

## Effects of soil microarthropods on plant litter decomposition across an elevation gradient in the Wuyi Mountains

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### ABSTRACT

Soil microarthropods are considered to be among the strongest determinants of plant litter decomposition in warm, humid sites. Little is known, however, about the regulation of plant litter decomposition dynamics along an elevation gradient in such sites. Our study examined the contributions of soil microarthropods to leaf litter decomposition of a single substrate (*Castanopsis carlesii*) along an elevation gradient across four types of zonal vegetations in southeastern China: evergreen broadleaf forest (EVB); coniferous forest (COF); dwarf forest (DWF); and alpine meadow (ALM) during April 2007 to March 2008. Leaf litter decomposition of *C. carlesii* was significantly accelerated by the presence of fauna in all four sites. After 360 days in the field, mass loss rates with the full decomposer assemblage and in the reduction of microarthropods were 62.9% and 41.2% in EVB, 48.1% and 30.6% in COF, 36.4% and 27.8% in DWF, 30.3% and 23.7% in ALM, respectively. The percentage of total decomposition due to the presence of soil fauna was 37% in EVB, 25% in COF, 12% in DWF, and 8% in ALM, thus showing strong systematic variation along the elevational gradient. The mass losses in control plots at the four sites were significantly correlated with the abundances of total Acari, Collembolans, and Mesostigmata mites. Although the proportion of Oribatid mites at EVB was not the highest among the four sites, there were elevated proportions of Mesostigmatid and Prostigmata mites, many of which were microbe-consuming species and induce an indirect influence on litter decomposition. Moreover, Shannon Index ( $F = 2.455$ ,  $p = 0.093$ ) and Group Number ( $F = 5.830$ ,  $p = 0.005$ ) both decreased along the elevation gradients. Mass losses were also found to be distinctively related to  $H'$  ( $r^2 = 0.984$ ,  $p = 0.016$ ), and GN ( $r^2 = 0.952$ ,  $p = 0.048$ ) across the four sites. Our results suggest that the faunal contribution to plant litter decomposition varies markedly across environmental gradients that differ in litter faunal diversity.

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### 1. Introduction

Plant litter decomposition is an important biological process driven by a range of complex and interacting physical factors, such as climate, substrate, soil organisms, and physical and chemical properties of soils (Dyer et al., 1990; Berg et al., 1993; Singh et al., 1999; Pausas et al., 2004). Mechanisms of soil faunal contribution to litter decomposition include digestion of substrates, increase of surface area through fragmentation, and acceleration of microbial inoculation to materials (Swift et al., 1979; Wise and Matthias, 1994; Coleman and Crossley, 1996; Ekschmitt et al., 2005; Janzen, 2006). Soil microarthropods as prevalent components of the soil fauna, have been shown to increase the rates of litter decomposition, nutrient cycling and primary productivity in forest ecosystems (Seastedt, 1984; Setälä and Huhta, 1991; Hart and Klironomos, 2002;

Moore et al., 2004; Kreuzer et al., 2004), through digestion and breakdown of the litter, stimulation of microbial activity and transport of fungal and bacterial propagules (Moore et al., 1988; Lussenhop, 1992; Byzov et al., 1996; Schlesinger, 1997; Read and Perez-Moreno, 2003). Soil fauna can influence microbial species composition or biomass (Visser, 1985; Bohan and Richard, 2001; Groffman et al., 2004), thus altering decomposition rates and nutrient cycles (Moore et al., 1988; Chauvel et al., 1999; Lavelle, 2002; Xuluc et al., 2003). Moreover, litter fragmentation and passage through the guts of microarthropods such as millipedes and isopods favor the establishment of soil microbial populations (Griffiths and Bardgett, 1997). As a consequence of these linkages between belowground trophic cascades and ecosystem processes, different microarthropod assemblages have proved to significantly affect the leaching of a wide range of soil nutrients (Hasegawa and Hiroshi, 1995; Heneghan and Bolger, 1996; Salmon, 2004).

