PROJECT REPORT

PHYTOSOCIOLOGICAL STUDY OF VEGETATION OF SHIKINOMORI PARK PROTECTED FOREST

The report is prepared as part of field investigation for the training course, *"Rehabilitation of Degraded Lands in Asia and Africa"*

(This is a training related exercise on the basis of a small sample study which can be used as training manual only)

PROJECT REPORT ON PHYTOSOCIOLOGICAL STUDY OF VEGETATION OF SHIKINOMORI PARK PROTECTED FOREST

Prepared BY

DR. V. P. UPADHYAY
Ms. AIGUL KURSANOVNA AKHMETOVA
DR. T. YAGASAKI

PROJECT SUPERVISOR

PROFESSOR SHIGETOSHI OKUDA

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CONTRIBUTORS TO THE REPORT

1	**Dr. V.P.Upadhyay**
2	**Ms.Aigul Kursanovna Akhmetova**
3	**Dr. Sibounma Veophet**
4	**Mr.San Hinn Aung**
5	**Ms. Inthapatha Syphavanh**
6	**Mr. Samson Ng'ang'a Njihia**
7	**Mr. Rajiv Kumar Srivastava**
8	**Mr. Albert Newtons Nyabuti**
9	**Mr. Aung Zaw Moe**

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The present report is DEDICATED TO PROFESSOR AKIRA MIYAWAKI from whom we got all inspirations for the study report

PHYTOSOCIOLOGICAL STUDY OF VEGETATION OF SHIKINOMORI PARK PROTECTED FOREST

INTRODUCTION

The environmental degradation in tropical world is an inevitable outcome of developmental activities. The ecosystem services are now shrinking due to erosion of genetic biodiversity in natural ecosystem. There is faster harvesting of natural resources due to increasing population and demand for material development. The economic growth depends much on the use their natural resources. The forests occupies a unique natural resources position because of its non-renewable nature and have been more in demand for fuel wood, fodder, non forest produces like minerals and soil.. Rapid destruction of forest has caused severe damage to natural habitats, thus threatening the very survival of several indigenous species of plants and animals. Therefore a number of plants are in danger of extinction and many of the rare, endangered and insufficiently known plants with indigenous species are no more seen in their original habitat. To protect the depleting floristic diversity, and to rehabilitate the degraded area, proper conservation and management strategies are required by creating biosphere reserves, reserve forests, national parks, sanctuaries, etc.. Rehabilitation of degraded areas by indigenous natural biotic population seems to be only answer in many areas where we need to re-establish the indigenous flora and flora which are facing the threat of extinction.

For the management of biodiversity, particularly in protected areas, and rehabilitation of natural species, it is essential to understand the roles of species. Species form functional groups across the ecological gradients, particularly with respect to edaphic factors; species traits that enable them to acquire and utilize resources from the environment to a large extent are central to the roles of species in patterns and process of communities and ecosystems.

Tropical ecosystems endowed with remarkable high level of biological diversity and habitat heterogeneity, are facing massive degradation and alteration due to intense development oriented anthropogenic activities (Howard and Lanly, 1975).Tropical forest environment which is quite different from the temperate ones in which almost all the developed countries are located, need special attention especially for developing specialized individuals and institution to deal with the problems of degradation of various kinds. It is in this context that a JICA supported training programme entitled, 'Rehabilitation of degraded lands in Asia and Africa' was organised at JICA Yokohama for the trainees of Asia and Africa. The programme aimed at providing vegetation survey techniques (phytosociology) to investigate ecological structure and function of natural vegetation and to suggest strategy (on the basis of study) for rehabilitation of degraded areas with potential natural vegetation.

Thus, conservation and management of forests require understanding of the composition of particular forests in relation to other forests, the effects of past impacts and the present status, the present relationship of the forest with surrounding land uses and qualitative and quantitative assessment of forest vegetation (Geldenhuys and Murray, 1993). Finding out the potential natural vegetation through phytosociological tool to use them in rehabilitation of degraded lands has become essential particularly when we have to take holistic view to conserve all the biotic components of the food chain of an ecosystem. The present training programme of JICA is one such step towards developing skilled human resource in Asia and Africa regions for ecological restoration programme.

PHYTOSOCIOLOGY

Information regarding structure and functioning of vegetation is basic to the understanding of particular ecosystem. Each organism present in the ecosystem is a by

product of its nature (genetic constitution) and nurture (its environment). The exercise of Phytosociology aims at finding out natural floristic richness of area including structure of the vegetation forms to understand the pattern and processes of their structure, type, quality and quantity and stratification of vegetation. Thus, it gives useful information regarding composition, structure, species diversity, resource share and growth trends of succession and other characteristics of the community (Harper, 1977).

PHYTOSOCIOLOGICAL ANALYSIS METHODS AND DATA OUTPUT

We carried out phytosociological study in Shikinomori park protected forests from 10-12th November 2010 at different locations by laying three quadrats. The quadrat size and number of quadrats to be laid during survey was also discussed with experts during their lectures. For more clarity we provide here tabular and graphical presentations to find out the size and number of quadrat for studying vegetation of a particular area (Fig.1 and Fig.2).

THE SPECIES AREA CURVE METHOD

In this method, number of species falling in each quadrat is recorded. The presence of additional species in each larger quadrat is recorded. A point is reached where increasing quadrat size does not significantly increase the number of species encountered. The minimal sample area can then be determined from the species/area curve where the slope is nearly horizontal. This resulting quadrat size is the minimal size of the quadrat which can be used for sampling the vegetation. The quadrat sizes for different types of vegetation as suggested by various researchers are as follows:

Cain and Castro (1959); Barbour et al. 1987)					
Life form	**Mosses**	**Low herbs**	**Tall herbs/low shrubs**	**Tall shrubs**	**Trees**
Quadrat area (m^2)	0.01-0.1	1-2	4	16	100

In the present example as given in Figure 1, the requisite size of quadrat is 10x15m which may be appropriate size for Phytosociology and to sample and study the vegetation. Following data has been used for species area curve calculations:

Example: THE SPECIES AREA CURVE METHOD

Quadrat Size	Species Number
5x5	8
10x5	10
10x10	11
10x15	12
15x20	11
20x20	12
22x25	12
25x25	11
25x30	12
30x30	12

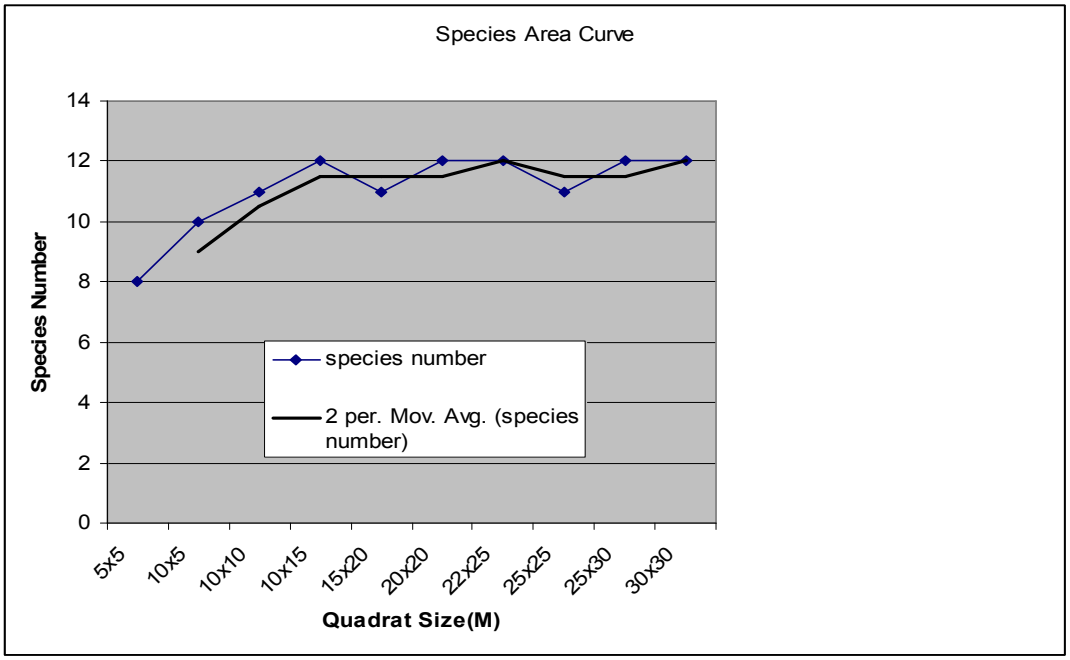

Fig.1. Species Area Curve to find out requisite quadrat size to study vegetation of an area.

