A preliminary study on the classification of steppe vegetation using Braun−Blanquet's method (Report of the field study under the Monbusho International Scientific Research Program)

Bull. Sugadaira Montane Res. Cen. No. 9, 9-17 pp. (1988)
(Sugadaira Montane Research Center, University of Tsukuba)

A Preliminary Study on the Classification of Steppe Vegetation Using Braun-Blanquet's Method in Some Areas of Xilin River Basin in Inner Mongolia

TORU NAKAMURA[1], GONG YAOMING[2], JIANG SHU[3]

[1] *Institute of Agriculture and Forestry, University of Tsukuba, Tsukuba, Ibaraki 305, Japan*

[2] *Department of Biology, Inner Mongolia University, Huhehot, Inner Mongolia, China*

[3] *Institute of Botany, Academia Sinica, Beijing, China*

Synopsis

A vegetation survey by Braun-Blanquet's method was conducted in a typical steppe area in Inner Mongolia in order to classify the grassland vegetation according to its species composition. Using 52 relevés collected from several types of vegetation, four associations containing two subassociations were recognized by characteristic species. They make up two orders, two alliances and one class hierarchically:

A. Aneurolepidetea chinensis
  a. Bromo-Agropyretalia desertorum
    1. Bromo-Agripyrion desertorum
      1) Bromo-Agropyretum desertorum
  b. Koelerio-Potentilletalia tanacetifoliae
    2. Koelerio-Potentillion tanacetifoliae
      2) Carici-Stipetum baicalensis
      3) Artemisio-Stipetum grandis
        i. Anemarrhenetosum asphodeoides
        ii. Typical subassociation
      4) Festuco-Stipetum krylovii

These units of vegetation distinguished by species composition can indicate the type and the magnitude of human impact such as mowing and grazing.

Key words: Xilingol grassland, vegetation, Braun-Blanquet's method, *Stipa*, grazing

Introduction

In this paper, the vegetation units of the Xilin River basin in Inner Mongolia are described using Braun-Blanquet's vegetation survey method. The Japan-China Cooporative Research Team for Vegetation Survey undertook this survey in the summer of 1987.

There are many reports on vegetation reserch in Inner Mongolia. Most are based on the Russian method, and few have used Braun-Blanquet's method. This is the first research report on vegetation in the Xilin River basin using Braun-Blanquet's phytosociological method. The species composition of grassland vegetation in the survey area will first be clarified, and will then be used for a classification into vegetation units. Finally, we will describe the relationship between the vegetation units and local environmenrtal factors.