Little is known about the response of soil biota to changes in climate, and the possible effects of soil communities on the process

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of decomposition. Altitudinal gradients often produce climatic effects that would result from latitudinal changes, and so have been used as surrogates for latitudinal gradients. This has prompted research on litter decomposition dynamics across elevational gradients, but such research has been hampered by the lack of methodological comparability, the paucity of comprehensive studies, and the lack of a unifying conceptual framework. Vitousek et al. (1994) suggested that decomposition rates decrease exponentially as temperature falls along elevation gradients, but there are many other factors that can alter to control litter decomposition rates in all terrestrial systems, including climate, edaphic structure, resource quality, fauna, and microbes. The limited climatic variability in warm humid zones means that mutualistic interactions of fauna and microbes that play a dominant role in biotic interactions may be the strongest determinants of decomposition dynamics for any one leaf type (Lavelle et al., 1993).

The Wuyi Mountains are located in the humid warm subtropics in the southeast of China, with strong climatic variation along elevational gradients, and clear vertical zonation of vegetation types. We carried out our studies in four sites representing four vegetation types: evergreen broadleaf forest (EVB); coniferous forest (COF); dwarf forest (DWF); and alpine meadow (ALM) with a distinct assemblage of microarthropod assemblages. Here we address three questions: (1) Along the elevational gradients, what are the effects of climate and biotic assemblages in regulating the decomposition of a common substrate? (2) Are microarthropods more influential on leaf litter decomposition rates in the low altitude sites than higher ones? (3) Is there a relationship between the composition and structure of the microarthropod assemblages and their contribution to decomposition across the elevation gradients?

## 2. Materials and methods

### 2.1. Site description

Four sites with different vegetation types (EVB, COF, DWF, and ALM) were established along an elevational gradient in the Wuyi National Nature Reserve in northern Fujian province, a 56,527 ha forested area in the southeast of China (117°27'–117°51'E, 27°33'–27°54'W). The lowest altitude site was located in a 1175 ha subtropical evergreen broadleaf forest at 500 m above sea level and annual mean rainfall of 1700 mm. The mean annual temperature is 17–19 °C (He et al., 1994). *Castanopsis carlesii* with 14.7 m of mean tree height is the prevailing tree species at this elevation.

The second site was temperate coniferous forest with an elevation of 1150 m, mean annual temperature of approximately 14.5 °C (Zheng and Fang, 2004), and annual mean rainfall of 2000 mm (He et al., 1994). Vegetation is dominated by *Pinus taiwanensis* with a mean diameter at breast height (DBH) 22 cm.

The third site at an elevation of 1750 m was dwarf forest with annual mean rainfall of 2200 mm and a mean annual temperature of 11.2 °C (He et al., 1994; Zheng and Fang, 2004). The dominant tree species in the site is *Symplocos paniculata* and *Stewartia sinensis* with 4.5 m of mean tree height.

Alpine meadow at an elevation of 2150 m is near the top of the highest mountain in southeast continent of China with annual mean rainfall of 3100 mm, and mean annual temperature of nearly 9.7 °C (He et al., 1994; Zheng and Fang, 2004). The site is covered by 25 cm of mean height herbage vegetation (e.g. *Calamagrostis brachytricha*, *Miscanthus sinensis*, and *Lycopodium clavatum*).

### 2.2. Experimental design and sampling

We collected recently senesced leaves of *C. carlesii* in the evergreen broadleaf forest at Wuyi Field Ecological Research Station,

and placed approximately 4 g of air-dried litter in nylon litterbags (10 × 10 cm). Leaf litter samples were oven-dried at 60 °C to establish the relationship between air-dry and oven-dry mass.

We placed a total of 288 litterbags in the field: 72 in each of the sites (EVB, COF, DWF, and ALM). At each site, 72 litterbags of nylon screen with 1.00 mm mesh size containing leaf litter of *C. carlesii* were placed into in each of three random blocks (50 × 60 m). Each block was spaced out 10 m apart.

Within each block, two plots of (4 × 4 m) were set up. Two treatments were randomly assigned to the two plots within each block: control (without naphthalene) and fauna-reduced (naphthalene applied). We placed 12 litterbags on each plot. The fauna-reduced litterbags were treated each month with naphthalene (100 g m<sup>-2</sup> mol<sup>-1</sup>) to quantify the mass loss contributed by the fauna (Heneghan et al., 1999; Hou et al., 2005).

