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Distribution Characteristics, Population and Vegetation Structure of *Corylopsis coreana* in Korea

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ABSTRACT: This study examined the distribution, population and vegetation structure of *Corylopsis coreana* in South Korea. *C. coreana* is distributed around the Suncheon area, Jeollanam-do, on the southern part of the Korean Peninsula, but the species is also found in Pocheon and Gangneung, on the central and central east parts of the peninsula. This discontinuous pattern of distribution is coupled with the unusual feature of only growing on northern exposed slopes. The mean density of *C. coreana* populations is 35 individuals per 100 m^2, ranging up to a maximum of 92 individuals per 100 m^2. Cut specimens sprouted a maximum of 38 stems per plant. Based on DCA analysis, the species' habitats was divided into three types by species composition and stratification structure. These types include: habitats affected strongly by human activities, valley and mantle communities which are affected relatively little by human activities, and stable forests. Populations affected by artificial intervention have actually flourished, while some populations in the stable forest system have declined. We conclude that the species, now endangered, should be maintained by means of specific external interventions such as cutting or removal of the canopy. To this end, further ecological data should be collected through monitoring and research to identify appropriate interventions to support threatened *C. coreana* populations.

Key words: *Corylopsis coreana* population, Cutting, Discontinuous distribution, Sprouting, Vegetation condition

INTRODUCTION

Corylopsis coreana Uyeki (family Hamamelidaceae) is endemic in the Korean peninsula, and is designated a Category Ⅱ Endangered Species by the Wildlife Protection Act. The Hamamelidaceae are mainly distributed throughout East Asia and also occur in North and Central America. A total of 140 species in 27 genera have been identified worldwide. The genus *Corylopsis* includes 29 species endemic to East Asia: 20 species in China, 5 species in Japan, 3 species in India, and 1 species in Korea (Lim et al. 2005a). Generally, plants of the family Hamamelidaceae tend to show endemic or isolated distributions at the species and genus level (Yamanaka 1986).

Since *C. coreana* was designated as an endangered species in 1998, extensive research on its distribution has been conducted (Kim and Han 1997, Kim and Han 1998, Hong and Choi 1998, Kim et al. 1999, Oh and Lee 1999, Lim and Yun 1999, Lim and Im 2002, Hyun and Park 2002, Lim et al. 2005b). Previous studies on *C. coreana* cover a diverse range of topics including ecological characteristics, new cultivars, sprouting dynamics, and comparisons between cut and non-cut populations (Kim et al. 1998, Lee et al. 1999, Lee 2002, Noh 2004).

C. coreana has many rootlets and a very positive sprouting response after cutting, but this species is better known for its easy preservation and management (Lim et al. 2005b). Lee et al. (1999) detail the vegetation structure and sprouting dynamics of the *C. coreana* community in the Bammuryjae area of Jiri national park, and noted the tendency for sprouting to occur from the root of *C. coreana* in closed fields. Lim et al. (2005a, b) also studied the dynamics and distribution characteristics of the population. However, Kim et al. (1998) report that the species has an extremely limited population and habitat. Noh (2004) studied the habitat characteristic of the species and reported that it is primarily distributed on north or northwest-facing slopes.

This paper investigates the distribution, population and vegetation structure of *C. coreana* in Korea. Specifically, we examined the geographical distribution of the *C. coreana* Uyeki on the Ko-

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rean Peninsula, including habitats from which it has not been previously reported.

MATERIALS AND METHODS

Information about the distribution of *C. coreana* was obtained from the literature, surveys, and consultation with specialists. We conducted fieldwork and vegetation surveys between July 2003 and September 2006 to confirm patterns of distribution. The vegetation surveys were performed using the phytosociological approach of Braun-Blanquet (1964). The arrangement included 1～5 relevés in each area in which the species was found, and data were gathered from 56 relevés in total. The vegetation data were used to compile a complete table of vegetation conditions. Subsequently, the characteristics of *C. coreana* habitats were identified using the vegetation data, and the structural differences among populations were analyzed with DCA (detrended correspondence analysis), PC-ORD ver. 2.0, MJM software. For the DCA analyses, the Braun-Blanquet scale was converted to Maarel's scale (van der Maarel 1979).

We established 1～4 quadrats (10 × 10 m^2) in each area to collect data such as sprout number, diameter and height. The diameter of each sprout was measured at 1/3 of its above-ground height because there are trees shorter than 1 meter. We then plotted the positions of all of the trees in the plots.

Taxonomic nomenclature used in this manuscript follows Lee (1999).

RESULTS

Distribution Characteristics

Fig. 1 shows the natural distribution of *C. coreana* in South Korea. It is widely distributed over the Korean peninsula, from 126° 55' 20" to 128° 55' 30" longitude and from 34° 31' 30" to 38° 05' 00" latitude. The distribution is concentrated in areas around Suncheon, Jeollanam-do, but *C. coreana* is also found in discrete patches on Mt. Baegun in Gyeonggi-do and Mt. Manggibong in Gangwon-do (number 33 and 34 in Fig. 1). Furthermore, these two populations, which were more than 2° in latitude away from Suncheon were thriving. In many cases, *C. coreana* is found within mantle communities in valley areas and is distributed on the middle and lower sections of slopes and ridges (Table 1). In Cheongsogol, Suncheon, the local population measured approximately 20～50 m in width and about 50～1,000 m in length along the forest edge, a relatively extended distribution for this species. In contrast, the populations on Mt. Cheonhwangbong in Namwon and Mt. Manggibong in Gangneung were distributed only in limited areas. The configuration of local populations in these areas was not elongated

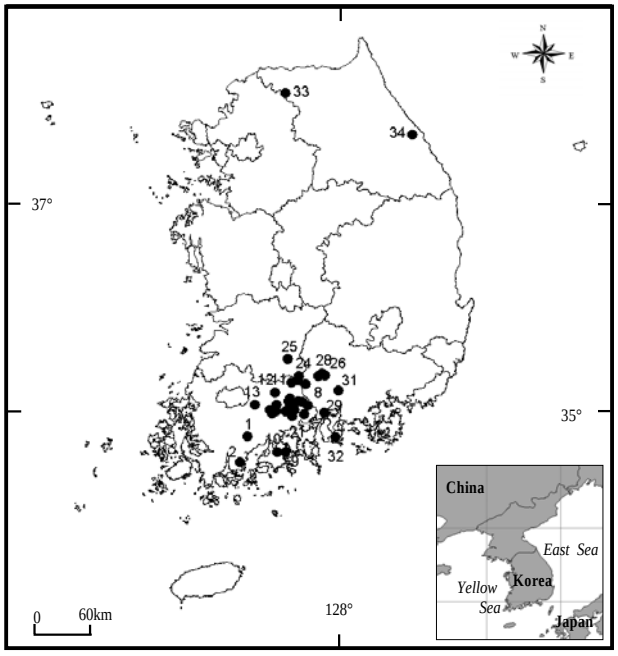

Fig. 1. Map showing the distribution of *Corylopsis coreana* populations. District numbers are listed in Table 1.

but generally circular. The distribution scales in these populations varied from hundreds to tens of thousands of square meters while the vertical distribution of *C. coreana* ranged from lowlands (60 m asl) to mountainous regions up to 1,000 m asl. In addition, a new population was discovered in Gangneung, Gangwon province. The population of *C. coreana* in this habitat covered a total area of about 12,303 m^2 at an elevation of 550 m on Mt. Manggibong in Eonbyeol-ri, Gangdong-myeon, Gangneung, Gangwon-do.

At present, the most unusual characteristic of the species is that its distribution is limited to north-facing, northwest-facing and northeast-facing slopes (Fig. 2, Appendix 1). The gradients of the slopes on which the species is found range from 5° to 40° (mean= 25°).

