Folk nomenclature of plants in Cistanche deserticola-associated community in South Gobi, Mongolia

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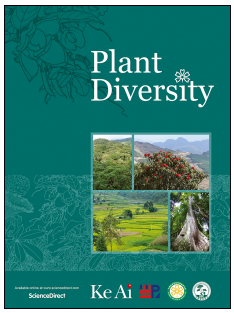

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Title page

Folk nomenclature of plants in *Cistanche deserticola*-associated community in South Gobi, Mongolia

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Folk nomenclature of plants in *Cistanche deserticola*-associated community in South Gobi, Mongolia

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Abstract:

Cistanche deserticola Y. C. Ma is an important medicinal plant in Mongolia. Despite its significant role in local healing systems, little traditional knowledge had been reported. The present study investigated folk names of *Cistanche deserticola* Y.C. Ma and other species of the same community in Umnugobi Province, South Gobi region of Mongolia, based on ethnobotanical approaches. The high correspondence between folk names and scientific names of plant species occurring in *Cistanche*-associated community shows the scientific meaning of folk nomenclature and classification in Mongolia. The Mongolian and folk names of plants were formed on the basis of observations and understanding of wild plants including their morphology, phenology and traditional uses as well. Results from this study will support the conservation of *Cistanche deserticola* itself, a rare and endangered plant species listed in the Monglian Red Data Book. Our documentation of folk nomenclature based on 96 plant species in the *Cistanche* community, as a part of traditional knowledge associated with biodiversity, will be very helpful for making strategy of plant biodiversity conservation in Mongolia.

Keywords: *Cistanche deserticola*, plant community, ethnobotany, folk nomenclature, conservation strategy, South Gobi of Mongolia

1. Introduction

Folk taxonomy and nomenclature are common in the world (Loko et al., 2018; Tokoula et al., 2019). The local people use their own knowledge to name plants, animals and microorganisms (Phaka et al., 2019; Wang et al., 2020). The traditional

knowledge of classification, identification and nomenclature has shown significant values in nature conservation and biodiversity uses (Turpin & Si, 2017; Ulicsni et al., 2016). Traditional knowledge associated with biodiversity (TK) covers the folk nomencluture systems, uses of bioresources available, and management of ecosystems by the local people of a given area (Khasbagan et al., 2000).

Folk nomenclature of plant species are the roots of traditional botanical knowledge (Khasbagan and Soyolt, 2008; Li et al., 2013). Thus it will be impossible to hand TK down to future generations. Collection and analysis of plant folk names of the Mongolians are extremely important because of the rapid socio-economic changes and desertification of grasslands in the country. Unfortunately few investigations had been conducted to document the folk names of plants in Mongolia. On the other hand, ethnobotanical investigation in Inner Mongolia have been carried out since 1980s, including useful plants of herders (Ulangerel Village and Khasbagan, 2017), and folk nomenclature (Soyolt et al., 2013).

The genus *Cistanche* is a group of perennial parasitic herbaceous plants in the family Orobanchaceae. About 20 species had been described in the genus, with distribution in Asia and Europe (Zhang and Tzvelev, 1998). Most of their host plants are sand-binding plants such as some species in *Kalidium* Miq., *Haloxylon* Bunge and *Tamarix* L. (Li et al, 2019), and *Ammopiptanthus mongolicus* (Maximowicz) Cheng, *Caragana tibetica* Komarov, *Potaninia mongolica* Maximowicz, *Reaumuria soongarica* (Pallas) Maximowicz, *Salsola passerina* Bunge, *Tetraena mongolica* Maximowicz, and *Zygophyllum xanthoxylon* (Bunge) Maximowicz. Other members in Amaranthaceae (mostly from the former Chenopodiaceae) may also be their host plants (Zhang and Tzvelev, 1998).

"*Conservation Flora MNR*" (Grubov, 1955) recorded three species of *Cistanche* or Argamjin tsetseg in Mongolia. They are *Cistanche feddenia* K. S. Hao, *C. salsa* (C.A. Meyer) G. Beck, and *C. tubulosa* (Schenk) R. Wright. In the *Key to Vascular Plants of Mongolia*, two species of *Cistanche* were included, i.e. *C. feddenia* K. S. Hao and *C. salsa* (C.A. Meyer) G. Beck. A Russian scientist Gubanov (1996) had recorded four species of *Cistanche* in *Conspectus of Flora in Outer Mongolia*. They are: 1) *Cistanche deserticola* Y. C. Ma, 2) *Cistanche lanzhouensis* Z. Y. Zang, 3) *C. ningxiaensis* D.Z. Ma et J.A. Duan, and 4) *C. salsa* (C.A. Meyer) G. Beck. The taxa, *Cistanche feddenia* was divided into two species (Grubov, 1982). Among all *Cistanche* species, *C. deserticola* is the most valuable and widely used for medicinal purposes in different countries.

Cistanche deserticola Y.C. Ma is mainly distributed in China (Xinjiang, Inner Mongolia, Ningxia, Gansu, and Qinghai), Iran, India and Mongolia (Wang et al., 2012). *Cistanche deserticola* has its own viable green leaf and root system, turning roots and leaves into parasites. The breeding organ stem has gained considerable resemnlance, but research has shown selectivity. It is also of the highest interest in breeding.

