

# Plant Diversity of Maoershan National Forest Park

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**Abstract** There are a wide variety of wild plants in Maoershan National Forest Park. According to a five-year survey, the plants are found to include 557 species belonging to 116 families and 335 genera. There are 10 dominant families, such as Asteraceae, Ranunculaceae, Rosaceae, Fabaceae, and Chenopodiaceae, including 251 species, accounting for 46.06% of the total. There are 9 dominant genera, such as *Polygonum*, *Potentilla*, *Viola*, *Artemisia*, and *Corydalis*, which include 82 species of plants, accounting for 14.72% of the total. This study statistically analyzed the diversity and function of plants in the park and classified useful plants to provide a basis for the conservation and development of plant resources in Maoershan National Forest Park.

**Keywords** Plant resources, Species diversity, Evaluation, Maoershan National Forest Park

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Maoershan National Forest Park (hereinafter referred to as Maoershan) has a variety of habitats and plant resources. There are many kinds of wild plants that are widely distributed. For Heilongjiang Province and even northeast China, the park is considered an important base for collecting, domesticating, and cultivating high-quality plant resources and for providing internship opportunities for college students in agricultural and forestry colleges and research institutes. From 2013 to 2018, researchers conducted an in-depth investigation and analysis on the current situation, habitat, and function of plant resources in Maoershan in accordance with the principles of respecting facts, adhering to standards, systematic investigation, highlighting characteristics, and serving localities.

## 1 Overview of the study area

Maoershan (45°20'–45°25' N, 127°30'–127°34' E) is located at the westernmost end of Shangzhi, Heilongjiang. Belonging to the Changbai Mountains, it stretches 30 km from north to south and 20 km from east to west, with an area of 26,507 hm<sup>2</sup>. The average altitude reaches 300 m, and the highest mountain is Maoershan (805 m above sea level). Because of its majesty, tall and straightness, Maoershan becomes one of the scenic areas in Heilongjiang Province.

Dominated by the continental monsoon climate, Maoershan has four distinct seasons. Springs are dry, with strong winds and less rainfall. Summers are hot and humid, with weak winds and heavy rain. Autumns are high

in temperature and strong in winds. Winters are long, cold, and dry. The annual average temperature is 2.80 °C, the annual accumulated temperature is 2495.74 °C (for temperature >10 °C), the annual average precipitation is 737.12 mm, the annual average frost-free period is 120–140 d, and the annual sunshine hours are 2,471.3 h. In terms of soil distribution, Maoershan is mainly covered by typical dark brown soil, followed by meadow dark brown soil. There are also lessive soil, meadow soil, swamp soil, etc. The vegetation is mainly composed of the *Pinus koraiensis*-broadleaf mingled forest, shrubs, meadows, swamps, aquatic vegetation, and rock vegetation<sup>[1]</sup>.

## 2 Research methods

### 2.1 Sample selection

Based on the ecological conditions, vegetation characteristics, and natural environment of Maoershan, a field survey was conducted from April 2013 to October 2018 using a typical sample method. Through the field survey, 9 neat, representative sample plots were selected, each with an area of 5 hm<sup>2</sup>. In each sample plot, 9 large quadrats were selected, totaling 81 sample plots, each of which is 20 m × 20 m, and all the trees and shrubs in these areas were surveyed. In each large quadrat, four 1 m × 1 m quadrats were set up, and herb species in each quadrat were investigated.

### 2.2 Resource survey

In the field survey, the size, elevation, slope direction, slope, photo, and photo number of sample plots were investigated, and the name,

number, coverage, and abundance of plant species in the arbor layer, the shrub layer, and the herb layer. The survey focused on the study of plant resources and their diversity. Based on a large number of original data and references, the plant resources and their diversity of Maoershan were evaluated and analyzed.

## 3 Results and analysis

### 3.1 The diversity of plants in Maoershan

According to the field survey results, there are 557 species of 335 genera in 116 families of common plants in Maoershan, including 2 species of the Bryophyte in 2 families and 2 genera, 20 species of the Pteridophyta in 11 families and 14 genera, 8 species of the Gymnospermae in 1 family and 5 genera, 457 species of the Angiospermae (Dicotyledoneae) in 83 families and 264 genera, and 70 species of the Angiospermae (Monocotyledoneae) in 19 families and 51 genera (Table 1). They accounts for around 40% of the plants in Heilongjiang Province<sup>[2-3]</sup>.

