Ecography

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Supplementary material

Appendix 1

Table A1. Species included in study, their functional group assignments, taxonomic family, and mountain ranges captured in during field surveys, excluding opportunistic captures (see Methods).

Species	Habitat	Geog.	Diet	Mass (g)	Family	Mountains
Ammospermophilus leucurus	Xeric	S	Omnivore	103.92	Sciuridae	TS
Callospermophilus lateralis	Mixed	N	Omnivore	175.1	Sciuridae	RTS
Chaetodipus formosus	Xeric	S	Granivore	19.45	Heteromyidae	T
Dipodomys deserti	Xeric	S	Granivore	107.63	Heteromyidae	T
Dipodomys merriami	Xeric	S	Granivore	37.91	Heteromyidae	T
Dipodomys microps	Xeric	E	Herbivore	56.26	Heteromyidae	TS
Dipodomys ordii	Xeric	S	Granivore	50.4	Heteromyidae	RTS
Lemmiscus curtatus	Xeric	N	Herbivore	28.27	Muridae	TS
Microdipodops megacephalus	Xeric	E	Granivore	12.3	Heteromyidae	TS
Microdipodops pallidus	Xeric	S	Granivore	13.36	Heteromyidae	T
Microtus longicaudus	Mesic	N	Herbivore	44.8	Muridae	RTS
Microtus montanus	Mesic	E	Herbivore	42.85	Muridae	RTS
Neotoma cinerea	Mesic	N	Herbivore	285.89	Muridae	RTS
Neotoma lepida	Xeric	S	Herbivore	143.88	Muridae	TS
Onychomys leucogaster	Xeric	E	Insectivore	27.92	Muridae	RTS
Onychomys torridus	Xeric	S	Insectivore	21.68	Muridae	T
Otospermophilus variegatus	Mixed	S	Omnivore	714.58	Sciuridae	S
Perognathus longimembris	Xeric	S	Granivore	8.07	Heteromyidae	TS
Perognathus mollipilosus	Xeric	E	Granivore	21.56	Heteromyidae	RTS
Peromyscus crinitus	Xeric	S	Omnivore	16.32	Muridae	T
Peromyscus maniculatus	Mixed	E	Omnivore	19.98	Muridae	RTS
Peromyscus truei	Xeric	S	Omnivore	27	Muridae	RTS
Reithrodontomys megalotis	Mixed	S	Granivore	10.72	Muridae	RTS
Sorex merriami	Mesic	E	Insectivore	5.99	Soricidae	T
Sorex monticolus	Mesic	E	Insectivore	6.92	Soricidae	R
Sorex palustris	Mesic	N	Insectivore	13.07	Soricidae	RTS
Sorex preblei	Mixed	N	Insectivore	3.12	Soricidae	R
Sorex tenellus	Mesic	S	Insectivore	3.8	Soricidae	RTS
Sorex vagrans	Mesic	N	Insectivore	5.99	Soricidae	RTS
Tamias dorsalis	Xeric	S	Omnivore	63.66	Sciuridae	TS
Tamias minimus	Mixed	N	Omnivore	42.87	Sciuridae	RTS
Tamias umbrinus	Mixed	E	Omnivore	51.75	Sciuridae	RTS
Urocitellus beldingi	Mixed	E	Omnivore	272.53	Sciuridae	RT
Zapus princeps	Mesic	N	Omnivore	27.2	Dipodidae	RT

Table A2. Significant species pairs, Pairs Z-scores, functional similarity characteristics (intra-guild or inter-guild pair), mass differential, elevational distribution overlap within the mountain range, and the most parsimonious mechanism causing their association. Negative Z-scores indicate aggregations, positive are segregations. EF = Environmental Filtering, BI = Biotic Interactions (positive or negative). Dashes indicate duplication of the row above. Full species names can be found in Table S1. Asterisks next to Species 1 indicates the pair is also significantly associated in other mountain ranges.

