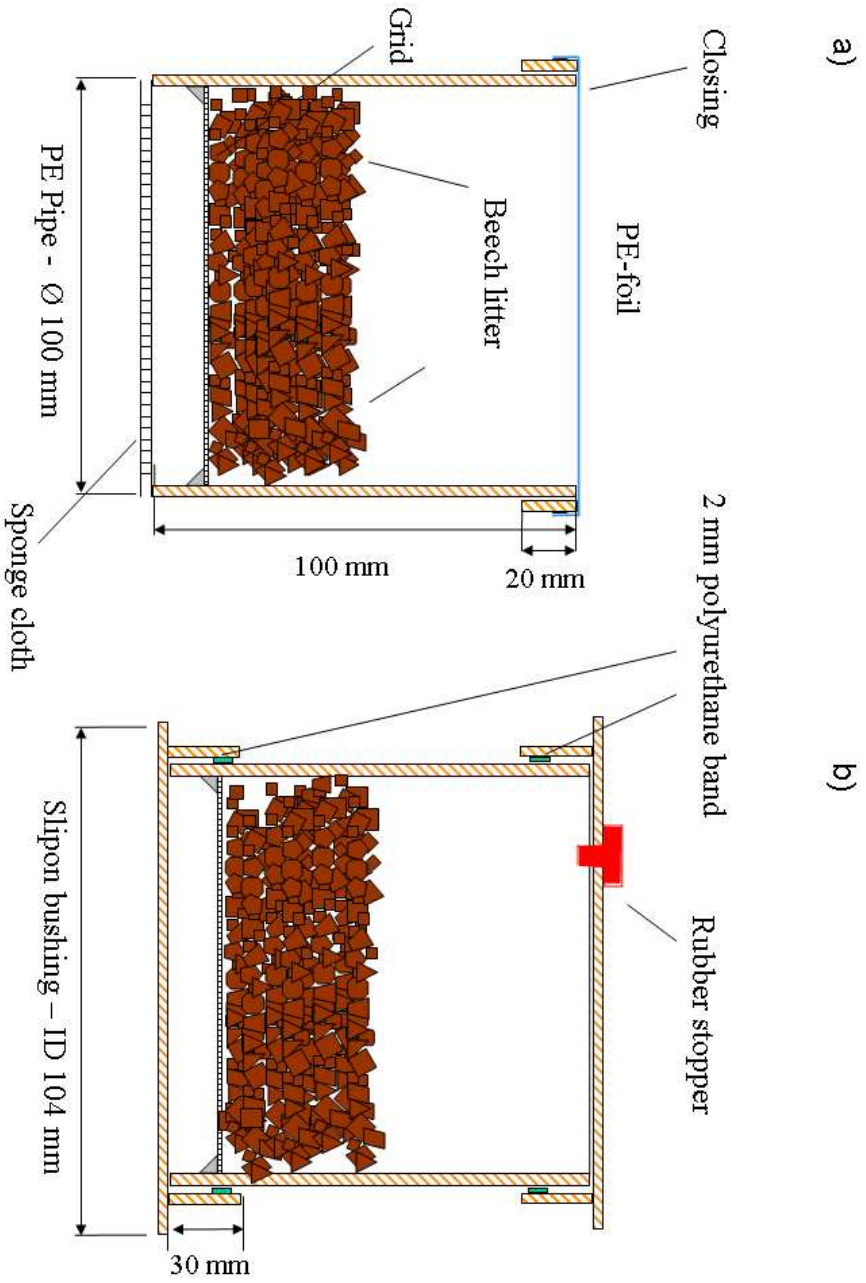

Fig. 1 The microcosm setup used for the experiment. 1a was the usual setup of the 60 microcosms. The cylinders stood upon a sponge cloth and a cover for preventing evapotranspiration was put on the top. In 4b the gas microcosms are shown. 4 cylinders per site were regarded as gas-microcosms: gas samples were taken out only of these. Airtight covers were put on top and bottom with a rubber stopping for gas extraction with a syringe. Additionally the covers were sealed with parafilm.

Table 1. Variance of replicates within and between individual microcosms. Four variables were tested for variance within two additional microcosms. The samples were taken out of different positions inside of single microcosms (top, center, bottom and side area) and not homogenized. The variance within one microcosm was bigger than between them.

		Microcosm 1	Microcosm 2	Our data
NH_4^+	Mean	3.21	13.52	13.27
	SD	2.14	9.94	3.07
	CV	**0.67**	**0.74**	**0.24**
NO_3^-	Mean	3.71	4.32	82.68
	SD	2.60	1.15	11.25
	CV	**0.70**	**0.27**	**0.15**
C_{mic}	Mean	220.15	391.55	215.45
	SD	99.04	333.96	35.58
	CV	**0.45**	**0.85**	**0.18**
N_{mic}	Mean	522.53	432.81	25.36
	SD	253.96	146.78	2.13
	CV	**0.49**	**0.34**	**0.09**

Notes: SD means standard deviation, CV means coefficient of variance. C_{mic} and N_{mic} represent microbial biomass C and N after chloroform fumigation. (Microcosm 1 and 2: n=4, Our data: n=36 (microcosms from week 5 and week 9)).

ANALYSES

Dry weight, C:N-Ratio

An amount of 10 g of fresh litter was oven dried overnight at 105 °C. The dried litter was chilled to room temperature in an exsiccator with silicagel. The C- and N-content was analyzed from the respective samples with a Leco CN2000 (LECO corp. St Joseph, MI, USA).

Nitrate / ammonium

Four replicates per microcosm were performed. The analyses of nitrate (NO_3^-) and ammonium (NH_4^+) were conducted according to Kandeler (1996) with minor modifications. An amount of 2.5 g of chopped litter was extracted with 50 ml *0.1 M* KCl-solution while shaking for one hour. Four replicates per microcosm were made. The extract was filtered through N-free folded filters and deep-frozen at – 20 °C. For the determination of nitrate 750 µl of diluted sample-solution were reduced overnight with 30 µl of 10 % sulfuric acid and 2 zinc-shots. Nitrate was measured photometrically at a wavelength of 210 nm with a µQuant mQx200 (Bio-Tek Instruments, Inc., Vermont, USA). Potassium-nitrate was used as a standard solution; the standard curve was linear in the range from 0 to 2.5 µg N ml^{-1}.

For ammonium determination 500 µl of diluted sample solution were mixed with 250 µl mix-solution (1:1:1 deionated water: *0.3 M* NaOH: sodium salicylate with sodium nitroprusside-solution) and 100 µl of dichloroisocyanurate (*39.1 mM*). After a reaction time of 30 minutes 250 µl of the liquid were transferred into a 96 well plate (Bio-Tek Instruments, Inc., Vermont, USA). Ammonium was measured photometrically at a wavelength of 660 nm with a µQuant mQx200. As a standard ammonium chloride was used in the range from 0 to 5 µg N ml^{-1}

Gas-measurements

The covers were removed from the microcosms two minutes before gas sampling (**Fig. 1a**), that retained gases were able to volatilize. Then 10 ml headspace air of the gas tight microcosms was gathered (**Fig. 1b**). Over a time course of 20 minutes gas samples were taken every five minutes. The 10 ml headspace-extract was filled into

airtight and vacuumized vials with an aluminium cap and a rubber stopper. Gas samples were analyzed by gas-chromatography with a 6890N-Network GC-System (Agilent Technologies, Inc., Santa Clara, USA) connected with a HSS 86.50 automatic headspace-sample-injecting system. (DANI, Inc., Milan, Italy). CO_2 and CH_4 were detected with a flame ionistation detector (FID) and N_2O with a ^{63}Ni-electron-capture detector (ECD). Helium was the carrier gas for the FID-detector, while nitrogen was the carrier gas for the ECD. Standards for CO_2-measurement contained 250, 512 and 1000 µl l^{-1} CO_2, for CH_4 they contained 1, 2 and 4 µl l^{-1} CH_4 and for N_2O 1, 2.5 and 5 µl l^{-1} N_2O (Linde Gas). Measurements and calculations of CO_2 and N_2O were conducted as described in Kitzler et al. (2006a), and of CH_4 as in Schaufler et al. (2009).

Microbial carbon (C_{mic}) and microbial nitrogen (N_{mic})

The determination of microbial assimilated nitrogen and carbon was performed via chloroform fumigation (Öhlinger 1996). An amount of 6 g of fresh litter was placed into an evacuated exsiccator for 24 hours at 25 °C. In advance about 100 ml of methanol-free $CHCL_3$ (chloroform), soda lime in a beaker and wet filter-papers were put on the ground of the exsiccator. For calculating the microbial part, 2.5 g of non-fumigated chopped litter was extracted with 50 ml *1 M* KCl-solution. The total amount of C and N was determined with a TOC-V CPH E200V, linked with a TN-unit TNM-1 220V (Shimadzu Corporation, Kyoto, Japan).

Phospholipid fatty acids PLFA

The litter for PLFAs was assayed at three time points (week one, five and nine). Lipids were extracted from 1 g subsamples using a modified Bligh and Dyer technique, as described by Hackl et al. (2005), referring to Frostegard et al. (1991). A short outline of the applied method is given with the following lines.

To 1 g of fresh litter 1.9 ml $CHCl_3$, 3.7 ml CH_3OH (methanol) and 2 ml Bligh and Dyer solution were added. Bligh and Dyer solution consisted of CH_3OH, $CHCl_3$ and citrate puffer at a pH of 4 (in the ratio of: 10:5:4). The tubes were intensely vortexed and after 2 hours of shaking and additionally vortexing they were centrifuged. The supernatant was withdrawn twice with another centrifugation in between. $CHCl_3$ and citrate puffer were added, followed by an additional centrifugation step. Of the lower

$CHCl_3$-phase 3 ml was gathered and dried at 40 °C via N_2-current. Then the samples were frozen at -20°C.

After storage (max. eight weeks) 0.3 ml $CHCl_3$ were added to the dried samples. Chloroform, acetone (C_3H_6O) and methanol were injected consecutively. After the fatty acid samples had passed the silica gel, the chloroform compound contained the neutral lipids and acetone contained the saccharolipids. The last compound containing methanol and the phospholipid fatty acid fraction was captured.

The phospholipid fatty acids were analysed with a HP 6890 Series GC-System and a 7683 Series injector and auto sampler on a HP-5 capillary column and detected with a FID. For identification of the fatty acid methyl esters an external standard (Bacterial acid methyl esters mix from SUPELCO, St. Louis, Missouri, USA) was used. For quantification of the peaks methyl non-adecanoate fatty acid (19:0) was added. The GC-injection volume was 0.2 µl.

PLFA nomenclature is based upon Frostegard et al. (1993). The PLFA i14:0, i15:0, a15:0, i16:0, i17:0, a17:0 were chosen to represent gram+ bacteria. The PLFA 16:1ω7, 16:1ω9, 17:1ω9, cy17:0, 18:1ω11, and cy19:0 were gram- (Fierer et al. 2003). 18:2ω6 was regarded as fungi (Zelles 1997) and 10Me16:0, 10Me17:0 and 10Me18:0 were regarded as actinomycetes (Frostegard et al. 1993). 14:0, 15:0 and 17:0 were unspecific bacteria. Gram+, gram- and unspecific bacteria account for total bacteria. The ratio fungal/bacterial PLFA was calculated with 18:2ω6 divided through the amount of bacterial PLFA (Frostegard and Baath 1996). 20:4ω6 and 20:2ω6 were regarded as protozoa (White et al. 1996). Among many others, Singh et al. (2006) have shown that PLFA-analyses lead to mostly similar results in community profiling as DNA-based methods.