Scientists had studied *Cistanche* species since 1980s (Kobayashi and Komotsu, 1983). Hundreds of publications had been issued in recent 20 years (Li et al, 2016; Wang et al, 2019). The chemical analysis demonstrated that phenylethanoid

glycosides, iridoids, betaine, Krebs cycle intermediates, lignans, alditols, oligosaccharides and polysaccharides are the main compounds in *Cistanche* plants (Lun et al., 2005; Li et al, 2016; Wang et al, 2019). Pharmacological research showed that the extracts from *Cistanche* plants possess a wide spectrum of activities, such as curing kidney deficiency and senile constipation, advancing the ability to study and memorize, enhancing immunity, anti-aging and antifatigue. Phytochemical studies on this genus have revealed the chemical constituent of *Cistanche* plants (Jiang and Tu, 2009; Li et al, 2016). The wild *C. deserticola* has been on the edge of extinction due to over-harvesting for medicinal uues, and it has been listed as one of the Grade-II plants needing protection in China.

However, little records of traditional knowledge associated with *Cistanche* and its plant community had been reported in Mongolia. The aim of this paper is to document the folk names of species in plant community where *Cistanche deserticola* occurs in Mongolia (thereafter *Cistanche*-associated community, or shortly *Cistanche* community) based on ethnobotanical investigations. The folk nomenclature of *Cistanche deserticola* in Mongolian Gobi will be presented in the paper. Some issues related to plant conservation in *Cistanche* community will be argued.

2. Material and methods

2.1. The study area

The study area is in Umnugobi of Southern Gobi Desert area. Umnugobi is the biggest province in Mongolia, with a total area of 165,500 km^2 and a population of about 66.7 thousand (NSO, 2018). The climate here is extreme in Umnugobi Province. Its temperatures reach up to +40°C in summer, and -30°C in winter. Precipitation averages less than 100mm per year, while in some areas it rains only once every two or three years.

The study was carried out in five sites: Zuun Bukht, Zuramtai Mountain, Naran Bag, Jaran Sand, and Tevsh Khairkhan, located in Umnugobi Province of Southern Gobi Desert area (between 24°12'–26°86' N and 98°13–102°42' E) (Figure 1).

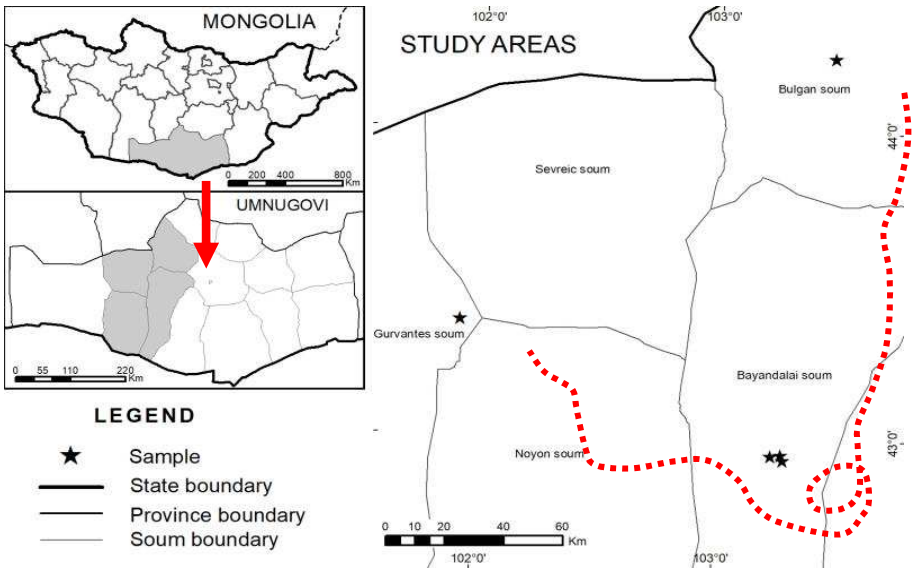

Figure 1. Study areas in Umnugobi Province shown sample sites.

2.2. Data collection and methods

All literatures related to Umnugobi Province were collected. The local names, frequency of uses, and other values of *Cistanche* were gathered from the literatures. Fieldworks were conducted from April 25 to August 12, 2019. Ethnobotanical data were collected from the field investigations in five selected sites (Table 1). Fieldworks were carried out in five villages, and 58 local herders as key informants were interviewed. The informants' age varied from 18 to 75 years old (comprising 25 males and 33 females). Key informants own rich traditional knowledge about the *Cistanche* including habitat of old *Cistanche* in saxaul forest area. They guided us to visit the saxaul forest area as well. Particular attention was paid to collect information about folk names of *Cistanche* (Table 1) and other species in the plant community. While noting the information, all relevant taxonomic characteristics were documented. The identification was done by consulting with an expert: botanist Battseren Munkhjargal, Department of Botany, Mongolian Academy of Sciences, and through several literature sources. The determined species were further compared with the "Key to the Vascular Plants of Mongolia" for justification of correct scientific names and author citations (Urgamal et al., 2019). All voucher specimens were deposited in the Herbarium, Mongolian Academy of Sciences.

Table 1. Information of case sites for ethnomedicinal investigation of *Cistanche deserticola* and associated plant community in South Gobi, Mongolia

No.	City	Site	Longitude	Latitude
1	Bayandalai Sum	Zuun Bukht, Zuramtai Mountain, saxaul forest	103°17'15.7"	42°56'13"
2	Bayandalai Sum	Zuun Bukht, Zuramtai Mountain, *Ephedra* steppe	103°16'39.9"	42°57'15"
3	Bayandalai Sum	Naran Bag	103°14'12.5"	42°57'03"
4	Gurvantes Sum	North part of Jaran Sand, saxaul forest	101°55'36.6"	43°22'37"
5	Bulgan Sum	Tevsh Mountain, saxaul forest	103° 28' 57.5"	44°14'50"

The methods of semi-structured interviews were used in field surveys. Ethnobotanical interviews were organized in two ways: local plant specimens were collected beforehand and then interviews were organized; and local herders were invited to the field and were interviewed. Mongolian was used as the working language, and findings were recorded in Mongolian. Folk names of plants were confirmed through collection and identification of voucher specimens.