THE RUNNING MEAN METHOD

The method consists of plotting a **running mean**. The X-axis is the number of quadrats (1, 2, 3, etc.) and the Y-axis is the **mean** number of individuals per quadrat (a **cumulative** value averaged over the continuously increasing number of quadrats). The running mean begins to stabilize as the number of samples increase (as you move to the right along the X-axis) the running mean should begin to stabilize as the number of samples increase. In this case 7 quadrats may be enough to carry out vegetation survey in the area (Fig.2).

Example: THE RUNNING MEAN METHOD

Quadrat Number	species number	cumulative	Mean
1	8	8	8
2	10	18	9
3	11	29	9.667
4	12	41	10.25
5	11	52	10.4
6	12	64	10.667
7	12	76	10.857
8	11	87	10.875
9	12	99	11
10	12	111	11.1

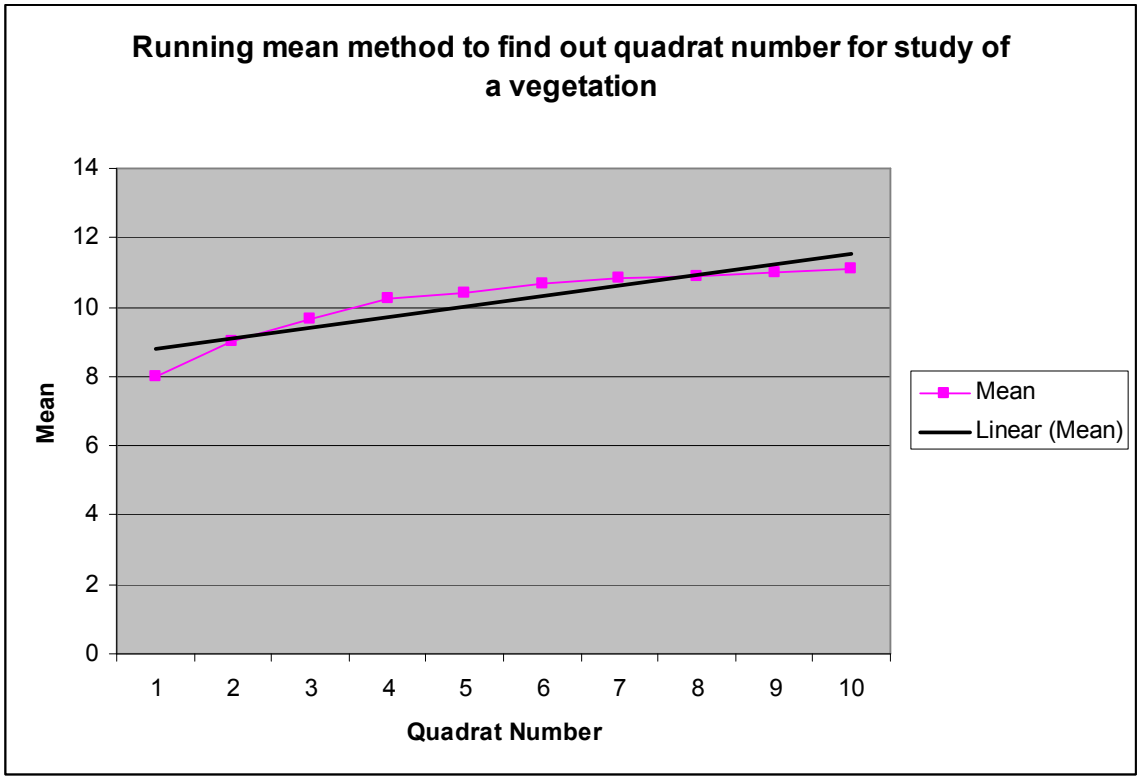

Fig.2. The Running Mean Method

THE SAMPLING

All the trees, shrubs and herbs species in quadrats were enumerated and indentified with the help of Expert ecologist, Dr. Shigetoshi Okuda. All the trees occurring inside the quadrat were recorded and measured for Girth at breast level (1.37 m).We examined the dominance and constancy of each plant species (tree, shrub, herb, climber and seedlings of trees) as per the methodology given by Braun-Blanquet (1964). Various class exercises were performed with the help of experts to prepare vegetation map including field verification of vegetation map vis-à-vis Google earth Map of the area. For the present report, quantitative data collected during field survey were subjected to various statistical calculations to derive results. The methods of calculations and formulae used are given below in the report.

Analysis and formulae

Methods provided by Kershaw (1973), Misra (1968), Philips (1959), Curtis (1959) were used for calculating the vegetation characteristics. Data of three quadrats were used for calculation of structural parameters of vegetation of Shikinomori protected forest. Although the sample size is very small, the data analysis can provide clarity on various structural characteristics which can be used to find out the "Potential Natural Vegetation" of the area.

1. **Percent Frequency**:

For comparison of different vegetation units frequency is expressed in terms of various species in a community.

$$\% \text{ Frequency} = \frac{\text{Number of quadrats in which the species occur}}{\text{Total number of quadrats studied}} \times 100$$

2. Raunkiaer's Law of Frequency:

The frequency values obtained were grouped in frequency classes to study the homogenous/ heterogeneous nature of vegetation (Raunkiaer, 1934). The Law of Frequency states that the numbers of species of a community in the 5 percentage frequency classes are distributed as-

$$A > B > C \geq D < E \leq$$

Where, A = frequency class- 0 to 20; B = = frequency class- 21 to 40; C = frequency class- 41 to 60; D = frequency class-61 to 80; and E = frequency class- 81 to 100.

$$\textbf{3. Relative Frequency (RF)} = \frac{\text{Number of occurrences of a species}}{\text{Number of occurrences of all species}} \times 100$$

4. Density- It is an expression of numerical strength of a species in a community. The formula used for calculation of density is,

$$\text{Density} = \frac{\text{Total no of individuals of a species}}{\text{Total number of quadrats studied}}$$

5. Relative Density: this provides for numerical strength of a particular species in relation to total number of individuals of all species.

$$\text{Relative density} = \frac{\text{Number of individuals of the species}}{\text{Number of individuals of all species}} \times 100$$

6. Abundance (A): this is a measure of the number of individuals of a species in a community per quadrat in which it occurred.

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrats of occurrence}}$$

7. Basal Area/ Dominance: This is regarded as an index of dominance of a species. Higher the basal area of a species indicates greater dominance. The average basal area and the relative basal area are calculated from the average diameter of the stem at breast height (diameter at Breast Height- DBH).

Basal area= $\Pi r^{2,}$ where $\Pi = 3.142$ or $22 / 7$

$$\text{Relative basal area} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}}$$

8. Importance Value Index (IVI)- A total picture of the ecological status of a species with respect to a community structure can be obtained by summing up relative frequency, relative density and relative basal area or dominance as Importance Value Index (IVI).