Statistical analyses

One-way ANOVAs followed by Tukey's HSD-test were used to assess the differences between stoichiometry and nutrient content of the litter. To perceive significant differences between PLFA-content during the experiment, a one-way ANOVA with Tukey's HSD-test was performed for every week. Quadratic regressions were performed between the variables log transformed CO_2 and $(\text{nitrate})^2$,

ammonium vs. $(N_{mic})^2$ and CN in biomass vs. N_{mic}^2. The program used for statistical analyses was R 2.9.0 (R_Development_Core_Team 2009). After log-transforming the variables ammonium and N_{mic} a Principal component analysis (PCA) was calculated with the PLFA-groups using the program SIMCA-P 11.0 (Umetrics, Umeå, Sweden). Used as an explanatory analysis technique, PCA is an unbiased data transformation that generates univariate canonical summary variables (Selvin 1995).

Results

Bench mark litter stoichiometry

The four sites showed major differences in nutrient ratios (C:N, C:P) and in nutrient content (Phosphorous, Potassium, Magnesium, Manganese) as is shown in **Table 2**. At the beginning C:N-ratios ranged from 48.71 to 57.60 where the lowest ratio was found for **A** an the highest for **P**, but there was no significant difference between **A** and **K**. **A** showed the highest N-content. Potassium was highest in **K**, followed by **P**, then by **O** and **A**, which is analogous to the pattern of CO_2 production.

Dryweight and C:N-Ratio

For estimating decomposition rate exponential k-values per year were calculated. The formula $M_t = M_0 e^{-kt}$ was applied and converted into $\ln(M_t/M_0) = -kt$ (Olson 1963). The average inversed k-rate (k^{-1}) over eight weeks was significantly different in **K** from **P** (one-way-ANOVA followed by Tukey-HSD-test, $p = 0.036$). It ranged from 0.42 (**P**) to 0.56 (**K**) (**Fig. 2a**). Total nitrogen content was highest in **A** (1.17 %) and lowest in **P** (0.93 %). At the end of the experiment (eight weeks), 8.8 % mass was lost in **K**, the most active site. The other sites showed mass losses from 6.6 to 7.1 % mass was lost. Only **K** was significant different from the other sites ($p=0.004$). The C:N-ratios decreased over time in all sites. In week zero, five and nine four replicate microcosms were sampled and significant differences between C:N-ratios were tested. The sites mostly remained significantly different over eight weeks, except for **P** and **O** in week 5 and 9. There was also a significant difference between the weeks 0 (initial leaf chemistry) and nine ($p < 0.001$). Over all eight weeks, the highest C:N-ratio of **P** (51.39) was followed by **O** (50.25), **K** (46.86) and **A** (43.90) (**Fig. 2b**).

Table 2. Initial beech litter chemistry from four different sites.

Site	C (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Zn (mg kg^{-1})	C:N Ratio	C:P Ratio	N:P Ratio
A	50.94	1.051	0.0301	0.099	1.48	0.225	121.92	103.8	32.33	48.71	1707.9	34.95
	(0.04^{c})	(0.007^{c})	(0.0004^{a})	(0.002^{a})	(0.02^{c})	(0.002^{d})	(3.73^{a})	(2.60^{a})	(0.91^{a})	(0.29^{a})	(18.2^{d})	(0.24^{d})
K	49.42	0.971	0.0330	0.395	1.30	0.155	175.50	985.2	39.00	50.89	1494.1	29.13
	(0.18^{b})	(0.014^{b})	(0.0007^{b})	(0.003^{d})	(0.02^{b})	(0.002^{b})	(4.46^{b})	(18.32^{d})	(1.63^{b})	(0.72^{a})	(33.7^{c})	(0.43^{c})
O	48.65	0.897	0.0446	0.179	2.03	0.163	240.92	521.2	34.08	54.16	1090.2	20.13
	(0.14^{a})	(0.007^{a})	(0.0007^{c})	(0.002^{b})	(0.02^{d})	(0.001^{c})	(16.83^{c})	(18.96^{c})	(0.60^{a})	(0.39^{b})	(15.8^{b})	(0.23^{b})
P	49.59	0.862	0.0555	0.212	1.16	0.129	181.50	292.8	41.17	57.60	892.2	15.78
	(0.16^{b})	(0.012^{a})	(0.0002^{d})	(0.002^{c})	(0.01^{a})	(0.002^{a})	(8.54^{b})	(9.40^{b})	(0.80^{b})	(0.79^{c})	(1.9^{a})	(0.18^{a})

Notes: Values are means, with +/- SE in parantheses, different letters indicate significant differences between sites after Tukey's post hoc test of significance (p=0.95, n=6)

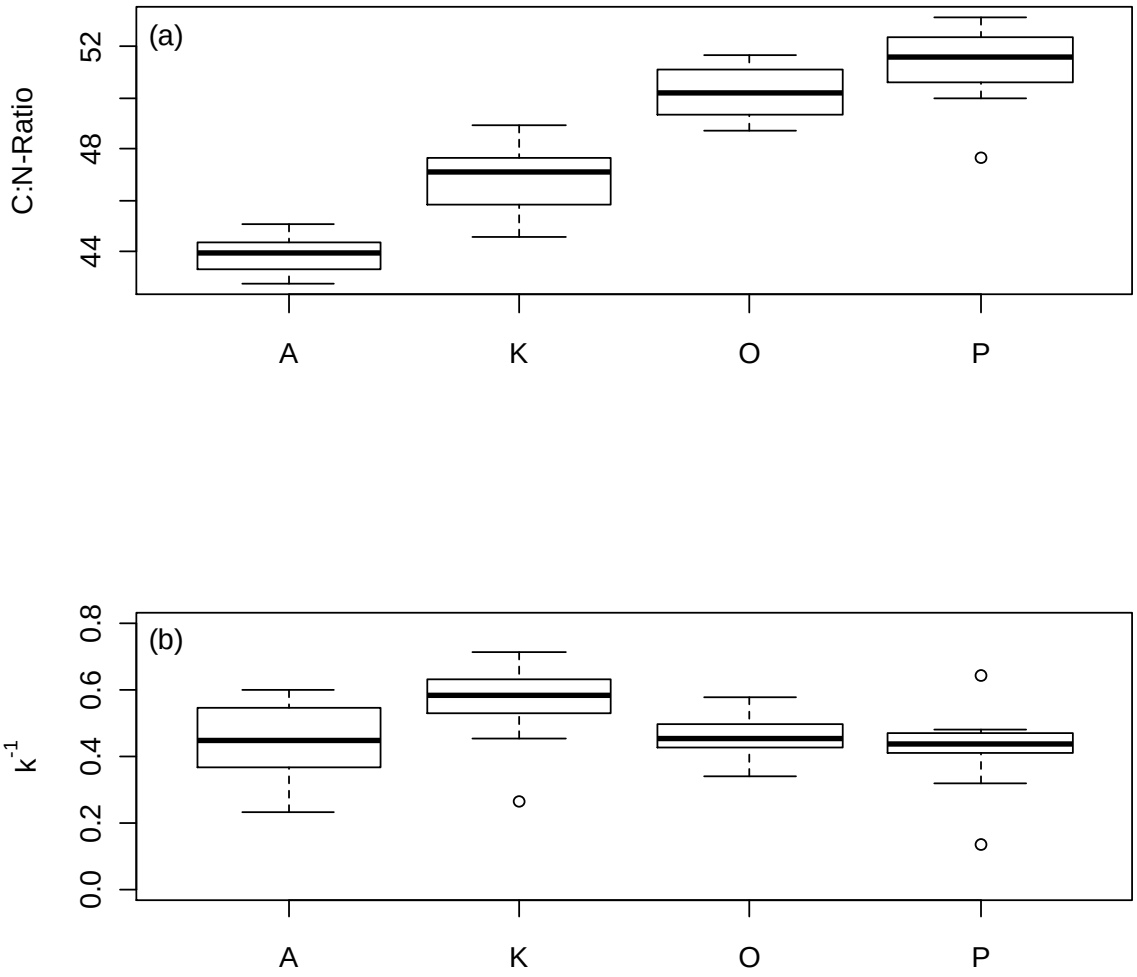

Fig. 2 Boxplots of the CN-ratios of the 4 sites of all eight weeks (2a) and of the inversed k-values of eight weeks (2b). Different letters indicate significant differences according to an ANOVA, followed by TukeyHSD-test. **A** stands for Achenkirch, **K** for Klausen-Leopoldsdorf, **O** for Orth and **P** for Perg.

Nitrate and ammonium

Generally nitrate decreased in the beginning and after 6 weeks it started to increase (**Fig. 3a**). Ammonium-N concentration was highest in **A** and lowest in **K**. The time course of ammonium concentrations for all sites was a strong decrease in the first weeks, remaining at a low level for the rest of the time (**Fig. 3b**). The order **A**>**O**>**P**>**K** for ammonium-concentration was exactly the opposite as for respiration **K**>**P**>**O**>**A**. Total inorganic N (ammonium + nitrate) was similar for all sites: over time an overall decrease occurred, whereas **O** had most inorganic N. In contrary to ammonium which was lowest, nitrate was highest in **K** at the beginning.

Gas measurements

CO_2 production was higher in the early stages and decreased over time. Thus, CO_2 production decreased and decomposition slowed down. Highest CO_2-respiration was observed for **K** (0.1044 mg C g^{-1} dw h^{-1}) in the first week. Most of the time **K** was significantly different from the other sites. Perg and **O** were significantly different only in week one and three (**Fig. 3c**). In the first week the respiration rates of the four sites were significantly different ($p < 0.001$) from each other. There was no noteworthy N_2O and CH_4 production during the experiment: N_2O values ranged from -0.017 to 0.009 µg N g^{-1} dw h^{-1} and CH_4 values from -0.026 to 0.008 µg C g^{-1} dw h^{-1}.

Microbial carbon and microbial Biomass

For C_{mic} and N_{mic} a similar trend was observed and they were well correlated (Pearson r = 0.835, n = 36, p=0.05), N_{mic} is shown in **Fig. 3d** and C_{mic} in **Fig. 4a**. As expected, the amount of N_{mic} was rather low in the beginning, with **K** being highest. In the first three weeks there was a strong increase, and then the amount of N_{mic} stayed almost constant with minor decrease in week 7. In **K** microbial biomass C and N remained mostly highest during eight weeks. The C:N-ratio in microbial biomass was reduced over time (**Fig. 4b**). The course of N_{mic} matched inverted to the progression of ammonium. A significant regression was observed between those two variables (**Fig. 4c**). Most of the ammonium was incorporated into microbial biomass within the first week, indicating, that microbial biomass is an important nitrogen pool in early litter decomposition. Moreover, a good quadratic regression between the C:N-ratio in microbial biomass and total inorganic nitrogen ($r^2 = 0.604$, $p < 0.001$) was found.

