Journal of Global Change Data & Discovery. 2021, 5(1): 99-107
DOI:10.3974/geodp.2021.01.13
www.geodoi.ac.cn

Global Change Research Data Publishing & Repository

Methodology of Leaf Anatomical Structure and Geographic Environmental Dataset of *Caryopteris mongholica* from Seven Regions in North and Northwest China

Ji, R. X. Yu, X. Chang, Y. Shen, C. Bai, X. Q. Xia, X. L. Yin, W. L. Liu, C.*

National Engineering Laboratory of Tree Breeding, College of Biological Sciences and Technology, Beijing Forestry University, Beijing 100083, China

Abstract: The genetic variation caused by long-term adaptation to the environment significantly affects plant growth and development. Leaves are the most important and sensitive organs in responding to environmental changes. Therefore, an understanding of the adaptive variation in leaf anatomical structures in different environments is the basis for exploring plant adaptation to the environment. Common garden experiments eliminate the influence of environmental gradients and are an effective approach to study the effects of genetic and environmental factors on plant structures. In this study, a common garden experiment was used to analyze the anatomical structures of *Caryopteris mongholica* leaves from seven different areas in north and northwest China, including Abaga Banner, Alxa Left Banner, Dongwu Banner, Mengxi, and Liangcheng in Nei Mongol (Inner Mongolia), Shenmu in Shaanxi province, and Kangbao in Hebei province. Conventional paraffin sectioning was used to analyze structures, and multiple comparisons, correlation analyses, and a general linear model (GLM) were used to identify the factors driving differences. The genetic variation driven by climate was one of the major factors that caused the differences in leaf anatomical structures from the different areas. The dataset includes the following: (1) geographical location data for the collection sites; (2) *C. mongholica* leaf cross sections; and (3) analysis of the relations between *C. mongholica* leaf anatomical structures and the geographic environmental factors that influence them. The dataset is archived in .shp, .kmz, .xls, .jpg, and .doc formats and consists of 14 data files, with a data size of 5.84 MB.

Keywords: ***Caryopteris mongholica*; common garden experiment; leaf anatomical structures**

Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodb.2021.01.03.V1.

Received: 26-01-2021; **Accepted:** 08-03-2021; **Published:** 25-03-2025

Foundations: Ministry of Ecology and Environment of P. R. China (2017ZX07101002); National Natural Science Foundation of China (32071734, 31770649, 31600484)

***Corresponding Author:** Liu, C. AAE-6091-2021, Beijing Forestry University, liuchao1306@bjfu.edu.cn

Data Citation: [1] Ji, R. X., Yu, X., Chang, Y., *et al*. Methodology of leaf anatomical structure and geographic environmental dataset of *Caryopteris mongholica* from seven regions in north and northwest China [J]. *Journal of Global Change Data & Discovery*, 2021, 5(1): 99–107. https://doi.org/10.3974/geodp.2021.01.13.
[2] Ji, R. X., Yu, X., Chang, Y., *et al*. Leaf anatomical structure and geographic environment data of *Caryopteris Mongholica* from 7 provenances [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2021. https://doi.org/10.3974/geodb.2021.01.03.V1.

1 Introduction

Plants are subject to the long-term effects of environmental factors such as temperature, water, and light and in the process of evolution, gradually develop phenotypic and genetic characteristics adapted to the environment. Even within the same species, long-term growth in different geographic environments can produce different degrees of gene differentiation that lead to specific regional characteristics adapted to local geographic environments[1–4]. The leaf is the plant organ with the largest area exposed to the environment, and its external morphological characteristics and internal anatomical structure can best reflect the adaptive evolution of plants to environmental factors[5–8]. Therefore, analyzing the anatomical structure of leaves is important in studying the adaptation strategies of plants in extreme environments.

Common garden experiments are used to minimize the effects of site conditions[9,10] and show that differences in leaf anatomical structures from different regions are due to the genetic variation in plants caused by environmental differences in the original regions. This experiment differs from previous ones on the characteristics of leaf anatomical structure, because the effects of both environmental factors, including climate indices and geographic location, and genetic factors were evaluated. Common garden experiments can provide important insights into local adaptability[11] and a better understanding of the responses and adaptation mechanisms of plants from different geographical regions to global changes. At present, few studies have used this method to analyze the differences in leaf anatomical structures from different regions and the factors that influence changes in those structures. Therefore, *Caryopteris mongholica* from seven regions in north and northwest China were planted under the same environmental conditions in a common garden experiment to exclude the effects of environmental factors. To explore the effect of locality on the plant, paraffin sectioning was used to study leaf anatomical structures. With an understanding of adaptive evolution according to regional environments, a theoretical basis is provided for protection of germplasm resources, genetic improvement, and exploration of the mechanisms by which differences in plant genotypes are driven by environmental variation.