				Functional trait similarity						
Sp. 1	Sp. 2	Scale	Z-score	Habitat	Geog. Aff.	Diet	Body size	Mass Diff. (g)	Ranges	Mechanism
Ruby Mountains										
C.lat	*M.lon*	Local	3.36	inter	intra	inter	inter	130.3	Overlap	EF
C.lat	*P.mol*	Local	2.63	inter	intra	inter	inter	153.54	Overlap	EF
C.lat	*T.umb*	Local	-2.69	intra	inter	intra	inter	123.35	Overlap	EF
C.lat	*U.bel*	Local	-2.75	intra	inter	intra	intra	97.43	Overlap	EF
M.lon	*S.vag*	Local	-2.5	intra	intra	inter	inter	38.81	Overlap	EF
M.lon	*Z.pri*	Local	-2.81	intra	intra	inter	inter	17.6	Overlap	EF
**M.mon*	*S.vag*	Local	-3.16	intra	inter	inter	inter	36.86	Overlap	EF
N.cin	*P.mol*	Landscape	-2.06	inter	intra	inter	inter	264.33	Overlap	EF
P.mol	*P.tru*	Local	-2.77	intra	inter	inter	intra	5.44	Overlap	EF
P.mol	*S.mon*	Landscape	3.3	inter	inter	inter	inter	14.64	Overlap	EF
P.mol	*S.mon*	Local	3.62	inter	inter	inter	inter	14.64	Overlap	EF
Snake Range										
**A.leu*	*D.mic*	Local	-4.84	intra	inter	inter	inter	47.66	Overlap	EF
A.leu	*D.ord*	Landscape	-2.73	intra	intra	inter	inter	53.52	Overlap	EF
A.leu	*D.ord*	Local	-4.67	intra	intra	inter	inter	53.52	Overlap	EF
A.leu	*P.mol*	Landscape	-2.44	intra	inter	inter	inter	82.36	Overlap	EF
A.leu	*P.mol*	Local	-4.71	intra	inter	inter	inter	82.36	Overlap	EF
A.leu	*T.umb*	Landscape	2.78	inter	inter	intra	inter	52.17	Non	EF
C.lat	*L.cur*	Landscape	-2.7	inter	intra	inter	inter	146.83	Overlap	EF/+BI

C.lat	*L.cur*	Local	-4.89	inter	intra	inter	inter	146.83	Overlap	EF/+BI
C.lat	*S.ten*	Landscape	-3	inter	inter	inter	inter	171.3	Overlap	EF/+BI
C.lat	*S.ten*	Local	-4.69	inter	inter	inter	inter	171.3	Overlap	EF/+BI
D.mic	*D.ord*	Local	-3.47	intra	inter	inter	intra	5.86	Overlap	EF
**D.mic*	*M.lon*	Landscape	3.27	inter	inter	intra	intra	11.46	Abut	EF
D.mic	*P.mol*	Local	-3.46	intra	inter	inter	inter	34.7	Overlap	EF
D.ord	*P.mol*	Landscape	-2.34	intra	inter	intra	inter	28.84	Overlap	EF
D.ord	*P.mol*	Local	-3.28	intra	inter	intra	inter	28.84	Overlap	EF
M.lon	*P.mol*	Local	2.74	inter	intra	inter	inter	23.24	Overlap	EF
M.lon	*T.dor*	Local	2.5	inter	inter	inter	intra	18.86	Overlap	EF
**M.mon*	*S.vag*	Landscape	-2.01	intra	inter	inter	inter	36.86	Overlap	EF
**M.mon*	*S.vag*	Local	-3.92	intra	inter	inter	inter	36.86	Overlap	EF
N.cin	*O.var*	Landscape	-2.99	inter	inter	inter	intra	428.69	Overlap	EF
P.mol	*T.umb*	Landscape	3.43	inter	inter	inter	inter	30.19	Abut	EF
P.mol	*T.umb*	Local	3.07	inter	inter	inter	inter	30.19	Abut	EF
P.tru	*T.dor*	Local	-3.42	intra	intra	intra	inter	36.66	Overlap	EF
T.dor	*T.umb*	Landscape	2.82	inter	inter	intra	intra	11.91	Abut	-BI
Toiyabe Range										
A.leu	*D.mer*	Landscape	-3.06	intra	intra	inter	inter	66.01	Overlap	EF
A.leu	*D.mer*	Local	-4.76	intra	intra	inter	inter	66.01	Overlap	EF
**A.leu*	*D.mic*	Landscape	-2.76	intra	inter	inter	inter	47.66	Overlap	EF
**A.leu*	*D.mic*	Local	-4.71	intra	inter	inter	inter	47.66	Overlap	EF
A.leu	*O.tor*	Landscape	-2.99	intra	intra	inter	inter	82.24	Overlap	EF
A.leu	*O.tor*	Local	-4.54	intra	intra	inter	inter	82.24	Overlap	EF
C.for	*N.lep*	Landscape	-2.75	intra	intra	inter	inter	124.43	Overlap	EF
C.for	*N.lep*	Local	-3.86	intra	intra	inter	inter	124.43	Overlap	EF
C.for	*P.cri*	Local	-3.7	intra	intra	inter	intra	3.13	Overlap	EF