### 3.2 The diversity of the family, genus and species of plants in Maoershan

A total of 10 dominant families (including Asteraceae, Ranunculaceae, Rosaceae, Fabaceae, Chenopodiaceae, Labiatae, Liliaceae, Caryophyllaceae, Gramineae, and Cruciferae), which are divided into 251 species, are discovered, accounting for 45.06% of the total. There are 9 dominant genera (including *Polygonum*, *Potentilla*, *Viola*, *Artemisia*, *Corydalis*, *Ranunculus*, *Salix*, *Anemone*, and *Senecio*), which cover 82 species, accounting for 14.72% of the total

number of plants in this area. It was found that there were 46 single-species families, accounting for 8.35% of the total. The results showed that plants in Maoershan were mainly concentrated on several dominant families and genera, and dispersed in single-species families and single-species genera (Table 2).

The statistical results of species contained in various genera of plants in Maoershan are shown in Table 3.

According to the statistics of the plants growing in Maoershan, single-species genera have obvious superiority. There were 231 single-species genera in 335 genera, making up 68.96% of the total genera and 41.47% of the total species. A total of 95 genera (28.36% of the total genera) and 45.24% of the total species

were found to be few-species genera, containing 2–5 species. There were 8 middle-scaled genera, containing 6–10 species, accounting for 2.39% of the total genera and 10.23% of the total species. Only 1 extra large-scaled genus was discovered in the study area, including 11–20 species, constituting 0.30% of the total genera and 3.05% of the total species.

### 3.3 The diversity of plant functions in Maoershan

Maoershan is rich for plant resources, which are full of utilization value. Through years of investigation, statistics analysis and referring to retrieval reference books<sup>[4-6]</sup>, we classified plants in Maoershan according to their value and uses. There were 16 classes, including the oil plant, the starch sugar plant, the aromatic oil plant, the

fiber plant, the medicinal plants, the feed plant, the nectariferous plant, the wild vegetable plant, the wood plant, the green pesticides plant, the green manure plant and the ornamental and landscaping plant, etc (Table 4).

As shown in Table 4, medicinal plants are the most plants in Maoershan, accounting for 73.25% of the total, followed by ornamental and landscaping plants (20.11%), wild vegetable plants (19.03%), and nectariferous plants (17.59%). There were also some feed plants, oil plants, wood plants, and other plants with certain functions.

### 4 Development and utilization of plant resources in Maoershan

If properly developed and utilized, plant resources are renewable green resources that can be recycled<sup>[7]</sup>. According to the *Pharmacopoeia*

**Table 1 Statistics of plant resources in Maoershan**

Plant group	Number of family	Number of genus	Number of species
Bryophyta	2	2	2
Pteridophyta	11	14	20
Gymnospermae	1	4	8
Angiospermae (Dicotyledoneae)	83	264	457
Angiospermae (Monocotyledoneae)	19	51	70
Total	116	335	557

**Table 2 Statistics of species in different families in Maoershan**

Family type	Number of family	Ratio to the total families/%	Example	Number of species	Ratio to the total species/%
Regional single-species family (1 species)	46	39.66	Marchantiaceae (1), Osmundaceae (1), Adiantaceae (1), Schisandraceae (1), Menispermaceae (1), Juglandaceae (1), Fagaceae (1), Lythraceae (1), Vi-taceae (1), Polemoniaceae (1), Phrymaceae (1), Sparganiaceae (1), Dioscoreaceae (1), Smilacaceae (1), etc.	46	8.26
Regional few-species family (2–5 species)	43	37.07	Equisetaceae (5), Urticaceae (5), Aceraceae (5), Iridaceae (5), Ulmaceae (4), Crassulaceae (4), Rhamnaceae (4), Celastraceae (4), Cucurbitaceae (3), Papaveraceae (3), Aselepiadaceae (3), Alismataceae (3), Orchidaceae (3), Aceraceae (2), Rutaceae (2), Typhaceae (2), etc.	134	24.06
Regional middle-scaled families (6–10 species)	17	14.66	Pinaceae (8), Fumariaceae (7), Betuiaceae (7), Chenopodiaceae (7), Violaceae (8), Salicaceae (10), Primulaceae (7), Saxifragaceae (7), Onagraceae (6), Umbelliferae (10), Convolvulaceae (6), Scrophulariaceae (8), Campanulaceae (8), Rubiaceae (6), Caprifoliaceae (9), Cyperaceae (6), etc.	126	22.62
Regional extra large-scaled families (11–20 species)	5	4.31	Caryophyllaceae (17), Cruciferae (13), Labiatae (18), Gramineae (16), and Liliaceae (19)	83	14.90
Regional large-scaled family (more than 20 species)	5	4.31	Ranunculaceae (34), Chenopodiaceae (21), Rosaceae (30), Asteraceae (62), and Fabaceae (21)	168	30.16

