Landscape Ecological Study on the Habitats of *Genus Ranunculus* Plants and its Distribution

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ABSTRACT

The purposes of this study were to clarify of floristic composition and the landscape structure on the habitats of each *Ranunculus* plant, which were distributed in Daejeon, Korea. Three taxa were distributed and investigated in this study. Floristic composition of habitats were organized by living in flatten open space needed a lot of sunlight and humidity species. Landscape ecological structure of habitats were defined by soils of coarse loamy and loamy skeletal, slope of under 15°, under the five percent of woody coverage at 100-300m above the sea levels. Distribution patterns of *Ranunculus* plants in Daejeon were presented on the 1km X 1km grid map.

Key Words : habitat, genus *Ranunculus*, landscape structure, distribution pattern

INTRODUCTION

The genus *Ranunculus* is particularly well represented in temperate zones especially of the East Asia northern hemisphere. It is a medium-sized genus of family Ranunculaceae of about 600 species (Komarov, 1968; Tamura, 1963; Fujishima, 1985).

Even genus *Ranunculus* species were distributed widely from North America to Asia, most people recognized that those are weeds (Fujishima, 1984; Radosevich *et al.*, 1986; Jones and Luchsinger, 1987). *Ranunculus* plant, however, need to study about the way of conservation and preservation because of use of *Ranunculus* plants are ornamental, medicinal and edible resources themselves and in most country they were designated for endangered or extinct species in their Red-data books (Environment Agency of Japan, 2000). Up to date, very few studies, cytological (Okada, 1981, 1989, 1997; Fujishima, 1983, 1984, 1991; Kang *et al.*, 1996), morphological (Yeau, 1993), palynological (Yeau, 1993) and genetical (Kang *et al.*, 1998) have been carried out on the genus *Ranunculus*, and more needs to be known about the pattern of distribution, population structure, preferred habitats, availability and quality of habitats in relation to landscape ecology.

The genus *Ranunculus* in Korea were reported by Lee (1980) as 10 species 1 varieties totally 11 taxa and all of these taxa 3 taxa were distributed, those were, *R. chienesis, R. japonicus, R. sceleratus* (Kim, *et al.*, 1995; Lee, *et al.*, 1995; Kang *et al.*, 1999; Park, *et al.*, 2000). Each species has a different structure of habitat.

The analysis of species-environment relationship has always been a central issue in ecology (Guisan and Zimmermann, 2000). The quantification of such species-environment relationships represents the core of

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predictive geographical modeling in ecology. These models are generally based on various hypotheses as to how environmental factors control the distribution of species and community. Beside its prime importance as a research tool in autecology, predictive geographical modeling impact of accelerated land use and other environmental change on the distribution of organisms (Lischke *et al.*, 1998; Kienast *et al.*, 1995; 1996; 1998; Guisan *et al.*, 2000), to test biogeographic hypotheses (Mourell and Ezcurra, 1996; Leathwick, 1998), to improve floristic and faunistic atlases (Hausser, 1995) or to set up conservation priorities (Margules and Austin, 1994).

To remedy localized approach, biological diversity need to be managed on the regional landscape level, at which the size of the landscape units more closely approximates the natural units prior to human disturbance (Grumbine, 1994; Noss and Cooperrider, 1994). An alternative to creating a miniature landscape of contrasting habitats on a small scale is to link all parks in an area in a regional plan so that larger habitat units can be created. Some of these larger habitats units would then be large enough to protect rare species that are not able to tolerate human disturbance (Primack, 1995). The objective of ecosystem management is to ensure a balance between sustainable development and preservation for ecological integrity (Gordon *et al.*, 2001).

This paper presents the distribution patterns about Korean *Ranunculus* plants and landscape ecological structure of habitats of three taxa in Daejeon and provides basic information for conserve and preserves Ranunculaceae plants.

MATERIALS AND METHODS

1. Description of Study area

This study was conducted at Daejeon, Korea during March to November 2000. Daejeon is located between 127° 16′ 4″-127° 18′ 36″ east of longitude and 36° 16′ 44″-36° 26′ 14″ of north of latitude at the center of the Korean Peninsula. Daejeon is an important transportation network center in Korea because national railroads, expressways, and highways converge here. Daejeon is situated in a valley that is located in the northwest part of the Noryeong Mountain Range. Mts. Shikjang (508m), Bomoon (457m), Kyejok (429m), and Koobong (264m) surround Daejeon. These mountains give the appearance of a folding screen surrounding Daejeon City. The Kapchon (35.2km), Yudungchon (15.7km), and the Daejeon streams (7.7km) flow from south to north and join the Kum Kang (River). Daejeon is a comfortable and cozy place with low hills, open fields, and numerous rivers.

