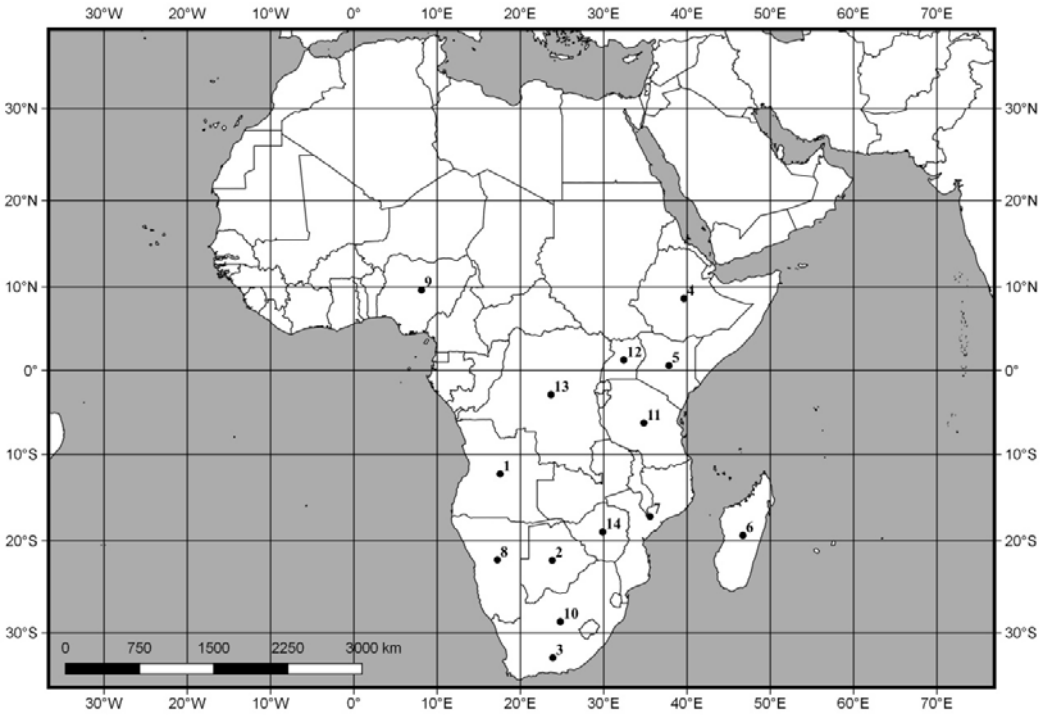
Ecography

ECOG-04224
Krasnov, B. R., Shenbrot, G. S., an der Mescht, L., Warburton, E. M. and Khokhlova, I. S. 2019. Phylogenetic and compositional diversity are governed by different rules: a study of fleas parasitic on small mammals in four biogeographic realms. – Ecography doi: 10.1111/ecog.04224

Supplementary material

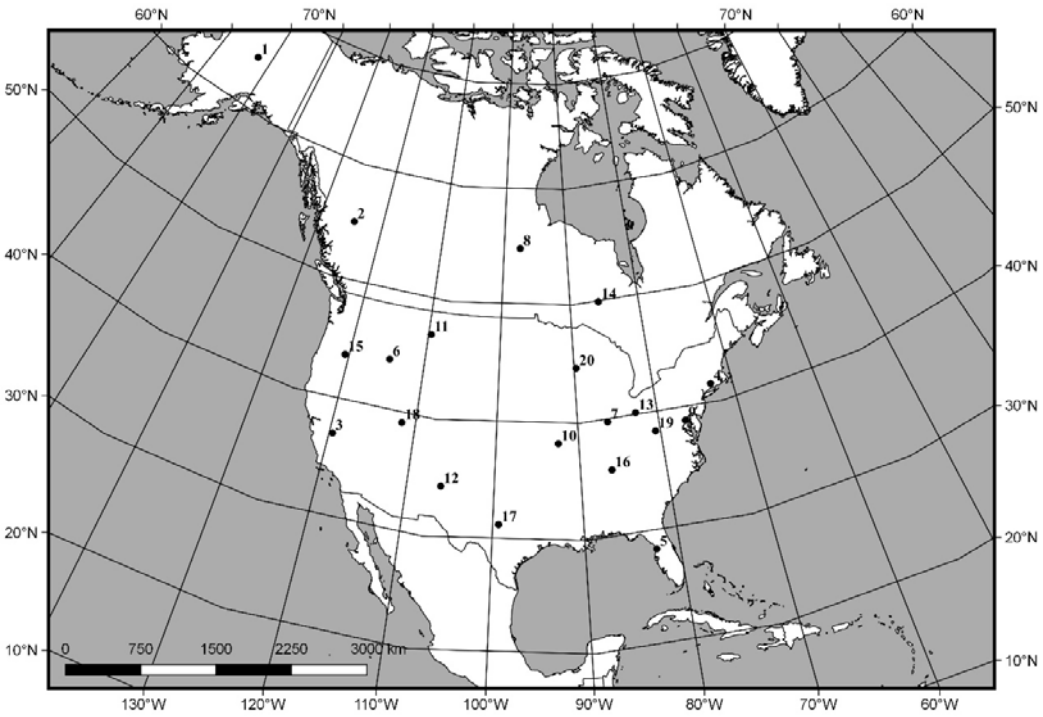
Appendix 1. Maps of regions of flea surveys.

