

Ecography

**ECOG-00860**

Buschke, F. T., De Meester, L., Brendonck, L. and Vanschoenwinkel, B. 2014. Partitioning the variation in African vertebrate distributions into environmental and spatial components – exploring the link between ecology and biogeography. – *Ecography* doi: 10.1111/ecog.00860

**Supplementary material**

1 APPENDIX 1

2 **Partitioning the variation in African vertebrate distributions into environmental and**  
3 **spatial components - exploring the link between ecology and biogeography**

4  
5 Falko T. Buschke\*<sup>a</sup>, Luc De Meester<sup>a</sup>, Luc Brendonck<sup>a</sup>, Bram Vanschoenwinkel<sup>a,b</sup>

6 <sup>a</sup> Laboratory of Aquatic Ecology, Evolution and Conservation, KU Leuven, Leuven, Belgium.

7 <sup>b</sup> Department of Biology, Vrije Universiteit Brussel, Brussels, Belgium.

8 \*Corresponding author: falko.buschke@gmail.com

9  
10 **Table A1.** Bioclimatic variables for the interval 1950-2000 assigned to each grid cell.

11 **Figure A1.** Variation components as a function of species geographic range size for  
12 individual species of amphibians, reptiles, birds and mammals without using forward  
13 selection to simplify the models.

14 **Figure A2.** Variation components (a) and frequency distributions of geographic ranges sizes  
15 (b) for the community matrices of two environmentally-neutral models and four classes of  
16 vertebrates. Box plots represent the minimum, 25 percentile, median, 75 percentile and  
17 maximum number of grid cells occupied on a logarithmic axis.

18 **Table A2.** Beta regression model parameters for the association of environmental and spatial  
19 variation components with geographic range size.

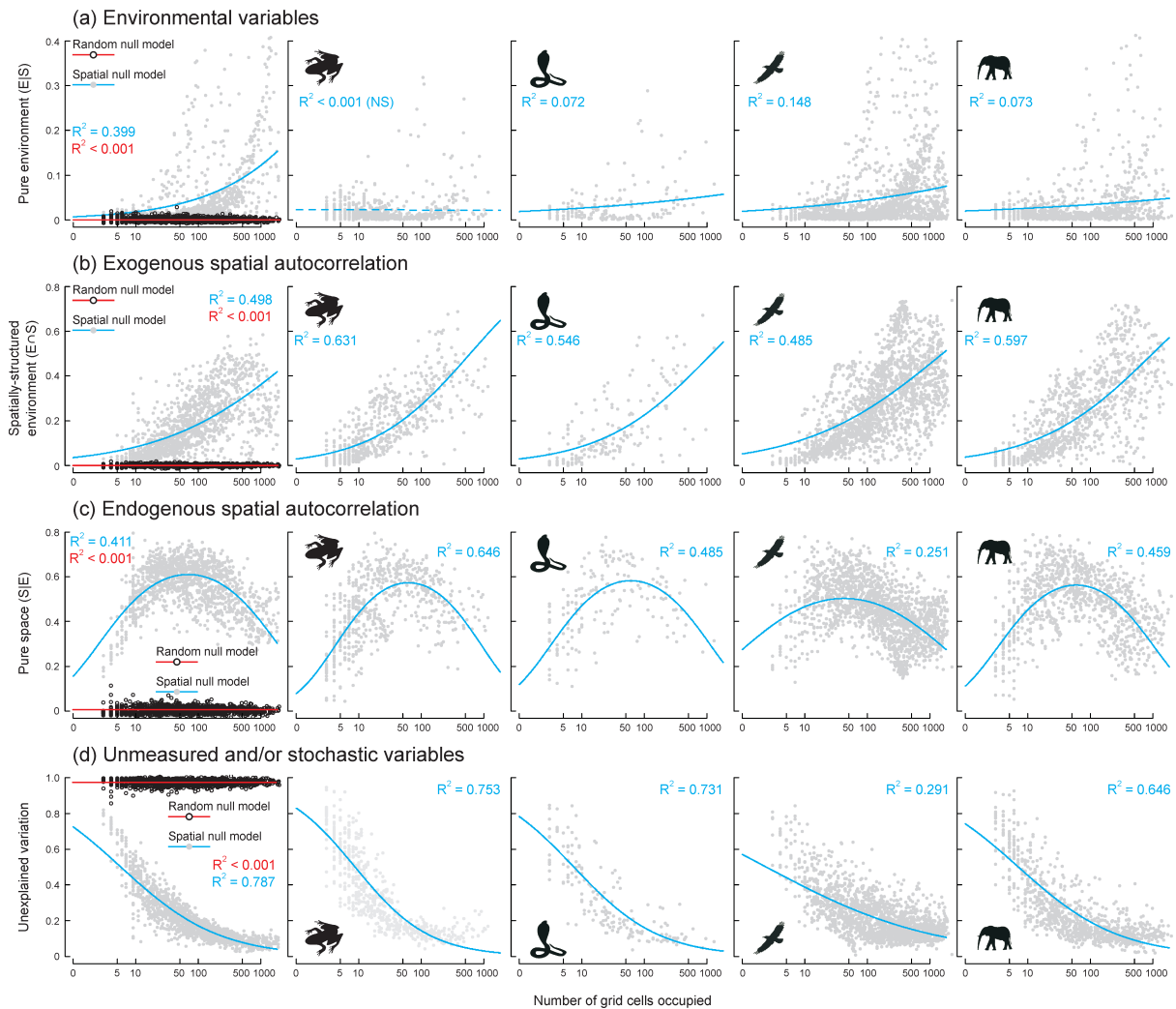
20 **Table A3.** The mean and standard deviation (in parentheses) of  $\overline{VR}$ , the standardised  
21 residuals for the relationship between variation components and geographic range size, for  
22 biogeographical regions in sub-Saharan Africa and Madagascar.