**Table 3 Statistics of species in different genera in Maoershan**

Genera type	Number of genus	Ratio to the total genera/%	Example	Number of species	Ratio to the total species/%
Single-species genus (1 species)	231	68.96	<i>Hylomecon</i> (1), <i>Delphinium</i> (1), <i>Chelidonium</i> (1), <i>Actinostemma</i> (1), <i>Menispermum</i> (1), <i>Metaplexis</i> (1), <i>Vitis</i> (1), <i>Xanthoceras</i> (1), <i>Dictamnus</i> (1), <i>Phellodendron</i> (1), <i>Nymphoides</i> (1), <i>Ipomopsis</i> (1), <i>Alisma</i> (1), <i>Dioscorea</i> (1), <i>Convallaria</i> (1), etc.	231	41.47
Regional few-species genus (2–5 species)	95	28.36	<i>Chenopodium</i> (5), <i>Lathyrus</i> (5), <i>Acer</i> (5), <i>Lonicera</i> (5), <i>Iris</i> (5), <i>Thalictrum</i> (5), <i>Betula</i> (4), <i>Ribes</i> (4), <i>Chrysosplenium</i> (4), <i>Rhamnus</i> (4), <i>Lily</i> (4), <i>Trollius</i> (3), <i>Calystegia</i> (3), <i>Scutellaria</i> (3), <i>Androsace</i> (2), <i>Campanula</i> (2), <i>Bupleurum</i> (2), etc.	252	45.24
Regional middle-scaled genus (6–10 species)	8	2.39	<i>Potentilla</i> (8), <i>Corydalis</i> (7), <i>Viola</i> (8), <i>Ranunculus</i> (6), <i>Anemone</i> (6), <i>Salix</i> (8), <i>Senecio</i> (6), and <i>Artemisia</i> (8)	57	10.23
Regional extra large-scaled genus (11–20 species)	1	0.30	<i>Polygonum</i> (17)	17	3.05

**Table 4 Statistics of classification by function of plants in Maershan**

No.	Plant type	Number of plants	Ratio to the total plants/%
1	Oil plant	52	9.34
2	Starch sugar plant	41	7.36
3	Aromatic oil plant	25	4.49
4	Fiber plant	35	6.28
5	Dye plant	7	1.26
6	Tanning plant	9	1.62
7	Spice plant	6	1.08
8	Medicinal plant	408	73.25
9	Nectariferous plant	98	17.59
10	Wild vegetable plant	112	20.11
11	Wood plant	32	5.75
12	Feed plant	96	17.24
13	Wine-making plant	13	2.33
14	Green pesticides plant	31	5.57
15	Green manure plant	19	3.41
16	Ornamental and landscaping plant	106	19.03

of the People's Republic of China<sup>[8]</sup>, the resources that can be developed and utilized in Maershan mainly include ornamental and landscaping plants, nectariferous plants, medicinal plants, and wild vegetable plants.

#### 4.1 Ornamental and landscaping plants

Ornamental and landscaping plants can beautify and green the environment. Such plants are planted to enjoy flowers, fruits, leaves or a unique style. They are appreciated because of their outstanding ornamental value. Ornamental and landscaping plants have fresh and beautiful appearances, unique colors or unique shapes. There are 72 species can be developed, including *Adiantum pedatum* L., *Matteuccia struthiopteris* L., *Aquilegia oxysepala* Tr., *Pulsatilla chinensis* Bge., *Delphinium grandiflorum* L., *Hylomecon japonica* Thunb., *Chelidonium majus* L., *Viola collina* Bess, *Viola yedoensis* Makino, *Rollius macropetalus* Fr., *Juglans mandshurica* Maxim., *Quercus mongolica* Fisch., *Betula platyphylla* Suk., *Betula costata* Trautv., *Ulmus laciniata* Mayr., *Alnus sibirica* Fisch., *Lychnis fulgens* Fisch., *Paeonia lactiflora* Pall., *Hypericum ascyron* L., *Tilia mandshurica* Rupr., *Tilia amurensis* Rupr., *Rhododendron dauricum* L., *Pyrola rotundifolia* L., *Lysimachia thyrsoflora* L., *Primula patens* Turcz., *Philadelphus schrenkii* Rupr., *Potentilla fragarioides* L., *Prinsepia sinensis* Oliv., *Micromles alnifolia* Koehne, *Sorbus pohuashanensis* Hedl., *Spiraea ussuriensis* A., *Spiraea salicifolia* L., *Lythrum Salicaria* L., *Lespedeza bicolor* Turcz., *Chamaenerion angustifolium* Scop., *Oenothera odorata* Jacq., *Xanthoceras sorbifolia* Bunge, *Acer ginnala* Maxim., *Acer mono* Maxim., *Acer mandshuricum* Maxim., *Trifolium lupinaster* L., *Calystegia sepium* Br., *Thymus dahuricus* Serg.,