2 Metadata of the Dataset

The metadata of Leaf anatomical structure and geographic environment data of *Caryopteris Mongholica* from 7 provenances[12] are summarized in Table 1, including the dataset full name, short name, authors, year of the dataset, temporal resolution, data format, data size, data files, data publisher, and data sharing policy, etc.

3 Data Development Methods

3.1 Study Area

The common garden experiment was conducted in the nursery of Beijing Forestry University (40.01°N, 116.34°E), China. The nursery is in the warm temperate zone with a semihumid continental monsoon climate. The mean annual temperature is 11.8 °C, the annual maximum temperature range is 37.5–42.6 °C, the annual minimum temperature range is –19.5 to –14.8 °C, and the mean annual precipitation is 500 to 650 mm[14]. Most precipitation occurs in the summer, accounting for 70% of the annual total, and severe drought is typical in spring. The research site was covered with a plastic shed overnight and when it rained to prevent the influence of additional water.

3.2 Plant Materials

One-year-old *C. mongholica* cuttings, approximately 20-cm stems, with good growth were collected. They were wrapped in damp cloth and immediately brought to Beijing. The cuttings were collected from Abaga Banner, Alxa Left Banner, Dongwu Banner, Mengxi, and Liangcheng in Nei Mongol (Inner Mongolia), Shenmu in Shaanxi province, and Kangbao in Hebei province in late March 2016. The cuttings from the different regions (Table 2) were treated with 0.1% rooting powder ABT1 (Research Institute of Forestry, Chinese Academy of Forestry, Beijing, China) and then planted in flowerpots (450 mm × 450 mm). The soil was a sandy loam, and the volume ratio of peat soil, loam soil, and sand was 4:4:3, which is similar to the composition of the field soil in which *C. mongholica* was collected. All materials were planted in the same soil mix.

Table 1 Metadata summary of the Leaf anatomical structure and geographic environment data of *Caryopteris Mongholica* from 7 provenances

Items	Description		
Dataset full name	Leaf anatomical structure and geographic environment data of *Caryopteris Mongholica* from 7 provenances		
Dataset short name	LeafAnatomicalStructure_CaryopterisMongholica		
Authors	Ji, R. X. AAE-6059-2021, Beijing Forestry University, bljrx@bjfu.edu.cn Yu, X. AAE-6050-2021, Beijing Forestry University, yuxiao@bjfu.edu.cn Chang, Y., Beijing Forestry University, 1034530229@qq.com Shen, C. 0000-0001-5037-4922, Beijing Forestry University, shenchaonow@bjfu.edu.cn Bai, X. Q., Beijing Forestry University, baixueqia88@qq.com Xia, X. L., Beijing Forestry University, xiaxl@bjfu.edu.cn Yin, W. L., Beijing Forestry University, yinwl@bjfu.edu.cn Liu, C. AAE-6091-2021, Beijing Forestry University, liuchao1306@bjfu.edu.cn		
Geographical region	China 38.88°N–45.73°N, 105.72°E–116.79°E	Year	2007–2017
Temporal resolution	Day		
Data format	.shp, .kmz, .xls, .jpg and .doc	Data size	5.84 MB
Data files	(1) Geographical location data of collection sites (2) Leaf cross section of *Caryopteris mongholica* (3) Analysis data of leaf anatomical structure and geographical environment influencing factors of *Caryopteris mongholica*: 1) Summary of general linear models for the effect of climate variations in different regions on individual leaf anatomical characters of *Caryopteris mongholica* 2) Correlation analyses data of *Caryopteris mongholica* leaf anatomical characters 3) Leaf anatomical parameters and basic conditions of *Caryopteris mongholica* regions		
Foundations	Ministry of Ecological Environment of P. R. China (2017ZX07101002); National Natural Sciences Foundation of China (32071734, 31770649, 31600484)		
Data Computing Environment	ArcGIS 10.2, Excel, R 3.2.2		
Data publisher	Global Change Research Data publishing & Repository, http://www.geodoi.ac.cn		
Address	No.11A, Datun Road, Chaoyang District, Beijing 100101, China		
Data sharing policy	***Data*** from the Global Change Research Data Publishing & Repository includes metadata, datasets (in the *Digital Journal of Global Change Data Repository*), and publications (in the *Journal of Global Change Data* & *Discovery*). ***Data*** sharing policy includes: (1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[13]		
Communication and searchable system	DOI, DCI, CSCD, WDS/ISC, GEOSS, China GEOSS, Crossref		