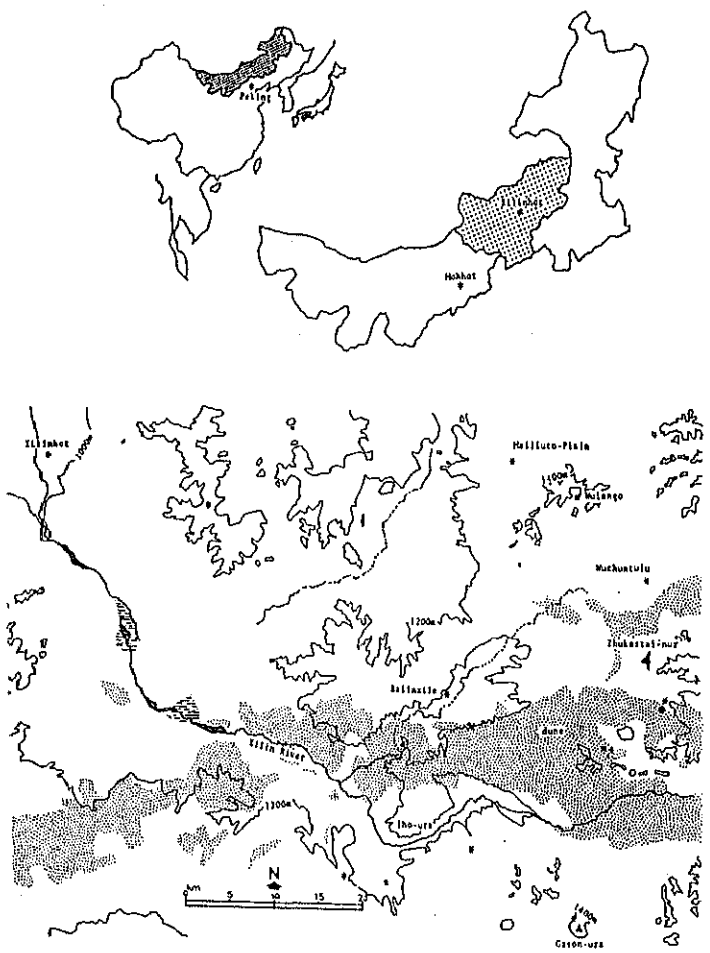

Fig.1 Area surveyed

Outline of area surveyed (Fig.1)

The Xilingol grassland in Inner Mongolia, China, is an area of typical steppe vegetation in the temperate region of the interior of Asia. The vegetation survey was conducted in this area, in the basin of the Xilin River. The Baiinxile Pasture, the center part of the Xilingol grassland, is situated at a latitude of 43°43'N. and at longitude 116°38'E., 1168m above sea level (CHEN 1988). The mean annual temperature is −0.4℃ and the annual precipitation is 427.9mm (CHEN 1988). All of the study area is in a Nature Protection Area, in which the haphazard development of nature is restricted, and was established in 1985 by the Environmental Protection Agency of the Government of Inner Mongolia Autonomous Region (LI et al. 1985). The topography of the survey areas consists of rolling hills 1000-1200m above sea level. Mount Gason-Ura (1506m) is the highest point in the survey area. The principal soils in the areas are Chestnut soils, but Chernozems and sandy soils are also present.

A sand dune where sandy soils is distributed spreads in a belt along the Xilin River.

Method

The vegetation survey in the field and the arrangement of collected relevés in the office were both carried out by the phytosociological method of Braun-Blanquet, in which plant communities are classified by their characteristic species and differential species on the basis of the floristic composition (BRAUN-BLANQUET 1964, MUELLER-DOMBOIS & ELLENBERG 1974). Therefore, the main aim of the vegetation survey was to carefully collect all the names of species growing in the plant community. The species name of plants are according to LIU & LIU (1982).

The survey was made between July and August 1987.

Results

From the various types of vegetation, 55 relevés were collected in the fields survey. This enabled a hierarchical classification to be made according to species composition by table work into 4 associations (containing 2 subassociations), belonging to 2 orders and 2 alliances, all forming one class, as follows (Table 1) :

A. Aneurolepidetea chinensis (*Aneurolepidium chinense* class)
  a. Bromo-Agropyretalia desertorum (*Agropyron desertorum-Bromus irukutensis* order)
    1. Bromo-Agropyrion desertorum (*Agropyron desertorum-Bromus irukutensis* alliance)
      1) Bromo-Agropyretum desertorum (*Agropyron desertorum-Bromus irukutensis* association)
        b. Koelerio-Potentilletalia tanacetifoliae (*Potentilla tanacetifolia-Koeleria cristata* order)

Table 1 Differential Table of Steppe Vegetation in Inner Mongolia

A. Aneurolepidetea chinensis
  a. Bromo-Agropyretalia desertorum
    1. Bromo-Agropyrion desertorum
      1) Bromo-Agropyretum desertorum
  b. Koelerio-Potentilletalia tanacetifoliae
    2. Koelerio-Potentillion tanacetifoliae
      2) Carici-Stipetum baicalensis
      3) Artemisio-Stipetum grandis
        i. Anemarrhenetosum asphodeoides
        ii. Typical subassociation
      4) Festuco-Stipetum krylovii

