

SUPPLEMENTARY MATERIALS

Table S1. Description of trait measurements. Weights given for the assessment of the Gower distance are included on the right of the table.

Trait	Category	Subcategory	Unit	Weight
Feeding relocation strategy	Feeding	Feeding	Qualitative, fuzzy coded	1
Adult trophic preference	Feeding	Relocation	Qualitative, fuzzy coded	1
Dry biomass	Morphological	Biomass	Quantitative	0.5
Fresh weight	Morphological	Biomass	Quantitative	0.5
Abdomen height	Morphological	Body size	Quantitative	1
Head length	Morphological	Head size	Quantitative	0.5
Head width	Morphological	Head size	Quantitative	0.5
Pronotum height	Morphological	Pronotum size	Quantitative	0.33
Pronotum length	Morphological	Pronotum size	Quantitative	0.33
Pronotum width	Morphological	Pronotum size	Quantitative	0.33
Elytrum area	Morphological	Elytrum size	Quantitative	0.25
Elytra length	Morphological	Elytrum size	Quantitative	0.25
Elytra width	Morphological	Elytrum size	Quantitative	0.25
Elytrum weight	Morphological	Elytrum size	Quantitative	0.25
Protibia area	Reproduction	Protibia size	Quantitative	0.5
Protibia length	Reproduction	Protibia size	Quantitative	0.5
Protibia tooth length	Reproduction	Protibia tooth length	Quantitative	1
Metatibia area	Reproduction	Metatibia size	Quantitative	0.33
Metatibia length straight	Reproduction	Metatibia size	Quantitative	0.33
Metatibia length curved	Reproduction	Metatibia size	Quantitative	0.33
Wing area	Dispersal	Wing size	Quantitative	0.5
Wing length	Dispersal	Wing size	Quantitative	0.5
Wing load	Dispersal	Dispersal ability	Quantitative	1