From three to five cuttings with similar growth from each site, three mature leaves in the middle of each branch were sampled. A 1 cm × 1 cm square (approximately) was cut from the middle of each leaf that included the main vein (Figure 1). The pieces were fixed in FAA (formaldehyde:acetic acid:70% ethanol = 1:1:18) and taken to the laboratory for determination of leaf anatomical structures.

Table 2 Locations and climate indices of *Caryopteris mongholica* collection sites in this study

Collection sites	Latitude (°N)	Longitude (°E)	Altitude (m)	*MAP* (mm)	*MAT* (°C)	*GSP* (mm)	*GST* (°C)	*TCM* (°C)	*PE* (mm)
Abaga Banner, Nei Mongol	43.90	115.35	1,177	224.03	2.9	434.71	17.74	–19.85	588.04
Alxa Left Banner, Nei Mongol	38.88	105.72	1,670	162.54	9.90	315.52	21.05	–7.51	712.81
Dongwu Banner, Nei Mongol	45.73	116.79	1,017	200.72	2.46	415.46	17.76	–20.52	531.06
Mengxi, Nei Mongol	40.08	106.92	1,193	118.00	8.92	243.64	20.95	–9.58	702.17
Liangcheng, Nei Mongol	40.66	112.30	1,429	313.75	5.18	611.46	17.13	–13.17	580.80
Shenmu, Shaanxi	39.29	110.33	1,209	369.79	9.78	729.85	20.85	–7.64	706.91
Kangbao, Hebei	41.99	114.85	1,590	279.72	3.82	556.53	16.78	–15.22	544.06

Note: *MAP*, mean annual precipitation; *MAT*, mean annual temperature; *GSP*, growth season precipitation; *GST*, growth season temperature; *TCM*, temperature of coldest month; *PE*, potential evaporation.

3.3 Methods and Algorithm Principle

Conventional paraffin sectioning was used to analyze the leaf structures[15]. The leaf squares were fixed for more than 24 h and then dehydrated in a four-step gradient of 70%, 85%, 95%, and 100% alcohol. The covers were sealed to prevent water entering the air space, and xylene was used to increase the transparency of leaf material. The leaf squares were embedded in liquid paraffin (paraffin melting point = 56–57 °C). After the paraffin solidified, blocks were sliced into sections 8 to 10 μm thick. The sections were stained with safranin-fast green and mounted in neutral gum[16]. A Leica DM2500 microscope with Leica LAS AF software was used to observe and analyze the sections (Leica, Wezlar, Germany).

Figure 1 Leaf section cut for determination of anatomical structures

Image J software was used to measure the thickness of the cuticle, the upper and lower epidermal cells (*UEC*, *LEC*), the upper and lower palisade tissues(*UPT*, *LPT*), and the leaf thickness(*LT*). The tightness of the leaf and the total thickness of the palisade tissue(*PT*) were calculated[17]. For each index, the measurement was repeated five times.

Leaf anatomical indices:

$Tight = PT/LT \times 100\%$

$PT = UPT + LPT$

Plasticity indices of leaf anatomical structures:

Coefficient of variation = Standard deviation / Arithmetic mean

Plasticity index = (Maximum – Minimum) / Maximum

According to the longitude and latitude of the different *C. mongholica* collection sites, the monthly average climate data (2007–2016) of each sample site were obtained from the WorldCLIM global high-resolution climate database of ArcGIS 10.2 and used to calculate the climate indices. The climate indices included mean annual precipitation (*MAP*), growth season precipitation (*GSP*), annual range of precipitation (*ARP*), mean annual temperature (*MAT*), growth season temperature (*GST*), annual range of temperature (*ART*), and potential evaporation (*PE*).