Daejeon has four distinct seasons. The average annual temperature is 12.1℃; the temperature variance between summer and winter is 27.8℃ with the hottest summer average monthly temperature of 25.5℃ in August and the coldest winter average monthly temperature of -2.3℃ in January. The average annual precipitation is 1,360mm. Fifty-five percent of the total precipitation falls in the summer season due to the influence of high-pressure systems from the northern Pacific Ocean.

2. Methods

This study was conducted landscape ecological structure of the species of *Ranunculus* through phytosociological method from March to November 2000. Surveyed area were all territories of Daejeon. Surveyed items were character of habitats, and their community species. Based on these result detailed soil map (1:25,000; Office of Rural Development, 1974), geography (1:25,000; National Geography Institute, 1996) and satellite photo were over-laid for determine their land use type. Then distribution sites were showed on the 1km x 1km grid map. Korean name and scientific name of plants were according to Lee (1980). The grid size of 1km x 1km was already tested and its efficacy and limit were reported in Korea (Kim and Lee, 1997) and Japan (Nakagoshi *et al.*, 1998).

RESULTS

Distribution patterns of each taxon were shown Fig. 1. Out of the 541 grids, at twenty-four only *R. chinensis*, at 17 only *R. sceleratus* and at 22 only *R. japonicus* were observed. At two *R. chinensis* and *R. sceleratus*, at one *R. japonicus* and *R. sceleratus*, and at five *R. japonicus* and *R. chinensis* were observed, respectively.

Species composition and landscape ecological structure of each habitat was as follow:

1) Ranunculus sceleratus

R. sceleratus is a perennials plant of Ranunculaceae, which grow near the rice fields and ditch of central and southern area about 100-300m above sea level in Korea. The characters of habitat of *R. sceleratus* are abundant of moist and semi-wet condition, but sufficient sunlight, and near the streams and eutrophic ponds. R. sceleratus is one of the important element of Alopecuro-Ranunculetum scelerati (Miyawaki and Okuda, 1972) with *Beckmannia syzigachne, Alopecurus aequalis* var. *amurensis, Cardamine flexuosa, Persicaria thunbergii, P. sieboldii, P. longiseta, P. nodosa, Majus japonicus, Youngia denticulata, Comnelina communis, Steptolirrion cordifolium, Juncus effusus* var. *decipiens, J. bufonius, Capsella bursa-pastoris, Alopecurus aequalis var. amurensis, Stellaria alsine* var. *undulata, Oryza sativa, Leersia japonica, Bidens frondosa, Oenanthe javanica, Aneilena keisak, Rorippa islandica, Mazus pumilus, Cardamine flexuosa, Erigeron canadensis*, and *E. annuus*. This community was found at south 0-10 slope, above the sea level 210m. Structure of this community was Shrub layer, 4m (20%); Herb. layer, 0.8m (90%), respectively. Distribution pattern of R. sceleratus was showed on the Fig 1.

High likelihood landscape ecological structure (Table. 1) of *R. sceleratus* was soils of Coarse loamy, mesic, under 250m above the sea level flat areas with 0-25 slope. Vegetation rating was spare woody cover (under 5 %).

2) Ranunculus japonicus

R. japonicus is a perennials plant of Ranunculaceae, which grow near the rice fields and ditch of central and southern area about 200-300m above sea level in Korea. The characters of habitat of *R. japonicus* are almost same with *R. sceleratus* that is abundant of moist and semi-wet condition, but sufficient sunlight, and near the streams and eutrophic ponds. This species build a communiy with *Beckmannia syzigachne, Alopecurus aequalis var. amurensis, Cardamine flexuosa, Persicaria thunbergii, P. sieboldii, P. longiseta, P. nodosa, Majus japonicus, Youngia denticulata, Comnelina communis, Steptolirrion cordifolium, Juncus effusus* var. *decipiens, J. bufonius, Capsella bursa-pastoris, Alopecurus aequalis var. amurensis, Stellaria alsine* var. *undulata, Oryza sativa, Leersia japonica, Bidens frondosa, Oenanthe javanica, Aneilena keisak, Rorippa islandica, Mazus pumilus, Carex humilis, Erigeron canadensis, Ranunculus japonicus, Ajuga multiflora, Galium pogonanthum,Cardamine flexuosa, Erigeron canadensis*, and *E. annuus*. This community was found at south 0-10 slope, above the sea level 210m. Structure of this community was Shrub layer, 3-4m (15-20%); Herb. layer, 0.8-1.5m (90%), respectively. Distribution pattern of *R. sceleratus* was showed on the Fig 1.

