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ARTICLE

Study on the mycorrhizal structure of common plants and rhizosphere AMF diversity of different plant communities in Central Province, Mongolia

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Abstract: With the dual destruction cased by man-made activities and natural causes, the biodiversity and ecosystem function of the prairie are reducing rapidly, which are manifest in such phenomenon as grassland desertification, sharp reduction in wetland, soil quality degradation, erosion of soil by wind, rain and watersheds. This condition restricts the development level of Mongolia's financial status and production forces, and so the protection and utilization of biodiversity resources are extremely important and harbor no delay. Arbuscular mycorrhizal fungi (AMF) has a broad distribution and species diversity, it also has very important functions of maintaining material circulation in ecosystems, improving ecosystem productivity, and ensuring ecological restoration. We selected different plant communities and the common plants in the Tuv aimag (Central province) of Mongolia to study the correlation between species diversity, genetic diversity and AM fungi distribution with physical and chemical properties of soil.

Keywords: *Central province; AM fungi; mycorrhizal structure; biodiversity;*

INTRODUCTION

Plants live surrounded by a thriving microbial community, interact with various fungi, bacteria and other microorganisms, with both beneficial and inhibitory effects. In 1885, German plant physiologist and forest scientist Frank, for the first time discovered in his research that some fungal hyphae normally symbiotically combine with tree roots, and named the symbiosis between fungi and tree roots as "mycorrhizae" [1-3] as observed by him. The main function of mycorrhizae is to expand the absorption area of plant roots and increase the absorption capacity of elements (especially phosphorus) outside the absorption range of the original root hair. The mycelium of mycorrhizal fungi not only expands to the soil around the root, but also communicates with the host plant tissue. On the one hand, it absorbs organic matter from the host plant as the nutrients needed for its own survival, and on the other hand, it absorbs nutrients and water from the soil to supply plants, forming a mutually beneficial relationship. Among them, arbuscular mycorrhiza fungi (AMF) are a kind of very important soil microorganisms, which can form mutualistic symbionts-mycorrhizae with 80% of plant roots [4-7].

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Arbuscular mycorrhizal fungi infect plant roots, first forming attachment vesicles and intrusion point structures, and then infecting hyphae into roots and expanding into intercellular and intracellular hyphae. Some of the hyphae in the root are connected with the fungal structure outside the root, and the other part swells at the top to form vesicles or and the hyphae grow bifurcated to form arbuscular structures [8]. Study shows that AM fungi can form arbuscules with different morphological structures, including *Arum*-type (A type), Intermediate-type (I type) and *Paris*-type (P type).

The classification of AM fungi has roughly gone through four stages of evolution from Endogone, established by Link in 1809, to Glomeromycota. Due to the application of molecular biology, biochemical analysis and multimedia methods in the field of mycorrhizal research, the classification system of AM fungi made a breakthrough in the past decade. In 2011, Oehl *et al* [9] integrated the morphological characteristics and molecular sequence characteristics of AM fungi, adjusted the AM fungi classification system, and formed an AMF classification system including 3 classes, 5 orders, 14 families and 26 genera. Redecker *et al* [10] revised the AMF classification system in 2013, cancelling the Entrophosporaceae *family*, adding the Sacculosporaceae family, adding Septoglomus under Glomeraceae, adding Cetraspora, Intraornatospora, Dentiscutata and Paradentiscutata under Gigasporaceae, adding Tricispora and Corymbiglomus under Diversisporaceae.

Phosphorus is one of the indispensable mineral nutrients in the process of plant growth and development, and an essential component of *important organic compounds in plants*. Many studies report that AM fungi improves plant growth, mineral nutrient and soil water. Myccorhiza improving plant acquisition of P from soil is an obvious alternative to the management of those low P soils and increases plant biomass [11]. The study found that different AM strains can promote the growth and phosphorus nutrient absorption of maize (Zea mays) for acidic soil conditions, and the effect of *G. rhizogenes* is the most obvious.

