Warming alters energetic structure and function but not resilience of soil food webs

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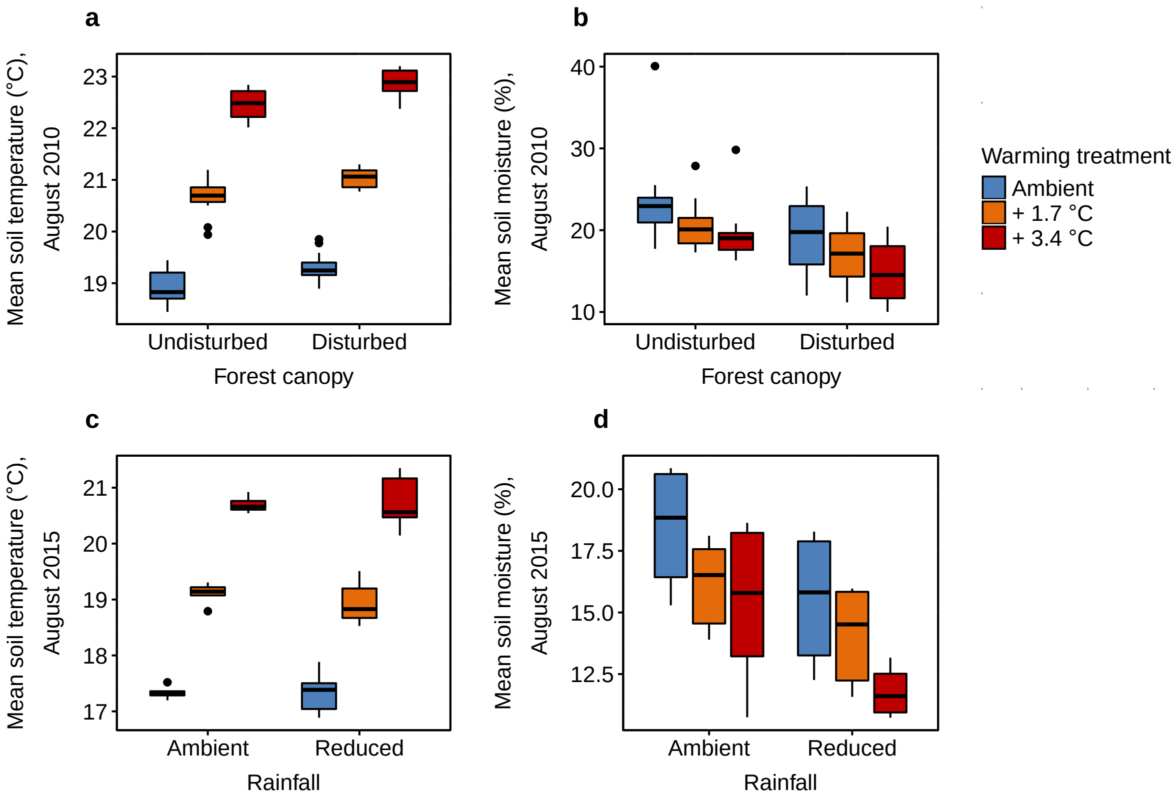
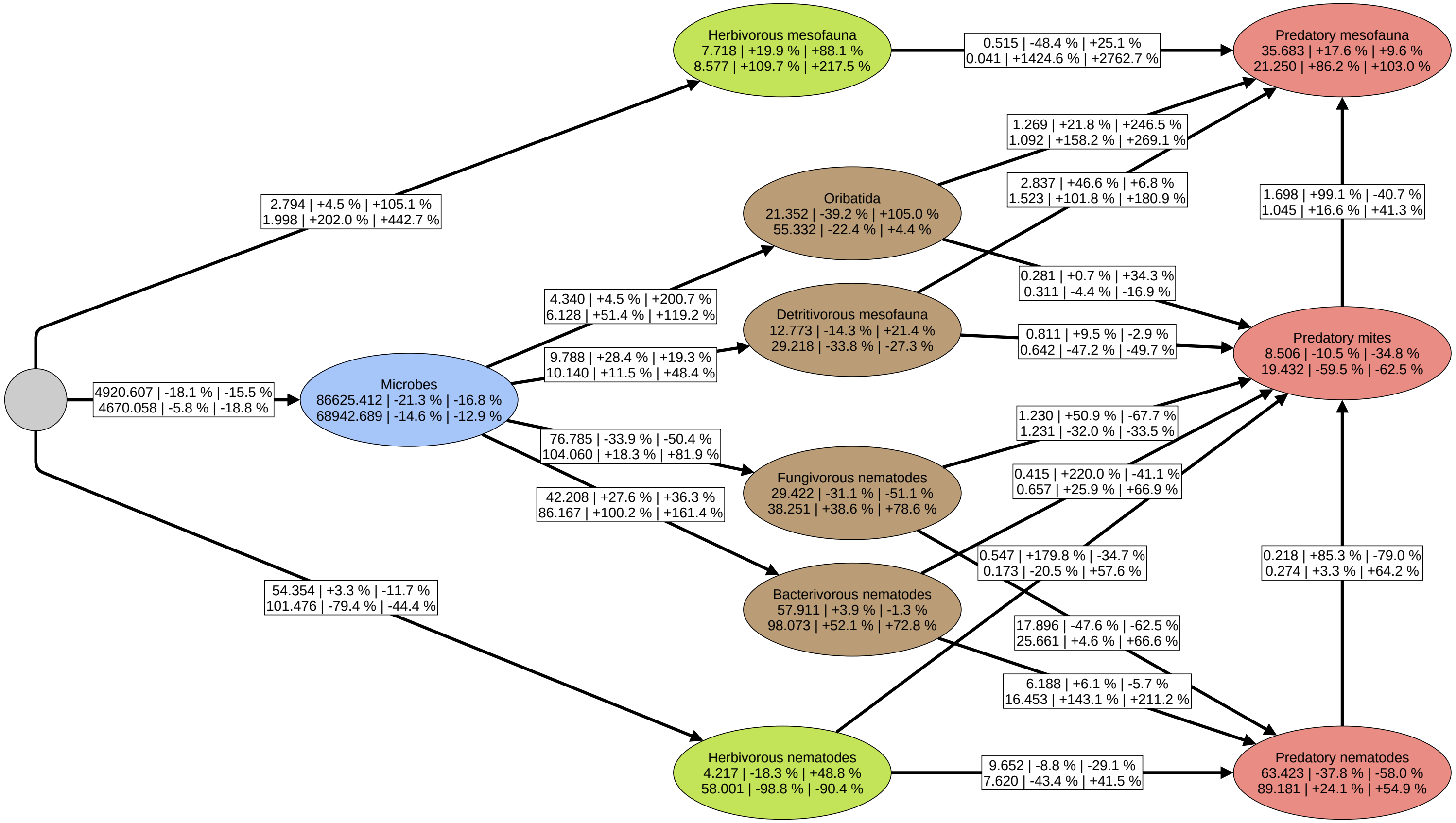
Supplementary Figures

