

Convergent Variations in the Leaf traits of Desert Plants

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Supplementary information

Table S1 Phylogenetic signals of the different leaf traits.

Table S2 The loading of six leaf traits on the three principal components analysis (PCA) axes at the species level (N=37).

Table S3 Correlation matrix for macro-elements of plant and soil.

Table S4 Correlation matrix for soil elements and soil variables.

Table S5 Concentrations (Mean \pm SE) of analyzed leaf traits for 37 plant species: as C, carbon (mg g⁻¹); N, nitrogen (mg g⁻¹); P, phosphorus (mg g⁻¹); K, potassium (mg g⁻¹); $\delta^{13}\text{C}$, carbon isotope ¹³C and LWP, water potential in MPa (ψ_w). The differences among species were assessed by one-way analysis of variance (ANOVA).

Table S6 Concentrations (Mean \pm SE) of analyzed leaf traits for 18 families: as C, carbon (mg g⁻¹); N, nitrogen (mg g⁻¹); P, phosphorus (mg g⁻¹); K, potassium (mg g⁻¹); $\delta^{13}\text{C}$, carbon isotope ¹³C and LWP, water potential in MPa (ψ_w). The differences among families were assessed by one-way analysis of variance (ANOVA).

Figure S1 Phylogenetic distributions patterns of leaf traits: leaf carbon concentration (C); leaf nitrogen concentration (N); leaf phosphorus concentration (P); leaf potassium concentration (K); carbon isotope concentration (C¹³) and leaf water potential (Ψ_l) concentrations (mean \pm SE) at the species level.

Figure S2 Phylogenetic distributions patterns of leaf traits: leaf carbon concentration (C); leaf nitrogen concentration (N); leaf phosphorus concentration (P); leaf potassium concentration (K); carbon isotope concentration ($\delta^{13}\text{C}$) and leaf water potential (Ψ_l) concentrations (mean \pm SE) at the family level.

Table S1 Phylogenetic signals of the different leaf traits.

Traits	<i>K</i> -value	<i>P</i> -value
C	0.348	0.010**
N	0.282	0.050*
P	0.173	0.515
K	0.123	0.732
$\delta^{13}\text{C}$	0.283	0.155
LWP	0.114	0.682

** $P \leq 0.01$ and * $P \leq 0.05$ represent significant phylogenetic signal in the corresponding traits

Table S2 The loading of 6 leaf traits on the three principal components analysis (PCA) axes at the species level ($N=37$).

Variables	PC1	PC2	PC3
C	0.717	-0.041	-0.520
N	0.810	0.190	0.358
P	0.594	0.604	0.342
K	-0.202	0.810	0.063
$\delta^{13}\text{C}$	-0.624	0.558	0.110
LWP	-0.052	-0.545	0.748
Total variation explained	32.7%	22.5%	18.5%

Table S3 Correlation matrix for macro-elements of plant and soil

	SOC	STN	STP
C	-0.072	-0.104	-0.285
N	-0.009	0.030	-0.091
P	0.510**	0.453**	0.191

SOC= soil organic carbon, STN= soil total nitrogen, STP= soil total phosphorus. Correlation is significant at ** $P \leq 0.01$ and * $P \leq 0.05$

Table S4 Correlation matrix for soil elements and soil variables

	SOC	STN	NH4	NO3	STP	SAP	SMC	pH	SEC
SOC	1								
STN	0.932**	1							
NH4	0.460*	0.534*	1						
NO3	-0.102	-0.018	0.272	1					
STP	0.593**	0.573**	0.289	0.042	1				
SAP	0.145	0.226	-0.177	-0.096	0.305	1			
SMC	0.514*	0.566**	0.649**	0.428	0.203	-0.379	1		
pH	-0.306	-0.346	-0.296	-0.294	0.044	0.263	-0.567**	1	
SEC	0.014	0.165	0.243	0.279	-0.232	-0.052	0.399	-0.641**	1

Correlation is significant at ** $P \leq 0.01$ and * $P \leq 0.05$

Table S5 Concentrations (Mean \pm SE) of analyzed leaf traits for 37 plant species: as C, carbon (mg g⁻¹); N, nitrogen (mg g⁻¹); P, phosphorus (mg g⁻¹); K, potassium (mg g⁻¹); $\delta^{13}\text{C}$, carbon isotope ¹³C and LWP, water potential in MPa (ψ_w). The differences among species were assessed by one-way analysis of variance (ANOVA).