3. Results

3.1. The Cistanche-associated community

Based on the identification results of specimens collected from the *Cistanche*

-associated community, the folk names of all plants corresponded with 96 species which belong to 26 families and 71 genera. Most species were confirmed as recorded by Ulziykhutag (1985) and Urgamal (2018). Some literatures did not report extensive research on species components of Mongolian saxaul forest, such as Yunatov (1943, 1950, 1952), Grubov (1955, 1963, 1982), Lavrenko (1960, 1962, 1965), and Gal (1975) who had given an overview of their work (Gal, 1975). The saxaul forest range is considered to be an independent region of the Asian desert. Its components are mostly from Asteraceae, Amaranthaceae, Zygophyllaceae, Poaceae, and other xerophytes, halophytes, gypsites and psamophytes.

The most dominant species in the *Cistanche*-associated community are *Peganum nigellastrum, Salsola collina, Aristida Heymannii,* and *Agriophyllum pungens,* and co-dominants are *Salsola passerine*, *Anabasis salsa*, *Calligonum mongolicum, Nitraria sibirica,* and *Stipa gobica* in the saxaul forest (Figure 2) (Table 2). Some photos of additional plants in the *Cistanche*-associated community may be available in the supplementary material (Figure S1).

Table 2. Life form of dominant and subdominant species in the *Cistanche* community

Life form	Habit	Species
Eucerophytes, halophytes, gypsites	Shrub	*Calligonum mongolicum, Atraphaxis pungens, Zygophyllum xanthoxylon, Tamarix ramosissima, Nitraria sibirica, Nitraria roborowskii*.
	Subshrubs	*Anabasis aphylla, Anabasis eriopodia, Eurotia ceratoides, Eurotia ewersmanniana, Artemisia xerophytica, Convolvulus gortschokovii, Ephedra przewalskii, Salsola ikonnikovii, Salsola passerine, Sympegma regelii, Kallidium cuspidatum, Kallidium fliatum, Kallidium gracile, Caragana microphylla.*
Mesoxero-galophyte	Biennial and annual herbaceous plants	*Chesneya mongolica, Artemisia gobica, Lasiagrostis splendens, Chloris virgata, Pappopnorum boreale, Aristida adscensionis, Setaria viridis, Cleistogens mutica, Eragrostost, Elymus ginganteus, Asparagus gobicum, Rheum nanum, Chenopodium acuminatum, Echinopsilon divaricatum, Corispermum mongolicum, Agriophyllum gobicum, Sueda corniculata, Salsola ikonnikovii, Halogeton glomeratus, Halogeton arachnoideus*

The scientific names, Mongolian names and folk names were presented, alphabetically listed by family, genus, and species name spellings. The confirmation of some species was mainly based on publications of Grubov (2001), Ulziykhutag (1989), Gubanov (1996), Urgamal et al. (2014, 2017).

Figure 2. *Cistanche deserticola*–associated communities

3.2. Folk names of plants in Cistanche-associated community

The vascular plants of *Cistanche*-associated community were listed in Table 3 according to the most recent Angiosperm Phylogeny Group (APG IV, 2016) and other research results (Urgamal, 2016). We compared Mongolian names with folk names about all species in *Cistanche* community, and showed different naming systems by morphology, original places and traditional uses of the recorded plants (Table 3).

Table 3. Folk names of plants in *Cistanche* community, South Gobi, Mongolia

Family	Scientific name	Mongolian name	Folk name
Amaranthaceae	*Agriophyllum pungens* (Vahl.) Link	Shivuurt tsulihir	Derveen tsulihir
Amaranthaceae	*Anabasis brevifolia* C. A. Mey.	Ahar navchit bagluur	Bagluur
Amaranthaceae	*Atriplex sibirica* L.	Sibiri shornoi	Gagadai, Luuli
Amaranthaceae	*Bassia dasyphylla* (Fisch. et Mey.)	Usleg manan-hamhag	Ust hamhag
Amaranthaceae	*Chenopodium acuminatum* Willd.	Shorgor luuli	Shornoi luuli
Amaranthaceae	*Corispermum mongolicum* Iljin	Mongol hamhuul	Horon hamhag
Amaranthaceae	*Eurota ceratoides* (L.) C. A. Mey.	Orog teseg	Tsomtsogt teseg
Amaranthaceae	*Haloxylon ammodendron* (C.A. Mey.) Bunge	Zag	Tsagaan zag
Amaranthaceae	*Halogeton glomeratus* (Bieb.)	Bag hush-hamhag	Hush-hamhag
Amaranthaceae	*Kalidium foliatum* (Pall.) Moq.	Navchirhagshar budargana	Undur shar, Shar budargana
Amaranthaceae	*K. gracile* Fenzl	Goolig badargana	Shar mod
Amaranthaceae	*Salsola passerina* Bunge	Bor budargana	Toson budargana
Amaranthaceae	*S. pestifera* Hels.	Urgust budargana	Urgust hamhuul