In recent years, scholars have studied the resistance mechanism of mycorrhizal plants to abiotic stresses in different depth, such as drought, salinity and environmental pollution [12,13,14,15]. Although AMF is widely distributed in the ecosystem, no more than 250 species are described in the data investigated by scholars, which obviously underestimates the overall biodiversity of AMF [16]. In fact, our understanding of AMF species diversity depends largely on the development of research methods and application of new technologies. Identification by morphological and molecular biology methods, such as denaturing gradient gel electrophoresis, restriction fragment length polymorphism, cloning and sequencing, pyrosequencing, etc. In many studies, *Funneliformis mosseae, Claroideoglomus claroideum and Claroideoglomus etunicatum* and other AMFs are the main species that are ubiquitous. The diversity of AM fungi varies widely, and their distribution is affected by a variety of factors, including soil, host plants, environmental conditions, and agricultural practices.

MATERIALS AND METHODS

Sample plots were set up in Ulaanbaatar's Gatsuurt District, Bayanchandmani Soum in Central Province, Ulaanbaatar Bayanzurh District, Mungunmorit Soum in Central Province and other areas (N $47^0$90'97"-N $48^0$23'50", E $106^0$11'49"- E $108^0$27'26").

The soil materials used in this study are layered soil with a soil depth of 0-30 cm in five plots and rhizosphere soil of common plants, each 10 cm is a layer, a total of 3 layers (in the text, 0-10 cm, 10-20 cm, 20-30 cm expression), used for physical and chemical properties determination of soil, soil enzyme determination, soil AM fungal spore isolation and identification and microbial investigation. Each plot was randomly selected, and the soil sample was about 2-3 kg.

Table-1 Basic information of sampling sites

№	Sampling sites	latitude	longitude
1	Gatsuurt district of Ulaanbaatar city (wetlands)	N 48000'02"	E 107001'32"
2	Bayanchandmani soum of Central province-mountain slope)	N 48023'50"	E 106011'49"
3	Bayanzurh district of Ulaanbaatar(-Botanical garden)	N 47090'97"	E 106099'97"
	Mungunmorit soum of Central province (wetlands)	N 48011'14"	E 108026'47"
4	Mungunmorit soum of Central province (mountain slope)	N 48011'26"	E 108027'24"
	Mungunmorit soum of Central province(larch forest edge)	N 48011'28"	E 108027'26"
	Gatsuurt district of Ulaanbaatar city (wetlands)	N 48000'37"	E 107013'09"
5	Gatsuurt district of Ulaanbaatar city (mountain slope)	N 48000'39"	E 107013'01"
	Gatsuurt district of Ulaanbaatar city (larch forest edge)	N 48000'24"	E 107013'12"

A total of 69 common plant root samples from 24 families were collected from the study area, and the plant species, sampling time and location were recorded, and the roots were protected. They were placed in a sealed bag together with the rhizosphere soil for the determination of AM fungal infection rate.

AMF staining was performed by using the method of Vierheilig H *et al.* [17], and the mycorrhizal infection rate was calculated by the grid intersection method of Mcgonigle T P *et al.* [18]. 50 root segments were randomly selected from each sample, and their infection was examined under a compound microscope. The hyphae, vesicles, arbuscules and their different combinations on the vertical cross line in each field of view are recorded as 1 intersection point. Count the number of crossovers equal to 1, denoted as m, and the total number of intersection points is counted as n. Infection rate = m/n×100%.

The picked spores were mounted with lactic acid, PVLG (containing 100 g of chloral hydrate, 5 g of potassium iodide, 1.5 g of iodine, and 100 mL of ddH2O), Mount the slides with PVLG+Melzer's reagent, and then observed and pictures taken under the Leica DM5500B and imaging system after drying. The identification of AM fungi species is mainly based on the classification system proposed by Redecker *et al.* (2013) and the International Arbuscular Mycorrhizal Fungi Collection（INVAM : http://invam.wvu.edu/ and http://www.amf-phylogeny.com/, including morphological descriptions of various species of AM fungi, as well as relevant literature and data on new species published in recent years [18].

Soil AM fungal spore extraction: Separation of AM fungal spores from soil samples by wet sieve pour-sucrose density gradient centrifugation [19-21]. Spore identification: The AM fungal spores were aspirated under the 10× field of view of a Leica EZ4HD optical dissecting microscope (Leica, Germany) by transillumination, Count the number of spores of different colors, sizes and shapes, and combined with the observation of the spore structure after the preparation, the species and the number of different species were determined, which is used to count the spore density. Statistical analysis: The experimental data were analyzed using Excel 2010 and SPSS Statistic 20.0. Before the analysis of variance, a homogeneity test needs to be performed, and the significance is set to $P<0.05$, and then a one-way analysis of variance is performed, and then multiple comparisons between means are performed, and finally a correlation analysis is performed.