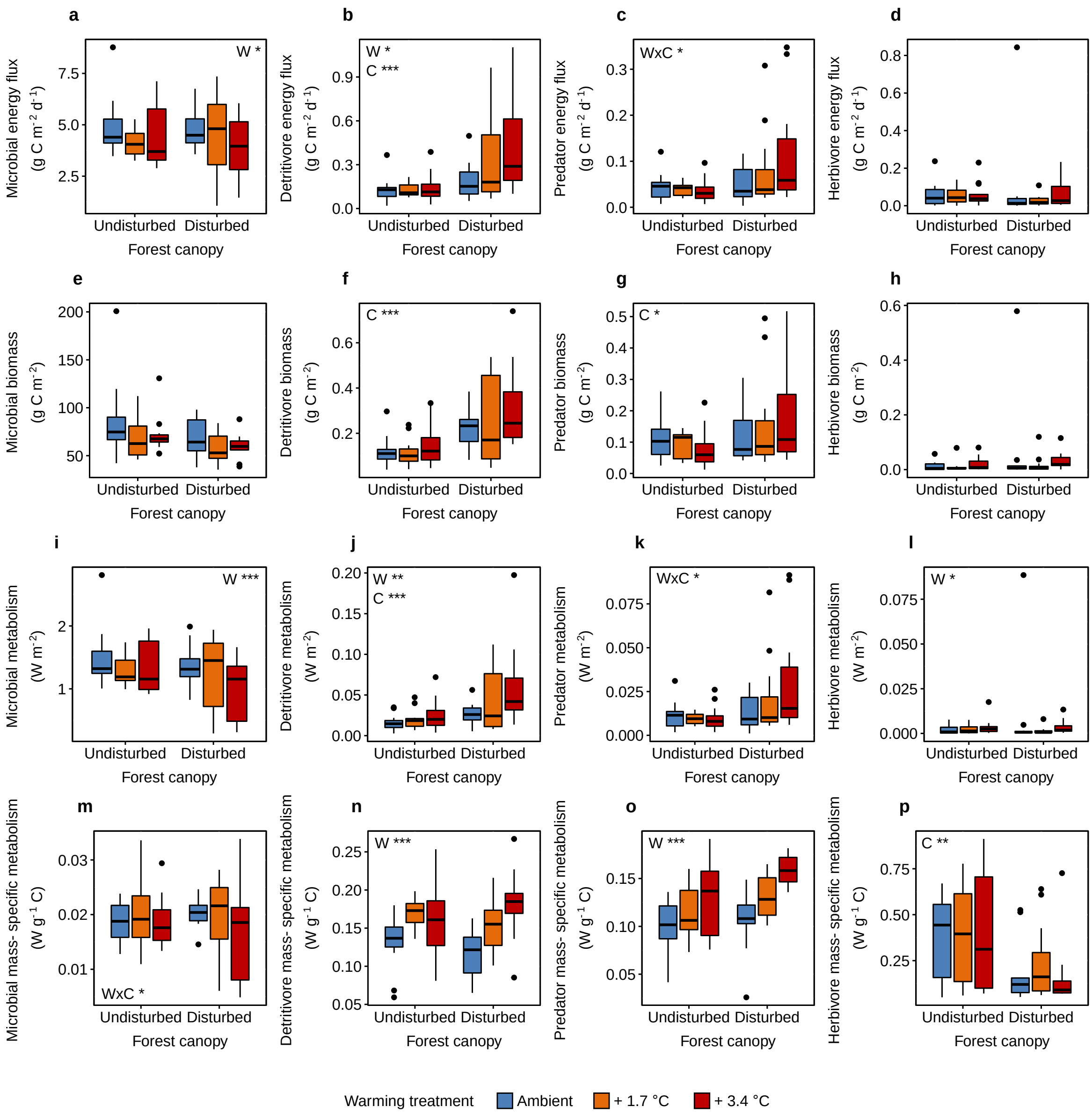


Supplementary Figure 1. Treatment effects on soil temperature and soil moisture. In the first experiment, the mean soil temperature in the sampling month increased with warming ($\chi 2$ (1) = 4779.751, $p < 0.001$) and canopy disturbance ($\chi 2$ (1) = 7.711, p = 0.005) (a), while the mean soil moisture in the sampling month decreased with warming ($\chi 2$ (1) = 46.619, $p < 0.001$) and canopy disturbance ($\chi 2$ (1) = 5.395, p = 0.020) (b). In the second experiment, the mean soil temperature in the sampling month increased with warming ($\chi 2$ (1) = 1533.125, $p < 0.001$), but was not affected by drought ($\chi 2$ (1) = 0.394, p = 0.530) (c), while the mean soil moisture in the sampling month was not affected by warming at ambient rainfall, but sharply declined with warming at reduced rainfall (warming × drought interaction: $\chi 2$ (1) = 7.618, p = 0.006) (d). Box plots are based on median (horizontal line), first and third quartile (rectangle), 1.5 × interquartile range (whiskers), and outliers (isolated points).

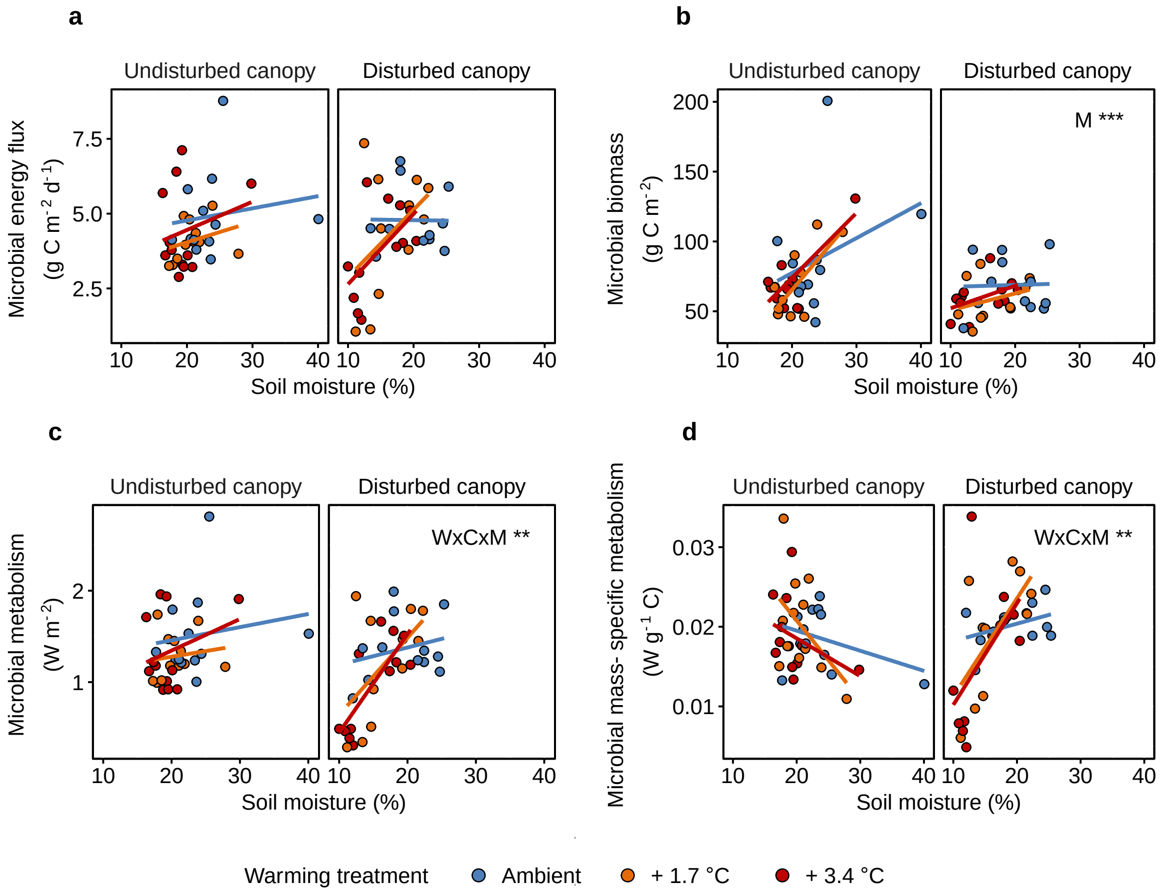
Supplementary Figure 2. Soil food web diagram presenting the feeding relationships among microbes and the nine faunal feeding guilds. Colors indicate different trophic levels: blue = microbes, brown = detritivores, green = herbivores, red = predators. The gray circle represents basal resources provided by primary producers.