C.lat	*T.min*	Local	-2.54	intra	intra	intra	inter	132.23	Overlap	EF
D.mer	*D.mic*	Landscape	-2.7	intra	inter	inter	intra	18.35	Overlap	EF
D.mer	*D.mic*	Local	-4.63	intra	inter	inter	intra	18.35	Overlap	EF
D.mer	*M.lon*	Local	2.55	inter	inter	inter	intra	6.89	Non	EF
D.mer	*O.tor*	Landscape	-2.95	intra	intra	inter	inter	16.23	Overlap	EF
D.mer	*O.tor*	Local	-4.68	intra	intra	inter	inter	16.23	Overlap	EF
D.mer	*P.lon*	Local	-3.38	intra	intra	intra	inter	29.84	Overlap	EF
**D.mic*	*M.lon*	Landscape	3.23	inter	inter	intra	intra	11.46	Non	EF
**D.mic*	*M.lon*	Local	2.87	inter	inter	intra	intra	11.46	Non	EF
D.mic	*O.tor*	Landscape	-2.7	intra	inter	inter	inter	34.58	Overlap	EF
D.mic	*O.tor*	Local	-4.55	intra	inter	inter	inter	34.58	Overlap	EF
D.mic	*P.lon*	Landscape	-2.6	intra	inter	inter	inter	48.19	Overlap	EF
D.mic	*P.lon*	Local	-3.93	intra	inter	inter	inter	48.19	Overlap	EF
D.ord	*M.lon*	Landscape	3.99	inter	inter	inter	intra	5.6	Non	EF
D.ord	*M.lon*	Local	2.84	inter	inter	inter	intra	5.6	Non	EF
D.ord	*P.lon*	Landscape	-2.35	intra	intra	intra	inter	42.33	Overlap	EF
M.lon	*P.lon*	Landscape	4.04	inter	inter	inter	inter	36.73	Non	EF
M.lon	*P.lon*	Local	3.11	inter	inter	inter	inter	36.73	Non	EF
M.mon	*N.cin*	Landscape	-1.92	intra	inter	intra	inter	243.04	Overlap	EF
M.mon	*P.cri*	Landscape	2.97	inter	inter	inter	inter	26.53	Overlap	EF
**M.mon*	*S.vag*	Local	-3.41	intra	inter	inter	inter	36.86	Overlap	EF
M.mon	*Z.pri*	Local	-3.3	intra	inter	inter	inter	15.65	Overlap	EF
N.lep	*P.cri*	Landscape	-2.46	intra	intra	inter	inter	127.56	Overlap	EF
O.tor	*P.lon*	Local	-3.75	intra	intra	inter	inter	13.61	Overlap	EF
P.lon	*P.mol*	Landscape	3.27	intra	inter	intra	inter	13.49	Overlap	-BI
R.meg	*Z.pri*	Landscape	2.86	inter	inter	inter	inter	16.48	Overlap	EF
S.pal	*S.vag*	Local	-3.51	intra	intra	intra	inter	7.08	Overlap	EF

Table A3. Results of exact binomial tests showing the observed number of non-randomly associated pairs (Obs. no. pairs), the expected (Exp.) and observed (Obs.) proportions of intra-guild and inter-guild pairs based on the total number of pairs per mountain range (*n*), and p-values. Tests were conducted separately for species assignments to four separate functional groups. Habitat affinity and geographic affinity related to the role of environmental filtering whereas diet group and body size class related to biotic interactions. Tests were conducted using the set of significant associations identified by Pairs for the Ruby Mountains, Toiyabe Range, and Snake Range, and for each scale and type of association (aggregation or segregation) separately. Expected proportions are the same for each trait within a mountain range. Bolded p-values indicate significant deviations from expected proportions ($p < 0.05$).