*Stachys chinensis* Bunge., *Sagittaria trifolia* L., *Typha latifolia* L., *Lilium distichum* Nakai, *Iris laevigata* Fisch., *Platanthera cholorantha* Cust, etc.

#### 4.2 Nectariferous plants

Nectariferous plants are plants for bees to collect nectar and pollen. These plants have certain ornamental value. There are 78 species can be developed, including *Chelidonium majus* L., *Juglans mandshurica* Maxim., *Tilia mandshurica* Rupr., *Tilia amurensis* Rupr., *Draba nemorosa* L., *Rhododendron dauricum* L., *Padus asiatica* Kom., *Padus maackii* Rupr., *Rubus crataegifolius* Bunge, *Prunus mandshurica* Maxim., *Vitis amurensis* Rup., *Eleutherococcus senticosus* Maxim., *Liparis japonica* Miq., *Berberis amurensis* Rupr., *Caulophyllum robustum* Maxim., *Hylomecon japonica* Thunb., *Ulmus japonica* Sarg., *Ulmus macrocarpa* Hance, *Betula platyphylla* Suk., *Quercus mongolica* Fisch., *Paeonia lactiflora* Pall., *Actinidia kolomikta* Maxim., *Salix raddeana* Laksch., *Deutzia amurensis* Regel, *Filipendula palmate* Pall., *Fragaria orientalis* Lozink., *Malus pallasiana* Jusepczuk, *Pyrus ussuriensis* Maxim., *Rosa davurica* Pall., *Sanguisorba grandiflora* Maxim., *Sorbaria sorbifolia* A., *Lespedeza bicolor* Turcz., *Maackia amurensis* Rupr., *Chamaenerion angustifolium* Scop., *Oenothera odorata* Jacq., *Acer mono* Maxim., *Acer mandshuricum* Maxim., *Trifolium lupinaster* L., *Geranium sibiricum* L., *Aralia mandshurica* Rupr, etc.

#### 4.3 Medicinal plants

There are many kinds of medicinal plants, which are widely distributed. There are 102 species can be developed, including *Selaginella tamariscina* Spring, *Adonis amurensis* Regel, *Chelidonium majus* L., *Trollius macropetalus* Fr.,

*Caulophyllum robustum* Maxim., *Menispermum dauricum* DC., *Papaver nudicaule* L., *Hylomecon japonica* Thunb., *Rhododendron dauricum* L., *Lysimachia davurica* Ledeb., *Agrimonia pilosa* Ledeb., *Sanguisorba grandiflora* Makino, *Viscum coloratum* Nakai, *Paeonia lactiflora* Pall., *Euphorbia humifusa* Willd., *Phellodendron amurense* Rupr., *Dictamnus dasycarpus* Turcz., *Impatiens noli-tangere* L., *Eleutherococcus senticosus* Maxim., *Aralia mandshurica* Rupr., *Bupleurum scorzoniferifolium* Willd., *Heracleum barbatum* Ledeb., *Angelica dahurica* Benth., *Gentiana triflora* Pall., *Metaplexis japonica* Makino, *Cynanchum atratum* Bunge, *Physalis alkekengi* L., *Solanum nigrum* L., *Plantago asiatica* L., *Cuscuta chinensis* Lam., *Glechoma longituba* Kupr., *Leonurus artemisia* Lour., *Lagopsia supins* Steph., *Scutellaria regeliana* Nakai., *Agastache rugosa* Fisch., *Campanula punctata* Lam., *Codonopsis pilosula* Nannf., *Platycodon grandiflorum* DC., *Xanthium sibiricum* Patr., *Synurus deltoides* Nakai., *Cirsium segetum* Bunge, *Artemisia annua* L., *Atractylis chinensis* DC., *Leontopodium leontopodioides* Beauv., *Alisma plantago-aquatica* L., *Sagittaria trifolia* L., *Convallaria majalis* L., *Fritillaria ussuriensis* Maxim., *Paris verticillata* M.-Bieb., *Polygonatum odoratum* Druce, *Smilacina japonica* A., *Dioscorea nipponica* Makino, etc.

