Supplementary Materials

I Supplementary Figures

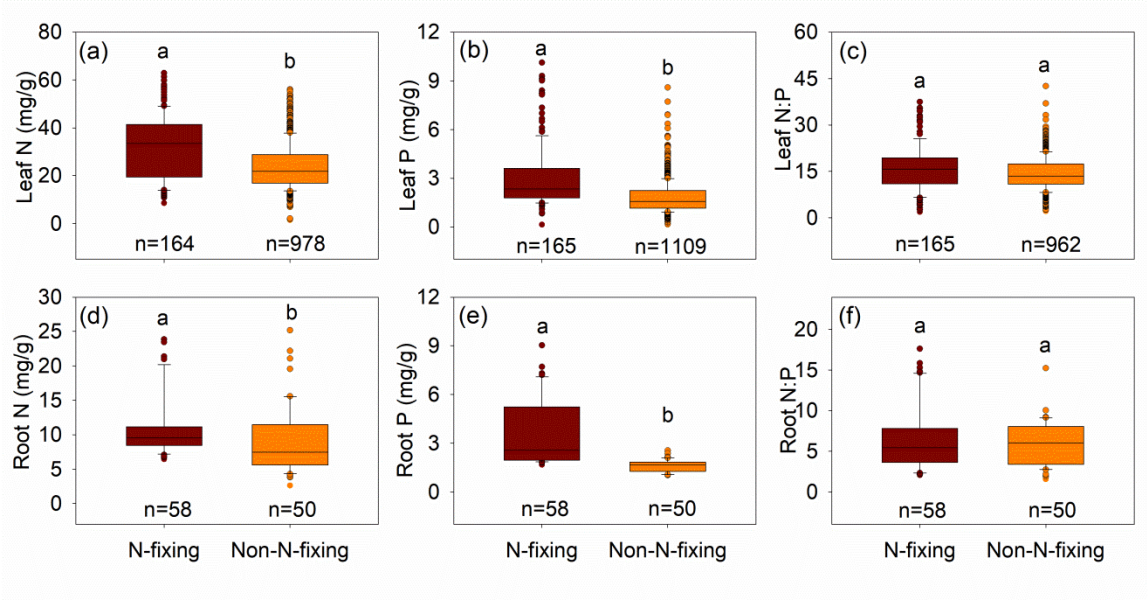


Figure S1 Changes in nitrogen (N), phosphorus (P) concentrations and their stoichiometric ratios in the leaves and roots between N-fixing and Non-N-fixing. Here, (a)-(c) show the N concentrations, P concentrations and N:P ratios in leaves between N-fixing and non-N-fixing, and (d)-(f) show the N and P concentrations and N:P ratios in roots between N-fixing and non-N-fixing. The different letters in each graph indicates significant differences between N-fixing and Non-N-fixing in leaves and roots. Significant difference ($P< 0.05$) was calculated by Student's *t*-test. The numbers (n) under the box-plot are the number of species for each group.

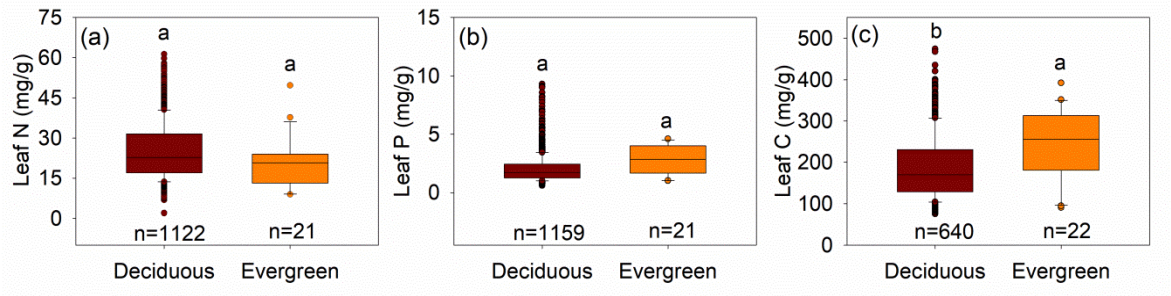


Figure S2. Changes in nitrogen (N), phosphorus (P) and carbon (C) concentrations in the leaves between deciduous and evergreen species when all pooled data were together. Here, (a) show the comparison of N concentrations, (b) P concentrations, and (c) the C concentrations. Different letters in each graph indicates the significant differences between deciduous and evergreen species (Student's *t*-test, $P< 0.05$). The numbers (n) under the box-plot are the number of species for each group.