Every two months, 12 litterbags (six from naphthalene-treated plots and six from control plots) were collected at random from each site. All collected litterbags were subjected to faunal extraction (see below) and then oven-dried at 60 °C and weighed to determine remaining litter mass.

We used 4 sets of HOBO onset micro-climatic recorders to measure the air temperatures from April 2007 to March 2008 at 15-min intervals at the four sites.

### 2.3. Fauna inventory

In the laboratory of the Wuyi Field Ecological Research Station, collected litterbags were immediately placed in modified Tullgren extractors to remove the litter invertebrates (Wallwork, 1976). This collection strategy is dependent upon convenient access to the sites and upon the efficiency of the extraction technique. All extracted faunal samples were preserved in 75% ethanol and then sorted under a dissecting microscope (Leica MZ 125) into broad taxonomic groups (e.g. Acari, Oribatid, Mesostigmatid, and Prostigmatid mites, Collembola, and Hymenoptera, Yin, 1998).

### 2.4. Statistical analysis

Mass remaining on each sampling date at each site was examined with repeated-measures analysis of variance. Repeated-measures analysis of variance provides a conservative test of the null hypothesis that mass loss of litter remained unaffected by the reduction of microarthropods. Preplanned contrasts of decomposition in litterbags from control and fauna-reduced were performed using repeated-measures analysis of variance.

Relative mass loss contributed by the fauna was calculated as:  $MLCF = (\text{treated litterbags} - \text{untreated litterbags}) / \text{treated litterbags}$  where treated litterbags are those to which naphthalene has been applied. Fauna-reduced rate by naphthalene was computed as:  $FRR = \text{treated litterbags} / \text{untreated litterbags}$ . Naphthalene reported as an effective biocide was widely applied in repelling soil microarthropods in litter decomposition experiments to quantify faunal contribution (Zlotin, 1971; Blair et al., 1989; Heneghan et al., 1999; Hou et al., 2005; Xiong et al., 2008). There is evidence from microcosm studies, however, that naphthalene can affect microbial activity and ecosystems (Williams and Wiegert, 1971; Heitkamp et al., 1987; Blair et al., 1989). So we mainly distributed naphthalene around the litterbags so that fauna would be reduced from the portion of the plots containing these bags. Although there is no evidence that naphthalene application in our study at the rates affects microbial activity, this caution must be borne in mind when the conclusions were drawn.

Diversity, Abundance and Group Number were calculated for fauna communities in the 60 d interval of 12 months decomposition in the four sites. Group Number (GN) and Abundance were

expressed as # individuals d. w. litter. Diversity was measured with the Shannon–Wiener Index ( $H'$ ):  $H' = -\sum n_i/N \times \ln(n_i/N)$  where  $n_i$  are individuals of group  $i$  and  $N$  totals of the groups in community (Whittaker, 1972). Pearson's correlation coefficients were used to express the relationships of the mass loss values with the litter microarthropod Abundance, Shannon Index, and Group Number. Statistical analyses were performed using SPSS Programme (Inso Corporation, 1999).

### 3. Results

#### 3.1. Leaf litter decomposition rates

Decomposition rates in litterbags from control or fauna-reduced plots were significantly different among the four sites ( $p < 0.05$ ). Mean mass losses in control and fauna-reduced plots were 46.7% and 29.7%, respectively, in EVB, 33.4% and 24.0% in COF, 27.6% and 22.4% in DWF, and 23.6% and 19.1% in ALM. We found that the mean mass loss along the elevation gradient was positively related to mean annual temperature (Fig. 1,  $p < 0.05$ ). The litter decomposition proceeded slowly during initial 60 days in the field, with a mean mass loss less than 8.7% at the four sites. After 60 days, rates of litter decomposition increased, and the mean mass loss was higher than 22% (Fig. 2). The mass loss rates both in control and fauna-reduced treatment at EVB were significantly faster than those at any of the other sites along the elevation gradients ( $p < 0.05$ ).