9. Distribution pattern (A/F Ratio)- The Abundance to percentage frequency ratio (A/F) provides information about the nature of distribution of species. The ratio value being less than 0.025 indicates regular, 0.025 to 0.05 random and above 0.05 is contagious distribution (Cottam and Curtis, 1956). The A/F value was calculated from the data of abundance and frequency of individual species.

10. Species Diversity: Species diversity of trees, and seedlings were determined with the Shannon-Wiener diversity index (Shannon & Wiener, 1963). A high index value is suggestive of more diverse community.

Formula for calculating the index is, $H' = \sum_{i=1}^{s} ni/N \ln ni/N$

Where H′ = Shannon Wiener Index of species diversity

ni = Number of individuals of the species

N = Number of individuals of all species

11. Concentration of Dominance: This is calculated to evaluate the level of dominance of a species within a community. This is expressed by Simpson's Index (1949). The index value is inversely proportional to Shannon-Wiener index and which means a higher value is indicative of a less diverse community.

$$\mathbf{C} = \sum_{i=1}^{s} (ni/N)^2$$

Where, C = Concentration of dominance

ni = Number of individuals of all species

S = Total number of species at the site

12. Species Evenness Index (EI): This is calculated as per Pielou (1975).

$$EI = \frac{H'}{\ln S}$$

Where, H′ is the Shannon-Wiener diversity index and S is the total number of species in the community.

13. Species Richness Index (RI): This is calculated as per Margalef (1958).

$$RI = \frac{S-1}{\ln N}$$

Where, S is the total number of species in the community and N is the total number of individuals of all species of a community.

14. Similarity Index/ Community Co-efficient:

The concept of similarity index was put forth by Jaccard (1912) to compare two plant communities to find out resemblance between each other in appearance. It is based on the presence/ absence relationship between the number of species common to two sites and total number of species. This, it expresses the ratio of the common species to all species found in the particular vegetation. Sorensen's (1948) formula for similarity index was used for the present study, which is

$$S = \frac{2C}{A + B} \times 100$$

Where, C is the number of species common to both the stands, A is the total number of species found in stand I and B is the total number of species found in stand II.

STUDY SITE CHARACTERISTICS:

The study sites of Shikinomori park forest area are located at an elevation ranging from 36 to 62m msl and slope of site was in the range of 10-30^0. Average height of upper tree canopy was recorded 17-30 m with canopy cover ranging from 80-95%. Average

height of shrub and herb layers was 1.5-3.0m and 0.3-0.8m and cover ranging from 10-40 and 30-90%, respectively, across all quadrats.

FLORISTIC COMPOSITION

The study explored the presence of 98 different naturalised plant species belonging to 55 families and representing a three storeyed floristic composition at these sites. Different storeys, observed, were 1) Upper canopy or upper strata, tree 2) Middle storey or under storey consisting of shrubs and saplings and 3) Under growth consisting of shrubs, seedlings and herbs of seasonal and perennial type.

In addition to these storeys more than 5 climber species were also recorded growing in association with different shrubs and tree species. Trees comprising 14 species were from different families. The respective numbers of species belonging to shrubs and herbs recorded were 24 and 60, respectively.

A majority of the families across all vegetation layers were represented by only two or less species. The best represented families were Liliaceae and Gramineae (each 7 species),Araliaceae, ,Lauraceae and Dryopteridaceae (each with with 5 species) followed by family caprifoliaceae,Cornaceae, and Compositae. Various phytosociological parameters of tree, shrub and herb layers are given in Table1-5.

DISTRIBUTION PATTERN OF SPECIES

Of the 14 tree species recorded in the study area(Table 1-2), nearly all species exhibited random distribution(7 species) or contiguous distribution(6 species). Only one species *Prunus grayana* exhibited weak regular distribution(nearing random).Among 24 species of shrubs, similar trend like trees was observed; Random(11 species),Contiguous(9 species) and Regular(4 species). Contiguous distribution was more pronounced in *Fatsia japonica, Aucuba japonioca*, and *Pleioblastus*

chino among shrub species. The herb layer species exhibited pronounced random distribution followed by contiguous distribution and weak regular distribution. Where as the seedlings of *Q, serrata* were observed in patches (contiguous), the seedlings of *Q. myrsinaefolia* exhibited random distribution.

RAUNKIAER'S FREQUENCY CLASS DISTRIBUTION

Raunkiaer's Law of Frequency (in graphical form referred to as Raunkiaer's J shaped distribution curves) was studied (Raunkiaer, 1934). The law (also known as the law of homogeneity) was expressed as A> B > C ≤ ≥ D < E, wherein, A to E are frequency classes suggested by Raunkiaer's from 0 to 100. There is no definite pattern of frequency distribution conforming to above order probably because sample size is too small to derive frequency class (Fig.3). However most of the species have fallen in class B for trees and herb layers and class D for shrub layer. The increase in class E reflects the theoretical infinite range of density and contrasts with the more strictly defined limits for classes A, B, C, and D (Kershaw 1973). This fifth class has a possible density range greatly exceeding that occurring in the remainder of the frequency classes A to D. Accordingly many more species fall into this class, despite the general tendency for 'common' species to be relatively few in number in a community".