#### 4.4 Wild vegetable plants

Due to the absence of chemical agents and pesticides, wild vegetable plants are harmless to the body, and they contain a large number of organic elements, and so wild vegetable plants have dual functions of nutrition and health care. There are 77 species can be developed, including *Osmunda cinnamomea* L., *Pteridium aquilinum* L., *Matteuccia struthiopteris* L., *Thalictrum simplex* L., *Urtica angustifolia* Fisch., *Chenopodium glaucum* L., *Chenopodium album* L., *Kochia scoparia* L., *Salsola collina* L., *Amaranthus retroflexus* L., *Portulaca oleracea* L., *Uglans mandshurica* Maxim., *Corylus heterophylla* Fisch., *Actinidia arguta* Planch., *Fagopyrum tataricum* L., *Polygonum aviculare* L., *Capsella bursa-pastoris* L., *Cardamine leucantha* Tausch, *Rorippa palustris* Leyss., *Rubus crataegifolius* Bunge, *Crataegus pinnatifida* Bunge, *Fragaria orientalis* Lozink., *Prunus mandshurica* Maxim., *Pyrus ussuriensis* Maxim., *Sanguisorba grandiflora* Maxim., *Lythrum Salicaria* L., *Trapa japonica* Fler, *Eleutherococcus senticosus* Maxim., *Aralia mandshurica* Rupr., *Heracleum barbatum* Ledeb., *Oenanthe javanica* DC., *Lycopus uniflorus* Michx., *Codonopsis pilosula*

(To be continued in P115)

(2) In terms of the daily average relative humidity, the inner and outer forests and the square ranked as follows: square < outer forest < inner forest. The average daily relative humidity of the square, the outer forest, and the inner forest was 68.57, 84.91, and 88.27%. The daily variation range of relative humidity of the inner forest was 81.03–93.57%, the daily variation range of relative humidity of the outer forest was 75.15–90.21%, and the daily variation range of relative humidity of the square was 56.12–82.76%.

(3) In terms of the daily average wind speed, the inner and outer forests and the square ranked as follows: square > outer forest > inner forest. Their daily variation ranges were 0–0.75 m/s, 0.18–0.43 m/s, and 0.12–0.31 m/s. The wind speed in the inner forest was 35.41% lower than that in the outer forest and 54.21% lower than in the square, and the wind speed in the outer forest was 27.21% than in the square.

(4) In terms of the daily average illumination intensity, the inner and outer forests and the square ranked as follows: square > outer forest > inner forest. Specifically, the inner forest had an average daily illumination intensity of 1,371.68 lux and a variation range of 95.61–6,768.12 lux, the outer forest had an average daily illumination intensity of 4,582.01 lux and a variation range of 432.11–6128.22 lux, and the square had an average daily illumination intensity of 17,641.63 lux and a variation range of 463.21–34,957 lux.

The above research results showed that the *Fokienia hodginsii* forest in summer played a great role in cooling and humidifying and alleviating the effect of urban heat island. Although the outer forest was not as effective as the inner forest in regulating the microclimate, it still played a role in regulating the microclimate

compared with the bare open space without trees, because it is close to trees and the physiological effects of trees will affect the surrounding environment more or less<sup>[12-13]</sup>. It can be seen that in urban areas, especially in the hot summer, constructing green squares with reasonable plant configuration and reducing the building and population density is an effective means to improve the urban ecological environment and alleviate the urban heat island effect. Therefore, on the basis of not affecting the tourist activity space, it is suggested to appropriately increase the amount of green spaces, lay lawns, and match the reasonable plant configuration, which will positively promote the comfort of tourists and improve the health of the human body.

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(Continued from P111)

Nannf., *Lonicera caerulea* L., *Sagittaria trifolia* L., *Typha latifolia* L., *Lilium dahuricum* Ker-Gawl, *Hemerocallis minor* Mill., *Lilium tenuifolium* Fisch, etc.

Maershan National Forest Park is rich in plant resources with various functions. The development and utilization of plant resources should be based on geographical features and resource distribution. It is recommended to select excellent germplasm for intensive and regional production. The key is to develop ornamental plant resources with local characteristics to promote the development of forest economy. It is necessary to strengthen the propaganda of

wild plant protection and utilization, establish breeding bases, strengthen technical training, and carry out innovative research.

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