Amaranthaceae	*Sympegma Regelii* Bunge	Regeliin shar mod	Shar mod
Amaryllidaceae	*Allium mongolicum* Regel	Humul	Humuul
Amaryllidaceae	*A. anisopodium* Ldb.	Sarvuun songino	Shuvuun hul
Amaryllidaceae	*A. polyrrhizum* Turcz. ex Regel	Taana	Taana
Apiaceae	*Ferula bungeania* Kitag.	Bungiin havrag	Havrag
Asclepiadaceae	*Vincetoxicum sibiricum* (L.) Decne	Sibiri erundgunu	Temeen huh
Asparagaceae	*Asparagus gobicus* Ivanova ex Grub.	Goviin hereen nud	Hereen nud
Asteraceae	*Ajania fruticulosa* (Ldb.) Poljak.	Suugun borolz	Bortaari
Asteraceae	*Artemisia pectinata* Pall.	Shulhii sharilj	Uher shulhii
Asteraceae	*A. intricata* Franch.	Orooldoo sharilj	Bor tulug
Asteraceae	*A. anethifolia* Web. ex Stechm.	Bojmog sharilj	Bojmog sharilj
Asteraceae	*A. scoparia* Waldst. et Kit.	Yamaan sharilj	Yamaan sharilj
Asteraceae	*A. xerophytica* Krasch.	Huuraisag sharilj	Bor shavag
Asteraceae	*A. annua* L.	Morin sharilj	Morin sharilj
Asteraceae	*A. xanthochroa* Krasch.	Shar sharilj	Shar shavag
Asteraceae	*Asterothamnus centrali- asiaticus* Novopokr.	Tuv aziin lavai	Bor lavai
Asteraceae	*Brachanthemum gobicum* Krasch.	Goviin tost	Umhii tulee
Asteraceae	*Cancrinia discoidea* (Ldb.) Poljak.	Zeerentseg altan tovch	Altan tovch
Asteraceae	*Echinops gmelinii* Turcz.	Gmelinii taijiin jins	Aduun uruul
Asteraceae	*Heteropappus altaicus* (Willd.) Novopokr	Altain sogsoot	Altain sogsoolj
Asteraceae	*Lactuca tatarica* (L.) C.A. Mey.	Tataar ziraa	Ziraa
Asteraceae	*Saussurea salsa* (Pall.) Spreng.	Martsnii banzdoo	Banzdoo
Asteraceae	*S. amara* DC.	Gashuun banzdoo	Gazriin huh

Asteraceae	*Scorzonera divaricata* Turcz.	Derevger havishana	Suut uvs
Asteraceae	*S. capito* Maxim.	Danhar havishana	Hurgan chih
Asteraceae	*Taraxacum leucanthum* (Ldb.) Ldb.	Tsagan tsetsegt bagvahai	Bagvaahai
Bignoniaceae	*Incarvillea potaninia* Batal.	Potaninii ulaan tulam	Tsagaan halgai
Boraginaceae	*Arnebia guttata* Bunge	Tolbot bereemeg	Bor elgene
Boraginaceae	*Lappula intermedia* (Ldb.) M. Pop	Zavsriin notsorgono	Zavsriin notsgono
Brassicaceae	*Dontostemon senilis* Maxim.	Utluun bagdai	Zurgaadai bagdai
Brassicaceae	*Isatis costata* C. A. Mey.	Gurvent huhurgunu	Havirgat huhurgunu
Brassicaceae	*Ptilotrichum canescens* (DC) C. A. Mey.	Buuralduu yangits	Tsagaan demeg
Convolvulaceae	*Convolvulus ammanii* Desr.	Ammanii sedergene	Sedergene
Convolvulaceae	*C. gortschakovii* Schrenk	Gorchakoviin sedergene	Shar bereemeg,
Cynomoriaceae	*Cynomorium songaricum* Rupr.	Zuungariin goyo	Ulaan goyo
Ephedraceae	*Ephedra sinica* Stapf	Nangiad zeergene	Zeergene
Ephedraceae	*E. monosperma* S. G. Gmel. ex C. A. Mey.	Yamaan zeergene	Yamaan zeergene
Euphorbiaceae	*Euphorbia humifusa* Schlecht	Nalchigar suut uvs	Suut uvs
Fabaceae	*Astragalus variabilis* Bunge ex Maxim.	Huvisangi hunchir	Horon hunchir
Fabaceae	*A. junatovii* Sancz.	Yunatoviin hunchir	Yunatoviin hunchir
Fabaceae	*A. grubovii* Sancz.	Gruboviin hunchir	Gruboviin hunchir
Fabaceae	*A. monophyllus* Bge.	Gants navchit hunchir	Gantsnavchintsar t hunchir
Fabaceae	*A. laguroides* Pall.	Tuulain hunchir	Bujin hunchir
Fabaceae	*Chesneya mongolica* Maxim.	Mongol buurtsgana	Buurtsgana
Fabaceae	*Caragana leucophloea* Pojark.	Altan hargana	Ulaan hargana Altargana
Fabaceae	*Oxytropis aciphylla*	Urgust ortuuz	Ortuuz