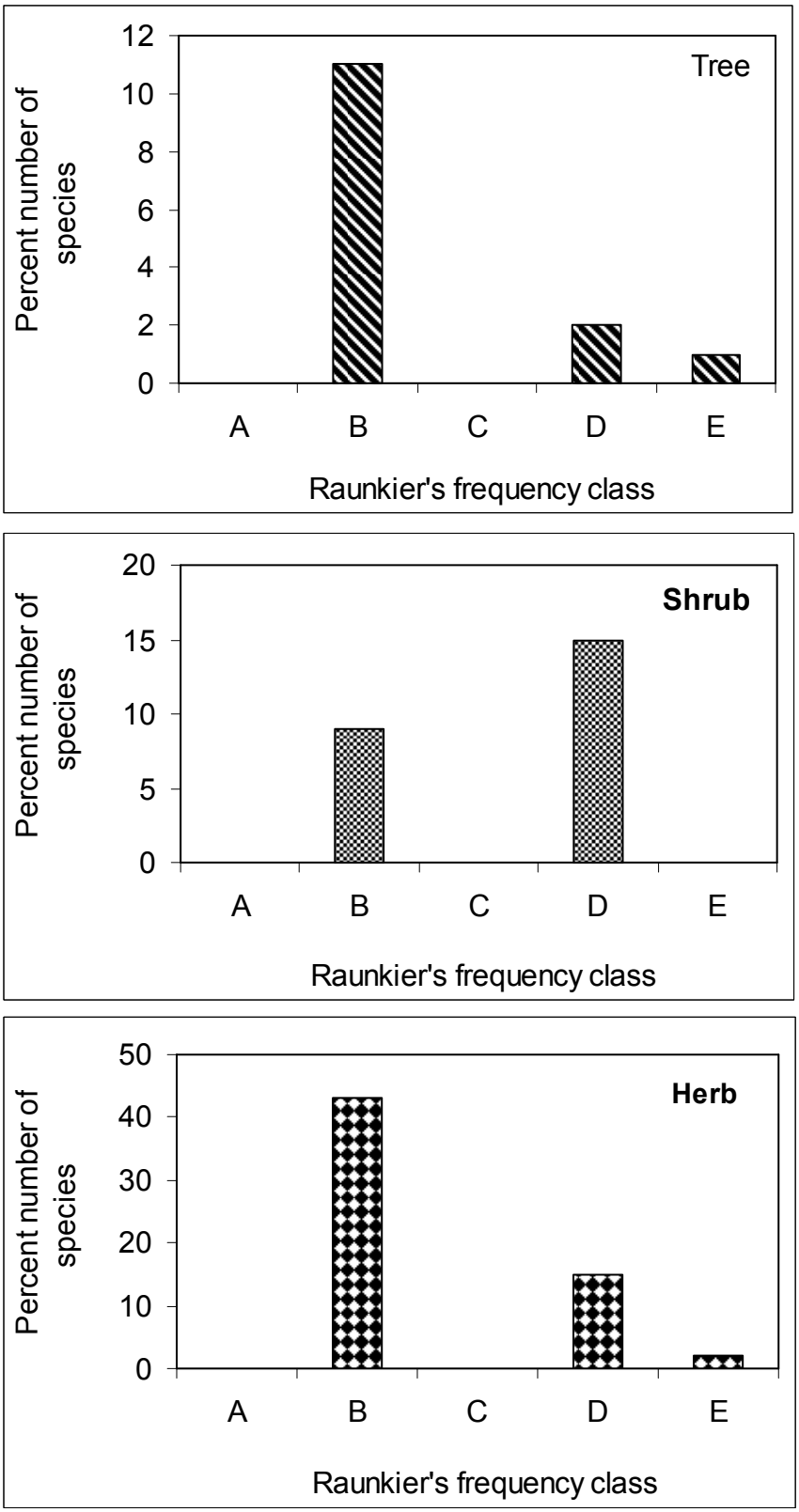

Fig.3. Raunkier's Frequency Class for Vegetation of Shikinomori Park.

SPECIES DIVERSITY AND CONCENTRATION OF DOMINANCE

The species diversity depends upon adaptation of species and increases with stability of community (Singh et al, 1994). Shannon Wiener species diversity was 3.287, 3.423, and 2.699, respectively, for tree, shrub and herb layers of the Shikinomori Park. The tree, shrub and herb layer species of the Shikinomori Park are highly diverse. The dominance is more pronounced in shrub layer. The Concentration of Dominance was 0.197, 0.237 and 0.198, respectively, for tree, shrub and herb layer species. Species richness and equitability is higher in shrub species and low in tree species. Similarity index value shows that the species of three quadrats of tree layer of Shikinomori Park has only less than 25% similarity, perhaps indicating the influence of microclimate on the species distribution. The study quadrats were laid on different aspects with differences in altitude.

DOMINANCE- DIVERSITY CURVES

Plotting 'dominance- diversity curves' (D-D curves) is a method of exploring species abundance relationships (Whittaker 1965, 1969,1972). By ordinating IVI (log values) against the species sequence, we can assess the community organisation in terms of resource share and niche space. This is based on the assumption that there is some correspondence between the share of community's resource a species utilizes and the share of community's niche space it occupies. Thus, degree of resource apportionment is considered as a measure of resource conservation (Pande et al. 2001). The D-D curve is log normal in shape for the study site (Fig 4). This means, the large number of factors determine the number of species (diversity) in a community. A log normal condition represents high diversity condition. (Pande et al. 2002). On the other hand, species which show geometric series conform to the 'niche preemption' hypothesis postulated by Whittaker (1975). The geometric form is often

exhibited by vascular plant communities having low species diversity and it is indicative of low competition among the species because IVI of species is proportional to the amount of the resources they utilize (Whittaker 1972).

It is observed from the D-D curve that *Quercus myrsinaefolia, Prunus grayana, Prunus jamasakura,Q.serrata,Cornus macrophylla* and *Cornus controversa* are the dominant species and thus use most part of the resources available in the forest and the rest 8 species use the balance of the resources. However, *Quercus myrsinaefolia* seems to enjoy highest proportion of resources and the curve shows a moderate steep downfall after this species. Balance resources are shared between the rest 13 tree species of the Shikinomori Park.

Name of tree species	Log IVI	species Sequence	Log IVI
Quercus myrsinaefolia	1.893018	1	1.893018
Prunus grayana	1.433702	2	1.433702
Prunus jamasakura	1.315462	3	1.315462
Quercus serrata	1.314485	4	1.314485
Cornus macrophylla	1.266438	5	1.266438
Cornus controversa	1.257818	6	1.257818
Styrax japonicus	1.095537	7	1.095537
Kalopanax pictus	1.074382	8	1.074382
Chamaecyparis obtusa	0.978069	9	0.978069
Machilus thunbergii	0.939965	10	0.939965
Ligustrum lucidum	0.921476	11	0.921476
Stachyurus praecox	0.924638	12	0.924638
Celtis sinensis var. japonica	0.921476	13	0.921476
Viburnum plicatum var. tomentosum	0.916001	14	0.916001

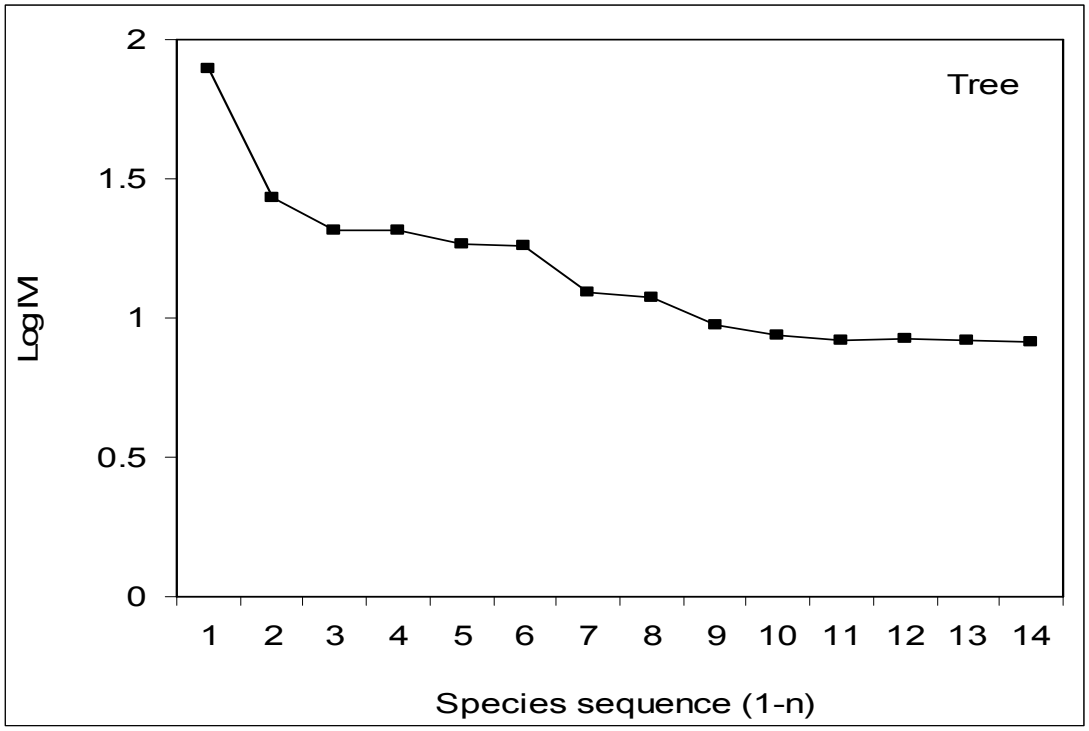

Figure4. Dominance diversity curve for tree layer OF Shikinomori park protected site on the basis of IVI Values .

