

## Ecological Study on the *Vitex rotundifolia* communities in Korea

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**Abstract** : Ecological characteristics of the five *V. rotundifolia* communities located at the east and west coast of Korea were investigated. The growth status of *V. rotundifolia* plant was fairly good, but the community habitats were faced on serious damages because there was no specific management and conservation plans. In the habitat soils, salt concentrations ranged from 8.20 to 14.5dS/m, and the contents organic matter were very low, 0.03 to 0.31%. Thus, the *V. rotundifolia* plant could be cultivated in unfertile soils with even high salts, such as barren coastal dunes and reclaimed lands. Also, it might be very useful as an environmental afforestation plants. Vascular plants grown in the five *V. rotundifolia* community habitats were up to 144 taxa with 45 families, 108 genus, 130 species, and 14 varieties. Among these plants, 25 taxa of woody plants, 119 taxa of herbaceous plants, and 21 taxa of naturalized alien plants were found.

### 1 Introduction

*Vitex rotundifolia* L. fil. is the deciduous broad-leaved shrub belonged to Verbenaceae growing naturally in the regions of China, Japan, and Korea. In Korea, it naturally inhabits in sandy soils of seashores (Lee, 1989; Yeeh et al., 1996). This plant species is known as a creeping plant, but occasionally found in shrubby form (Kim & Park, 1998).

*V. rotundifolia* grown in the seashore areas stabilizes sandy hills, and also it can be well grown and adapted in different conditions of nature; arid or humid soil, sea sand, weathered granite soil, and red silty loam soil. Moreover, the plant species is very applicable to afforest any of littoral and inland areas because of its strong salt-tolerance and growth stability in any soil conditions (Park & Kim, 2004; Park & Lee, 2004).

In addition, the leaves and branches of *V. rotundifolia* have been used as bathing materials because they have strong and unique herbal incense, and its dried nuts (so-called Manhyungja) have been used as an oriental medicine for tonic or fiber and pain relievers. (Perry, 1980; Korea Research Institute of Chemical Technology, 1988; Song et al., 1990; Kimura et al., 1996). Also, many scientists have been interested in the plant species containing some of bioactive materials that would be applicable for anticancer, antioxidant, antimutagen, antiallergy, insect repellence, and pain relief (Miyazawa et al., 1995; Watanabe et al., 1995; You et al., 1998; Okuyama et al., 1998; Ono et al., 1999; Shin et al., 2000).<sup>1</sup>

However, the habitats of *V. rotundifolia* have been continuously reduced by negative impacts due to the constructional and recreational developments and damages at seashore areas in Korea. Furthermore, only a few ecological and morphological studies for the habitat conservation and the cultivation of the plant species have been found in Korea. Kim and Park (1998) reported the

ecological habitat survey and morphological characteristics of the plant. Studies related to the plant propagation and cultivation have only been reported by Park and Park (2001) and Kim and Park (2004), which were conducted to investigate the properties of seed germination in the different stage of seed collection and to examine the method of cutting propagation as influenced by the treatment of growth stimulant in different topsoil conditions. Kim et al. (2007) reported a study relevant to the plant seedling cultivation as affected by the different applications of fertilizers in different soils.

Therefore, this study was conducted to investigate the ecological characteristics of *V. rotundifolia* grown in its community habitats in Korea to release important information for the conservation and propagation of the plant species because they are very applicable for stabilizing coastal sand dunes, afforesting damaged littoral and inland areas, and natural incense material.

### 2 Materials and Methods

#### 2.1 Geographic and topographic distributions

Five *V. rotundifolia* communities investigated are all close to the west and east coasts of the Korean peninsula (Table 1 and Figure 1); thus, they were highly influenced by sea wind and salts. The plants in the habitats were grown approximately from 50~70m to 10m above the sea level during the low and high tides, respectively. In particular, around the 15<sup>th</sup> of July in the lunar calendar every year (so-called Baekjung-sari) or when it was severe storm, the sea water occasionally reached close to the plant habitats. However, the mean altitude of the five community habitats ranged from 3 to 10m, and the mean gradient of the habitats was up to 15°.