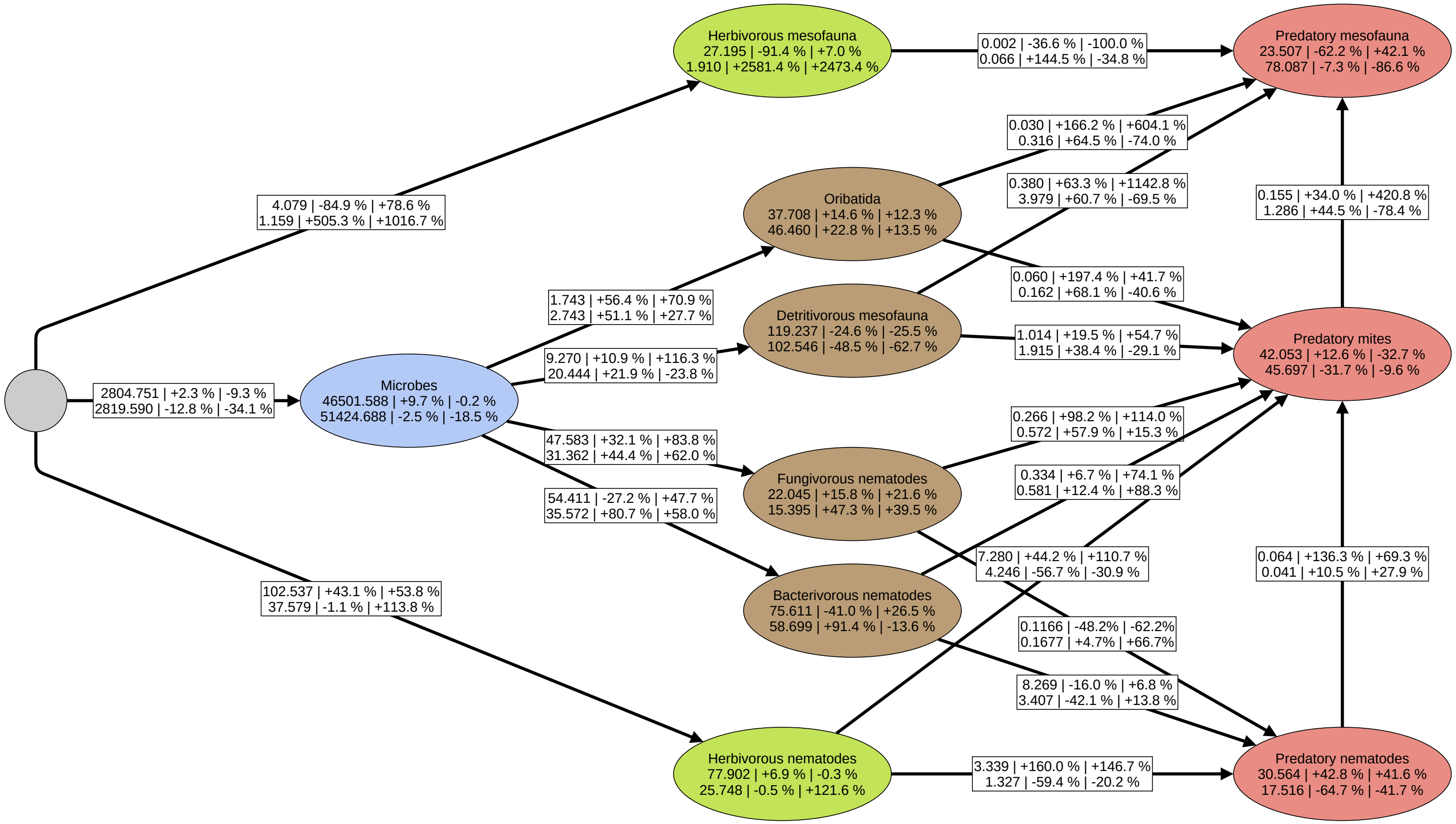
Supplementary Figure 3. Soil food web diagram presenting all feeding guilds and their trophic relationships in the first experiment. Numbers in nodes represent biomasses (mg m^{-2}), and numbers attached to arrows represent energy fluxes (mg C m^{-2} d^{-1}) between the respective feeding guilds. The first line refers to undisturbed, the second line to disturbed canopy habitats. The first value in each line is the mean biomass or energy flux in the ambient temperature treatment, while second and third values indicate relative changes with + 1.7°C and + 3.4°C warming compared to ambient temperature. Colors indicate different trophic levels: blue = microbes, brown = detritivores, green = herbivores, red = predators.



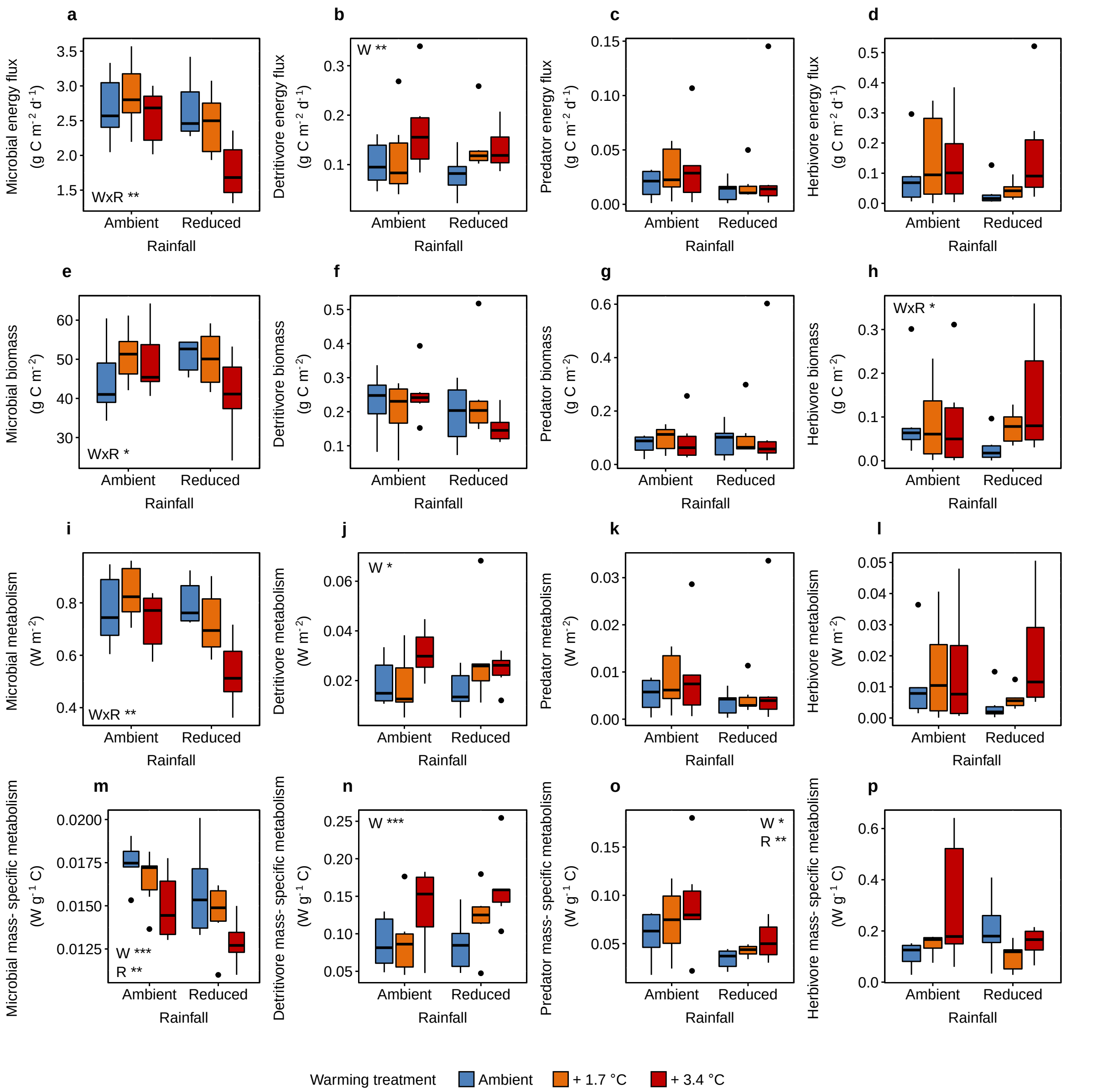
Supplementary Figure 4. Effects of warming (W) and canopy disturbance (C) on energy fluxes (a–d), biomass (e–h), metabolism (i–l), and mass-specific metabolism (m–p) of microbes (a, e, i, m), detritivores (b, f, j, n), predators (c, g, k, o), and herbivores (d, h, l, p) in the first experiment. Box plots are based on median (horizontal line), first and third quartile (rectangle), 1.5 × interquartile range (whiskers), and outliers (isolated points). Asterisks denote significant effects of warming (W), canopy disturbance (C), and their interaction (WxC): * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.