3.4 Data Analysis

A multiple comparisons method was used to compare differences in the anatomical structures of *C. mongholica*. Pearson correlations were used to analyze the relations between leaf anatomical structures and environmental factors.

Combined with a general linear model (GLM) ANOVA to analyze the effects of collection-site climate on the anatomical structures[19]. Based on the correlations between collection-site environmental factors and leaf anatomical structures, *MAP*, *MAT*, *PE*, *Alt*, and Site were selected as environmental factors that were included in the model.

Data analyses were conducted in Excel and R 3.2.2.

3.5 Data Development Flowchart

The following steps were used to produce the dataset (Figure 2): *Caryopteris mongholica* was collected in seven different sites based on previous data collection and field investigations. The *C. mongholica* were planted in the nursery of Beijing Forestry University in a common garden experiment. After 18 months, samples were cut from *C. mongholica* leaves and fixed. Leaf anatomical structures were measured. Correlations were conducted between the anatomical structures themselves and between geographic environmental factors and anatomical structures. The GLM was used to verify the significant factors of influence. Thus, leaf anatomical structure and geographic environmental datasets of *C. mongholica* collected from seven sites were formed.

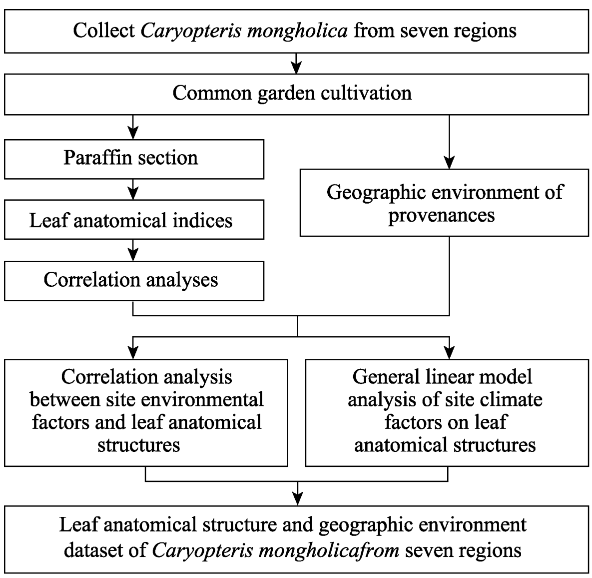

Figure 2 Technical flowchart of the analysis of leaf anatomical structures of *Caryopteris mongholica* and the environmental factors of influence

4 Data Results and Verification

4.1 Dataset composition

The dataset is composed of four files. The data files include geographical location data of the collection sites; 2007 to 2016 climate indices; leaf cross sections and parameters; and GLM analysis of regional climate factors and leaf anatomical structures. The dataset is stored in .shp, .kmz, .xls, .jpg, and .doc formats.

4.2 Data Results

Caryopteris mongholica from the seven collection sites had typical isolateral leaves, and the thickness of leaves was between 192.34 and 270.30 μm (Table 3). The internal structure of leaves was divided into the epidermis, mesophyll, and veins (Figure 3).

Table 3 Leaf anatomical indices of *Caryopteris mongholica*

Anatomical indices	Number of observations	Average	Standard deviation	95% Confidence interval of mean	Maximum	Minimum	Coefficient of variation	Plasticity index
Cuticle (μm)	70	6.87	1.66	6.05–7.70	11.92	5.07	0.24	0.57
UEC (μm)	70	18.53	5.37	15.86–21.20	26.46	9.87	0.29	0.63
LEC (μm)	70	11.14	2.32	9.99–12.30	17.64	8.74	0.21	0.50
UPT (μm)	70	106.35	17.94	97.43–115.27	146.64	89.24	0.17	0.39
LPT (μm)	70	76.17	13.44	69.48–82.85	109.42	59.57	0.18	0.46
PT (μm)	70	182.52	29.16	168.02–197.02	243.12	156.05	0.16	0.36
LT (μm)	70	220.02	25.71	207.24–232.80	270.30	192.34	0.12	0.29
Tight (%)	70	0.83	0.04	0.80–0.85	0.90	0.74	0.05	0.18

Note: *UEC*, upper epidermal cell; *LEC*, lower epidermal cell; *UPT*, upper palisade tissue; *LPT*, lower palisade tissue; *PT*, palisade tissue; *LT*, leaf thickness.