#### 2.2 Ecological investigation for *V. rotundifolia* community habitats

##### 2.2.1 Description of experimental habitats

Five different habitats of the plant community were selected. The habitats were located in the west and east cost of Korea. Size of the selected habitats was at least 1,500m<sup>2</sup> or larger, and the locations are Taean peninsula

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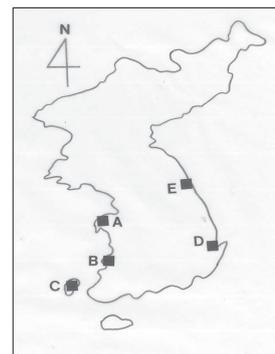
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**Table 1.** Description of the selected five *V. rotundifolia* community habitats

Community	Administrative district	North Altitude	Longitude	Azimuth
Shinduri (A)	Shinduri beach, Wonbuk-myun, Taehan-gun, Chungnam	36°51'	126°12'	N25°W
Gyukpori (B)	Jackeundang beach, Gyukpo-ri Byunsan-myun, Buahn-gun, Chunbuk	35°35'	126°28'	N5°W
Bikeumdo (C)	Wonpyung beach, Bikeum-do, Bikeum-myun, Shinahn-gun, Chonnam	34°47'	125°54'	N60°W
Hwajinri (D)	Hwajin-2-ri beach, Songra-myun, North-gu, Pohang-si, Kyungbuk	36°15'	129°23'	N30°E
Mengbangri (E)	Upper Mengbang beach, Mengbang-ri Keunduck-myun, Samchuck-si, Kangwon	37°22'	129°13'	N55°E

**Figure 1.** Locations of the selected five *V. rotundifolia* community habitats in Korea.

in Chungnam, Byunsan peninsula in Chonbuk, Bikeumdo in Chonnam, Pohang in Kyungbuk, and Samchuck in Kangwon. The administrative districts and geological locations of the experimental habitats were presented in Table 1 and Figure 1.

### 2.2.2 Investigation of the plant growth conditions

#### A. Habitat status

The investigation for the plant habitat status was conducted during the periods of May to September of 2006 and 2007 to collect experimental information including the locations of the community habitats, the sizes of experimental habitats, and their damaged status.

#### B. Soil survey

Soils were collected from the three sampling sites: the front sandy beach, inside and outside of back parts of the plant community habitats. The soil samples were air-dried to pass through a 2-mm sieve and analyzed for selected chemical properties: soil pH, salt content, soil organic matter content, concentration of total nitrogen. The soil pH was measured in a 1:5 soil-to-water mixture (v/v) using a pH meter (pH340i, WTW, Germany). The content of soil organic matter was determined by the Tyurin method. The concentration of total nitrogen was measured by the micro-Kjeldahl method after digesting the soil samples with conc. sulfuric acid. The salt content was analyzed in a 1:5 soil-to-water mixture (v/v) using a electric conductivity (EC) meter (Conductivity meter, ORION, model135, Germany).

#### C. Flora survey

The vascular plants grown in the each community habitats were investigated. The list of the plants investigated were arranged by the classification system of Fuller and Tipppo (Lee, 1989), and the naturalized plants were classified by using the system proposed by Park et al. (2002).

## 3 Results and Discussion

### 3.1 Ecological aspect of *V. rotundifolia* communities

#### 3.1.1 Conditions of the community and their growth environment

##### A. Shinduri community in Taehn peninsula

The community habitat is wide-spread in the large area of the dunes, which is formed in approximately 2km in length around Shinduri beach in Wonbuk-myun, Taehan-gun of Chungnam province. The community habitat was the largest one among the five selected habitats, but the investigated area in the community habitat was about 1,740m<sup>2</sup>. The natural *V. rotundifolia* is densely growing at the part of the beach dunes, and the growth status of the plant is fairly good (Fig. 2). However, the plant community habitat is now seriously considered in major damage problems because there are several on-going constructional projects at the Shinduri beach, such as the constructions of seawall, road, and recreational and private lodging facilities (Fig. 3).

