

The Ecological Characteristics of Native Habitat of Korean Native Wando Holly(*Ilex* × *wandoensis*)

Young-Hee Ahn and Chang-Ho Choi

Department of Applied Plant Science, Chung-Ang University, Gyeonggi-do 456-756, Korea
(Manuscript received 7 May, 2007; accepted 20 July, 2007)

This study was conducted to analysis the ecological characteristics of "Wando Holly"(*Ilex* × *wandoensis*) which is expecting as a possible ornamental tree with its beautiful leaves, flowers and fruits, and to find special breeding material which have particular characteristics and also provide correct environmental information which are required for commercial cultivation. The hill of Galmoon-Ri, Gunoei-Myon, Jeonnam Province, Korea, were reported as a original habitat of native *Ilex* × *wandoensis*. The investigation shows that soil pH of native habitat was 6.18, hardness was 2.39, humidity was 38.6%, direction of slope is SSW, and average inclination was 15°. The vegetation around *I. × wandoensis* is occupied by trees like an *Quercus variabilis*, *Q. serrata*, *Q. acuta* and so on. These are mixed forest of deciduous trees. Tree height reached up to about 12m and its coverage is about 30%. *Q. salicina*, *Camellia japonica*, *I. integra*, *Cryptomeria japonica* account for sub-tree layer. Tree height is around 8m and coverage is about 20%. Shrub layer was taken by *Viburnum furcatum*, *Callicarpa japonica*, *Styrax japonica*, *Eurya japonica*, *Lindera obtusiloba*, *Ligustrum japonicum*, *Smilax china*, *Cornus walteri* etc. Tree height reaches around 1.2m and coverage is around 20%. Herb layer includes *Trachelospermum asiaticum* var. *intermedium*, *Cymbidium goeringii*, *Dryopteris bissetiana*, *Disporum viridescens*, *Disporum smilacinum*, *Sasa borealis* var. *gracilis* etc. *Trachelospermum asiaticum* var. *intermedium*, which are observed in southern evergreen zone, are dominant and its coverage is around 20%. The native habitat was in spoiled condition because of artificial thin out.

Key Words : Wando holly, Habitat, Ecological characteristics

1. Introduction

There are increasing demands of various ornamental trees to improve living environment and beautify the national territory^{1,2)}. Therefore not only native species, but also foreign ornamental trees have been introduced. It is time to develop native ornamental trees suitable for Korean's taste and ecology of Korea^{3,4)}. Especially *Ilex* species are very useful for ornamental tree because of its high decorative value of leaf and fruit. It is strong resistant to heavy pruning allow to grow it various tree shapes. It is generally known that there are 440 *Ilex* species distributed around the world especially in the subtropics. However, various native *Ilex* species which have excellent characters are dis-

tributed in Korea. There are 5 species, 2 varieties, and a hybrid such as *Ilex cornuta*, *I. crenata*, *I. crenata* var. *microphylla*, *I. rotunda*, *I. integra*, *I. macro-poda*, *I. macro-poda* var. *pseudoma-cropoda*, and *I. × wandoensis* grow in Korea⁵⁾.

I. species are widely used as christmas ornamental trees in the world and also used as ornamental, artistic, medicinal purpose and so on⁶⁾. "Wando holly"(*I. × wandoensis*) is natural hybrid evergreen between *I. cornuta* and *I. integra*, rare natives in south-west seashore in Korea⁷⁾. It has intermediate characteristics between *I. cornuta* and *I. integra*. *I. × wandoensis* is small tree grow to 5~8 m, *I. cornuta* is shrub grow to 1~3 m, and *I. integra* is tall tree grow to 15~20 m.

By reason of its unique leaf shape and high ornamental value of fruit shape and colour, *I. × wandoensis* can be planted as a representative landscape plants in the subtropical zone, and also it is a native species

Corresponding Author : Young-Hee Ahn, Department of Applied Plant Science, Chung-Ang University, Gyeonggi-do 456-756, Korea
Phone: +82-31-670-3041
E-mail: ecoplant@cau.ac.kr

with high potential of export to the West which have great demand for *Ilex* species. Especially its hard fruit could hang for a long time from branch during winter season so it can be used as an environmental trees for lure the birds from shortage of food in winter. So far, it is unknown that accurate original area of native *I. × wandoensis*. Uncertainty of original area of native *I. × wandoensis* may restrict approval of its value of species internationally. There is not enough collection of various individuals for breeding of new variety and enough environmental information for cultivation^{1,8)}.