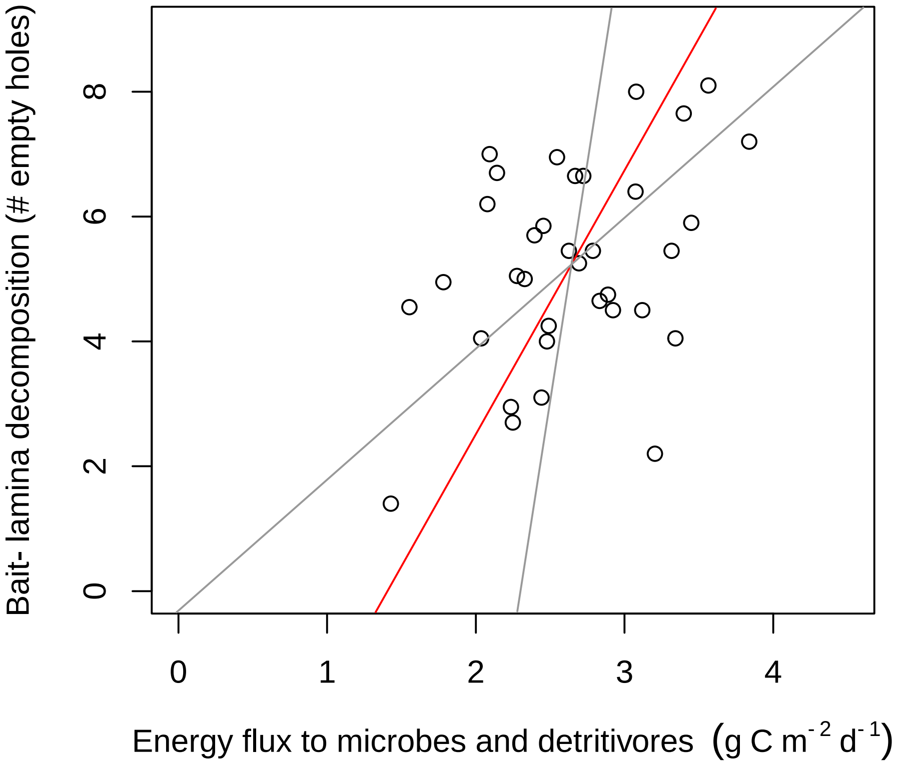
Supplementary Figure 5. Relationships of soil moisture and microbial energy flux (a), biomass (b), metabolism (c), and mass-specific metabolism (d) in the first experiment. They are separately presented for each treatment combination. Asterisks denote significant effects of warming (W), canopy disturbance (C), soil moisture (M), and all interactions: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.



Supplementary Figure 6. Soil food web diagram presenting all feeding guilds and their trophic relationships in the second experiment. Numbers in nodes represent biomasses (mg m−2), and numbers attached to arrows represent energy fluxes (mg C m^{-2} d^{-1}) between the respective feeding guilds. The first line refers to undisturbed, the second line to disturbed canopy habitats. The first value in each line is the mean biomass or energy flux in the ambient temperature treatment, while second and third values indicate relative changes with + 1.7°C and + 3.4°C warming compared to ambient temperature. Colors indicate different trophic levels: blue = microbes, brown = detritivores, green = herbivores, red = predators. Note that energy fluxes from nematodes to predatory mesofauna are not shown as they entirely depended on the presence of Symphyla, which, however, were only present in four out of 36 plots.



Supplementary Figure 7. Effects of warming (W) and rainfall reduction (R) on energy fluxes (a–d), biomass (e–h), metabolism (i–l), and mass-specific metabolism (m–p) of microbes (a, e, i, m), detritivores (b, f, j, n), predators (c, g, k, o), and herbivores (d, h, l, p) in the second experiment. Box plots are based on median (horizontal line), first and third quartile (rectangle), 1.5 × interquartile range (whiskers), and outliers (isolated points). Asterisks denote significant effects of warming (W), rainfall reduction (R), and their interaction (WxR): * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.



Supplementary Figure 8. Ranged major axis regression of the combined energy fluxes to microbes and detritivorous fauna on bait-lamina data. n = 35, r^2= 0.164, slope=4.227 (95% CI=2.097; 15.251), intercept=-5.943 (95% CI=-35.089; -0.311), p=0.009 (one-tailed, 9999 permutations).

Supplementary Tables

Supplementary Table 1. Results of linear mixed effects models testing the effects of warming, canopy disturbance, and their interaction on metabolism of the whole food web, microbes, total fauna, and the three faunal trophic groups (Detritivores, Predators, Herbivores) and on mass-specific metabolism of microbes, total fauna, and the three faunal trophic groups (Detritivores, Predators, Herbivores). (a) Significance of fixed effects obtained by Wald chi-square tests. Significant effects (p < 0.05) are reported in bold. (b) Results of post-hoc Tuckey´s HSD tests performed for models with significant (p < 0.05) and marginally significant (p < 0.1) interaction terms. Asterisks denote significance levels: * p < 0.05; ** p < 0.01; *** p < 0.001.