##### B. Gyukpori community in Byunsan peninsula

The community habitat is located at the Jackeundang beach of Gyukpo-ri in Byunsan-myun, Buahn-gun of Chunbuk province. It is settled at the sandy field of the beach close to sea level, which is spread around the area of approximately 2,100m<sup>2</sup>, and the plant is relatively well grown (Fig. 4). However, this community habitat also has problems. The habitat is separated by a local road, and the soils in the habitat field have been eroded up to 20cm along with the roadsides. Thus, the *V. rotundifolia* root exposure has been occurred with the severe soil erosion damages. Furthermore, this habitat is now faced on a serious damage-causing problem because this area has been publically allowed for recreational sea bathing which makes many visitors, so that finally being public recreational place will cause more and severe damages.

##### C. Bikeumdo community in Shinahn

The community habitat is existed around the Wonpyung beach of Bikeum-do, Bikeum-myun, Shinahn-gun of Chonnam province. The plant in the

community habitat was densely grown along with all area of the beach, but now the habitat is left only about 2,500m<sup>2</sup> because this area has been damaged by the constructions of roads and seawall (wave breaker) and the afforestation for wind break. Also, during the every summer, the plant has been cut or rooted out by local residents (fishers) to dry all kinds of fishes. Thus the plant has been seriously damaged, so that it will be necessary to apply specific managements for the plant and habitat (Fig. 5).

#### D. Hwajinri community in Pohang

The community habitat has been formed at the seashore of Hwajin-2-ri in Songra-myun, North-gu of Pohang-si in Kyungbuk province, which covers approximately 8,017m<sup>2</sup> in large area. At the center of the community habitat, there are military patrol roads and wired fences; thus, because of these, a part of *V. rotundifolia* plants has been damaged, but most of the plants are fairly well grown (Fig. 6). In the *V. rotundifolia* community habitat, another plant species, *Rosa rugosa*, can be found, so that local residents have collected the parts of both plant species, roots of *Rosa rugosa* and nuts of *V. rotundifolia*, to use as oriental medicinal materials. Therefore, the habitat damages are seriously expected in near future.

#### E. Mengbangri community in Samchuck

The community habitat is placed at the seashore of the upper Mengbang in Mengbang-ri, Keunduck-myun of Samchuck-si in Kangwon province. The overall area of the community habitat reaches about 54,000m<sup>2</sup>, which is the second largest one next to the Shinduri community habitat located in Taean peninsula. This habitat is clearly separated to two sections by a military boundary fence. One is sandy hill area at the sea-side zone, and the other is a zone in *Pinus thunbergii* forest (about 1.5km in length and 30~40m in width) that has relatively lower growth density of the *V. rotundifolia* with fairly good conditions. Both habitat zones are well protected because these areas are in military restriction (Fig. 7).



Fig. 2. *V. rotundifolia* community habitat in Shinduri

Fig. 3. *V. rotundifolia* community habitat in Shinduri(2009)

Fig. 4. *V. rotundifolia* community habitat in Gyukpori

Fig. 5. *V. rotundifolia* community habitat in Bikeumdo

Fig. 6. *V. rotundifolia* community habitat in Hwajinri

Fig. 7. *V. rotundifolia* community habitat in Mengbangri

### 3.2 Soil conditions in the communities

The results of the chemical characteristics of soils in the five *V. rotundifolia* community habitats were shown in Table 2. Soil pH of the habitat sites ranged from 5.64 to 7.49, which indicates that the soils were distributed from weak acid to weak alkali. It was clearly lower at the area getting far from the beaches, and then there is any significant difference among the soils in the five community habitats. In addition, the soil pH only in the areas within the community habitats was tended to be mostly neutral (data not shown). The concentrations of salts in the habitat soils were between 5.54 and 18.24 dS/m with large deviation, but the salt concentrations within the community habitats were from 8.20 to 14.52dS/m, which indicates that the *V. rotundifolia* is surely a strong salt-resistant plant. As comparing the salt concentrations in the soils among the different habitats, they were 14.52dS/m and 13.55dS/m in the Bikeumdo and Gyukpori habitat soils, respectively, which are relatively higher than those in other habitat soils. Also, the salt concentration increased with getting close to the beaches, which shows a similar trend as the soil pH changes.