This study was conducted to analysis the original habitat of ecological characteristics of native *I. × wandoensis* which could be possible ornamental trees and search for breeding material with special characteristics and also provide accurate environmental information⁹⁾.

2. Materials and Methods

Survey of original habitat of ecological characteristics of "Wando holly"(*I. × wandoensis*) was conducted from May 2004 to May 2005 at the colony on a hill in Galmoon-Ri, Gunoei-Myon, Wando-Gun, Jeonnam Province, Korea(N 34°21'40.9" E126°39'8.6"). The site was measured with GPS(global position system, GPSIII Plus). The altitude above the sea level was measured with digital altimeter(RRETEL ALTI-D2). The gradient was measured with clinometer(SUUNTO PM-5). The soil acidity and humidity¹⁰⁾ were measured with handy pH and hygrometer(Takemura Electric DM-15). The soil hardness was measured with durometer(Yamanaka K-730).

Existing vegetation was surveyed with 10 m × 10 m square plot in the existing site of *I. × wandoensis*¹¹⁾. A projection diagram of plant canopy and stratum transect of community at the native habitat of *I. × wandoensis* were drew up^{12,13)}. The coverage and sociability were surveyed for investigating vegetation of the native following the phytosociological research method of Braun Blanquet¹⁴⁾. The height of vegetation and coverage of plant species were surveyed with the plants sorted by tree layer, sub-tree layer, shrub layer, and herb layer¹⁵⁾. Flora existed in the native site were recorded on the field note, classified as Lee's systematics, and listed⁵⁾. The climate of the native site was drew up by climate diagram following Walter *et al.*¹⁶⁾ with arrangement of the climatic data from 1971 to

2004¹⁷⁾.

3. Results and Discussion

Wando-Gun, Jeonnam Province is located southernmost in Korean peninsular. It is one of the six great islands in Korea. Wando Island is consisting of several islands around Wando-Gun County(Fig. 1). It is known as potential touristic place because of its affluent natural and cultural touristic sources and distribution of the temperate evergreen broad-leaved forest¹⁸⁾. Its area is 392.76 km², including 66.8%(262.09 km²) of forest, 14.2%(55.81 km²) of rice field, and 9.3%(36.45 km²) of dry field.

Wando Island is known as the region which is under the influence of typical oceanic and mild climate and has distinguished four seasons(Fig. 2). In the climate data of the latest 33 years, the yearly mean temperature is 14.0°C, the yearly mean rain fall is 1,456 mm. The half of rainfall is concentrated on from June to August and the monthly mean minimum temperature of January is -0.5°C. Therefore it shows the typical characteristics of southern subtropical climate zone.

Area of Galmoon-Ri, Gunoei-Myon, Wando-Gun, Jeonnam Province, where are identified as a native habitat of *I. × wandoensis* in this study, were in ecologically spoiled condition. This region had been

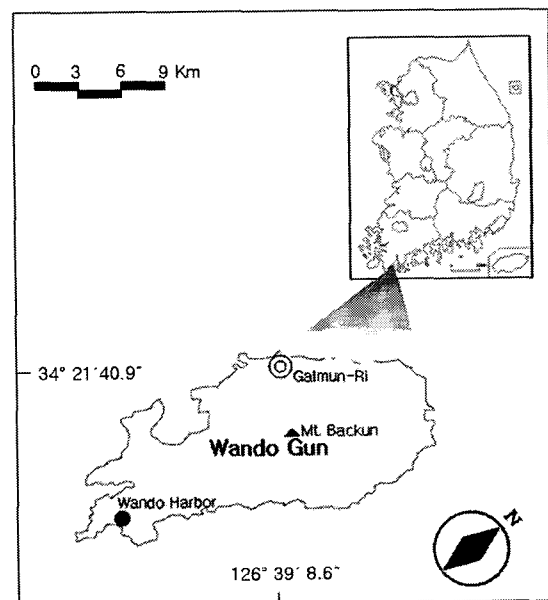


Fig. 1. Location map of surveyed plots in Wando Island.