Leaf litter decomposition rate was significantly influenced by fauna in all the four sites after 60 days (Figs. 2 and 3). Leaf litter mass loss at EVB was consistently affected by the presence of fauna (Fig. 2A, Table 1). After 12 months, 62.9% of its original mass had been lost and the mean contribution of the fauna was 36.9%. The faunal influence on decomposition at COF was only significant later in the sampling period (Fig. 2B, Table 1). After 360 d the mass loss in the litterbags from the control sites exceeded 48.1%, and the difference in the ratio of the % mass loss between the control and fauna-reduced litterbags was 21.3%. An interaction between month and treatment was noted at EVB, COF and DWF, indicating differences in the trajectories with and without fauna (Table 1). The contributions of microarthropods to mass loss did not show significance until 120 d decomposition at DWF (Fig. 2C, Table 1). At the end of 360 d, 36.4% of the substrate had decomposed, with a contribution of 12.0% by the fauna. After 360 d of decomposition in the field the mass loss was 30.3% in litterbags with fauna at ALM, similar to DWF (Fig. 2D).

#### 3.2. Inventory of fauna

Fauna extracted from the litterbags at two treatments varied among the four sites (Table 2). Oribatids, Prostigmata, Mesostigmata and Collembola were the predominant groups, with each group comprising almost 8% or more of the individuals collected at all sites.

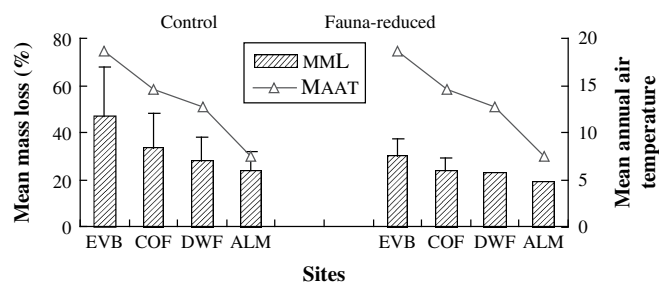


Fig. 1. The relationship between the mean mass loss (the average of six samples in the 12 months decomposition) of *C. carlesii* leaf litter (MML) in the control and fauna excluded plots, and the mean annual air temperature (MAAT) at the four sites.

Proportions of Oribatid mites were particularly high, ranging from 40% to 53% among sites. Although the proportion of Oribatid mites in the evergreen broadleaf forest was not the highest of all four sites, there were elevated proportions of Mesostigmatid and Prostigmata mites, many of which were microbe-consuming species (Newell, 1984a,b; Heneghan et al., 1999). Thus the largest functional component of the mesofauna of all sites was non-predatory mites. Prostigmata were the second most dominant component of the mesofauna at ALM, and the fourth largest component at EVB, COF and DWF. Collembola were the second largest faunal component at COF and DWF, and the third most numerous groups at EVB, where Mesostigmatid mites ranked second (Table 2). The individual of total Acari, Oribatid, Mesostigmatid mites, Prostigmatid mites and total microarthropods were found to be significantly different in litterbags with and without naphthalene (Table 2). The Abundance of Astigmatids, Hymenoptera, Diptera, and other litter microarthropods did not vary between treatments, and that of collembolans did not vary at ALM. The Abundance of microarthropods was significantly different along the elevation gradients ( $F = 48.650$ ,  $p < 0.001$ ). Shannon Index ( $F = 2.455$ ,  $p = 0.093$ ) and Group Number ( $F = 5.830$ ,  $p = 0.005$ ) both decreased across the four sites.

Although all mesofauna were not excluded by naphthalene application with the concentration and frequency in our experiment, macrofauna were all excluded and total microarthropods also reduced by over 60 percent in the four sites (Table 2). Especially the individuals of Mites and Collembolas, 85–91% of microarthropods, were reduced in large scale. Oribatid, Mesostigmatid mites, and Prostigmatid mites reported to have important contribution to litter decomposition were also cut from 62% to 73%. Collembolans were decreased by 73–83% at EVB, COF, and DWF, and 55% at ALM. Other mesofauna, e.g., Astigmata, Coleoptera, Hymenopter, Homoptera, Isopoda, and Protura were less in the two treatments. Opiliones, Thysanopte, Isoptera, Pseudoscor and Synphyla were excluded in the four sites.