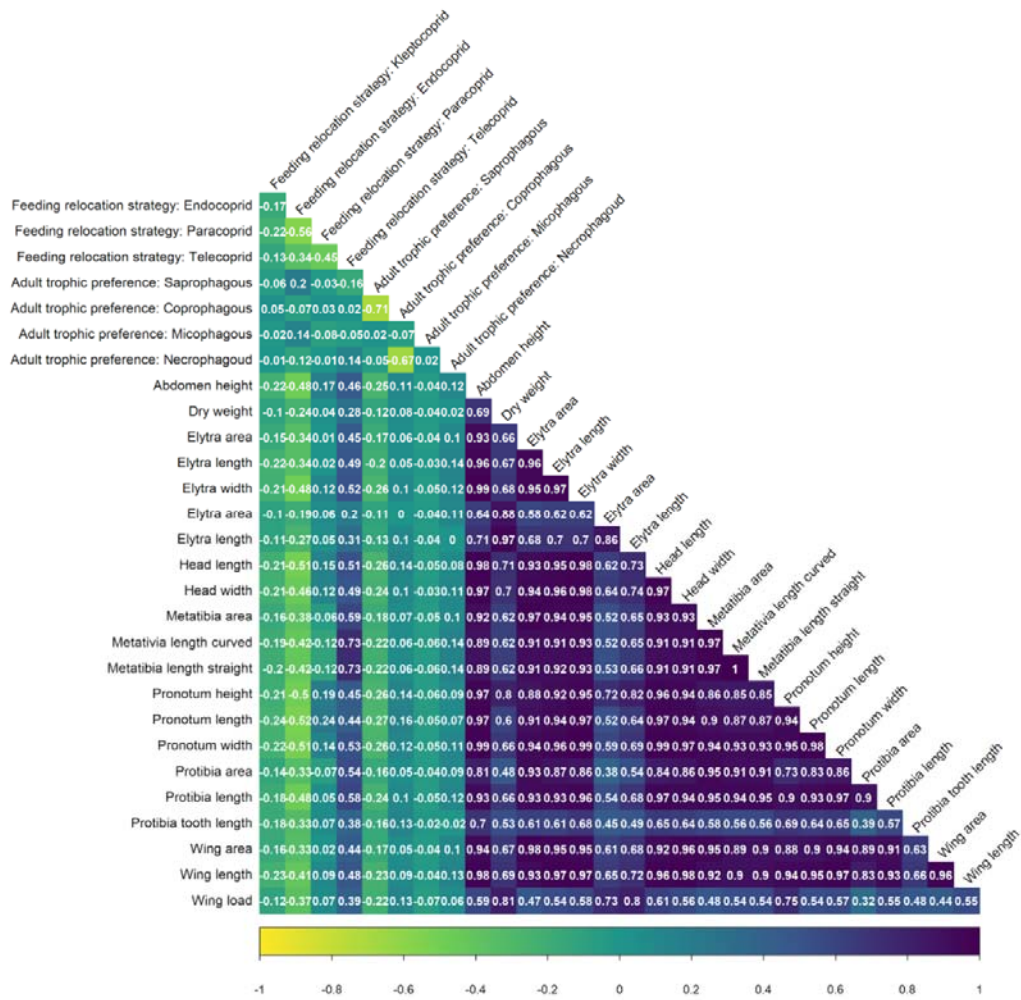


Figure S1. Correlations between functional traits; increasingly yellow colours point to strong negative correlations; increasingly green colours indicate low correlation; strong correlations are represented by dark colours.

