Conservation and use of *Calligonum* for the stability of desert ecosystems

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Abstract

There are 35 species of *Calligonum* L. in the worldwide, 23 of which are in China and 8 which are endemic. They play a key role in the stability of desert and gravelly desert ecosystem of China. In order to maintain sustainable utilization, Turpan Eremophytes Botanical garden of the Chinese Academy of Sciences (CAS) have collected 90% of the species of Chinese *Calligonum*. Based on the Eremophytes Botanical Garden's expertise in desert wildlife breeding and introduction ,our study focussed on construction of a specialist *Calligonum* garden.

The long-term objective of the Global Strategy for Plant Conservation is to halt the current and continuing loss of plant diversity. Improve long-term conservation, management and restoration of plant diversity, plant communities, and the associated habitats and ecosystems, *in situ* (both in more natural and in more managed environments), and, where necessary to complement *in situ* measures, *ex situ*, preferably in the country of origin (CBD 2003).

A living plant collection is a group of plants grown for a defined purpose.(BGCI 1998).The *Calligonum* genus is found in North Africa, southern Europe and Asia. It is an ancient genus in the arid desert flora, and the *Calligonum* is found in central Asia (Mao and Pan 1988). *Calligonum* is mainly distributed in arid or semi-arid zone of northwestern China. Because of its high tolerance, extensive root system and considerable seed production, *Calligonum* can survive under severe stress. In China, people have widely used *Calligonum* as a sand-fixing tree (Gao 1988).

Our work is documenting the *Calligonum'*s diversity in China, including its uses and distribution in the wild, in protected areas and in *ex situ* collections; and identifying plant species, plant communities, and associated habitats and ecosystems. Our objective is the construction of a field germplasm garden and community garden for *Calligonum*

The distribution of *Calligonum* in China

The genus *Calligonum* includes a total number of 34 species in the world, of which 23 are in China. They are grouped into four sections (Li *et al*. 2003). *Calligonum* is an ancient genus in the arid desert flora. It is distributed in North Africa, Southern Europe and Asia, and China is in the easternmost part of the distribution range. It grows in Inner Mongolia, Gansu, Qinghai and Xinjiang. There are 12 species in the Zhuengar Basin, covering 50 percent of the total number of species in China, and thus the genus is the most abundant there.

The base of field germplasm garden for *Calligonum*

Turpan Eremophytes Botanical Garden

The *Calligonum* Collection of the Turpan Eremophytes Botanical Garden was begun in the 1970s. In the Garden, more than 19 species were collected and some new species will be introduced in the future. Turpan Eremophytes Botanical Garden has demonstrated positive and promotive results for sand control and desertification control in China; its research on the introduction and application of sand fixation plants gained many outstanding awards. For example, "Tarim Desert Highway" won the 1st-class award for national technological advancement, and a special award for technological advancement from the Ministry of Oil; "Widespread Experiment Research on Fixation Sand and Afforestation in Turpan" won 2nd-class prize for technological achievement from CAS, and 3rd-class prize for technological achievement from the Ministry of Forestry. We have supplied millions of seedlings and ten tons of seeds for afforestation in northwestern China.

Research on *Calligonum* in the Turpan Eremophytes Botanical Garden

We have studied the *Calligonum*'s anatomy, pollen and chromosome characteristics for the *Flora of China* and the *Flora of Xinjiang* .In line with our long-term introduction and experimentation, we have recommended its characteristics and planting techniques in *Desert Control and Forestation* (Gao 1988).