#### 3.3. Influence of faunal diversity on decomposition

After one year of incubation in the field, the mass losses of *C. carlesii* leaf litter in litterbags from control plots at the four sites were significantly correlated with the Abundance of total Acari, Collembolans, and Mesostigmata mites (Table 3). However, only in the Alpine Meadow were mass losses significantly related to the total microarthropods while the temporal dynamics of total numbers of mesofauna in the site, showed distinctly increased trend that coincides with the change of mass losses of leaf litter. The Abundance of Oribatids was significantly contributed to leaf litter decomposition only in the evergreen broadleaf forest, dwarf forest, and alpine meadow. Variation in litter decomposition was related to Abundances of Prostigmatid mites in the coniferous forest and alpine meadow. Furthermore, the Abundances of Astigmatid mites and other microarthropods were not significantly correlated with leaf litter mass losses. Although the abundances of microarthropods were not significantly related to mass loss, there were distinctively different ( $F = 48.650$ ,  $p < 0.001$ ) along the elevation gradients. Both Shannon Index ( $F = 2.455$ ,  $p = 0.093$ ) and Group Number ( $F = 5.830$ ,  $p = 0.005$ ) decreased and mass losses were significantly related to  $H'$  ( $r^2 = 0.984$ ,  $p = 0.016$ ), and GN ( $r^2 = 0.952$ ,  $p = 0.048$ ) across four sites (Fig. 4).

## 4. Discussion

#### 4.1. Decomposition among sites

Climate exerts an important influence on decomposition in hierarchical models of decomposition (Lavelle et al., 1993; Aerts,

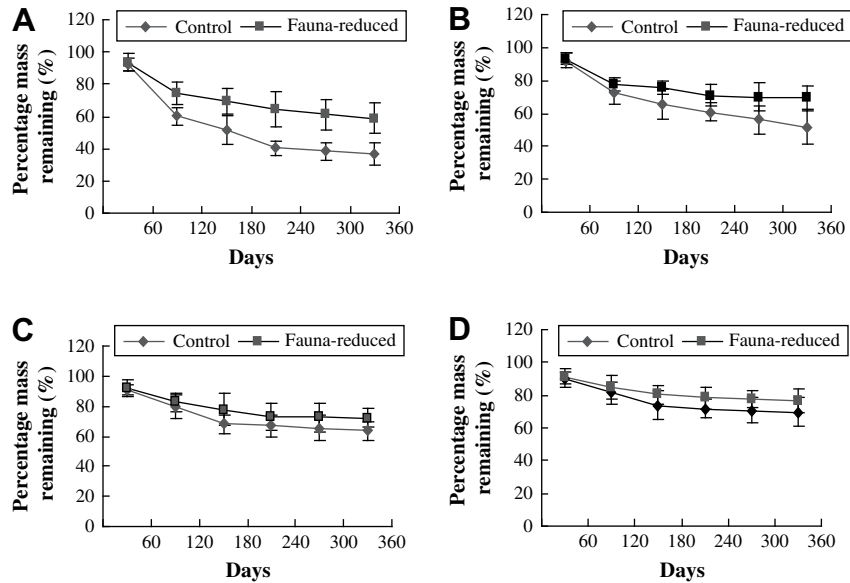


Fig. 2. Changes in mass of *C. carlesii* leaf litter remaining at: (A) Evergreen broadleaf forest (EVB); (B) Coniferous forest (COF); (C) Dwarf forest (DWF); (D) Alpine meadow (ALM).

1997), and litter decomposition decreases as air temperature falls along elevation gradients (Vitousek et al., 1994). Climatic effects on decomposition at large scales are apparent from the relationship between actual evapotranspiration and decomposition rates (Meentemeyer, 1978; Dyer et al., 1990; Berg et al., 1993).

We found a positive relationship between the mean mass loss and annual air temperature along the elevation gradients (Fig. 2), supporting previous work. The mass loss of *C. carlesii* leaf litter, with the full decomposer assemblage and in the fauna-reduced plots, was subtropical evergreen broadleaf forest > temperate coniferous forest > cold temperate dwarf forest > frigid zone alpine meadow. It is similar to the latitudinal decomposition rule of tropics > subtropics > temperate zone > cold temperate zone > frigid zone (Berg et al., 1993). The marked spatial differences in temperature and water along elevation gradients in the Wuyi Mountains are probably responsible for the strong observed response of litter decomposition. Total mass loss in control plots after one year decomposition in the subtropical evergreen broadleaf forest site was approximately 63%, much more rapid than at the other three sites (48.1%, 36.4%, and 30.3%), indicating that climatic constraints are the strongest regulators of decomposition. Within sites, fauna often had significant effects on litter decomposition (Table 3).