High likelihood landscape ecological structure (Table 1) of R. japonicus was soils of Coarse loamy, mesic, under 210m flat areas with 0-30 slope and near drainage within 10m flood plains. Vegetation rating was spare woody cover (under 5 %).

Table 1. Landscape structure of habitats of genus *Ranunculus* plants.

Taxon		R. Chinensis	R. japonicus	R. sceleratus
Soil structure	High likelihood	Loamy skeletal, mesic	Coarse loamy, mesic	Coarse loamy, mesic
	Medium likelihood	Coarse loamy, mesic Coarse loamy, mixed nonacid, mesic Sandy skeletal, mixed, mesc	Loamy skeletal, mesic Sandy skeletal, mesic	Coarse laomy, mixed, nonacid, mesic Loamy skeletal, mesic
	Low likelihood	Coarse silty, mixed, nonacid, mesic Fine clayey, mixed, mesic Fine loamy, mixed, mesic	Coarse silty, mixed, nonacid, mesic Fine clayey, mixed, mesic Fine loamy, mixed, nonacid	Fine clayey, mixed, mesic Fine loamy, mixed, mesic
Landform structure	High likelihood	< 250m flat area (0<slope<15) near the drainage within 10m flood plains	< 210m flat area (0<slope<30) near the drainage within 10m flood plains	< 250m flat area (0<slope<25) near the drainage within 10m flood plains
	Medium likelihood	>250m steep slope (slope > 15) more than 20m away from drainage	>250m steep slope (slope > 30) more than 30m away from drainage	>250m steep slope (slope > 30)
Vegetation structure	High likelihood	Spare woody cover (<5%)	Spare woody cover (<5%)	Spare woody cover (<5%)
	Medium likelihood	medium to hugh woody cover (5-30%)	medium to hugh woody cover (5-30%)	medium to hugh woody cover (5-30%)
	Low likelihood	High woody canopy cover (>30%)	High woody canopy cover (>30%)	High woody canopy cover (>30%)

3) Ranunculus chienesis

R. chienesis is a perennials plant of Ranunculaceae, which grow near the rice fields and ditch of central and southern area about 200-300m above sea level in Korea. The characters of habitat of *R. sceleratus* are abundant of moist and semi-wet condition, but sufficient sunlight, and near the streams and eutrophic ponds. *Adenophora triphylla* var. *japonica, Pteridium aquilinum* var. *latiusculum, Thesium chinense, Chrysanthemum boreale, Potentilla fragarioides, Eupatorium chinense* var. *simplicifolium, Artemisia keiskeana, Angelica cartilagino-marginata, Chaenomeles lagenaria, Senecio integrifolius* var. *spathulatus, Poa acroleuca, Galium verum var. asiaticum, Cynanchum paniculatum, Lespedeza maximowiczii, Arundinella hirta, Sanguisorba officinalis, Solidago virga-aurea* var. *asiatica, Carex forficula, Patrinia scabiosaefolia, Gentiana squarrosa, Aster scaber, Lysimachia clethroides, Miscanthus sinensis, Ixeris dentata, Viola violacea, Imperata cylindrica* var. *roenigii, Cirsium japonicum var. ussuriense, Potentilla freyniana, Carex neurocarpa, Viola mandshurica, Gentiana scabra* var. *buergeri, Miscanthus sinensis var. purpurascens, Smilaxchina, Carex humilis, Hypericum erectum, Eupatorium lindleyanum, Artemisia princeps* var. *orientalis, Allium monanthum, A. thunbergii, Festucaovina, Rhus chinensis.* This community was found at south 0-10 slope, above the sea level 200-300m. Structure of this community was Shrub layer, 1.5m (15-20%); Herb. layer, 0.5-1m (90%), respectively. Distribution pattern of *R. sceleratus* was showed on the Fig 1.

