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Klarner, B., Ehnes, R. B., Erdmann, G., Eitzinger, B., Pollierer, M. P., Maraun, M. and Scheu, S. 2014. Trophic shift of soil animal species with forest type as indicated by stable isotope analysis. – Oikos doi: 10.1111/j.1600-0706.2013.00939.x

Appendix 1

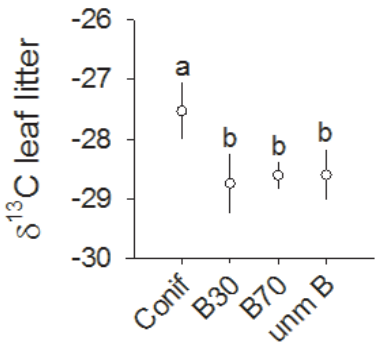

Figure A1. $\delta^{13}C$ signatures (means ± SD) of leaf litter of the four forest types studied (Conif = coniferous forest, B30 = young managed beech, B70 = old managed beech, unm B = unmanaged beech); different letters indicate significant differences between means ($p < 0.05$, Tukey's HSD).

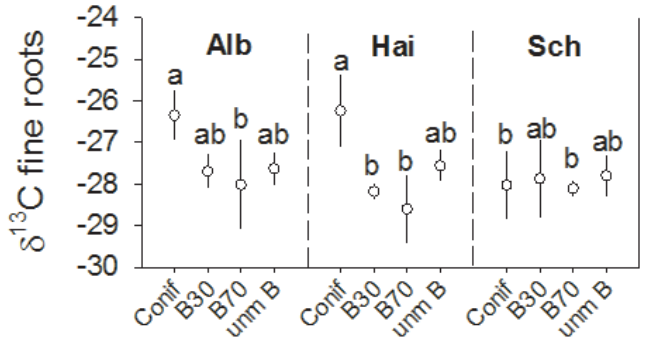

Figure A2. $\delta^{13}C$ signatures (means ± SD) of fine roots of trees of the four forest types in the three regions studied (Alb = Swabian Alb, Hai = Hainich, Sch = Schorfheide, Conif = coniferous forest, B30 = young managed beech, B70 = old managed beech, unm B = unmanaged beech); different letters indicate significant differences between means ($p < 0.05$, Tukey's HSD).

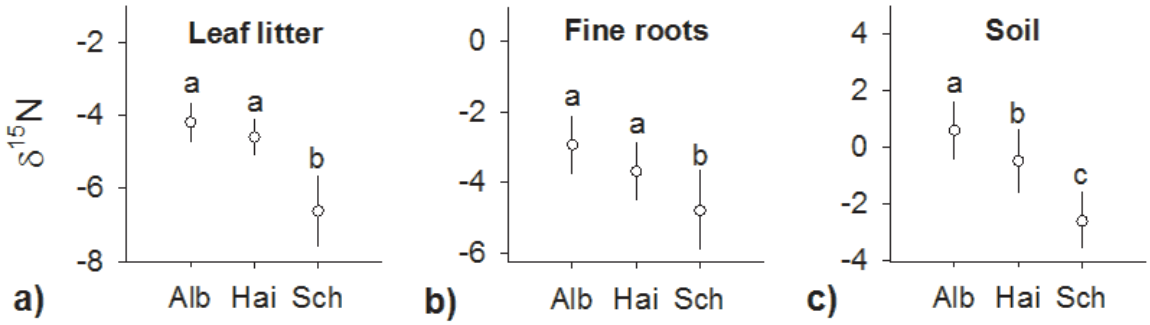

Figure A3. $\delta^{15}N$ signatures (means ± SD) of (a) leaf litter, (b) fine roots and (c) soil of the three regions studied; for legend see Fig. A2; different letters indicate significant differences between means ($p < 0.05$, Tukey's HSD).