Plant Name	Statistic	C	N	P	K	$\delta^{13}\text{C}$	LWP
<i>Allium mongolicum</i>	Mean	470.74	40.38	1.97	7.25	-24.38	-9.18
	SE	19.45	0.77	0.04	0.12	0.39	1.15
<i>Artemisia desertorum</i>	Mean	772.99	29.88	1.02	12.12	-25.78	-13.36
	SE	24.36	0.61	0.02	0.10	0.75	0.20
<i>Asterothamnus centralasiaticus</i>	Mean	449.05	27.89	0.88	9.07	-26.80	-7.60
	SE	27.58	0.98	0.02	0.62	0.41	0.15
<i>Halogeton glomeratus</i>	Mean	298.86	16.97	0.91	8.04	-13.98	-8.13
	SE	18.62	1.33	0.01	0.23	0.36	0.16
<i>Hedysarum multijugum</i>	Mean	405.04	24.94	0.66	10.80	-27.51	-3.91
	SE	23.14	0.82	0.03	0.25	1.26	0.04
<i>Hedysarum scoparium</i>	Mean	473.07	19.56	0.63	9.48	-26.86	-3.01
	SE	18.67	0.99	0.05	0.31	0.12	0.87
<i>Karelinia caspia</i>	Mean	448.91	28.14	0.81	4.32	-27.79	-7.81
	SE	7.01	0.43	0.07	0.37	0.81	0.18
<i>Limonium aureum</i>	Mean	455.40	13.33	0.50	7.95	-27.47	-11.83
	SE	18.42	0.27	0.00	0.32	0.20	0.10
<i>Phragmites australis</i>	Mean	492.26	23.18	0.81	10.00	-25.39	-7.09
	SE	24.76	0.82	0.04	0.42	0.74	0.04
<i>Salsola ikoikovii</i>	Mean	338.96	15.54	0.87	6.14	-13.63	-19.60
	SE	19.28	0.31	0.08	0.09	0.20	1.07
<i>Scorzonera pseudodivaricata</i>	Mean	538.12	14.52	0.50	11.26	-26.92	-7.27
	SE	22.23	1.01	0.03	0.34	0.19	0.09
<i>Sonchus oleraceus</i>	Mean	467.76	18.66	1.01	6.95	-28.98	-3.67
	SE	19.73	1.06	0.02	0.34	0.20	0.05
<i>Zygophyllum gobicum</i>	Mean	439.96	12.99	0.43	5.61	-27.94	-10.06
	SE	22.58	1.82	0.07	0.27	0.66	0.17
<i>Ammopiptanthus mongolicus</i>	Mean	614.79	32.68	0.71	26.35	-25.22	-7.04
	SE	24.11	0.66	0.01	0.21	0.79	1.11
<i>Artemisia frigida</i>	Mean	639.65	33.79	1.21	16.79	-26.68	-4.39
	SE	24.47	0.69	0.08	0.35	1.28	0.03
<i>Calligonum mongolicum</i>	Mean	444.09	15.89	1.02	10.82	-14.76	-6.19
	SE	10.24	1.42	0.04	0.34	1.10	0.93
<i>Caragana korshinskii</i>	Mean	511.55	26.74	0.42	14.01	-23.65	-5.34
	SE	17.50	0.42	0.02	0.06	0.60	1.36
<i>Caragana roborovskyi</i>	Mean	501.08	25.74	0.72	13.66	-25.13	-12.81
	SE	21.48	1.11	0.04	0.19	0.43	1.08
<i>Elaeagnus angustifolia</i>	Mean	542.67	37.40	1.02	9.65	-25.83	-4.88
	SE	20.79	0.86	0.11	0.79	0.40	0.01
<i>Gymnocarpos przewalskii</i>	Mean	426.86	16.27	0.62	12.35	-24.57	-4.36
	SE	28.45	0.13	0.01	0.27	0.13	0.22
<i>Lycium ruthenicum</i>	Mean	379.19	30.04	0.76	8.08	-27.14	-4.24
	SE	11.22	1.46	0.05	0.24	0.12	0.05
<i>Nitraria sphaerocarpa</i>	Mean	449.05	53.40	1.29	11.90	-26.38	-8.29
	SE	11.34	1.84	0.06	0.43	0.57	0.91
<i>Reaumuria songarica</i>	Mean	262.25	25.51	0.47	25.00	-27.59	-5.09
	SE	12.80	0.56	0.03	0.04	0.24	0.04
<i>Salsola arbuscula</i>	Mean	380.79	22.41	0.73	15.45	-16.39	-7.40
	SE	14.43	0.55	0.12	0.44	0.07	0.09