(a)

	Transformation	**Warming**			**Canopy**			**Warming x Canopy**		
		$\chi 2$	**df**	**p-value**	**$\chi 2$**	**df**	**p-value**	**$\chi 2$**	**df**	**p-value**
Metabolism (W m^{-2})										
Whole food web	$\log_{10}(x)$	7.961	1	**0.005**	1.044	1	0.307	2.065	1	0.151
Microbes	$\log_{10}(x)$	11.040	1	**<0.001**	1.696	1	0.193	3.341	1	0.068
Fauna	$\log_{10}(x)$	5.015	1	**0.025**	15.847	1	**<0.001**	1.893	1	0.169
Detritivores	$\log_{10}(x)$	7.714	1	**0.005**	12.835	1	**<0.001**	0.911	1	0.340
Predators	$\log_{10}(x)$	1.991	1	0.158	6.379	1	**0.012**	4.622	1	**0.032**
Herbivores	$\log_{10}(x+0.0001)$	5.302	1	**0.021**	0.099	1	0.753	0.007	1	0.935
Mass-specific metabolism (W g^{-1} C)										
Microbes	$\log_{10}(x)$	4.533	1	**0.033**	0.493	1	0.482	4.798	1	**0.028**
Fauna	$\log_{10}(x)$	17.397	1	**<0.001**	0.281	1	0.596	0.891	1	0.345
Detritivores	$\log_{10}(x)$	14.373	1	**<0.001**	0.102	1	0.749	2.024	1	0.155
Predators	$\log_{10}(x)$	18.972	1	**<0.001**	2.723	1	0.099	1.314	1	0.252
Herbivores	$\log_{10}(x)$	0.251	1	0.616	6.730	1	**0.009**	0.001	1	0.973

(b)

Model	**Linear hypotheses**	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**	
Predator metabolism ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	0.041	0.083	0.493	0.857	
	undisturbed:3.4 - 0 == 0	0.082	0.165	0.493	0.857	
	undisturbed:3.4 - 1.7 == 0	0.041	0.083	0.493	0.857	
	disturbed:1.7 - 0 == 0	-0.214	0.085	-2.524	0.023	*
	disturbed:3.4 - 0 == 0	-0.427	0.169	-2.524	0.023	*
	disturbed:3.4 - 1.7 == 0	-0.214	0.085	-2.524	0.023	*
Microbial mass-specific metabolism ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	-0.003	0.077	-0.043	0.999	
	undisturbed:3.4 - 0 == 0	-0.007	0.154	-0.043	0.999	
	undisturbed:3.4 - 1.7 == 0	-0.003	0.077	-0.043	0.999	
	disturbed:1.7 - 0 == 0	0.235	0.077	3.054	0.005	**
	disturbed:3.4 - 0 == 0	0.470	0.154	3.054	0.005	**
	disturbed:3.4 - 1.7 == 0	0.235	0.077	3.054	0.005	**

Supplementary Table 2. Post-hoc Tuckey´s HSD tests performed for linear mixed effects models with significant ($p < 0.05$) and marginally significant ($p < 0.1$) interaction terms in the first experiment (see Table 1). Asterisks denote significance levels: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Model	Linear hypotheses	Estimate	Std. Error	z value	Pr(>|z|)	
Faunal energy flux ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	0.019	0.081	0.239	0.964	
	undisturbed:3.4 - 0 == 0	0.039	0.161	0.239	0.964	
	undisturbed:3.4 - 1.7 == 0	0.019	0.081	0.239	0.964	
	disturbed:1.7 - 0 == 0	-0.193	0.082	-2.337	0.039	*
	disturbed:3.4 - 0 == 0	-0.385	0.165	-2.337	0.039	*
	disturbed:3.4 - 1.7 == 0	-0.193	0.082	-2.337	0.039	*
Detritivore energy flux ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	-0.009	0.077	-0.115	0.992	
	undisturbed:3.4 - 0 == 0	-0.018	0.153	-0.115	0.992	
	undisturbed:3.4 - 1.7 == 0	-0.009	0.077	-0.115	0.992	
	disturbed:1.7 - 0 == 0	-0.222	0.078	-2.826	0.009	**
	disturbed:3.4 - 0 == 0	-0.444	0.157	-2.826	0.009	**
	disturbed:3.4 - 1.7 == 0	-0.222	0.078	-2.826	0.009	**
Predator energy flux ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	0.053	0.083	0.640	0.772	
	undisturbed:3.4 - 0 == 0	0.107	0.167	0.640	0.772	
	undisturbed:3.4 - 1.7 == 0	0.053	0.083	0.640	0.772	
	disturbed:1.7 - 0 == 0	-0.213	0.085	-2.499	0.025	*
	disturbed:3.4 - 0 == 0	-0.426	0.171	-2.499	0.025	*
	disturbed:3.4 - 1.7 == 0	-0.213	0.085	-2.499	0.025	*
Predator biomass ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	0.136	0.086	1.578	0.216	
	undisturbed:3.4 - 0 == 0	0.272	0.173	1.578	0.216	
	undisturbed:3.4 - 1.7 == 0	0.136	0.086	1.578	0.216	
	disturbed:1.7 - 0 == 0	-0.093	0.088	-1.048	0.502	
	disturbed:3.4 - 0 == 0	-0.185	0.176	-1.048	0.502	
	disturbed:3.4 - 1.7 == 0	-0.093	0.088	-1.048	0.502	
Relative energy flux to microbes ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	0.018	0.071	0.258	0.959	
	undisturbed:3.4 - 0 == 0	0.037	0.142	0.258	0.959	
	undisturbed:3.4 - 1.7 == 0	0.018	0.071	0.258	0.959	
	disturbed:1.7 - 0 == 0	0.250	0.073	3.448	0.001	**
	disturbed:3.4 - 0 == 0	0.500	0.145	3.448	0.001	**
	disturbed:3.4 - 1.7 == 0	0.250	0.073	3.448	0.001	**
Relative energy flux to detritivores ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	-0.043	0.069	-0.628	0.779	
	undisturbed:3.4 - 0 == 0	-0.087	0.138	-0.628	0.779	
	undisturbed:3.4 - 1.7 == 0	-0.043	0.069	-0.628	0.779	
	disturbed:1.7 - 0 == 0	-0.278	0.071	-3.939	<0.001	***
	disturbed:3.4 - 0 == 0	-0.556	0.141	-3.939	<0.001	***
	disturbed:3.4 - 1.7 == 0	-0.278	0.071	-3.939	<0.001	***
Relative energy flux to predators ~ Warming * Canopy	undisturbed:1.7 - 0 == 0	0.020	0.075	0.262	0.957	
	undisturbed:3.4 - 0 == 0	0.040	0.151	0.262	0.957	
	undisturbed:3.4 - 1.7 == 0	0.020	0.075	0.262	0.957	
	disturbed:1.7 - 0 == 0	-0.258	0.077	-3.333	0.002	**
	disturbed:3.4 - 0 == 0	-0.516	0.155	-3.333	0.002	**
	disturbed:3.4 - 1.7 == 0	-0.258	0.077	-3.333	0.002	**

Supplementary Table 3. Results of linear mixed effects models testing the effects of warming, canopy disturbance, soil moisture, and their interactions on microbial energy flux, biomass, metabolism, and mass-specific metabolism in the first experiment. Models were selected based on AIC in a stepwise backward selection procedure eliminating interaction terms but not main effects. Significance of fixed effects obtained by Wald chi-square tests. Asterisks denote significance levels: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Marginally significant effects ($p < 0.1$) are marked with †.

