Survey of alpine vegetation near the forest line in the Ertash Valley of the Sarychat–Ertash State Reserve in the northern Tian Shan Mountains, Kyrgyz Republic

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Summary

As a part of an ecological research project on wild animals in the Sarychat–Ertash State Reserve, we surveyed the alpine vegetation near the forest line (at an elevation from ca. 3,000 to 3,200 m) in the Ertash Valley of the northern Tian Shan mountains of the Kyrgyz Republic. Horses and sheep are kept as livestock in the area and Marco–Polo sheep (argali) and wolves inhabit the region, but information on wildlife, weather conditions and inhabitants' livelihood is hard to obtain. In May 2011, we established 5 transverse transects across a river to describe a cross–sectional view of the vegetation. As a result, the 8 woody species identified belonged to 6 families and all exhibited shrubby forms. Shrubby cinquefoil (*Potentilla fruticosa*) was distributed throughout the survey area, and thorny *Caragana jubata* was interspersed locally. The number of woody species increased significantly at higher elevations. We discuss the reason for the unexpected increase in number of species with increasing elevation.

Key words : Kyrgyz Republic, Tian Shan mountains, Forest line, Moraine, Shrub, Elevation

1. Introduction

In Japan, alpine vegetation is suspected to be damaged by wildlife such as sika deer that invade the alpine zone (Izumiyama and Mochizuki, 2008). Alpine plants grow under severe environments, exposed to low temperature, soil drying, freezing and melting, movement of the soil surface, strong winds, and ultraviolet rays (Masuzawa, 1997 ; Kikuchi, 2003). Vegetation in decline recovers with difficulty because of the low survival of seedlings outside of safe sites (Erschbamer *et al*., 2001) and the erosion or deterioration of bare soil (Tamura and Cheng, 2009). However, alpine zones without herbivores, as in Japan, are a minority ; livestock is often grazed in alpine zones in, for example, Europe, Asia and South America (Takatsuki, 2003). It is expected to be useful for the conservation of vegetation in Japan to understand the development and distribution of alpine vegetation under continuous grazing pressure.

We focused on the Ertash Valley of the Sarychat–Ertash State Reserve of the Kyrgyz Republic (Figs. 1 and 2 ; Photos 1 and 2), an alpine zone inhabited by both livestock and wildlife. This region is located at the northern foot of the Tian Shan mountains ; the Ertash Valley, with an elevation of over 3,000 m, was formed by glacial erosion and reaches the Petrova Glacier at its upper point. Horses and sheep are kept as livestock in the area. Herbivores such as Marco Polo sheep (argali), ibex and deer, and carnivores such as wolves, snow leopards and brown bears also inhabit the region. However, information on wildlife, weather conditions and human inhabitants' livelihood in this region is scarce and hard to obtain, except

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Fig. 1 Location of Sarychat-Ertash State Reserve, Kyrgyz Republic

Table 1 The transects investigated in this study

transect	elevation (m)	length (m)	remarks
No. 1	2,980	90	around Ertash Hut
No. 2	3,060	125	around Kooilu Hut
No. 3	3,120	70	the right bank of Ertash River
No. 4	3,100	45	tributary stream of Ertash River
No. 5	3,160	60	around Bordu Hut

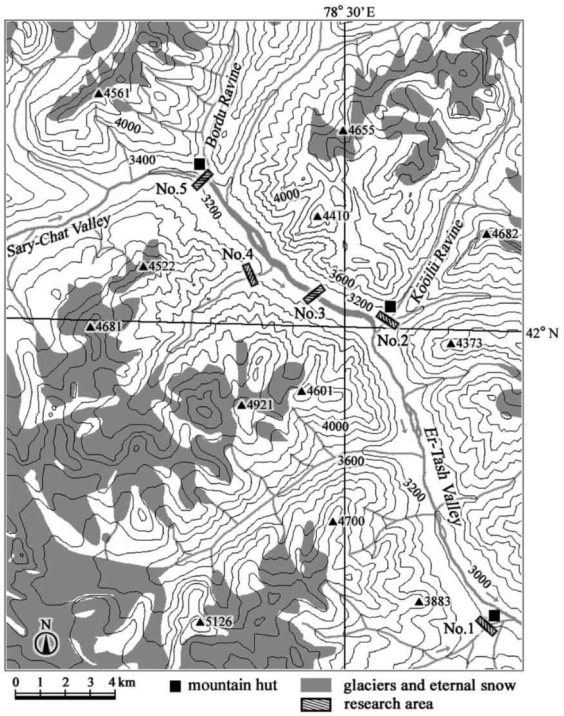

Fig. 2 Geomorphology of Ertash Valley and locations of transects for the vegetation survey