Population Density and Sprouting Characteristics

The population density, sprout numbers and characteristics of the *C. coreana* populations surveyed are shown on Table 2. Population densities ranged from 5 to 92 individuals/100 m^2 (mean= 35/100 m^2), the number of sprouts ranged from 1 to 38 stems/plant (mean 4.6/plant) and the sprout diameter at one third of the height above the ground ranged from 0.1 to 9.5 cm (mean= 1.7 cm). The population density was highest, at 56～92 individuals/100 m^2, on Mt. Eokbulbong in Gwangyang-si, Jeollanam-do, and lowest, at 8～10 individuals/100 m^2, on Mt. Geum in Namhae-gun, Gyeongsangnam-do (Fig. 3). The species is broadly distributed in dense local populations on the mid-section of the pine- and oak-dominated slopes

Table 1. The administrative district and simple information on the distribution of *Corylopsis coreana*. The number is the same as that for Fig. 1

No.	District	Features of locality
1	Mt. Hwangchu, Boseong-gun, Jeollanam-do	~400 m asl
2	Mt. Cheongwan, Jangheung-gun, Jeollanam-do	Valley
3	Mt. Baegun, Gwangyang-si, Jeollanam-do	500~1,000 m asl, ridge, mantle
4	Mt. Dosolbong, Gwangyang-si, Jeollanam-do	600~800 m asl, ridge, mantle
5	Mt. Dungjuribong, Suncheon-si, Jeollanam-do	350~500 m asl, ridge, mantle
6	Mt. Yonggye, Suncheon-si, Jeollanam-do	300~500 m asl, ridge, mantle
7	Mt. Guksabong, Gwangyang-si, Jeollanam-do	300~400 m asl, ridge, mantle
8	Mt. Eokbulbong, Gwangyang-si, Jeollanam-do	400~700 m asl, middle part of slope
9	Mt. Paryeong, Goheung-gun, Jeollanam-do	Mantle community of valley, ridge
10	Mt. Ullam, Goheung-gun, Jeollanam-do	Mantle community of valley
11	Mt. Nogodan, Jirisan (Mt.), Jeollanam-do	Middle-lower part of slope
12	Bongjo-ri, Gokseong-gun, Jeollanam-do	Valley
13	Seo-ri Hwasun-gun Jeollanam-do	Middle-lower part of slope
14	Mt. Jogye, Suncheon-si, Jeollanam-do	Lower part of slope
15	Juamdaem (dam), Suncheon-si, Jeollanam-do	Lower part of slope
16	Mt. Huia, Suncheon-si, Jeollanam-do	Lower part of slope
17	Cheongsogol, Suncheon-si, Jeollanam-do	Valley
18	Pyeongchon-ri, Suncheon-si, Jeollanam-do	Lower part of slope
19	Mojeon-ri, Suncheon-si, Jeollanam-do	*Castanea crenata* afforestation
20	Sinjeon-ri, Suncheon-si, Jeollanam-do	Valley
21	Mt. Jukdobong, Suncheon-si, Jeollanam-do	Lower part of slope
22	Mt. Guksabong, Suncheon-si, Jeollanam-do	Middle-lower part of slope
23	Mt. Bannyabong, Jirisan (Mt.), Jeollabuk-do	400~500 m asl
24	Baemsagol, Jirisan (Mt), Jeollabuk-do	Lower valley
25	Mt. Cheonhwang, Namwon-si, Jeollabuk-do	600~700 m asl
26	Mt. Ungseokbong, Sancheong-gun, Gyeongnam	420~980 m asl
27	Daewonsa (Temple), Sancheong-gun, Gyeongsangnam-do	900 m a.s.l. middle-lower part of slope
28	Mt. Bammeorijae, Sancheong-gun, Gyeongsangnam-do	Valley, lower part of slope
29	Mt. Geumo, Hadong-gun, Gyeongsangnam-do	Valley, around 600m a.s.l.
30	Daeseong-ri, Hadong-gun, Gyeongsangnam-do	Middle part of valley
31	Myeongseok-myeon, Jinju-si, Gyeongsangnam-do	Lower part of slope
32	Mt. Geum, Namhae-gun, Gyeongsangnam-do	Valley
33	Mt. Baegun, Pocheon-si, Gyeonggi-do	Top, around 762 m asl
34	Mt. Manggibong, Gangneung-si, Gangwon-do	Slope, around 550 m asl

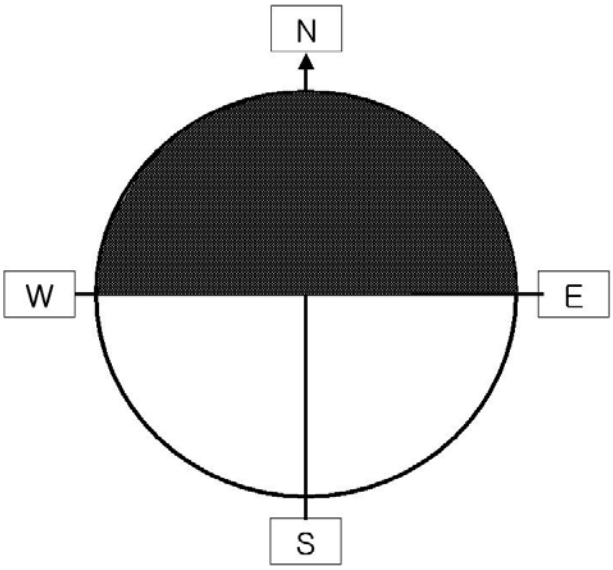

Fig. 2. Direction of slopes inhabited by *Corylopsis coreana* populations.

of Mt. Eokbulbong and exhibits low densities along the forest edge in the valley at Mt. Geum. The sprout numbers were highest, at 4. 7～11.3 sprouts/plant, on Mt. Ungseokbong in Sancheong-gun, Gyeongsangnam-do and lowest, at 1.8～2.9 sprouts/ plant on Mt. Eokbulbong.

Vegetation Conditions

The vegetation conditions of *C. coreana* communities surveyed are shown in Appendix 2. The DCA analysis based on these vegetation data divided *C. coreana* communities into three groups according to their species compositions (Fig. 4). The total number of species was 247 and the average number of species per relevé was 27 (range= 4～51 species).

The first roup (group Ⅰ) was concentrated mainly in or near the following locations: Cheongsogol, Sinjeon-ri, Mojeon-ri, near Suncheon university, near Taeansa (temple), near Juamdaem (dam), near Songgwangsa (temple), near Sangsadaem (dam) in Suncheon-si, near Cheoneunsa (temple) in Gurye-gun, and Bongjo-ri, Gokseong-gun, Jeollanam-do. This group was also found in the area of Myeongseok-myeon, Jinju-si, Gyeongsangnam-do. This group is mostly found in lowland areas where human disturbance is frequent such as mantle communities close to farmhouses or cultivated land. The population in the Cheongsogol area, Suncheon-si, is most representative of group Ⅰ. Due to intensive human activity, habitats in this group often are unstable in structure. Group Ⅰ *C. coreana* communities are observed in afforestation areas including *Castanea crenata*, *Cryptomeria japonica*, *Chamaecyparis obtusa* and *Pinus rigida* forests. In some areas *P. densiflora*, *Quercus mongolica*, *Q. veriabilis*, *Q. serrata*, *Q. acutissima*, *Zelkova serrata*, and *Lindera erythrocarpa* were also observed in the tree layer but the percentage of canopy cover is very low, about 25～60%. In some cases, the

Table 2. Population density, number of sprout, diameter at study site (In.: Individual). The number is the same as that for Fig. 1