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II Supplementary Tables

Table S1

Complete the basic information for the three different desert ecosystem and related climatic variables

Figures	Desert vegetative types	Growth forms	Number of plants	Longi. (°E)	Lati. (° N)	Alti. (m)	MAT (°C)	MAP (mm)
Figure 1- 4 and Figure S1-S2	Desert	Herbs, shrubs, trees, grass	496	1.6- 175	11.8- 57.32	245-4318	0.19- 13	20- 502
Figure 1- 4 and Figure S1-S2	Steppe desert	Herbs, shrubs, trees, grass	363	69.1- 128.5	32.9- 57.2	207-2018	-2.17- 11.7	45- 360
Figure 1- 4 and Figure S1-S2	Temperate desert	Herbs, shrubs, trees, grass	436	71.1- 129.18	28.3- 51.44	38.43- 2560	3.2- 13.9	40- 265

Note: mean annual temperature (MAT); mean annual precipitation (MAP); longitude (Longi.); latitude (Lati.); altitude (Alti.)

Table S2

Comparison of the three different ecosystem types for different elements in root and soil for growth forms

Growth form	Ecosystem type	N Mean± SE	P Mean± SE	N:P Mean± SE	C Mean± SE	C:N Mean± SE	C:P Mean± SE
Herbs (Root)	Desert						
	Steppe desert	18.17±1.2[a]	1.7±0.23[a]	12.2±1.2[a]	220.83±7.2	12.93±1.06	146.83±11.73
	Temperate desert	7.95±0.88[b]	1.69±0.22[a]	5.42±0.9[b]			
Shrubs (Root)	Desert	9.15±0.28	2.93±0.33	4.67±0.36	259.29±9.66	29.37±1.33	139.11±13.06
	Steppe desert						
	Temperate desert						
Trees (Root)	Desert	11.35±2.54	2.57±0.39	10.82±1.9		62.90±14.5	
	Steppe desert						
	Temperate desert						
Grass (Root)	Desert	9.09±0.67	2.11±0.19	6.48±0.73		54.02±3.6	
	Steppe desert						
	Temperate desert						
Herbs (Soil)	Desert	3.16±0.58	0.52±0.09	7.44±1.66	3.34±0.17	11.20±0.99	8.99±0.54
	Steppe desert						
	Temperate desert						
Shrubs (Soil)	Desert	1.21±0.3[c]	0.34±0.00[c]	3.49±0.87[a]	3.04±0.19[c]	10.65±0.3[a]	8.51±0.39[a]
	Steppe desert	3.31±0.16[b]	2.18±0.09[b]	1.86±0.1[b]	9.20±0.16[b]	3.99±0.15[b]	6.37±0.34[a]
	Temperate desert	5.75±0.71[a]	3.20±0.31[a]	2.22±0.28[b]	13.93±0.95[a]	3.30±0.5[b]	4.73±0.67[a]
Trees (Soil)	Desert						
	Steppe desert	2.98±0.26[b]	1.89±0.14[a]	1.66±0.09[b]	10.38±0.28[b]	4.63±0.27[a]	7.28±0.56[a]
	Temperate desert	5.88±0.83[a]	2.26±0.26[a]	2.99±0.71[a]	11.79±0.66[a]	2.72±0.53[b]	6.56±1.04[a]
Grass (Soil)	Desert						
	Steppe desert						
	Temperate desert						

