Electronic supplementary material

Title: Species-specific use of allochthonous resources by ground beetles (Carabidae) at a river–land interface
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ESM 1 Influence of propylene glycol on isotopic signatures

We examined the influence of propylene glycol on isotopic signatures of ground beetles (*Lithochlaenius noguchii*). We collected 20 individuals of *L. noguchii* from the Tattabetsu River in late June, 2014. Ten individuals were collected using pitfalls with 100% propylene glycol (remained for 4 days at the sampling site), whereas the other 10 individuals were collected using pitfalls with no propylene glycol. Stable isotopes were analyzed as described in the main text. We found no significant differences in isotopic values between raw and treated samples (Mann-Whitney U-test, $p > 0.1$ for both $\delta^{13}C$ and $\delta^{15}N$, $n = 20$; see below for details).

Variable	Raw sample (SD)	Treated sample (SD)
$\delta^{13}C$	-23.5 (1.1)	-24.3 (0.9)
$\delta^{15}N$	5.3 (1.4)	4.9 (1.0)

ESM 2 Model comparison of the RIS and RI models

We constructed a random intercept model (RI model), in which location effects $\beta 1_i$ do not vary among sampling months while the other parameters being identical with the random intercept and slope model (RIS model), to compare their performance through a Bayes factor (BF). The BF quantifies the weight of evidence in favor of the null hypothesis H_0 (in this case, "the RI model is true"). The BF value exceeds 1 if the null hypothesis is supported, otherwise taking a value of < 1.

The BF was calculated for a combination of the RIS and RI models according to the method described in Lunn et al. (2013). Alternative models (i.e., RIS and RI models) were combined into a single large model and relative probabilities of them were simultaneously evaluated as one of parameters in the course of parameter estimation of the large model. We assigned the same probabilities (i.e., 0.5) as priors for the two competing models. We ran three MCMC chains as described in the Method and checked the convergence of the relative probability parameters of candidate models based on trace plots.

The Bayes factor for the RI model compared to the RIS model was 0, indicating that the RIS model was decisively superior to the RI model.

References

Lunn D., C. Jackson, N. Best, A. Thomas, D. Spiegelhalter. 2013. The BUGS Book: A Practical Introduction to Bayesian Analysis. CRC Press, Boca Raton, USA

Table S1 Average dry mass (± standard deviation) of emerging aquatic insect individuals. Sample size indicates the number of individuals whose dry mass was measured.

Order	Dry mass (mg)	Sample size
Ephemeroptera	2.7 ± 2.5	17
Plecoptera	1.2 ± 0.3	6
Trichoptera	3.8 ± 8.2	19
Diptera	0.7 ± 0.5	7

Table S2 Inventory of ground beetle species collected in the Tottabetsu River.

Species name	Abundance (individuals)	%dominance
Amara ampliata	21	0.2
Amara macra	13	0.2
Apristas grandis	2630	30.8
Bembidion spp	451	5.3
Brachinus stenoderus	670	7.8
Carabus procerulus	1	< 0.1
Chlaenius pallipes	4	< 0.1
Craspedonotus tibialis	25	0.3
Cychrus morawitzi	1	< 0.1
Diplous caligatus	30	0.4
Dolichus halensis	2	< 0.1
Lithochlaenius noguchii	4170	48.8
Nebria macrogona	342	4.0
Nebria subdilatata	41	0.5
Platynus sculptipes	1	< 0.1
Pterostichus fortipes	10	0.1
Pterostichus leptis	130	1.5
Synuchus callitheres	2	< 0.1
Synuchus melantho	1	< 0.1
Total	8545	

Table S3 Average body size and dry mass (± standard deviation) of major ground beetles. Sample size indicates the number of individuals whose body size and dry mass were measured.

Species	Body size (mm)	Dry mass (mg)	Sample size
Apristas grandis	4.4 ± 0.3	1.3 ± 0.2	40
Bembidion spp	5.0 ± 0.8	2.1 ± 1.0	40
Brachinus stenoderus	10.3 ± 1.0	16.8 ± 4.4	43
Lithochlaenius noguchii	15.6 ± 0.9	44.4 ± 11.4	59
Nebria macrogona	19.2 ± 0.9	98.8 ± 22.5	29
Pterostichus leptis	19.1 ± 1.1	118.4 ± 37.9	25

Table S4 Ground beetles used for stable isotope analysis. Sample size indicates the number of stable isotope samples that were analyzed.

Period	Sampling date	Species	Sample size
Jun-Jul	Jun 19–23, Jul 11–18	*Apristas grandis*	20
		Bembidion spp	16
		Brachinus stenoderus	20
		Lithochlaenius noguchii	20
		Pterostichus leptis	5
Aug-Sep	Aug 22–28, Sep 13–18	*Apristas grandis*	20
		Bembidion spp	14
		Brachinus stenoderus	20
		Lithochlaenius noguchii	20
		Pterostichus leptis	18

Table S5 Prey samples used for stable isotope analysis. Sample size indicates the number of stable isotope samples that were analyzed.