THE POTENTIAL NATURAL VEGETATION

From vegetation analysis results, it is observed that *Quercus myrsinaefolia* is the dominant species of Shikinomori Park Forest. It has presence in all the quadrats with a very high density of 5.33 and abundance of equal value. *Q.myrsinaefolia* exhibits nearly random distribution. All deciduous tree species show weak contiguous distribution indicating resource competition among its populations. *Q.myrsinaefolia* also accounts for 1/3rd of the total IVI values of the forest among tree species which shows strong dominance character of this species. From D-D curve (Fig.4) it is also observed that *Q.myrsinaefolia* enjoys highest proportion of resources of the forest as it it is placed at the top of the species sequence. Thus, *Q.myrsinaefolia* qualifies for being 'Potential Natural Species"(PNS) of the Shikinomori Park.Among the shrub layer species, *Pleioblastus chino* and *Aucuba jap*onica are the 1st and 2nd dominant species the Seedlings of *Q.myrsinaefolia* also exhibited highest IVI values among ground flora species with highest density of >18%. Among herb layer species, *Carex duvaliana, Dryopteris erythrosora,Hedera rhombia, Ophiopogan ohwii* and *Tracheospermum asiaticaum* are the dominant species enjoying higher proportion of resources and these species are natural associations of Potential Natural Vegetation (PNV) dominated by *Q.myrsinaefolia.*

We also carried out phytosociological survey at a few other sites viz., Sankeien garden and Sakuragaoka Park during field visits. It was observed that a total of 55 families were represented across all sites located in Kanagawa Prefecture. The flora of the Kanagawa is extremely diverse and seems to be one of the richest of the protected ecosystems in the area. Presence of 55 families indicates richness in biodiversity and these habitats are gene banks of the majority of important keystone species. Table 6 provides a list of plants with their families of the study sites.

Table 1. Importance value Index (IVI) for the tree layer species of Shikinomori Protected forest

Name of tree species	**RD**	**RF**	**RBA**	**IVI**
Quercus myrsinaefolia	43.243	17.647	40.690	101.581
Chamaecyparis obtusa	2.7027	5.882	0.500	9.085
Quercus serrata	5.4054	5.882	12.046	23.333
Cornus macrophylla	5.4054	5.882	9.463	20.750
Kalopanax pictus	5.4054	5.882	1.570	12.857
Prunus grayana	8.1081	11.765	10.206	30.078
Prunus jamasakura	5.4054	5.882	12.102	23.389
Styrax japonicus	5.4054	5.882	2.278	13.566
Cornus controversa	5.4054	5.882	9.028	20.316
Machilus thunbergii	2.7027	5.882	0.781	9.366
Ligustrum lucidum	2.7027	5.882	0.347	8.9323
Stachyurus praecox	2.7027	5.882	0.420	9.0052
Celtis sinensis var. japonica	2.7027	5.882	0.347	8.9323
Viburnum plicatum var. tomentosum	2.7027	5.882	0.222	8.8073
	100	100	100	300

RD= relative density; RF= relative Frequency; RBA= Relative Basal Area

Table 2 . Phytosociological data (IVI) for the tree layer species of Shikinomori Protected forest

Name of tree species	F	D	A	A/F	H/	Cd
Quercus myrsinaefolia	100	5.333	5.33	0.053	0.36252	0.18700
Chamaecyparis obtusa	33.33	0.333	1	0.03	0.09759	0.00073
Quercus serrata	33.33	0.667	2	0.06	0.15772	0.00292
Cornus macrophylla	33.33	0.667	2	0.06	0.15772	0.00292
Kalopanax pictus	33.33	0.667	2	0.06	0.15772	0.00292
Prunus grayana	66.67	1	1.5	0.023	0.2037	0.00657
Prunus jamasakura	33.33	0.667	2	0.06	0.15772	0.00292
Styrax japonicus	33.33	0.667	2	0.06	0.15772	0.00292
Cornus controversa	33.33	0.667	2	0.06	0.15772	0.00292
Machilus thunbergii	33.33	0.333	1	0.03	0.09759	0.0007
Ligustrum lucidum	33.33	0.333	1	0.03	0.09759	0.0007
Stachyurus praecox	33.33	0.333	1	0.03	0.09759	0.0007
Celtis sinensis var. japonica	33.33	0.333	1	0.03	0.09759	0.0007
Viburnum plicatum var. tomentosum	33.33	0.333	1	0.03	0.09759	0.0007
		12.333			**2.09808**	**0.21549**

F= Frequency; D= density; A= Abundance ;A/F = Abundance/Frequency; H/= Species Diversity; Cd= Concentration of Dominance. **Total no. of species=14**
E.I. (Evenness index)= 1.83058

Similarity index			
Quadrat	**Q1**	**Q2**	**Q3**
Q1		**22.22**	**20**
Q2			**26.67**
Q3			

Table. Importance value Index (IVI) for the shrub layer species of Shikinomori Protected forest

Name of species of shrubs	F	D	A	A/F	RF	RD	RA	IVI	F Class
Acanthopanax spinosus	33.33	1	3	0.09	3.030	1.887	2.521	7.438	B
Aucuba japonica	66.67	15.667	23.5	0.35	6.061	29.560	19.747	55.368	D
Broussonetia kazinoki	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Callicarpa japonica	66.67	1	1.5	0.023	6.061	1.887	1.261	9.208	D
Cocculus orbiculatus	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Daphne pseudo-mezereum	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Dendropanax trifidus	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Eurya japonica	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Fatsia japonica	33.33	2.667	8	0.24	3.030	5.031	6.722	14.784	B
Hedera rhombea	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Helwingia japonica	66.67	1.333	2	0.03	6.061	2.516	1.681	10.257	D
Ilex crenata	66.67	0.667	1	0.015	6.061	1.258	0.840	8.159	D
Ligustrum japonicum	66.67	1.667	2.5	0.037	6.061	3.145	2.100	11.306	D
Lindera umbellata	33.33	0.667	2	0.06	3.030	1.258	1.680	5.969	B
Osmanthus heterophyllus	33.33	0.667	2	0.06	3.030	1.258	1.680	5.969	B
Pleioblastus chino	33.33	16.667	50	1.5	3.030	31.447	42.017	76.494	B
Quercus myrsinaefolia	33.33	1.333	4	0.12	3.030	2.516	3.361	8.907	B
Stachyurus praecox	66.67	1.333	2	0.03	6.061	2.516	1.681	10.257	D
Stephanandra incisa	66.67	0.667	1	0.015	6.061	1.258	0.840	8.159	D
Thea sinensis	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Trachelospermum asiaticum f. intermedium	33.33	0. 667	2	0.06	3.030	1.258	1.681	5.969	B
Trachycarpus fortunei	66.67	3.667	5.5	0.083	6.061	6.918	4.622	17.601	D
Viburnum erosum	33.33	0.333	1	0.03	3.030	0.629	0.840	4.500	B
Wisteria floribunda(cl.)	66.67	0.667	1	0.015	6.061	1.258	0.840	8.159	D
Total	**1100**	**53**	**119**		**100**	**100**	**100**	**300**	

F= Frequency; D= density; A= Abundance; RF= Relative frequency; D= relative Density; RA= Relative Abundance; IVI= Importance Value Index.