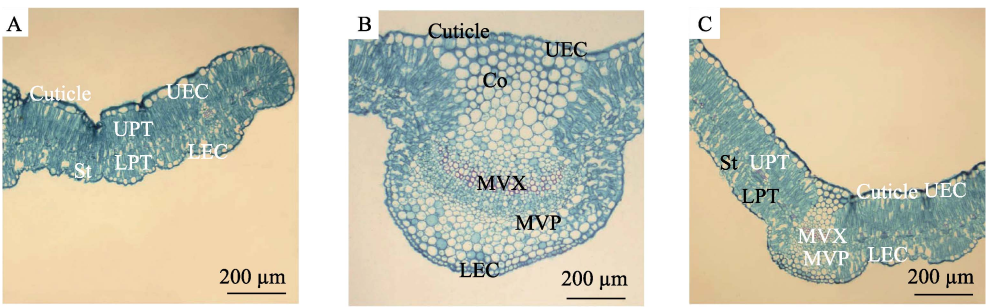

Figure 3 Leaf cross sections of *Caryopteris mongholica* (A. Mesophyll structure; B. Main vein structure; C. Mesophyll and main vein structure)

(Note: Co, collenchyma; LEC, lower epidermal cell; LPT, lower palisade tissue; MVP, main vein phloem; MVX, main vein xylem; St, stomatal chamber; UEC, upper epidermal cell; UPT, upper palisade tissue)

Most of the leaf anatomical structures were correlated with other structures, with *UPT*, *LPT*, *PT*, *LT*, and *Tight* highly significantly positively correlated with other structures ($P < 0.01$, Table 4).

4.3 Dataset Verification

Leaf anatomical structures were significantly correlated with one or more of geographical location (latitude, longitude), temperature, and precipitation (Table 5).

Longitude and latitude were highly significantly positively correlated with *UEC* but were significantly negatively correlated with *UPT*, *LPT*, *PT*, *LT*, and *Tight* ($P < 0.05$). On the geographical gradient, *UEC* gradually increased from west to east and south to north, whereas *UPT*, *LPT*, *PT*, *LT*, and *Tight* gradually decreased.

Table 4 Pearson coefficients of correlation between leaf anatomical structures of *Caryopteris mongholica*

Leaf characters	*Cuticle* (μm)	*UEC* (μm)	*LEC* (μm)	*UPT* (μm)	*LPT* (μm)	*PT* (μm)	*LT* (μm)	*Tight* (%)
Cuticle (μm)								
UEC (μm)	0.201							
LEC (μm)	0.590**	0.107						
UPT (μm)	–0.246	–0.355	–0.203					
LPT (μm)	–0.434	–0.545*	–0.436	0.721**				
PT (μm)	–0.351	–0.470*	–0.326	0.948**	0.904**			
LT (μm)	–0.260	–0.268	–0.259	0.945**	0.825**	0.962**		
Tight (%)	–0.432	–0.770*	–0.391	0.683**	0.806**	0.792**	0.595**	

*$P < 0.05$; **$P < 0.01$.

Note: *UEC*, upper epidermal cell; *LEC*, lower epidermal cell; *UPT*, upper palisade tissue; *LPT*, lower palisade tissue; *PT*, palisade tissue; *LT*, leaf thickness.

Leaf *UPT*, *LPT*, *PT*, *LT*, and *Tight* were all significantly positively correlated with *MAT* ($P < 0.05$), whereas *UEC* was significantly negatively correlated with *MAT* and *GST* ($P < 0.05$) and significantly positively correlated with *ART* ($P < 0.05$). As temperature increased, *UPT*, *LPT*, *PT*, *LT*, and *Tight* increased and *UEC* decreased.

The precipitation indices *MAP*, *GSP*, and *ARP* were only significantly negatively correlated with *UPT* ($P < 0.01$), *LT* ($P < 0.05$), and *PT* ($P < 0.05$).