class		A				
order		a		b		
alliance		1		2		
association		1)	2)	3)		4)
subassociation				i	ii	
n. of sp.	average	38.4	45.2	31.0	30.5	23.5
	range	32-44	32-55	20-41	25-40	21-36
n. of relevé		5	13	17	6	11
CHARACTERISTIC SPECIES OF ASSOCIATION [1)],ORDER[a] and ALLIANCE[1]						
Agropyron desertorum		V	.	.	.	.
Bromus irukutensis		IV	.	.	.	.
Psammochloa villosa		IV	.	.	.	.
Hedysarum fruticosum var. lignosum		IV	.	.	.	.
Artemisia intra-mongolica		V	.	.	.	.
Ribes diancatum		V	.	.	.	.
Prunus sibilica		IV	.	.	.	.
Artemisia parustris		IV	.	.	.	.
Poa argunensis		IV	.	.	.	.
CHARACTERISTIC SPECIES OF ASSOCIATION [2)]						
Stipa baikalensis		.	V	.	.	.
Poa angustifolia		.	V	.	.	.
Carex pediformis		.	V	.	.	.
Thalicutrum minus		.	V	.	.	.
Inula britanica		.	IV	.	.	.
Artemisia laciniata		.	IV	.	.	.
Sanguisorba officinalis		.	IV	.	.	.
Hemerocallis minor		.	IV	.	.	.
Artemisia eliopoda		.	III	.	.	.
Vicia cracca		.	III	.	.	.
Vicia unijuga		.	III	.	.	.
CHARACTERISTIC SPECIES OF ASSOCIATION [3)]						
Stipa grandis		.	.	V	V	.
Allium condensatum		.	I	V	V	.
Artemisia commutata		.	I	IV	V	.
Kochia prostata		.	.	III	III	I
Linum stelleroides		.	II	IV	III	.
DIFFERENTIAL SPECIES OF SUBASSOCIATION [i]						
Anemarrhena asphodeloides		.	.	V	I	.
Thalictrum petaloideum supradecompositum		I	IV	V	.	I
Haplophyllum dauricum		.	.	IV	.	.
Astragalus melilotoides		.	IV	IV	.	.
Gypsophyla davurica		.	.	III	.	.

CHARACTERISTIC SPECIES OF ASSOCIATION (4)]					
Stipa krylovii	·	·	·	·	V
Festuca dahurica	·	II	·	·	IV
Iris tenuifolia	II	II	I	·	IV
Thymus mongolicus	·	·	·	·	II
CHARACTERISTIC SPECIES OF ORDER(b)] and ALLIANCE(2]					
Potentilla tanacetifolia	I	IV	V	V	V
Koeleria cristata	·	IV	V	V	IV
Potentilla bifurca	·	IV	IV	V	V
Potentilla acaulis	·	IV	II	V	IV
Allium tenuissimum	·	III	V	IV	V
Gentiana squarrosa	·	II	V	V	V
Carex korshinskyi	·	III	II	V	V
CHARACTERISTIC SPECIES OF CLASS[A]					
Aneurolepidium chinense	III	V	V	V	V
Agropyron cristatum	II	II	V	V	V
Allium senescens	III	V	V	IV	II
Artemisia frigida	V	IV	V	V	V
Melissitus ruthenica	II	IV	IV	IV	IV
Bupleurum scorzonerifolium	IV	V	III	II	IV
DIAGNOSIS SPECIES					
Serratula centauloides	II	V	V	V	I
Saposhnikovia divaricata	V	IV	V	IV	I
Caragana microphylla	IV	II	V	V	IV
Heteropappus altaicus	·	I	IV	V	V
COMPANIONS					
Schizonepeta multifida	III	V	I	II	·
Cleistogenes squarrosa	·	II	III	V	V
Oxytropis myriophylla	I	IV	II	III	II
Artemisia scoparia	I	II	V	IV	II
Saussurea japonica elata	IV	III	II	II	·
Astragalus adsurgenes	·	IV	III	I	I
Melandrium apricum	IV	I	III	·	III
Achnatherum sibilicum	V	II	II	V	·
Adenophola stenanthina	III	V	I	·	·
Silene jenisseensis	·	II	·	IV	III
Leontopodium leontopodioides	·	IV	I	·	I
Veronica incana	I	III	·	·	V
Dianthus chinensis	III	V	·	·	II