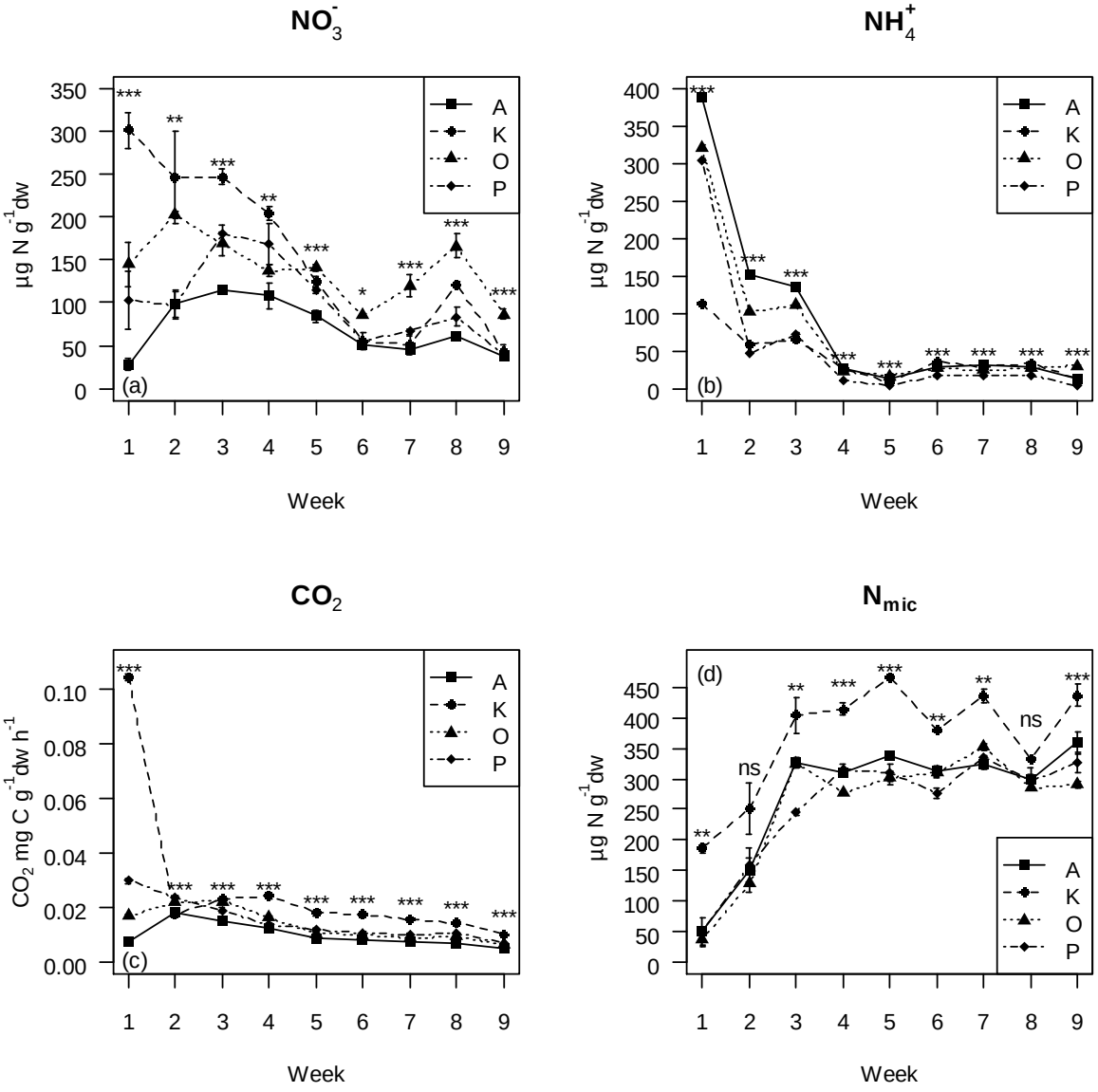

Fig. 3 The time course of four crucial variables during the decomposition experiment. 3a displays the course of nitrate, 3b the course of ammonium, 3c shows the CO_2 development and 3d the amount of microbial nitrogen after chloroform fumigation. If there are significant differences at one time point, stars indicate significant differences and “ns” represents not significant. ANOVAs between the sites for each time point were perfomed. The following signature was used: p>0.5: ns, p<0.5:*, p<0.1:**, p<0.01: ***. **A** stands for Achenkirch, **K** for Klausen-Leopoldsdorf, **O** for Orth and **P** for Perg.

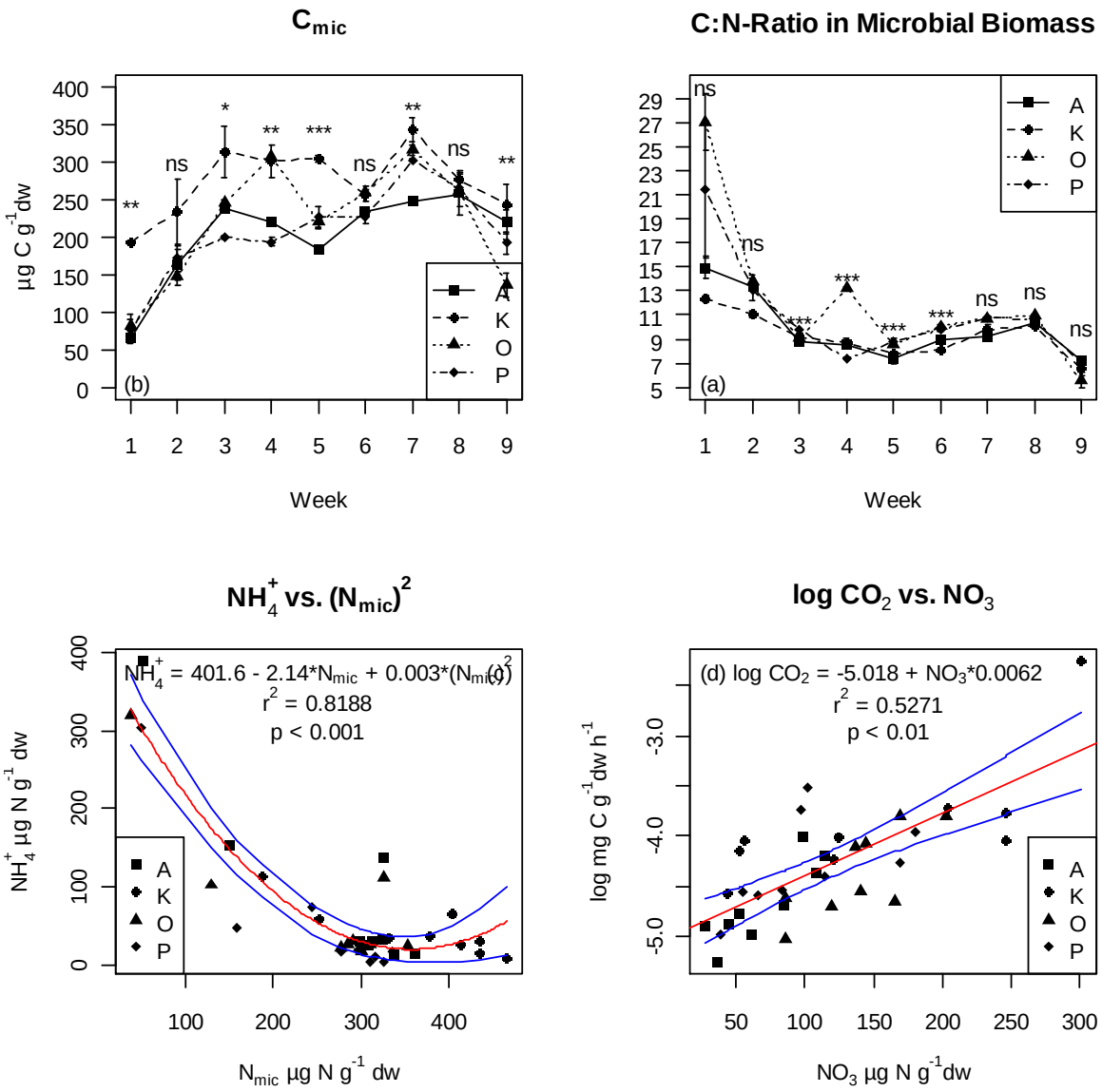

Fig. 4 4a shows the development of the microbial biomass C after chloroform fumigation during 9 weeks and 4b shows the C:N-ratio in microbial biomass. Between the sites in fig. 4a and 4b ANOVAs for each time point were perfomed. The following signature was used: p>0.5: ns, p<0.5:*, p<0.1:**, p<0.01: ***. Fig 4c and fig 4d display plots of two variables: 4c is a plot between ammonium and N_{mic}, and fig 4d shows a plot between CO_2 and nitrate. The outer lines of the regression curves indicate a 95 % confidence interval and the line in between is the regression line. **A** stands for Achenkirch, **K** for Klausen-Leopoldsdorf, **O** for Orth and **P** for Perg.

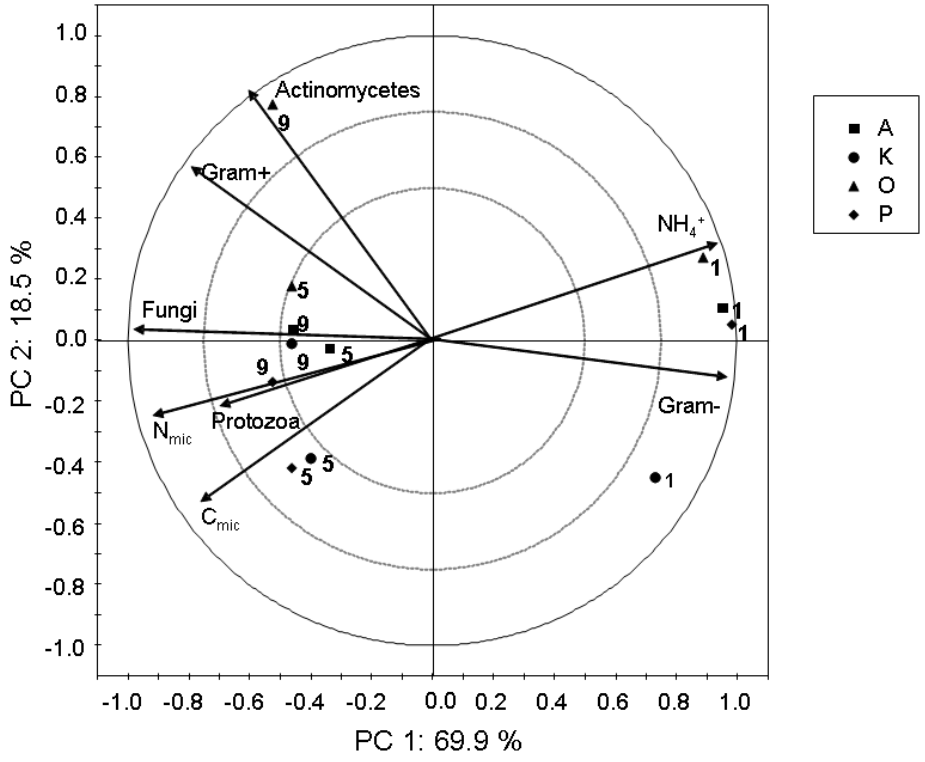

Fig. 5 Principal component analysis with PLFA data and the log-transformed variables NH_4^+, N_{mic} and C_{mic} of beech litter decomposition of four sites at three time points. Data points are indicated as symbols with numbers and they represent litter samples from different sites at week 1, 5, and 9. **A** stands for Achenkirch, **K** for Klausen-Leopoldsdorf, **O** for Orth and **P** for Perg. PC: Principal Component; N_{mic} and C_{mic}: microbial biomass C and N after chloroform fumigation

Phospholipid fatty acids

PLFA data were classified as actinomycetes, fungi, gram+, gram-, and protozoa. PLFA measurements were conducted at three different time points. In the first five weeks of the experiment, there was an increase in all groups, except for gram- bacteria. (**Table 3**) Then a general decrease was observed, with the exception of actinomycetes and gram+ bacteria, which both increased exceptionally in microcosms of **O**. Achenkirch had the highest fungal:bacterial-ratios during the experiment and in the microcosms of **O** most gram+ bacteria and actinomycetes were found. PLFA analysis showed highest amount of gram- bacteria in the microcosms of **K** in the first week, a group which was most abundand in all sites. During the experiment, gram- decreased averaged from 43.4 nmol g^{-1} dw in the first week to 30.3 in week nine, and fungi increased from 9.0 to 17.6. For calculating the total amount of PLFA, the amount of PLFA from the observed groups was summed up. In the first week 54.3 ± 0.7 (SE, n = 12), in week five 56.1 ± 0.6 (SE, n = 16) and in week nine 53.3 ± 1.4 (SE, n = 20) total PLFA were measured. The amount of PLFA didn't change significantly, but a major shift occurred between the groups.