	Ruby Mountains (*n*=105)				Toiyabe Range (*n*=351)				Snake Range (*n*=190)			
	Aggregations		Segregations		Aggregations		Segregations		Aggregations		Segregations	
Functional group	Landscape	Local	Landscape	Local	Landscape	Local	Landscape	Local	Landscape	Local	Landscape	Local
Obs. no. pairs	1	6	1	3	11	15	6	4	7	10	4	3
Habitat Affinity												
Exp. Intra/Inter	0.35/0.65	0.35/0.65	0.35/0.65	0.35/0.65	0.36/0.64	0.36/0.64	0.36/0.64	0.36/0.64	0.31/0.69	0.31/0.69	0.31/0.69	0.31/0.69
Obs. Intra/Inter	0.00/1.00	1.00/0.00	0.00/1.00	0.00/1.00	1.00/0.00	1.00/0.00	0.17/0.83	0.00/1.00	0.57/0.43	0.8/0.2	0.00/1.00	0.00/1.00
p-value	1	**0.00019**	1	0.56	**<0.0001**	**<0.0001**	0.43	0.3	0.21	**0.00018**	0.32	0.56
Geographic Affinity												
Exp. Intra/Inter	0.35/0.65	0.35/0.65	0.35/0.65	0.35/0.65	0.32/0.68	0.32/0.68	0.32/0.68	0.32/0.68	0.31/0.69	0.31/0.69	0.31/0.69	0.31/0.69
Obs. Intra/Inter	0.00/1.00	0.33/0.67	1.00/0.00	0.67/0.33	0.55/0.45	0.6/0.4	0.00/1.00	0.00/1.00	0.29/0.71	0.4/0.6	0.25/0.75	0.33/0.67
p-value	1	1	0.35	0.29	0.11	**0.0025**	0.19	0.32	1	0.51	1	1
Diet Group												
Exp. Intra/Inter	0.27/0.73	0.27/0.73	0.27/0.73	0.27/0.73	0.24/0.76	0.24/0.76	0.24/0.76	0.24/0.76	0.26/0.74	0.26/0.74	0.26/0.74	0.26/0.74
Obs. Intra/Inter	0.00/1.00	0.33/0.67	0.00/1.00	0.00/1.00	0.18/0.82	0.2/0.8	0.33/0.67	0.25/0.75	0.14/0.86	0.2/0.8	0.75/0.25	0.00/1.00
p-value	1	0.66	1	0.57	1	1	0.64	1	0.69	1	0.0055	0.57
Body Size Class												
Exp. Intra/Inter	0.21/0.79	0.21/0.79	0.21/0.79	0.21/0.79	0.25/0.75	0.25/0.75	0.25/0.75	0.25/0.75	0.23/0.77	0.23/0.77	0.23/0.77	0.23/0.77
Obs. Intra/Inter	0.00/1.00	0.33/0.67	0.00/1.00	0.00/1.00	0.009/0.91	0.13/0.87	0.33/0.67	0.75/0.25	0.14/0.86	0.1/0.9	0.5/0.5	0.33/0.67
p-value	1	0.66	1	1	0.31	0.38	0.65	0.0053	1	0.47	0.23	0.55

Figure A1.