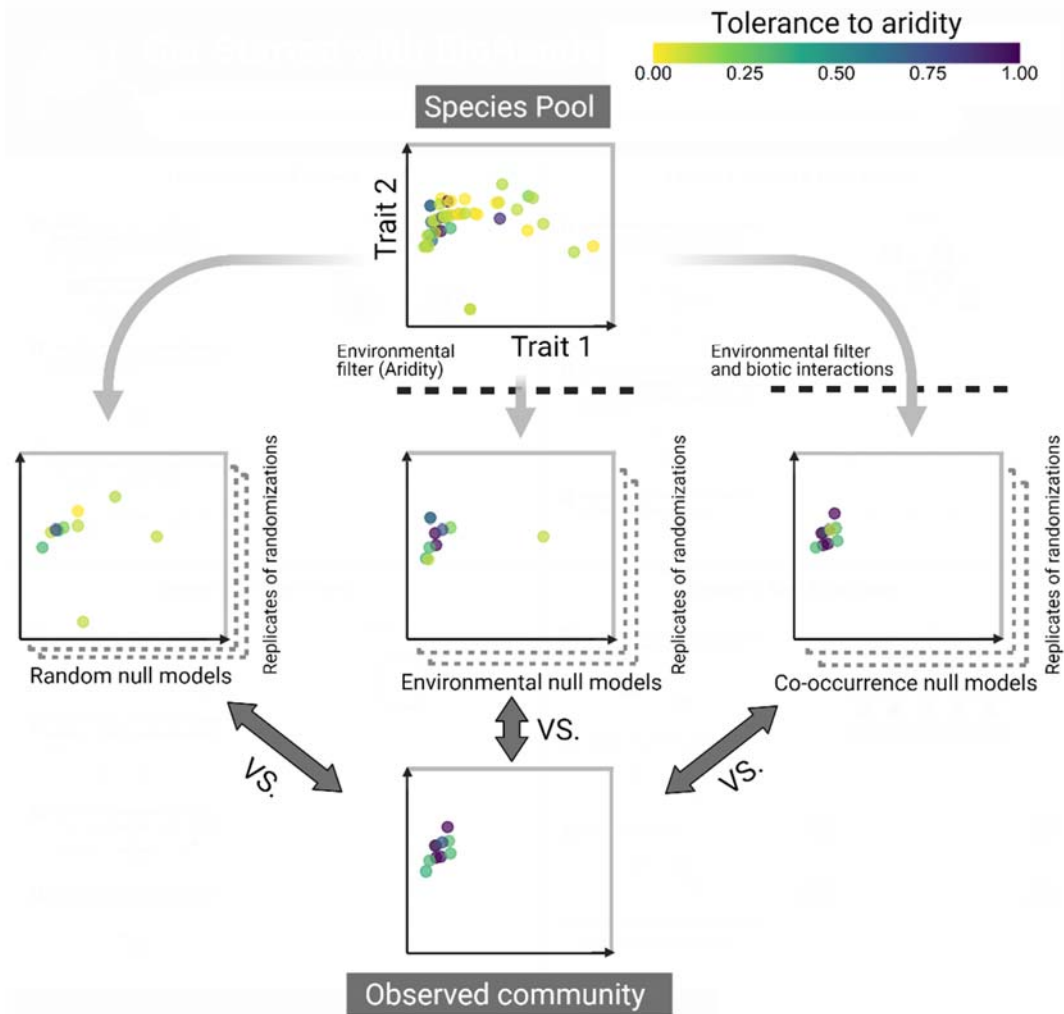


Figure S2. Conceptual framework for the null model approach. Null models differ in the process for generating simulated communities from the total species pool. From left to right, the null models hierarchically incorporate additional assembly constraints. This hypothetical example shows one community located at the arid extreme of one transect. In the random null model, simulated communities are randomly generated from the total species pool in the desert. The environmental null model runs simulations considering the response of the species to aridity. Finally, the co-occurrence null model runs simulations accounting for the probability of species occurring together with the species present in the observed communities. Finally, simulated communities are compared with that observed in the desert.

Supplementary Appendix S1. Climatic and weather information for study sites.

We performed a principal component analysis (PCA) for the daily weather during the months of survey in six different locations. These were located at the edges of the transects (Oujda and Tendirra in the Sahara, Torreón and Parral in the Chihuahua, and Vanwyksvlei and Prieska in the Kalahari). We used daily data for maximum temperature, minimum temperature, precipitation and humidity obtained from <http://www.worldweatheronline.com/>. All the transects show strong overlap, even though some days in the Chihuahua seemed more humid and rainier in comparison with those in the Kalahari and the Sahara.