Concentration of Dominance= 0.19845; Species Diversity= 2.18109

Table. Importance value Index(IVI) for the herb layer species of Shikinomori Protected forest

Name of herbacious species	F	D	A	A/F	RF	RD	RA	IVI	F class
Acanthopanax nipponicus	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Achyranthes bidentata var. japonica	33.33	0.3333	1	0.03	1.266	0.292	0.391	1.950	B
Akebia quinata	66.67	1.333	2	0.03	2.532	1.170	0.783	4.484	D
Akebia trifoliata	33. 33	0.667	2	0.06	1.266	0.585	0.783	2.633	B
Aphananthe aspera	66.67	0.667	1	0.015	2.532	0.585	0.391	3.508	D
Arachniodes standishii	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Ardisia crenata	66.67	0.667	1	0.015	2.532	0.585	0.391	3.508	D
Ardisia crispa	33.33	1.667	5	0.15	1.266	1.462	1.957	4.685	B
Ardisia japonica	66.67	1.333	2	0.03	2.532	1.170	0.783	4.484	D
Berberis thunbergii	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Carex duvaliana	33.33	10	30	0.9	1.266	8.772	11.742	21.779	B
Carex lenta	33.33	0.667	2	0.06	1.266	0.585	0.783	2.633	B
Cephalanthera longibracteata	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Cimicifuga japonica	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Coniogramme japonica	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Cryptomeria japonica	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Cymbidium goeringii	66.67	0.667	1	0.015	2.532	0.585	0.391	3.508	D
Cyrtomium fortunei	33.33	1	3	0.09	1.266	0.878	1.1742	3.317	B
Daphne pseudo-mezereum	33. 33	0.333	1	0.03	1.266	0.2924	0.391	1.950	B
Desmodium podocarpium ssp. oxyphyllum	66.67	1.667	2.5	0.0375	2.532	1.462	0.979	4.972	D
Dioscorea japonica	33.33	0. 333	1	0.03	1.266	0.2924	0.391	1.950	B
Dioscorea tokoro	33.33	0.333	1	0.03	1.266	0.2924	0.391	1.950	B
Disporum sessile	66.67	0.667	1	0.015	2.532	0.585	0.391	3.508	D
Dryopteris erythrosora	100	5	5	0.05	3.798	4.386	1.957	10.140	E
Dryopteris uniformis	66. 67	1.333	2	0.03	2.532	1.170	0.783	4.484	D
Dryopteris varia var. setosa	33.33	0.667	2	0.06	1.266	0.585	0.783	2.633	B
Elaeagnus macrophylla	33.33	1.333	4	0.12	1.266	1.170	1.566	4.001	B
Euonymus sieboldianus	33.33	0.667	2	0.06	1.266	0.585	0.783	2.633	B
Euscaphis japonica	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Fatsia japonica	33.33	1	3	0.09	1.266	0.877	1.174	3.317	B
Gynostemma pentaphyllum	33.33	0.333	1	0.03		0.292	0.391	1.950	B

					1.266				
Hedera rhombea	100	10	10	0.1	3.798	8.772	3.914	16.483	E
Hosta sieboldiana	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Houttuynia cordata	33.33	0.667	2	0.06	1.266	0.585	0.783	2.633	B
Kalopanax pictus	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Lindera glauca	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Lindera umbellata	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Liparis nervosa	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Liriope muscari	66.67	2.333	3.5	0.0525	2.532	2.047	1.370	5.948	D
Lonicera japonica	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Mahonia japonica	33. 33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Morus Australis	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Neolitsea sericea	66.67	0.667	1	0.015	2.532	0.585	0.391	3.508	D
Ophiopogon japonicus	66.67	1.333	2	0.03	2.532	1.170	0.783	4.484	D
Ophiopogon ohwii	33.33	13.333	40	1.2	1.266	11.696	15.656	28.617	B
Oplismenus undulatifolius var. japonicus	66.67	2	3	0.045	2.532	1.754	1.174	5.460	D
Osmunda japonica	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Parthenocissus tricuspidata	33.33	0.667	2	0.06	1.266	0.585	0.783	2.633	B
Pertya scandens	33.33	2.333	7	0.21	1.266	2.047	2.740	6.052	B
Pleioblastus chino	33.33	2.333	7	0.21	1.266	2.047	2.740	6.052	B
Quercus myrsinaefolia	66.67	18.667	28	0.42	2.532	16.374	10.9589	29.865	D
Quercus serrata	33.33	3.333	10	0.3	1.266	2.924	3.914	8.104	B
Smilax china	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Stegnogramma pozoi ssp. mollissima	66.67	0.667	1	0.015	2.532	0.5845	0.391	3.508	D
Syneilesis palmata	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Trachelospermum asiaticum f. intermedium	33.33	12	36	1.08	1.266	10.526	14.090	25.882	B
Viburnum dilatatum	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Viola grypoceras	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Viola hondoensis	33.33	0.333	1	0.03	1.266	0.292	0.391	1.950	B
Wisteria floribunda	66.67	3.667	5.5	0.0825	2.532	3.216	2.153	7.901	D

F= Frequency; D= density; A= Abundance; RF= Relative frequency; D= relative Density; RA= Relative Abundance; IVI= Importance Value Index.

Concentration of Dominance= 0.07425; Species Diversity= 3.1601

Table 5. Species diversity and related parameters of tree, shrub and herb layer species of Shikinomori Park

Vegetation	Shannon Index (H')	Simpson's Index (Cd)	Species richness(d)	Equitability (e)
Tree layer	3.2872	0.197	2.0704	1.246
Shrub Layer	3.42324587	0.237	2.917925	3.13549422
Herb Layer	2.69897	0.19768136	1.448201	2.48490665

Table 6. Vegetation analysis of various sites around Yokohama, Kanagawa Prefecture,Japan

S.No.	**Species**	**Family**	**Layers**	**D.C**
Sankeien Garden				
1.	*Aucuba japonica*	Cornaceae	SH	3.3
2.	*Celtis sinensis var. japonica*	Ulmaceae	T1	2.1
3.	*Citrus natsudaidai*	Rutaceae	S	1.1
4.	*Dryopteris erythrosora*	Dryopteridaceae	H	1.1
5.	*Dryopteris varia var. hikonensis*	Dryopteridaceae	H	1.1
6.	*Fatsia japonica*	Araliaceae	S	1.1
7.	*Hedera rhombea*	Araliaceae	T2SH	1.1
8.	*Lygodium japonicum*	Schizaeaceae	H	+
9.	*Machilus thunbergii*	Lauraceae	T1H	5.4
10.	*Morus australis*	Moraceae	S	1.1
11.	*Neolitsea sericea*	Lauraceae	SH	2.2
12.	*Ophiopogon ohwii*	Liliaceae	H	+
13.	*Pleioblastus chino*	Gramineae	SH	2.3
14.	*Prunus jamasakura*	Rosaceae	T2	2.1
15.	*Sasa veitchii*	Gramineae	SH	2.3
16.	*Thea sinensis*	Theaceae	H	+
17.	*Trachycarpus fortunei*	Palmae	S	1.1
18.	*Aucuba japonica*	Cornaceae	S	3.3
19.	*Aucuba japonica*	Cornaceae	H	+
20.	*Hedera rhombea*	Araliaceae	T2	1.1
21.	*Hedera rhombea*	Araliaceae	S	+
22.	*Hedera rhombea*	Araliaceae	H	+
23.	*Machilus thunbergii*	Lauraceae	T1	5.4
24.	*Machilus thunbergii*	Lauraceae	H	1.1
25.	*Neolitsea sericea*	Lauraceae	S	2.2
26.	*Neolitsea sericea*	Lauraceae	H	1.1
27.	*Pleioblastus chino*	Gramineae	S	2.3
28.	*Pleioblastus chino*	Gramineae	H	1.1
29.	*Sasa veitchii*	Gramineae	S	2.3
30.	*Sasa veitchii*	Gramineae	H	2.2
Sankeien Garden				
1.	*Aucuba japonica*	Cornaceae	SH	3.3
2.	*Aucuba japonica*	Cornaceae	S	3.3
3.	*Aucuba japonica*	Cornaceae	H	+
4.	*Celtis sinensis var. japonica*	Ulmaceae	T1	2.1

