Ecography

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Supplementary material

Appendix 1

Latitudinal gradients of diversity

Detritivores

We identified 154 detritivore morphospecies belonging to 7 insect orders (in order of descending species richness: Trichoptera, Plecoptera, Diptera, Coleoptera, Ephemeroptera, Lepidoptera and Blattodea), 3 crustacean orders (Decapoda, Amphipoda and Isopoda), and the class Gastropoda. Local diversity (α-diversity) increased with latitude ($r = 0.49$, $P < 0.0001$); γ-diversity did not change with absolute latitude ($r = 0.16$, $P = 0.61$) or corrected latitude ($r = 0.27$, $P = 0.38$); none of the β-diversity measures changed with absolute latitude (β_m: $r = 0.10$, $P = 0.76$; β_a: $r = 0.03$, $P = 0.92$; β_p: $r = 0.05$, $P = 0.87$; β_J: $r = 0.06$, $P = 0.84$) or corrected latitude (β_m: $r = 0.02$, $P = 0.94$; β_a: $r = 0.14$, $P = 0.65$; β_p: $r = 0.005$, $P = 0.99$; β_J: $r = 0.003$, $P = 0.93$).

All litter invertebrates

Leaf litter samples contained 807 non-detritivore morphospecies. The dominant taxa were Coleoptera, Diptera, Trichoptera, Ephemeroptera, Odonata, Heteroptera, Plecoptera and Gastropoda. Invertebrates other than litter-consuming detritivores included representatives of all functional groups of stream invertebrates: fine-particle collectors (including filterers of suspended particles), herbivores, and predators. Thus, there were 951 morphospecies included in the dataset comprising all litter-associated invertebrates (detritivores + all others). Local diversity (α-diversity) determined for this dataset did not change with latitude ($r = 0.06$, $P = 0.50$), nor did γ-diversity vary with absolute latitude ($r = 0.22$, $P = 0.49$) or corrected latitude ($r = 0.17$, $P = 0.60$); none of the β-diversity measures changed with absolute latitude (β_m: $r = 0.30$, $P = 0.35$; β_a: $r = 0.27$, $P = 0.39$; β_p: $r = 0.26$, $P = 0.42$; β_J: $r = 0.30$, $P = 0.35$) or corrected latitude (β_m: $r = 0.32$, $P = 0.31$; β_a: $r = 0.22$, $P = 0.50$; β_p: $r = 0.26$, $P = 0.42$; β_J: $r = 0.31$, $P = 0.33$).

Taxonomic groups

Local (α-) diversity of Trichoptera showed no latitudinal gradient (r = 0.01, p = 0.92); α-diversity of Ephemeroptera, Diptera and Coleoptera decreased with latitude (Ephemeroptera: $r = 0.31$, $P = 0.001$; Diptera: $r = 0.20$, $P = 0.042$; Coleoptera: $r = 0.47$, $P < 0.0001$). Regional (γ-) diversity did not change for any taxonomic group with absolute latitude (Ephemeroptera: $r = 0.47$, $P = 0.14$; Trichoptera: $r = 0.11$, $P = 0.75$; Diptera: $r = 0.27$, $P = 0.43$; Coleoptera: $r = 0.51$, $P = 0.11$) or corrected latitude (Ephemeroptera: *r* = 0.51, *P* = 0.11; Trichoptera: *r* = 0.08, *P* = 0.82; Diptera: *r* = 0.16, *P* = 0.63; Coleoptera: *r* = 0.49, *P* = 0.13). Likewise, none of the β-diversity measures changed with absolute or corrected latitude and thus we only report results for β_m and absolute latitude (Trichoptera: *r* = 0.16, *P* = 0.65; Ephemeroptera: *r* = 0.13, *P* = 0.71; Diptera: *r* = 0.24, *P* = 0.47; Coleoptera: *r* = 0.03, *P* = 0.93).

Latitudinal gradients of ecological processes

Detritivores

See main Results section.

All litter invertebrates

Neither nestedness based on abundance (WINE) or presence/absence (NODF) varied with absolute latitude (WINE: *r* = 0.25, *P* = 0.43; NODF: *r* = 0.28, *P* = 0.57) or corrected latitude (WINE: *r* = 0.32, *P* = 0.32; NODF: *r* = 0.19, *P* = 0.54); this was also true for the DDR slope (r = 0.01, p = 0.97 and *r* = 0.12, *P* = 0.73, respectively), as well as the AAC slope (*r* = 0.57, *P* = 0.09 and *r* = 0.60, *P* = 0.07, respectively) and the AES slope (*r* = 0.47, *P* = 0.17 and *r* = 0.47, *P* = 0.17, respectively); the C-score was higher than expected by chance in most cases (i.e., species were segregated), but it did not change with absolute latitude (*r* = 0.10, *P* = 0.76) or corrected latitude (*r* = 0.16, *P* = 0.61) (Table S2). The environmental variables correlated with all litter invertebrates were, in order of importance, those related to channel size and morphology, leaf litter availability, and water chemistry (Table S3).