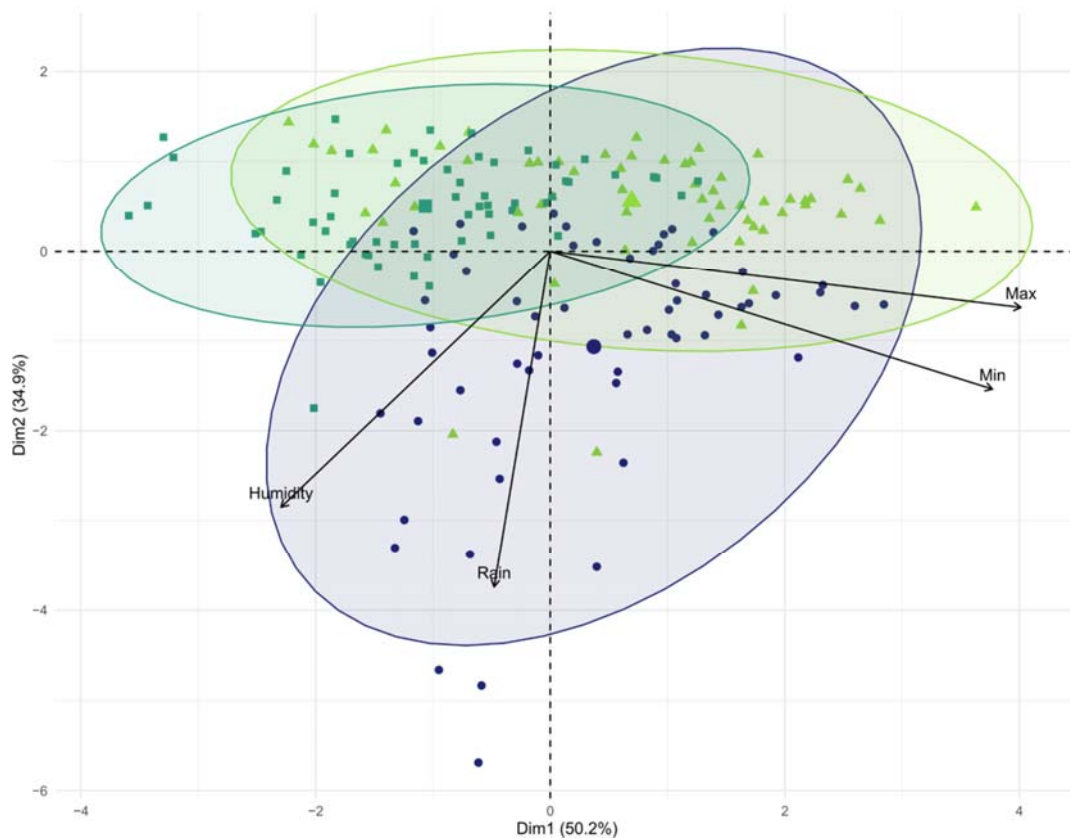


Figure S1.1. Principal Component Analysis of weather for the different sites in the different transects. Coloured areas represent the confidence intervals at 95% and symbols represent the observed values for every desert (blue dots: Chihuahua, light green triangles: Kalahari, and dark green squares: Sahara). Centroids of the confidence intervals are represented by the big symbols.

Also, we compared climographs for the selected weather stations as obtained from <https://climatecharts.net/>. Precipitation regimes are similar in the Sahara and Kalahari where rainfall occurs between November and March but different in the Chihuahua, where the rainy season occurs between June and October.

Supplementary Appendix S2. Taxonomic and functional indices analyses using extrapolated data.

Due to the low values of sample coverage found at the hyper-arid extreme of the gradient in the Kalahari, we repeated the linear mixed models for the taxonomic and functional indices using extrapolated richness. We assessed the extrapolated richness through Hill numbers (Chao & Jost 2012) as implemented in the ‘iNEXT’ R package (Hsieh, Ma & Chao 2016).

Results in these analyses support the evidence found in the original analyses using the measured species richness (see Supplementary Appendix S2 Table S2.1). Main effects remain similar as in the original analyses, even though there are slight differences in the values of AIC, especially in the case of Fric and FDis.

Table S2.1. Model selection for analyses of the drivers of the six taxonomic and functional indices. Competing explanatory models are marked in bold.

Response variable	Aridity	Extrapolated richness	Desert	Df	Int	AICc	ΔAICc	weight	R ²
log (Extrapolated richness)	-1.78	+	5	2.40	46.33	0.00	0.97	0.72	
				4	1.42	53.68	7.34	0.02	0.63
	1.17		3	1.50	79.21	32.88	0.00	0.08	
				2	2.37	79.44	33.11	0.00	0.00
log (Abundance)		+	4	4.42	107.78	0.00	0.72	0.32	
				-1.33	+	5	5.15	109.87	2.09
	0.39		2	5.31	114.83	7.05	0.02	0.00	
				3	5.02	117.22	9.44	0.01	0.00
Evenness		+	4	0.74	-22.67	0.00	0.63	0.23	
				2	0.64	-19.79	2.88	0.15	0.00
	0.03	+	5	0.72	-19.76	2.91	0.15	0.22	
				-0.14	3	0.74	-18.34	4.33	0.07
sqrt(FRic)		0.002	+	5	0.14	-92.45	0.00	0.43	0.71