Calculating one-way ANOVAs with week as factor showed highly significant differences in all groups, as well as in fungal:bacteria-ratio and total bacteria, but no significant difference in total amounts of PLFA over the weeks. For fungi, an ANOVA with TukeyHSD-test showed only differences between week one and the other two weeks ($p < 0.001$). But an additional t-test showed that the fungal PLFA data are not equal in week five and nine ($p = 0.343$). A good significant correlation of gram+ bacteria with actinomycetes (Pearson's $r = 0.89$, $p = 0.05$) and a weak significant correlation of fungi with actinomycetes (Pearson's $r = 0.47$, $p = 0.05$) over time was observed. A general increase over time was observed for all the three groups. Principal component analysis was conducted, containing all the PLFA groups and the log-transformed variables ammonium, N_{mic} and C_{mic} (**Fig. 5**). Prior to performing the PCA, the arithmetic mean of the data set was calculated for each week (one, five and nine) and site, resulting in 12 observations and 8 variables for the PCA. Two principal components were computed, with the first principal component (PC) explaining 69.9 % of variation and the second PC 18.5 %. These two principal components could explain 88.5 % of variation of the data set for the three weeks.

Table 3. PLFA-contents of beech leaf litter of four sites at three time points. The amount of the accounting PLFAs have been summed up to result in the designed groups.

Week 1	Actinomycetes	Fungi	Gram +	Gram -	Protozoa	FB-Ratio
Site						
A	0.201 (0.026^{b})	9.932 (0.756^{a})	1.195 (0.091^{a})	42.413 (2.703^{a})	0.264 (0.022^{a})	0.219 (0.030^{a})
K	0.014 (0.014^{a})	7.626 (0.088^{a})	0.832 (0.007^{a})	42.39 (0.099^{a})	0.213 (0.014^{a})	0.166 (0.002^{a})
O	0.292 (0.037^{b})	9.623 (0.712^{a})	2.542 (0.234^{b})	43.536 (1.749^{a})	0.318 (0.042^{a})	0.199 (0.021^{a})
P	0.207 (0.029^{b})	8.714 (0.157^{a})	1.301 (0.049^{a})	45.28 (0.284^{a})	0.329 (0.016^{a})	0.178 (0.004^{a})
Week 5						
Site						
A	0.317 (0.005^{c})	18.119 (0.254^{ab})	4.413 (0.126^{c})	30.601 (0.751^{a})	0.499 (0.018^{b})	0.478 (0.005^{a})
K	0.238 (0.002^{b})	18.272 (0.174^{ab})	3.845 (0.063^{b})	34.283 (0.952^{b})	0.427 (0.005^{a})	0.448 (0.010^{a})
O	0.406 (0.006^{d})	18.771 (0.170^{b})	7.112 (0.146^{d})	31.051 (0.878^{ab})	0.466 (0.004^{ab})	0.457 (0.013^{a})
P	0.215 (0.005^{a})	17.682 (0.269^{a})	3.356 (0.088^{a})	33.503 (0.736^{ab})	0.892 (0.023^{c})	0.446 (0.008^{a})
Week 9						
Site						
A	0.366 (0.007^{ab})	18.884 (0.077^{a})	5.354 (0.104^{a})	28.689 (0.455^{a})	0.474 (0.026^{a})	0.523 (0.004^{a})
K	0.418 (0.034^{b})	18.325 (1.486^{a})	4.79 (0.202^{a})	30.895 (0.585^{bc})	0.491 (0.015^{a})	0.475 (0.047^{a})
O	0.706 (0.022^{c})	17.047 (1.086^{a})	9.142 (0.371^{b})	29.681 (0.368^{ab})	0.489 (0.013^{a})	0.446 (0.042^{a})
P	0.312 (0.011^{a})	16.721 (1.156^{a})	5.277 (0.296^{a})	31.794 (0.557^{b})	0.858 (0.055^{b})	0.418 (0.036^{a})

Notes: Values are means, with +/- SE in parantheses, different letters indicate significant differences between sites after Tukey's post hoc test of significance (p=0.95, n=3 at week 1, n=4 at week 5, n=5 at week 9) Except for FB-Ratio all units are nMol PLFA g^{-1} dw.

Discussion

Effects of nitrogen (Hypothesis i)

The potential influence of nitrogen on litter decomposition is ambivalent. On the one hand nitrogen was attributed to accelerate litter decomposition (Mungai and Motavalli 2006) and on the other hand decomposition was found to be slowed down with higher nitrogen concentrations, especially in later decomposition stages (Frey et al. 2000; Prescott 1995). In this study different decomposition rates between the sites could not be explained by initial total N-content or C:N-ratios. However, microbial activity, measured as CO_2 respiration was highest in sites with low ammonium-N, with ammonium representing the major nitrogen source. This indicates an inhibiting effect of ammonium on microbial activity. **K** had the significantly highest decomposition rate (k^{-1}-ratio) and the lowest concentration of ammonium. Furthermore, an inverse relationship between ammonium and potassium was observed. A toxic effect of high ammonium concentration in combination with low potassium concentrations was reported for yeast by Hess et al. (2006). They assumed that potassium and ammonium use the same transporters due to similar ionic-radii, so potassium inhibits the ammonium-uptake. In this study potassium and initial ammonium -concentration were negatively correlated (Pearson's r = -0,998, $p<0.01$, n = 4), as was reported earlier (Hobbie and Gough 2002). An alternative reason for ammonium -toxicity could be amino compounds, which are released at a high ammonium-level by yeast (Hess et al. 2006). They enhance the formation of polyphenols, which may form oligomers with some toxic properties (Fog 1988). A third possibility for lower decomposition rate in ammonium-rich sites could be the so-called "ammonia metabolite repression" of fungi (Keyser et al. 1978). Ammonium can repress the synthesis of some fungal enzymes. The relationship between log transformed CO_2 and nitrate in this work (**Fig. 4d**) might be explained by the inhibiting effects of ammonium. So far It is not totally clear, whether the ammonium or the potassium concentration is of major importance for the decomposition velocity. Also the initial manganese contents were significantly different between the sites and would fit into the pattern of decomposition: the higher the manganese concentration, the higher was respiration. The exoenzyme manganese peroxidase is produced by the majority of wood degrading basidiomycetes for degrading lignin (Berg et al. 2007).

Community changes (Hypothesis ii)

During litter decomposition, the carbon pool is subject to qualitative changes: Long term decomposition leads to an increase in more recalcitrant C-containing molecules (Berg 2000). There is a shift from rather easily accessible carbohydrates like cell solubles and cellulose to cumulative lignin. So a community shift from bacteria to fungi was expected, which have in comparison the better capability to degrade lignin (Osono 2007). As was expected, the beginning decomposition was dominated by bacteria, and with continuing succession fungi increased, as was also found earlier by Marinucci (1983). Primarily dominating gram- bacteria were followed by gram+- bacteria and fungi, but the gram- bacteria were still the dominating group after eight weeks. For soils of early successional stages it was stated that gram- bacteria dominate in the beginning, succeeded later by gram+ (Tscherko et al. 2004). This fits to the achieved data, although exclusively litter was used. Nonetheless succession proceeded, but here also fungal biomass increased. Actinomycetes as an important decomposer group increased over eight weeks of decomposition. Actinomycetes significantly increased from week 5 to 9, which could indicate an already observed antagonistic effect between fungi and actinomycetes (Jayasinghe and Parkinson 2008). Especially in **O**, where actinomycete PLFA reached the highest amounts, fungal biomass decreased most. The PCA revealed, that the time course of ammonium concentrations - and gram- bacteria was correlated, whereas microbial biomass C and N grouped together with other organisms, especially with protozoa. Ammonium concentration was highest in the first week and decreased over time as did gram- bacteria. Microbial biomass was lowest in the first week, and increased quickly. It was also shown, that week one was rather different from week five and nine, which were grouped closer together. In this litter decomposition experiment, microbial biomass was not related to respiration and mass loss. In the early stages respiration was highest, but microbial biomass was lowest indicating an increase of carbon use efficiency during the time course of the experiment. This is consistent with the shift from bacteria to fungi.

PLFA data showed nearly no increase in total fatty acid concentrations over the whole experiment (Week1: 54.3 ± 0.7, Week5: 55.9 ± 0.6, Week9: 55.0 ± 0.5 nmol PLFA g^{-1} dw ± SE), whereas the chloroform fumigation indicated a steady increase in microbial biomass, from the beginning. While others (Bailey et al. 2002; Leckie et al.

2004) found a correlation between PLFA data and microbial biomass after chloroform fumigation this was not observed in this study. This might be because of plant material containing polyunsaturated (linoleic acid 18:2(9:12), the fungal biomass marker) and monounsaturated fatty acids (gram- marker), so the detected PLFA in the beginning might as well come from plant material (Zelles 1997). Further PLFA observations on beech litter could be supported by DNA-based methods, for being capable of better distinguishing between plant and microbial biomass.

Microcosm usability

The microcosm-approach used in this study allowed a fast and easy replication and it was sensitive enough to indicate differences of crucial chemical and biological characteristics in decomposition of leaf litter of the same plant from different sites. As N-concentration was rising over time (data not shown), losses due to leaching or denitrification in litter were regarded as marginal. N_2O-production was measured and it was slightly negative or not significant. Nonetheless it is not sure to 100 percent that there was no denitrification, as N_2 wasn't measured. The decomposition rates of this experiment were compared to literature values. The decomposition rates ranged from 0.14 to 0.88 (**Fig. 2a**). Inversed k-values for beech-litter from literature varied from 0.271 in Swiss (Heim and Frey 2004), over 0.33, 0.60 and 2.15 with high earthworm activity in southern Sweden (Staaf 1987) to 0.66 in the Mediterranean (Cortez 1998). It was not intended to take continuous samples out of one microcosm, but to sample in totally, in effort to not disturb the decomposition process. For continuous sampling of the gases, always the same microcosms were used for sampling. Over this short period, it seemed that the factor time was more predictive for differences of many variables, than the factor site.

Conclusions

The exclusive usage of litter (without soil) in a microcosm-system allowed excluding the soil influence on litter decomposition. In this experiment early beech litter decomposition was examined in weekly time steps. Many crucial parameters of decomposition and community changes were monitored. The combination of high temporal resolution of litter decomposition measurements and this broad range of analyses were never carried out before. Beside the undoubted relationships between initial elemental stoichiometry and early decomposition rates, the influence of other

nutrients like potassium on litter decomposition could be shown. Higher decomposition rates were expected in nitrogen richer beech litter, however, the chemical nature of inorganic nitrogen and not the amount of total nitrogen was the crucial factor: litter from sites with more nitrate, less ammonium and more potassium were faster decomposed during these eight weeks of initial litter decomposition.