2. Koelerio-Potentillion tanacetifoliae (*Potentilla tanacetifolia-Koeleria cristata* alliance)
   2) Carici-Stipetum baicalensis (*Stipa baicalensis-Carex pediformis* association)
   3) Artemisio-Stipetum grandis (*Stipa grandis-Artemisia commutata* association)
      i. Anemarrhenetosum asphodeoides (*Anemarrhena asphodeoides* subassociation)
      ii. Typical subassociation
   4) Festuco-Stipetum krylovii (*Stipa krylovii-Festuca dahurica* association)

Populus forest was present only on the north face of gentle sand dunes. It contained many tree species unique to it, such as *Populus daviniana, Betula platyphylla, Prunus sibirica, Lonicera chrysantha, Cotoneaster mongolicus* and *Crataegus sanguinea.*

Steppe vegetation in Inner Mongolia can be distingushed from deciduous *Populus* forests by characteristic species of the Class Aneurolepidetea chinensis, such as *Aneurolepidium chinense, Agropyron cristatum, Allium senescens, Artemisia frigida, Melissitus ruthenia* and *Bupleurum scorzonerifolium.*

The steppe vegetation in Inner Mongolia can be classified into two orders (and alliances), Bromo-Agropyretalia (-ion) desertorum and Koerelio-Potentilletalia (-ion) tanacetifoliae. The characteristic species of the former order/alliance are *Agropyron desertorum, Bromus irkutensis, Psammochloa villosa, Hedysarum fruticosum* var. *lignosum, Artemisia palustris* and *Poa argunensis*, and some tree species such as *Artemisia intramongolica, Ribes diacanthum* and *Prunus sibirica*; and the latter order/alliance is characterized by *Potentilla tanacetifolia, Koeleria cristata, Potentilla bifurca, P. acaulis, Allium tenuissimum, Gentiana squarrosa* and *Carex korshinskyi.*

Bromo-Agropyretalia(-ion) desertorum grows only on sand dunes and in sandy soils, and has a distinctive physiognomy of an open grassland containing shrubs.

The soil of the grassland in Inner Mongolia is Chestnut soils on the gentle hill slopes and hilltops.

Details of the four associations are described below:

1. Bromo-Agropyretum desertorum

This association is distinguished by the same characteristic species as that of the order and the alliance with the same species name. The association is widespread on both the northern and southern slopes of the sand dunes along the Xilin River. The species composition and physiognomy of the association differ clearly from other grassland associations in Inner Mongolia. The characteristic species of the association are peculiar to sand dunes, and make up the particular physiognomy.

There are no villages near the sand dunes, and so the magnitude of human impact such as grazing or mowing is not great.

2. Carici-Stipetum baicalensis

This association is distingushed by characteristic species such as *Stipa baikalensis, Poa angustifolia, Carex pediformis* and *Thalictrum minus.* All of them are herbaceous species.

This combination of species is Ass. *Stipa baikalensis* + *Aneurolepidium chinensis* + *Carex pediformis* according to the Russian school of vegetation study, and is known as meadow steppe (THE INNER MONGOLIA INTEGRATED INVESTIGATION TEAM 1985).

This association has the largest number of species and the tallest vegetation height, and the total coverage is almost 100%. It is therefore the most developed grassland association in the survey area. The mean number of species in the surveyed stands belonging to this association is 45.2, and the mean height 0.77m.

This vegetation is mown only once a year, in autumn, and is not grazed because it

is so remote from villages and rivers that it is impossible for livestock to go to the site and return in a day.