High likelihood landscape ecological structure (Table 1) of *R. japonicus* was soils of loamy skeletal, mesic, under 250m flat areas with 0-15 slope and near drainage within 10m flood plains. Vegetation rating was spare woody cover (under 5 %).

DISCUSSION

Environmental heterogeneity and interspecific differences in microhabitat preferences appears to be important factors contributing to the maintenance of species diversity within the genus *Ranunculus* in the forests understory.

Form the viewpoint of species composition; habitat structure is almost same between *Ranunculus japonicus* and *R. sceleratus*. Observed plants in their habitat are needed abundant of moist and semi-wet condition, but sufficient sunlight, and near the streams and eutrophic ponds. *Commelina communis* is the most abundant species in the habitat with some *Carex* and *Persicaria* spp. Those species also need the same condition such as humidity and sunlight. While species composition of habitat of *R. chinensis* is different from other two species. Species composition of habitat of *R. sceleratus* and *R. japonicus* is more closer than *R. chinensis*.

The common features of landscape ecological structure were a lot of sunlight and high humidity under 300m above the sea level. Fewer than 5% woody cover in vegetation rating was also the same among these taxa. The habitats of these taxa were distributed near the cultivated fields such as paddy and rice field. Rice field has special vegetation structures of habitats of mire species and cultivated species. However, a lot of cultivated field of Daejeon has been decreased year by year. From 1990 to 1998, eleven (4%) grids from 92 to 81 (from 19.44% to 16.44%) decreased cultivated field of Daejeon (Kang *et al.*, 2000). Habitat loss and modification are the most important cause of endangered species (Foin *et al.*, 1998). It is essential for rare plant conservation to incorporate habitat assessment into development planning to minimize destruction of their habitats and maximize the effectiveness of mitigation efforts (Dale *et al.*, 1998; Cuperus *et al.*, 1999). Given the many conflicts between