	Ledeb.		
Geraniaceae	*Erodium stephanianum* Willd.	Stepanii zaan tavag	Zaan tavag
Geraniaceae	*E. tibetanum* Edgew.	Tuvd zaan tavag	Hereen hoshuu
Iridaceae	*Iris tenuifolia* Pall.	Nariin tsahildag	Tsulbuur ubs
Iridaceae	*I. lactea* Pall.	Tsagaalin tsahildag	Hos hairst tsahildag
Lamiaceae	*Lagochilus ilicifolius* Bunge	Yamaan angalzuur	Tsarsnavchit angalzuur
Lamiaceae	*Panzeria lanata* (L.) Bun ge	Ushii nohoin hel	Temeen angalzuur
Orobanchaceae	*Cistanche deserticola* Y. C. Ma	Argamjin tsetseg	Tsagaan goyo
Plantaginaceae	*Plantago minuta* Pall.	Baga tavan salaa	Ulaan tulam
Plumbaginaceae	*Limonium aureum* (L.) Hill et Ktze	Altan bereemeg	Shar bermeg
Plumbaginaceae	*L. tenellum* (Turcz.) Ktze.	Tuyahan bereemeg	Tuyahan bermeg
Poaceae	*Aristida heymannii* Regel	Geimaniin buudii	Nohoin shivee
Poaceae	*Cleistogenes soongorica* (Roshev.) Ohwi	Zuungariin hazaar uvs	Sorgui hazaar uvs
Poaceae	*Enneapogon desvauxii* P.Beauv.	Umardiin ogotniin suul	Hurgalj, Budnuur
Poaceae	*Eragrostis minor* Host.	Baga hurgalj	Budneen ur
Poaceae	*Leymus paboanus* (Claus) Pilg.	Paboani Tsagaan suli	Suli
Poaceae	*Ptilagrostis pelliot* (Danguy) Grub.	Pellitiin yet uvs	Yet uvs
Poaceae	*Setaria viridis* (L.) Beauv.	Nogoon honog budaa	Hermen suul
Poaceae	*Stipa gobica* Roshev.	Goviin hyalgana	Mongol uvs
Poaceae	*S. glareosa* var. *pubescens* Gub.	Sairiin hyalgana	Mongol hyalgana
Polygonaceae	*Atraphaxis pungens* (Biab.)	Urgust emgen shilbe	Emgen shilbe
Polygonaceae	*A. frutescens* (L.) K. Koch.	Suugun emgen shilbe	Tsagaan mod
Polygonaceae	*Calligonum mongolicum* Turcz.	Mongol azar	Toson torlog
Polygonaceae	*Rheum nanum* Siev.	Namhan gishuune	Bajuuna
Rosaceae	*Amygdalus*	Bariult builes	Builees

	pedunculata Pall.		
Rosaceae	*Potaninia mongolica* Maxim.	Hulan hoirgo	Mongol hoirog
Rosaceae	*Sibbaldianthe sericea* Grub.	Torgon hereen hoshuu	Torgomsog hereen hoshuu
Salicaceae	*Populus diversifolia* Schrenk	Eldev navchit ulias	Tooroi, Turaanga
Tamaricaceae	*Reaumuria soongarica* (Pall.) Maxim.	Zuungariin budargana	Ulaan budargana
Tamaricaceae	*Tamarix ramosissima* Ledeb.	Olon tsetsegt suhai	Ulaan suhai
Ulmaceae	*Ulmus pumila* L.	Odoi hailas	Tarvagan hailas
Verbenaceae	*Caryopteris mongolica* Bge.	Mongol dogor	Yamaan ever
Zygophyllaceae	*Nitraria sibirica* Pall.	Sibiri harmag	Tovtsog harmag
Zygophyllaceae	*Peganum nigellastrum* Bge.	Harlag umhii uvs	Umhii uvs
Zygophyllaceae	*Tribulus terrestris* L.	Zelen zanguu	Nohoi zanguu
Zygophyllaceae	*Zygophyllum xanthoxylon* (Bge.) Maxim.	Shar hotir	Nohoin sheerenge
Zygophyllaceae	*Z. rosovii* Bunge	Rozoviin hotir	Botgon tavag
Zygophyllaceae	*Z. potaninii* Maxim.	Potaninii hotir	Argaliin und

As shown in Table 3, the plants recorded from the *Cistanche*-associated community are mostly perennial herbaceous with 72 species, accounting for 75% of the total number of plants. Annual herbaceous plants of 24 species occupy 25%. There are 11 species of shrubs in the community, occupying 11.5%.

Mongolians have rich and unique traditional knowledge because of their long-term survival in the pasturelands and desert areas. The local people in South Gobi named wild plants based on their traditional knowledge (Figure 3).