The contents of soil organic matter ranged between 0.01 and 0.31% in the habitats, which are much lower than those in upland/paddy/forest soils. These lower contents of soil organic matter might be caused by the difficulties of organic layer formation due to the instability of soil horizons with severe sea winds. Although the contents of soil organic matter is very low, in the Hwajinri habitat in Pohang and Mengbangri habitat in Samchuck located at the east sea coast, the contents were relatively higher (about 0.2 to 0.3%) than other habitats. It might be caused by the *P. thunbergii* community habitats placed with the *V. rotundifolia* community habitats in the same areas.

The concentrations of total nitrogen in the habitat soils were negligibly low or less than in detection limit, which was caused by the lower contents of soil organic matter due to the difficulties of organic accumulation in the habitats.

Those results indicate that the *V. rotundifolia* dominates and forms a community in unfertile soils with high salt concentrations. Therefore, the *V. rotundifolia* is very important and useful for the phytoprotection, reclamation and/or environmental afforestation, of coastal dunes and lands.

### 3.3 Vascular plants in the *V. rotundifolia* community habitats

Vascular plants mixed in the five *V. rotundifolia* community habitats were total 144 taxa consisted of 45 families, 108 genus, 130 species, and 14 varieties (Appendix 1). Among these, the herbaceous plants were

**Table 2.** Selected chemical properties of soils in the five *V. rotundifolia* community habitats

Site	pH(1:5)					Salt conc.(1:5, dS/m)					Organic matter(%)					Total nitrogen(%)				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
I	6.92	7.49	7.21	7.10	6.75	10.42	16.70	18.24	9.84	10.66	0.01	-	-	0.01	0.02	-	-	0.01	0.02	0.01
II	6.43	6.64	6.83	6.54	6.42	8.50	13.55	14.52	8.20	9.32	0.07	0.03	0.05	0.12	0.31	0.02	-	0.02	0.06	0.08
III	5.84	5.68	6.50	5.81	5.64	7.44	10.85	10.30	6.38	5.54	0.08	0.02	0.03	0.14	0.22	0.03	-	0.01	0.08	0.07

Note: I(front), II(inside), III(background), A (Shinduri community in Taeahn peninsula), B (Gyukpori in Byunsan peninsula), C(Bikeumdo community), D(Hwajinri community in Pohang), E(Mengbangri in Samchuck)

**Table 3.** Vascular plants found in the five *V. rotundifolia* community habitats

Habitat	Herbaceous plants					Woody plants					Total				
	F	G	S	V	taxa	F	G	S	V	taxa	F	G	S	V	taxa
Shinduri	26	45	47	6	53	8	12	12	-	12	32	56	59	6	65
Gyukpori	25	49	57	4	61	11	14	14	-	14	34	63	70	5	75
Bikeumdo	27	53	60	6	66	9	11	12	-	12	33	64	72	6	78
Hwajinri	30	60	65	7	72	6	7	6	1	7	33	67	70	8	79
Mengbangri	25	54	53	8	61	6	8	10	-	10	29	60	63	8	71
Total	36	91	107	12	119	14	19	23	2	25	45	108	130	14	144

Note: F(Family), G(Genus), S(Species), V(Variety)

119 taxa with 36 families, 91 genus, 107 species, and 12 varieties, and the woody plants were 25 taxa with 14 families, 19 genus, 23 species, and 2 varieties (Table 3).

The herbaceous plants existed in all of the five *V. rotundifolia* community habitats were *Elymus mollis*, *Ischaemum antheperodes*, *Zoysia macrostachya*, *Carex kobomugi*, *C. pumila*, *Suaeda japonica*, *Lathyrus japonica*, *Limonium tetragonum*, *Calystegia soldanella*, *Aster hispidu*, *Sonchus brachyotus*, *Dagitaria sanguinalis*, *Miscanthus sinensis* var. *purpurascen*, *Setaria viridis*, *Commelina communi*, *Humulus japonicus*, *Rumex crispus*, *Lepidium apetalu*, *Oxalis corniculat*, *Oenothera odorat*, *Metaplexis japonicus*, *Scutellaria strigillos*, *Bidens bipinnata*, *Erigeron canadensi*, and *Lactuca indica* var. *laciniata*, but *Pinus thunbergii* was only the woody plant grown in all of the habitats.