Fig. A1a. Afrotropics



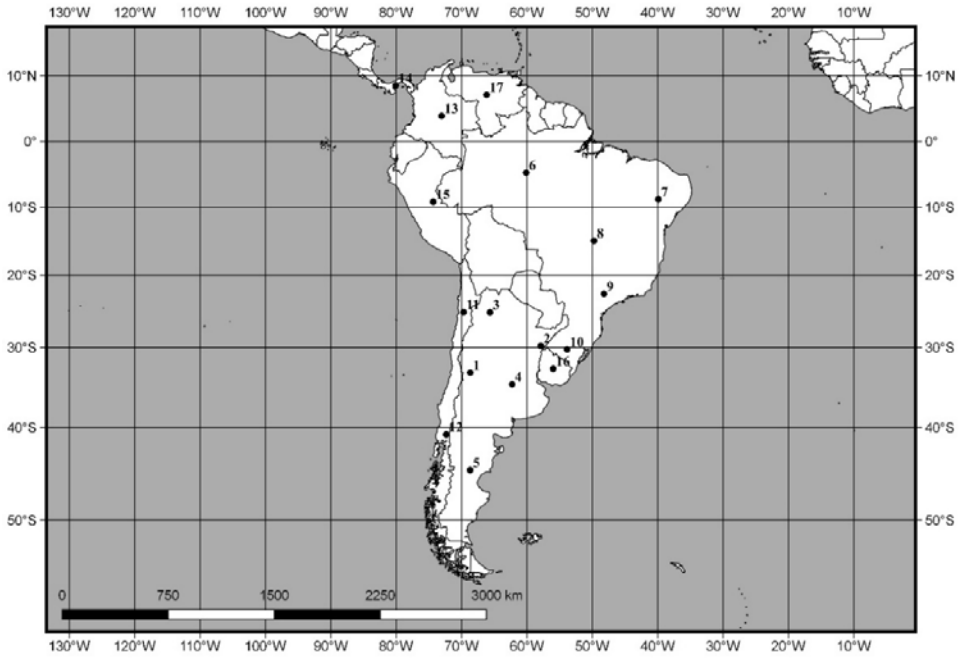
1 – Angola, 2 – Botswana, 3 – coastal South Africa (Eastern Cape and Western Cape provinces), 4 – Ethiopia, 5 – Kenya, 6 – Madagascar, 7 – Mozambique, 8 – Namibia, 9 – Nigeria, 10 – northern South Africa (Northern Cape, Orange Free State, Northwest, Gauteng, Mpumalanga, KwaZulu Natal and Northern provinces), 11 – Tanzania, 12 – Uganda, 13 – Zaire, 14 – Zimbabwe.