5.	*Citrus natsudaidai*	Rutaceae	S	1.1
6.	*Dryopteris erythrosora*	Dryopteridaceae	H	1.1
7.	*Dryopteris varia var. hikonensis*	Dryopteridaceae	H	1.1
8.	*Fatsia japonica*	Araliaceae	S	1.1
9.	*Hedera rhombea*	Araliaceae	T2SH	1.1
10.	*Hedera rhombea*	Araliaceae	T2	1.1
11.	*Hedera rhombea*	Araliaceae	S	+
12.	*Hedera rhombea*	Araliaceae	H	+
13.	*Lygodium japonicum*	Schizaeaceae	H	+
14.	*Machilus thunbergii*	Lauraceae	T1H	5.4
15.	*Machilus thunbergii*	Lauraceae	T1	5.4
16.	*Machilus thunbergii*	Lauraceae	H	1.1
17.	*Morus australis*	Moraceae	S	1.1
18.	*Neolitsea sericea*	Lauraceae	SH	2.2
19.	*Neolitsea sericea*	Lauraceae	S	2.2
20.	*Neolitsea sericea*	Lauraceae	H	1.1
21.	*Ophiopogon ohwii*	Liliaceae	H	+
22.	*Pleioblastus chino*	Gramineae	SH	2.3
23.	*Pleioblastus chino*	Gramineae	S	2.3
24.	*Pleioblastus chino*	Gramineae	H	1.1
25.	*Prunus jamasakura*	Rosaceae	T2	2.1
26.	*Sasa veitchii*	Gramineae	SH	2.3
27.	*Sasa veitchii*	Gramineae	S	2.3
28.	*Sasa veitchii*	Gramineae	H	2.2
29.	*Thea sinensis*	Theaceae	H	+
30.	*Trachycarpus fortunei*	Palmae	S	1.1
Shikinomori Park				
1.	*Ardisia japonica*	Myrsinaceae	H	+
2.	*Aucuba japonica*	Cornaceae	S	2.2
3.	*Callicarpa japonica*	Verbenaceae	S	+
4.	*Cephalanthera longibracteata*	Orchidaceae	H	+
5.	*Chamaecyparis obtusa*	Cupressaceae	T1	1.1
6.	*Cymbidium goeringii*	Orchidaceae	H	+
7.	*Dendropanax trifidus*	Araliaceae	S	+
8.	*Desmodium podocarpium ssp. oxyphyllum*	Leguminosae	H	+
9.	*Dryopteris erythrosora*	Dryopteridaceae	H	1.2
10.	*Dryopteris uniformis*	Dryopteridaceae	H	+
11.	*Dryopteris varia var. setosa*	Dryopteridaceae	H	+
12.	*Eurya japonica*	Theaceae	S	+
13.	*Hedera rhombea*	Araliaceae	SH	2.2
14.	*Helwingia japonica*	Cornaceae	S	+

15.	*Ligustrum japonicum*	Oleaceae	S	1.1
16.	*Lindera umbellata*	Lauraceae	S	+
17.	*Liparis nervosa*	Orchidaceae	H	+
18.	*Ophiopogon ohwii*	Liliaceae	H	4.4
19.	*Osmanthus heterophyllus*	Oleaceae	S	+
20.	*Parthenocissus tricuspidata*	Vitaceae	H	+
21.	*Quercus myrsinaefolia*	Fagaceae	T1T2SH	5.5
22.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	SH	3.3
23.	*Trachycarpus fortunei*	Palmae	S	1.1
24.	*Viburnum erosum*	Caprifoliaceae	S	+
25.	*Wisteria floribunda*	Leguminosae	T1T2H	+
26.	*Hedera rhombea*	Araliaceae	S	+
27.	*Hedera rhombea*	Araliaceae	H	2.2
28.	*Quercus myrsinaefolia*	Fagaceae	T1	5.5
29.	*Quercus myrsinaefolia*	Fagaceae	T2	1.1
30.	*Quercus myrsinaefolia*	Fagaceae	S	1.1
31.	*Quercus myrsinaefolia*	Fagaceae	H	3.2
32.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	S	+
33.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	H	3.3
34.	*Wisteria floribunda*	Leguminosae	T1	+
35.	*Wisteria floribunda*	Leguminosae	T2	+
36.	*Wisteria floribunda*	Leguminosae	H	+
Shikinomori Park				
1.	*Ardisia japonica*	Myrsinaceae	H	+
2.	*Aucuba japonica*	Cornaceae	S	2.2
3.	*Callicarpa japonica*	Verbenaceae	S	+
4.	*Cephalanthera longibracteata*	Orchidaceae	H	+
5.	*Chamaecyparis obtusa*	Cupressaceae	T1	1.1
6.	*Cymbidium goeringii*	Orchidaceae	H	+
7.	*Dendropanax trifidus*	Araliaceae	S	+
8.	*Desmodium podocarpium ssp. oxyphyllum*	Leguminosae	H	+
9.	*Dryopteris erythrosora*	Dryopteridaceae	H	1.2
10.	*Dryopteris uniformis*	Dryopteridaceae	H	+
11.	*Dryopteris varia var. setosa*	Dryopteridaceae	H	+
12.	*Eurya japonica*	Theaceae	S	+
13.	*Hedera rhombea*	Araliaceae	SH	2.2
14.	*Hedera rhombea*	Araliaceae	S	+
15.	*Hedera rhombea*	Araliaceae	H	2.2
16.	*Helwingia japonica*	Cornaceae	S	+

17.	*Ligustrum japonicum*	Oleaceae	S	1.1
18.	*Lindera umbellata*	Lauraceae	S	+
19.	*Liparis nervosa*	Orchidaceae	H	+
20.	*Ophiopogon ohwii*	Liliaceae	H	4.4
21.	*Osmanthus heterophyllus*	Oleaceae	S	+
22.	*Parthenocissus tricuspidata*	Vitaceae	H	+
23.	*Quercus myrsinaefolia*	Fagaceae	T1T2SH	5.5
24.	*Quercus myrsinaefolia*	Fagaceae	T1	5.5
25.	*Quercus myrsinaefolia*	Fagaceae	T2	1.1
26.	*Quercus myrsinaefolia*	Fagaceae	S	1.1
27.	*Quercus myrsinaefolia*	Fagaceae	H	3.2
28.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	SH	3.3
29.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	S	+
30.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	H	3.3
31.	*Trachycarpus fortunei*	Palmae	S	1.1
32.	*Viburnum erosum*	Caprifoliaceae	S	+
33.	*Wisteria floribunda*	Leguminosae	T1T2H	+
34.	*Wisteria floribunda*	Leguminosae	T1	+
35.	*Wisteria floribunda*	Leguminosae	T2	+
36.	*Wisteria floribunda*	Leguminosae	H	+
Shikinomori Park				
1.	*Acanthopanax nipponicus*	Araliaceae	H	+
2.	*Akebia quinata*	Lardizabalaceae	H	1.2
3.	*Aphananthe aspera*	Ulmaceae	H	+
4.	*Ardisia crenata*	Myrsinaceae	H	+
5.	*Ardisia crispa*	Myrsinaceae	H	+.2
6.	*Berberis thunbergii*	Berberidaceae	H	+
7.	*Callicarpa japonica*	Verbenaceae	S	1.1
8.	*Carex duvaliana*	Cyperaceae	H	1.2
9.	*Carex lenta*	Cyperaceae	H	+
10.	*Cornus macrophylla*	Cornaceae	T1	1.1
11.	*Cymbidium goeringii*	Orchidaceae	H	+
12.	*Daphne pseudo-mezereum*	Thymelaeaceae	H	+
13.	*Desmodium podocarpium ssp. oxyphyllum*	Leguminosae	H	+
14.	*Dioscorea japonica*	Dioscoreaceae	H	+
15.	*Dioscorea tokoro*	Dioscoreaceae	H	+
16.	*Disporum sessile*	Liliaceae	H	+
17.	*Dryopteris erythrosora*	Dryopteridaceae	H	2.2
18.	*Dryopteris uniformis*	Dryopteridaceae	H	+
19.	*Elaeagnus macrophylla*	Elaeagnaceae	H	+
20.	*Euonymus sieboldianus*	Celastraceae	H	+