Other plants frequently found in the habitats were *Asparaus cochinchinensis*, *Chenopodium album* var. *centrorub-rum*, *Achyranthes japonica*, *Phytolacca americana*, *Sedum oryzifolium*, *Rosa rugosa*, *Trifolium repens*, *Glehnia littoralis*, *Messerschmidia sibirica*, *Astemisia annua*, *A stemisia princeps* var. *orientalis*, *Aster spathulifolius*, *Bidens tripartita*, and *Erigeron annuus*. Total 21 taxa of the naturalized alien plants were found in all of the habitats, which were composed of 10 families, 17 genus, 20 species, and 1 variety. Among them, *Amorpha fruticosa* and *Robinia pseudoacacia* were only the woody plants, and five species, *Rumex crispus*, *Phytolacca americana*, *Lepidium apetalu*, *Oenothera odorat* and *Erigeron canadensi*, were widely distributed in all the community habitats.

Thirteen naturalized alien plants were found In the Mengbangri habitat, Samchuck (E), which were the highest populations of alien plants found among the community habitats, and the smallest population was

10 naturalized alien plants found in the Jackeundang habitat in Byunsan peninsula (B). Increases of the naturalized alien plants have made many ecological problems. They disturbed natural endemic plants; for example, the plant like *Ambrosia artemisiifloia* var. *elatior* disturbs our ecological system and causes allergy symptoms with its pollen (Park et al., 2002). Therefore, it is necessary to continuously manage the habitats with long-term monitoring systems.

#### 4 Conclusions

Ecological characteristics of the five *V. rotundifolia* community habitats located at the east and west coast of Korea were investigated. *V. rotundifolia* plant is deciduous broad-leaved shrub that naturally grows around seashore areas. The growth status of the plant in the five habitats was fairly good. However, the habitats are faced on serious damages in near future because there is no specific management and conservation plans. In the habitat soils, salt concentrations ranged from 8.20 to 14.52dS/m, and the contents organic matter were very low, 0.03 to 0.31%. According to the results, the *V. rotundifolia* plant could be cultivated in unfertile soils with even high salts, such as barren coastal dunes and reclaimed lands. Thus, it might be very useful as an environmental afforestation plants. Vascular plants grown in the five *V. rotundifolia* community habitats were up to 144 taxa with 45 families, 108 genus, 130 species, and 14 varieties. Among these plants, woody plants were 25 taxa including 14 families, 19 genus, 23 species, and 2 varieties, and herbaceous plants were 119 taxa consisted of 36 families, 91 genus, 107 species, and 12 varieties. On the other hand, there are 21 taxa of naturalized alien plants found. The Hwajinri habitat in Pohang had the largest number of plants, 79 taxa, whereas the habitat in the Taeahn peninsula contained the smallest, 65 taxa, among all the five habitats. The biodiversity with various plants is

positively effective for the stabilization and maintenance of the sand dune ecosystems. However, the *V. rotundifolia* community habitats might be degenerated by increasing prevalent plants such as *P. Thunbergii*, *Rosa multiflora*, *Phragmites communis*, *Ischaemum antheperodes*, *Imperata cylindrical* Var. *koenigii*, and *Humulus japonicu*.

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**Appendix 1. Vascular plants in the five *Vitex rotundifolia* community habitats in Korea**