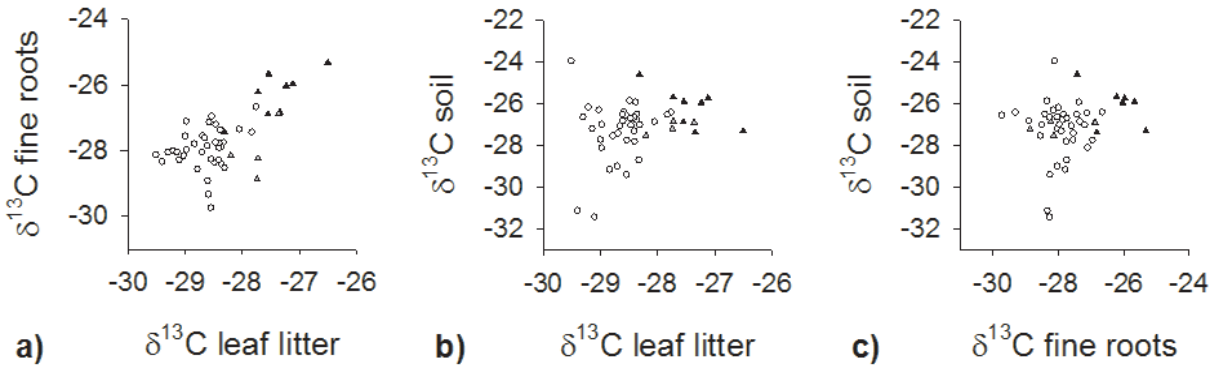

Figure A4. Relationship between $\delta^{13}C$ signatures of (a) leaf litter and fine roots ($r = 0.63$, $p < 0.001$), (b) leaf litter and soil ($r = 0.24$, $p = 0.09$), and (c) fine roots and soil ($r = 0.20$, $p = 0.18$) in the studied forests (Pearson correlation); open dots = beech, black triangles = spruce, grey triangles = pine.

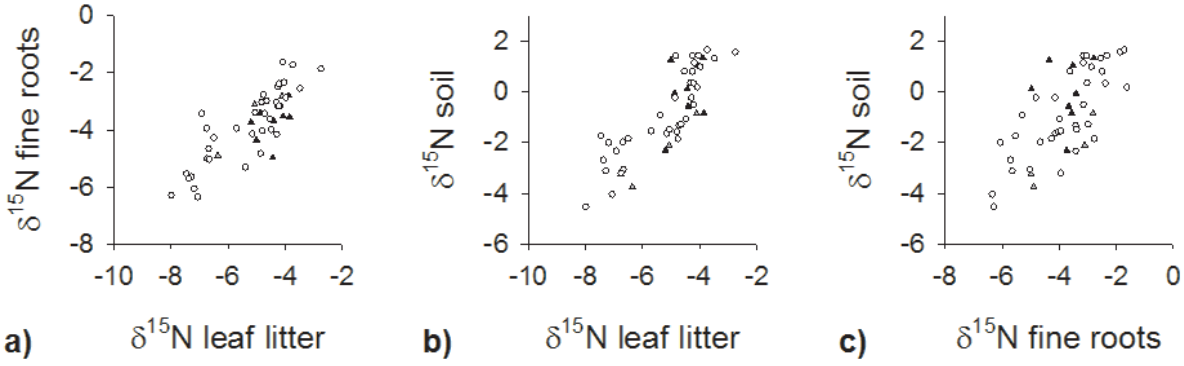

Figure A5. Relationship between $\delta^{15}N$ signatures of (a) leaf litter and fine roots ($r = 0.82$, $p < 0.001$), (b) leaf litter and soil ($r = 0.84$, $p < 0.001$), and (c) fine roots and soil ($r = 0.70$, $p < 0.001$) in the studied forests (Pearson correlation); open dots = beech, black triangles = spruce, grey triangles = pine.