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Anhang

Zusammenfassung

In temperaten Ökosystemen durchläuft ein großer Teil der Primärproduktion den Laubfall. Laubstreu liefert eine wichtige Nährstoffgrundlage für das Bodenleben und in weiterer Folge durch Abbauprozesse wieder für die Pflanzen. Die elementare chemische Zusammensetzung und die chemische Veränderung der Laubstreu während des Abbauprozesses spielen eine große Rolle in der Natur. Im Laufe des Abbaus werden leichter abbaubare Kohlenhydrate veratmet und schwer degradierbare hochpolymere Substanzen reichern sich an. Durch die Besiedelung von Mikroorganismen und deren aktiven Metabolismus werden dem restlichen Ökosystem viele wertvolle Nährstoffe für die Wieder-Aufnahme verfügbar gemacht. Dieser Prozess unterliegt vielen natürlichen Einflüssen, die durch die Verwendung eines Mikrokosomos-Systems verringert wurden. Die beiden großen Einflussfaktoren Temperatur und Feuchtigkeit wurden im vorliegenden Versuch nahezu konstant gehalten. Das Ziel dieser Arbeit war es, den Einfluss der unterschiedlichen Nährelementzusammensetzung der verwendeten Buchenlaubstreu (*Fagus sylvatica* L.) auf den Abbau zu untersuchen. Dafür wurden 60 Mikrokosmen konstruiert, in denen je 38 g Laubstreu über eine Periode von acht Wochen inkubiert wurden. Die Auswirkungen der Herkunft und der elementaren Zusammensetzung der Laubstreu auf die Nährstofffreisetzung wurden untersucht. Es wurden mikrobielle Biomasse nach Chloroform-Fumigation, Kohlendioxid, Methan, Lachgas, Ammonium und Nitrat in wöchentlichen Intervallen und Phospholipidfettsäuren (PLFS) zu drei Zeitpunkten gemessen.

Der Fokus der vorliegenden Arbeit lag auf dem zeitlichen Ablauf des Abbaus, dem Einfluss der ursprünglichen Nährstoff-Stöchiometrie auf den Abbauprozess und mikrobiellen Interaktionen und Verschiebungen in der Gemeinschaft. Ein wichtiger Aspekt war die Akkumulation von Stickstoff in der mikrobiellen Biomasse. Es konnten einige der untersuchten Variablen miteinander in Beziehung gesetzt werden. Die Ammonium-Konzentration war mit der mikrobiellen Biomasse stark negativ korreliert, und die Respiration war schwach mit der Nitratkonzentration korreliert. Die mikrobielle Gemeinschaft veränderte sich von sog. r-Strategen (gram-) in Richtung

K-Strategen (gram+ und Pilze). Es wurde außerdem ein Antagonismus zwischen Pilzen und Aktinomyceten gezeigt. Sehr deutlich war auch der Rückgang an Aktivität: so wurde bei den meisten Standorten zu Beginn am meisten geatmet, und im Verlauf der acht Wochen immer weniger. Diese Beobachtung lässt sich auf die sich ändernde chemische Zusammensetzung während des Laubabbaus zurückführen. Die Zunahme von mikrobieller Biomasse war zu Beginn am stärksten und veränderte sich im weiteren Verlauf des Versuchs nur marginal. Lachgas und Methan waren nur in sehr kleinen Konzentrationen vorhanden, was darauf hindeutet, dass das System durchwegs aerob war.

Durch den Versuch wurde gezeigt, dass es einen Unterschied macht, ob in der Streu der Stickstoff als Ammonium oder Nitrat vorliegt. In unserem Fall hatten Standorte mit höherem Ammonium-Gehalt weniger Respiration. Auch der Einfluss anderer Nährelemente, wie Kalium oder möglicherweise sogar Mangan spielte eine Rolle. So hatten Standorte mit höherem Ammoniumgehalt zusätzlich wenig Kalium und Mangan. Die interessanteste Erktenntnis war, dass die weit verbreitete Meinung, dass die Gesamtstickstoffkonzentration der bestimmende Faktor für die Abbaugeschwindigkeit von Laubstreu ist, in unserem Versuch nicht bestätigt werden konnte.

Table A 1: Litter data

ID	Week	Site	Microcosm	C:N	DW	Remaining mass	Water content	N	C	K-Value^{-1}	Dry weight
					%	%	%	%	%		g
1	1	A	S 1	44.69	41.3848	100.00	58.62	1.15	51.38		
5	1	K	S 1	48.78	41.00691	100.00	58.99	1.04	50.52		
9	1	O	S 1	51.64	37.96443	100.00	62.04	0.93	48.24		
13	1	P	S 1	53.13	40.78268	100.00	59.22	0.90	47.74		
17	2	A	S 2	45.06	41.17118	99.68	58.83	1.14	51.28	0.269107	15.74
21	2	K	S 2	48.93	41.47852	101.14	58.52	1.03	50.34		15.82
25	2	O	S 2	51.12	37.73227	99.33	62.27	0.95	48.33		14.37
29	2	P	S 2	52.25	41.0114	100.46	58.99	0.91	47.63	0.318965	15.64
33	3	A	S 3	43.26	40.47571	97.72	59.52	1.19	51.40	0.577499	15.43
37	3	K	S 3	47.16	40.59188	99.13	59.41	1.07	50.24	0.264485	15.51
41	3	O	S 3	49.28	37.13257	97.73	62.87	0.98	48.09	0.57603	14.14
45	3	P	S 3	51.60	40.57	99.56	59.43	0.92	47.66	0.135942	15.50
49	4	A	S 4	44.34	39.3281	95.17	60.67	1.16	51.39	0.883554	15.03
53	4	K	S 4	47.83	39.53611	96.68	60.46	1.05	50.27	0.63312	15.12
57	4	O	S 4	51.67	36.13247	95.04	63.87	0.93	48.22	0.857268	13.75
61	4	P	S 4	52.27	39.94233	97.97	60.06	0.91	47.75	0.360894	15.25
65	5	A	S 5	44.40	39.52885	95.28	60.47	1.16	51.37	0.596478	15.04
67	5	A	M 1	44.67	40.04642	96.91	59.95	1.15	51.43	0.427367	15.30
69	5	A	M 2	44.23	40.22241	97.11	59.78	1.17	51.55	0.370362	15.33
71	5	A	M 3	44.15	40.22649	97.22	59.77	1.17	51.47	0.369043	15.35
73	5	K	S 5	47.68	39.19293	95.66	60.81	1.06	50.41	0.598386	14.96
75	5	K	M 1	47.72	39.14209	95.54	60.86	1.05	50.28	0.584603	14.94
77	5	K	M 2	47.15	39.19677	95.67	60.80	1.07	50.48	0.580089	14.97
79	5	K	M 3	47.04	39.01167	95.15	60.99	1.07	50.54	0.658657	14.88
81	5	O	S 5	51.12	36.75514	96.78	63.24	0.94	47.94	0.441285	14.00
83	5	O	M 1	50.25	36.99147	97.59	63.01	0.96	48.29	0.340915	14.12
85	5	O	M 2	51.35	36.75057	96.72	63.25	0.94	48.20	0.456539	13.99
87	5	O	M 3	51.09	36.58556	96.31	63.41	0.94	48.26	0.511628	13.94
89	5	P	S 5	52.89	39.32231	96.55	60.68	0.90	47.74	0.436591	15.03
91	5	P	M 1	51.94	39.45821	96.78	60.54	0.92	47.60	0.418982	15.07
93	5	P	M 2	52.51	38.84784	95.18	61.15	0.91	47.75	0.642082	14.82
95	5	P	M 3	52.44	39.51805	96.90	60.48	0.91	47.59	0.409499	15.09

Notes: DW means dryweight, % N and % C are based on dryweight. Microcosm code: S 1-8 were for each week, M 1-3 were in the middle of the experiment and G 1-4 were the microcosms for Gas-measurements. A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table A 2: Litter data

ID	Week	Site	Microcosm	C:N	DW	Remaining mass	Water content	N	C	K-Value^{-1}	Dry weight
					%	%	%	%	%		g
97	6	A	S 6	43.78	39.62339	95.99	60.38	1.17	51.31	0.452339	15.16
101	6	K	S 6	47.43	39.26423	95.56	60.74	1.06	50.32	0.451638	14.95
105	6	O	S 6	50.51	36.30958	95.66	63.69	0.92	46.58	0.463506	13.84
109	6	P	S 6	51.17	38.94532	95.52	61.05	0.93	47.52	0.479429	14.87
113	7	A	S 7	43.68	40.30102	97.30	59.70	1.17	51.31	0.229986	15.36
117	7	K	S 7	46.63	38.02355	92.59	61.98	1.08	50.42	0.654636	14.48
121	7	O	S 7	50.10	36.44611	96.17	63.55	0.92	46.31	0.353729	13.92
125	7	P	S 7	51.58	38.92286	95.44	61.08	0.92	47.58	0.404522	14.86
129	8	A	S 8	44.34	39.72316	96.13	60.28	1.16	51.51	0.304417	15.18
133	8	K	S 8	46.37	38.45001	93.75	61.55	1.09	50.34	0.478263	14.66
137	8	O	S 8	49.38	35.83004	94.40	64.17	0.94	46.34	0.429839	13.66
141	8	P	S 8	50.73	38.47146	94.36	61.53	0.94	47.53	0.433388	14.69
145	9	A	S 9	43.37	38.44836	93.04	61.55	1.19	51.42	0.478384	14.57
147	9	A	G 1	43.11	39.12176	94.20	60.88	1.19	51.38	0.365527	14.69
149	9	A	G 2	42.76	38.65099	93.31	61.35	1.20	51.32	0.444218	14.87
151	9	A	G 3	42.86	37.91345	91.51	62.09	1.20	51.57	0.569449	14.73
153	9	A	G 4	43.65	38.2042	92.31	61.80	1.18	51.39	0.519793	14.45
155	9	K	S 9	45.29	37.35149	90.98	62.65	1.08	49.08	0.593229	14.37
157	9	K	G 1	45.78	37.52007	91.41	62.48	1.10	50.40	0.579325	14.23
159	9	K	G 2	45.87	36.73647	89.53	63.26	1.10	50.57	0.713103	14.30
161	9	K	G 3	45.48	37.89785	92.24	62.10	1.10	50.21	0.526144	14.00
163	9	K	G 4	44.61	37.63879	91.90	62.36	1.10	49.25	0.54175	14.43
165	9	O	S 9	49.71	35.40875	93.39	64.59	0.93	46.37	0.444466	13.42
167	9	O	G 1	49.70	35.60074	93.79	64.40	0.93	46.24	0.422954	13.51
169	9	O	G 2	49.14	35.78443	94.35	64.22	0.94	46.29	0.375863	13.57
171	9	O	G 3	48.71	35.18334	92.62	64.82	0.95	46.27	0.497912	13.65
173	9	O	G 4	49.28	35.241	92.72	64.76	0.94	46.29	0.492387	13.40
175	9	P	S 9	51.01	37.8318	92.74	62.17	0.93	47.45	0.479677	14.51
177	9	P	G 1	47.68	37.84812	92.81	62.15	0.99	47.41	0.473467	14.44
179	9	P	G 2	50.01	38.18702	93.64	61.81	0.95	47.35	0.422342	14.45
181	9	P	G 3	50.53	37.9426	92.99	62.06	0.94	47.43	0.458961	14.58
183	9	P	G 4	50.43	38.03985	93.18	61.96	0.94	47.45	0.447436	14.48