	-0.07	0.002	+	6	0.18	-91.14	1.31	0.23	0.73
	-0.10		+	5	0.21	-90.77	1.68	0.19	0.70
			+	4	0.15	-90.35	2.11	0.15	0.67
	-0.21			3	0.22	-71.60	20.85	0.00	0.34
	-0.20	-0.001		4	0.22	-69.38	23.07	0.00	0.34
		-0.002		3	0.10	-61.67	30.78	0.00	0.08
				2	0.06	-61.58	30.87	0.00	0.00
F _{Eve}				2	0.57	-26.23	0.00	0.46	0.00
	0.13			3	0.47	-24.97	1.26	0.24	0.04
		0.0003		3	0.56	-23.76	2.48	0.13	0.00
	0.14	-0.001		4	0.47	-22.31	3.92	0.06	0.04
			+	4	0.54	-22.13	4.11	0.06	0.03
	0.11		+	5	0.48	-19.56	6.67	0.02	0.04
		-0.001	+	5	0.55	-19.52	6.71	0.02	0.04
	0.08	-0.001	+	6	0.50	-16.54	9.69	0.00	0.05
sqrt(F _{Dis})	-0.22		+	5	0.36	-53.83	0.00	0.56	0.38
			+	4	0.24	-51.94	1.89	0.22	0.28
	-0.23	-0.001	+	6	0.37	-50.92	2.91	0.13	0.37
		0.0004	+	5	0.24	-49.07	4.76	0.05	0.28
		0.003		3	0.25	-46.96	6.87	0.02	0.09
				2	0.29	-46.38	7.45	0.01	0.00
	0.002	0.003		4	0.24	-44.28	9.55	0.00	0.09
	0.05			3	0.25	-44.21	9.62	0.00	0.01

Supplementary Appendix S3. Datasets used in the analyses.

Attached document “SA.S3.Datasets.xlsx”

Supplementary Appendix S4. R Scripts for the analyses

Supplementary materials “SA.S4.1.Question 1 Responses of diversity indices to aridity” and “SA.S4.2.Question 2 Effect of aridity on community assembly rules” in the attached document “S4. Scripts.R”

Supplementary Appendix S5. Testing the assumptions for each model

Plots to study the residuals of each linear mixed model included in the analyses. Each figure includes: (1) a residuals vs fitted values plot, which was used for testing homoscedasticity and linearity of the residuals; (2) a histogram of the residuals, which were used to check whether the variance is normally distributed; and (3) a Q-Q plot for the deviance residuals, which aim to test whether or not there is normality in the residuals.

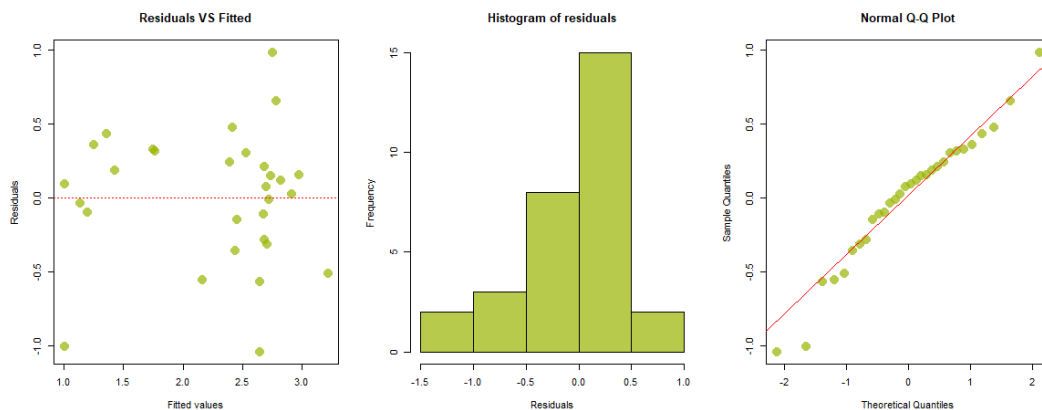


Figure S5.1. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of richness versus aridity.