#### 4.2. Faunal influence on decomposition rates overall across the four sites

It has been widely observed that increased microarthropod Abundance leads to more mass loss from a variety of substrates at both tropical and temperate sites (Crossley and Hoglund, 1962; Reddy and Venkataiah, 1989; Reddy, 1995; González et al., 2001; Ruan et al., 2005). In the subtropics, however, few decomposition studies have manipulated microarthropod Abundances to understand the role of microarthropods in accelerating mass loss, e.g. Ke et al. (1999). Xiong et al. (2005) manipulated the Abundance of soil fauna in decomposing leaves and reported that decomposition of the leaf litter proceeded more rapidly in coarse- than fine-mesh litterbags.

In this study the two lower-altitude sites had the most abundant soil fauna, yet during the first two months, litter decomposition was slower. Rainfall increases with elevation may have accelerated the leaching process. It might also be that rainfall increased the loss of small fragments from 1.0 mm bags. Decompositions during the final 10 months were faster at the lower elevations, perhaps related to the contributions of microarthropods. At the same time, there were strong differences in decomposition between subtropical

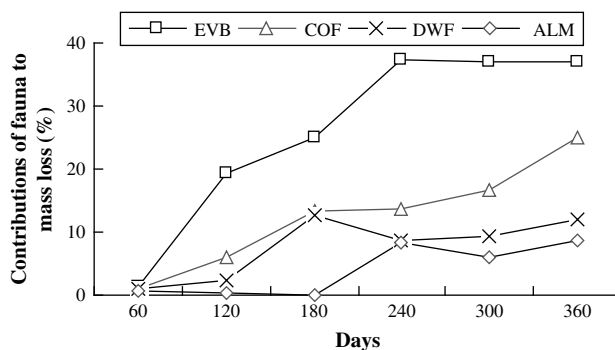


Fig. 3. The contribution of soil fauna to the mass loss of *C. carlesii* leaf litter at the four sites.

**Table 1**

Results of repeated-measures analysis of variance (ANOVA), showing the *F* values and associated significance for comparisons of amounts of dry mass remaining at the four sites.

Site	SS	df	MS	<i>F</i>	<i>P</i>
<i>EVB</i>					
Treatment	2589.41	1	2589.41	23.293	0.004
Time	8545.078	5	1709.016	16.634	0.004
Treatment × time	550.051	5	110.010	3.5812	0.015
Error	737.250	24	30.719		
<i>COF</i>					
Treatment	793.361	1	793.361	15.688	0.012
Time	4045.547	5	809.109	16.515	0.005
Treatment × time	261.999	5	52.399	2.7534	0.042
Error	456.745	24	19.031		
<i>DWF</i>					
Treatment	244.922	1	244.922	7.808	0.038
Time	2358.041	5	471.608	15.035	0.005
Treatment × time	156.838	5	31.367	5.053	0.003
Error	148.971	24	6.207		
<i>ALM</i>					
Treatment	187.006	1	187.006	10.347	0.002
Time	1347.112	5	269.422	14.907	0.005
Treatment × time	90.366	5	18.073	1.172	0.352
Error	370.017	24	15.417		

evergreen broadleaf forest and temperate coniferous forest, cold temperate dwarf forest, and frigid zone alpine meadow in control litterbags. The diversity and activity of soil animals may be constrained by climate at the higher sites. Our results suggest that decomposition in warm humid sites can be strongly influenced by elevation effects on the local biota.

#### 4.3. Faunal diversity and its function within the sites

The diversity of microarthropod populations found in decomposing litter is an important indication of nutrient cycling of ecosystem (Setälä and Huhta, 1991; Moore et al., 2004; Kreuzer et al., 2004). Heneghan et al. (1999) observed a positive relationship between the densities of microarthropods and litter decomposition rates. During the 12 months of our study, the mass loss of *C. carlesii* litter was significantly higher in the control treatments, suggesting a strong effect of microarthropods on decomposition.