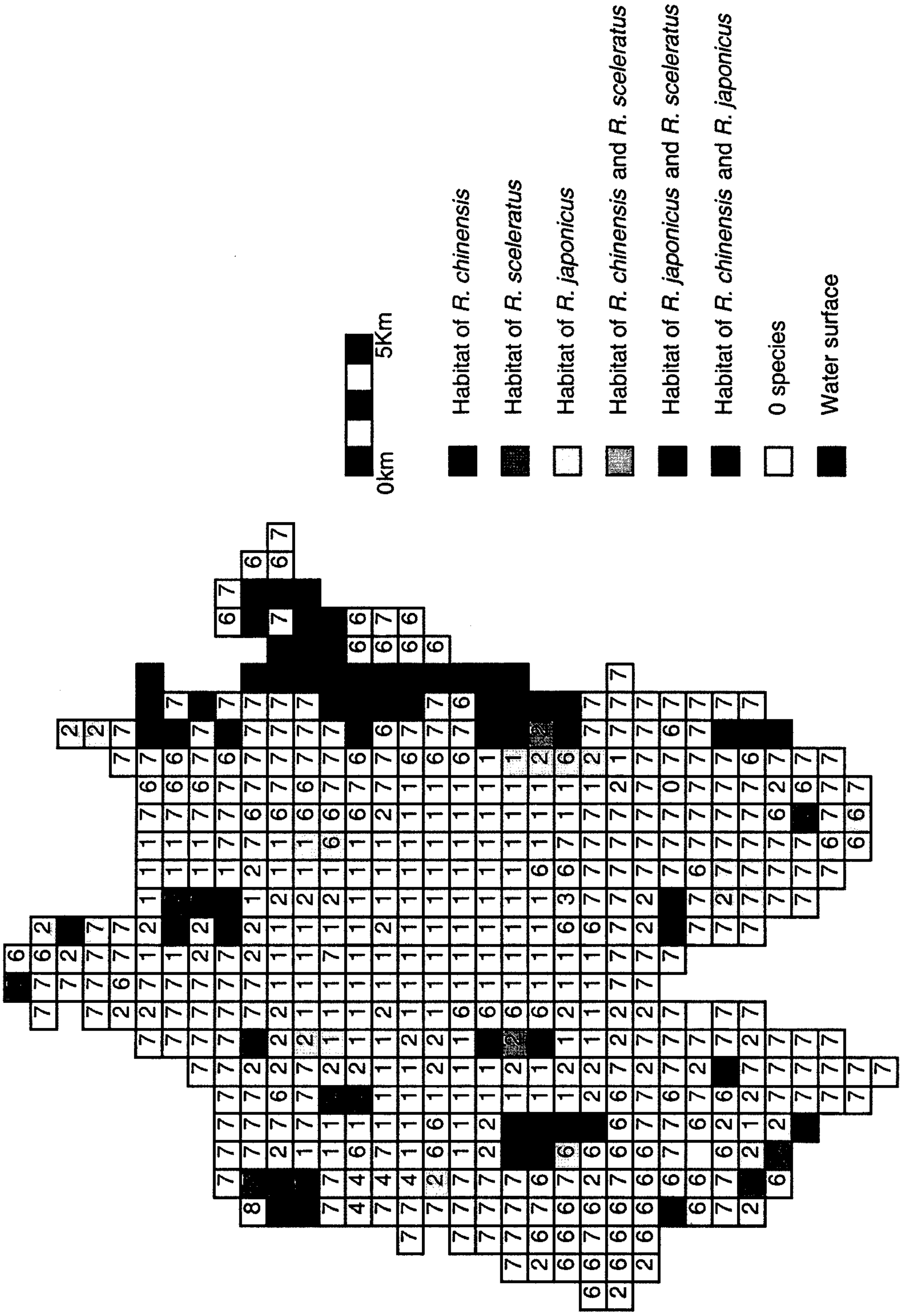

Fig.1. Distribution map of the genus *Ranunculus* in Taejon, Korea, Numbers mean the land use type (Korean Ministry of Environment, 1988)

rare species conservation and regional economic development (Stevens, 1996), it is also essential for distribution in evaluation of alternative plans to minimize potential land use conflicts (Nantel *et al.*, 1998) and reduce development project costs. Although potential benefits are great, assessment of habitat distribution and suitability for rare plant species is often not incorporated into planning processes. One reason is the limited information, often largely scattered in gray literature, on the biology and especially ecology of rare plant species (Smith *et al.*, 1997; Smeins and Wu, 1998; Wiser *et al.*, 1998). This literature must be complied and synthesized to make it readily accessible to researchers and practitioners. Another reason is the lack of effective approaches for multiple-species habitat assessment across different spatial scales (Wu and Smeins, 2000). The need for regional-scale conservation planning has increased given the recent emphasis on regional habitat conservation planning and the development of regional and multispecies recovery plant (Martin, 1995). Regional-scale habitat assessment can improve spatial allocation of conservation efforts and resources, and facilitate strategic development planning to minimize impacts on rare plant resources and potential land use conflicts (Nantel *et al.*, 1998). Planning processes for conservation reserve design and development project sitting most often occur at large landscape-scales and need spatially explicit assessment of suitability and spatial configuration of habitats for evaluation of metapopulation viability and selection of alternative sites (Akcakaya *et al.*, 1995; Lindenmayer and Possingham, 1996). Site level assessment is needed for verification of landscape scale interpretation and field evaluation for fine-scale surveys, construction or maintenance planning, monitoring and mitigation (Pavlik, 1997).

Species diversity at any one point in a landscape is determined by multiple factors acting at multiple scales (Turner and Gardner 1991, Turner 1989, Wiens 1989). At the landscape sale, The frequency and spatial distribution of critical habitats and resources determines species distribution patterns (Swingland and Greenwood 1983, Pearson, 1993), while historical accidents, community interactions, and spatio-temporal variability further limit the distribution that is realized at any given time (Debinski *et al.* 2001).

Information on the habitat requirement of the rare plants was synthesized and formalized through the development of the models. These syntheses and models greatly improve the availability of information and habitat assessment tools to involved in conservation and development planning The processes of model development and application help to identify knowledge and data gaps to guide future research and provide a framework for improving habitat assessment with new knowledge grained in the future (Wu and Smeins, 2000).

We have shown that these three species differ considerably in their small landscape scale environmental distribution. Our results suggest and support that environmental heterogeneity is an important determinant of interspecific distribution patterns in the forest understory not just for common species (Bratton, 1976; Crozier and Boerner, 1984; Beatty, 1985), but also for relatively infrequent species within a funtional group (Vellend *et al.*, 2000).

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