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Plant Name	Statistic	C	N	P	K	$\delta^{13}\text{C}$	LWP
<i>Sarcozygium xanthoxylon</i>	Mean	432.99	13.52	0.43	17.32	-27.08	-4.33
	SE	23.27	2.44	0.05	0.36	0.11	0.14
<i>Tamarix chinensis</i>	Mean	518.40	22.96	0.70	18.12	-26.26	-11.33
	SE	9.41	0.77	0.06	1.13	0.28	0.12
<i>Xanthoceras sorbifolia</i>	Mean	602.50	24.46	0.83	9.26	-25.88	-16.33
	SE	11.12	0.52	0.10	0.46	0.89	0.82
<i>Alhagi sparsifolia</i>	Mean	415.83	23.55	0.60	8.64	-27.65	-11.00
	SE	4.34	0.50	0.02	0.24	0.68	0.05
<i>Bassia dasyphylla</i>	Mean	326.53	19.43	0.62	22.08	-24.70	-5.26
	SE	25.70	1.37	0.11	0.61	0.18	0.80
<i>Caryopteris mongholia</i>	Mean	541.11	38.79	2.51	9.94	-26.88	-11.00
	SE	11.55	0.91	0.03	0.48	0.08	0.08
<i>Clematis tangutica</i>	Mean	487.61	24.12	0.78	11.32	-26.76	-5.79
	SE	15.64	0.67	0.04	0.38	0.50	0.18
<i>Cynanchum chinense</i>	Mean	466.11	30.81	0.81	9.02	-28.13	-5.76
	SE	27.62	0.92	0.04	0.08	0.06	0.65
<i>Ephedra przewalskii</i>	Mean	509.09	17.54	0.72	4.13	-25.19	-9.47
	SE	9.50	1.04	0.05	0.21	0.69	0.19
<i>Ephedra sinica</i>	Mean	506.42	33.14	0.83	10.01	-24.81	-9.59
	SE	15.24	0.22	0.07	0.37	0.56	0.16
<i>Haloxylon ammodendron</i>	Mean	282.72	13.53	0.51	16.82	-13.62	-4.18
	SE	2.12	0.14	0.05	0.33	0.13	0.11
<i>Sophora alopecuroides</i>	Mean	500.86	35.81	0.52	5.33	-24.82	-4.45
	SE	17.89	0.40	0.05	0.25	0.72	0.95
<i>Sympegma regelii</i>	Mean	373.85	31.64	1.62	14.35	-23.77	-3.05
	SE	17.03	0.69	0.12	0.20	0.15	0.02
Mean (37-species)	Mean	463.98	25.27	0.85	11.60	-24.66	-7.68
	SE	9.83	0.87	0.04	0.50	0.41	0.37
	F-value	28.63	85.68	52.70	185.00	56.63	43.91
	P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

SE = standard error; P-values are in bold when $P < 0.001$.

Table S6 Concentrations (Mean \pm SE) of analyzed leaf traits for 18 families: as C, carbon (mg g⁻¹); N, nitrogen (mg g⁻¹); P, phosphorus (mg g⁻¹); K, potassium (mg g⁻¹); $\delta^{13}\text{C}$, carbon isotope ¹³C and LWP, water potential in MPa (ψ_w). The differences among families were assessed by one-way analysis of variance (ANOVA).