Mites and Collembolans, 85–91% of microarthropods in the sites, appear to drive the decomposition process, as mass loss rates were significantly correlated with their Abundances (Tables 2 and 3). The individuals were decreased by naphthalene treatments in a large scale. Especially Oribatid, Mesostigmatid mites, Prostigmatid mites reduced from 65% to 75%, may have important implication to the difference of litter decomposition. These two groups include both detritivorous and fungivorous

feeders and affect the decomposition process (Petersen and Luxton, 1982; Newell, 1984a,b). Microbial grazing by Mites and Collembolans influences microbe Abundances, although the extent of grazing pressure appears to determine how microbe affected: when grazing pressure is high, microbial activity is depressed, but when grazing pressure is moderate, microbial Abundance can be enhanced, at least in some instance (Hanlon and Anderson, 1980).

In our study, the proportion of collembolans and Oribatid mites was almost 77% in all samples. At the same time other mesofauna, e.g., Astigmata, Coleoptera, Hymenoptera, Synphyla, Homoptera, Isopoda, and Protura which were less in their Abundance (from 8% to 15%) and less different in the two treatments, might be subordinate in decomposition. We suggest that differences in the mass loss between the fauna-reduced and control treatments were attributed to the activity of these microarthropods.

The stronger contribution from the fauna to mean mass loss at EVB (26.2%) compared to COF (12.7%), even though the two sites have generally similar levels of diversity, points to a significant interaction between the microarthropod species that is specific to these divergent assemblages. Oribatids are generally considered to be fungal feeders, and some of them often feed selectively on particular species of fungi. Some graze on bacteria, while others consume plant material. Many of Prostigmata are predators, and some species feed on fungi and are capable of rapid increase in reproduction in response to a sudden shift in available resource. Mesostigmata mites are almost exclusively predators, with some taxa feeding as Fungivores (Christine et al., 2001).

Although the proportion of Oribatid mites at evergreen broadleaf forest was not highest of all four sites, there were elevated proportions of Mesostigmatid and Prostigmatid mites, many of which are microbe-consuming species that induce a strong influence on decomposition dynamics indirectly. This may be an interpretation related to differences in the Abundance of some faunal function groups or to the species-specific trophic behavior of the animals. The elucidation of mechanism, however, would require the direct observation of the trophic ecology of the assemblages. Here will be a comparison of fungivory. The high moisture and warm temperatures which favor fungal growth may in turn increase the number of fungal grazers (Levings and Windsor, 1996). This, in turn, may increase the influence of microarthropods on litter decomposition.

Increased complexity of detrital assemblages has been widely demonstrated to have an important effect on an ecosystem-level function in other studies. In laboratory systems replicating the complexity of forest soil, more complex fauna (including nematodes, tardigrades, microarthropods) increased nutrient mineralization (Setälä et al., 1991; Hunt and Wall, 2002; Fu, 2007). Studies of various substrates have shown effects of food web

**Table 2**

Abundance and percentage of principal microarthropod groups from litterbags collected in the two treatments. Data in parentheses are abundance in naphthalene applied litterbags. The percentage data of soil microarthropod were the totals collected in the two kinds of plots. Asterisks within a faunal group represent significant difference of abundance between two contrast litterbags (\**p* < 0.05; \*\**p* < 0.01).

	EVB		COF		DWF		ALM	
	Abundance	%	Abundance	%	Abundance	%	Abundance	%
<i>Acari</i>								
Oribatids	294(86)**	40.41	419(126)*	53.22	152(58)*	47.73	81(23)*	51.23
Mesostigmata	113(31)*	17.37	86(27)*	11.04	43(12)*	12.50	19(6)*	12.32
Prostigmata	74(21)*	11.46	70(18)*	8.59	32(12)*	10.00	23(8)*	15.27
Astigmata	7(7)	1.69	10(8)	1.76	7(6)	2.95	4(5)	4.43
Collembola	94(19)*	13.63	135(36)*	16.70	54(9)*	14.32	11(5)*	7.88
Others	67(61)	15.44	46(43)	8.69	28(27)	12.50	18(9)*	8.87
Total	649(225)*	100	765(259)*	100	316(124)*	100	147(56)*	100

**Table 3**

Correlations between the mass losses of *C. carlesii* leaf litter and abundance of litter microarthropods collected from the control treatment litterbags at the four sites. Values are Pearson's correlation coefficients ( $n = 6$ ); \* $p < 0.05$ , \*\* $p < 0.01$ .