In the survey area, this association was investigated at the foot of Mount Gason-Ura, in Wulangou and in the land adjacent to the *Populus* forest on the sand dunes near Zhukestai-nur.

3. Artemisio-Stipetum grandis

This association is a steppe vegetation typical of Inner Mongolia distinguished clearly by five characteristic species, *Stipa grandis, Allium condensatum, Artemisia commutata, Kochia prostata* and *Linum stelleroides*. The association grown in Chestnut soils and Dark Chestnut soils on sites that are completely or almost flat. The vegetation height is shorter than that of the previous association.

This association is divided into the following two subassociations on the basis of the species composition:

1) Anemarrhenetosum asphodeloides

Within Artemisio-Stipetum grandis, Anemarrhenetosum asphodeloides is distinguished by five differential species: *Anemarrhena asphodeloides, Thalictrum petaloideum* var. *supradecompositum, Haplophyllum dauricum, Astragalus melilotoides* and *Gypsophyla davurica*.

The site of this subassociation are rather far from villages, and so grazing is not very intence and mowing is moderate.

This subassociation was observed on the Hailiuto Plain and in Haobuhaxia. The mean number of species is 31.5.

2) Typical subassociation

Stands lacking the differential species of Anemarrhenetosum asphodeloides belong to the typical subassociation of Artemisio-Stipetum grandis. Compared to Anemarrhenetosum asphodeloides, the vegetation height is short and the mean number of species is rather small (30.5 sp.).

The sites of this subassociation are fairly near to villages, so the amount of grazing is moderate. Mowing is not done.

This subassociation grows in Yihewura and elsewhere.

4. Festuco-Stipetum krylovii

At the tops of gentle hills and convex landforms, degraded steppe of this type is established with a paticular species composition and physiognomy. Characteristic species of the association are *Stipa krylovii, Festuca dahurica, Iris tenuifolia* and *Thymus mongolica*.

This association grows on sites near villages and therefore suffers over-grazing. The coverage of vegetation is the lowest (72.7 %) of all in the surveyed area, and the mean number of species is also the smallest (23.5 sp.). The mean vegetation height is 0.18m.

This association grows in Wucunturu, Baiinxile and elsewhere.

Discussion

In the course of our study, it became clear that the grassland in the Xilin River basin of Inner Mongolia could be classified into four associations based on species composition. The relationship of environental factocrs and vegetation units are described below. In the survey area, the grassland vegetation except that on sand dune can be distinguished mainly by three species of the Genus *Stipa (S. baikalensis, S. grandis* and *S. krylovii)* and their companions. *Stipa* is the most important genus of grassland in the cool temperate arid zone of the world. It is windely distributed also in the grasslands of Inner Mongolia, and is differentiated into 11 species in Inner Mongolia (LIU&LIU 1983) according to the growing environment. In the survey area, three species of *Stipa* are distributed according to the type of human impact, in particular to the degree of grazing. *Stipa krylovii* grows at overgrazed sites with some companions; *S. grandis* is distributed in moderately grazed sites with other species; and *S. baikalensis* is established on ungrazed sites. Therefore, the distribution of the three grassland associations is determined primarily by the amount of grazing, through the distribution of the *Stipa* species. The factor that limits the amount of grazing is distance from villages.

The distribution of the three associations is secondarily determind by topography. Carici-Stipetum baikalensis is distributed at the feet of hills; Artemisio-Stipetum grandis grows on flat land or very gentle slopes; and Festuco-Stipetum krylovii is found on hilltops or convex landforms. For this reason, it is considered that the susceptibility to grazing differs accoding to the topology, even if the same number of cattle is grazed.

Acknowledgement

We are obliged to Mr. LIAN HAO, Director of Construction and Environmental Protection Bureau of Inner Mongolia Autonomous Region for his help throughout the reasach. We thank Mr. LI ZHONGHOU and Mr. LI YONGHONG for their assistance of data collection in the field.

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