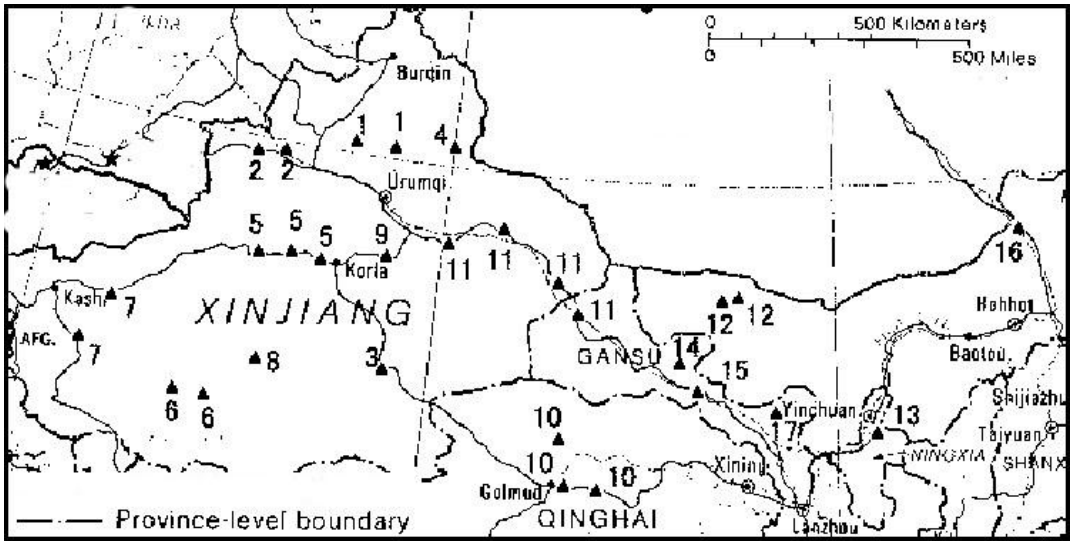

Figure.1 Geographical location of samples for Calligonum *in China*

1 *C.mongolicum* 2 *C.ebi-nuricum* 3 *C.mongolicum* 4 *C.klementzii* 5 *C.kuerlese* 6 *C.roborovskii*
7 *C.yingisarium* 8 *C.taklimakanensis* 9 *C.mongolicum* 10 *C.zaidamense* 11 *C.pumilum* 12 *C.gobicum*
13 *C.mongolicum* 14 *C.mongolicum* 15 *C.chinense* 16 *C.mongolicum* 17 *C.alaschanicun*

The collection of germplasm resource and community elements

We have collected about 29 community plots and 60 soil samples (Figure.1) from 2005 to 2006, some new species are to be surveyed in this July (2007). In our field survey, we set up a community area that measured 10m×10m, and three 0~30cm soil samples were mixed as this community 's soil sample and these three soil samples were disposed following by the community plot's diagonal. We recorded the community 's species

and drew the community's overlay. In every sample plot, we collected fruits, flowers and tress from 20 individuals of *Calligonum* for germplasm resource conservation.

Community gardens' construction

According to soil characteristics and community species elements that we surveyed in

Table 1 Plants occur in community of *Callignum ebi-nuricum*

Family name	Genus name	Species name
Chenopodiaceae	*Atriplex* L.	*Atriplex laevis*
	Corispermum L.	*Corispermum lehmannianum*
	Kochia Roth.	*Kochia prostrata*
	Horaninowia Fisch.et Mey.	*Horaninowia ulicina*
	Lappula V.Wolf.	*Lappula semiglabra*
	Anabasis L.	*Anabasis aphylla*
	Ceratocarpus L.	*Ceratocarpus arenarius*
	Arthrophytum Schrenk	*Arthrophytum longibracteatum*
	Agriophyllum Bieb.	*Agriophyllum squarrosum*
	Haloxylon Bge.	*Haloxylon persicum*
		H. ammodendron
	Halogeton C.A.Mey.	*Halogeton arachnoideus*
		H. glomeratus
	Salsola L.	*Salsola ferganica*
		S. arbuscula Pall.
		S. collina
Labiatae	*Nepeta* L.	*Nepeta pungens*
Compositae	*Echinops* L.	*Echinops gemlini*
	Senecio L.	*Senecio subdentatus*
	Artemisia L.	*Artemisia sphearocephala*
Tamaricaceae	*Tamarix* L.	*Tamarix elongata*
	Reaumuria L.	*Reaumuria soongorica*
Euphorbiaceae	*Euphorbia* L.	*Euphorbia turczaninovii*
Gramineae	*Eremopyrum* (Ldb.)Jaub.	*Eremopyrum orientale*
	Aristida L.	*Aristida pennata*
Zygophyllaceae	*Zygophyllum* L.	*Zygophyllum sp.*
	Nitra L.	*Nitra sp.*
Polygonaceae	*Calligonum* L.	*Calligonum ebi-nuricum*
		C. leucocladum
		C. junceum
Ephedraceae	*Ephedra* L.	*Ephedra glauca Rgl.*
Cruciferae	*Neotorularia*(Coss.)Hedge	*Torularia torulosa*
	Tetracme Bge.	*Tetracme recurvata Bge.*
	Heliotropium L.	*Heliotropium acutiflorum*

field, we selected typical elements for the *c* specific garden. For example, .*Calligonum ebi-nuricum* is endemic. We want to construct its field community garden according as field survey's results (Tables 1 2).