The Ecological Characteristics of Native Habitat of Korean Native Wando Holly(*Ilex wandoensis*)

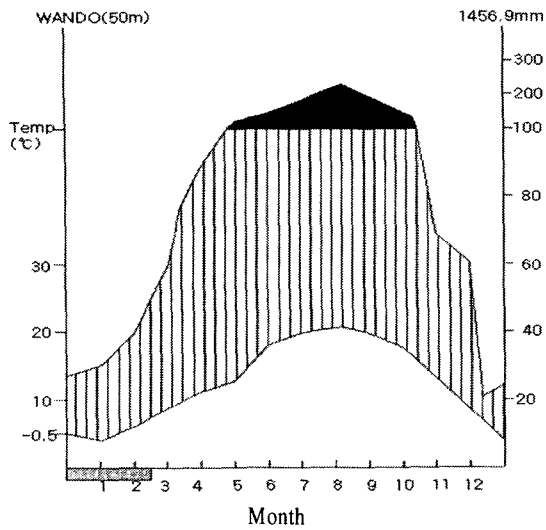


Fig. 2. Climate diagram of the Wando Island meteorological station. (The period observed : 1971~2004)

spoiled by thin out, and sprouts from cut *I. × wandoensis* are growing as 30-120cm high. According additional inquiry to nearby regional resident, "It is difficult to find native habitat of *I. × wandoensis* currently and some big trees are existed in some existing and abolished elementary school." These results surmised that school parents planted *I. × wandoensis* taking from nearby hills to beautified the school when it established.

Investigation shows that soil pH of native habitat was 6.18, hardness was 2.39, humidity was 38.6%, direction of slope is SSW, and average inclination was 15. The vegetation existing around *I. × wandoensis* is drew up (Table 1). Vegetation around *I. × wandoensis* is occupied by trees like a *Quercus variabilis*, *Q. serrata*, *Q. acuta* and so on. These are mixed forest of deciduous trees. Tree height reached up to 12m and its coverage is about 30%. *Q. salicina*, *Camellia ja-*

Table 1. Floristic composition table *Ilex × wandoensis* habitat in Wando Island

Study area : Galmun-Ri, Gunwae-Myun, Wando-Gun, Chunnam
 Date : 2005. 2. May Slope degree(°) : 15 Latitude : N34° 21' 39.8"
 Slope aspect : SSW Number of species : 26 Longitude : E 126° 39' 09.5"

Scientific name	Layer Height(m) Coverage(%)	Tree	Subtree	Shrub	Herb
		12 30	8 20	1.2 20	0.2 20
<i>Quercus variabilis</i>		2.2			
<i>Pinus densiflora</i>		+			
<i>Quercus serrata</i>		1.1			
<i>Quercus acuta</i>		1.1			
<i>Castanopsis cuspidata</i> var. <i>thunbergii</i>		+			
<i>Quercus salicina</i>			1.1		
<i>Camellia japonica</i>			+		
<i>Ilex integra</i>			2.2		
<i>Cryptomeria japonica</i>			+		
<i>Viburnum erosum</i>				+	
<i>Callicarpa japonica</i>				+	
<i>Styrax japonica</i>				+	
<i>Eurya japonica</i>				1.1	
<i>Lindera obtusiloba</i>				+	
<i>Ligustrum japonicum</i>				+	
<i>Stephanandra incisa</i>				+	
<i>Symplocos chinensis</i> for. <i>pilosa</i>				+	
<i>Pourthiaea villosa</i>				+	
<i>Smilax china</i>				1.1	
<i>Ilex × wandoensis</i>				+	
<i>Cornus walteri</i>				+	
<i>Trachelospermum asiaticum</i> var. <i>intermedium</i>					2.2
<i>Cymbidium goeringii</i>					1.1
<i>Dryopteris bissetiana</i>					+
<i>Dispirum viridescens</i>					+
<i>Sasa borealis</i> var. <i>gracilis</i>					1.1