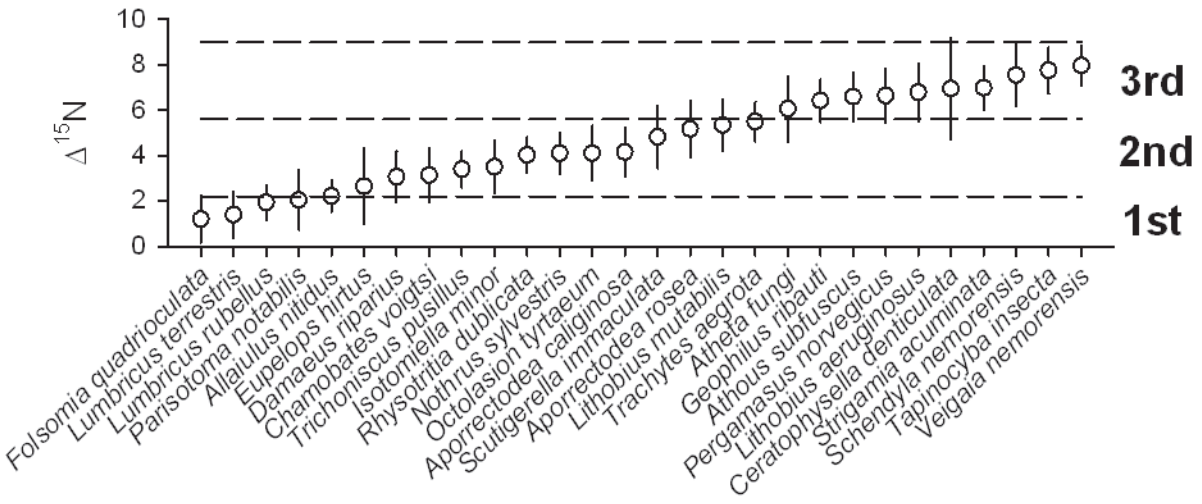

Figure A6. Differences between $\delta^{15}N$ values of leaf litter and that of soil animal species ($\Delta^{15}N$; means ± SD); dashed lines denote boundaries for the first, second and third consumer level assuming a mean enrichment of 0.5‰ for the first and 3.4‰ for the second and third consumer level; each consumer level is assumed to span 3.4‰.