Vol. 62 No 04 (244) 2022
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RESULTS AND DISCUSSION

Distribution of Mycorrhizal plants and Families in the Central provinces of Mongolia

A total of 68 species of common plants were collected in this study (including 14 species of Compositae, 2 species of Liliaceae, 10 species of Poaceae, 2 species of Caryophyllaceae, 5 species of Leguminosae, 5 species of Cyperaceae, 6 species of Rosaceae, and 5 species of Ranunculaceae. species, 2 species of Umbelliferae, 2 species of Primrose family, 2 species of Scrophulariaceae, 2 species of Scrophulariaceae, 1 species each of Verbeaceae, Cruciferae, Lamiaceae, Gentianaceae, Saxifrabaceae, Phyllanthus, Daphneaceae, Plantain, Lithaceae, Platycodonaceae, Rubiaceae, and Polygonaceae) (Table 3.1), of which 65 species were infected by arbuscular mycorrhizal fungi, accounting for 94.2%. The proportion of AM plants was 85.7% in Compositae; 90% in Poaceae; 100% in Rosaceae and Legumes. *Arenaria capillaris* Poir. and *Dianthus versicolor* Fisch., which were considered incapable of being infected in the past, were all infected to varying degrees.

The main plants in the river beach wetland community are: *Taraxacum glaucanthum, Plantago depressa, Carex duriuscula, Sanguisorbo officinalis, Ranunculus japonicus, Fescuta ovina*, etc.; the main plants in the hillside grassland community are *Artemisia frigida, Artemisia laciniata, Fescuta lenensis, Koeleria macrantha, Leontopodium ochroleucum, Arenaria capillaris*, etc.; the main plants in the forest edge community are *Carex pediformis* and *Sanguisorbo officinalis, Geranium transbaicalicum, Plantago depressa, Potentilla tanacetifolia, Polygonum angustifolia*, etc. The analysis showed that both the constructive and dominant species in the plant community in the survey area were infected by AM fungi.

The classification of common plants is summarized and sorted out with reference to related reference books [22-26]. Among them, there are 4 unrecorded species in China, namely *Artemisia laciniata* Willd of Compositae Asteraceae, *Festuca ovina* L in Poaceae, *Thalictrum pediformus* in Ranunculaceae, *Geranium transbaicalicum* Serg in Gentianaceae.

Mycorrhizal infection rate

By observing the infection rate, it can be found that *Crepis bungei* Ledeb of Compositae has the highest infection rate of 93.3%, followed by Caryopteris mongolica Bge of Verbenaceae and *Allium bidentatum* Fesch of Liliaceae, with 90% and 79.5%, respectively. The three plants with lower infection rates were *Scabiosa comosa* Fisch, *Leonurs* sp. and *Parnasia palustris* L. with infection rates of 4.2%, 8.5% and 11%, respectively. The calculation shows that the average infection rate of Gramineae is 40.07%, the average infection rate of Compositae is 36.04%, and the average infection rate of Rosaceae is 30.27%. However, the number of plant species in other families is small, and the average infection rate cannot objectively represent the infection status of AM fungi in their families.

The infection rates of the dominant species *Taraxacum glaucanthum*, *Plantago depressa*, and *Carex duriuscula* were 42.8%, 34.4%, and 27.9%, respectively, in the river beach wetland community; The infection rates of the dominant species *Artemisia frigida, Artemisia laciniata* and *Fescuta lenensis* in the hillside grassland community were 17.7%, 12.5% and 9.55%, respectively. The dominant species in the forest edge community were *Carex pediformis, Sanguisorbo officinalis, Geranium transbaicalicum*, etc., the infection rates were 26.6%, 38% and 35.3%, respectively.