Family Name	Statistic	C	N	P	K	$\delta^{13}\text{C}$	LWP
<i>Asteraceae</i>	Mean	552.75	25.48	0.91	10.08	-27.16	-7.35
	SE	1.11	0.51	0.03	0.10	0.14	0.04
<i>Lamiaceae</i>	Mean	541.11	38.79	2.51	9.94	-26.88	-11.00
	SE	11.55	0.91	0.03	0.48	0.08	0.08
<i>Solanaceae</i>	Mean	379.19	30.04	0.76	8.08	-27.14	-4.24
	SE	11.22	1.46	0.06	0.24	0.12	0.05
<i>Apocynaceae</i>	Mean	466.11	30.81	0.81	9.02	-28.13	-5.76
	SE	27.62	0.92	0.07	0.08	0.06	0.65
<i>Amaranthaceae</i>	Mean	333.62	19.93	0.88	13.82	-17.68	-7.94
	SE	7.74	0.68	0.03	0.11	0.07	0.26
<i>Caryophyllaceae</i>	Mean	426.86	16.27	0.62	12.35	-24.57	-4.36
	SE	28.45	0.13	0.01	0.27	0.13	0.22
<i>Polygonaceae</i>	Mean	444.09	15.89	1.02	10.82	-14.76	-6.19
	SE	10.24	1.42	0.04	0.34	1.10	0.93
<i>Plumbaginaceae</i>	Mean	455.40	13.33	0.50	7.95	-27.47	-11.83
	SE	18.42	0.27	0.03	0.32	0.20	0.10
<i>Tamaricaceae</i>	Mean	390.32	24.23	0.59	21.56	-26.93	-8.21
	SE	7.28	0.39	0.04	0.55	0.05	0.06
<i>Zygophyllaceae</i>	Mean	436.48	13.25	0.43	11.47	-27.51	-7.20
	SE	19.72	1.67	0.04	0.30	0.29	0.12
<i>Fabaceae</i>	Mean	488.89	27.00	0.61	12.61	-25.83	-6.79
	SE	8.01	0.11	0.01	0.12	0.28	0.17
<i>Elaeagnaceae</i>	Mean	542.67	37.40	1.02	9.65	-25.83	-4.88
	SE	20.79	0.86	0.02	0.79	0.40	0.01
<i>Sapindaceae</i>	Mean	602.50	24.46	0.83	9.26	-25.88	-16.33
	SE	11.12	0.52	0.10	0.46	0.89	0.82
<i>Nitrariaceae</i>	Mean	449.05	53.40	1.29	11.90	-26.38	-8.29
	SE	11.34	1.84	0.06	0.43	0.57	0.91
<i>Ranunculaceae</i>	Mean	487.61	24.12	0.78	11.32	-26.76	-5.79
	SE	15.64	0.67	0.04	0.38	0.50	0.18
<i>Amaryllidaceae</i>	Mean	470.74	40.38	1.97	7.25	-24.38	-9.18
	SE	19.45	0.77	0.04	0.12	0.39	1.15
<i>Poaceae</i>	Mean	492.26	23.18	0.81	10.00	-25.39	-7.09
	SE	24.76	0.82	0.04	0.42	0.74	0.04
<i>Ephedraceae</i>	Mean	507.76	25.34	0.77	7.07	-25.01	-9.53
	SE	4.79	0.44	0.04	0.25	0.34	0.08
Mean (18-families)	Mean	470.41	26.85	0.95	10.79	-25.20	-7.89
	SE	9.41	1.41	0.07	0.44	0.47	0.41
	F-value	16.56	123.47	128.10	80.22	56.40	36.58
	P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

SE = standard error; *P*-values are in bold when *P* < 0.001.