Table 2. The list of vascular plants in *Ilex × wandoensis* habitats

Family name	Korean name	Scientific name	Raunkiaer's Life Form
Aspidiaceae	나도히초미	<i>Polystichum polyblepharum</i>	H
	쇠고사리	<i>Arachniodes amabilis</i>	G
	족제비고사리	<i>Dryopteris bissetiana</i>	Ch
Polypodiaceae	콩짜개덩굴	<i>Lemmaphyllum microphyllum</i>	E
Pinaceae	리기다소나무	<i>Pinus rigida</i>	M
	소나무	<i>Pinus densiflora</i>	M
	곰솔	<i>Pinus thunbergii</i>	M
Taxodiaceae	삼나무	<i>Cryptomeria japonica</i>	M
Cupressaceae	노간주나무	<i>Juniperus rigida</i>	M
Gramineae	섬대	<i>Sasa borealis</i> var. <i>gracilis</i>	N
	김의털	<i>Festuca ovina</i>	H
	조릿대풀	<i>Lophatherum gracile</i>	H
Cyperaceae	대사초	<i>Carex siderosticta</i>	H
Liliaceae	털중나리	<i>Lilium amabile</i>	G
	비짜루	<i>Asparagus schoberioides</i>	G
	등골래	<i>Polygonatum odoratum</i> var. <i>pluriflorum</i>	G
	애기나리	<i>Disporum smilacinum</i>	G
	큰애기나리	<i>Disporum viridescens</i>	G
	맥문동	<i>Liriope platyphylla</i>	G
	소엽맥문동	<i>Ophiopogon japonicus</i>	G
	청미래덩굴	<i>Smilax china</i>	N
Dioscoreaceae	단풍마	<i>Dioscorea quinqueloba</i>	G
Orchidaceae	보춘화	<i>Cymbidium goeringii</i>	H
Betulaceae	소사나무	<i>Carpinus coreana</i>	M
	서어나무	<i>Carpinus laxiflora</i>	M
Fagaceae	밤나무	<i>Castanea crenata</i>	M
	모밀잣밤나무	<i>Castanopsis cuspidata</i> var. <i>thunbergii</i>	M
	굴참나무	<i>Quercus variabilis</i>	M
	줄참나무	<i>Quercus serrata</i>	M
	참가시나무	<i>Quercus salicina</i>	M
	붉가시나무	<i>Quercus acuta</i>	M
Ulmaceae	팽나무	<i>Celtis sinensis</i>	M
Moraceae	모람	<i>Ficus nipponica</i>	M
Ranunculaceae	노루귀	<i>Hepatica asiatica</i>	G
Lardizabalaceae	으름	<i>Akebia quinata</i>	N
	멀꿀	<i>Stauntonia hexaphylla</i>	N
Menispermaceae	맹맹이덩굴	<i>Cocculus trilobus</i>	N
Lauraceae	생강나무	<i>Lindera obtusiloba</i>	N
Rosaceae	국수나무	<i>Stephanandra incisa</i>	N
	복분자딸기	<i>Rubus coreanus</i>	N
	찔레꽃	<i>Rosa multiflora</i>	N
	산벚나무	<i>Prunus satgentii</i>	M
	윤노리나무	<i>Pourthiaea villosa</i>	M
Leguminosae	조록싸리	<i>Lespedeza villosa</i>	N
	자귀나무	<i>Albizzia julibrissin</i>	M
Anacardiaceae	개웃나무	<i>Rhus trichocarpa</i>	M
Aquifoliaceae	완도호랑가시나무	<i>Ilex × wandoensis</i>	M
	감탕나무	<i>Ilex integra</i>	M
Celastraceae	사철나무	<i>Euonymus japonica</i>	N
	참회나무	<i>Euonymus oxyphyllus</i>	M
	노박덩굴	<i>Celastrus orbiculatus</i>	M

The Ecological Characteristics of Native Habitat of Korean Native Wando Holly(*Ilex wandoensis*)

Table 2. Continued

Family name	Korean name	Scientific name	Raunkiaer's Life Form
Staphyleaceae	말오줌때	<i>Euscaphis japonica</i>	N
Sabiaceae	나도밤나무	<i>Meliosma myriantha</i>	M
Theaceae	동백나무	<i>Camellia japonica</i>	M
	사스레나무	<i>Eurya japonica</i>	N
Elacagnaceae	보리밥나무	<i>Elaeagnus macrophylla</i>	M
Araliaceae	송악	<i>Hedera rhombea</i>	M
	읍나무	<i>Kalopanax pictus</i>	M
Cornaceae	말채나무	<i>Cornus walteri</i>	M
Ericaceae	진달래	<i>Rhododendron mucronulatum</i>	N
	정금나무	<i>Vaccinium oldhamii</i>	N
Myrsinaceae	자금우	<i>Ardisia crenata</i>	Ch
Symplocaceae	노린재나무	<i>Symplocos chinensis for. pilosa</i>	N
Styracaceae	매죽나무	<i>Styrax japonica</i>	M
Oleaceae	쇠물푸레	<i>Fraxinus sieboldiana</i>	M
	광나무	<i>Ligustrum japonicum</i>	M
	취뽕나무	<i>Ligustrum obtusifolium</i>	M
Apocynaceae	마삭줄	<i>Trachelospermum asiaticum var. intermedium</i>	M
Verbenaceae	작살나무	<i>Callicarpa japonica</i>	M
Rubiaceae	계요등	<i>Paederia scandens</i>	Ch
Campanulaceae	더덕	<i>Codonopsis lanceolata</i>	G
Carprifoliaceae	덜꿩나무	<i>Viburnum erosum</i>	N
	병꽃나무	<i>Weigela subsessilis</i>	N
	인동	<i>Lonicera japonica</i>	M
Compositae	참취	<i>Aster scaber</i>	G
	삼주	<i>Artactylodes japonica</i>	G