Response	Fixed effects	$\chi2$	df	p-value	
Microbial energy flux $log_{10}(x)$	Warming	1.950	1	0.163	
	Canopy	0.031	1	0.860	
	Moisture	0.750	1	0.386	
	Warming : Moisture	3.814	1	0.051	†
Microbial biomass $log_{10}(x)$	Warming	0.031	1	0.861	
	Canopy	0.113	1	0.737	
	Moisture	15.444	1	<0.001	***
Microbial metabolism $log_{10}(x)$	Warming	3.221	1	0.073	†
	Canopy	0.587	1	0.444	
	Moisture	1.666	1	0.197	
	Warming : Canopy	0.416	1	0.519	
	Warming : Moisture	8.571	1	0.003	**
	Canopy : Moisture	3.061	1	0.080	†
	Warming : Canopy : Moisture	7.483	1	0.006	**
Microbial mass-specific metabolism $log_{10}(x)$	Warming	3.022	1	0.082	†
	Canopy	0.289	1	0.591	
	Moisture	0.608	1	0.436	
	Warming : Canopy	0.001	1	0.976	
	Warming : Moisture	5.749	1	0.016	*
	Canopy : Moisture	2.093	1	0.148	
	Warming : Canopy : Moisture	7.263	1	0.007	**

Supplementary Table 4. Results of linear mixed effects models testing the effects of warming, drought (reduced rainfall), and their interaction on metabolism of the whole food web, microbes, total fauna, and the three faunal trophic groups (Detritivores, Predators, Herbivores) and on mass-specific metabolism of microbes, total fauna, and the three faunal trophic groups (Detritivores, Predators, Herbivores). (a) Significance of fixed effects obtained by Wald chi-square tests. Significant effects ($p < 0.05$) are reported in bold. (b) Results of post-hoc Tuckey´s HSD tests performed for models with significant ($p < 0.05$) and marginally significant ($p < 0.1$) interaction terms. Asterisks denote significance levels: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

(a)

	Transformation	**Warming**			**Drought**			**Warming x Drought**		
		$\chi2$	**df**	**p-value**	**$\chi2$**	**df**	**p-value**	**$\chi2$**	**df**	**p-value**
Metabolism (W m^{-2})										
Whole food web	$\log_{10}(x)$	10.638	1	**0.001**	9.730	1	**0.002**	9.679	1	**0.002**
Microbes	$\log_{10}(x)$	14.897	1	**<0.001**	8.482	1	**0.004**	9.632	1	**0.002**
Fauna	$\log_{10}(x)$	12.412	1	**<0.001**	0.400	1	0.527	0.510	1	0.475
Detritivores	$\log_{10}(x)$	5.887	1	**0.015**	0.012	1	0.915	0.004	1	0.947
Predators	$\log_{10}(x)$	1.155	1	0.282	1.399	1	0.237	0.024	1	0.876
Herbivores	$\log_{10}(x)$	2.437	1	0.119	0.004	1	0.949	3.150	1	0.076
Mass-specific metabolism (W g^{-1} C)										
Microbes	$\log_{10}(x)$	12.468	1	**<0.001**	9.761	1	**0.002**	0.138	1	0.710
Fauna	$\log_{10}(x)$	17.277	1	**<0.001**	0.138	1	0.710	0.247	1	0.619
Detritivores	$\log_{10}(x)$	12.692	1	**<0.001**	2.037	1	0.154	0.732	1	0.392
Predators	$\log_{10}(x)$	4.263	1	**0.039**	7.520	1	**0.006**	0.004	1	0.949
Herbivores	$\log_{10}(x)$	1.593	1	0.207	0.369	1	0.544	2.767	1	0.096

(b)

Model	**Linear hypotheses**	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**	
Whole food web metabolism ~ Warming * Rainfall	ambient:1.7 - 0 == 0	-0.003	0.077	-0.043	0.999	
	ambient:3.4 - 0 == 0	-0.007	0.154	-0.043	0.999	
	ambient:3.4 - 1.7 == 0	-0.003	0.077	-0.043	0.999	
	reduced:1.7 - 0 == 0	0.235	0.077	3.054	0.005	**
	reduced:3.4 - 0 == 0	0.470	0.154	3.054	0.005	**
	reduced:3.4 - 1.7 == 0	0.235	0.077	3.054	0.005	**
Microbial metabolism ~ Warming * Rainfall	ambient:1.7 - 0 == 0	0.018	0.071	0.258	0.959	
	ambient:3.4 - 0 == 0	0.037	0.142	0.258	0.959	
	ambient:3.4 - 1.7 == 0	0.018	0.071	0.258	0.959	
	reduced:1.7 - 0 == 0	0.250	0.073	3.448	0.001	**
	reduced:3.4 - 0 == 0	0.500	0.145	3.448	0.001	**
	reduced:3.4 - 1.7 == 0	0.250	0.073	3.448	0.001	**

Supplementary Table 5. Post-hoc Tuckey´s HSD tests performed for linear mixed effects models with significant ($p < 0.05$) and marginally significant ($p < 0.1$) interaction terms in the second experiment (see Table 2). Asterisks denote significance levels: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Model	**Linear hypotheses**	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**	
Whole food web energy flux ~ Warming * Rainfall	ambient:1.7 - 0 == 0	0.019	0.081	0.239	0.964	
	ambient:3.4 - 0 == 0	0.039	0.161	0.239	0.964	
	ambient:3.4 - 1.7 == 0	0.019	0.081	0.239	0.964	
	reduced:1.7 - 0 == 0	-0.193	0.082	-2.337	0.039	*
	reduced:3.4 - 0 == 0	-0.385	0.165	-2.337	0.039	*
	reduced:3.4 - 1.7 == 0	-0.193	0.082	-2.337	0.039	*
Microbial energy flux ~ Warming * Rainfall	ambient:1.7 - 0 == 0	-0.009	0.077	-0.115	0.992	
	ambient:3.4 - 0 == 0	-0.018	0.153	-0.115	0.992	
	ambient:3.4 - 1.7 == 0	-0.009	0.077	-0.115	0.992	
	reduced:1.7 - 0 == 0	-0.222	0.078	-2.826	0.009	**
	reduced:3.4 - 0 == 0	-0.444	0.157	-2.826	0.009	**
	reduced:3.4 - 1.7 == 0	-0.222	0.078	-2.826	0.009	**
Whole food web biomass ~ Warming * Rainfall	ambient:1.7 - 0 == 0	0.053	0.083	0.640	0.772	
	ambient:3.4 - 0 == 0	0.107	0.167	0.640	0.772	
	ambient:3.4 - 1.7 == 0	0.053	0.083	0.640	0.772	
	reduced:1.7 - 0 == 0	-0.213	0.085	-2.499	0.025	*
	reduced:3.4 - 0 == 0	-0.426	0.171	-2.499	0.025	*
	reduced:3.4 - 1.7 == 0	-0.213	0.085	-2.499	0.025	*
Microbial biomass ~ Warming * Rainfall	ambient:1.7 - 0 == 0	0.136	0.086	1.578	0.216	
	ambient:3.4 - 0 == 0	0.272	0.173	1.578	0.216	
	ambient:3.4 - 1.7 == 0	0.136	0.086	1.578	0.216	
	reduced:1.7 - 0 == 0	-0.093	0.088	-1.048	0.502	
	reduced:3.4 - 0 == 0	-0.185	0.176	-1.048	0.502	
	reduced:3.4 - 1.7 == 0	-0.093	0.088	-1.048	0.502	
Herbivore biomass ~ Warming * Rainfall	ambient:1.7 - 0 == 0	0.041	0.083	0.493	0.857	
	ambient:3.4 - 0 == 0	0.082	0.165	0.493	0.857	
	ambient:3.4 - 1.7 == 0	0.041	0.083	0.493	0.857	
	reduced:1.7 - 0 == 0	-0.214	0.085	-2.524	0.023	*
	reduced:3.4 - 0 == 0	-0.427	0.169	-2.524	0.023	*
	reduced:3.4 - 1.7 == 0	-0.214	0.085	-2.524	0.023	*

Supplementary Table 6. (a) Nematode taxa identified in the first experiment (2010) and fresh body masses [µg]. Fresh mass data were derived from "Nemaplex" (http://plpnemweb.ucdavis.edu/nemaplex/Ecology/nematode_weights.htm). Fresh masses of subclasses, which were not available in the database, were assessed by taking the mean of all families within the respective subclasses, which were also present in 2015. (b) Nematode taxa identified in the second experiment (2015) and fresh body masses [µg] derived from "Nemaplex" (http://plpnemweb.ucdavis.edu/nemaplex/Ecology/nematode_weights.htm).