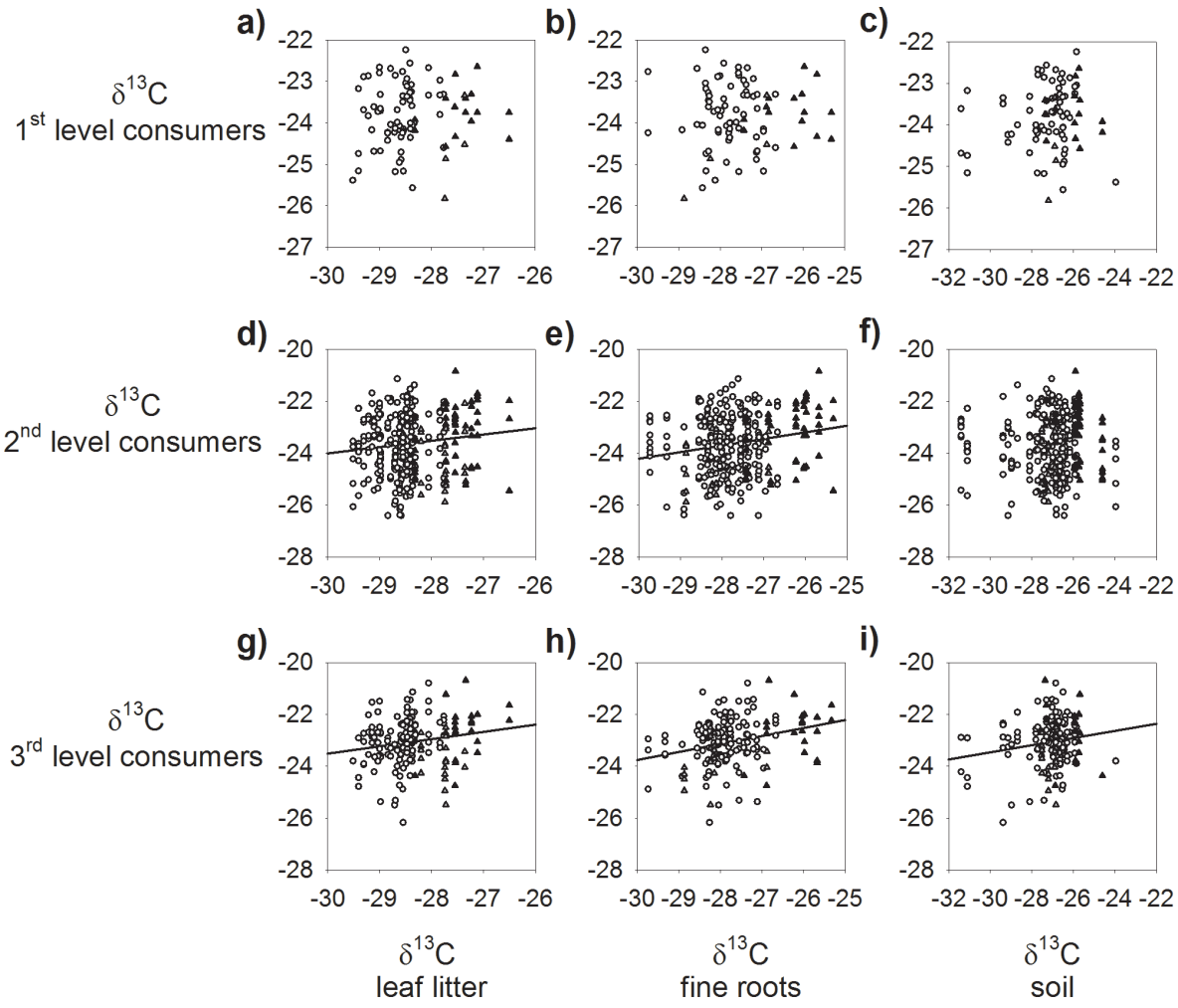

Figure A7. Relationship between $\delta^{13}C$ signatures of resources (leaf litter, fine roots and soil) and soil animals of different trophic levels (first, second and third level consumers); for r^2- and p-values see Table 1; open dots = beech, black triangles = spruce, grey triangles = pine.