No.	Site	Number of In./100 m^2	Number of sprout/In.			Diameter (cm)		
			Mean	Max	Min	Mean	Max	Min
8	Mt. Eokbulbong ①	61	2.8	10	1	1.4	5	0.1
	Mt. Eokbulbong ②	56	2.6	7	1	1.7	4.5	0.2
	Mt. Eokbulbong ③	92	1.8	5	1	1.0	3.5	0.1
9	Mt. Paryeong ①	20	4.1	11	1	1.1	3.5	0.2
	Mt. Paryeong ②	16	4.8	14	1	2.1	7	0.2
10	Mt. Ullam ①	73	3.0	10	1	1.5	5	0.1
	Mt. Ullam ②	34	4.4	16	1	2.0	6.2	0.3
17	Cheongsogol ①	63	1.9	5	1	1.5	3.2	0.4
	Cheongsogol ②	16	2.2	4	1	1.7	3.8	0.5
	Cheongsogol ③	15	2.5	5	1	1.5	4.2	0.5
	Cheongsogol ④	5	3.0	5	2	1.6	3.5	0.5
20	Sinjeon-ri ①	72	3.3	11	1	1.1	5	0.2
	Sinjeon-ri ②	6	3.0	7	1	2.0	4	0.2
25	Mt. Cheonhwangbong ①	15	4.4	9	2	1.9	5	0.5
	Mt. Cheonhwangbong ②	33	2.9	9	1	2.1	6	0.5
	Mt. Cheonhwangbong ③	17	3.2	11	2	1.5	4	0.5
26	Mt. Ungseokbong ①	8	11.3	30	2	3.0	9.5	0.5
	Mt. Ungseokbong ②	35	4.7	13	1	1.8	5	0.2
27	Daewonsa (Temple) ①	16	5.6	13	1	2.8	5	0.5
	Daewonsa (Temple) ②	42	4.8	10	1	1.8	6	0.5
29	Mt. Geumo ①	32	6.8	17	1	2.1	7.5	0.2
	Mt. Geumo ②	17	7.4	30	1	1.9	8	0.2
32	Mt. Geum ①	10	6.8	19	1	1.7	5	0.2
	Mt. Geum ②	8	14.0	38	2	1.4	5	0.2
33	Mt. Baegun	87	2.4	16	1	1.7	9.5	0.2
34	Mt. Manggibong ①	69	3.4	14	1	1.6	3.9	0.2
	Mt. Manggibong ②	33	5.6	23	1	1.8	6.0	0.2
	Mt. Manggibong ③	31	5.5	28	1	1.4	5.0	0.1
	Mean	35	4.6	14	1	1.7	5.3	0.3

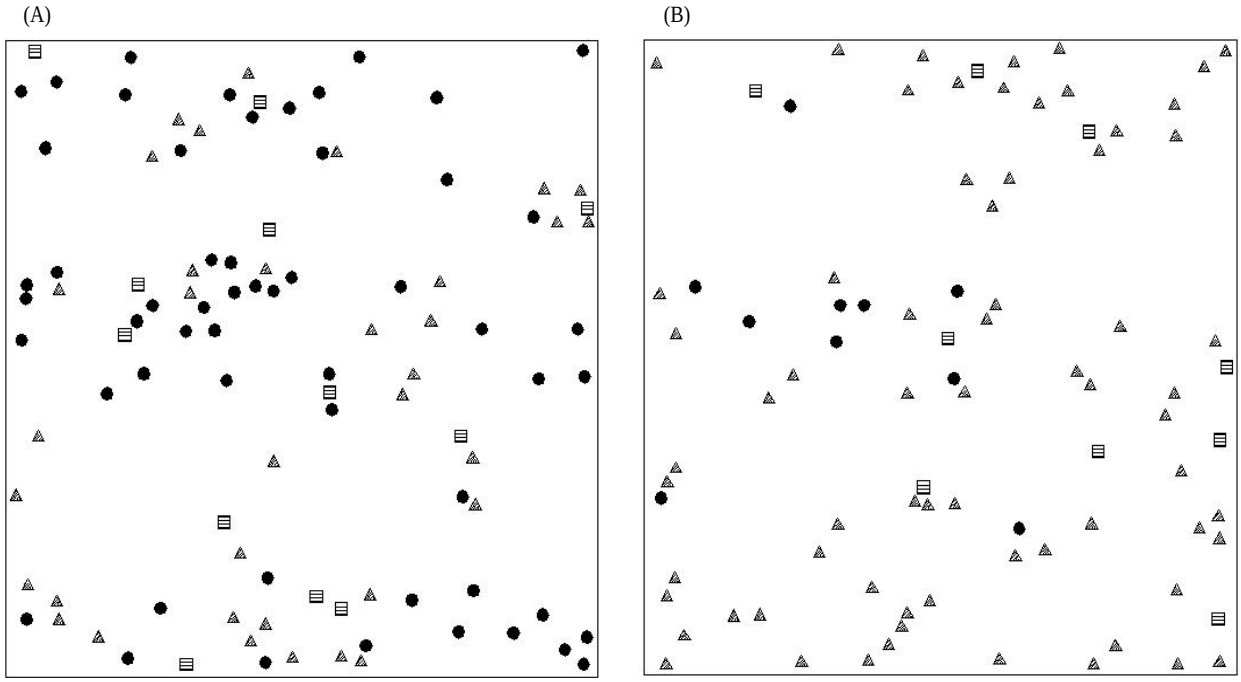

Fig. 3. Projection of plane for quadrats in Mt. Eokbulbong (A), Gwangyang- si, Jeollanam-do and in Mt. Geum (B), Namhae-gun, Gyeongsangnam-do. ●: *Corylopsis coreana*, ▲: other subtrees and shrubs, ■: other trees.

habitat of the group is lacking a tree layer and *C. coreana* is dominant in the subtree or shrub layer. The main species in the first group include *Smilax china*, *Carex siderosticta*, *straxjaponica*, *Rhododendron muconulatum*, *P. densiflora*, *Q. serrata*, *Disporum smilaciunm*, *C. crenata*, *Lindera obtussiloba*, *Stephanandra incisa*, *Corylus heterophylia* var. *thunbergii*, *Q. acutissma*, *Oplimenus undulatifolius*, *Weigela subsessilis*, *Q. mongolica*, *Rhus trichocarpa* and *Lespedeza maximowiczii*.

The second group (group Ⅱ) was observed mainly on Mt. Ungseokbong and Mt. Wangdeungjae, in the Guryonggyegok valley in the Mt. Jiri area, and on Mt. Cheonhwangbong, Mt. Eokbulbong, Mt. Geumo, Mt. Geum, Mt. Paryeong and Mt. Ullam in Goheung-gun. Unlike the first group, this second group mostly appeared in areas where human traffic was infrequent, such as mantle communities in valleys or on the lower-middle slopes of mountainous regions. Representative areas of the second group include Mt. Eokbulbong, Mt. Ungseokbong, and Mt. Cheonhwang, where the population density of *C. coreana* is relatively high, with coverage of 20～90% at the shrub and subtree layers. The vegetation types in this group include *Q. mongolica-Pinus densiflora* community, *Q. mongolica* community and *P. thunbergii* community, as well as communities in which *Q. mongolica*, *Pinus densiflora*, *Q.s serrata*, *Pinus thunbergii*, and *Q. variabilis* appear in the tree layer. These communities are well stratified into herb, shrub, subtree and tree layers. These communities also include various species such as *Acer pseudo-sieboldianum*, *Styrax japonica*, *Styrax obassia*, *Rhododendron mucronulatum* var. *ciliatum*, *Stewartia koreana*, *Weigela subsessilis*, *Vaccinium oldhami*, *Fraxinus sieboldiana*, *R. trichocarpa*, *L. erythrocarpa*, *Lespedeza maximowiczii*, *Viburnum wrightii*, *R. schlippenbachii* etc. in the shrub and subtree layers. *Carex lanceolata*, *C. okamotoi*, *Pyrola japonica*, *C. ciliato-marginata*, *Disporum smilacinum*, *Polygonatum lasianthum* var. *coreanum*, *Ainsliaea acerifolia*, *C. siderosticta*, *Chrysanthemum zawadskii* var. *latilobum*, *Atractylodes japonica*, *Smilax sieboldii*, and *Viola rossii* appear in the herb layer, where seedlings of *C. coreana* were also frequently seen.