- M - Phanerophytes
- N - Nanophanerophytes
- E - Epiphytes
- Ch - Chamephytes
- H - Hemicryptophytes
- G - Geophytes

ponica, *I. integra*, *Cryptomeria japonica* account for sub-tree layer. Tree height is around 8m and coverage is 20 %. Shrub layer was taken by *Viburnum furcatum*, *Callicarpa japonica*, *Styrax japonica*, *Eurya japonica*, *Lindera obtusiloba*, *Ligustrum japonicum*, *Smilax china*, *Cornus walteri* etc. Tree height reaches around 1.2m and its coverage is around 20%. Herb layer includes *Trachelospermum asiaticum var. intermedium*, *Cymbidium goeringii*, *Dryopteris bissetiana*, *Disporum viridescens*, *Disporum smilacinum*, *Sasa borealis var. gracilis* etc. *Trachelospermum asiaticum var. intermedium*, which are observed in southern evergreen zone, are dominant and its coverage is around 20%.

Existing plant species included the vines such as

Smilax china, *Cocculus trilobus*, *Trachelospermum asiaticum var. intermedium*, *Paederia scandens*, and so on, pioneer plants, which roots are widely developed, *Sasa borealis var. gracilis*, *Festuca ovina*, *Carex okamotoi*, and so on, and also light flavoring rosaceous plants. These were appeared mixed or solely. In the spoiled site of natural environment, plants which have guerilla reproduction strategy, that is easy to ear into near by plant community, may relatively increase¹⁹⁾.

Flora of wando holly growing region and Raunkiaer's life form²⁰⁾ were drew up(Table 2.). Flora of native site were counted as 40 families, 66 genera, 76 species, 5 varieties, and 1 hybrid. life form of survey area shows 47.36% of macrotype terrestrial plant(M) and 23.68% of small terrestrial plant(N). Raunkiaer's

life form in Korea were reported as M-16, N-16.2, E-1.2, Ch-1.5, H-35.1, and G-15. Those of south Korea were reported as M-20, N-14.8, E-7.4, Ch-1.9, H-30, and G-12.3 life form of the native habitat of *I. × wandoensis* showed high value and vegetation was considered to be stabilized comparing macrotype terrestrial plant and small terrestrial plant of south Korea and Korean peninsular²¹⁾. The eroptophyte, half eroptophyte and chamaephyte accounted 17.11%, 6.58% and 1.32%, respectively(Fig. 3). Therefore vegetation of upper level and middle level at native habitat of *I. × wandoensis* was stabilized, but extensive management of low level and ground level vegetation regarded to be necessary.

Individual number of *I. × wandoensis* was counted at the native site(Fig. 4). The native site was severely spoiled by thin out. Twenty-one sprouts from cut

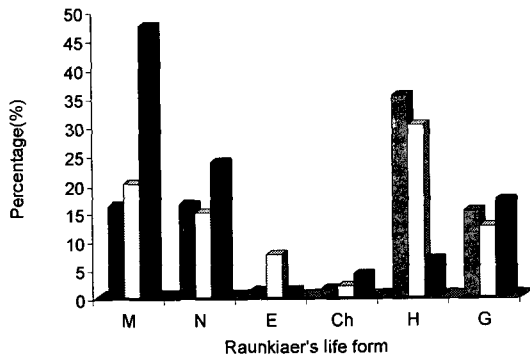


Fig. 3. The composition of plants species in *Ilex × wandoensis* community.