for our survey of steppe vegetation in the neighboring Koyondu Valley (Arase *et al*., 2011) and a study of glacier retreat (Solomina *et al*., 2004).

Many foreign tourists visit the Kyrgyz Republic because of its favorable mountain environment ; the country faces a number of problems as a result of demands for both sightseeing and protection of the national environment. Trophy hunting of wildlife by wealthy foreigners is currently a large source of income, and limited shrubs are excessively gathered for fuel (Watanabe *et al*., 2008).

In this study, as a part of an ecological research project on wild animals in the Sarychat-Ertash State Reserve, we surveyed the alpine vegetation near the forest line (at an elevation from ca. 3,000 to 3,200 m) in the Ertash Valley. We discuss mainly the species and distribution of woody plants in this paper.

2. Methods

In May 2011, we established 5 transverse transects across a river (Fig. 2 ; Table 1) to describe a cross-sectional view of the vegetation. Both the left and the light banks are slopes of a moraine piled with debris.

We measured and described the rough geomorphology using a clinometer and a portable GPS, and recorded the species and location of woody plants. Identification of species is referred to in the literature, e.g., Konta and Shimizu (1996) and Osada (1993).

In order to analyze the relationship between the richness of woody species and the habitat, we calculated the value for Spearman's ρ, a nonparametric statistic of rank correlation. The calculation was manually operated using spreadsheet software (Microsoft Excel 2003).

3. Results

The 8 woody species identified belonged to 6 genera of 6 families, including 1 species of the Salicaceae, 2 species of Rosaceae, 1 species of Fabaceae, 1 species of Elaeagnaceae, 1 species of Caprifoliaceae and 2 species of Asteraceae (Table 2). All exhibited shrubby forms with a height from several dozens of

Table 2 List of woody plant species in Ertash Valley

family name	species name	transect					flood plain	moraine slope
		No.1	No.2	No.3	No.4	No.5		
Salicaceae	*Salix* sp.					○	○	
Rosaceae	*Potentilla fruticosa* L.	○	○	○	○	○	○	○
	Potentilla sp. 2				○	○		
Fabaceae	*Caragana jubata* (Pallas) Poir.			○	○	○		○
Elaeagnaceae	*Hippophae rhamnoides* L.					○	○	
Caprifoliaceae	*Lonicera* sp.							○
Asteraceae	*Artemisia* sp. 1							○
	Artemisia sp. 2							○
	number of woody species	1	1	2	2	5	4	5