Fig. A1b. Nearctic



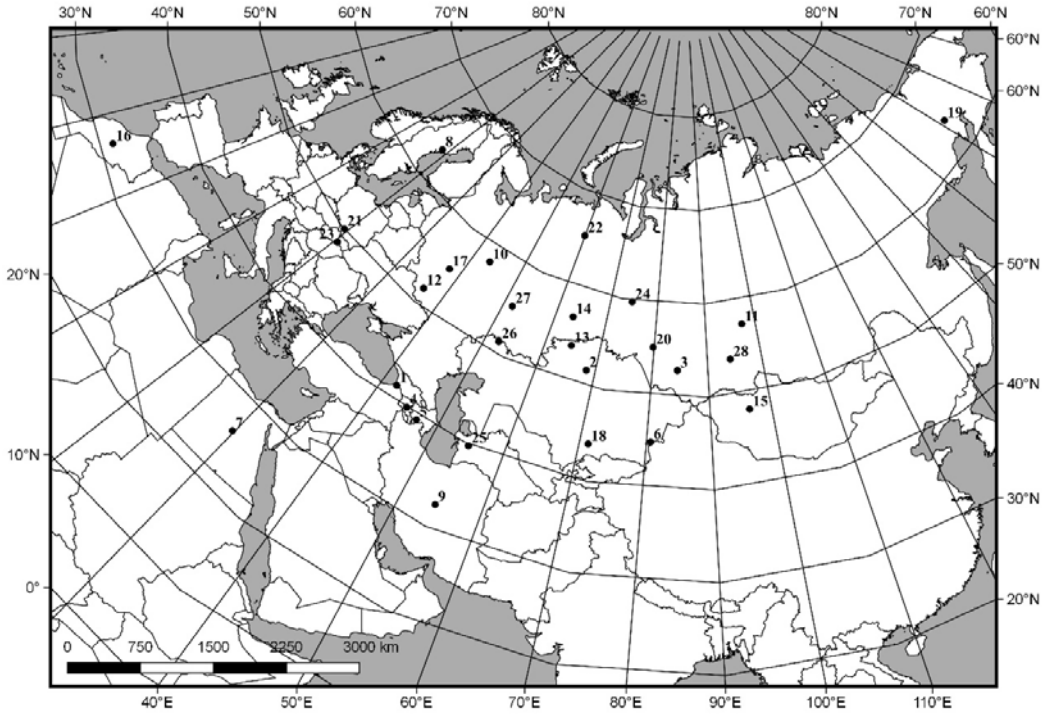
1 – Alaska (mainland), 2 – British Columbia (mainland), 3 – California, 4 – Connecticut, 5 – Florida, 6 – Idaho, 7 – Indiana, 8 – Manitoba, 9 – Maryland, 10 – Missouri, 11 – Montana, 12 – New Mexico, 13 – Ohio, 14 – Ontario, 15 – Oregon, 16 – Tennessee, 17 – Texas, 18 – Utah, 19 – West Virginia, 20 – Wisconsin.

Fig. A1c. Neotropics



1 – Argentinian Cuyo (Mendoza and San Juan provinces), 2 - Argentinian Mesopotamia (Corrientes, Missiones and Entre Rios provinces), 3 – Argentinian Pampas (Buenos Aires, La Pampa, Santa Fe and Cordoba provinces), 4 – Argentinian Patagonia (provinces Rio Negro, Chubut and Santa Cruz), 5 – Argentinian Northwest (Jujuy, Salta, Catamarca and Tukuman provinces), 6 – Brazilian Amazonia [Amazonas, Para and Mato Grosso (north of 15˚S) provinces], 7 – Brazilian Caatinga [Ceara, Paraibo, Alagoas, Rio Grande do Norte and Pernambuco (east of 47˚W) provinces], 8 - Brazilian Cerrado [Goyaz, Maranhao, Minas Gerais, Piaui and Pernambuco (east of 47˚W) provinces], 9 – Brazilian Mata Atlantica (Bahia, Esperito Santo, Rio de Janeiro, Parana and San Paulo provinces), 10 – Brazilian Pampa (Santa Catarina and Rio Grande do Sul provinces), 11 – Northern Chile (north of 32˚S), 12 – Southern Chile (south of 32˚S), 13 – Colombia, 14, Panama, 15 – Peru, 16 – Uruguay, 17 - Venezuela.

Fig. A1d. Palearctic



1 – Adzharia, 2 – Akmolinsk region, 3 – Altai mountains, 4 – Armenia, 5 – Azerbaijan, 6 – Dzungarian Alatau, 7 – Egypt, 8 – Fennoscandia, 9 – Iran, 10 – Kostroma region, 11 – Krasnojarsk region, 12 – Kursk region, 13 – Kustanai region, 14 – Middle Ural Mountains, 15 – Mongolia (north-west Khangai), 16 – Morocco, 17 – Moscow region, 18 - Moyyunkum desert, 19 - Northern Russian Far East, 20 – Novosibirsk region, 21 – Poland, 22 – Pre-Polar Ural Mountains, 23 – Slovakia, 24 – Tomsk and Tyumen region, 25 – Turkmenistan, 26 – Ural River valley, 27 – Volga-Kama region (Tatarstan), 28 – Western Sayan mountains.

Appendix 2

Sources of information on species composition of fleas and their small mammalian hosts

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Appendix 4.