Table 5 Pearson coefficients of correlation between environmental factors at collection sites and leaf anatomical structures of *Caryopteris mongholica*

Environmental factors	*Cuticle* (μm)	*UEC* (μm)	*LEC* (μm)	*UPT* (μm)	*LPT* (μm)	*PT* (μm)	*LT* (μm)	*Tight* (%)
Latitude (°N)	0.328	0.638**	0.451	–0.526*	–0.694**	–0.643**	–0.529*	–0.724**
Longitude (°E)	0.437	0.704**	0.366	–0.787**	–0.801**	–0.854**	–0.730**	–0.886**
Altitude (m)	–0.124	–0.034	–0.358	0.547*	0.579*	0.604**	0.690**	0.237
MAP (mm)	0.261	0.074	–0.103	–0.671**	–0.250	–0.528*	–0.555*	–0.307
GSP (mm)	0.244	0.085	–0.110	–0.689**	–0.269	–0.548*	–0.575*	–0.321
ARP (mm)	0.348	0.195	–0.064	–0.640**	–0.236	–0.503*	–0.495*	–0.365
MAT (°C)	–0.446	–0.803**	–0.421	0.534*	0.735**	0.668**	0.495*	0.860**
GST (°C)	–0.476*	–0.863*	–0.290	0.512*	0.672**	0.625**	0.424	0.880**
ART (°C)	0.338	0.503*	0.529*	–0.426	–0.626**	–0.551*	–0.465	–0.597**

*$P < 0.05$; **$P < 0.01$.

According to the ANOVA GLM analysis (Table 6), the genetic variation driven by the climate (temperature, precipitation, evapotranspiration) of the original collection sites had significant effects on leaf anatomical structures of *C. mongholica*, with between 34.09% and 81.43% of the variation explained. The variation explained for *LE*C was the smallest (34.09%), and that for *Tight* was the largest (81.43%). Among the climate indices of the collection sites, *MAT* had a significant effect on all eight leaf anatomical indices, with very highly significant effects on *UEC*, *LT*, *UPT*, *LPT*, *PT*, and *Tight* ($P < 0.001$) and between 21.69% and 71.89% of the variation explained. The *PE* significantly affected *UEC*, *LT*, *UPT*, *LPT*, and *PT* ($P < 0.05$), with between 5.48% and 14.34% of the variation explained. The *MAP* significantly affected *LT*, *UPT*, *LPT*, *PT*, and *Tight*, with between 4.78% and 45.93% of the variation explained. The *MAP* had very highly significant effects on *LT*, *UPT*, and *PT* ($P < 0.001$). The *Alt* had significant effects on *LT*, *UPT*, *LPT*, and *PT*, with between 8.33% and 16.76% of the variation explained.

Table 6 Summary of general linear models for the effects of climate variations (*MAP*, *MAT*, *PE*, *Alt*, Site) at different collection sites on leaf anatomical structures of *Caryopteris mongholica*

Climate factor	*Cuticle*						*UEC*					
	df	Sum Sq	Mean Sq	*F* value	%SS	Sig.	*df*	Sum Sq	Mean Sq	*F* value	%SS	Sig.
MAP	1	0.015	0.015	2.53	10.13	0.147	1	3×10^{-4}	3×10^{-4}	0.07	0.12	0.804
MAT	1	0.031	0.031	5.18	20.77	0.049*	1	0.204	0.204	34.84	65.82	2.3×10^{-4}***
PE	1	0.006	0.006	1.02	4.08	0.339	1	0.028	0.028	4.87	9.20	0.055*
Alt	1	0.004	0.004	0.68	2.74	0.430	1	2.783	2.783	4.76	0.00	0.999
Site	4	0.039	0.010	1.63	26.20	0.248	4	0.024	0.006	1.04	7.86	0.438
Residuals	9	0.054	0.006	NA	36.09	NA	9	0.053	0.006	NA	17	NA
Total	17	0.150			100		17	0.310			100	

Climate factor	*LEC*						*LT*					
	df	Sum Sq	Mean Sq	*F* value	%SS	Sig.	*df*	Sum Sq	Mean Sq	*F* value	%SS	Sig.
MAP	1	0.001	0.001	0.23	0.98	0.646	1	0.012	0.012	85.50	31.40	6.8×10^{-6}***
MAT	1	0.019	0.019	3.84	16.78	0.082*	1	0.009	0.009	59.05	21.69	3.0×10^{-5}***
PE	1	0.019	0.019	3.74	16.33	0.085	1	0.006	0.006	39.05	14.34	1.5×10^{-4}***
Alt	1	9×10^{-5}	9×10^{-5}	0.02	0.08	0.894	1	0.007	0.007	45.62	16.76	8.3×10^{-5}***
Site	4	0.031	0.008	1.52	26.52	0.276	4	0.005	0.001	8.51	12.50	0.004**
Residuals	9	0.045	0.005	NA	39.30	NA	9	0.001	1×10^{-4}	NA	3.31	NA
Total	17	0.115			100		17	0.040			100	