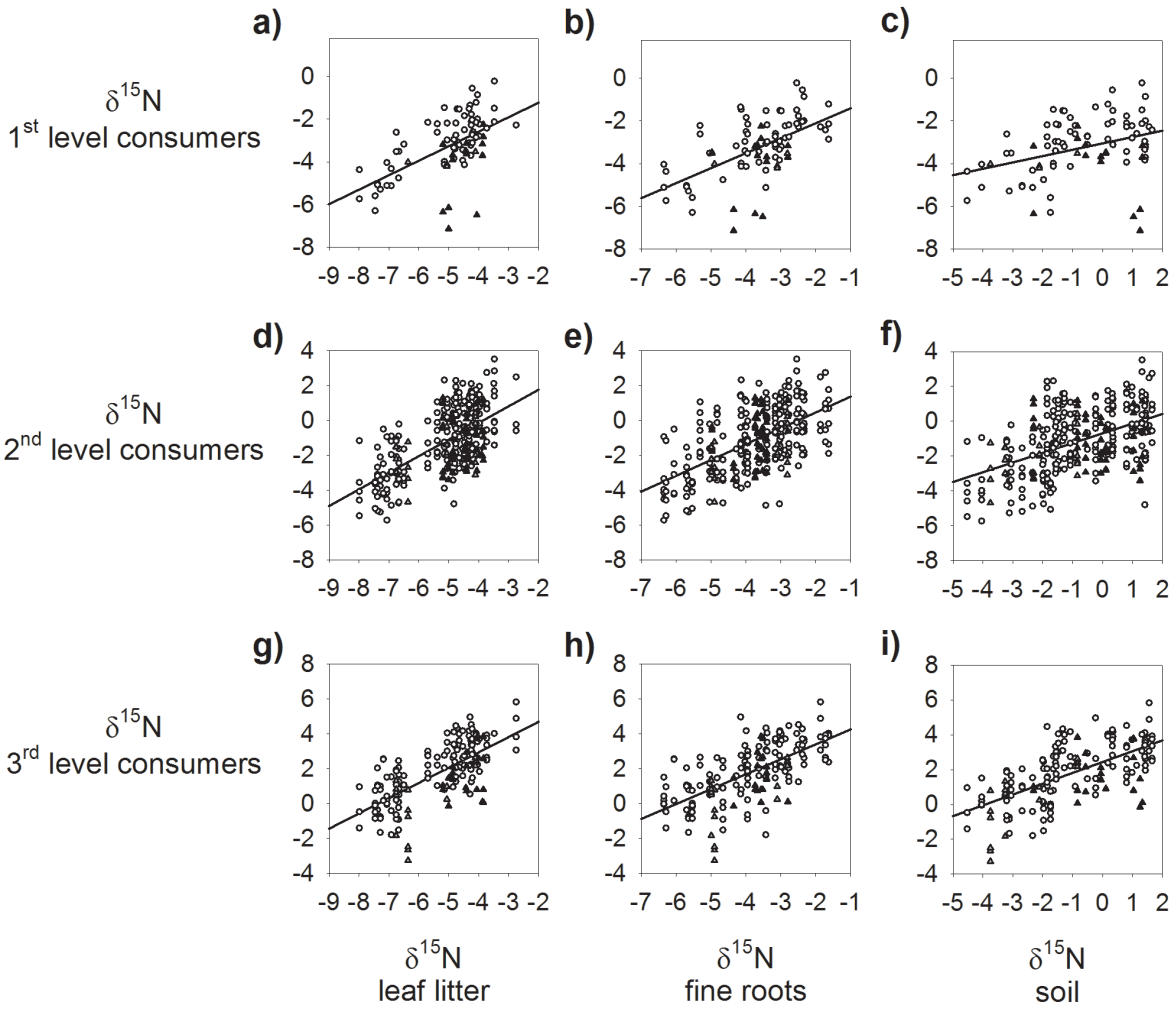

Figure A8. Relationship between $\delta^{15}N$ signatures of resources (leaf litter, fine roots and soil) and soil animals of different trophic levels (first, second and third level consumers); for r^2- and p-values see Table 1; open dots = beech, black triangles = spruce, grey triangles = pine.