The third group (group Ⅲ) includes the areas of Mt. Baegun in Pocheon-si, Gyeonggi-do as well as Mt. Manggibong in Gangneung-si, Gangwon-do. Populations in this group are distributed mainly on the upper sections of mountains, the upper parts of slopes, and surrounding ascending mountain paths. Group Ⅲ is latitudinally distinct from groups Ⅰ and Ⅱ. The densities of *C. coreana* populations are relatively high in group Ⅲ, like group Ⅱ. Vegetation types in group Ⅲ include *Quercus mongolica-Quercus serrata* community, *Quercus mongolica-Carpinus laxiflora* community and *Pinus koraiensis* afforestation areas. The *Quercus mongolica-Carpinus laxiflora* community in the area of Mt. Baegun in Pocheon-si, Gyeonggi-do, was partially cut down in 2001 due to a military exercise but now *C. coreana* is growing very well in this region. This community, like group Ⅱ communities has a well- developed stratification structure including herb, shrub, subtree and tree layers.

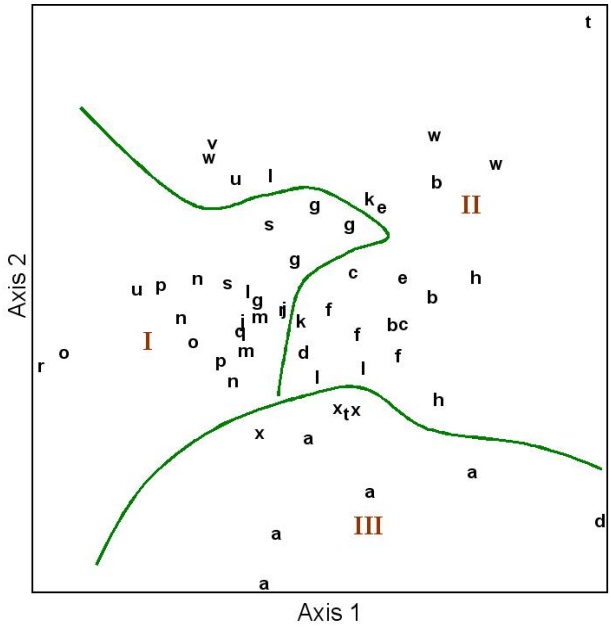

Fig. 4. Plot ordination by DCA of 50 relevés. a: Mt. Baegun, Pocheon-si, Gyeonggi-do, b: Mt. Cheonhwangbong, Namwon-si, Jeollabuk-do, c: Daewonsa(Temple), Sancheong-gun, Gyeongsangnam-do, d: Mt. Ungseokbong, Sancheong-gun, Gyeongsangnam-do, e: Mt. Ullam, Goheung-gun, Jeollanam-do, f: Mt. Eokbulbong, Gwangyang-si, Jeollanam-do, g: Cheongsogol, Suncheon-si, Jeollanam-do, h:Mt. Paryeong, Goheung-gun, Jeollanam-do, i: Mt. Geumo, Hadong-gun, Gyeongsangnam-do, j: Mt. Jogye, Suncheon-si, Jeollanam-do, k:Mt. Geum, Namhaegun, Gyeongsangnam-do, l: Sangsadaem(dam), Suncheon-si, Jeollanam-do, m: Bongjo-ri, Gokseong-gun, Jeollanam-do, n: Juamdaem, Suncheon-si, Jeollanam-do, o: Sinjeon-ri, Suncheon-si, Jeollanam-do, p:Mt. Huia, Suncheon-si, Jeollanam-do, q: Pyeongchon-ri, Suncheon-si, Jeollanam-do, r: Mojeon-ri, Suncheon-si, Jeollanam-do, s: Mt. Nogodan, Jirisan(Mt.), Jeollanam-do, t: Baemsagol, Jirisan(Mt.), Jeollabuk-do, u: Myeongseok-myeon, Jinju-si, Gyeongsangnam-do, v: Dungjuribong, Suncheon-si, Jeollanam-do, w: Mt. Bannyabong, Jirisan(Mt.), Jeollabuk-do, x: Manggibong, Gangneung-si, Gangwon-do.

The tree layers include *Carpinus laxiflora*, *Q. serrata*, *Tilia amurensis*, *Q. mongolica*, and *Kalopanax pictus*, and *Carpinus laxiflora*, *R. schlippenbachii*, *Acer pseudo-sieboldianum*, and *Symplocos chinensis* for. *pilosa* appear in the shrub and subtree layer together with *C. coreana*. Species appearing in the herb layer include *Ainsliaea acerifolia*, *Smilax nipponica*, *C. siderosticta*, *Viola albida*, *Athyrium yokoscense*, *Aster scaber*, *Viola rossii*, *Disporum smilacinum*, *Polygonatum odoratum* var. *pluriflorum*, *Asarum sieboldii*, *Arisaema amurense* var. *serratum*, *Asperula maximowiczii*, *Isodon excisus*, and *Artemisia stolonifera* etc.

DISCUSSION

The distribution of *C. coreana* was assessed in the Jeollanam-do, Gyeongsangnam-do, Gyeonggi-do and Gangwon-do regions of South Korea (Kim and Chang 1982, Kim et al. 1989, Kim et al. 1992, Kim and Han 1997, Kim et al. 1998, Kim and Han 1998, Hong and Choi 1998, Kim et al. 1999, Oh and Lee 1999, Lim and Yun 1999, Lee et al. 1999, Lim and Im 2002, Hyun and Park 2002, Lee 2002, Lim et al. 2005b, Noh 2004). We identified populations of the species in mountainous regions including Mt. Jogye, Mt. Baegun (Gwangyang-si), Mt. Paryeong, Mt. Cheonhwang, Mt. Geum, Mt. Baegun (Pocheon-si), and Mt. Manggibong, demonstrating that is widely distributed over the Korean peninsula. In Korea, the center of *C. coreana* distribution is in the vicinity of 35° latitude and 127° 30' longitude. *C. coreana* exhibits discontinuous distributions throughout Korea, and although populations are concentrated in the southern Suncheon area local populations are often separated by several or even dozens of kilometers in the district. There is a general tendency for a few lone specimens of the species to appear at the edge of forests or valleys (Lim et al. 2005a). When the distribution range and growth conditions of *C. coreana* are considered, we should expect that *C. coreana* will be distributed throughout the inland areas of Korean. However, so far there are no reports of *C. coreana* in the central inland areas of Chungcheongbuk-do, Chungcheongnam-do and Gyeongsangbuk-do which raises questions about the distribution characteristics of the species. In Japan, the center of distribution for the genus *Corylopsis* is at around 35° latitude and ranges from 130°30' to 135°30' longitude (Yamanaka 1986). Therefore, the distribution of genus *Corylopsis* seems to be more restricted in terms of latitude than longitude in Japan. Yamanaka (1986) argues that the genus *Corylopsis* can also occur in unusual environments such as serpentine areas, but more research is needed.