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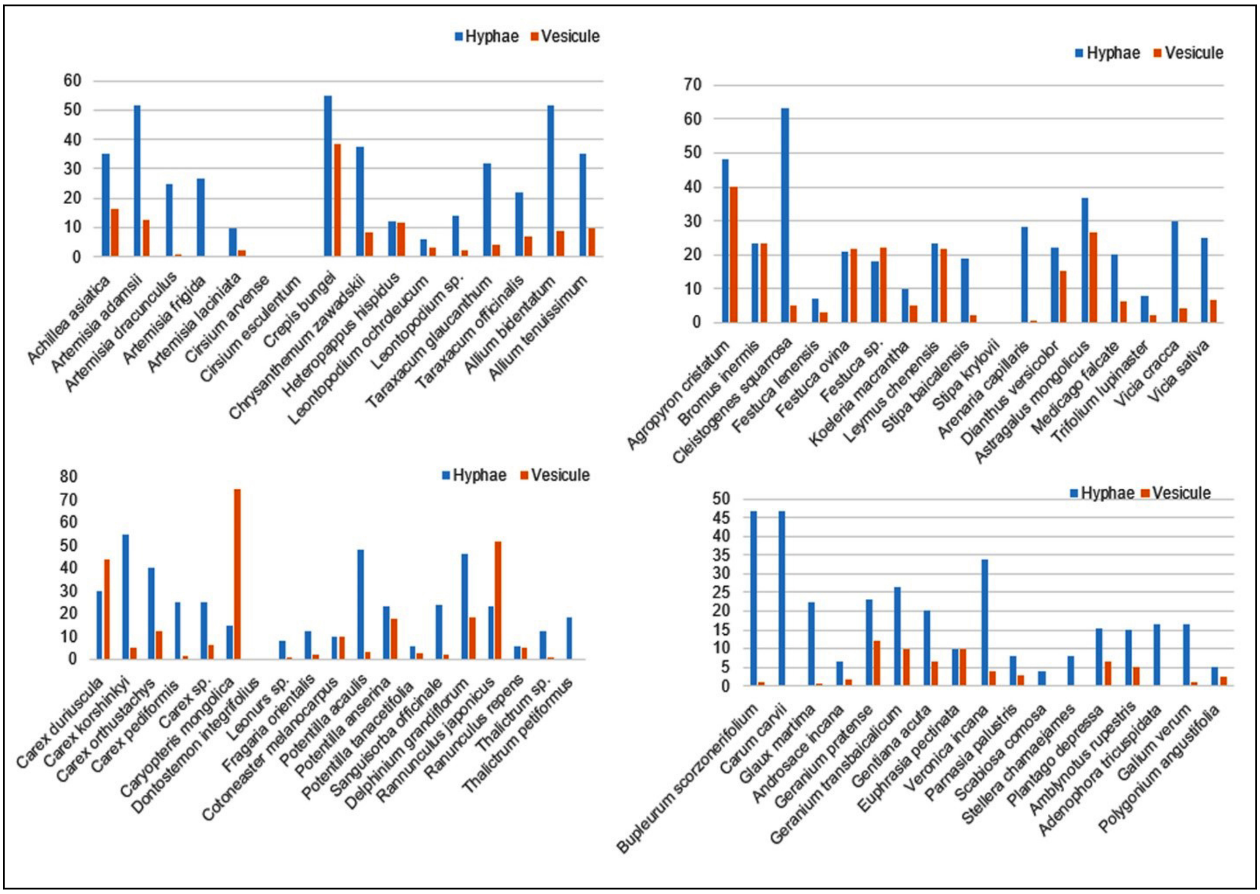

Figure 1. Histogram of infection rate of hyphae and vesicles

From Figure 1. it can be seen that except *Carex duriuscula, Festuca* sp, A*gropyron cristatum, Caryopteris mongolica*, the hyphae infection rate of AM fungi of other 61 common plants were higher than that of vesicles, and the arbuscular structure is not obvious (the ordinate is the percentage).

Mycorrhizal structure types and characteristics

According to the morphological description of arbuscular mycorrhiza by Smith & Smith (1997) [26], the development of AM mycorrhiza can be divided into *Arum*-type, Intermediate-type and *Paris*-type. Among the 65 species of AM plants in 24 families, there are 37 species of star type in Tuv aimag, accounting for 56.92% of AM plants, while there are 15 species of heavy building type, accounting for 24.62%, and there are two intermediate types. Ranunculaceae, Umbelliferae, Gentianaceae, Platycodonaceae, and some grasses are of the *Paris*-type; most of the plants such as Compositae, Liliaceae, Leguminosae, Cyperaceae are *Arum*-type.