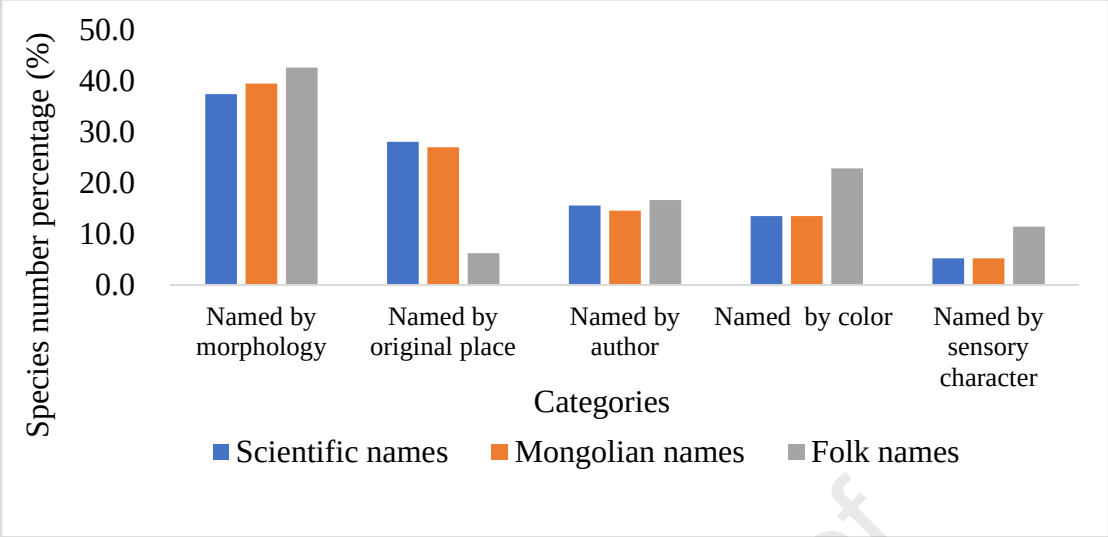

Figure 3. Meanings of plant names in the *Cistanche* community (%)

The plant names mostly presented the information of plants. A comparison of meanings of plant names in the *Cistanche* community was shown in Figure 3. The plant names in *Cistanche* community could be divided into five categories including morphology, original place, author name, color, and sensory character. In the scientific names of plants, the category of morphological characteristics constituted the highest proportion represented by 36 species (37.5%), while there were 15 species (15.6%) named in memory of authors and authority botanists or other people, 13 (13.5%) for color, 27 (28.1%) for original place, and 5 (5.2%) for sensory character. In Mongolian names, species named by morphological characteristics reached 38 species (39.6%), original place was 26 (27.1%), author name was 14 (14.6%), color was 13 (13.5%), and sensory character was 5 (5.2%). According to these data, the scientific and Mongolian names are not significantly different in five categories. That means the Mongolian names and scientific names are very similar by using all of categories as translated into Mongolian language.

The folk names indicated that meanings of plants were ranked by morphological characteristics (42.7%), color (22.9%), and sensory character (11.5%). The author names was 14 (14.6%), the same as that of scientific and Mongolian names. But the original place (27.1%) was quite different from other categories in folk names. In scientific nomenclature, the morphological characteristics of a plant is usually used to name the species. The original place names revealed the origins of plants, the first sites to collect specimens or their growing environment, such as Mongolia, Zuungariin gobi, Sibiri, Tataar, Center, Northern, Gobi, borderland, dryland and marsh, and others. Some plants were named in memory of the botanists' names who firstly discovered the plants. This category is almost equal in scientific, Mongolian and folk names. For example, Amman, Bunge, Gmelin, Grubov, Potanin, Regel, Rozov, Yunatov and other botanists or authors had been used to name the plants. Scientifically the Latin names are used as classifying or identifying specific plants. The name of a plant is also given by the color of flowers, or stem, or leaves which have golden, brown, grey, green, pearl grey, yellow, white, stain or other colors. The

meanings of names related to sensory characters have been identified as edible, salty, poisonous, tasteless, stinky or oily, which reflected the local people's traditional knowledge about these plants.

3.3. Folk nomenclature of Cistanche deserticola

Six folk names of *Cistanche deserticola* were recorded (Table 4). The plant grows in two forms: red and white. The white one is called "Tsoliin Argamjin tsetseg" and plays a key role in maintaining the local Gobi ecosystem.

Table 4. Information of *Cistanche deserticola* from the case sites

Scientific name	*Cistanche deserticola* Y. C. Ma
Mongolian name	Tsoliin Argamjin tsetseg
Folk names	1) Tsagaan goyo; 2) Zerleg goyo; 3) Toson goyo; 4) Suman goyo; 5) Tatigshamo; 6) Goyohoi
Life form and morphology	Parasitic plant, with inflorescences up to 30 cm long (occasionally up to 50 cm), pale pink, sparse hairy, flower petals very short. Desert shrubs are good for breeding and are capable of producing up to 330 flowers per plant and producing about 2,000,000 seeds. Seeds survive for 10-12 years without losing germination.
Habitat	It grows mainly on thick sandy dunes in the Central Asian desert called Gobi.

Tsoliin Argamjin tsetseg is the Mongolian name for *Cistanche deserticola*. Because it mainly grows on the roots of *Haloxylon ammodendron*, and the name comes from the Mongolian which means tethering animals in the desert. Another possibility is because it grows on sand dunes like a rope made of animal's hair. Under the species level of Tsoliin Argamjin tsetse, six folk names were used. This species in South Gobi has been called "goyo" for a long history (Ligaa et al., 2006; Khurelchuluun et al., 2007). Therefore, "goyo" appeared in five names.

The only exception is Tatigshamo (རྟ་ཐེག་ཤ་མོ) (No. 5) which is a Tibetan name. The Gobi region was rich in *Cistanche deserticola*. Since ancient times it has been used as Tibetan medicine to treat many diseases. In South Gobi, the Tibetan medicine is still commonly adopted by the indigenous people, and the local healers and herdsmen call medicinal *Cistanche deserticola* as Tatigshamo.

Goyohoi (No. 6) is a folk name for a type of *Cistanche deserticola*. It refers to the *Cistanche deserticola* with small size but beautiful flower. Goyohoi is very rarely occurred. Other four folk names (No. 1-4: Tsagaan goyo, Zerleg goyo, and Suman goyo) are related to the principal growth stage and development of *Cistanche deserticola*. The explainations are shown in Figure 4.