The most noteworthy characteristic of the *C. coreana* distribution is that it is found only on north-, northwest- or northeast-facing slopes (Noh 2004, Lim et al. 2005a), which may result from several environmental factors. First, these areas are typically characterized by relatively low temperatures and high humidity. *C. coreana* seedlings are not tolerant of dry conditions in the early settlement stage, and the soil moisture during the thawing period is higher on northern slopes than southern slopes. We conclude that *C. coreana* populations are highly influenced by microclimate factors until the seedling stage has been reached (Lee et al. 2007). This conclusion is supported by a large body of research demonstrating that vegetation patterns are related to environmental heterogeneity (Gleason 1926, Cooper 1926, Whittaker 1967, Austin 1985). Specifically, micro-topography and soil characteristics determine the spatial distributions of tree populations in forested areas (Beatty 1984, Huen-

neke and Sharitz 1986, Streng et al. 1989, Peterson and Pickett 1990, Itoh 1995, Clark et al. 1998, Svenning 1999). Barberis et al.(2002) have also asserted that forest structure is dependent on micro topography and soil moisture. This study provides supporting evidence that *C. coreana* distributions are determined by their ecological characteristics such as sensitivity to slope directionality and soil moisture for germination (Lim et al. 2005a, Lee et al. 2007). However the results of the vegetation data analysis suggest that, *C. coreana* was not associated with a specific community type or species group.

Local residents reported that the species was widely distributed throughout the whole district of Sinjeon-ri in Suncheon-si, Jeollanam-do, about 30～40 years ago. However, the area is now almost entirely dominated by deciduous broad-leaved trees of the *Quercus* variety. Moreover, *C. coreana* appeared very rarely in the shrub layer. The *C. coreana* population in the Cheongsogol area in Suncheon-si is also declining through a succession process, and occurs only at the forest edge. We assume that the population in this area is declining due to a neighborhood effect (Mack and Harper 1977, Antonnovics and Levin 1980, Pacala and Silander 1990, Kenkel 1988, Woods 2000). - related to a reduction in human traffic. As human activity decreases, the canopy layer is thickened by the deciduous broad-leaved trees, which changes the light conditions for *C. coreana* in the shrub layer (Lim et al. 2005a).

At this point, it may be that the flourishing populations in other areas hold the key to protecting *C. coreana*. For example, although the population in the *Castanea crenata* afforestation area in Mojeon-ri in Suncheon-si has been cut every year, many new sprouts are still seen. In addition, the population on Mt. Baegun in Pocheon-si was cut several years ago but it is now thriving again (Lim et al. 2005b, 2006). These observations suggest that external interventions such as stem cutting may be very important for population maintenance (Bellingham 1994, Sonoyama et al., 1997, Lim et al. 2006). These results suggest that a regular routine of specific intervention including cutting and canopy removal may be required to promote healthy population growth in this endangered species. More ecological data should also be gathered to better design effective conservation strategies.

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Appendix 1. Site characteristics for each relevé including *Corylopsis coreana*

Serial number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Altitude (m)	760	760	760	760	760	450	550	600	350	350	520	100	100	400	450	500
Slope aspect	NE	NE	E	NW	W	E	E	E	NW	NW	N	NE	NE	NE	NE	NW
Slope degree (°)	35	35	35	25	25	25	35	25	30	30	30	25	20	25	30	25
Quadrat size (m^2)	100	100	100	100	225	225	100	100	225	225	100	100	100	100	225	225
Height of tree layer (m)	10	12	11	13	13	15	12	12	14	15	10	8	11	13	15	13
Coverage of tree layer(%)	60	40	20	90	95	70	50	90	50	70	40	10	40	60	70	70
Height of subtree layer (m)	.	.	.	7	7	7	7	7	7	7	7	5	7	6	7	6
Coverage of subtree layer (%)	.	.	.	50	60	50	80	60	60	50	80	20	70	50	70	50
Height of shrub layer (m)	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2
Coverage of shrub layer (%)	80	70	75	30	10	30	10	20	20	10	10	85	20	40	20	30
Height of herb layer (m)	0.2	0.3	0.5	0.5	0.3	0.7	0.5	0.5	0.7	0.7	0.7	0.7	0.5	0.5	0.7	0.7
Coverage of herb layer (%)	10	10	30	40	15	60	30	30	30	20	20	40	65	25	15	30

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
150	150	150	150	300	200	434	680	650	260	360	150	150	150	150	90	120	110	60	80
N	NE	NW	NE	NE	N	NE	NE	NW	NW	NW	N	NW	NW	NW	N	NE	NW	NE	NE
30	25	25	40	15	5	25	35	25	15	20	5	10	30	15	20	30	35	25	20
225	100	100	100	225	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
12	12	12	12	13	11	8	.	12	12	9	12	12	14	9	15	10	10	11	10
95	90	60	60	70	40	10	.	30	40	95	30	40	90	65	75	55	100	45	20
6	4	4	7	7	9	5	8	7	7	4	6	7	6	6	6	5	7	5	5
90	50	20	40	40	60	95	80	60	60	20	70	60	90	95	50	70	40	80	80
2	2	2	2	2	2	2	3	2	4	2.5	1.5	2	1.5	2	2.5	1.8	2	1.7	1.5
50	25	60	25	25	5	30	15	10	70	65	20	20	25	35	50	50	1	20	40
0.7	0.5	0.5	0.6	0.7	0.7	0.4	0.4	0.3	0.5	0.5	0.5	0.3	0.4	0.3	0.7	0.4	0.3	0.4	0.5
15	10	10	5	95	10	30	70	70	70	40	50	15	20	30	70	50	10	10	70

37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
240	270	260	140	220	210	210	290	290	300	250	170	100	170	270	270	270	470	480	500
NW	NE	NW	NW	N	NW	NW	NW	NW	NW	NW	N	NE	NE	NE	N	N	N	N	NW
35	25	25	35	30	10	30	25	20	30	25	25	40	30	30	30	25	10	20	15
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
13	13	9	.	9	.	.	13	13	13	9	11	9	.	14	15	12	15	15	15
85	5	75	.	60	.	.	80	80	95	30	95	60	.	80	30	10	90	90	90
7	.	6	.	5	5	5	7	7.5	7	7	5	6	7	7	6	7	7	7	7
95	.	95	.	70	85	85	70	70	70	90	80	60	10	70	80	80	25	30	20
1.5	3.5	1.5	1.5	1	1.5	1.5	1.8	2	2.5	2.5	1.5	2	2.5	2	2	1.5	3	3	3
10	100	20	70	40	10	10	50	50	20	20	40	60	80	60	20	60	80	85	90
3	0.4	0.2	0.8	0.5	1	1	0.5	0.3	0.5	0.5	0.3	0.3	0.4	0.3	0.3	0.3	0.5	0.5	0.5
5	40	50	30	40	95	95	50	20	10	15	10	60	80	40	40	30	5	5	5

Appendix 2. Synthesis table of vegetation including *Corylopsis coreana*. The alphabet symbol of administrative district is same as that for Fig. 4