23 Table A1. Bioclimatic variables of the interval 1950-2000 assigned to each grid cell.

<b>Code</b>	<b>Description</b>	<b>Indicator Type</b>
BIO 1	Annual mean temperature	AT
BIO 2	Mean diurnal range (mean of monthly (max temp- min temp))	S
BIO 3	Isothermality (Mean diurnal range/temperature annual range)	S
BIO 4	Temperature seasonality (standard deviation of temperature)	S
BIO 5	Maximum temperature of warmest month	ELC
BIO 6	Minimum temperature of coldest month	ELC
BIO 7	Temperature annual range	S
BIO 8	Mean temperature of wettest quarter	ELC
BIO 9	Mean temperature of driest quarter	ELC
BIO 10	Mean temperature of warmest quarter	ELC
BIO 11	Mean temperature of coldest quarter	ELC
BIO 12	Annual precipitation	AT
BIO 13	Precipitation of wettest month	ELC
BIO 14	Precipitation of driest month	ELC
BIO 15	Precipitation seasonality (coefficient of variation)	S
BIO 16	Precipitation of wettest quarter	ELC
BIO 17	Precipitation of driest quarter	ELC
BIO 18	Precipitation of warmest quarter	ELC
BIO 19	Precipitation of coldest quarter	ELC

(AT-Annual trend; S- Seasonality; ELC- Extreme or limiting conditions)

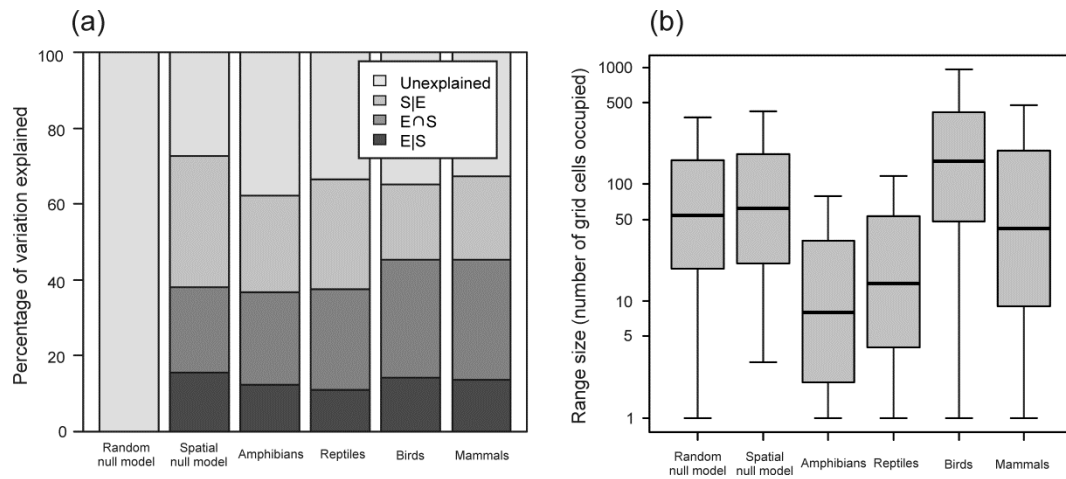
25 Figure A1. Variation components as a function of species geographic range size for  
 26 individual species of amphibians, reptiles, birds and mammals without using forward  
 27 selection to simplify the models. Regression lines and R-squared values represent the beta  
 28 regression model that best described the data.