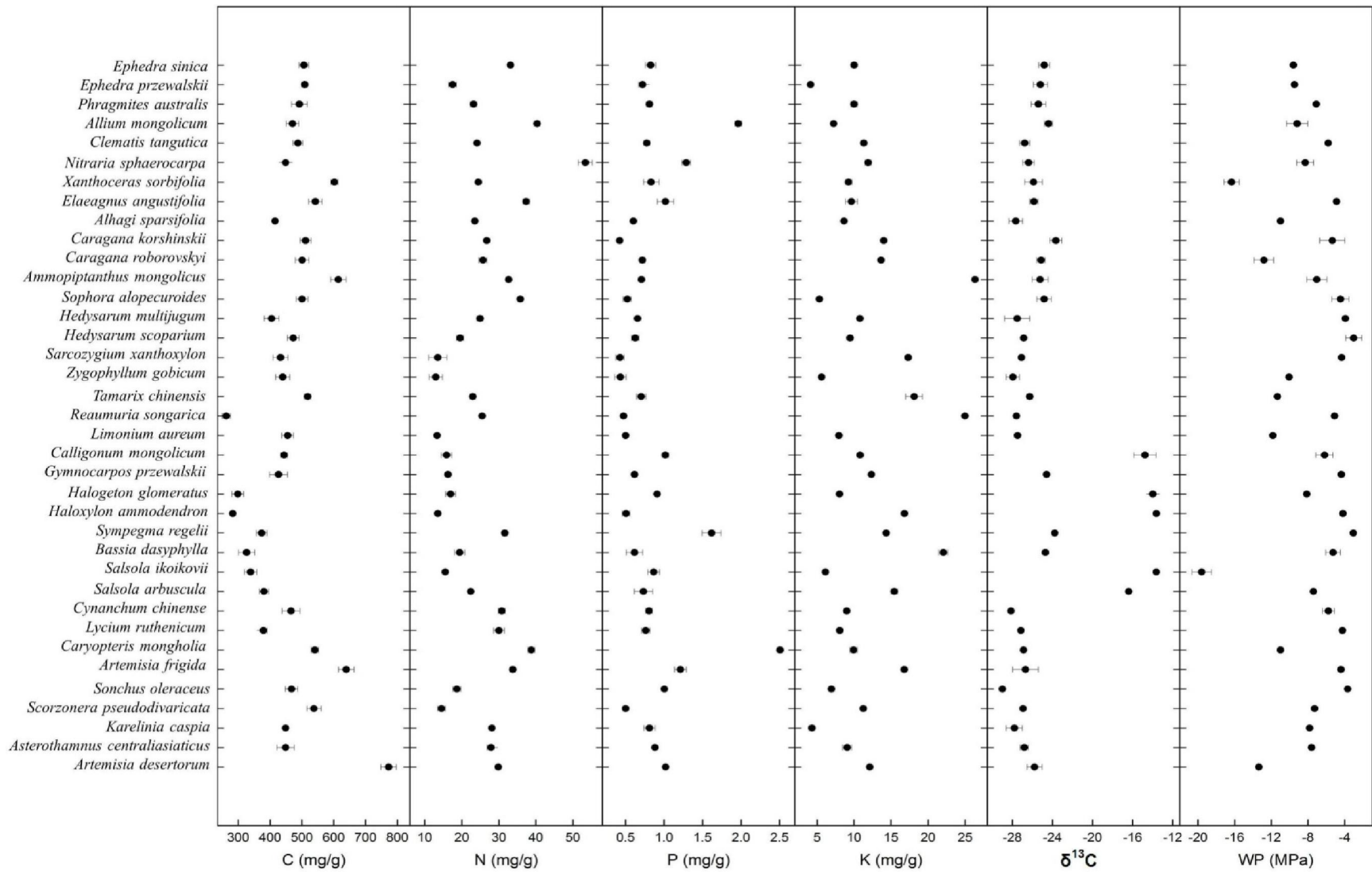


Fig.S1 Phylogenetic distributions patterns of leaf traits: leaf carbon concentration (C); leaf nitrogen concentration (N); leaf phosphorus concentration (P); leaf potassium concentration (K); carbon isotope concentration ($\delta^{13}\text{C}$) and leaf water potential (Ψ) concentrations (mean \pm SE) at the species level.

