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Supplement of

Variations of leaf N, P concentrations in shrubland biomes across northern China: phylogeny, climate and soil

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Supplementary material

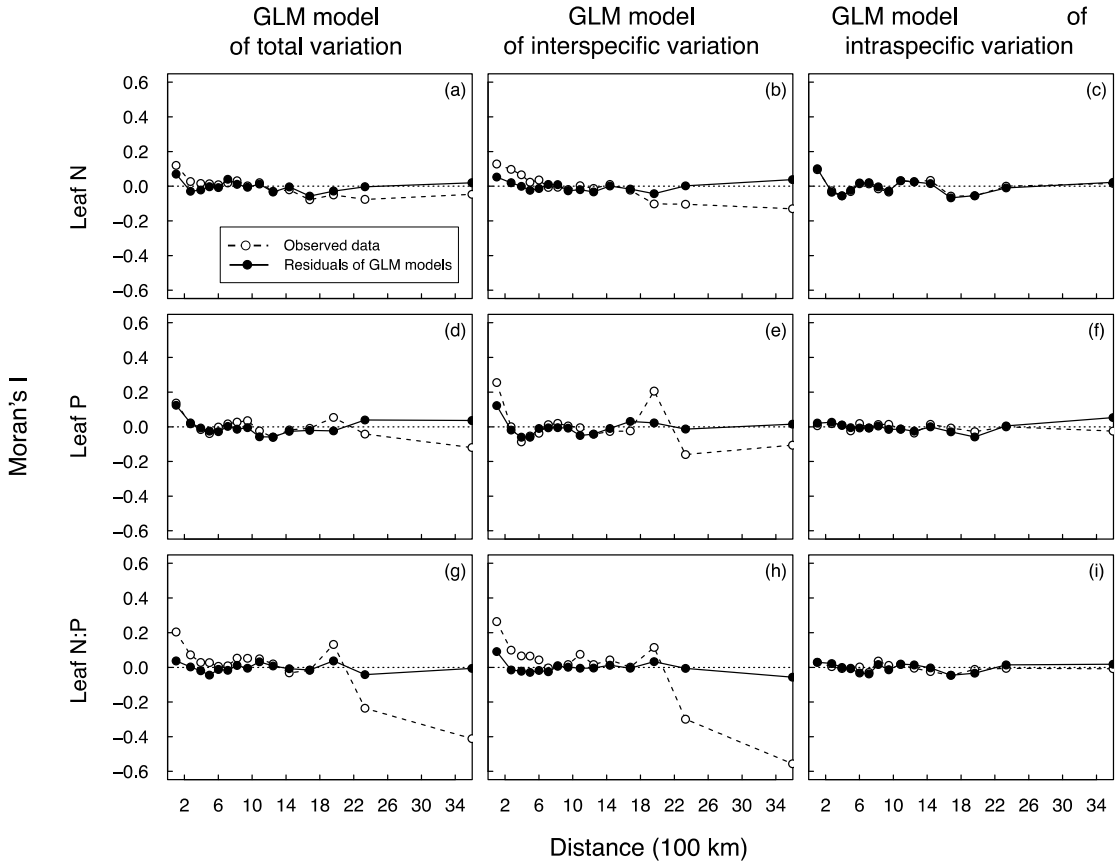
The supplementary material for this manuscript consists of three figures and a table. The figure and table captions including methodology are given below.

Fig. S1. Variation of Moran's I along distance bands for observed (grey dot) and residuals in general linear models (black open), for inter-specific (left column, a, d, g), intra-specific (central column, b, e, h), and total (right column c, f, i) variations in the leaf nitrogen (upper row, a-c), phosphorus (middle row, d-f) concentrations and leaf N:P (lower row, g-i).

Fig. S2. Histograms showing the distributions of leaf nitrogen (mg g^{-1}) (a), phosphorus (mg g^{-1}) (b), and N:P (c) for all observations.

Fig. S3. Different leaf N (black) and P (grey) concentrations among life forms (a) and different leaf N concentration among functional groups (b) in China. In (a), data for "tree" and "shrub" were from Han *et al.* (2005); data for "herb" were from Han *et al.* (2005) and He *et al.* (2006); data for "shrub*" were from this study. Letters above the error bars show the results of multiple comparisons tests. Life forms and functional groups with same letters are not significantly different, while different letters are significantly different.