(a)

Taxon	**Fresh mass [µg]**
Alaimina	0.7564
Aphelenchoides spp.	0.1616
Aphelenchus avenae	0.2306
Araeolaimida	0.7256
Basiria sp.	0.1676
Cepahlenchus leptus	0.1239
Cephalenchus hexalineatus	0.1239
Criconema sphagni	0.4507
Ditylenchus anchilisposomus	0.5878
Ditylenchus spp.	0.5878
Dorylaimida	9.7748
Enoplida	2.4757
Filenchus discrepans	0.0483
Filenchus misellus	0.0219
Filenchus spp.	0.0984
Filenchus vulgaris	0.1535
Lelenchus leptosoma	0.0414
Mononchida	5.3291
Ogma menzeli	0.7990
Ogma octangulare	0.3676
Ogma sp.	0.7140
other Tylenchida	7.6246
Paratylenchus straeleni	0.0456
Pseudhalenchus minutus	0.0482
Rhabditida	2.5066

(b)

Taxon	**Fresh mass [µg]**
Acrobeles	0.7113
Acrobeloides	0.1481
Alaimus	0.5340
Aphelenchoides	0.1616
Aphelenchus	0.2306
Aporcelaimellus	8.8288
Axonchium	3.7392
Cephalobidae	0.4348
Cephalobus	0.2702
Cervidellus	0.1565
Chiloplacus	0.5296
Clarkus	4.3894
Coomansus	6.7031
Coslenchus	0.1095
Diphtherophora	0.5039
Ditylenchus	0.5878
Dolichodoridae	0.4581
Dorylaimoides	1.1588
Enchodelus	3.6802
Epidorylaimus	1.3937
Eudorylaimus	3.3950
Eumonhystera	0.2408
Filenchus	0.0984
Geomonhystera	0.2787
Gracilacus	0.0328
Heterocephalobus	0.3559
Heterodera	42.5256
Laimydorus	4.5654
Mesodorylaimus	1.4764
Mesorhabditis	0.5676
Nordiidae	2.3940
Panagrolaimus	0.6375
Paraphelenchus	0.3434
Paratylenchus	0.0609
Plectus	1.0183
Pratylenchus	0.1397

Prismatolaimus	0.4865
Qudsianematidae	2.7639
Rhabditidae dauer larvae	5.3934
Rhabditis	7.4997
Rhabdolaimus	0.0795
Teratocephalus	0.0895
Thonus	1.9541
Tripyla	4.0454
Tylenchidae	0.1516
Tylencholaimellus	0.8698
Tylencholaimus	0.5057
Tylenchorhynchus	0.2082
Tylenchus	0.5173
Tylocephalus	0.2135
Wilsonema	0.0543
Xiphinema	4.3081

Supplementary Table 7. (a) Mean body lengths [mm] of soil mesofauna used for animals extracted in the first experiment (2010). Means are based on animals extracted in 2012 and 2015 at the same field sites. (b) Mean body lengths [mm] and length range of soil mesofauna extracted in the second experiment (2015).

(a)

Group	**Taxon**	**Mean body length [mm]**
Acari	Astigmata/Prostigmata	0.21
Acari	Mesostigmata	0.46
Acari	Oribatida	0.35
Collembola	Collembola	0.68
Insecta	Hemiptera	0.74
Insecta	Thysanoptera	0.83
other arthropods	Araneae	1.44
other arthropods	Diplura	1.67
other arthropods	Protura	0.73
other arthropods	Pseudoscorpionida	1.00

(b)

Group	Taxon	Min [mm]	Max [mm]	Mean body length [mm]	Standard deviation	n
Acari	Astigmata/ Prostigmata	0.08	0.42	0.14	0.03	2585
Acari	Bdelloidea	0.18	0.72	0.30	0.12	57
Acari	Eupodoidea	0.08	0.50	0.18	0.05	1016
Acari	Gamasina	0.10	1.68	0.40	0.20	614
Acari	Mesostigmata	0.18	0.32	0.22	0.07	4
Acari	Oribatida	0.08	1.01	0.28	0.14	2275
Acari	Prostigmata (predatory)	0.13	0.53	0.36	0.15	7
Acari	Rhagidiidae	0.29	0.72	0.42	0.09	58
Collembola	Entomobryidae	0.16	3.04	0.58	0.42	194
Collembola	Isotomidae	0.18	1.09	0.40	0.16	130
Collembola	Neanurinae	0.72	0.72	0.72	NA	1
Collembola	Neelidae	0.11	0.24	0.17	0.03	61
Collembola	Onychiuridae	0.18	1.07	0.37	0.12	464
Collembola	Poduridae	0.19	0.74	0.31	0.15	108
Collembola	Sminthuridae	0.10	0.82	0.26	0.13	103
Insecta	Aphidina	0.30	1.28	0.59	0.22	30
Insecta	Coccina	0.38	2.40	0.72	0.34	36
Insecta	Diptera-larvae	0.13	3.12	0.93	0.61	38
Insecta	Heteroptera nymphs	0.30	1.44	0.64	0.22	35
Insecta	other Hemiptera	0.35	2.24	1.32	0.79	6
Insecta	Thysanoptera	0.43	1.09	0.85	0.25	10
other arthropods	Araneae	0.72	2.48	1.56	0.79	4
other arthropods	Diplura	0.64	2.56	1.52	0.41	43
other arthropods	Pauropoda	0.14	0.92	0.35	0.14	102
other arthropods	Protura	0.35	0.80	0.55	0.16	9
other arthropods	Symphyla	0.85	2.37	1.64	0.48	10

Supplementary Table 8. Length-mass regressions from the literature to calculate body masses (M) from measured body lengths (L).