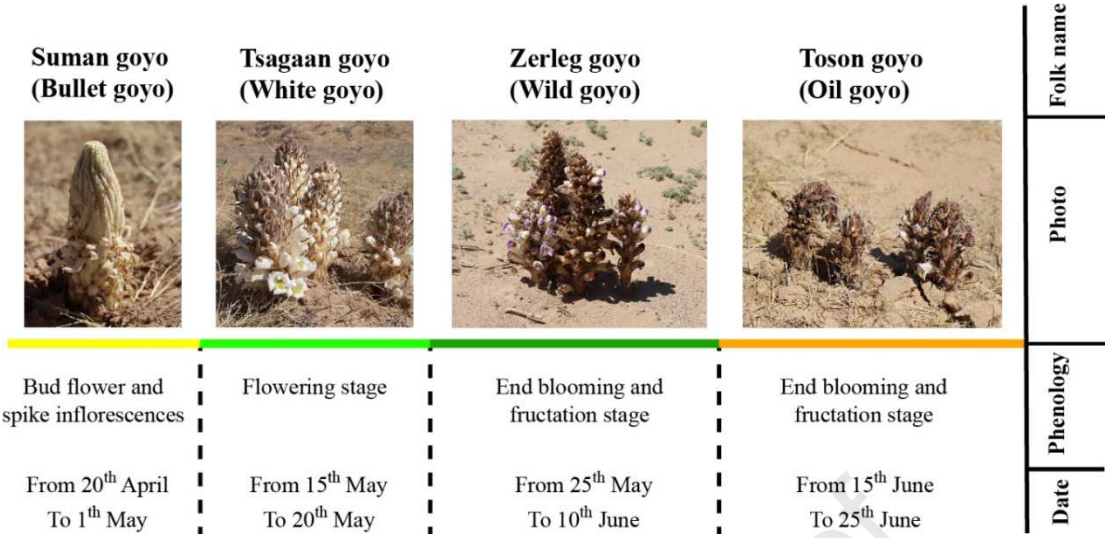

Figure 4. Principal growth stage related to folk names of *Cistanche deserticola*

Suman goyo (Bullet goyo): It is probably because it protrudes from the ground, like a shotgun's bullet. At the bud flower and spike inflorescences stage (Zhang and Tzvelev, 1998) of *Cistanche deserticola*, it is 50-150 (sometimes 250) cm high, with stem rounded, diameter 8(-20) cm, opposite scales, with wide scaly apex, dense surface yellowish or pale yellow, bluish-brown after flowering it becomes colored. The lower part of the stem, which is located at the base of the stem, is coarse, with a cylindrical shape. The scales are often blunt. It resembles like shotgun's bullet form.

Tsagaan goyo (White goyo): The flowering stage starts in early or mid-May (Figure 3), with year to year variations. During the flowering stage, some small floret buds may also form at the top of each side axis of the inflorescence and at the base of each floret group. Inflorescences with drooping flowers begin to bloom from about May 1, and full bloom occurs on May 15-20, and from then on.

Zerleg goyo (Wild goyo): In Mongolia, this type is rarely found. Some plants that do not bloom in the spring will bloom in the fall (September-October) when the moisture content is higher. But they will often fail to produce fruits.

Toson goyo (Oil goyo): Stage of end blooming and fructation of *Cistanche deserticola* is more useful. When the flowering phase is over and the plants are mowing, the resinous liquid is released from the plant. Apart from the fact that the people called resinous liquid as oil, it was also named after the name of the land because of the widespread distribution of the place Tost and Toson Bumba in Umnugobi Province.

We found six developmental stages of *Cistanche deserticola*: bud flower, inflorescence emergence, full flowering, end blooming, senescence and beginning of dormancy. The local people named four flowering stages with different names. It is useful that the growth cycle of *Cistanche deserticola* was differed by folk names in southern Mongolia.

3.4. Folk usage and conservation of Cistanche deserticola

The informants reported that the Gobi bear eats a little of *Cistanche deserticola* during the flowering period, and after flowering. The local people has used it to strengthen valetudinarian animals. *Cistanche deserticola* has been used in traditional Mongolian medicine to heal wounds and stomach aches of children. *Cistanche deserticola* has been used in combination with fluoride for headaches, jaundice, and stomach cramps due to its ability to suppress jaundice and digestion.

In traditional Mongolian medicine, the healing properties of white goyo and red goyo are considered to be similar, and they are also called "oil goyo". It has been a leading fitness medicine for many years and used in traditional medicine. In particular, *Cistanche deserticola* is regarded as one of the best herbal medicines to treat some diseases such as male premature ejaculation and ejaculation, infertility in women, cold back pain, and anemia.

It is common to sink the fleshy stems of *Cistanche deserticola* in alcohol at about 40 degrees in local societies. The dried *Cistanche deserticola* plants are also used for medicinal purposes. Other uses had not been reported.

Cistanche deserticola has, unfortunately, become endangered due to various reasons. The major factors to threat *Cistanche deserticola* are destruction of saxaul forest, overharvest because of increasing market demand, and drought resulted from global environmental change. It has been included in the Mongolian Law on Plants as a rare plant. In the 2nd edition of the "Mongolian Red Book" (1997), it was registered as a very rare and endangered plant. As the only rare and endangered parasitic plant species, it has been included in the 3rd edition of the "Mongolian Red Book" (2013) as an endangered species, and listed in the Mongolian Plant Red List and Conservation Plan (2012).