M - Phanerophytes, N - Nanophanerophytes,
E - Epiphites, Ch - Chamephytes,
H - Hemicryptophytes, G - Geophytes

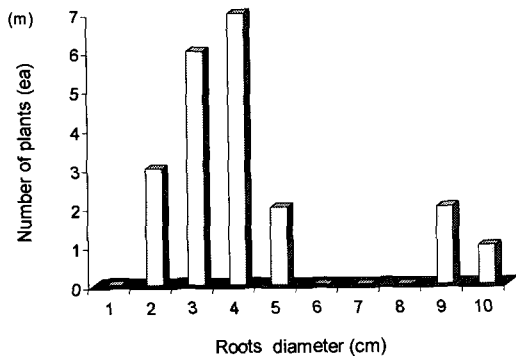


Fig. 4. Distribution of root diameter classes of *Ilex × wandoensis* in surveyed areas.

trees of about 1m high were found. These were measured by diameter of above ground part. Twelve *I. × wandoensis* were found which were over 4cm on their diameter of above ground part. The others were less than 4 cm. Nearby residents stated that shrub layer was thin out three years ago. We considered that the colony was spoiled at that time.

Fig. 5. shows the projection diagram of plant canopy draw up after establishment of 10 m × 10 m square plot in the *I. × wandoensis* existing site. *Q. serrata* and *Q. variabilis* were dominant colonies in the site. Tree layer is surveyed as 2 *Q. serrata* which are 8-12 m high and 20-30 cm of diameter breast height(DBH), one *Q. variabilis* with 12m high and 25 cm of DBH, and one *Q. salicina*. Beside that one each of *Q. acuta*, *Pinus densiflora*, and *P. thunbergii* were identified. Sub-tree layer is identified as one each of *Camellia japonica* and *I. integra*. *Viburnum furcatum* and *I. × wandoensis* were identified as shrub layer. The stratum transect of community of habitat of *I. × wandoensis* is drawn(Fig. 6).

By the consequence of the investigation, second succession, various plant species are competing, is proceed at the native site of *I. × wandoensis* which are artificially interfered like environmental disturbance such as thin out²²⁾. Proper forest management, for en-

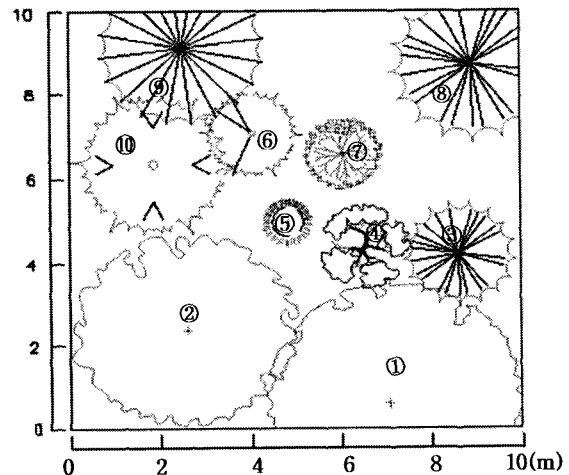


Fig. 5. Projection chart of *Ilex × wandoensis* habitat.

- ① *Quercus serrata*, ② *Quercus variabilis*,
- ③ *Quercus acuta*, ④ *Camellia japonica*
- ⑤ *Ilex × wandoensis*, ⑥ *Viburnum erosum*,
- ⑦ *Ilex integra*, ⑧ *Pinus densiflora*,
- ⑨ *Pinus thunbergii*, ⑩ *Quercus salicina*

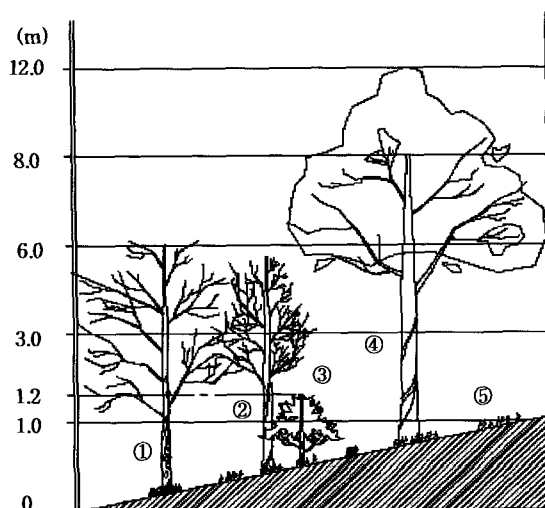


Fig. 6. Vegetation profile of *Ilex x wandoensis* habitat.
 ① *Quercus serrata*, ② *Ilex integra*
 ③ *Ilex x wandoensis*, ④ *Quercus variabilis*
 ⑤ *Trachelospermum asiaticum* var. *intermedium*

hancing lighting and easing competition, is inevitable for sustainable conservation of *I. x wandoensis*. Proper control of vine plants like *Trachelospermum asiaticum* var. *intermedium*, *Coculus trilobus*, *Smilax china*, *Celastrus orbiculatus* and so on is necessary rather than natural succession stage by complete negligence.