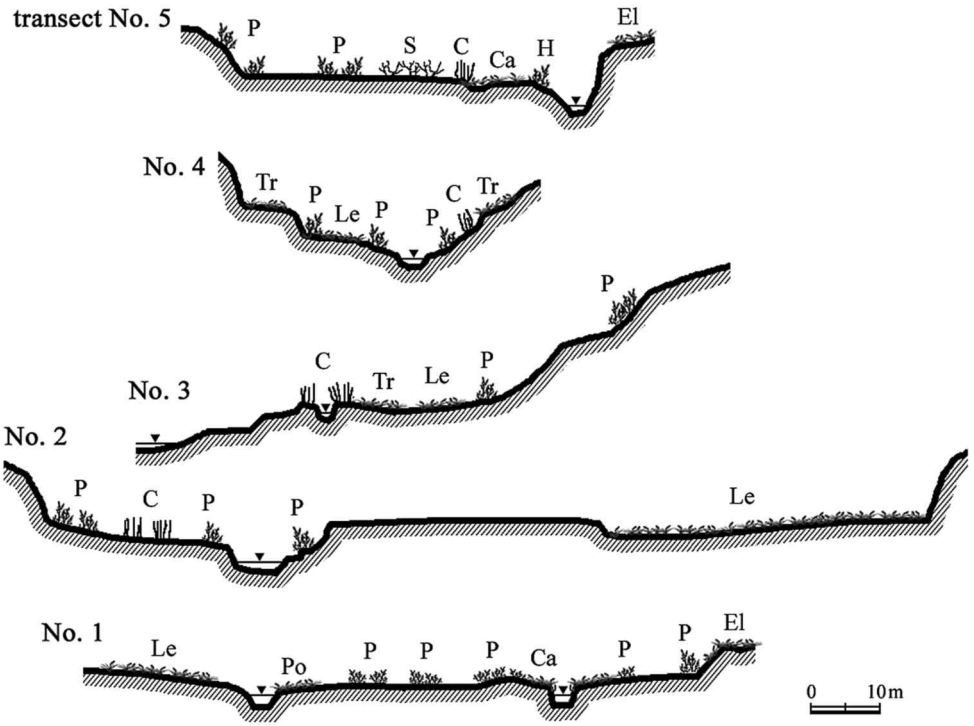

Fig. 3 Cross-sectional views of vegetation along 5 transects
P : *Potentilla fruticosa*, C : *Caragana jubata*, H : *Hippophae rhamnoides*, S : *Salix* sp., Ca : *Carex* sp., Tr : *Trisetum sibiricum*, Le : *Leymus secalinus*, Po : *Poa* sp.
▼ means the water level of each stream.

centimeters to 150 cm.

Shrubby cinquefoil (*Potentilla fruticosa* ; Photo 3) was distributed throughout the survey area, and thorny *Caragana jubata* (Photo 4) was interspersed locally. Observed shrubs with sap fruits, possibly edible to humans and animals, included sea buckthorn (*Hippophae rhamnoides* ; Photo 5) and an unknown species of *Lonicera*. An unknown species of *Salix* showed a tree form creeping on rocks on the ground (Photo 6) at transect No. 5. Most of the surface of the ground was bare ; some patches of a graminoid community lay sporadically, and shrubs grew rather specifically where debris or rocks had accumulated (Fig. 3). Exceptionally, a large-scale grassland of *Leymus secalinus* or *Trisetum sibilicum* existed on the tableland around the Ertash Hut and the Kooilu Hut.

Rank correlation between the number of woody species and elevation was significantly positive

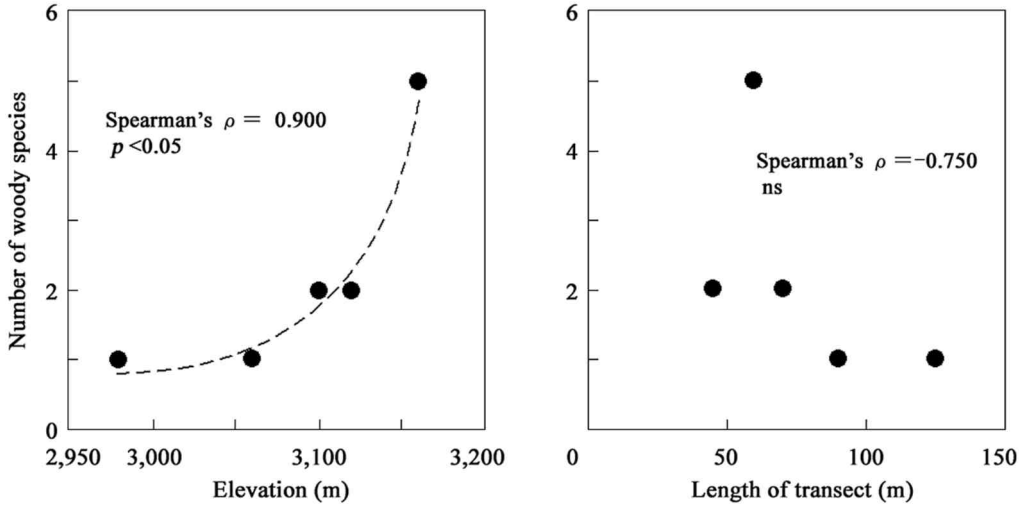

Fig. 4 Number of woody species in relation to elevation and length of transect

(Spearman's $\rho = 0.900$, $p < 0.05$), which indicates that the number of woody species increased at higher elevation (Fig. 4). In particular, a large expanse of brush involving 5 woody species was observed in Bordu Ravine (transect No. 5), at the highest elevation in our survey area. In contrast, the rank correlation between the number of woody species and the length of the transect was not significant ($\rho = -0.750$, ns) and the number of species even tended to decrease in longer transects (Fig. 4), which confirms that the number of woody species was not regulated by the size of survey area. The correlation between elevation and the length of transect was not significant ($\rho = -0.600$, ns).