Period	Group	Taxon	Sampling date	Sample size
Jun-Jul	Terrestrial predator	Ground spider	Jun 27	19
	Terrestrial prey	Coleoptera	Jun 9	10
		Larval Lepidoptera	Jun 10	5
		Terrestrial fly	Jun 9–10	5
		Snail and slug	Jun 13–20	5
		Earthworm	Jun 12–20	5
	Aquatic prey	Ephemeroptera	Jun 11	5
		Plecoptera	Jun 11	4
		Trichoptera	Jun 11	5
		Diptera	Jun 11	6
Aug-Sep	Terrestrial predator	Ground spider	Aug 29	15
	Terrestrial prey	Coleoptera	Aug 8–9, Sep 8	10
		Larval Lepidoptera	Aug 9–10, Sep 8–9	9
		Terrestrial fly	Aug 10, Sep 9	10
		Snail and slug	Aug 8, Sep 8	10
		Earthworm	Aug 8–9, Sep 8	10
	Aquatic prey	Ephemeroptera	Aug 10, Sep 9	9
		Plecoptera	Sep 9	5
		Trichoptera	Aug 10, Sep 9	8
		Diptera	Aug 10, Sep 9	5

Table S6 Results of a two-source SIAR model. Values represent mode estimates and associated 95% credible intervals (brackets) of proportional contribution of each prey item.

Species	Source	Proportional contribution	
		Jun-Jul	Aug-Sep
A. grandis	Aquatic prey	0.33 [0.22, 0.49]	0.28 [0.18, 0.39]
	Terrestrial prey	0.67 [0.51, 0.78]	0.72 [0.61, 0.82]
Bembidion spp.	Aquatic prey	0.57 [0.40, 0.77]	0.62 [0.49, 0.75]
	Terrestrial prey	0.43 [0.23 0.60]	0.38 [0.25, 0.51]
B. stenoderus	Aquatic prey	0.35 [0.25, 0.46]	0.22 [0.13, 0.32]
	Terrestrial prey	0.65 [0.54, 0.75]	0.78 [0.68, 0.87]
L. noguchii	Aquatic prey	0.50 [0.39, 0.63]	0.32 [0.23, 0.43]
	Terrestrial prey	0.50 [0.37, 0.61]	0.68 [0.57, 0.77]
P. leptis	Aquatic prey	0.04 [0.00, 0.69]	0.15 [0.05, 0.25]
	Terrestrial prey	0.96 [0.31, 1.03]	0.85 [0.75, 0.95]

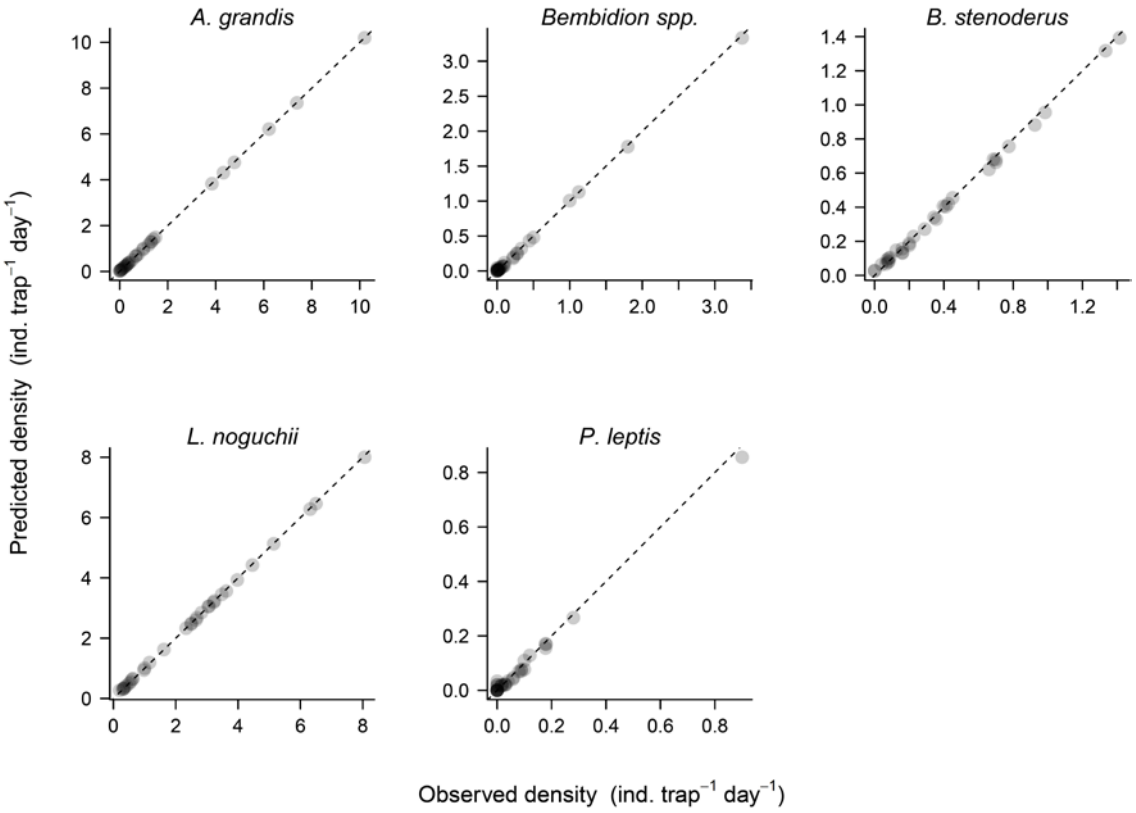

Figure S1 Comparison of predicted and observed density of ground beetles. The broken lines denote a 1:1 relationship.

Figure S2 Picture of gravel bars in the Tottabetsu River.