AM fungal species

There are 34 species belong to 10 genera of 6 families isolated and identified from AM fungi spores in research area: 9 species of Acaulospora, 1 species of Ambispora, 3 species of Claroideoglomus, 1 species of Diversispora, 1 species of Funneliformis, 13 species of Glomus, 1 specie of Rhizophagus, 2 species of Septoglomus, 1 species of Scutellospora. 2 species of Entrophospora (1 unknown species) of unclassified taxonomic status; Based on morphological characteristics, 23 AMF species, 11unknown species were isolated and indentified.

The arbuscular mycorrhizal fungus dominant genera were Acaulospora and Glomus, the dominant species was *C. etunicatum*, common species were *Acaulospora mellea, Glomus multiforum* and the occasional species was *Ambispora feninica*. Until now, the first reported species both in China and Mongolia was *Ambispora feninica*, the first reported species in Mongolia were *Acaulospora denticulate, Acaulospora mellea, Glomus multiforum*.

Vol. 62 No 04 (244) 2022
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Table 2. AM fungus isolated from the research area

Genus	Species			
Acaullospora	Acau. denticulate	Acau. leavis	Acau. mellea	Acau. scrobiculata
	Acau. spinosa	Acau. sp1	Acau. sp 2	Acau. sp 3
	Acau. sp 4			
Ambispora	Amb. feninica			
Claroideoglomus	C. clariodeum	C. etunicatum	C. luteum	
Diversispora	D. spurca			
Entrophospora	E. infrequens	E. sp1		
Funneliformis	F. mosseae			
Glomus	G. brohultii	G. convolutun	G. formosanum	G. macrocarpum
	G. microaggregatum	G. multiforum	G. versiforme	G. sp1-6
Rhizophagus	R.intraradices			
Septoglomus	Sept. constrictum	Sept. deserticola		
Scutellospora	Scut. calospora			

AMF spore were observed in 15 common plant rhizosphere in the Tuv aimag of Mongolia. AMF spore richness (SR) in 100 g soil sample was highest in rhizosphere soil of *Crepis bungei* (12), followed by *Cirsium arvense* (10) and *Potentilla anserina* (10). And these three kinds of plant spore density (SD) are relatively high, respectively 164, 103 and 136/100g soil samples (Table 3.). The types and species richness of AM fungi in the rhizosphere of these plants were different, ranging from 2-12 species/100g soil samples, the separation frequency was 1.12-10.47%, and the spore density was between 12-164 species/100g soil samples, the relative abundance is between 0.024-0.8.

In this paper, the Shannon-Wiener index and Simpson index were used to reflect the diversity and uniformity of AM fungal communities in the rhizosphere of different plants. The Shannon-Wiener index of the AM fungal community in the study samples was between 0.5 and 2.238, and the Simpson index was between 0.32 and 0.999. (Table 3.) The Shannon Wiener indices of AM fungi in the rhizosphere soil of *Crepis bungei, Cirsium arvense* and *Potentilla anserina* were 2.238, 1.843 and 2.038, respectively; the Simpson indices were 0.866, 0.782 and 0.839, respectively.

Table 3. AMF diversity in different plants Rhizosphere in central province, Mongolia

№	Plant of name	AM species	F(%)	SR	SD	RA	H	D
1	*Artemisia dracunculus*	A.sp1	1.16	3	55	0.1455	0.618	0.336
		G. macrocarpum	3.48			0.8		
		Scut. calospora	2.32			0.0545		
2	*Cirsium arvense*	A. denticulate	9.3	10	103	0.1068	1.843	0.782
		A. scrobiculata	5.81			0.0388		
		G. brohultii	4.65			0.0388		
		C. claroideum	1.16			0.0388		
		G. luteum	1.16			0.0388		
		Sept. deserticola	6.98			0.0388		
		C. etunicatum	10.47			0.3495		
		F. mosseae	8.14			0.0388		
		G. macrocarpum	3.48			0.0388		
		G. multiforum	9.3			0.2718		
3	*Cirsium esculentum*	A. denticulate	9.3	6	60	0.2	1.749	0.818
		A. mellea	2.32			0.1333		
		Sept. constrictum	8.14			0.1333		
		Sept. deserticola	6.98			0.1333		
		C. etunicatum	10.47			0.1333		
		G. multiforum	9.3			0.2667		
4	*Cotoneaster melancarpa*	C. etunicatum	10.47	3	12	0.3333	1.099	0.667
		G. versiforme	4.65			0.3333		