Other notable observations during our survey and travels were :

a) Based on observation along the principal roads toward Ertash Valley, tall spruce forests expanded at an elevation of ca. 1,800 m, juniper forests were distributed from an elevation of 2,500 m, and standing timber disappeared beyond an elevation of ca. 2,800 m.

b) Inhabitants and the guides generally used dried livestock dung for fuel, which seemed to consist of undigested grass fibers.

c) At Kooilu Hut, a juniper branch, not indigenous to the Ertash Valley, was placed on a beam at the entrance. One of the guides showed us how to ignite it to smoke the hut, which served as an insect repellent. It was unclear whether this evergreen branch also had a religious meaning.

4. Discussion

In all transects, small shrubs were distributed on a flood plain and a moraine slope rather specifically where debris or rocks had accumulated. This landscape is considered the common forest line vegetation, since the upper part of Bordu Ravine (transect No. 5) reaches the permanent glacial area.

The number of woody species increased unexpectedly at higher elevations ; in particular, a large expanse of brush consisting of many species was formed in Bordu Ravine. We could not tell whether the increase was successive or nonlinear, since there were small numbers of transects and species in this study. Our data seem to agree with those of Hulten (1998), who reported two peaks of plant species' richness at low elevation and the forest line in Europe. At higher elevation areas, i.e., along the upper course of a river, it is presumed that the hours of sunlight, soil moisture and production of debris will change gradually as the breadth of the valley decreases. Thus, our observed increase in number of species might resemble the phenomenon that both species diversity and forest line are higher on humid northern slopes than dry southern slopes in the alpine zone (Kikuchi, 2003 ; Raffl *et al*., 2006). However, since the opposite vertical distribution of vegetation has been reported around a singular point such as the cool air lake of

a wind cave (Maki, 1998), it will be useful to obtain data on microgeomorphology and temperature in each transect.

The unexpected pattern of woody plant distribution in this paper will influence the feeding pattern of herbivores, which will complicate the distribution and movement of other wildlife. A year-round vegetation survey involving herbaceous species would help to explain the distribution and movement of wildlife in this area.

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天山山脈北麓エルタシュ谷（キルギス共和国サリチャット・エルタシュ自然保護区）の森林限界の高山植生

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要　　約

野生動物生態調査の一環として，天山山脈北麓エルタシュ谷（キルギス共和国サリチャット・エルタシュ

自然保護区）において，標高およそ3,000～3,200mの森林限界付近の高山植生調査を行った。この地域では，ウマとヒツジの放牧が行なわれ，マルコポーロシープ（アルガリ）やオオカミ等の野生動物も生息しているが，野生生物，気象，生活の情報はほとんどない状況である。植生断面を調査するため，2011年 5 月に，谷を横切る 5 つの帯状区を設けた。確認された 6 科 8 種の木本植物はすべて灌木類であった。キンロバイ（*Potentilla fruticosa*）が調査地全域に分布し，局所的に有刺植物の *Caragana jubata* が点在していた。木本種数は標高が高くなると有意に増加しており，種数増加の原因について考察を加えた。

キーワード：キルギス共和国，天山山脈，モレーン，森林限界，灌木，標高

Photo 1 Landscape of Ertash Valley. The bottom of the valley is about 1 to 2 km broad. Photographed near transect No. 3, 6th May, 2010.

Photo 2 Landscape of Bordu Ravine. The valley narrows and is inhabited by various woody species. Photographed near transect No. 5, 8th May, 2010.

Photo 3 *Potentilla fruticosa* L.

Photo 4 *Caragana jubata* (Pallas) Poir.

Photo 5 *Hippophae rhamnoides* L.

Photo 6 An unidentified species of genus *Salix*. The tree creeps along rocks on the ground.