Climate factor	*UPT*						*LPT*					
	df	Sum Sq	Mean Sq	*F* value	%SS	Sig.	*df*	Sum Sq	Mean Sq	*F* value	%SS	Sig.
MAP	1	0.037	0.037	93.72	45.93	4.7×10^{-6}***	1	0.004	0.004	7.47	4.78	0.023*
MAT	1	0.020	0.020	50.18	24.59	5.8×10^{-5}***	1	0.048	0.048	90.20	57.74	5.5×10^{-6}***
PE	1	0.005	0.005	12.82	6.28	0.006**	1	0.005	0.005	8.56	5.48	0.017*
Alt	1	0.007	0.007	17.65	8.65	0.002**	1	0.007	0.007	13.01	8.33	0.006**
Site	4	0.008	0.002	5.17	10.13	0.019*	4	0.015	0.004	6.99	17.91	0.008**
Residuals	9	0.004	4×10^{-4}	NA	4.41	NA	9	0.005	5×10^{-4}	NA	5.76	NA
Total	17	0.081			100		17	0.084			100	

Climate factor	*PT*						*Tight*					
	df	Sum Sq	Mean Sq	*F* value	%SS	Sig.	*df*	Sum Sq	Mean Sq	*F* value	%SS	Sig.
MAP	1	0.019	0.019	208.39	27.38	1.6×10^{-7}***	1	8×10^{-4}	8×10^{-4}	6.81	8.93	0.028*
MAT	1	0.031	0.031	337.66	44.37	1.9×10^{-8}***	1	0.007	0.007	54.80	71.89	4.1×10^{-5}***
PE	1	0.005	0.005	51.63	6.78	5.2×10^{-5}***	1	6×10^{-5}	6×10^{-5}	0.46	0.61	0.514
Alt	1	0.007	0.007	73.49	9.66	1.3×10^{-5}***	1	1×10^{-5}	1×10^{-5}	0.09	0.12	0.772
Site	4	0.007	0.002	20.20	10.62	1.6×10^{-4}***	4	6×10^{-4}	2×10^{-4}	1.27	6.65	0.097*
Residuals	9	8×10^{-4}	9×10^{-5}	NA	1.18	NA	9	0.001	1×10^{-4}	NA	11.81	NA
Total	17	0.070			100		17	0.009			100	

Note: * $P < 0.05$; * $P < 0.01$; *** $P < 0.001$.

5 Discussion and Conclusion

Leaf anatomical structures of *C. mongholica* from seven collection sites from 2006 to 2017 in north and northwest China in daily were measured, and the significant environmental factors that caused differences in the structures were determined. A common garden experiment was used to minimize the influence of environmental gradients of the seven collection sites. Leaf anatomical structures were subject to multiple comparisons and correlation analyses, and a general linear model was used to identify the significant climate indices driving changes in leaf structure. The genetic variation driven by climate was one of the major factors that caused the differences in leaf anatomical structures from the different collection sites. This dataset shows local adaptation in leaf structures and therefore will help to understand the adaptation mechanisms of plants in different regions in responding to global change. In addition, the dataset can provide basic data for research on global change and germplasm resource protection.

Author Contributions

Liu, C., Xia, X. L., Yin, W. L., and Ji, R. X. were responsible for the overall design and development of the dataset. Yu, X., Chang, Y., Shen, C., Bai, X. Q., and Ji, R. X. collected plant materials. Ji, R. X. processed leaf-related data and performed data validation. Liu, C. designed the model and algorithm. Ji, R. X. wrote the data paper.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Smith, W. K., Vogelmann, T. C., DeLucia, E. H., *et al*. Leaf form and photosynthesis [J]. *BioScience*, 1997, 47: 785–793.