Table A1. Two-factorial ANOVA table of F-values on the effect of region and forest type on stable isotope signatures ($\delta^{13}C$, $\delta^{15}N$) of leaf litter, fine roots and soil; significant results are marked in bold (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$).

	Region		Forest type		Region*forest type	
Resource	$\delta^{13}C$	$\delta^{15}N$	$\delta^{13}C$	$\delta^{15}N$	$\delta^{13}C$	$\delta^{15}N$
Leaf litter	$F_{2,36} = 1.84$	**$F_{2,36} = 65.01$*****	**$F_{3,36} = 22.57$*****	$F_{3,36} = 1.49$	$F_{6,36} = 1.27$	$F_{6,36} = 2.09$
Fine roots	$F_{2,36} = 2.54$	**$F_{2,36} = 17.27$*****	**$F_{3,36} = 9.27$*****	$F_{3,36} = 1.05$	**$F_{6,36} = 2.72$***	$F_{6,36} = 1.56$
Soil	$F_{2,36} = 0.89$	**$F_{2,36} = 33.25$*****	$F_{3,36} = 1.12$	$F_{3,36} = 0.27$	$F_{6,36} = 0.75$	$F_{6,36} = 0.32$

Table A2. Stable isotope signatures ($\delta^{13}C$, $\delta^{15}N$) of leaf litter, fine roots and soil (means ± SD) of the four forest types in the three regions studied (Alb = Swabian Alb, Hai = Hainich, Sch = Schorfheide, Conif = coniferous forest, B30 = young managed beech, B70 = old managed beech, unm B = unmanaged beech).

		Leaf litter		Fine roots		Soil	
Factor lvl.	N	$\delta^{13}C$	$\delta^{15}N$	$\delta^{13}C$	$\delta^{15}N$	$\delta^{13}C$	$\delta^{15}N$
Total	48	-28.37 ± 0.64	-5.13 ± 1.27	-27.68 ± 0.89	-3.80 ± 1.19	-27.07 ± 1.34	-0.85 ± 1.69
Alb	16	-28.28 ± 0.63	-4.19 ± 0.54	-27.43 ± 0.89	-2.94 ± 0.82	-26.78 ± 1.22	0.58 ± 1.03
Hai	16	-28.53 ± 0.80	-4.59 ± 0.50	-27.65 ± 1.08	-3.68 ± 0.82	-27.33 ± 1.87	-0.50 ± 1.12
Sch	16	-28.30 ± 0.48	-6.61 ± 0.96	-27.95 ± 0.62	-4.79 ± 1.12	-27.09 ± 0.67	-2.62 ± 1.00
Conif	12	-27.53 ± 0.48	-4.83 ± 0.94	-26.87 ± 1.11	-3.82 ± 0.80	-26.49 ± 0.90	-0.83 ± 1.71
B30	12	-28.75 ± 0.50	-5.14 ± 1.47	-27.92 ± 0.58	-3.80 ± 1.18	-27.29 ± 1.89	-0.63 ± 1.67
B70	12	-28.61 ± 0.24	-5.38 ± 1.29	-28.24 ± 0.76	-4.12 ± 1.26	-27.40 ± 1.55	-1.04 ± 1.66
Unm B	12	-28.6 ± 0.43	-5.19 ± 1.43	-27.67 ± 0.41	-3.47 ± 1.49	-27.09 ± 0.56	-0.90 ± 1.93
Alb, Conif	4	-27.42 ± 0.16	-4.16 ± 0.48	-26.35 ± 0.60	-3.32 ± 0.36	-26.52 ± 0.72	0.37 ± 1.00
Alb, B30	4	-28.82 ± 0.51	-3.86 ± 0.74	-27.70 ± 0.42	-2.66 ± 0.62	-27.05 ± 2.38	1.24 ± 0.34
Alb, B70	4	-28.47 ± 0.11	-4.41 ± 0.36	-28.02 ± 1.07	-3.48 ± 1.04	-26.64 ± 0.77	0.38 ± 0.90
Alb, unm B	4	-28.43 ± 0.49	-4.35 ± 0.53	-27.64 ± 0.41	-2.29 ± 0.72	-26.91 ± 0.67	0.35 ± 1.60
Hai, Conif	4	-27.42 ± 0.78	-4.76 ± 0.40	-26.24 ± 0.88	-4.18 ± 0.61	-25.83 ± 1.11	-0.37 ± 1.49
Hai, B30	4	-28.95 ± 0.43	-4.62 ± 0.40	-28.18 ± 0.19	-3.68 ± 0.55	-28.02 ± 2.49	-0.71 ± 0.93
Hai, B70	4	-28.76 ± 0.25	-4.70 ± 0.58	-28.60 ± 0.81	-3.80 ± 1.13	-27.99 ± 2.32	-0.69 ± 1.15
Hai, unm B	4	-28.99 ± 0.25	-4.30 ± 0.65	-27.57 ± 0.39	-3.07 ± 0.75	-27.46 ± 0.62	-0.22 ± 1.29
Sch, Conif	4	-27.76 ± 0.34	-5.57 ± 1.22	-28.03 ± 0.83	-3.95 ± 1.15	-27.11 ± 0.31	-2.49 ± 1.29
Sch, B30	4	-28.47 ± 0.57	-6.96 ± 0.44	-27.88 ± 0.92	-5.07 ± 0.71	-26.79 ± 0.32	-2.40 ± 0.60
Sch, B70	4	-28.59 ± 0.27	-7.02 ± 0.33	-28.11 ± 0.19	-5.09 ± 1.23	-27.57 ± 1.23	-2.79 ± 0.99
Sch, unm B	4	-28.37 ± 0.25	-6.90 ± 0.95	-27.80 ± 0.50	-5.06 ± 1.29	-26.89 ± 0.16	-2.82 ± 1.33