Family name	Scientific name	Community				
		A	B	C	D	E
Equisetaceae	<i>Equisetum arvense</i>	○		○		
Pinaceae	<i>Pinus thunbergii</i>	○		○		○
Graminaceae	<i>Arundinaria simonii</i>		○		○	
	<i>Arundinella hirta</i>			○		
	<i>Avena fatua</i>			○		
	<i>Beckmannia syzigachne</i>		○	○		
	<i>Bromus japonicus</i>				○	
	<i>Cymbopogon tortilis</i> var. <i>goeringii</i>					○
	<i>Digitaria sanguinalis</i>	○	○	○	○	○
	<i>D. violascens</i>	○	○			
	<i>Echinochloa crus-galli</i>			○		
	<i>Eleusine indica</i>		○	○		○
	<i>Elymus mollis</i>	○	○	○	○	○
	<i>Eragrostis multicaulis</i>		○			
	<i>Ischaemum antheplhorodes</i>	○	○	○	○	○
	<i>Miscanthus sacchariflorus</i>		○	○		
	<i>M. sinensis</i> var. <i>purpurascens</i>	○	○	○	○	○
	<i>Phragmites communis</i>			○	○	
	<i>Setaria glauca</i>		○			
	<i>S. viridis</i>	○	○	○	○	○
	<i>Sporobolus elongatus</i>				○	
Cyperaceae	<i>Zoysia macrostachya</i>	○	○	○	○	○
	<i>Carex kobomugi</i>	○	○	○	○	○
	<i>C. pumila</i>	○	○	○	○	○
	<i>Cyperus amuricus</i>	○		○	○	
Commelinaceae	<i>Commelina communis</i>	○	○	○	○	○
Liliaceae	<i>Allium senescens</i>				○	
	<i>Asparagus cochinchinensis</i>		○	○	○	○
	<i>Smilax china</i>	○	○			
Dioscoreaceae	<i>Diospyros batatas</i>	○		○		○
	<i>D. japonica</i>		○			
Fagaceae	<i>Quercus serrata</i>					○
Ulmaceae	<i>Ulmus davidiana</i> var. <i>japonica</i>		○			
Cannabiaceae	<i>Humulus japonicus</i>	○		○	○	○
Urticaceae	<i>Boehmeria tricuspis</i>		○	○		
Polygonaceae	<i>Persicaria blumei</i>		○	○		
	<i>P. lapathifolia</i>		○		○	
	<i>P. nodosa</i>	○		○		
	<i>P. perfoliata</i>	○		○	○	
	<i>P. senticosa</i>		○	○		
	<i>P. thunbergii</i>				○	
	<i>Polygonum aviculare</i>				○	○
	<i>P. bellardi</i> var. <i>effusum</i>				○	
	<i>Rumex acetosa</i>			○	○	
	<i>R. crispus</i>	○	○	○	○	○
Chenopodiaceae	<i>Atriplex subcordata</i>		○	○	○	
	<i>Chenopodium album</i> var. <i>centrorubrum</i>	○		○	○	○
	<i>C. ficifolium</i>	○		○		
	<i>Salsola collina</i>	○				
Chenopodiaceae	<i>S. komarovii</i>					○
	<i>Suaeda asparagoides</i>	○		○	○	
	<i>S. japonica</i>	○	○	○	○	○
Amaranthaceae	<i>Achyranthes japonica</i>	○	○	○	○	
	<i>Amaranthes viridis</i>				○	
Phytolaccaceae	<i>Phytolacca americana</i>	○	○	○	○	
Portulacaceae	<i>Portulaca oleacea</i>				○	
Caryophyllaceae	<i>Cerastium fischerianum</i>	○			○	
	<i>Dianthus sinensis</i>				○	○
Ranunculaceae	<i>Clematis apiifolia</i>	○	○	○		
	<i>C. mandshurica</i>					○
Menispermaceae	<i>Cocculus trilobus</i>	○	○	○		
Fumariaceae	<i>Corydalis heterocarpa</i>				○	○
Cruciferae	<i>Lepidium apetalum</i>	○	○	○	○	○
Crassulaceae	<i>Orostachys malacophyllus</i>				○	○
	<i>Sedum oryzifolium</i>	○		○	○	○
Rosaceae	<i>Potentilla chinensis</i>				○	○
	<i>P. chinensis</i> var. <i>concolor</i>				○	○
	<i>Rosa multiflora</i>		○			
	<i>R. rugosa</i>	○		○	○	○
	<i>R. wichuraiana</i>	○		○		
Fabaceae	<i>Rubus parvifolius</i>	○	○			
	<i>Amaphicarpaea edgeworthii</i> var. <i>trisperma</i>		○	○		
	<i>Amorpha fruticosa</i>		○		○	○