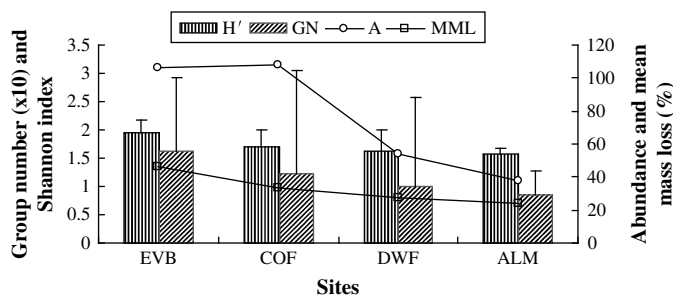
	EVB	COF	DWF	ALM
Acari	0.903*	0.842*	0.883*	0.927**
Oribatids	0.884*	0.644	0.929**	0.920**
Prostigmata	0.719	0.941*	-0.294	0.902*
Mesostigmata	0.856*	0.947*	0.840*	0.908*
Astigmata	-0.033	0.457	0.447	0.585
Collembola	0.857*	0.875*	0.826*	0.934**
Others	-0.824*	-0.818*	-0.706	0.307
Total	0.546	0.104	-0.551	0.918**

complexity on decomposition rates and N dynamics (Couteaux et al., 1996; Vedder et al., 1996). Our results indicate that microarthropod manipulation can have a large impact on decomposition. This may coincide well with observations on the unique contribution to decomposition and N mobilization dynamics which are perhaps attributed to some functional groups of microarthropod (Faber and Verhoef, 1991; Siepel and Maaskamp, 1994).

Relationships between biodiversity and ecosystem function are often identified by experimental manipulations. Many studies have found relationships between diversity manipulations and ecosystem function (Ewel et al., 1991; Tilman and Downing, 1994; Hooper et al., 2005). Other comparative surveys and experimental manipulations have reported an absence of such relationships (Wright, 1996; Wardle et al., 1997; Huston et al., 2000). Therefore it is important for relationships diversity and system function to be based on detailed knowledge of the systems being examined.

In our study mass losses were related to Shannon Index ( $r^2 = 0.984$ ,  $p = 0.016$ ), and Group Number ( $r^2 = 0.952$ ,  $p = 0.048$ ) across four sites. Shannon Index and Group number decreased across four sites, ranking EVB ( $1.959 \pm 0.230$ ,  $16.2 \pm 1.302$ ) > COF ( $1.707 \pm 0.290$ ,  $12.3 \pm 1.820$ ) > DWF ( $1.617 \pm 0.394$ ,  $10.0 \pm 1.571$ ) > ALM ( $1.565 \pm 0.122$ ,  $8.5 \pm 0.428$ ) though there was no statistical difference in Shannon Index. Simultaneity at lower elevations of the Wuyi Mountains located in the humid warm subtropics, higher temperatures may favor fungal growth, in turn, increase the preponderance of fungal grazers. So we suggest that discussions of the linkages between diversity and ecosystem function should consider the interaction of the fauna and their local environment.

This study has two implications for ecosystem function. Firstly, the strong faunal effects on decomposition argue for greater consideration of the role of decomposer organisms in subtropical ecosystems. If feedbacks between detrital food-webs and ecosystem processes occur, this may affect subtropical soil fertility. Secondly, global climate change where temperature and



**Fig. 4.** The relationship between the mean mass loss of *C. carlesii* leaf litter in the control litterbags and Shannon Index ( $H'$ ), the Group Number (GN), and Abundance (A) at the four sites.

precipitation change over broad geographical regions with likely strong consequences for structure of plant and animal communities and ecosystem processes, may both directly and indirectly facilitate an increase in the decomposition by microarthropods. We propose that climate change may increase the effects of elevation on soil microarthropod litter processing.

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