Serial number	0000000001	1111111112	2222222223	3333333334	4444444445555555
	1234567890	1234567890	1234567890	1234567890	1234567890123456
Relevé number	0000000001	1111111112	2222222223	3333333334	4444444445555555
	1234567890	1234567890	1234567890	1234567890	1234567890123456
Administrative district	aaaaabbbcc	deefffgggg	hhdiijjkkl	lmmnnnoopp	qrrssttuuvwwwxxx
Number of species	1113353322	2322133322	3232233332	3321221223	3331331213212000
	8301116414	5779721495	5826652663	9087475579	0538019246870984
Corylopsis coreana	5423233333	3343432332	2354341325	4333445354	3533323433323555
Smilax china	.....+1+.+	.2++++2+1+	++1.++1111	++1++2+1++	2+++++...++.....
Quercus serrata	1.+23++...	.++1.+1.2.	..2..2+22.	2r+1.121++	24.+141..+...242
Disporum smilacinum	...++.++..	.1.++1++..	211++11++.	+.21+++23+	+++.1.....+2+...
Lespedeza maximowiczii	...+.++++.	++.....+.+	+.13+1.2++	+++..1.1+1	1+1.....++.....
Rhus trichocarpa	.....1++..	.+.1++1111	..++1.++12	+11++..3..	+1..++.+..+1+1..
Carex siderosticta	1+.222....	.....++++	+.++11....	+22.13++++	.++.+..1.+.....
Styrax japonica	.....21+..	+11+++2..1	+22..++2..	1++.+.1+.+	.1..11..1..22...
Pinus densiflora	.....413..	.++2.142.2	31324	22.132..1+	11.53..5..54....
Lindera obtusiloba	++.+.++11+	1..++++1.+	...+++..+r	+1...+....	.+...++.....2.+.
Rhododendron mucronulatum	.....	1111	..+212.32+	1++.21.2..	+...+..+2+.....
Quercus mongolica	.2113.121.	...1333.11	2+22224...	1	..+.....1.3.3
Rhododendron schlippenbachii	.+.+....++	.+.1.+.+1.	+....32+11	.3.....1.	2...2.+2+.1.....
Viburnum wrightii	.....+	.+.++112+.	++...1+.++	1.+...+++.	.+.+1.....
Stephanandra incisa	....+.....	.+.....+11	+.+12..++.	..1.1+.3.+	++...+.+42324...
Weigela subsessilis	....2+++..	11+....1.1	+++....+..	+++.....	++...+.+.+.....
Carex lanceolata	....+++...	...+..1++.	21++23.31.	...+...+.+	+2.....+2+...
Smilax nipponica	+..12.+...	....++....	..+.++++..	++.+..+.++	...++..+.....+.
Fraxinus sieboldiana	.....+11+	.+.+++2+..	.....+.2+.	..+.1.....	...21.+.2.....
Aster scaber	++.++.+...	.1.....	...+.++...	..+.++.+++	.++..+...1..+...
Ainsliaea acerifolia	++.++...+1	.+.+.1.+..	3++...+..+	.....+.	...++.....+.
Viola rossii	+..+++...+	++..++.+..	.+.+++..+.	.....	+.....+.....
Lindera erythrocarpa	.....2.+++	+r...+.+++	11+.+.....	.....	.+....+.....
Quercus variabilis	.....+2.23	.1.12.1...	2.....23.	...1.....	...1.1..1.+...1.
Castanea crenata	.....+....	...+..2423	.....	311.++2.4.	..5..2.....+...
Dryopteris chinensis	. . . +	.1+.....	...+....++	+..1..r++.	+.....++++.....
Symplocos chinensis for. *pilosa*	...++.....	.....	+.1+..+++.	1+1.....	+..+.+.....
Astilbe chinensis var. *davidii*	....++....	.+.....	+.+.++....	....+...++	1+.++.....
Carex okamotoi	.....+.+	...1+1+...	.+.+1.1+..	.....2.	....2.....
Polygonatum lasianthum var. *coreanum*	.....+.++.	++.+.+....	.....+..+	+..+....+.	....+.....
Indigofera kirilowii	22	.+.....	..1..+.++.	.++.++....	..2+.....
Pteridium aquilinum var. *latiusculum*	.....+....	.....	....++..+	+.+.++....	+.3++....2.....
Stewartia koreana	.....+	..+++121..	.....11+.	.....	...1..2.....
Callicarpa japonica	.....+.++	..+....1++	.+.....1+.	.....	.....2+.....
Oplismenus undulatifolius	.....1...+	.....++	+.....1	1.....+..	.+..+..+.2+.3...
Pyrola japonica	.+....+...	...++1+...	.+...+....	+.....	.++.....
Hosta longipes	.....+++..	.2....+...	.....++.+.	+.....+...	....+.....
Polygonatum odoratum var. *pluriflorum*	.+..++++..	.....	.....+..+.	.1..+.....	....++.....
Athyrium yokoscense	...1+.....	.....+....	3..22.....	+.....+.	..2..+...2.....
Carex humilis	.....2+1+	.+.+.++...	..1...2...	.....	.....1.....
Acer pseudo-sieboldianum	.+.+.....	...+.+1...	+1.....++.	.....	.....+.....1.+1+
Carpinus laxiflora	21.3....+1	..1...1...	.....+.	...2....1.	.....+..