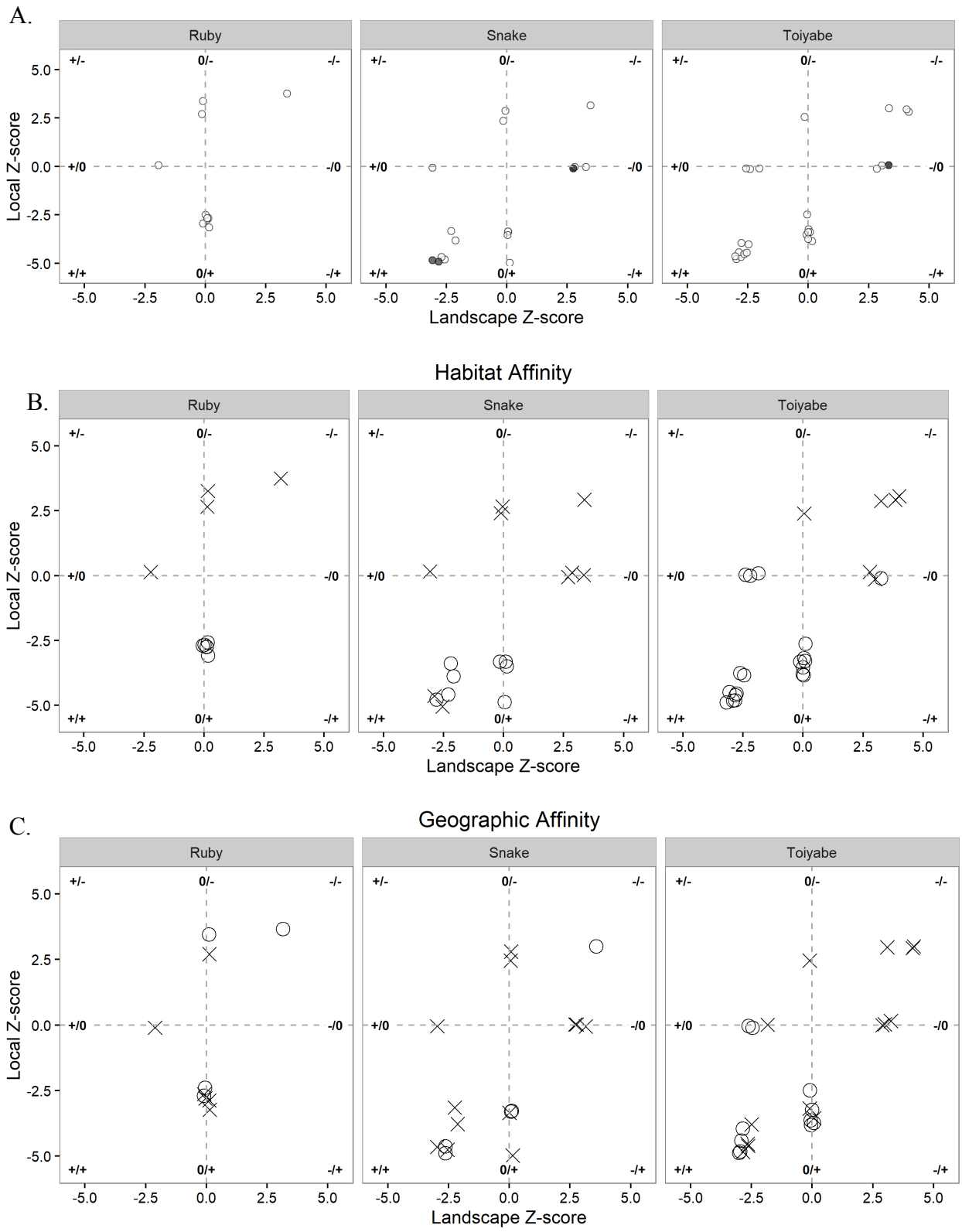
A.
Ruby
Snake
Toiyabe
+/-
0/-
-/-
+/0
-/0
+/+
0/+
-/+
Local Z-score
Landscape Z-score
5.0
2.5
0.0
-2.5
-5.0
Habitat Affinity
B.
Geographic Affinity
C.

Fig. A1 continued.