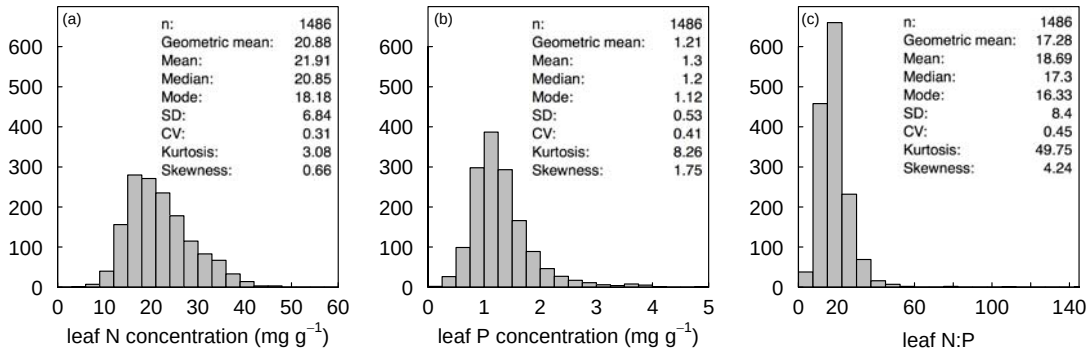
Table S1. Summary of general linear models for leaf N (a), P (b) concentrations and N:P (c) of shrubs in Northern China with interaction terms.


GLM model of total variation
GLM model of interspecific variation
GLM model of intraspecific variation
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
Leaf N
Leaf P
Leaf N:P
Moran's I
Observed data
Residuals of GLM models
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
2 6 10 14 18 22 26 30 34
Distance (100 km)

1

2

3 Fig. S1


(a)
n: 1486
Geometric mean: 20.88
Mean: 21.91
Median: 20.85
Mode: 18.18
SD: 6.84
CV: 0.31
Kurtosis: 3.08
Skewness: 0.66
leaf N concentration (mg g−1)
(b)
n: 1486
Geometric mean: 1.21
Mean: 1.3
Median: 1.2
Mode: 1.12
SD: 0.53
CV: 0.41
Kurtosis: 8.26
Skewness: 1.75
leaf P concentration (mg g−1)
(c)
n: 1486
Geometric mean: 17.28
Mean: 18.69
Median: 17.3
Mode: 16.33
SD: 8.4
CV: 0.45
Kurtosis: 49.75
Skewness: 4.24
leaf N:P

1

2

3 Fig. S2

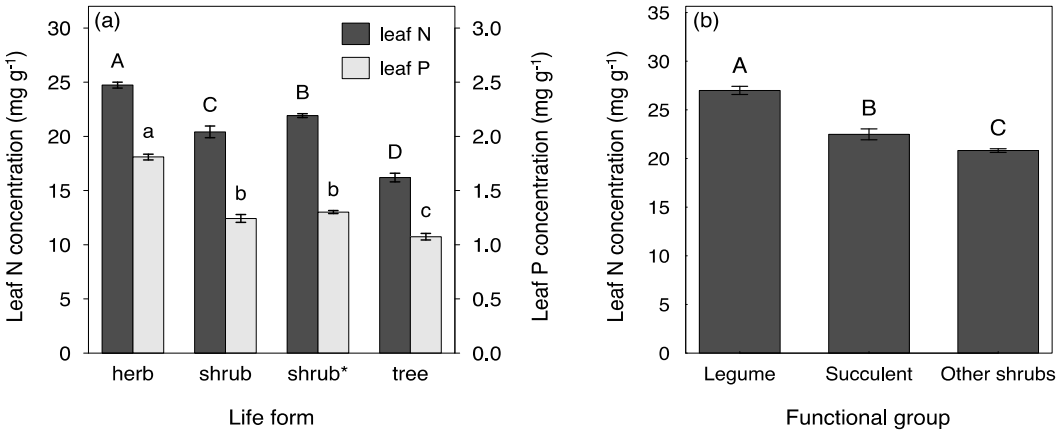

(a)
leaf N
leaf P
A
a
C
b
B
b
D
c
Leaf N concentration (mg g-1)
Leaf P concentration (mg g-1)
herb
shrub
shrub*
tree
Life form
(b)
A
B
C
Leaf N concentration (mg g-1)
Legume
Succulent
Other shrubs
Functional group

Fig. S3

Table S1. Summary of general linear models for leaf N (a), P (b) concentrations and N:P (c) of shrubs in Northern China with interaction terms.