Notes: DW means dryweight, % N and % C are based on dryweight. Microcosm code: S 1-8 were for each week, M 1-3 were in the middle of the experiment and G 1-4 were the microcosms for Gas-measurements. A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table B 1: Nitrogen and microbial biomass data

ID	Week	Site	Microcosm	Replicate per MC	NH_4^+ µg N g^{-1}	NO_3^- µg N g^{-1}	N_{inorg} µg N g^{-1}	C_{mic} µg N g^{-1}	N_{mic} µg N g^{-1}	C:N in BM
1	1	A	S 1	1	381.99	27.68		60.98	3.72	14.06
2	1	A	S 1	2	389.26	39.27		67.57	3.65	15.86
3	1	A	S 1	3	391.84	16.31				
4	1	A	S 1	4	391.03		416.29			
5	1	K	S 1	1	112.69	263.64		194.00	13.77	12.07
6	1	K	S 1	2	113.13	307.27		189.86	12.87	12.65
7	1	K	S 1	3	111.78	332.83				
8	1	K	S 1	4	114.64		414.31			
9	1	O	S 1	1	328.37	95.46		90.36	3.14	24.65
10	1	O	S 1	2	323.22	141.35		71.96	2.09	29.48
11	1	O	S 1	3	313.28	215.66				
12	1	O	S 1	4	317.05	126.55	465.24			
13	1	P	S 1	1	299.00	43.83		96.31	5.25	15.73
14	1	P	S 1	2	299.12	80.80		57.42	1.81	27.16
15	1	P	S 1	3	307.32	200.35				
16	1	P	S 1	4	311.42	85.48	406.83			
17	2	A	S 2	1	148.31	58.04		189.47	13.35	12.16
18	2	A	S 2	2	148.76	87.78		136.77	8.14	14.39
19	2	A	S 2	3	151.11	119.96				
20	2	A	S 2	4	158.95	129.94	250.71			
21	2	K	S 2	1	61.72	153.00		276.79	20.95	11.32
22	2	K	S 2	2	60.25	339.10		189.03	15.01	10.80
23	2	K	S 2	3	53.79	246.03				
24	2	K	S 2	4	54.09		303.50			
25	2	O	S 2	1	103.38			154.33	9.38	14.11
26	2	O	S 2	2	103.38	198.35		141.70	9.03	13.45
27	2	O	S 2	3	99.27	198.01				
28	2	O	S 2	4	101.32	210.51	304.12			
29	2	P	S 2	1	46.68	69.66		159.19	10.45	13.05
30	2	P	S 2	2	46.68	142.41		184.37	12.15	13.00
31	2	P	S 2	3	47.43	96.64				

Notes: N_{inorg} is the sum of NO_3^- and NH_4^+. Cmic and Nmic represent microbial biomass after chloroform fumigation.
C:N in BM (Biomass) is the C:N ratio of microbial biomass after chloroform fumigation.
A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table B 2: Nitrogen and microbial biomass data

ID	Week	Site	Microcosm	Replicate per MC	NH_4^+ µg N g^{-1}	NO_3^- µg N g^{-1}	N_{inorg} µg N g^{-1}	C_{mic} µg N g^{-1}	N_{mic} µg N g^{-1}	C:N in BM
32	2	P	S 2	4	45.62	77.84	143.24			
33	3	A	S 3	1	137.66	115.04		236.09	22.72	
34	3	A	S 3	2	141.31	117.54		242.47	23.76	8.77
35	3	A	S 3	3	135.70	120.65				8.80
36	3	A	S 3	4	132.76	103.20	250.96			8.69
37	3	K	S 3	1	62.41	219.97		279.23	26.80	8.90
38	3	K	S 3	2	65.00	249.83		346.57	30.96	8.96
39	3	K	S 3	3	66.19	255.37				9.56
40	3	K	S 3	4	64.86	261.56	311.30			9.63
41	3	O	S 3	1	114.76	144.93		241.27	22.70	9.12
42	3	O	S 3	2	111.40	202.58		250.65	23.84	9.10
43	3	O	S 3	3	113.84	182.98				8.94
44	3	O	S 3	4	106.36	144.26	280.28			9.08
45	3	P	S 3	1	74.89	198.86		196.60	17.21	9.86
46	3	P	S 3	2	73.71	153.57		202.67	17.75	9.73
47	3	P	S 3	3	69.79	189.60				9.91
48	3	P	S 3	4	74.47	180.21	253.77			9.66
49	4	A	S 4	1	26.70	131.30		216.79	22.03	8.43
50	4	A	S 4	2	26.48	96.09		223.27	22.14	8.64
51	4	A	S 4	3	25.54	131.37				
52	4	A	S 4	4	24.39	73.01	133.72			
53	4	K	S 4	1	26.34	225.57		323.38	30.32	9.14
54	4	K	S 4	2	24.04	198.22		279.19	28.85	8.29
55	4	K	S 4	3	27.34	188.01				
55	4	K	S 4	3	27.34	188.01				
56	4	K	S 4	4	24.19	202.65	229.09			
57	4	O	S 4	1	22.54	136.63		305.88	19.96	13.14
58	4	O	S 4	2	22.23	154.75		307.01	19.71	13.35
59	4	O	S 4	3	21.68	135.26				
60	4	O	S 4	4	22.15	121.98	159.30			
61	4	P	S 4	1	10.02	226.90		198.98	23.13	7.37
62	4	P	S 4	2	9.31	180.87		188.46	22.00	7.34

Notes: N_{inorg} is the sum of NO_3^- and NH_4^+. Cmic and Nmic represent microbial biomass after chloroform fumigation.
C:N in BM (Biomass) is the C:N ratio of microbial biomass after chloroform fumigation.
A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table B 3: Nitrogen and microbial biomass data

ID	Week	Site	Microcosm	Replicate per MC	NH_4^+ µg N g^{-1}	NO_3^- µg N g^{-1}	N_{inorg} µg N g^{-1}	C_{mic} µg N g^{-1}	N_{mic} µg N g^{-1}	C:N in BM
63	4	P	S 4	3	10.80	115.92				
64	4	P	S 4	4	10.80	151.24	178.97			
65	5	A	S 5	1	13.69	100.13		184.85	24.40	6.49
66	5	A	S 5	2	10.26	79.34	101.71	188.63	23.64	6.84
67	5	A	M 1	1	8.45	103.98		182.77	22.78	
68	5	A	M 1	2	13.18	65.51	95.56	182.77	22.82	
69	5	A	M 2	1	15.51	103.87			24.60	7.09
70	5	A	M 2	2	11.69	94.19	112.63	184.14	22.73	6.94
71	5	A	M 3	1	10.77	80.37			25.78	8.27
72	5	A	M 3	2	15.24	51.17	78.77		26.29	8.44
73	5	K	S 5	1	8.37	126.67		284.50	32.24	7.56
74	5	K	S 5	2	7.10	102.55	122.35	318.77	33.95	8.05
75	5	K	M 1	1	6.25	114.69		302.86	33.68	7.70
76	5	K	M 1	2	8.97	154.91	142.41	301.63	33.35	7.75
77	5	K	M 2	1	8.19	153.22		304.96	32.60	8.02
78	5	K	M 2	2	7.46	116.25	142.56	321.33	34.45	7.99
79	5	K	M 3	1	8.16	96.60		302.93	33.12	7.84
80	5	K	M 3	2	10.64	128.58	121.99	300.61	32.72	7.87
81	5	O	S 5	1	23.64	129.62		234.76	23.26	8.65
82	5	O	S 5	2	22.90	122.22	149.19	242.33	23.45	8.86
83	5	O	M 1	1	23.48	130.59		213.21	22.08	8.27
84	5	O	M 1	2	22.25	150.04	163.18	209.87	21.74	8.27
85	5	O	M 2	1	11.02	147.84		217.04	22.45	8.28
86	5	O	M 2	2	10.84	142.84	156.27		16.97	
87	5	O	M 3	1	10.72	155.43		195.77	20.30	8.27
88	5	O	M 3	2	10.93	150.56	163.82	225.53	21.84	8.85
89	5	P	S 5	1	2.75	122.16		269.35	24.86	9.29
90	5	P	S 5	2	2.48	123.14	125.27	253.66	23.65	9.19
91	5	P	M 1	1	4.53	119.81		252.30	23.65	9.14
92	5	P	M 1	2	3.64	88.99	108.49	225.27	22.14	8.72
93	5	P	M 2	1	2.75	120.25		172.74	19.13	

Notes: N_{inorg} is the sum of NO_3^- and NH_4^+. Cmic and Nmic represent microbial biomass after chloroform fumigation.
C:N in BM (Biomass) is the C:N ratio of microbial biomass after chloroform fumigation.
A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table B 4: Nitrogen and microbial biomass data

ID	Week	Site	Microcosm	Replicate per MC	NH_4^+ µg N g^{-1}	NO_3^- µg N g^{-1}	N_{inorg} µg N g^{-1}	C_{mic} µg N g^{-1}	N_{mic} µg N g^{-1}	C:N in BM
94	5	P	M 2	2	2.91	130.67	128.29	256.84	23.92	9.20
95	5	P	M 3	1	2.70	108.73		230.78	22.23	8.90
96	5	P	M 3	2	3.37	104.06	109.43	147.62	17.51	7.21
97	6	A	S 6	1	27.98	46.72		231.12	21.74	9.09
98	6	A	S 6	2	34.77			234.93	22.91	9.13
99	6	A	S 6	3	24.50	56.97				8.57
100	6	A	S 6	4	28.92	52.53	81.11			9.00
101	6	K	S 6	1	35.25	36.74		257.78	27.04	8.24
102	6	K	S 6	2	36.98	40.04		255.83	27.13	8.10
103	6	K	S 6	3	35.64	66.64				8.13
104	6	K	S 6	4	36.74	79.10	91.78			8.04
105	6	O	S 6	1	25.34	87.05		268.75	22.63	10.25
106	6	O	S 6	2	27.89	83.12		248.33	21.62	10.11
107	6	O	S 6	3	27.81					
108	6	O	S 6	4	25.34	86.27	112.08			9.80
109	6	P	S 6	1	15.84	59.27		237.15	20.35	9.90
110	6	P	S 6	2	18.07	60.18		217.10	19.19	10.08
111	6	P	S 6	3	16.48	49.35				9.91
112	6	P	S 6	4	16.79	51.67	71.91			9.48
113	7	A	S 7	1	29.04	25.64		243.44	22.52	9.45
114	7	A	S 7	2	32.74	47.94		252.32	23.87	9.08
115	7	A	S 7	3	30.15	54.93				9.11
116	7	A	S 7	4	33.98	51.63	76.51			9.14
117	7	K	S 7	1		54.05		326.84	31.86	
118	7	K	S 7	2	29.81	44.06		359.46	30.29	9.07
119	7	K	S 7	3	29.81	75.90				10.24
120	7	K	S 7	4	30.05	33.39	81.74			10.10
121	7	O	S 7	1	26.01	138.99		323.12	25.58	10.81
122	7	O	S 7	2	22.78	99.17		309.04	24.82	10.85
123	7	O	S 7	3	24.73	144.85				10.70
124	7	O	S 7	4	24.23	94.57	143.83			10.65