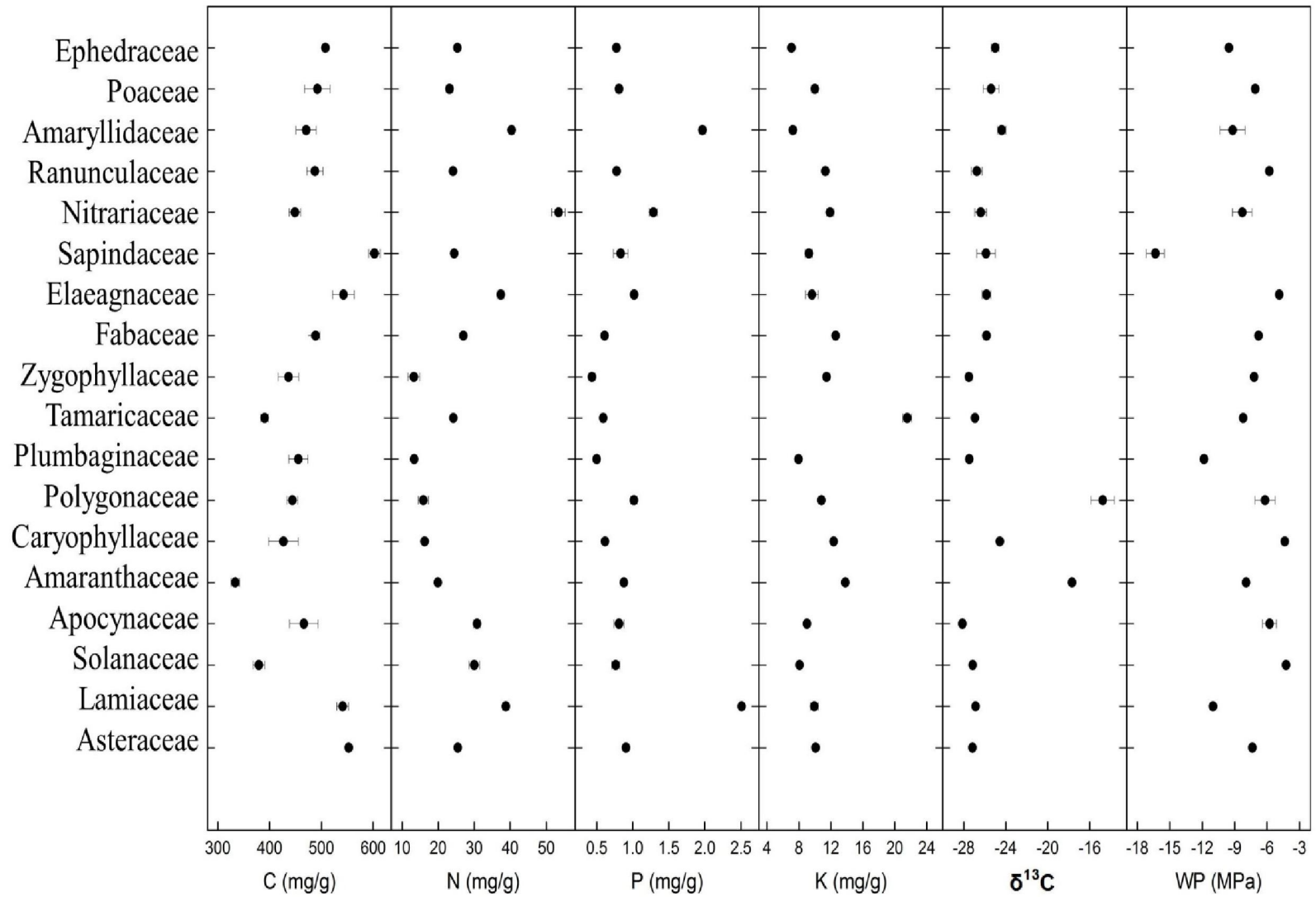


Fig.S2 Phylogenetic distributions patterns of leaf traits: leaf carbon concentration (C); leaf nitrogen concentration (N); leaf phosphorus concentration (P); leaf potassium concentration (K); carbon isotope concentration ($\delta^{13}\text{C}$) and leaf water potential (Ψ_l) concentrations (mean \pm SE) at family level.