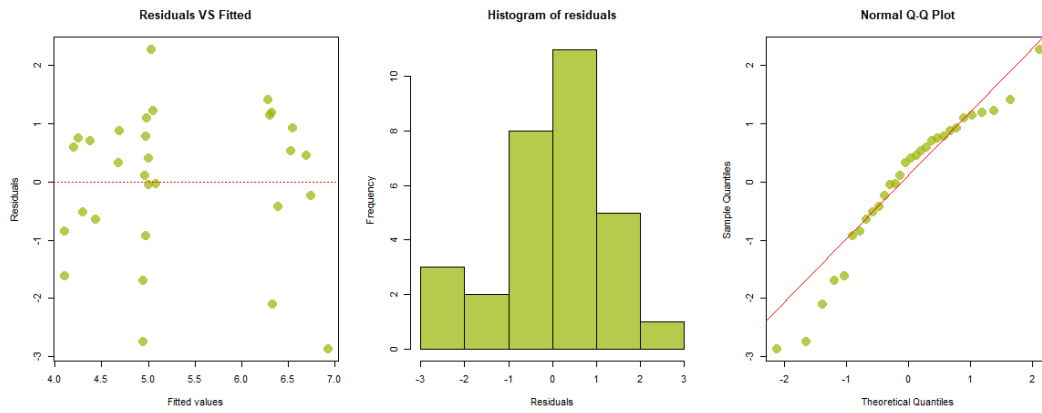


Figure S5.2. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of abundance versus aridity.

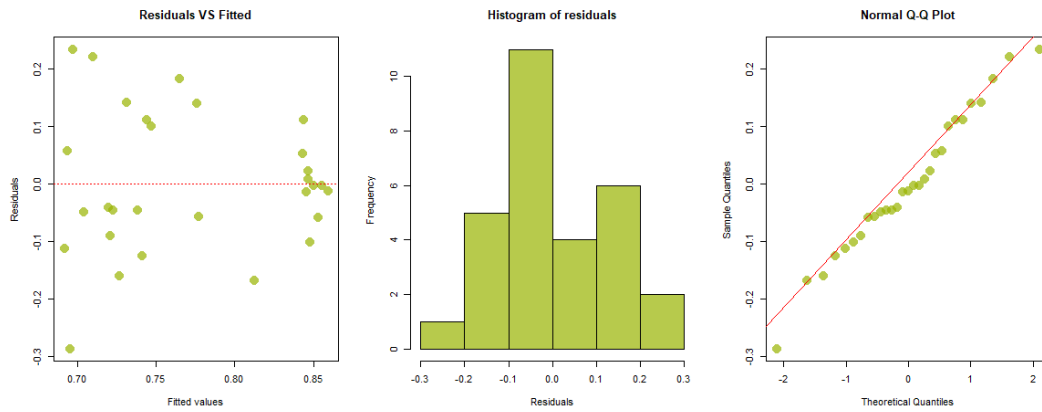


Figure S5.3. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of evenness versus aridity.

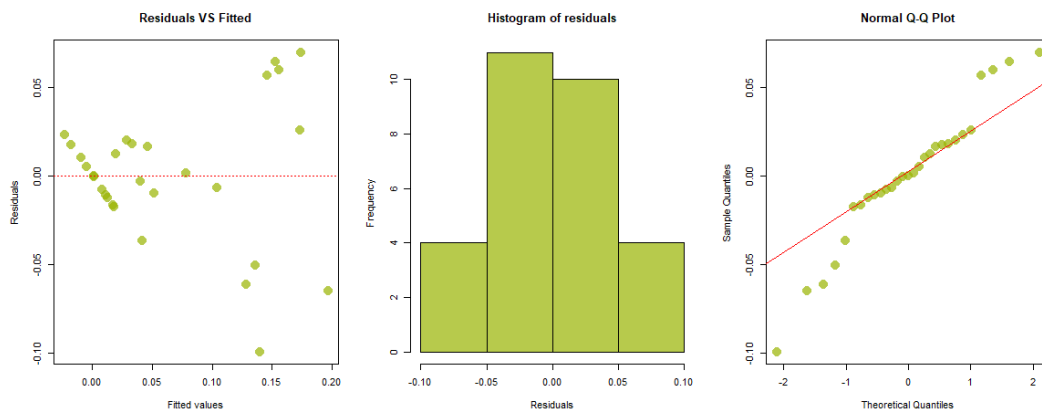


Figure S5.4. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of FRic versus aridity.