Vol. 62 No 04 (244) 2022
DOI: https://doi.org/10.5564/pmas.v62i04.2680

		G. multiforum	9.3			0.3333		
5	*Crepis bungei*	A. denticulate	9.3	12	164	0.2683	2.238	0.866
		A. scrobiculata	5.81			0.0244		
		A. mellea	2.32			0.0488		
		A. spinosa	3.49			0.122		
		Sept. constrictum	8.14			0.0488		
		Sept. deserticola	6.98			0.0244		
		C. etunicatum	10.47			0.122		
		F. mosseae	8.14			0.0488		
		G. versiforme	4.65			0.0976		
		G. multiforum	9.3			0.0488		
		G. sp2	4.65			0.0976		
		Scut.calospora	2.32			0.0488		
6	*Dianthus versicolor*	Am. feninica	3.49	2	16	0.5	0.69	0.5
		G. sp	1.12			0.5		
7	*Euphrasia pectinata*	A. denticulate	9.3	6	32	0.125	1.667	0.98
		Am. feninica	2.32			0.125		
		Sept. deserticola	6.98			0.125		
		C. etunicatum	10.47			0.375		
		G. macrocarpum	3.48			0.125		
		Entrophospora sp.	1.12			0.125		
8	*Fescuta sp.*	A. denticulate	9.3	5	28	0.1429	1.55	0.98
		A. leavis	3.49			0.2857		
		Acau. sp2	1.12			0.1426		
		Am. feninica	2.32			0.1426		
		C. etunicatum	10.47			0.2857		
9	*Gentiana acuta*	A. denticulate	9.3	6	40	0.1	1.498	0.7
		Sept. constrictum	8.14			0.1		
		Sept. deserticola	6.98			0.1		
		C. etunicatum	10.47			0.1		
		F. mosseae	8.14			0.1		
		G. multiforum	9.3			0.5		
10	*Geranium pratense*	A. denticulate	9.3	6	36	0.1111	1.68	0.988
		A. scrobiculata	5.81			0.1111		
		A. leavis	3.49			0.1111		
		A. spinosa	3.49			0.1111		
		Sept. constrictum	8.14			0.2222		
		F. mosseae	8.14			0.3333		
11	*Glaux martima*	Sept. constrictum	8.14	7	136	0.0294	1.459	0.999
		C. etunicatum	10.47			0.0882		
		G. sp1	1.12			0.0294		
		F. mosseae	8.14			0.1471		
		G. sp2	4.65			0.0588		
		G. multiforum	9.3			0.1176		
		Acau.sp3	1.12			0.5294		
12	*Heteropappus hispidus*	Sept. constrictum	8.14	3	16	0.25	1.04	0.94
		G. brohultii	4.65			0.25		
		F. mosseae	8.14			0.5		
13	*Leontopodium ochroleucum*	G. brohultii	4.65	2	20	0.8	0.5	0.32
		G. multiforum	9.3			0.2		
14	*Parnasia palustris*	A. denticulate	9.3	5	28	0.2857	1.55	0.92
		A. scrobiculata	5.81			0.1429		
		A. spinosa	3.49			0.1429		
		G. versiforme	4.65			0.1429		
		G. multiforum	9.3			0.2857		
15	*Potentilla anserina*	A. scrobiculata	5.81	10	136	0.0882	2.04	0.84
		A. leavis	3.49			0.1176		
		G. brohultii	4.65			0.0294		

Vol. 62 No 04 (244) 2022
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		Sept. constrictum	8.14			0.2941		
		Sept. deserticola	6.98			0.0294		
		C. etunicatum	10.47			0.0882		
		G. intraradices	1.12			0.0588		
		F. mosseae	8.14			0.1765		
		G. versiforme	4.65			0.0294		
		G. sp2	4.65			0.0882		

Table 3. F: separation frequency; SR: species richness; SD: spore density; RA: relative abundance; H: Shannon Wiener index; D: Simpson index

The dominant genera of AM fungi in this study area are Acaulospora and Glomus, the dominant species was *C. etunicatum*, the common species were *Acaulospora mellea*, *Glomus multiforum*, and the occasional species is *Amb. fenínica*, which is the first reported species in China and Mongolia, three species were first reported in Mongolia, *Acau. denticulate*, *Acau. mellea*, *G. multiforum*; the species richness was 2-12 species/100g soil sample, the spore density was between 12-164 spores/100g soil samples, Shannon's Wiener index was between 0.5-2.138, and Simpson's index was between 0.32-0.999.