Taxonomic groups

We report only results for absolute latitude, because results for corrected latitude were similar. Nestedness showed no latitudinal change for all taxonomic groups (Trichoptera: *r* = 0.29, *P* = 0.38; Ephemeroptera: *r* = 0.03, *P* = 0.94; Diptera: *r* = 0.59, *P* = 0.06; Coleoptera: *r* = 0.07, *P* = 0.84), and the same occurred for the DDR slope (Trichoptera: *r* = 0.56, *P* = 0.07; Ephemeroptera: *r* = 0.38, *P* = 0.24; Diptera: *r* = 0.02, *P* = 0.96; Coleoptera: *r* = 0.20, *P* = 0.55), the AAC slope (Trichoptera: *r* = 0.54, *P* = 0.09; Ephemeroptera: *r* = 0.28, *P* = 0.41; Diptera: *r* = 0.01, *P* = 0.97; Coleoptera: *r* = 0.08, *P* = 0.80), the AES slope (Trichoptera: *r* = 0.20, *P* = 0.55; Ephemeroptera: *r* = 0.19, *P* = 0.57; Diptera: *r* = 0.35, *P* = 0.29; Coleoptera: *r* = 0.02, *P* = 0.95), and the C-score

(Trichoptera: $r = 0.39$, $P = 0.23$; Ephemeroptera: $r = 0.14$, $P = 0.73$; Diptera: $r = 0.38$, $P = 0.28$; Coleoptera: $r = 0.13$, $P = 0.75$).

Table A1. First-order Jackknife estimates of species richness in each region (codes are given in Table 1) and % of species recorded in this study.

Region	No. Species observed	Jackknife estimate	% Species recorded
ECD	16	19.6	82
KEN	2	2.9	69
MLY	22	24.75	89
COL	12	12	100
FGN	3	3	100
PAN	7	7.9	89
IND	15	16.8	89
QLD	3	3	100
BRL	8	8.9	90
HKN	13	16.6	78
MLD	14	17.6	80
PTG	11	11.9	92
ARG	10	10	100
FRN	19	23.5	81
SWD	16	19.6	82

Table A2. Nestedness index; slopes of the relationships between assemblage similarity and distance between sites (DDR), assemblage similarity and altitudinal change (AAC), and assemblage similarity and environmental similarity (AES); and C-score quantifying species co-occurrences, for complete assemblages of leaf litter-associated invertebrates in each study region (codes are given in Table 1). Asterisks indicate significant results (*** $P < 0.001$; ** $P < 0.001$; * $P < 0.05$; ns, not significant); (o) indicate outliers that were removed from regression analyses based on Cook's distance.

Region	**Nestedness**		**DDR slope (× 10^{-7})**		**AAC slope (× 10^{-4})**		**AES slope (× 10^{-3})**		**C-score**	
ECD	0.86	***	133.00	ns (o)	3.60	ns	1.66	*	0.61	*
KEN	0.47	*	-1.96	ns	-1.23	ns	1.86	ns	-0.06	ns
COL	0.08	ns	-43.86	** (o)	-2.08	***	0.98	*	1.85	***
FGN	0.32	ns	-2.84	ns	-1.60	ns	2.56	ns	-0.22	ns
PAN	0.90	***	-6.29	**	-16.5	ns	-2.40	ns	1.23	***
IND	0.59	**	-0.77	ns	-10.3	***	1.83	***	-0.18	ns
BRL	0.23	ns	1.35	ns	-0.80	ns	3.69	**	0.75	***
HKN	0.94	***	-0.59	ns	-3.92	*	2.87	ns	0.91	***
PTG	0.38	ns	-12.1	ns	-2.54	*	3.77	**	-0.20	ns
ARG	-0.03	ns	-0.40	ns	-0.80	ns	9.02	** (o)	1.09	***
FRN	0.79	***	-60.84	* (o)	-5.19	***	2.67	***	0.54	**
SWD	0.25	ns	8.41	ns	-3.47	ns	8.19	ns (o)	0.92	***

Table A3. Rank correlation between detritivore and leaf litter-associated invertebrate assemblages and combinations of environmental variables in each region (codes are given in Table 1). Codes for environmental variables are as follows: Alk, alkalinity; ChW, channel width; Con, conductivity; DO, dissolved oxygen concentration; LD, leaf litter diversity; LP, leaf litter prevalence; LQ, leaf litter quantity; NO_X, nitrate and nitrite concentration; pH, pH value; PPh, prevalence of pool habitats; RpC, riparian cover; RpD, riparian diversity; SRP, concentration of soluble reactive phosphorus; Tem, water temperature; TN, total nitrogen concentration; TP, total phosphorus concentration; WAr, watershed area; WD, median water depth; WVg, vegetation in watershed.

	Detritivores		**All invertebrates**	
Region	**r**	**Environmental variables**	**r**	**Environmental variables**
ECD	0.49	LQ, DO, WD	0.54	LQ, DO, WD
KEN	–		0.40	ChW, WVg
MLY	0.61	LQ, Tem, WD, ChW, PPh, RpC	0.98	LQ, Tem, WD, RpC
COL	0.81	Tem, TP, LQ	0.71	Tem, Alk, TP, PPh
FGN	–		0.39	DO, PPh, RpC, LD
PAN	0.68	Tem, Con, pH, Alk, DO, WD, ChW, PPh, RpC, WAr, LP	0.55	Tem, Alk, WD, ChW, PPh, RpC, WVg, WAr, LP, RpD, LD
IND	0.54	LQ, Alk, TN, TP, RpC	0.63	LQ, TP
QLD	0.35	pH, WD, PPh	–	
BRL	0.40	pH, Alk, TP	0.65	Con, DO, TP, RpC, WVg
HKN	0.59	LQ, TN, SRP, RpC	0.39	Tem, Con, pH, NO_X
MLD	0.44	NO_X	–	
PTG	0.45	Tem, Con, LQ, LD	0.54	Tem, PPh, LD
ARG	0.50	TP, PPh, WAr, LQ, RpD	0.53	PPh, WVg
FRN	0.49	Alk, WVg, RpC, WAr	0.76	Con, pH, Alk, PPh, RpC, WVg, WAr, RpD, LD
SWD	0.56	pH, RpC	0.29	LQ, pH, ChW