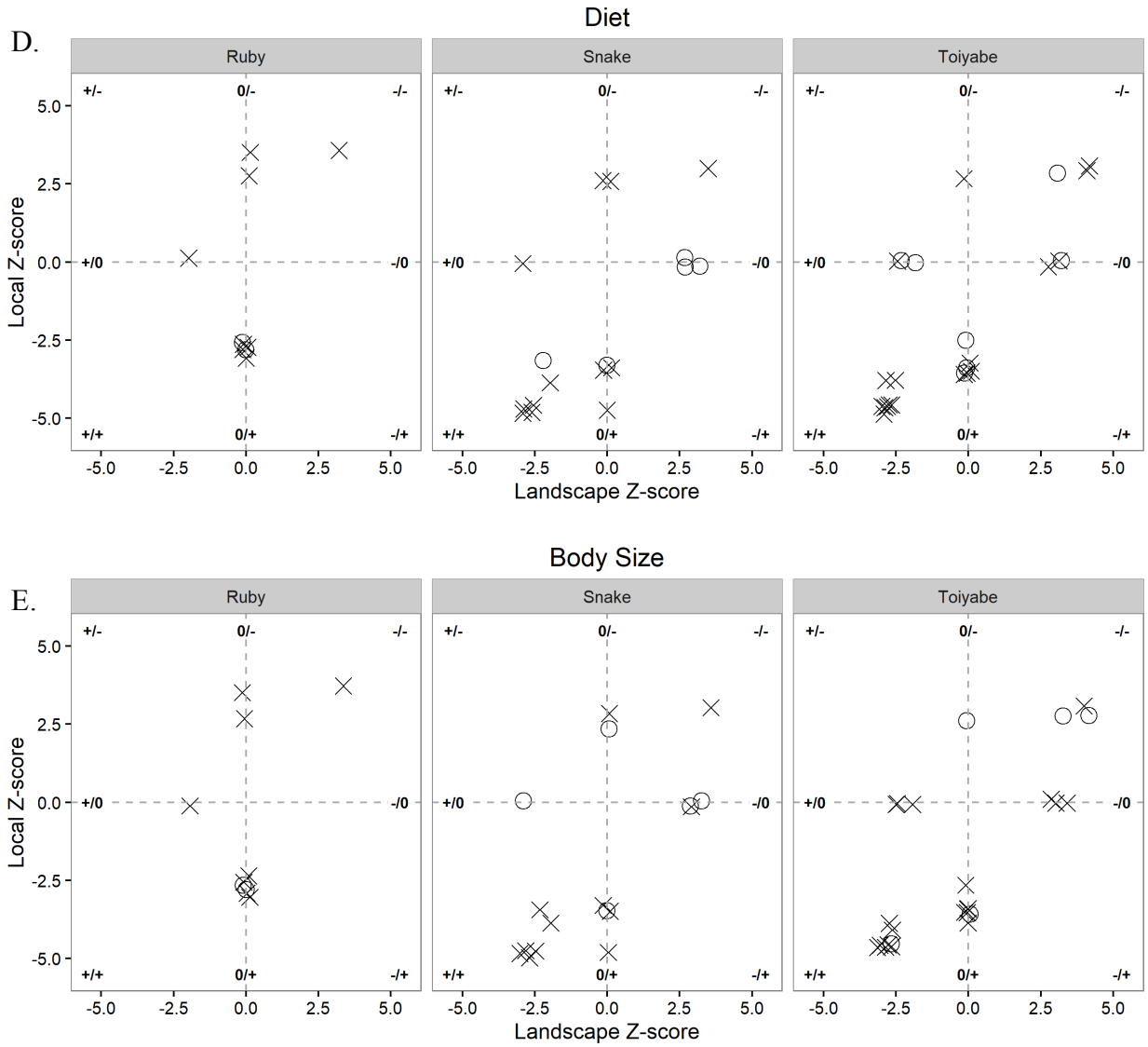

Figure A1. A.) Nonrandom species association patterns and their most parsimonious ecological mechanism for each mountain range. Signs (+/-) indicate the combination of association types each quadrant contains, for landscape and local scales, respectively. Due to the method of calculation, significant aggregations (+) correspond to negative Z-scores and segregations (-) have positive Z-scores. Points falling along a zero line indicate a pair that showed a random pattern (Bayes Mean Z = 0) at one scale. Shading correspond to the likely underlying mechanism for the co-occurrence pattern, as determined by trait-based testing: white, environmental filtering (EF); light gray, facilitation or environmental filtering (+BI/EF); dark gray, competition (-BI). Points are jittered for ease of visualization. B-E.) The functional similarity (circles, intra-guild; crosses, inter-guild) of significantly associated species pairs for four traits: B.) habitat affinity, C.) geographic affinity, D.) diet group, and E.) body size class.