Notes: N_{inorg} is the sum of NO_3^- and NH_4^+. Cmic and Nmic represent microbial biomass after chloroform fumigation.
C:N in BM (Biomass) is the C:N ratio of microbial biomass after chloroform fumigation.
A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table B 5: Nitrogen and microbial biomass data

ID	Week	Site	Microcosm	Replicate per MC	NH_4^+ µg N g^{-1}	NO_3^- µg N g^{-1}	N_{inorg} µg N g^{-1}	C_{mic} µg N g^{-1}	N_{mic} µg N g^{-1}	C:N in BM
125	7	P	S 7	1	14.42	74.37		302.19	24.05	10.93
126	7	P	S 7	2	18.95	61.33		303.49	23.90	10.60
127	7	P	S 7	3	18.23	67.77				11.01
128	7	P	S 7	4	15.85	61.38	83.08			10.76
129	8	A	S 8	1	29.12	51.29		229.76	20.05	9.86
130	8	A	S 8	2	26.90	64.87		285.23	22.64	9.78
131	8	A	S 8	3	29.66	59.04				10.91
132	8	A	S 8	4	32.45	69.82	90.78			10.70
133	8	K	S 8	1	37.18	111.25		283.49	23.86	10.11
134	8	K	S 8	2	29.02	129.90		271.55	23.47	10.25
135	8	K	S 8	3	34.49	118.91				10.15
136	8	K	S 8	4	35.39	124.52	155.16			9.68
137	8	O	S 8	1	27.99	182.89		265.98	20.42	10.94
138	8	O	S 8	2	26.06	138.86		256.11	20.39	11.37
139	8	O	S 8	3	26.41	175.97				10.74
140	8	O	S 8	4	25.80		192.47			10.80
141	8	P	S 8	1	19.46	98.71		240.93	20.28	10.11
142	8	P	S 8	2	17.66	88.88		288.87	22.02	10.25
143	8	P	S 8	3	18.31	64.26				10.78
144	8	P	S 8	4	16.19		101.86			11.66
145	9	A	S 9	1	13.05	29.52		223.50	25.10	7.53
146	9	A	S 9	2	12.13	51.94	53.32	284.21	29.77	7.72
147	9	A	G 1	1	17.86	35.49		235.04	26.75	7.59
148	9	A	G 1	2	14.06	51.51	59.46	267.53	29.68	7.32
149	9	A	G 2	1	8.80	27.73		248.20	28.04	6.42
150	9	A	G 2	2	9.59	37.45	41.78	240.47	28.16	6.45
151	9	A	G 3	1	18.15	29.62		182.18	24.34	5.74
152	9	A	G 3	2	18.38	26.23	46.18	181.20	24.07	7.75
153	9	A	G 4	1	11.17	45.01		118.15	17.65	7.63
154	9	A	G 4	2	11.40	30.09	48.84	217.57	24.07	8.18
155	9	K	S 9	1	15.84	24.71		217.35	28.63	8.17

Notes: N_{inorg} is the sum of NO_3^- and NH_4^+. Cmic and Nmic represent microbial biomass after chloroform fumigation.
C:N in BM (Biomass) is the C:N ratio of microbial biomass after chloroform fumigation.
A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table B 6: Nitrogen and microbial biomass data

ID	Week	Site	Microcosm	Replicate per MC	NH_4^+ µg N g^{-1}	NO_3^- µg N g^{-1}	N_{inorg} µg N g^{-1}	C_{mic} µg N g^{-1}	N_{mic} µg N g^{-1}	C:N in BM
156	9	K	S 9	2	16.32	78.48	67.68	340.89	34.37	8.12
157	9	K	G 1	1	11.69	32.33		348.09	36.52	3.96
158	9	K	G 1	2	12.18	27.94	42.07	344.25	36.34	5.75
159	9	K	G 2	1	8.40	21.22		123.56	26.71	4.00
160	9	K	G 2	2	6.90	38.86	37.70	199.06	29.65	5.40
161	9	K	G 3	1	15.55	54.69		117.14	25.07	7.22
162	9	K	G 3	2	18.18	64.42	76.42	171.91	27.28	7.27
163	9	K	G 4	1	16.95	52.05		275.94	32.73	6.51
164	9	K	G 4	2	16.31		68.69	289.44	34.10	8.50
165	9	O	S 9	1	28.57			118.97	21.36	1.72
166	9	O	S 9	2	27.31	70.78	98.72	145.36	22.48	3.63
167	9	O	G 1	1	21.80	90.01		35.69	17.55	7.00
168	9	O	G 1	2	22.31	85.98	110.05	83.93	19.79	7.64
169	9	O	G 2	1	31.38	85.70		170.55	20.83	7.72
170	9	O	G 2	2	29.33	106.96	126.69	195.31	21.91	7.55
171	9	O	G 3	1	31.84	111.37		193.37	21.46	4.95
172	9	O	G 3	2	31.92		143.25	180.23	20.43	4.93
173	9	O	G 4	1	38.88	76.94		120.23	20.82	4.77
174	9	O	G 4	2	37.70	61.29	107.40	120.32	20.93	5.54
175	9	P	S 9	1		55.65		162.49	20.85	6.71
176	9	P	S 9	2		32.77		170.91	20.44	6.63
177	9	P	G 1	1	6.14	39.68		223.97	28.59	6.16
178	9	P	G 1	2	4.57	31.74	41.06	197.55	25.53	5.16
179	9	P	G 2	1	3.26	40.87		148.98	20.70	7.95
180	9	P	G 2	2	4.28		44.64	103.75	17.17	7.67
181	9	P	G 3	1	2.38	32.01		234.21	25.25	8.14
182	9	P	G 3	2	2.38	35.37	36.07	212.48	23.73	7.82
183	9	P	G 4	1	3.43			257.58	27.12	6.68
184	9	P	G 4	2	3.35			211.40	23.18	7.17

Notes: N_{inorg} is the sum of NO_3^- and NH_4^+. Cmic and Nmic represent microbial biomass after chloroform fumigation.
C:N in BM (Biomass) is the C:N ratio of microbial biomass after chloroform fumigation.
A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table C 1: Gas measurements

ID	Week	Site	Microcosm	N_2O µg N g dw^{-1}	CO_2 mg C g dw^{-1}	CH_4 µg C g dw^{-1}	ID	Week	Site	Microcosm	N_2O µg N g dw^{-1}	CO_2 mg C g dw^{-1}	CH_4 µg C g dw^{-1}
1	1	A	G1	0.0030	0.0068	0.0014	27	2	O	G3	-0.0019	0.0243	-0.0231
2	1	A	G2	0.0076	0.0080	0.0022	28	2	O	G4		0.0230	-0.0131
3	1	A	G3	0.0072	0.0083	0.0011	29	2	P	G1	-0.0030	0.0227	-0.0121
4	1	A	G4	0.0089	0.0069	0.0016	30	2	P	G2	0.0036	0.0251	-0.0184
5	1	K	G1	0.0069	0.1018	0.0013	31	2	P	G3	-0.0015	0.0230	-0.0115
6	1	K	G2	0.0010	0.1063	0.0011	32	2	P	G4	-0.0016	0.0253	-0.0031
7	1	K	G3		0.1069		33	3	A	G1	0.0018	0.0139	-0.0048
8	1	K	G4	0.0033	0.1027	0.0015	34	3	A	G2	0.0028	0.0159	-0.0044
9	1	O	G1	-0.0022	0.0180	-0.0062	35	3	A	G3	0.0028	0.0159	-0.0046
10	1	O	G2	-0.0013	0.0164	-0.0135	36	3	A	G4	0.0023	0.0141	
11	1	O	G3	-0.0016	0.0180	-0.0065	37	3	K	G1	-0.0016	0.0212	-0.0077
12	1	O	G4	-0.0010	0.0155	-0.0079	38	3	K	G2	-0.0021	0.0231	-0.0105
13	1	P	G1	-0.0026	0.0276	-0.0058	39	3	K	G3	-0.0014	0.0236	-0.0076
14	1	P	G2	-0.0038	0.0300	-0.0084	40	3	K	G4	-0.0024	0.0251	-0.0113
15	1	P	G3	-0.0022	0.0310	-0.0071	41	3	O	G1	-0.0080	0.0222	-0.0067
16	1	P	G4	-0.0014	0.0314	-0.0051	42	3	O	G2	-0.0028	0.0214	-0.0065
17	2	A	G1	-0.0019	0.0207	-0.0046	43	3	O	G3	-0.0024	0.0237	-0.0091
18	2	A	G2	-0.0033	0.0177	-0.0097	44	3	O	G4	-0.0041	0.0225	-0.0085
19	2	A	G3	-0.0027	0.0186	-0.0093	45	3	P	G1	0.0054	0.0209	
20	2	A	G4	-0.0018	0.0160	-0.0054	46	3	P	G2	0.0064	0.0165	-0.0163
21	2	K	G1	-0.0077	0.0172	-0.0102	47	3	P	G3	0.0064	0.0187	-0.0155
22	2	K	G2	-0.0075	0.0172	0.0024	48	3	P	G4	0.0066	0.0205	-0.0143
23	2	K	G3	-0.0048	0.0191	0.0079	49	4	A	G1	0.0017	0.0101	-0.0169
24	2	K	G4	-0.0048	0.0161	-0.0020	50	4	A	G2	0.0014	0.0142	-0.0176
25	2	O	G1	-0.0018	0.0198	-0.0175	51	4	A	G3	0.0015	0.0143	-0.0017
26	2	O	G2	-0.0024	0.0221	-0.0264	52	4	A	G4	0.0004	0.0123	-0.0097

Notes: A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table C 2: Gas measurements