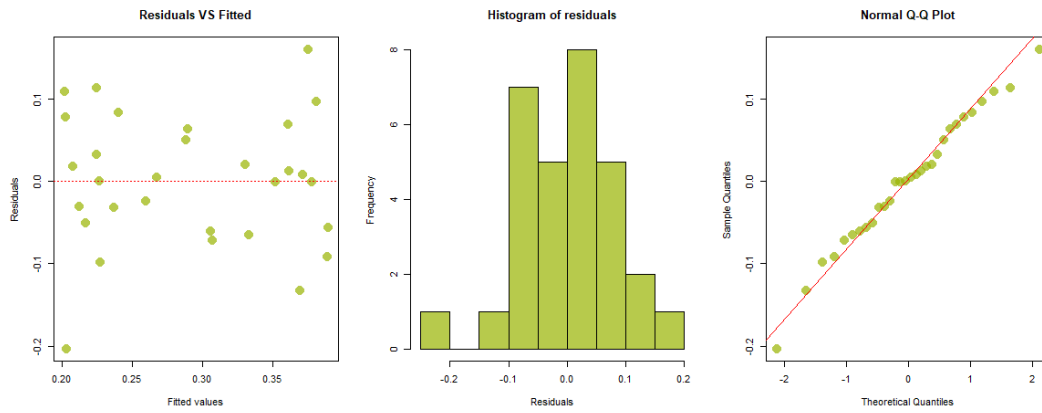


Figure S5.5. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of FDis versus aridity.

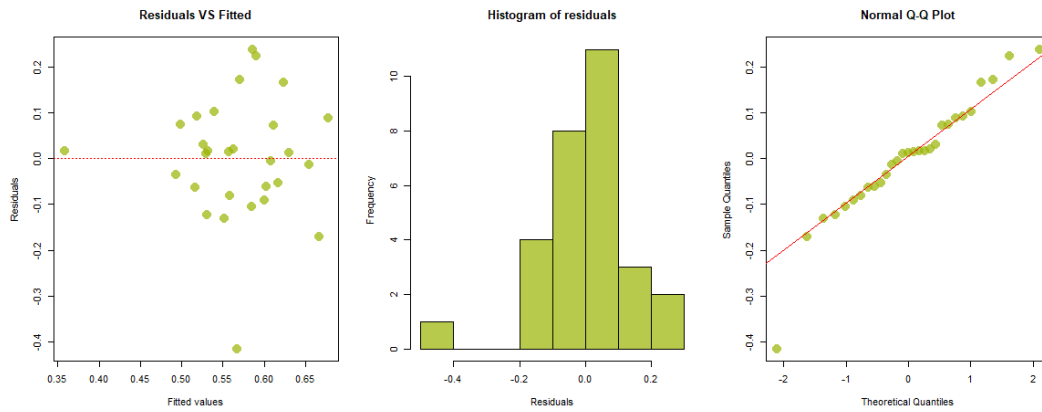


Figure S5.6. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of FEve versus aridity.