III Supporting references for all dataset used in this article

1. Akram, M.A.; Wang, X.; Hu, W.; Xiong, J.; Zhang, Y.; Deng, Y.; Ran, J.; Deng, J. Convergent variations in the leaf traits of desert plants. *Plants* **2020**, *9*, 990.
2. Chen, Z.; Huang, D.; Zhang, H. The characteristics of element chemistry of 122 plants on the Xilin river valley, Inner Mongolia. *Res. Grassl. Ecosyst.* **1985**, *1*, 112–131.
3. Mo, D.-l.; Wu, J.-x. A Study on the Characteristics of the Chemical Composition and the Interrelationship Between the Elements in the Plants of 86 Species in Hainan Island. *Chin. J. Plant Ecol.* **1988**, *12*, 51–62.
4. Han, W.; Fang, J.; Guo, D.; Zhang, Y. Leaf nitrogen and phosphorus stoichiometry across 753 terrestrial plant species in China. *New Phytol.* **2005**, *168*, 377–385. https://doi.org/10.1111/j.1469-8137.2005.01530.x.
5. He, J.S.; Wang, L.; Flynn, D.F.; Wang, X.; Ma, W.; Fang, J. Leaf nitrogen: Phosphorus stoichiometry across Chinese grassland biomes. *Oecologia* **2008**, *155*, 301–310.
6. Hou, X. *Chinese Vegetable Geography and Chemical Elements: Analyses of the Dominant Plant Species*; Science Press: Beijing, China, 1982.
7. Huang, J.; Wang, P.; Niu, Y.; Yu, H.; Ma, F.; Xiao, G.; Xu, X. Changes in C: N: P stoichiometry modify N and P conservation strategies of a desert steppe species Glycyrrhiza uralensis. *Sci. Rep.* **2018**, *8*, 12668.
8. Huang, J.-h.; Chen, L.-z. A study of chemical contents in a mixed shrubland near Baihuashan mountain in Beijing. *Chin. J. Plant Ecol.* **1991**, *15*, 224.
9. Jiang, X.; Jia, X.; Gao, S.; Jiang, Y.; Wei, N.; Han, C.; Zha, T.; Liu, P.; Tian, Y.; Qin, S. Plant nutrient contents rather than physical traits are coordinated between leaves and roots in a desert shrubland. *Front. Plant Sci.* **2021**, *12*, 734775.
10. Luo, Y.; Lian, C.; Gong, L.; Mo, C. Leaf Stoichiometry of Halophyte Shrubs and Its Relationship with Soil Factors in the Xinjiang Desert. *Forests* **2022**, *13*, 2121.
11. Nurbolat, S.; Guanghui, L.; Lamei, J.; Lei, Z. Convergent Variation in the Leaf Traits of Desert Plants in the Ebinur Lake Basin. *Front. Environ. Sci.* **2022**, *10*, 927572.
12. Tao, Y.; Qiu, D.; Gong, Y.-M.; Liu, H.-L.; Zhang, J.; Yin, B.-F.; Lu, H.Y.; Zhou, X.B.B.; Zhang, Y.M. Leaf-root-soil N: P stoichiometry of ephemeral plants in a temperate desert in Central Asia. *J. Plant Res.* **2022**, *135*, 55–67.
13. Tao, Y.; Zhou, X.-B.; Zhang, Y.M.; Yin, B.F.; Li, Y.G.; Zang, Y.-X. Foliar C: N: P stoichiometric traits of herbaceous synusia and the spatial patterns and drivers in a temperate desert in Central Asia. *Glob. Ecol. Conserv.* **2021**, *28*, e01620.
14. Li, J.-q.; Gong, W.-g. Characteristic Analysis of Nutrient Contents of Major Tree Species in Northeast China. *Chin. J. Plant Ecol.* **1991**, *15*, 380–385.
15. Yin, H.; Zheng, H.; Zhang, B.; Tariq, A.; Lv, G.; Zeng, F.; Graciano, C. Stoichiometry of C: N: P in the roots of alhagi sparsifolia is more sensitive to soil nutrients than aboveground organs. *Front. Plant Sci.* **2021**, *12*, 698961.
16. Zhang, K.; Li, M.; Su, Y.; Yang, R. Stoichiometry of leaf carbon, nitrogen, and phosphorus along a geographic, climatic, and soil gradients in temperate desert of Hexi Corridor, northwest China. *J. Plant Ecol.* **2020**, *13*, 114–121.
17. Zhang, X.; Guan, T.; Zhou, J.; Cai, W.; Gao, N.; Du, H.; Jiang, L.; Lai, L.; Zheng, Y. Community characteristics and leaf stoichiometric traits of desert ecosystems regulated by precipitation and soil in an arid area of China. *Int. J. Environ. Res. Public Health* **2018**, *15*, 109.
18. Zhu, Z.X.; Harris, A.; Nizamani, M.M.; Thornhill, A.H.; Scherson, R.A.; Wang, H.F. Spatial phylogenetics of the native woody plant species in Hainan, China. *Ecol. Evol.* **2021**, *11*, 2100–2109.