29

30

31 Figure A2. Variation components (a) and frequency distributions of geographic ranges sizes  
 32 (b) for the community matrices of two environmentally-neutral models and four classes of  
 33 vertebrates. Box plots represent the minimum, 25 percentile, median, 75 percentile and  
 34 maximum number of grid cells occupied on a logarithmic axis.



35

36

37 Table A2. Beta regression model parameters for the association of environmental and spatial  
 38 variation components with geographic range size.

Variation component		Beta regression parameters			
		Estimate (St. error)	Z-value	P-value	R-squared
<b>Pure environment (E S)</b>					
Random null model	(Range)	-0.001 (0.001)	-1.784	0.0747 <sup>NS</sup>	~ 0
Spatial null model	(Range)	0.453 (0.015)	30.08	<< 0.0001	0.439
Frogs	(Range)	0.297 (0.02)	14.72	<< 0.0001	0.281
Reptiles	(Range)	0.401 (0.036)	11.0	<< 0.0001	0.402
Birds	(Range)	0.254 (0.013)	19.86	<< 0.0001	0.236
Mammals	(Range)	0.293 (0.014)	0.016	<< 0.0001	0.354
<b>Spatially-structured environment (E∩S)</b>					
Random null model	(Range)	1.15 x 10 <sup>-4</sup>	1.506	0.132 <sup>NS</sup>	~ 0
Spatial null model	(Range)	0.456 (0.013)	34.53	<< 0.0001	0.533
Frogs	(Range)	0.508 (0.019)	25.52	<< 0.0001	0.457
Reptiles	(Range)	0.467 (0.039)	11.92	<< 0.0001	0.429
Birds	(Range)	0.438 (0.013)	34.47	<< 0.0001	0.462
Mammals	(Range)	0.471 (0.016)	29.56	<< 0.0001	0.496
<b>Pure space (S E)</b>					
Random null model	(Range)	1.8 x 10 <sup>-4</sup>	-0.764	0.445 <sup>NS</sup>	~ 0
Spatial null model	(Range)	1.752 (0.062)	28.31	<< 0.0001	0.372
	(Range <sup>2</sup> )	-0.183 (0.007)	-26.66	<< 0.0001	
Frogs	(Range)	1.302 (0.087)	14.96	<< 0.0001	0.308
	(Range <sup>2</sup> )	-0.150 (0.012)	-12.18	<< 0.0001	
Reptiles	(Range)	0.843 (0.140)	6.01	<< 0.0001	0.201
	(Range <sup>2</sup> )	-0.096 (0.019)	-5.03	<< 0.0001	
Birds	(Range)	0.959 (0.057)	16.86	<< 0.0001	0.178
	(Range <sup>2</sup> )	-0.106 (0.005)	-17.93	<< 0.0001	
Mammals	(Range)	1.062 (0.068)	15.73	<< 0.0001	0.182
	(Range <sup>2</sup> )	-0.123 (0.008)	-15.2	<< 0.0001	
<b>Unexplained variation</b>					
Random null model	(Range)	2.6 x 10 <sup>-4</sup>	0.949	0.343 <sup>NS</sup>	~ 0
Spatial null model	(Range)	-0.590 (0.011)	-55.29	<< 0.0001	0.663
Frogs	(Range)	-0.549 (0.021)	-26.49	<< 0.0001	0.488
Reptiles	(Range)	-0.468 (0.034)	-13.77	<< 0.0001	0.516
Birds	(Range)	-0.331 (0.011)	-28.92	<< 0.0001	0.297
Mammals	(Range)	-0.418 (0.014)	-29.75	<< 0.0001	0.455

39

40

41 Table A3. The mean and standard deviation (in parentheses) of  $\overline{VR}$ , the standardised  
 42 residuals for the relationship between variation components and geographic range size, for  
 43 biogeographical regions in sub-Saharan Africa and Madagascar as delineated by Linder *et al.*  
 44 (2012). Here  $n$  refers to the number of grid cells in each region and \* indicates whether the 5<sup>th</sup>  
 45 and 95<sup>th</sup> percentiles of  $\overline{VR}$  in each the region were greater or smaller, respectively, than the  
 46 average  $\overline{VR}$  of entire biogeographical realm.