The AM mycorrhizae and their infection characteristics of 69 common plant roots in the central province of Mongolia were studied and analyzed, and it was found that 65 plants were infected by AM fungi, accounting for 94.20%. The proportion of AM plants was 85.7% in Compositae; 90% in Poaceae; 100% in Rosaceae and Legumes. This study is consistent with the findings of many domestic and foreign studies, which can indicate that AM mycorrhizal plants are widespread and universal in terrestrial ecosystems [27]. This prevalence may also indicate that AM fungi play a pivotal role in the natural ecosystem of the central province of Mongolia. *Arenaria capillaris* Poir. and *Dianthus versicolor* Fisch., which were considered incapable of being infected in the past, were all infected to varying degrees.

Through comparative analysis, it is concluded that the infection rate of AM fungi varies greatly among different plants, among which *Crepis bungei* Ledeb of Compositae has the highest infection rate of 93.3%, Followed by the Verbenaceae plant *Caryopteris mongolica* Bge and the Liliaceae plant *Allium bidentatum* Fesch, with 90% and 79.5% respectively, indicated that these plants had higher affinity with AM fungi. The three plants with lower infection rates are *Scabiosa comosa* Fisch of Brassaceae, *Leonurs* sp., and *Parnasia palustris* L whose infection rates were 4.2%, 8.5% and 11%, respectively, with low affinity to AM fungi.

We also analyzed the AM fungal infection rates of dominant species plants in three different ecological types of plots, and concluded that the infection rates of the dominant species *Taraxacum glaucanthum, Plantago depressa, Carex duriuscula*, etc. 42.8%, 34.4% and 27.9%. The infection rates of the dominant species *Artemisia frigida, Artemisia laciniata* and *Fescuta lenensis* in the hillside grassland community were 17.7%, 12.5% and 9.55%, respectively; The dominant species in the forest edge community were *Carex pediformis, Sanguisorbo officinalis, Geranium transbaicalicum,* etc., the infection rates were 26.6%, 38% and 35.3%, respectively. Compared with the other two types, the AM infection rate of dominant species in the wetland community is higher than that of the other two types, which is slightly different from the research results of Ren Jianting [28] (In the relatively arid study area with an annual rainfall of less than 300 mm, common perennial plants have the symbiotic characteristics of AM fungi and have a high infection rate. Possibly higher infection rate and extra-root hyphae help increase water uptake by plant roots and promote the growth of plant aboveground parts), it may be the result of different natural geographical locations and different natural ecological environments.

Extensive studies have shown that different plant species or the same plant in different habitats have different AM infection rates or difference. The AM mycorrhizal infection rate of plants varies with plant species, root structure, and AM fungi species and habitats. [28, 29].

Vol. 62 No 04 (244) 2022
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Hyphae, vesicles and arbuscules are typical structural features of AM fungi, which reflect the degree of infection of host plants by AM fungi. The survey found that except *Carex duriuscula, Festuca* sp, *Agropyron cristatum, Caryopteris mongolica*, the hyphae infection rate of other 61 common plants AM fungi was higher than the vesicle infection rate, and the arbuscular structure was not obvious, which was consistent with the domestic and foreign survey results. The survival duration was less than ten days on arbuscular structure but more than ten days on vesicle structure, indicating the life cycle arbuscular structure is shorter.