Table 2 The habitat types of *Calligonum* in China

Species	partical size				salinization			nutrition	
	Coarse Sand to gravel sand	More gravel Sand or sand loam	Clay and silt Sand with few gravel	Silver sand without gravel	Few	Low	middle	High total P, total K, available K	High total K
C.mongolicum(caiman)				□	□			□	
C.ebi-nuricum				□		□		□	
C.mongolicum (ruoqiang)		□					□	□	
C.klementzii			□			□		□	
C.kuerlese		□			□			□	
C.roborovskii			□			□		□	
C.yingisarium		□				□		□	
C.taklimakanensis				□	□			□	
C.mongolicum	□					□		□	
C.zaidamense			□		□			□	
C.pumilum		□			□			□	
C.gobicum			□			□			□
C.mongolicum (yinchuan)				□	□				□
C.mongolicum (jinta)□		□			□			□	
C.chinense	□				□				□
C.mongolicum (erlian)	□				□				□
C.alaschanicun	□				□				□

In our field survey, we collected different population's germplasm resource which will increase genetic diversity of the specific garden. The field germplasm resources garden for *Calligonum* is characteristic as different populations and communities. Finally, we want to construct the *Calligonum*. community based on natural community and *Calligonum leucocladum* community,*Calligonum rubicundum* community and so on, which are recorded in *Vegetation of China* and *Vegetation and their utilization in Xinjiang*

According to our survey and analyses (Table 2), we can define five of soil habitat types: none-salinization and alkalization sand habit, high total K sand habitat which the clay and silt are comparative high, light salinization and alkalization sand habit with silver sand, alkalization sand habitat with middle salinization, high total P, available N and available K sand habitat which the clay and silt are comparatively high. And the first type is the main habitat of *Calligonum* in China. In a word, *Calligonum*'s soil habit is sand in China and mainly represents alkalization.

Conservation in future

In order to develop the conservation of *Calligonum* species germplasm, some detailed investigations on the distribution, resources, extinction status and biological and ecological characteristics of *Calligonum* are proposed.

We want to collect all the species of *Calligonum* in the world, including those which are native to central Asia, southern Europe and North Africa, and also collect different populations and communities. In summary, we want our *Calligonum* specialist garden to cover different populations and different types of desert vegetation. Turpan Eremophytes Botanical Garden will become the main centre for the study and conservation of *Calligonum* by 2010.We want to research the genetic diversity, systematics, taxonomy, ecology and conservation biology of *Calligonum* and its communities, associated habitats and ecosystems, and the social, cultural and economic factors that affect its biodiversity. We want to construct specific gardens showing four aspects of *Calligonum*: as living plant collections; community garden; field germplasm resource garden and databank (including its use and its distribution in the wild, in protected areas and in *ex situ* collections).

Discussion

Ex-situ conservation patterns

Most *ex situ* conservation projects relate to germplasm, and the collection of environment and planting patterns of *ex situ* conservation are ignored. This pattern can be called "*ex situ* cultivation", not *"ex situ* conservation"(He 2005). We have collected different populations and community elements in our field survey for our community pattern of *ex situ* conservation. This work is in its early stages and we have much work to do. The design of a community for *ex situ* conservation is the key for our work. The principles and methods of choosing habitat and determining areas, species component and community structure would be addressed. The community structure and the patterns of plants populations will be developed step by step with the growth of the plants in the community. Once a stable community for *ex situ* conservation has been constructed, *Calligonum* species will be more effectively conserved.

Plant nutrition in *ex situ* conservation

Extensive *ex situ* conservation is under way in all of the Chinese botanical gardens. Attention is paid to most of the plant species introduction requirements, but past studies seldom looked at components related to available nutrient conditions required to sustain plant growth and reproduction (Wan et al. 2006). In our field survey, we collected and studied particle size, salinity and nutrient contents in natural soils (Table 2). So we can provide sufficient nutritional supplies through methods, which improve soil fertility and provide essential mineral elements.

Utilization

Some species of *Calligonum*, such as *C. ebi-nuricum*, *C. taklimakanensis* etc, are dominant species in deserts; this must be remembered when restoring desert ecosystems. According to different natural conditions, we should choose suitable plants for introduction from different vegetation types, and pay attention to the character of genetic diversity of plants.

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