Appendix 2. Continued

Smilax sieboldii	. . . . . + . . .	. . + + . + ...	+ . + . . + + . . .	. . . . . +	. + ...
Lindera glauca	. . . . . 1	. . + . + ...	+ . . . . . 1 + +	. r . . . + ...	. + ... + ...
Prunus sargentii	. . . . . + . 2 . .	. . . + . . 2 1 . .	. . . . . + . . .	. + 1 . . . . . +	. + ... + ...
Atractylodes japonica	. . . . . + . +	. . . . . + . .	. . + . . . + . . .	. . . . + + . . + .	. . + ... r . . + ...
Vaccinium oldhami	. . . . .	. . . + . . 2 . . .	. . . . . 2 1 . . +	1 + ...	. . . 2 2 + ... 2 . . . . .
Osmunda japonica	. . . . .	. 2 . . . + ...	. . . . . + . .	. . + . 2 . + . . 1	1 + 1 . . . . . + . . .
Corylus heterophylla var. *thunbergii*	. . . . .	. . . . . 1 1 .	. . . . .	1 . + . . + . + + .	+ + + ...
Sapium japonicum	. . . . . 1 . 1 .	. . . . . 1 1 . . .	. 1 . + + . . + + .	. . . . .	. . . . .
Ampelopsis brevipedunculata var.*heterophylla*	. . . . .	+ . . . . . + . +	. . . . . + . .	. . . . . +	. . . . . + + . + . + . . .
Lespedeza bicolor	. . . . . + + . .	. + ...	. . + ... +	+	. . + ... + ...
Rhododendron mucronulatum var. *ciliatum*	. + 1 . . . . 1 . .	. + . 1 1 1	. . . . . 1 . . .	. . . . .	. . . . . + + . . .
Cocculus trilobus	. . . . . + . + . .	. . + ... + . .	. . . . . + . + . .	+	+ . . . . .
Codonopsis lanceolata	. . . . + + + . . .	. . . . . + . .	+	. . r	+ r . . . . .
Hosta capitata	. . . . .	. . . . . + . + .	. . + . . + ...	+ . . . . . +	. . 1 . + ...
Chamaecyparis obtusa	. . . . .	. . . . . + .	. . . . . + . + .	+ . 3 5	. . . 1 2 . . . . .
Ilex macropoda	. . . . .	. . . . .	. . . . . + 1 . . +	. + . . 2	. . . 1 1 1 . . . . .
Isodon inflexus	. . . . .	. . . . .	. . + . . + ...	+ . . . + ...	+ + + . . + ...
Paederia scandens	. . . . . 1 . + + +	. + ...	. . . . . + .	. . . . .	. . . . + ... + ...
Spodiopogon sibiricus	. . . . . + + . + 1	. + ...	. . . + . . + . . .	. . . . .	. . . . .
Fraxinus rhynchophylla	. . + ... + . .	. . . . .	+ . + ...	. . + . + ...	. . . . . 1 . . . . .
Veratrum versicolor	. . . . .	. . . . . + + .	. . + . . + ...	r	+ + ...
Artemisia keiskeana	. . . . + + . + . .	. . . . .	. . . . .	. . + . + ...	+ . + ...
Rubus crataegifolius	+ . . . . + ...	. . . . .	. . . . . +	. . . . . 4 . 1	. . + ... 2 . . . . .
Pueraria thunbergiana	. . . . . + . + . .	+ . . . . . + .	. . . . .	. . + ...	. . . . . + ...
Dioscorea tokoro	. . . . .	. . . . .	. . . . .	. . . r . + . . + 1	+ . . . . . + ...
Pourthiaea villosa	. . . . .	. . . . .	. + . + 1 + . + + .	. . . . .	. . . . .
Styrax obassia	. . + . 2 . . + + .	. . . + . 1	. . . . .	. . . . .	. . . . .
Euonymus oxyphyllus	+ . + + . . + . . .	. . . . .	. + ...	. . . . .	. . . . . + ...
Syneilesis palmata	. . . . . + + . . .	. . . . . + . +	. . . . .	. . . . .	. + + ...
Dryopteris bissetiana	. . . . .	. . . . . + + + +	. . . . .	. . . . .	. . . . . + . + . + + 1 . . .
Pinus rigida	. . . . .	. 1 + ...	. . . . .	3 . . . 3	3 . . . 2 . . . . .
Asplenium incisum	. . . . .	. . . . .	. . . . + ...	+ . . . . r	. . + ... + ...
Dryopteris uniformis	. . . . . + .	+ 1 1	. + ...	. . . . .	. . . . .
Cornus kousa	. . . . . + ...	. . . . . + ...	. 1 . . . . . 1 . .	. . . . .	. . . . . 2 . . . . .
*Arisaema amurense*var. *serratum*	. . . + + ...	+	+	. . . . .	. . . . . + ...
*Viola dissecta*var. *chaerophylloides*	. . . . .	. . . . .	+ + ...	. . . + ...	. + + ... + ...
Juniperus rigida	. . . . .	. . . . . 1 . . .	. . . . . 1	. + . . 1 + ...	. . . . .
Celastrus orbiculatus	. . . . . + ...	. . . . .	. . . . . + . .	+ . . . . . +	. . . . . + ...
Cymbidium goeringii	. . . . .	. + 2	. . . . .	. + . + . . r . . .	. . . . .
Alnus firma	. . . . .	. + + ...	. . . . .	. . . . . + . .	. . . . . 2 4 . . . . .
Lysimachia clethroides	+ . . . + ...	. . . . .	. . . . .	. . . . .	. . + ... + ...
Miscanthus sinensis	. . . . .	. . . . .	. . . . .	. . . . . 1 . + . .	. . + ... + ...
Zanthoxylum schinifolium	. . . . .	. . . . .	. . . . .	. . . . . 2 . +	. . . . . + + ...
Isodon japonica	. . . . . + . . . +	. + ...	+	. . . . .	. . . . .
Albizzia julibrissin	. . . . . 1 . . .	. . + ... +	. . . . . + .	. . . . .	. . . . .
Dioscorea japonica	. . . . . 1 + . . .	. + ...	. + ... W . . .	. . . . .	. . . . .
Carex ciliato-marginata	. . . . .	. 2 . + ...	. + ... + . . .	. . . . .	. . . . . 1 2 . . . .
Platycarya strobilacea	. . . . . + ...	. . + ... + . .	. . . . .	. . . . .	+ . . . . .
Parthenocissus tricuspidata	. . . . . + . . + .	. . . . +	. . . . .	. . . . .	. . . . . 4 . . . . .
Thalictrum filamentosum	. . . + ...	. . . . .	. . . + + ...	. . . . .	. . . . . + ...

Appendix 2. Continued

Hydrangea serrata for. *acuminata*	. . . . . + ...	1	. . . + ...	. . . . .	. . . . . 2 . . . . + ...
Rhododendron yedoense var. *poukhanense*	. . . . .	. . . . . + ...	. . + . . . + . . .	+	. . . . .
Corylus sieboldiana	. . . . . + ...	. . + ...	+	. r	. . . . .
Meliosma myriantha	. . . . .	. . . . . + . . .	. + ...	. . + ...	. . . . . 1 . . . . .
Solidago virga-aurea var. *asiatica*	. . . . . + ...	. . . . . + . .	. . . . .	r . . . . + ...	. . . . . + . . .
Hemerocallis minor	. . . . .	. . . . .	. . . . .	. . . . . + . . r +	. 1 . . . . .
Convallaria keiskei	. . . . .	. . . . .	. . . . .	. . . . . + .	. + + . . + ...
Alnus hirsuta	. . . . .	. . + . . . 1 1 . .	. . . . .	. . . . .	. . . . . 1 . . . . .
Viola selkirkii	. . . . + ...	. . . . .	+	. . . . .	. . . . . + ...
Acer mono	. . . . + ...	2	+	. . . . .	. . . . .
Pinus thunbergii	. . . . .	. . 2	. . . 2 + ...	. . . . .	. . . . .
Dioscorea quinqueloba	+ . . + ...	. . . . . + .	. . . . .	. . . . .	. . . . .
Liriope spicata	. . . . . + ...	. . + ... + .	. . . . .	. . . . .	. . . . .
Tripterygium regelii	. . . + + ...	. . . . . + ...	. . . . .	. . . . .	. . . . .
Eurya japonica	. . . . .	. 1 1	. . . . . + .	. . . . .	. . . . .
Isodon excisus	+ . . + + ...	. . . . .	. . . . .	. . . . .	. . . . .
Hemerocallis fulva	. . . . . + + + . .	. . . . .	. . . . .	. . . . .	. . . . .
Thalictrum uchiyamai	. . . . . + + . .	+	. . . . .	. . . . .	. . . . .
Lastrea japonica	. . . . .	. . . . .	. . 1 . . . . + + .	. . . . .	. . . . .
Athyrium japonicum	. . . . .	. + ...	. + . . 2	. . . . .	. . . . .
Tilia amurensis	1 . 1 1	. . . . .	. . . . .	. . . . .	. . . . .
Viburnum erosum	. . . . . + ...	. . . . .	. . . . . + . .	. + ...	. . . . .
Aralia elata	+ + ...	. . . . .	. . . . .	1	. . . . .
Cryptomeria japonica	. . . . .	. . . . . 4 3	. . . . .	. . . . . +	. . . . .
Zanthoxylum piperitum	. . . . .	. . . . . +	. . + ...	. . . . .	. . . . . + ...
Galium dahuricum	. . . . .	. . . . .	. . . + . + ...	. . . . .	. . 1 . . . . .
Pinus koraiensis	+ . 1	. . . . .	. . . . .	. . . . . 2 . .	. . . . . 1 . .
Commelina communis	. . . . .	. . . . .	+	r . . . . . +	. . . . . + ...
Quercus acutissima	. . . . .	. . . . .	. . . . . + . .	. . . . . r	. . . . . 2 . . + ...
Cephalanthera erecta	. . . . .	. . . . .	. . . . .	. . . . r . . . + .	. + ...
Viburnum dilatatum	. . . . .	. . . . .	. . . . .	. . . . . +	. 1 . . . . . + ...
Rhus sylvestris	. . . . .	. . + ...	. . . . .	. . . . . + . . 1 .	. . . . .
Boehmeria spicata	. . . . .	. . . . . + .	. . . . .	. . . . .	. . . . . + ...
Bidens frondosa	. . . . .	. . . . .	. . . . .	. . . . . +	. . . . . + ...
Potentilla fragarioides var. *major*	. . . . .	. . . . .	. . . . .	. . . . . +	. . . . . + ...
Erigeron annuus	. . . . .	. . . . .	. . . . .	. . . . . +	. . . . . + ...
Asperula maximowiczii	. . . + ...	. . . . .	+	. . . . .	. . . . .
Securinega suffruticosa	. . . . . +	. . . . .	. . . . . + . .	. . . . .	. . . . .
Festuca parvigluma	. . . . .	. . . . .	. . . + 2	. . . . .	. . . . .
Vitis thunbergii var. *sinuata*	. . . . . + . + . .	. . . . .	. . . . .	. . . . .	. . . . .
Artemisia stolonifera	. . . + + ...	. . . . .	. . . . .	. . . . .	. . . . .
Galium trachyspermum	. . . . . + ...	. . . . . + .	. . . . .	. . . . .	. . . . .
Abelia mosanensis	. . . . . + ...	. . . . .	+	. . . . .	. . . . .
Trachelospermum asiaticum var. *intermedium*	. . . . .	. . 3	. + ...	. . . . .	. . . . .
Dryopteris saxifraga	. . . . .	. . . . .	. . . 1 1	. . . . .	. . . . .
Calamagrostis epigeios	. . . . . + . + . .	. . . . .	. . . . .	. . . . .	. . . . .
Cephalanthera longibracteata	. . . + ...	. . . . .	. . . . . + .	. . . . .	. . . . .
Kalopanax pictus	1 . . + ...	. . . . .	. . . . .	. . . . .	. . . . .