4. Discussion

Researches about folk nomenclature of *Cistanche deserticola* and other plants in the community were very rare in Mongolia and other countries. Mongolian botanists studied plant systematics (Ulziykhutag, 1984; Manibazar, 2000; Sanchir, 1999; Urgamal, 2019), especially the identification with scientific nomenclature (Banzragch and Luvsanjav, 1965). But none had studied the folk nomenclature. We documented the folk names and Mongolian names of plants in the *Cistanche*-associated community. In particular, folk names of *Cistanche deserticola* related to plant morphology and phenology were described. The folk nomenclature for *Cistanche deserticola* is very useful for people to understand this important medicinal plant, especially its different developmental stages (No. 1-4), its special form (No. 5), and its medicinal property (No. 6).

Based on our field surveys in the Gobi region, local people have a lot of traditional knowledge to recognize plant species and plant phenology by giving them

different names based on morphological and ecological characteristics. Similarities exist in folk and scientific taxonomy. Some folk names for plants in our study areas are similar to those of binomial nomenclature (e.g. names for species in *Artemisia*).

Meanings of names with morphological characteristics showed that physical form and external structure of plants (height, inflorescence, handle, roof, pony, in the shower, or thorns). Additionally, the meanings of folk names contained morphological, color and sensory characters of plants, but only a few original places were recorded because the herders live usually in an area smaller than the plant distribution range. The meaning of name with color is dominant in folk names compared with the other two-name categories (scientific and Mongolian names). The local people mostly named plants by colors of plant parts (leaves, stems, flowers and others). To compare with scientific and Mongolian names, the folk names with sensory characters are used very often for the plants in *Cistanche*-associated community. As the locals do not know the scientific or even Mongolian names, they named plants by sensory characters based on their traditional uses. Therefore, they prefer to give names to plants followed sensory characteristics. There are many cases when the names of different species of plants overlap, and due to this, it is often the case that non-medicinal plants of the same name are wrongly used. For example, two names, red goyo and white goyo, are called “Goyo” under the same folk name, but the scientific names are different. That is, red goyo is for *Cynomorium songaricum* Rupr., while white goyo is for *Cistanche deserticola* Y. C. Ma.

In some cases, there are several different species of plants under the same name (Ligaa et al., 2005). That is, an ethno-species is much bigger than a natural species. Researchers in Inner Mongolia have noted that the folk names of plants are based on observations and understanding of the wild plants that grow in their desert environment (Khasbagan et al, 2000; Khasbagan and Soyolt, 2016), and that the high correlation between folk names and scientific names reflects the scientific meaning of folk botanical names and classifications (Ligaa et al., 2005). Complex primary names consist of two Mongol words. Some complex primary names include a word which indicates the life form. *Caragana spinosa* grows taller for camels, *Caragana pygmaea* is short for goats, and *Caragana leucophloea* is known for its golden stems. In Umnugobi Province, we also found similar names used by the local herders.

Our paper provided a comprehensive list of plants associated with *Cistanche deserticola* in South Gobi of Mongolia. Information presented in this study, especially the host plants of *Cistanche deserticola*, would be valuable to understand this important plant community. Then conservation strategies may be made to effectively protect the rare and endangered species, *Cistanche deserticola*, and the plant community as a whole.

The folk nomenclature of plants was formed gradually based on the local people’s knowledge about plants and their ecological environments. It not only reflects how people describe a plant “species” and its natural ecosystem, but also relates it to its traditional uses. A recent study revealed that local people understood the habitat difference of different ethno-taxa of *Acorus* (Cheng et al., 2020). In the present study, there is also rich ethnoecological information in the *Cistanche* deserticola-associated

community. The morphological and ecological features of plants are the most frequently used terms in the folk nomenclature. The ethnoecological implication of folk nomenclature is valuable for understanding the plant community and conserving plant diversity in Umnugobi Province, and other parts of Mongolia.

As a part of traditional botanical knowledge, the folk names of plants in the *Cistanche* community implied local people's wisdoms. The nomenclature was mostly originated from their morphological, color and sensory characters, or uses. The local people understand the relationships between *Cistanche deserticola* and its associated species. It is essential to document such traditional knowledge associated with plant biodiversity. Thus, biodiversity conservation, taking its associated traditional knowledge as a whole, will be well-implemented according to the Convention on Biological Diversity.

5. Conclusion

In this study, we recorded six folk names for *Cistanche deserticola* in Umnugobi Province, South Gobi of Mongolia. Six developmental stages of *Cistanche deserticola* (bud flower, inflorescence emergence, flowering, end blooming, senescence and beginning of dormancy) were found. The local herders in southern Mongolia named four flowering stages with different folk names.

We recorded 96 species in 26 families and 71 genera from the *Cistanche* community in Umnugobi Province. These plants have been named by morphological characteristics, original place, name in memory of botanist or author, color of plant part, and traditional uses in southern Mongolia. There are some similarities between folk and binominal nomenclature, according to our case study. Many folk names in Umnugobi Province are from the colors of plant parts, i.e. leaves, stems, flowers, fruits, and others. The sensory character has commonly used to name plants in the *Cistanche* community.

Our study provided essential information for biodiversity conservation through documentation of traditional knowledge including folk nomenclature. Conservation strategy will be proposed to protect *Cistanche deserticola* and other species in the plant community in South Gobi of Mongolia.

Conflict of interest

The authors declare that there is no conflict of interest.

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Conflict of Interest

The authors declared that they have no conflicts of interest to this work.

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Title:

Folk nomenclature of plants in *Cistanche deserticola*-associated community in South Gobi, Mongolia

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