Summary of principal component analyses of environmental variables in four biogeographic realms. PC1, PC2, and PC3 – the first, the second and the third principal component, respectively. NDVIa, NDVIsp, NDVIsu, and NDVIw - Normalized Difference Vegetation Indices for (boreal or austral) autumn, spring, summer and winter, respectively. Pa, Psp, Psu, and Pw – mean precipitation in autumn, spring, summer and winter, respectively. Ta and Tm – annual and mean monthly air temperature ranges. Tmax, Tmin and Tmean – maximal, minimal and mean annual air temperature. Wa, Wsp, Wsu, and Ww – water vapour pressure in autumn, spring, summer and winter, respectively. Alt – mean altitude.

Table A4a. Afrotropics

Principal component		PC1	PC2	PC3
Eigenvalue		11.08	2.53	2.34
Explained variance		7.84	2.78	5.33
Proportion of total variance		0.44	0.15	0.30
Linear correlation between a principal component and environmental variable	NDVIa	0.32	0.55	0.74
	NDVIap	0.73	0.59	0.27
	NDVIsu	0.34	0.60	0.65
	NDVIw	0.55	0.54	0.52
	Pa	0.69	0.26	0.54
	Psp	0.88	0.32	0.01
	Psu	0.03	0.18	0.92
	Pw	0.80	0.41	-0.12
	Ta	-0.93	0.05	-0.26
	Tm	-0.88	-0.03	-0.24
	Tmax	0.10	-0.87	0.05

Tmean	0.54	-0.50	0.59
Tmin	0.84	-0.28	0.44
Wa	0.72	-0.03	0.69
Wsp	0.85	-0.08	0.50
Wsu	0.39	-0.02	0.91
Ww	0.92	-0.02	0.32
Alt	-0.11	0.10	-0.73

Table A4b. Nearctic

		PC1	PC2	PC3
Eigenvalue		11.16	3.94	1.36
Explained variance		7.48	6.15	2.82
Proportion of total variance		0.42	0.34	0.16
Linear correlation between a principal component and environmental variable	NDVIa	0.42	0.72	0.46
	NDVIap	0.65	0.51	0.52
	NDVIsu	-0.10	0.92	0.28
	NDVIw	0.81	0.30	0.46
	Pa	0.23	0.83	0.44
	Psp	0.34	0.74	0.48
	Psu	0.36	0.85	-0.05
	Pw	0.18	0.31	0.91
	Ta	-0.56	0.06	-0.67
	Tm	0.61	-0.67	0.02
	Tmax	0.94	0.07	0.02
	Tmean	0.95	0.08	0.25
	Tmin	0.90	0.00	0.41
	Wa	0.81	0.54	0.12
	Wsp	0.85	0.46	0.16
	Wsu	0.66	0.74	0.02
	Ww	0.88	0.15	0.26
	Alt	-0.07	-0.92	0.01

Table A4c. Neotropics

Principal component		PC1	PC2	PC3
Eigenvalue		12.82	2.14	1.62
Explained variance		8.63	2.67	5.29
Proportion of total variance		0.48	0.15	0.29
Linear correlation between a principal component and environmental variable	NDVIa	0.46	0.20	0.81
	NDVIap	0.33	0.34	0.84
	NDVIsu	0.28	0.28	0.87
	NDVIw	0.64	0.24	0.70
	Pa	0.74	0.50	0.32
	Psp	0.60	0.49	0.47
	Psu	0.86	0.22	0.35
	Pw	0.04	0.93	0.33
	Ta	-0.88	-0.39	0.02
	Tm	-0.44	-0.69	-0.33
	Tmax	0.50	-0.52	0.57
	Tmean	0.89	-0.08	0.43
	Tmin	0.94	0.09	0.30
	Wa	0.91	0.08	0.41
	Wsp	0.91	0.12	0.38
	Wsu	0.84	0.04	0.52
	Ww	0.94	0.10	0.29
	Alt	-0.19	-0.15	-0.86

Table A4d. Palearctic

Principal component		PC1	PC2	PC3
Eigenvalue		7.31	6.57	1.87
Explained variance		7.26	6.47	2.03
Proportion of total variance		0.40	0.36	0.11
Linear correlation between a principal component and environmental variable	NDVIa	0.07	0.89	0.32
	NDVIap	0.40	0.66	0.46
	NDVIsu	-0.44	0.79	0.36
	NDVIw	0.75	0.28	0.11
	Pa	0.02	0.93	-0.06
	Psp	0.30	0.87	-0.22
	Psu	-0.34	0.90	0.06
	Pw	0.30	0.76	-0.17
	Ta	-0.76	-0.48	0.24
	Tm	0.15	-0.83	-0.25
	Tmax	0.66	-0.66	0.21
	Tmean	0.95	-0.26	0.08
	Tmin	0.98	0.01	-0.07
	Wa	0.97	0.03	0.14
	Wsp	0.97	-0.06	0.15
	Wsu	0.58	0.31	0.68
	Ww	0.96	-0.14	-0.08
	Alt	0.02	0.03	-0.89

Appendix 5.