Region	$n$	[E S] residuals	[S∩E] residuals	[S E] residuals	Unexplained residuals
<b>Amphibians</b>					
Saharan	591	-0.012 (0.39)	-0.399 (0.26)	0.186 (0.24)	0.699 (0.52)
Somalian	112	-0.285 (0.17)	-0.340 (0.26)	0.396 (0.09)*	0.818 (0.09)
Sudanian	453	-0.292 (0.27)	-0.502 (0.16)	0.353 (0.11)	0.920 (0.12)
Kenyan-Ethiopian	92	-0.348 (0.19)	-0.654 (0.17)	0.451 (0.08)*	0.978 (0.05)*
Congolian	181	-0.181 (0.16)	0.203 (0.36)*	-0.437 (0.34)*	0.314 (0.28)
Albertine Rift	33	-0.566 (0.19)	-0.321 (0.18)	0.249 (0.27)	0.746 (0.15)
Zambeian	361	-0.598 (0.10)*	-0.396 (0.26)	0.444 (0.12)	0.730 (0.13)
Southern African	314	0.185 (0.77)	-1.132 (0.56)	0.269 (0.30)	0.808 (0.15)
Cape Richtersveld	38	1.676 (0.53)*	-1.195 (0.99)	-0.368 (0.28)*	0.225 (0.37)
Madagascar	64	-1.427 (0.12)*	-0.757 (0.55)	0.829 (0.10)*	0.531 (0.46)
<b>Reptiles</b>					
Saharan	493	0.179 (0.51)	0.394 (0.99)	-0.261 (0.62)	0.102 (0.40)
Somalian	204	-0.080 (0.43)	-1.409 (0.64)*	0.635 (0.20)*	0.810 (0.12)*
Sudanian	440	-0.625 (0.41)	0.326 (0.48)	0.151 (0.23)	0.355 (0.22)
Ethiopian	85	-0.696 (0.29)*	-0.509 (0.43)	0.402 (0.22)	0.994 (0.12)*
Guinea-Congolian	340	-0.925 (0.37)*	0.718 (0.34)*	-0.104 (0.21)*	0.213 (0.12)
Zambeian	427	-0.535 (0.64)	-0.529 (0.83)	0.355 (0.16)	0.571 (0.22)
Namibian	96	0.658 (0.94)	-1.724 (1.19)	0.544 (0.22)	0.695 (0.35)
Southern African	90	0.767 (0.59)*	-1.678 (0.60)*	0.366 (0.16)	0.736 (0.14)*
Madagascar	64	-1.777 (0.71)*	1.108 (0.31)*	0.483 (0.48)	-1.714 (0.73)*
<b>Birds</b>					
Saharan	684	-0.349 (0.06)	0.207 (0.48)	0.246 (0.13)	0.081 (0.37)
Somalian	128	-0.284 (0.06)	-0.219 (0.08)*	0.357 (0.05)	0.361 (0.06)
Sudanian	288	-0.405 (0.03)*	-0.081 (0.09)	0.311 (0.06)	0.363 (0.05)*
Ethiopian	51	-0.294 (0.03)	-0.251 (0.02)*	0.342 (0.02)*	0.409 (0.01)*
Guinea-Congolian	267	-0.403 (0.4)*	0.248 (0.11)*	0.069 (0.06)*	0.157 (0.07)
Zambezi	435	-0.361 (0.04)	-0.169 (0.12)	0.356 (0.08)	0.338 (0.05)
Southern Africa	322	-0.085 (0.15)*	-0.497 (0.12)*	0.381 (0.04)*	0.386 (0.02)*
Madagascar	64	-0.303 (0.06)	0.093 (0.06)*	0.329 (0.04)	0.003 (0.05)*

**Mammals**

Saharan	535	0.015 (0.29)	0.273 (0.39)	-0.093 (0.30)	0.143 (0.36)
Somalian	167	-0.399 (0.07)	-0.346 (0.05)*	0.390 (0.04)*	0.695 (0.04)*
Sudanian	485	-0.492 (0.09)	-0.181 (0.10)	0.341 (0.06)	0.675 (0.06)*
Guinea-Congolian	309	-0.499 (0.08)*	0.266 (0.15)*	0.024 (0.12)*	0.392 (0.09)
Zambeian	375	-0.533 (0.08)*	-0.331 (0.17)	0.429 (0.08)*	0.629 (0.06)*
Southern African	304	0.001 (0.27)	-0.959 (0.23)*	0.392 (0.06)*	0.730 (0.03)*
Madagascar	64	-1.339 (0.19)*	0.580 (0.30)*	0.667 (0.10)*	-0.652 (0.34)*

---

47

48

**49 References**

- 50 Linder, H. P. et al. 2012. The partitioning of Africa: statistically defined biogeographical  
51 regions in sub-Saharan Africa. - J. Biogeogr.39: 1189-1205.