		Interspecificvariation		Intraspecificvariation		Totalvariation		
		F	SS	F	SS	F	SS	SS%
(a)	MAT	0.012	0.2^{NS}	0.08	1.1^{NS}	0.01	0.3^{NS}	0.00
	AP	50.72	932.1^{***}	0.86	12^{NS}	22.17	742.9^{***}	5.73
	STN	18.75	344.6^{***}	0.89	12.4^{NS}	6.75	226.2^{**}	1.74
	STP	0.01	0.2^{NS}	2.07	29.1^{NS}	0.75	25.3^{NS}	0.20
	MAT:AP	0.4	7.4^{NS}	0.68	9.6^{NS}	0.93	31.2^{NS}	0.24
	AP:STN	11.19	205.8^{***}	0.15	2.1^{NS}	6.94	232.6^{**}	1.79
	MAT:STN	11.37	208.9^{***}	3.99	56^{*}	1.55	51.9^{NS}	0.40
	AP:STP	3.42	62.9^{NS}	0.01	0^{NS}	2.05	68.5^{NS}	0.53
	Residuals		6359.1		4671.9		11594.6	
	Total		8121.2		4794.2		12973.5	10.63
(b)	MAT	18.72	1.821^{***}	11.14	1.272^{***}	29.25	6.026^{***}	5.69
	AP	37.25	3.625^{***}	1.58	0.18^{NS}	26.09	5.375^{***}	5.07
	STN	2.9	0.282^{NS}	13.57	1.549^{***}	2.55	0.526^{NS}	0.50
	STP	0.29	0.028^{NS}	39.9	4.554^{***}	18.61	3.834^{***}	3.62
	MAT:AP	19.39	1.887^{***}	0.27	0.031^{NS}	7.1	1.463^{**}	1.38
	MAT:STN	20.85	2.029^{***}	0.81	0.092^{NS}	14.53	2.993^{***}	2.82
	AP:STN	5.22	0.508^{*}	0.54	0.061^{NS}	1.24	0.255^{NS}	0.24
	MAT:STP	8.01	0.78^{**}	3.34	0.381^{NS}	11.02	2.271^{***}	2.14
	AP:STP	8.65	0.842^{**}	9.99	1.14^{**}	18.93	3.9^{***}	3.68
	STN:STP	8.09	0.787^{**}	8.08	0.922^{**}	16.86	3.475^{***}	3.28
	MAT:AP:STN	0.54	0.052^{NS}	0.24	0.027^{NS}	0.17	0.034^{NS}	0.03
	MAT:AP:STP	0.01	0.001^{NS}	6.77	0.772^{**}	3.38	0.697^{NS}	0.66
	MAT:STN:STP	4.59	0.446^{*}	14.33	1.636^{***}	18.55	3.822^{***}	3.61
	AP:STN:STP	0.14	0.013^{NS}	9.18	1.048^{**}	5.95	1.227^{*}	1.16
	Residuals		33.08		37.32		70.06	
	Total		46.19		50.99		105.95	33.88
(c)	MAT	7.49	103.2^{**}	3.54	58.4^{NS}	10.99	312^{**}	1.96
	AP	253.01	3487.2^{***}	0.82	13.5^{NS}	138.26	3926.6^{***}	24.64
	STN	6.03	83.1^{*}	0.02	0.3^{NS}	2.73	77.6^{NS}	0.49
	STP	0.81	11.2^{NS}	12.32	203.1^{***}	4.11	116.6^{*}	0.73
	MAT:AP	28.52	393^{***}	0.3	4.9^{NS}	17.1	485.5^{***}	3.05
	MAT:STN	4.92	67.8^{*}	3.28	54.1^{NS}	7.96	226.2^{**}	1.42
	AP:STN	20.01	275.8^{***}	0.7	11.5^{NS}	12.36	351.2^{***}	2.20
	MAT:STP	0.75	10.4^{NS}	0.01	0.1^{NS}	0.43	12.1^{NS}	0.08
	AP:STP	4.33	59.6^{*}	0.53	8.7^{NS}	3.85	109.4^{NS}	0.69
	STN:STP	0.42	5.7^{NS}	1.32	21.7^{NS}	1.87	53.2^{NS}	0.33
	MAT:AP:STN	9.4	129.6^{**}	0	0^{NS}	6.54	185.8^{*}	1.17

MAT:AP:STP	1.76	24.2^{NS}	1.65	27.2^{NS}	0	0.1^{NS}	0.00
MAT:STN:STP	7.88	108.5^{**}	5.24	86.4^{*}	13.98	397.1^{***}	2.49
AP:STN:STP	2.05	28.3^{NS}	0.01	0.1^{NS}	0.95	27^{NS}	0.17
Residuals		4686.2		5390.7		9656.2	
Total		9473.8		5880.7		15936.6	39.41

The effects of MAT, AP, STN, STP and all of their possible interactions on leaf N (a), P (b) concentrations and N:P (c) were analyzed using general linear models (GLM). Akaike information criterion (AIC) was used to select competing models. For each trait, effects that were selected in the any of the three models (interspecific, intraspecific and total variation) were included in the final model.

Abbreviations: MAT, mean annual temperature; AP, annual precipitation; STN, soil total nitrogen; STP, soil total phosphorus. *** $p<0.001$, ** $p< 0.01$ and ^{NS} non-significance.

1