References

- 1) Ahn Y. H., Sul J. H., Cho K. H., 1998, Effect of preservation period. light, temperature, and priming on the seed germination of *Lysimachia mauritiana*, Kor. J. Env. Eco., 12, 9-13.
- 2) Ahn Y. H., Yeau S. H., Lee N. S., Lee S. T., 1999, Studies on characteristics of *Adonis amurensis* native to South Korea, Kor. J. Env. Eco., 13, 203-208.
- 3) Ahn Y. H., Kim S. H., Lee C. H., Lee S. T., 1999, Palynotaxonomic study of the genus *Hemerocallis* in Korea, J. Kor. Soc. Hort. Sci., 40, 505-510.
- 4) Cho K. H., Ahn Y. H., 2000, Effect of sucrose and supplementary substances on the germination ecology and the seedling growth of native *Bletilla striata*, Kor. J. Env. Eco., 14, 205-211.
- 5) Lee T. B., 1982, Illustrated flora of Korea. Hyangmoonsa publishing Co, Seoul, pp.460-461.

- 6) Shibata K., 1998, A cyclopedia of useful plants and plant products, Hokuryukan Co., Tokyo, pp. 514-519.
- 7) Miller C. F., Kim M. Y., 2002, *Ilex X Wandoensis*, a new hybrid species of *Ilex* from Korea, Kor. J. Plant Tax., 32, 293-299.
- 8) Matsuo T. N., 1989, Collected data of plant genetic resources. Kodansha Scientific Co., Tokyo, pp. 4-27.
- 9) Ahn Y. H., Chung K. H., Choi K. Y., Park D. S., 2001, Ecological characteristics and distribution of plant resources of *Pyrus* and *Malus* sp. in Jindong vally, Gwangwon province, Kor. J. Plant Res., 4, 130-139.
- 10) Page A. L., 1984, Methods of soil analysis. Soil Science Society of America, Inc., Wisconsin, pp. 149-262.
- 11) Ecology research group, 1967, Manual of ecological research, Asakura publishing Co., Tokyo, pp. 238-246.
- 12) Ahn Y. H., 2003, Distribution of *Hibiscus hamabo* and ecological characteristics of naturally inhabited areas in Jeju Island, Kor. J. Hort. Sci. & Technol., 21, 440-446.
- 13) Ahn Y. H., 2005, Ecological characteristics and distribution of native *Scrophularia takesimensis* in Ulleung-do Island, Kor. J. env. Sci., 14, 897-904.
- 14) Braun-Blanquet J., 1964, Pflanzensozioologie, Grundzude der Vegetationskunde, 3rd ed., Springer, New York, 85pp.
- 15) Ahn Y. H., Choi K. Y., 2002, Ecological characteristics and distribution of Korean native *Rhapontica uniflora* at habitats, Kor. J. Hort. Sci. & Technol., 20, 126-133.
- 16) Walter H., Harnickell E., Mueller-Dombois, 1975, Climate diagram maps, Springer, New York, 36pp.
- 17) Korea Meteorological Administration, 2006, <http://www.kma.go.kr/>
- 18) Ahn Y. H., Chung K. H., Park H. S., 2003, Vegetation and flora of *Hibiscus hamabo* inhabited naturally in Soan Island, Kor. J. Env. Sci., 12, 1181-1187.
- 19) Wilson J. B., Lee G. W., 1989, Infiltration invasion, Functionnal Ecology, 3, 379-382.
- 20) Barbour M. G., Burk J. H., Pitts W. D., 1980, Terrestrial plant ecology, The Benjamin publishing company, Inc., California, pp. 54-59.

- 21) Song J. S., Ahn Y. H., 2002, Phytosociological study on composition, distribution and habitat of Ussurian Pear and Chinese Pear, Korean wild species, *Kor. J. Env. Eco.*, 16, 160-171.
- 22) Ishitsuka K. O., 1982, Distribution of plant community and environment, Asakura publishing Co., Tokyo, pp.329-340.