Table A3. Full names of species, taxonomic group, affiliation to trophic level and number of replicates studied; for legend see Table A2.

			Swabian Alb				Hainich				Schorfheide			
Trophic level	Species	Taxonomic group	Conif	B30	B70	B unm	Conif	B30	B70	B unm	Conif	B30	B70	B unm
1st level consumers	*Folsomia quadrioculata* (Tullberg, 1871)	Collembola	3	2	3	2	3	3	3	4	NA	NA	NA	NA
	Lumbricus rubellus Hoffmeister, 1843	Lumbricidae	NA	NA	NA	NA	NA	NA	NA	NA	1	2	4	2
	Lumbricus terrestris Linnaeus, 1758	Lumbricidae	1	3	1	3	2	2	2	2	NA	NA	NA	NA
	Parisotoma notabilis (Schaeffer, 1896)	Collembola	3	3	3	4	3	3	3	4	3	3	3	3
2nd level consumers	*Allajulus nitidus* (Verhoeff, 1891)	Diplopoda	3	3	3	3	3	3	2	3	NA	NA	NA	NA
	Aporrectodea caliginosa (Savigny, 1826)	Lumbricidae	NA	NA	NA	NA	3	4	3	3	NA	NA	NA	NA
	Aporrectodea rosea (Savigny, 1826)	Lumbricidae	NA	NA	NA	NA	3	2	3	2	NA	NA	NA	NA
	Chamobates voigtsi (Oudemans, 1902)	Oribatida	3	3	2	3	3	3	3	4	2	3	3	3
	Damaeus riparius Nicolet, 1855	Oribatida	1	3	3	3	2	3	3	4	2	3	3	3
	Eupelops hirtus (Berlese, 1916)	Oribatida	NA	NA	NA	NA	NA	NA	NA	NA	3	3	3	2
	Isotomiella minor (Schaeffer, 1896)	Collembola	3	2	3	3	3	3	3	3	3	2	3	3
	Lithobius mutabilis L. Koch, 1862	Chilopoda	3	2	3	2	2	3	3	4	NA	NA	NA	NA
	Nothrus sylvestris Nicolet, 1855	Oribatida	NA	NA	NA	NA	NA	NA	NA	NA	3	4	4	2
	Octolasion tyrtaeum Savigny, 1826	Lumbricidae	1	1	2	3	3	3	4	2	NA	NA	NA	NA
	Rhysotritia dublicata (Grandjean, 1953)	Oribatida	NA	NA	NA	NA	NA	NA	NA	NA	3	4	4	4
	Scutigerella immaculata (Newport, 1845)	Symphyla	3	2	4	3	2	3	3	3	NA	NA	NA	NA
	Trachytes aegrota (Koch, 1841)	Mesostigmata	3	3	3	3	2	2	2	3	3	3	3	3
	Trichoniscus pusillus Brandt, 1833	Isopoda	3	3	3	3	2	3	3	4	NA	NA	NA	NA
3rd level consumers	*Atheta fungi* (Gravenhorst, 1806)	Coleoptera	NA	NA	NA	NA	NA	NA	NA	NA	1	2	2	3
	Athous subfuscus (O. F. Muller, 1764)	Coleoptera	3	2	3	3	3	3	3	2	3	3	2	1
	Ceratophysella denticulata (Bagnall, 1941)	Collembola	NA	NA	NA	NA	NA	NA	NA	NA	2	3	3	3
	Geophilus ribauti Brolemann, 1908	Chilopoda	3	1	2	2	1	3	3	3	NA	NA	NA	NA
	Lithobius aeruginosus L. Koch, 1862	Chilopoda	3	4	3	4	NA	NA	NA	NA	NA	NA	NA	NA
	Pergamasus norvegicus (Berlese, 1906)	Mesostigmata	NA	NA	NA	NA	NA	NA	NA	NA	3	2	3	2
	Schendyla nemorensis C.L. Koch, (1837)	Chilopoda	NA	NA	NA	NA	1	2	1	3	3	2	2	2
	Strigamia acuminata Leach, (1815)	Chilopoda	1	2	3	3	NA	NA	NA	NA	NA	NA	NA	NA
	Tapinocyba insecta (L. Koch, 1869)	Araneae	NA	NA	NA	NA	NA	NA	NA	NA	2	3	3	4
	Veigaia nemorensis (C.L. Koch, 1839)	Mesostigmata	3	3	3	3	3	3	3	4	3	3	3	3