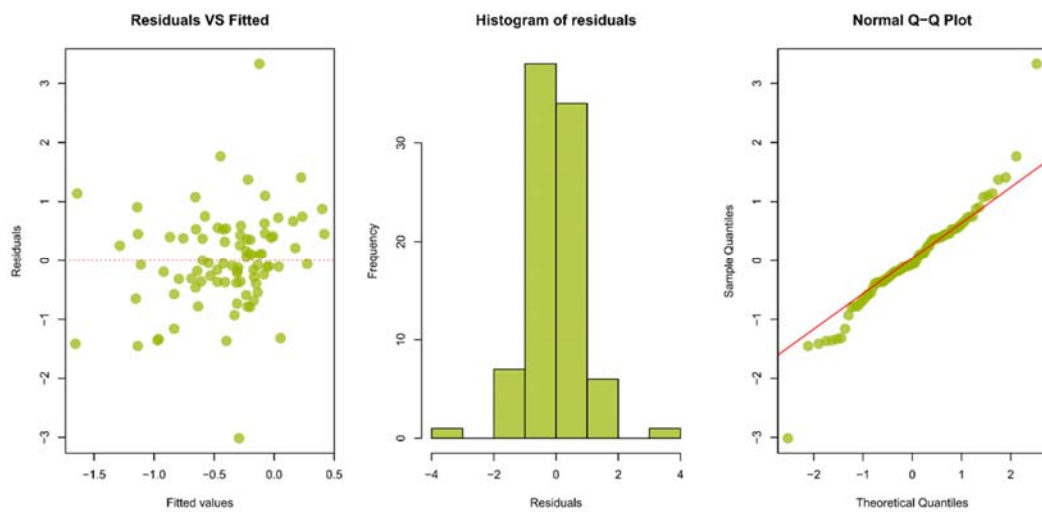


Figure S5.7. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of SES (FRic) versus aridity.

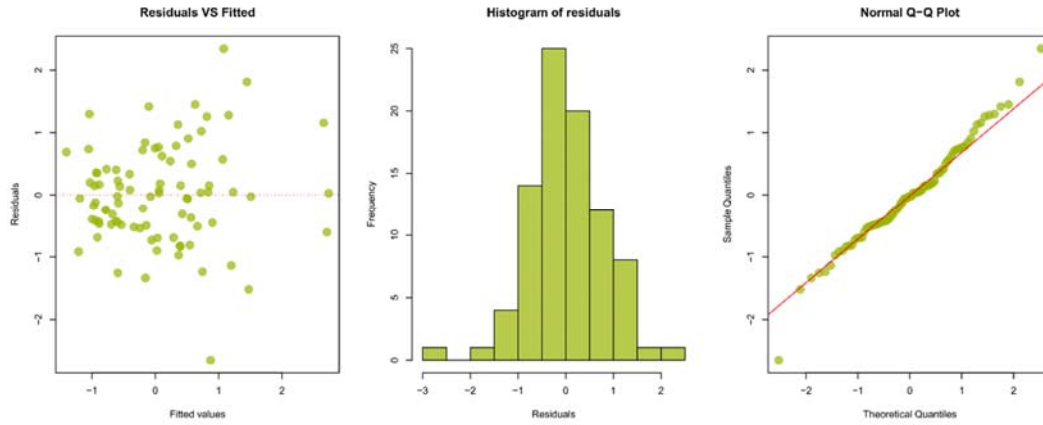


Figure S5.8. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of SES(FDis) versus aridity.

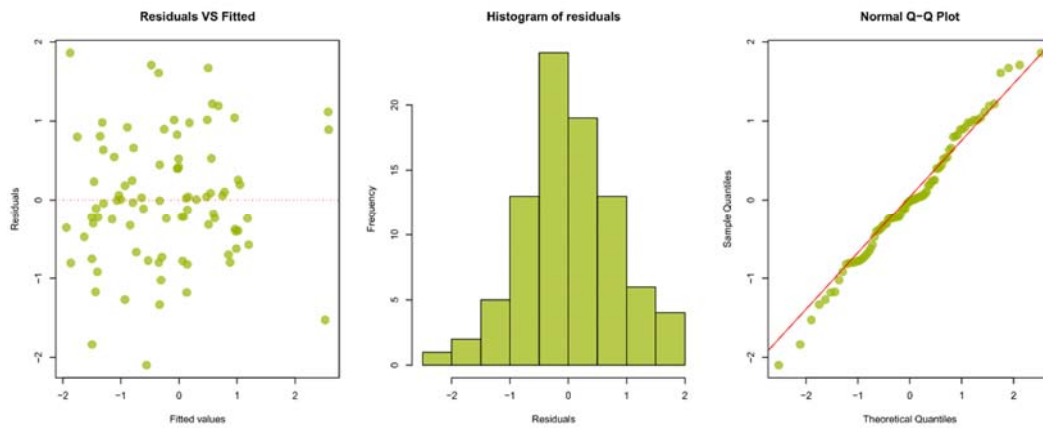


Figure S5.9. Diagnostic plots for assumptions of normality, homoscedasticity and linearity for the model of SES(FEve) versus aridity.