[2] Barboni, D., Harrison, S. P., Bartlein, P. J., *et al*. Relationships between plant traits and climate in the mediterranean region: a pollen data analysis [J]. *Journal of Vegetation Science*, 2004, 15: 635–646.

[3] Pigliucci, M. Phenotypic plasticity and evolution by genetic assimilation [J]. *Journal of Experimental Biology*, 2006, 209: 2362–2367.

[4] Hu, M. Y., Zhang, L., Luo, T. X., Shen, W. Variations in leaf functional traits of *Stipa purpurea* along a rainfall gradient in Xizang, China [J]. *Chinese Journal of Plant Ecology*, 2012, 36: 136–143.

[5] Wright, I. J., Reich, P. B., Westoby, M. Strategy shifts in leaf physiology, structure and nutrient content between species of high- and low-rainfall and high- and low-nutrient habitats [J]. *Functional Ecology*, 2001, 15: 423–434.

[6] Chartzoulakis, K., Patakas, A., Kofidis, G., *et al*. Water stress affects leaf anatomy, gas exchange, water relations and growth of two avocado cultivars [J]. *Scientia Horticulturae*, 2002, 95: 39–50.

[7] Zhong, Y. M., Dong, F. Y., Wang, W. J., *et al*. Anatomical characteristics and adaptability plasticity of *Populus euphratica* in different habitats [J]. *Journal of Beijing Forestry University*, 2017, 39: 53–61.

[8] Yu, H. Y., Hu, X. Y., He, C. X., *et al*. Differential response of water stress on leaf morphological anatomical structures of varied provenances *Xanthocera sorbifolium* [J]. *Journal of Beijing Forestry University*, 2019, 41(1): 57–63.

[9] Wang, X. Q., Wang, C. K., Han, Y. Effects of tree species on soil organic carbon density: a common garden experiment of five temperate tree species [J]. *Chinese Journal of Plant Ecology*, 2015, 39: 1033–1043.

[10] Chen, J. J., Yu, H., Xu, C. B., *et al*. Effects of provenance and common garden environment on leaf functional traits of *Machilus pauhoi* seedlings [J]. *Chinese Journal of Applied and Environmental Biology*, 2019, 25: 648–654.

[11] de Villemereuil, P., Gaggiotti, O. E., Mouterde, M., *et al*. Common garden experiments in the genomic era: New perspectives and opportunities [J]. *Heredity*, 2016, 116: 249–254.

[12] Ji, R. X., Yu, X., Chang Y., *et al*. Leaf anatomical structure and geographic environment data of *Caryopteris Mongholica* from 7 provenances [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2021. https://doi.org/10.3974/geodb.2021.01.03.V1.

[13] Ji, R. X., Yu, X., Chang Y., *et al*. Geographical provenance variation of leaf anatomical structure of Caryopteris mongholica and its significance in response to environmental changes [J]. *Chinese Journal of Plant Ecology*, 2020, 44: 277-286.

[14] GCdataPR Editorial Office. GCdataPR Data Sharing Policy [OL]. https://doi.org/10.3974/dp.policy.2014.05 (Updated 2017)

[15] Feng, Y. Q., Qin, L., Ma, H. P. The discussion on efficiency and quality of paraffin section in plant microscopy technique course [J]. *Experimental Technology and Management*, 2008, 25: 160–162.

[16] de Lima Silva, A., da Silva Alves, M. V., Coan, A. I. Importance of anatomical leaf features for characterization of three species of Mapania (*Mapanioideae*, *Cyperaceae*) from the Amazon Forest, Brazil [J]. *Acta Amazonica*, 2014, 44: 447–456.

[17] Li, F. L., Bao, W. K. Responses of the morphological and anatomical structure of the plant leaf to environmental change [J]. *Chinese Bulletin of Botany*, 2005, 22: 118–127.

[18] Hijmans, R. J., Cameron, S. E., Parra, J. L., *et al*. Very high resolution interpolated climate surfaces for global land areas [J]. *International Journal of Climatology*, 2005, 25: 1965–1978.

[19] He, J. S., Wang, X. P., Flynn, D. F. B., *et al*. Taxonomic, phylogenetic, and environmental trade-offs between leaf productivity and persistence [J]. *Ecology*, 2009, 90: 2779–2791.

[20] Delzon, S. New insight into leaf drought tolerance [J]. *Functional Ecology*, 2015, 29: 1247–1249.