Taxon	Group	Mass type	Equation (M[mg], L[mm])	a	b	min [mm]	max [mm]	Reference	Details of body length measurements	Regression specificity
Acari	all Mesostigmata	fresh mass	M = (10^a × L^b) / 1000	2.064	2.857	0.39	1.26	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Mesostigmata
Acari	all Prostigmata	fresh mass	M = (10^a × L^b) / 1000	2.124	2.808	0.14	1.12	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Prostigmata
Acari	Bdelloidea	fresh mass	M = (10^a × L^b) / 1000	2.124	2.808	0.14	1.12	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Prostigmata
Acari	Eupodoidea	fresh mass	M = (10^a × L^b) / 1000	2.124	2.808	0.14	1.12	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Prostigmata
Acari	Gamasina	fresh mass	M = (10^a × L^b) / 1000	2.064	2.857	0.14	1.12	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Mesostigmata
Acari	Oribatida	fresh mass	M = (10^a × L^b) / 1000	2.146	2.77	0.24	1.19	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Cryptostigmata
Acari	Astigmata/ Prostigmata	fresh mass	M = (10^a × L^b) / 1000	2.124	2.808	0.14	1.12	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Prostigmata
Acari	Rhagidiidae	fresh mass	M = (10^a × L^b) / 1000	2.124	2.808	0.14	1.12	Mercer et al., 2001	anterior tip of the gnathosoma to the posterior margin of the notogaster	Prostigmata
Arachnida	Araneae	fresh mass	M = exp(a) × L^b	-1.958	2.746	0.56	2.5	Höfer and Ott, 2009	edge of prosoma (without chelicerae) to edge of opisthosoma (excl. spinnerets)	Araneae < 2.5 mm
Arachnida	Araneae	dry mass	M = exp(a) × L^b	-3.121	2.680	0.56	2.5	Höfer and Ott, 2009	edge of prosoma (without chelicerae) to edge of opisthosoma (excl. spinnerets)	Araneae < 2.5 mm
Arachnida	Pseudo-scorpionida	fresh mass	M = exp(a) × L^b	-1.892	2.515	0.86	2.1	Höfer and Ott, 2009	edge of prosoma (without chelicerae) to edge of opisthosoma (excl. spinnerets)	Pseudo-scorpiones
Arachnida	Pseudo-scorpionida	dry mass	M = exp(a) × L^b	-2.967	2.771	0.86	2.1	Höfer and Ott, 2009	edge of prosoma (without chelicerae) to edge of opisthosoma (excl. spinnerets)	Pseudo-scorpiones
Arthropoda	all	dry mass	M = a × L^b	0.034	2.191	0.9	17.6	Gruner, 2003	tip of the abdomen to the end of the head or carapace	all arthropods
Arthropoda	Diplura	dry mass	M = a × L^b	0.034	2.191	0.9	17.6	Gruner, 2003	tip of the abdomen to the end of the head or carapace	all arthropods
Arthropoda	Pauropoda	dry mass	M = a × L^b	0.034	2.191	0.9	17.6	Gruner, 2003	tip of the abdomen to the end of the head or carapace	all arthropods
Arthropoda	Protura	dry mass	M = a × L^b	0.034	2.191	0.9	17.6	Gruner, 2003	tip of the abdomen to the end of the head or carapace	all arthropods
Arthropoda	Symphyla	dry mass	M = a × L^b	0.034	2.191	0.9	17.6	Gruner, 2003	tip of the abdomen to the end of the head or carapace	all arthropods
Collembola	All	fresh mass	M = (10^a × L^b) / 1000	1.339	1.992	0.12	4.06	Mercer et al., 2001	anterior of the head to posterior of the abdomen	all Collembola
Collembola	Entomobryidae	fresh mass	M = (b × L^3) / 1000		2.46	0.6	2.8	Edwards, 1967		Entomobryidae
Collembola	Hypogastruridae	fresh mass	M = (b × L^3) / 1000		2.81	0.5	2.5	Edwards, 1967		Hypo-gastruridae
Collembola	Isotomidae	fresh mass	M = (b × L^3) / 1000		3.06	0.5	6.1	Edwards, 1967		Isotomidae
Collembola	Neanurinae	dry mass	M = (a × L^b) / 1000	10.715	2.24	-	-	Tanaka, 1970		Neanura sp.
Collembola	Neelidae	fresh mass	M = (10^a × L^b) / 1000	1.339	1.992	0.12	4.06	Mercer et al., 2001	anterior of the head to posterior of the abdomen	all Collembola
Collembola	Onychiuridae	fresh mass	M = (b × L^3) / 1000		2.22	0.5	2.5	Edwards, 1967		Onychiuridae
Collembola	Sminthuridae	fresh mass	M = (b × L^3) / 1000		3.8	0.5	2	Edwards, 1967		Sminthuridae
Insecta	Aphidina	dry mass	M = a × L^b	0.075	2.629	1.6	3.05	Gruner 2003	tip of the abdomen to the end of the head or carapace	Psyllidae & Aphidae
Insecta	Ciccadina	dry mass	M = exp(a) × L^b	-3.735	2.561	2.13	13.25	Sample et al., 1993	From frons to tip of abdomen excluding appendages	Cicadellidae
Insecta	Coccina	dry mass	M = exp(a) × L^b	-2.823	2.225	2.13	13.25	Sample et al., 1993	From frons to tip of abdomen excluding appendages	Homoptera
Insecta	Diptera larvae	dry mass	M = a × L^b	0.029	1.73	1.7	16.65	Gruner, 2003	tip of the abdomen to the end of the head or carapace	holometabolous larvae
Insecta	herbivorous insects (2010)	dry mass	M = exp(a) × L^b	-2.823	2.225	2.13	13.25	Sample et al., 1993	From frons to tip of abdomen excluding appendages	Homoptera
Insecta	Heteroptera nymph	dry mass	M = a × L^b	0.0585	1.67	1.1	5.2	Gruner, 2003	tip of the abdomen to the end of the head or carapace	Homoptera larvae
Insecta	other insects	dry mass	M = exp(a) × L^b	-3.628	2.494	2.13	54.51	Sample et al., 1993	From frons to tip of abdomen excluding appendages	all insects
Insecta	Thysanoptera	fresh mass	M = (10^a × L^b) × 1000	-4.441	1.205	0.9	1.55	Mercer et al., 2001	anterior margin of the eye to final abdominal segment	*Apterothrips apteris*

Supplementary Table 9. Relationship between dry body mass (DM) and fresh body mass (FM) of mesofaunal groups. Equations were applied for different taxa if body length could not be directly converted to dry body mass or fresh body mass.

Taxon	Equation (FM[mg], DM[mg])	a	b	Reference	Regression specificity
Acari	DM = a × FM	0.431		Edwards, 1967	Acari
Collembola	FM = (10^a × (DM/1000)^b) × 1000	0.0504	0.9547	Mercer et al., 2001	Collembola
Collembola	DM = (10^a × (FM/1000)^b) × 1000	-0.5499	0.9402	Mercer et al., 2001	Collembola
all other groups	FM = (10^a × (DM/1000)^b) × 1000	0.611	1.0213	Mercer et al., 2001	Insects
all other groups	DM = (10^a × (FM/1000)^b) × 1000	-0.693	0.9411	Mercer et al., 2001	Insects

Supplementary Table 10. Regression parameters from Ehnes et al. (2011) (Ref. 7) used to calculate individual metabolic rates. If possible the taxa-specific phylogenetic model was used: $\ln we = \ln i_{oPG} + a_{PG} \ln M - E_{PG}(1/kT)$; For nematodes the linear model was used: $\ln we = \ln i_o + a \ln M - E(1/kT)$. We is the metabolic rate, a is the allometric exponent, E is the activation energy, k is the Boltzmann constant, T the temperature in Kelvin and i_o a normalisation factor.

Regression group	Applied to taxa	$\ln i_o$ / $\ln i_{oPG}$	a / a_{PG}	E / E_{PG}	Model
Arachnida	Araneae, Pseudoscorpionida	24.581475	0.5652537	0.7093476	phylogenetic
General	Nematoda	23.055335	0.695071	0.68642	linear
Insecta	Collembola, Diplura, Insecta, Protura	21.97205	0.758895	0.6574038	phylogenetic
Mesostigmata	Mesostigmata	9.674023	0.6904864	0.3792541	phylogenetic
Oribatida	Oribatida	22.02277	0.6793706	0.7060855	phylogenetic
Progoneata	Pauropoda, Symphyla	22.347024	0.5713411	0.6700449	phylogenetic
Prostigmata	all other Acari	10.281495	0.6599399	0.3792541	phylogenetic

Supplementary Table 11. Assimilation efficiencies of the focal feeding guilds in this study. Animal efficiencies were taken from literature[8,9]. Microbial efficiency was assumed to vary around 0.60 (Ref. 10).

Feeding guild	**Assimilation efficiency**
Microbes	0.55-0.65
Herbivorous nematodes	0.25
Herbivorous mesofauna	0.45
Bacterivorous nematodes	0.60
Fungivorous nematodes	0.38
Detrivorous mesofauna	0.50
Predatory nematodes	0.50
Predatory mites	0.60
Predatory mesofauna	0.60

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