The development of AMF mycorrhiza can be divided into *Arum*-type, intermediate-type and *Paris*-type. The arbuscules in the *Paris*-type are wrapped in the entangled circle mycelium. Scholars believe that the structure and function of AM mycorrhiza are adaptive to each other, and are related to the metabolism, infection and nutrient exchange of mycorrhiza. The difference in mycorrhizal types is mainly related to the host plant species. AMF colonization were observed in 65 AM plants in 24 families. AMF colonization levels in 37 species of *Arum*-type, 15 species of *Paris*-type, 2 intermediate- types and 10 uncertain types was 56.92, 24.62, 0.05 and 15.38%, respectively. Ranunculaceae, Umbelliferae, Gentianaceae, Platycodonaceae, and some grasses are of the *Paris*-type; most of the plants such as Compositae, Liliaceae, Leguminosae, Cyperaceae are *Paris*-type. Studies have shown that the AM mycorrhizal morphotypes of some plants are extremely controlled by the genotype of the host plant. Although a single plant is infected by multiple AM fungi [30, 31], the AM morphotype is only one of the *Arum*- or *Paris*-type. Laboratory inoculation studies have also shown that, as in plants in natural ecosystems, the mycorrhizal morphology of the tested plants is controlled by the host genotype despite preferential symbiotic selectivity between host plants and AM fungi [31]. The study by Cavagnaro *et al*. (2001) showed that the effect of fungal species on AM morphotypes was obvious, and wild-type tomatoes developed Arum-type and *Paris*-type mycorrhizae depending on inoculated fungal species [32]. Dickson (2004) pointed out that the mycorrhizal morphology of some plants infected with different AM fungi was consistent, while other plants showed that mycorrhizal morphology was dependent on the fungal species. The morphological and structural differences of arbuscules are related to the species of mycorrhizal fungi and the structure of host root cortical cells [8]. It can be seen that the mycorrhizal morphotype of plants is determined by the host and fungal species [33]. Due to the limitation of seasons, the entry and exit of biological samples, and other factors, this study only carried out mycorrhizal observation on the 69 species of plants tested. Furthermore, relationships between host plants and mycorrhizal fungi should be studied using morphological characteristics.

CONCLUSIONS

- Among the 69 common plants in Mongolia's Central Province, 65 species were infected by arbuscular mycorrhizal fungi, accounting for 94.2%. The proportion of AM plants in the Asteraceae is 85.7%; 90% in Gramneae; 100% in Rosaceae and legumes; both Arenaria capillaris Poir and Dianthus versicolor Fisch of Caryophyllaceae were colonized in different degrees, respectively. There were 37 species of *Arum*-type in AM plants, accounting for 54.92%; 15 species of *Paris*-type, accounting for 24.62%. *Paris*-type mostly appeared in Ranunculaceae, Umbelliferae, Gentianaceae, Campanulaceae, and some Gramineae; The *Arum*-type mostly appeared in the plants of Asteraceae, Liliaceae, Leguminosae and Cyperaceae.
- There are 34 species belong to 10 genera of 6 families isolated and identified from AM fungi spores in research area: 9 species of Acaulospora, 1 species of Ambispora, 3 species of Claroideoglomus, 1 species of Diversispora, species of Funneliformis, 13 species of Glomus, 1 species of Rhizophagus, 2 species of Septoglomus, 1 species of Scutellospora. 2 species of

Entrophospora (1 unknown species) of unclassified taxonomic status; we identified 23 species to genus, 11 unknown species to genus.
- The arbuscular mycorrhizal fungus dominant genera were Acaulospora and Glomus, the dominant species was *C. etunicatum*, common species were *Acaulospora mellea, Glomus multiforum* and the occasional species was *Ambispora feninica*. Until now, the first reported species both in China and Mongolia was *Ambispora feninica*, the first reported species in Mongolia were *Acau. denticulate, Acau. mellea, G. multiforum*. The Species richness was between 2-12 and spore density was between 12-164 in 100 g soil of samples. Shannon-Weiner index was between 0.5-2.138 and the Simpson index was between 0.32-0.999.
- The AM fungi diversity indices such as spore density, species richness, Shannon-Weiner index and Simpson index were different in 15 common plants soil, and the Simpson index is extremely negative correlated with the available phosphorus content in soil (P<0.01).
- High proportion of mycorrhizal plants in common plants in the study area, AM fungi diversity in plant rhizosphere was also high, and the species richness is higher in the Acaulospora and Glomus, influenced by host plants and soil environmental factors. The results of this study have laid the foundation for the investigation of mycorrhizal plants and AM fungi resources, biological diversity and their distribution rules in different vegetation types of Mongolia, and the physiological and ecological functions of AM fungi.

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