Appendix 2. Continued

Iris pallasii var. *chinensis*	. . . . . + + . .	. . . . .	. . . . .	. . . . .	. . . . .
Viola albida	. . . + + ...	. . . . .	. . . . .	. . . . .	. . . . .
Sorbus alnifolia	. . 2	. . . . .	. . . . . + .	. . . . .	. . . . .
Euonymus sachalinensis	. . . . .	. . . . .	. . . . . + + .	. . . . .	. . . . .
Euonymus alatus for. *ciliato-dentatus*	. . . . .	+ + ...	. . . . .	. . . . .	. . . . .
Staphylea bumalda	. . . . .	1	. . . . .	. . . . .	. . . . . + ...
Rubia akane	. . . . . + ...	. . . . .	. . . . .	. . . . . r . . .	. . . . .
Deutzia glabrata	. . . . .	1	. . . . .	. . . . .	. . . . . 2 . . . . + + . . .
Morus bombycis	. . . + ...	. . . . .	. . . . .	. . . . .	. . . . . + ... 1 . . . . .
Calamagrostis arundinacea	. . . . .	. . . . .	2	. r	. . . . .
Sanguisorba officinalis	. . . . .	. . . . . + .	. . . . .	. . . . .	+ . . . . .
Sasa borealis	. . . . .	. . . . .	. . . . . + . . .	. . . . .	. . . . + ...
Ligustrum obtusifolium	. . . . .	. . + ...	. . . . .	. . . . .	. + ...
Rhamnus yoshinoi	. . . . . + . . .	. . . . .	. . . . .	. . . . .	. + ...
Cornus controversa	+ 1	. . . . .	. . . . .	. . . . .	. . . . .
Robinia pseudo-acacia	. . . . .	. . . . .	 1	. . . . . +	. . . . . 3 . . .
Carpinus tschonoskii	. . . . .	. . . . .	 2	2	. . . . . 3 . . . .
Rubus corchorifolius	. . . . .	. . . . .	. . . . .	. . + ... 2 . .	. . . . .
Populus tomentiglandulosa	. . . . .	. . . . .	. . . . .	. . . . . 4 3 . .	. . . . .
Dennstaedtia wilfordii	. . . . .	. . . . .	. . . . .	. . . . . + .	. . + ...
Meliosma oldhamii	. . . . .	. . . . .	. . . . .	. . . . .	1 . . . . 3 . . . . .
Pimpinella brachycarpa	. . . . .	. . . . .	. . . . .	. . . . .	. . . + + ...
Zelkova serrata	. . . . .	. . . . .	. . . . .	. . . . .	. . . . r 2 . . . . .
Diospyros kaki	. . . . .	 1	. . . . .	. . . . .	. . . . . 3 + ...
Celtis sinensis	. . . . .	. . . . .	. . . . .	. . . . .	. . . . . 1 . 1 . . . . .
Actinidia polygama	. . . . . 1	. . . . .	. . . . .	. . . . .	. . . . . + ...
Boehmeria tricuspis var. *unicuspis*	. . . . .	. . . . .	. . . . .	1	. . . . . + . . .
Lespedeza cyrtobotrya	. . . . .	. . . . .	. . . . .	. . . . . 1 . .	. . . . . + . .
Maackia, amurensis	. . . . .	. . . 1	. . . . .	. . . . .	. . . . . + . .

Species occurred once in serial no.: *Viola collina* (4-1), *Melampyrum roseum* (5-1), *Tilia mandshurica* (5-1), *Campanula punctata* (5-1), *Dioscorea nipponica* (5-1), *Cephalotaxus koreana* (6-1), *Thalictrum actaefolium* (6-1), *Lilium amabile* (7-1), *Adenophora triphylla* var. *japonica* (8-1), *Adenophora triphylla* var. *hirsuta* (8-1), *Rhus chinensis* (9-1), *Clerodendron trichotomum* (10-+), *Hylomecon hylomeconoides* (11-1), *Larix leptolepis* (11-1), *Ulmus davidiana* var. *japonica* (11-1), *Aconitum uchiyamai* (11-1), *Erythronium japonicum* (11-1), *Vitis amurensis* (11-1), *Lilium tsingtauense* (11-1), *Melica onoei* (16-1), *Nepeta cataria* (18-1), *Dioscorea japonica* (19-1), *Aconogonum polymorphum* (19-1), *Scutellaria indica* (20-1), *Botrychium ternatum* (22-1), *Athyrium conilii* (22-1), *Chrysanthemum zawadskii* var. *latilobum* (23-1), *Leibnitzia anandria* (24-1), *Stachys riederi* var. *japonica* (26-1), *Spiranthes sinensis* (27-1), *Rosa wichuraiana* (28-1), *Prunus japonica* var. *nakaii* (30-1), *Artemisia princeps* var. *orientalis* (30-1), *Rosa multiflora* (32-1), *Dioscorea bulbifera* (32-1), *Athyrium niponicum* (32-1), *Wistaria floribunda* (34-1), *Lycopodium clavatum* var. *nipponicum* (36-1), *Hemerocallis lilioasphodelus* (38-1), *Persicaria perfoliata* (40-1), *Lysimachia barystachys* (40-1), *Phytolacca americana* (40-1), *Erechtites hieracifolia* (40-1), *Persicaria hydropiper* (40-1), *Bidens bipinnata* (40-1), *Cirsium japonicum* var. *ussuriense* (40-1), *Humulus japonicus* (40-1), *Ixeris dentata* var. *albiflora* (41-1), *Euonymus alatus* (43-1), *Vicia amoena* (43-1), *Lactuca indica* var. *laciniata* (43-1), *Galium pogonanthum* (43-1), *Lathyrus davidii* (43-1), *Philadelphus schrenckii* (46-1), *Actinidia arguta* (46-1), *Euscaphis japonica* (46-1), *Magnolia sieboldii* (47-1), *Syringa velutina* var. *kamibayashii* (47-1), *Paeonia japonica* (47-1), *Dryopteris crassirhizoma* (47-1), *Euonymus trapococcus* (48-1), *Dictamnus dasycarpus* (48-1), *Allium thunbergii* (48-1), *Phegopteris decursive-pinnata* (50-1), *Patrinia villosa* (50-1), *Clematis apiifolia* (50-1), *Viola mandshurica* (50-1), *Setaria viridis* (50-1), *Mosla dianthera* (50-1), *Iris rossii* (51-+), *Spodiopogon cotulifer* (51-+), *Rubus phoenicolasius* (51-+), *Coniogramme intermedia* (52-+), *Poncirus trifoliata* (53-+), *Eupatorium chinense* var. *simplicifolium* (53-+), *Akebia quinata* (53-+), *Betula davurica* (55-1)