Table A4. Two-factorial ANOVA table of F-values on the effect of region and forest type on the stable isotope enrichment ($\Delta^{13}C$, $\Delta^{15}N$) of soil animal species ordered by trophic level; significant effects are marked in bold (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$).

		Forest type		Region		Region*forest type	
Trophic level	Species	$\Delta^{13}C$	$\Delta^{15}N$	$\Delta^{13}C$	$\Delta^{15}N$	$\Delta^{13}C$	$\Delta^{15}N$
1st level consumers	*Folsomia quadrioculata* (Tullberg, 1871)	**$F_{3,15} = 10.25$*** **	**$F_{3,15} = 3.93$***	$F_{1,15} = 0.65$	$F_{1,15} = 0.75$	$F_{3,15} = 3.31$	$F_{3,15} = 1.29$
	Lumbricus rubellus Hoffmeister, 1843	$F_{3,5} = 4.38$	$F_{3,5} = 1.38$	NA	NA	NA	NA
	Lumbricus terrestris Linnaeus, 1758	$F_{3,8} = 1.77$	$F_{3,8} = 2.97$	$F_{1,8} = 0.00$	$F_{1,8} = 0.93$	$F_{3,8} = 0.88$	$F_{3,8} = 1.79$
	Parisotoma notabilis (Schaeffer, 1896)	**$F_{3,26} = 18.81$*** **	**$F_{3,26} = 11.80$*** **	**$F_{2,26} = 24.83$*** **	**$F_{2,26} = 12.15$*** **	**$F_{6,26} = 3.24$***	$F_{6,26} = 0.48$
2nd level consumers	*Allajulus nitidus* (Verhoeff, 1891)	$F_{3,15} = 1.37$	$F_{3,15} = 2.74$	$F_{1,15} = 0.11$	$F_{1,15} = 2.00$	$F_{3,15} = 0.24$	$F_{3,15} = 0.32$
	Aporrectodea caliginosa (Savigny, 1826)	$F_{3,9} = 1.23$	$F_{3,9} = 0.27$	NA	NA	NA	NA
	Aporrectodea rosea (Savigny, 1826)	$F_{3,6} = 1.68$	$F_{3,6} = 0.56$	NA	NA	NA	NA
	Chamobates voigtsi (Oudemans, 1902)	**$F_{3,23} = 14.09$*** **	$F_{3,23} = 2.37$	$F_{2,23} = 0.43$	$F_{2,23} = 2.70$	$F_{6,23} = 2.07$	$F_{6,23} = 1.05$
	Damaeus riparius Nicolet, 1855	**$F_{3,21} = 4.29$***	$F_{3,21} = 0.24$	$F_{2,21} = 1.11$	$F_{2,21} = 1,78$	$F_{6,21} = 1.23$	$F_{6,21} = 0.94$
	Eupelops hirtus (Berlese, 1916)	$F_{3,7} = 1.35$	$F_{3,7} = 2.05$	NA	NA	NA	NA
	Isotomiella minor (Schaeffer, 1896)	**$F_{3,22} = 6.48$*** **	**$F_{3,22} = 12.22$*** **	$F_{2,22} = 0.97$	$F_{2,22} = 0.13$	$F_{6,22} = 2.29$	$F_{6,22} = 2.51$
	Lithobius mutabilis L. Koch, 1862	**$F_{3,14} = 6.75$*** **	**$F_{3,14} = 3.55$***	$F_{1,14} = 0.62$	$F_{1,14} = 3.44$	$F_{3,14} = 0.05$	$F_{3,14} = 0.63$
	Nothrus sylvestris Nicolet, 1855	**$F_{3,9} = 10.29$*** **	$F_{3,9} = 0.63$	NA	NA	NA	NA
	Octolasion tyrtaeum Savigny, 1826	$F_{3,11} = 0.57$	$F_{3,11} = 0.37$	$F_{1,11} = 1.62$	$F_{1,11} = 0.02$	$F_{3,11} = 2.10$	$F_{3,11} = 0.08$
	Rhysotritia dublicata (Grandjean, 1953)	$F_{3,11} = 3.15$	$F_{3,11} = 0.62$	NA	NA	NA	NA
	Scutigerella immaculata (Newport, 1845)	$F_{3,15} = 1.51$	$F_{3,15} = 0.42$	$F_{1,15} = 0.16$	$F_{1,15} = 0.23$	$F_{3,15} = 0.52$	$F_{3,15} = 1.58$
	Trachytes aegrota (Koch, 1841)	**$F_{3,21} = 24.05$*** **	**$F_{3,21} = 9.21$*** **	$F_{2,21} = 1.07$	$F_{2,21} = 2.07$	$F_{6,21} = 0.94$	$F_{6,21} = 0.83$
	Trichoniscus pusillus Brandt, 1833	**$F_{3,16} = 7.22$*** **	$F_{3,16} = 3.92$	$F_{1,16} = 0.28$	**$F_{1,16} = 3.61$***	$F_{3,16} = 1.35$	$F_{3,16} = 1.61$
3rd level consumers	*Atheta fungi* (Gravenhorst, 1806)	$F_{3,4} = 5.53$	$F_{3,4} = 1.24$	NA	NA	NA	NA
	Athous subfuscus (O. F. Muller, 1764)	**$F_{3,19} = 4.72$***	**$F_{3,19} = 9.04$*** **	$F_{2,19} = 0.95$	**$F_{2,19} = 4.63$***	$F_{6,19} = 0.53$	$F_{6,19} = 1.85$
	Ceratophysella denticulata (Bagnall, 1941)	$F_{3,7} = 1.27$	$F_{3,7} = 1.58$	NA	NA	NA	NA
	Geophilus ribauti Brolemann, 1908	$F_{3,10} = 0.76$	$F_{3,10} = 0.92$	$F_{1,10} = 1.20$	$F_{1,10} = 0.70$	$F_{3,10} = 0.49$	$F_{3,10} = 1.31$
	Lithobius aeruginosus L. Koch, 1862	$F_{3,10} = 3.10$	$F_{3,10} = 2.11$	NA	NA	NA	NA

Pergamasus norvegicus (Berlese, 1906)	**$F_{3,6}$ = 15.24****	$F_{3,6}$ = 3.13	NA	NA	NA	NA
Schendyla nemorensis C.L. Koch, (1837)	$F_{3,8}$ = 3.99	**$F_{3,8}$ = 5.14***	$F_{1,8}$ = 0.01	$F_{1,8}$ = 0.04	$F_{3,8}$ = 0.42	$F_{3,8}$ = 1.09
Strigamia acuminata Leach, (1815)	$F_{3,5}$ = 3.28	$F_{3,5}$ = 1.04	NA	NA	NA	NA
Tapinocyba insecta (L. Koch, 1869)	**$F_{3,8}$ = 4.49***	$F_{3,8}$ = 1.14	NA	NA	NA	NA
Veigaia nemorensis (C.L. Koch, 1839)	**$F_{3,25}$ = 20.44*****	**$F_{3,25}$ = 13.33*****	$F_{2,25}$ = 0.57	$F_{2,25}$ = 0.66	$F_{6,25}$ = 1.95	$F_{6,25}$ = 0.88