	<i>Cassia minosoides</i> var. <i>nomane</i>	○				○
	<i>Glycine soja</i>		○			○
	<i>Kummerowia striata</i>		○		○	
	<i>Lespedeza bicolor</i>	○				○
	<i>L. cuneata</i>				○	○
	<i>L. thunbergii</i> var. <i>intermedia</i>					○
	<i>L. tomentosa</i>					○
	<i>Lathyrus japonica</i>	○	○	○	○	○
	<i>Medicago lupulina</i>			○	○	○
	<i>M. sativa</i>				○	
	<i>Pueraria thunbergiana</i>	○	○	○		
	<i>Robinia pseudoacacia</i>	○		○		○
	<i>Trifolium repens</i>	○	○	○		○
Oxalidaceae	<i>Vicia angustifolia</i>		○			
Euphorbiaceae	<i>Oxalis corniculata</i>	○	○	○	○	○
	<i>Euphorbia jalkini</i>					○
	<i>E. humifusa</i>					○
Celastraceae	<i>Celastrus orbiculatus</i>			○		
Vitaceae	<i>Parthenocissus tricuspidata</i>		○			
	<i>Vitis coignetiae</i>		○			
Violaceae	<i>Viola seoulensis</i>					○
Onagraceae	<i>Oenothera odorata</i>	○	○	○	○	○
Umbelliferae	<i>Glehnia littoralis</i>	○	○	○	○	
Plumbaginaceae	<i>Limonium tetragonum</i>	○	○	○	○	○
Asclepiadaceae	<i>Metaplexis japonica</i>	○	○	○	○	○
Convolvulaceae	<i>Calystegia hederacea</i>		○			
	<i>C. soldanella</i>	○	○	○	○	○
Borraginaceae	<i>Messerschmidia sibirica</i>	○	○	○	○	
Verbenaceae	<i>Vitex rotundifolia</i>	○	○	○	○	○
Labiatae	<i>Leonurus sibiricus</i>	○				
	<i>Scutellaria strigillosa</i>	○	○	○	○	○
Solanaceae	<i>Datura stramonium</i>				○	
	<i>Lycium chinensis</i>			○	○	
	<i>Solanum nigrum</i>	○		○	○	○
Scrophulariaceae	<i>Linaria japonica</i>				○	○
Acanthaceae	<i>Justicia procumbens</i>		○			
Plantaginaceae	<i>Plantago depressa</i>				○	
Rubiaceae	<i>Galium spurium</i>				○	○
	<i>Paederia scandens</i>		○	○		
	<i>Rubia akane</i>	○		○		
	<i>R. cordifolia</i> var. <i>pratensis</i>	○		○		
Carprifoliaceae	<i>Lonicera japonica</i>	○	○			
	<i>L. japonica</i> var. <i>repens</i>				○	
Cucurbitaceae	<i>Actinostemma lobatum</i>				○	
	<i>Trichosanthes kirilowii</i>		○	○		
Compositae	<i>Ambrosia artemisiifolia</i> var. <i>elatio</i>					○
	<i>Asteris annua</i>	○	○	○	○	
	<i>A. japonica</i>	○				
	<i>A. princeps</i> var. <i>orientalis</i>	○	○	○	○	
	<i>Aster hispidus</i>	○	○	○	○	○
	<i>A. spathulifolius</i>	○	○	○	○	
	<i>Bidens bipinnata</i>	○	○	○	○	○
	<i>B. frondosa</i>					○
	<i>B. parviflora</i>					○
	<i>B. tripartite</i>		○	○	○	○
	<i>Chrysanthemum boreale</i>		○		○	○
	<i>Eclipta prostrata</i>		○			
	<i>Erigeron annuus</i>		○	○	○	○
	<i>E. bonariensis</i>	○				
	<i>E. canadensis</i>	○	○	○	○	○
	<i>E. sumatrensis</i>	○	○			○
	<i>Filifolium sibiricum</i>	○				
	<i>Ixeris repens</i>			○	○	○
	<i>Lactuca indica</i> var. <i>laciniata</i>	○	○	○	○	○
	<i>Petasites japonicus</i>					○
	<i>Siegesbeckia glabrescens</i>	○		○	○	
	<i>Sonchus brachyotus</i>	○	○	○	○	○
	<i>Tagetes minuta</i>				○	
	<i>Taraxacum hallaisanensis</i>		○			○
	<i>Xanthium strumarium</i>	○	○			○
	<i>Youngia sonchifolia</i>					○

Note: A, Shinduri community in Taean peninsula; B, Gyukpori community in Byunsan peninsula; C, Bikeumdo community in Shinahn; D, Hwajinri community in Pohang; E, Mengbangri community in Samchuck

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