ID	Week	Site	Microcosm	N_2O µg N g dw^{-1}	CO_2 mg C g dw^{-1}	CH_4 µg C g dw^{-1}	ID	Week	Site	Microcosm	N_2O µg N g dw^{-1}	CO_2 mg C g dw^{-1}	CH_4 µg C g dw^{-1}
52	4	A	G4	0.0004	0.0123	-0.0097	89	5	P	G1	-0.0019	0.0126	-0.0033
53	4	K	G1	-0.0004	0.0222	-0.0101	90	5	P	G2	-0.0024	0.0114	-0.0058
54	4	K	G2	0.0040	0.0271	0.0008	91	5	P	G3	-0.0020	0.0113	-0.0021
55	4	K	G3	-0.0029	0.0244	-0.0076	92	5	P	G4	-0.0015	0.0133	-0.0020
56	4	K	G4	-0.0036	0.0240	-0.0104	97	6	A	G1	-0.0007	0.0074	
57	4	O	G1	-0.0007	0.0154	-0.0096	98	6	A	G2	-0.0017	0.0084	-0.0067
58	4	O	G2	-0.0059	0.0165	-0.0144	99	6	A	G3	-0.0013	0.0096	-0.0059
59	4	O	G3	-0.0027	0.0165	-0.0103	100	6	A	G4	-0.0014	0.0083	-0.0054
60	4	O	G4	-0.0053	0.0173	-0.0150	101	6	K	G1	-0.0012	0.0159	-0.0024
61	4	P	G1	0.0026	0.0147	-0.0067	102	6	K	G2	0.0040	0.0176	-0.0053
62	4	P	G2	0.0028	0.0135	-0.0099	103	6	K	G3	-0.0016	0.0179	-0.0090
63	4	P	G3	0.0011	0.0132	-0.0069	104	6	K	G4	0.0036	0.0185	-0.0027
64	4	P	G4	0.0024	0.0150	-0.0133	105	6	O	G1	-0.0056	0.0083	-0.0030
65	5	A	G1	-0.0019	0.0089	-0.0126	106	6	O	G2	-0.0013	0.0103	-0.0107
66	5	A	G2	-0.0024	0.0097	-0.0162	107	6	O	G3	-0.0079	0.0111	-0.0013
67	5	A	G3	-0.0023	0.0103	-0.0056	108	6	O	G4	-0.0038	0.0098	-0.0069
68	5	A	G4	-0.0014	0.0077	-0.0126	109	6	P	G1	-0.0034	0.0096	-0.0070
73	5	K	G1	-0.0019	0.0161	-0.0077	110	6	P	G2	-0.0092	0.0108	
74	5	K	G2	0.0029	0.0193	-0.0084	111	6	P	G3	-0.0040	0.0093	-0.0068
75	5	K	G3	-0.0003	0.0196	-0.0046	112	6	P	G4	-0.0008	0.0124	-0.0070
76	5	K	G4	-0.0012	0.0173	-0.0152	113	7	A	G1	0.0063	0.0068	-0.0043
81	5	O	G1	-0.0014	0.0093	-0.0080	114	7	A	G2	0.0027	0.0082	-0.0026
82	5	O	G2	0.0006	0.0095	-0.0097	115	7	A	G3	0.0020	0.0085	-0.0045
83	5	O	G3	0.0006	0.0128	-0.0065	116	7	A	G4	-0.0008	0.0070	-0.0020
84	5	O	G4	0.0014	0.0109	-0.0065	117	7	K	G1	0.0033	0.0148	-0.0049
89	5	P	G1	-0.0019	0.0126	-0.0033	118	7	K	G2	0.0085	0.0175	0.0019

Notes: A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table C 3: Gas measurements

ID	Week	Site	Microcosm	N_2O µg N g dw^{-1}	CO_2 mg C g dw^{-1}	CH_4 µg C g dw^{-1}	ID	Week	Site	Microcosm	N_2O µg N g dw^{-1}	CO_2 mg C g dw^{-1}	CH_4 µg C g dw^{-1}
119	7	K	G3	0.0028	0.0159	-0.0090	140	8	O	G4	-0.0024	0.0092	-0.0034
120	7	K	G4	0.0075	0.0148	-0.0046	141	8	P	G1	0.0013	0.0108	-0.0027
121	7	O	G1	-0.0033	0.0090	-0.0031	142	8	P	G2	0.0034		-0.0006
122	7	O	G2	-0.0043	0.0095	-0.0059	143	8	P	G3		0.0108	-0.0035
123	7	O	G3	-0.0040	0.0095	-0.0101	144	8	P	G4	0.0011	0.0104	-0.0026
124	7	O	G4	-0.0013	0.0086	-0.0082	147	9	A	G1	0.0039	0.0051	-0.0041
125	7	P	G1	0.0056	0.0103	-0.0066	149	9	A	G2	0.0024	0.0053	-0.0020
126	7	P	G2	0.0084	0.0088	-0.0125	151	9	A	G3	0.0020	0.0056	-0.0028
127	7	P	G3	0.0077	0.0092	-0.0166	153	9	A	G4	0.0002	0.0049	-0.0043
128	7	P	G4	0.0064	0.0121	-0.0143	157	9	K	G1	0.0021	0.0107	-0.0051
129	8	A	G1	-0.0068	0.0058	-0.0053	159	9	K	G2	0.0004	0.0095	-0.0115
130	8	A	G2	-0.0025	0.0063	-0.0084	161	9	K	G3	0.0004	0.0106	-0.0089
131	8	A	G3	0.0034	0.0075	-0.0062	163	9	K	G4	0.0007	0.0103	-0.0071
132	8	A	G4	-0.0019	0.0081	0.0056	167	9	O	G1	-0.0041	0.0050	-0.0055
133	8	K	G1	0.0033	0.0138	-0.0053	169	9	O	G2	-0.0040	0.0064	-0.0056
134	8	K	G2	0.0039	0.0144	0.0003	171	9	O	G3	-0.0041	0.0077	-0.0055
135	8	K	G3	0.0027	0.0154	0.0054	173	9	O	G4		0.0071	-0.0056
136	8	K	G4	0.0064	0.0150	0.0050	177	9	P	G1	0.0035	0.0066	-0.0143
137	8	O	G1	-0.0023	0.0086	-0.0061	179	9	P	G2	0.0029	0.0067	-0.0054
138	8	O	G2	-0.0094	0.0101	0.0003	181	9	P	G3	0.0045	0.0070	-0.0033
139	8	O	G3	-0.0179	0.0106	-0.0066	183	9	P	G4	0.0009	0.0072	-0.0110

Notes: A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table D 1: PLFA data

ID	Week	Site	MC	Rep	Fungi ng g dw^{-1}	Gram+ ng g dw^{-1}	Gram- ng g dw^{-1}	Actinomycetes ng g dw^{-1}	Bacteria ng g dw^{-1}	Protozoa ng g dw^{-1}	FB-Ratio	Total PLFA ng g dw^{-1}
1	1	A	S 1	1	11.418	1.375	37.028	0.254	41.005	0.307	0.278	50.382
2	1	A	S 1	2	9.438	1.085	44.700	0.180	48.006	0.244	0.197	55.648
3	1	A	S 1	3	8.941	1.127	45.510	0.171	48.814	0.239	0.183	55.989
5	1	K	S 1	1	7.801	0.832	42.251	0.043	46.032	0.237	0.169	51.164
6	1	K	S 1	2	7.560	0.820	42.337	0.000	45.950	0.188	0.165	50.906
7	1	K	S 1	3	7.517	0.844	42.580	0.000	46.169	0.213	0.163	51.154
9	1	O	S 1	1	11.047	3.010	40.051	0.366	45.798	0.362	0.241	54.836
10	1	O	S 1	2	8.929	2.317	45.004	0.259	49.904	0.235	0.179	56.743
11	1	O	S 1	3	8.892	2.301	45.552	0.251	50.407	0.357	0.176	57.354
13	1	P	S 1	1	9.026	1.392	44.737	0.264	48.550	0.360	0.186	55.778
14	1	P	S 1	2	8.597	1.287	45.410	0.187	49.079	0.317	0.175	55.798
15	1	P	S 1	3	8.519	1.224	45.693	0.169	49.240	0.309	0.173	55.915
65	5	A	S 5	1	18.173	4.624	29.353	0.319	36.961	0.509	0.492	52.978
67	5	A	M 1	1	17.404	4.629	29.331	0.328	36.944	0.528	0.471	52.220
69	5	A	M 2	1	18.306	4.141	31.390	0.305	38.322	0.446	0.478	54.589
71	5	A	M 3	1	18.594	4.258	32.328	0.317	39.368	0.514	0.472	56.011
73	5	K	S 5	1	17.834	3.697	33.136		39.674	0.423	0.449	
75	5	K	M 1	1	18.548	3.844	32.230	0.234	38.916	0.421	0.477	55.276
77	5	K	M 2	1	18.555	4.006	36.214	0.240	42.881		0.433	
79	5	K	M 3	1	18.151	3.831	35.554	0.239	42.054	0.436	0.432	58.211
81	5	O	S 5	1	18.856	6.927	29.291	0.418	39.235	0.472	0.481	55.965
83	5	O	M 1	1	18.853	6.868	29.789	0.402	39.686	0.463	0.475	56.375
85	5	O	M 2	1	19.088	7.139	32.534	0.413	42.550	0.455	0.449	59.630
87	5	O	M 3	1	18.287	7.515	32.588	0.393	43.049	0.473	0.425	59.256
89	5	P	S 5	1	18.134	3.283	32.528	0.217	38.627	0.825	0.469	54.988
91	5	P	M 1	1	16.965	3.141	32.029	0.202	37.979	0.895	0.447	53.231
93	5	P	M 2	1	18.052	3.496	35.163	0.216	41.395	0.932	0.436	57.858

Notes: MC means microcosm and Rep means replication inside a microcosm. In week one the samples were taken out of the litter pool. Details on PLFA-composition for the particular groups are found in the text (Material and Methods).
Sites: A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Table D 1: PLFA data

ID	Week	Site	MC	Rep	Fungi ng g dw^{-1}	Gram+ ng g dw^{-1}	Gram- ng g dw^{-1}	Actinomycetes ng g dw^{-1}	Bacteria ng g dw^{-1}	Protozoa ng g dw^{-1}	FB-Ratio	Total PLFA ng g dw^{-1}
95	5	P	M 3	1	17.579	3.504	34.292	0.224	40.529	0.914	0.434	56.514
145	9	A	S 9	1	18.980	5.170	27.758	0.345	35.842	0.501	0.530	52.753
147	9	A	G 1	1	18.731	5.268	28.047	0.377	36.301	0.530	0.516	52.952
149	9	A	G 2	1		5.704	29.526	0.352	38.245	0.388		
151	9	A	G 3	1		5.471	30.026	0.377	38.541	0.445		
153	9	A	G 4	1	18.942	5.159	28.086	0.379	36.199	0.508	0.523	53.075
155	9	K	S 9	1	21.054	4.435	29.714	0.403	37.291	0.485	0.565	56.091
157	9	K	G 1	1	15.192	5.338	32.055	0.388	40.464	0.436	0.375	53.410
159	9	K	G 2	1	14.265	5.099	32.518	0.431	40.831	0.499	0.349	52.813
161	9	K	G 3	1	20.069	4.828	29.793	0.535	38.018	0.521	0.528	55.745
163	9	K	G 4	1	21.047	4.249	30.393	0.331	37.706	0.516	0.558	56.535
165	9	O	S 9	1	15.076	10.149	30.174	0.699	43.899	0.458		
167	9	O	G 1	1	19.683	8.371	28.902	0.643	40.591	0.531	0.485	58.131
169	9	O	G 2	1	19.722	8.239	28.678	0.681	40.260	0.505	0.490	57.825
171	9	O	G 3	1	15.523	9.234	30.207	0.774	42.886	0.473	0.362	56.211
173	9	O	G 4	1	15.232	9.715	30.441	0.733	43.602	0.476		
175	9	P	S 9	1	14.707	5.696	33.595	0.320	42.391	0.758	0.347	55.077
177	9	P	G 1	1	14.826	6.190	31.416	0.330	40.834	0.762	0.363	53.525
179	9	P	G 2	1	19.125	4.814	30.929	0.331	38.898	1.056	0.492	56.255
181	9	P	G 3	1	19.942	4.572	30.537	0.273	38.264	0.892	0.521	56.215
183	9	P	G 4	1	15.007	5.113	32.491	0.308	40.626	0.820	0.369	53.740

Notes: MC means microcosm and Rep means replication inside a microcosm. In week one the samples were taken out of the litter pool. Details on PLFA-composition for the particular groups are found in the text (Material and Methods).
Sites: A stands for Achenkirch, K for Klausen-Leopoldsdorf, O for Orth and P for Perg.

Lebenslauf

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Persönliche Daten

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Beruf der Mutter: pensionierte Unternehmerin (Bäckerei Brandstätter)

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1989 - 1993 Volksschule Tragwein

1993 - 1997 Gymnasium Petrinum Linz

1997 - 2002 Höhere Bundeslehranstalt für wirtschaftliche Berufe in Perg

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