Descriptions of correlations between original environmental variables and the three principal components (PC1, PC2 and PC3).

In the Afrotropics, PC1 reflected mainly variation in (a) spring and winter precipitation and water vapor pressure and minimal annual temperature (positive correlations) and (b) annual and monthly temperature ranges (negative correlations). PC2 correlated negatively with maximal annual air temperature, and PC3 correlated positively with summer precipitation and water vapor pressure. In the Nearctic, PC1 represented an increase in maximal, mean and minimal air temperature, water vapour pressure (except in summer) and winter NDVI, PC2 - an increase in summer precipitation and NDVI and a decrease in altitude, whereas PC3 correlated mainly with an increase in winter precipitation. In the Neotropics, factors positively correlating with PC1 were summer precipitation, mean and minimal annual air temperature and water vapour pressure in either season, whereas annual range of air temperature correlated negatively with this principal component negatively. PC2 represented an increase with winter (austral) precipitation and PC3 – an increase in NDVI and a decrease in mean altitude. In the Palearctic, PC1 reflected an increase in mean and minimal annual air temperature and water vapour pressure (except in summer). PC2 correlated positively with precipitation and summer and autumn NDVI and negatively with monthly temperature range, while PC3 represented a decrease in altitude.

Appendix 6

Results of dominance analyses of the models of phylogenetic diversity.

Table A6. Unique contribution of predictors of phylogenetic diversity of flea assemblages in four biogeographic realms. N – number of predictors in a subset model; PUf -phylogenetic uniqueness of regional flea assemblage; PDh - phylogenetic diversity of regional host assemblage; PUh - phylogenetic uniqueness of regional host assemblages; PC1 and PC2 – principal components of environmental variables (see text for explanation). An example of interpretation is as follows. In the subset model of Uf and Uh for the Palearctic, both predictors explained 67% of the variance of phylogenetic diversity of regional flea assemblages. In addition, phylogenetic diversity of hosts added a unique 21% variance after controlling for the former two predictors.

Realm	N	Subset model	r^2	Unique contribution of a predictor		
Afrotropics				Uf	PC1	
	1	Uf	0.67	-	0.11	
	1	PC1	0.09	0.68	-	
	2	Uf-PC1	0.78	-	-	
Nearctic				Uf	PC2	
	1	Uf	0.76	-	0.08	
	1	PC2	0.53	0.32	-	
	2	Uf-PC2	0.84	-	-	
Palearctic				Uf	Dh	Uh
	1	Uf	0.56	-	0.12	0.0001
	1	Dh	0.001	0.67	-	0.0003

1	Uh	0.002	0.59	0.0001	-
2	Uf-Dh	0.67	-	0.10	-
2	Uf-Uh	0.57	-	0.21	-
2	Dh-Uh	0.002	0.77	-	-
3	Uf-Dh-Uh	0.77	-	-	-

Appendix 7

Results of dominance analyses of the models of compositional diversity.

Table A7. Unique contribution of predictors of compositional diversity of flea assemblages in four biogeographic realms. N – number of predictors in a subset model; CDh - compositional diversity of regional host assemblage; PC1, PC2 and PC3 – principal components of environmental variables (see text for explanation). See legend to Table S6, Appendix 6 for an example of interpretation.

Realm	N	Subset model	r^2	Unique contribution of a predictor		
Afrotropics				CDh	PC3	
	1	CDh	0.50	-	0.29	
	1	PC31	0.39	0.40	-	
	2	CDh-PC3	0.79	-	-	
Nearctic				CDh	PC1	PC2
	1	CDh	0.78	-	0.04	0.07
	1	PC1	0.07	0.75	-	0.64
	1	PC2	0.63	0.22	0.07	-
	2	CDh-PC1	0.82	-	-	0.08
	2	CDh-PC2	0.86	-	0.04	-
	2	PC1-PC2	0.71	0.19	-	-
	3	CDh-PC1-PC2	0.90	-	-	-
Neotropics				PC1	PC2	
	1	PC1	0.19	-	0.22	
	1	PC2	0.22	0.19	-	
	1	PC1-PC2	0.42	-	-	-