21.	*Euscaphis japonica*	Staphyleaceae	H	+
22.	*Fatsia japonica*	Araliaceae	H	+
23.	*Hedera rhombea*	Araliaceae	H	1.2
24.	*Ilex crenata*	Aquifoliaceae	S	+
25.	*Kalopanax pictus*	Araliaceae	T1H	1.1
26.	*Lindera glauca*	Lauraceae	H	+
27.	*Lindera umbellata*	Lauraceae	H	+
28.	*Liriope muscari*	Liliaceae	H	+
29.	*Mahonia japonica*	???	H	+
30.	*Morus Australis*	Moraceae	H	+
31.	*Neolitsea sericea*	Lauraceae	H	+
32.	*Ophiopogon japonicus*	Liliaceae	H	+
33.	*Oplismenus undulatifolius var. japonicus*	Gramineae	H	+
34.	*Osmunda japonica*	Osmundaceae	H	+
35.	*Pertya scandens*	Compositae	H	1.2
36.	*Pleioblastus chino*	Gramineae	H	1.2
37.	*Prunus grayana*	Rosaceae	T1	2.2
38.	*Prunus jamasakura*	Rosaceae	T1	1.1
39.	*Quercus myrsinaefolia*	Fagaceae	T1T2H	2.2
40.	*Quercus serrata*	Fagaceae	T1H	4.4
41.	*Smilax china*	Liliaceae	H	+
42.	*Stachyurus praecox*	Stachyuraceae	S	+
43.	*Stegnogramma pozoi ssp. mollissima*	Thelypteridaceae	H	1.2
44.	*Stephanandra incisa*	Rosaceae	S	+
45.	*Styrax japonicus*	Styracaceae	T2	1.1
46.	*Syneilesis palmata*	Compositae	H	+
47.	*Viburnum dilatatum*	Caprifoliaceae	H	+
48.	*Viola grypoceras*	Violaceae	H	+
49.	*Viola hondoensis*	Violaceae	H	+
50.	*Wisteria floribunda*	Leguminosae	H	+.2
51.	*Akebia quinata*	Lardizabalaceae	H	1.2
52.	*Akebia trifoliata*	Lardizabalaceae	H	1.2
53.	*Kalopanax pictus*	Araliaceae	T1	1.1
54.	*Kalopanax pictus*	Araliaceae	H	+
55.	*Quercus myrsinaefolia*	Fagaceae	T1	1.1
56.	*Quercus myrsinaefolia*	Fagaceae	T2	2.2
57.	*Quercus myrsinaefolia*	Fagaceae	H	2.2
58.	*Quercus serrata*	Fagaceae	T1	4.4
59.	*Quercus serrata*	Fagaceae	H	1.1
Shikinomori Park				
1.	*Acanthopanax nipponicus*	Araliaceae	H	+
2.	*Akebia quinata*	Lardizabalaceae	H	1.2

3.	*Akebia quinata*	Lardizabalaceae	H	1.2
4.	*Akebia trifoliata*	Lardizabalaceae	H	1.2
5.	*Aphananthe aspera*	Ulmaceae	H	+
6.	*Ardisia crenata*	Myrsinaceae	H	+
7.	*Ardisia crispa*	Myrsinaceae	H	+.2
8.	*Berberis thunbergii*	Berberidaceae	H	+
9.	*Callicarpa japonica*	Verbenaceae	S	1.1
10.	*Carex duvaliana*	Cyperaceae	H	1.2
11.	*Carex lenta*	Cyperaceae	H	+
12.	*Cornus macrophylla*	Cornaceae	T1	1.1
13.	*Cymbidium goeringii*	Orchidaceae	H	+
14.	*Daphne pseudo-mezereum*	Thymelaeaceae	H	+
15.	*Desmodium podocarpium ssp. oxyphyllum*	Leguminosae	H	+
16.	*Dioscorea japonica*	Dioscoreaceae	H	+
17.	*Dioscorea tokoro*	Dioscoreaceae	H	+
18.	*Disporum sessile*	Liliaceae	H	+
19.	*Dryopteris erythrosora*	Dryopteridaceae	H	2.2
20.	*Dryopteris uniformis*	Dryopteridaceae	H	+
21.	*Elaeagnus macrophylla*	Elaeagnaceae	H	+
22.	*Euonymus sieboldianus*	Celastraceae	H	+
23.	*Euscaphis japonica*	Staphyleaceae	H	+
24.	*Fatsia japonica*	Araliaceae	H	+
25.	*Hedera rhombea*	Araliaceae	H	1.2
26.	*Ilex crenata*	Aquifoliaceae	S	+
27.	*Kalopanax pictus*	Araliaceae	T1H	1.1
28.	*Kalopanax pictus*	Araliaceae	T1	1.1
29.	*Kalopanax pictus*	Araliaceae	H	+
30.	*Lindera glauca*	Lauraceae	H	+
31.	*Lindera umbellata*	Lauraceae	H	+
32.	*Liriope muscari*	Liliaceae	H	+
33.	*Mahonia japonica*	???	H	+
34.	*Morus Australis*	Moraceae	H	+
35.	*Neolitsea sericea*	Lauraceae	H	+
36.	*Ophiopogon japonicus*	Liliaceae	H	+
37.	*Oplismenus undulatifolius var. japonicus*	Gramineae	H	+
38.	*Osmunda japonica*	Osmundaceae	H	+
39.	*Pertya scandens*	Compositae	H	1.2
40.	*Pleioblastus chino*	Gramineae	H	1.2
41.	*Prunus grayana*	Rosaceae	T1	2.2
42.	*Prunus jamasakura*	Rosaceae	T1	1.1
43.	*Quercus myrsinaefolia*	Fagaceae	T1T2H	2.2
44.	*Quercus myrsinaefolia*	Fagaceae	T1	1.1
45.	*Quercus myrsinaefolia*	Fagaceae	T2	2.2

46.	*Quercus myrsinaefolia*	Fagaceae	H	2.2
47.	*Quercus serrata*	Fagaceae	T1H	4.4
48.	*Quercus serrata*	Fagaceae	T1	4.4
49.	*Quercus serrata*	Fagaceae	H	1.1
50.	*Smilax china*	Liliaceae	H	+
51.	*Stachyurus praecox*	Stachyuraceae	S	+
52.	*Stegnogramma pozoi ssp. mollissima*	Thelypteridaceae	H	1.2
53.	*Stephanandra incisa*	Rosaceae	S	+
54.	*Styrax japonicus*	Styracaceae	T2	1.1
55.	*Syneilesis palmata*	Compositae	H	+
56.	*Viburnum dilatatum*	Caprifoliaceae	H	+
57.	*Viola grypoceras*	Violaceae	H	+
58.	*Viola hondoensis*	Violaceae	H	+
59.	*Wisteria floribunda*	Leguminosae	H	+.2
Shikinomori Park				
1.	*Acanthopanax spinosus*	Araliaceae	S	1.1
2.	*Achyranthes bidentata var. japonica*	Amaranthaceae	H	+
3.	*Akebia quinata*	Lardizabalaceae	H	1.2
4.	*Akebia trifoliata*	Lardizabalaceae	T2	+
5.	*Aphananthe aspera*	Ulmaceae	H	+
6.	*Arachniodes standishii*	Dryopteridaceae	H	+
7.	*Ardisia crenata*	Myrsinaceae	H	1.1
8.	*Ardisia japonica*	Myrsinaceae	H	+
9.	*Aucuba japonica*	Cornaceae	S	3.2
10.	*Broussonetia kazinoki*	Moraceae	S	+
11.	*Celtis sinensis var. japonica*	Ulmaceae	T2	+
12.	*Cimicifuga japonica*	Ranunculaceae	H	+
13.	*Cocculus orbiculatus*	Menispermaceae	S	+
14.	*Coniogramme japonica*	Parkeriaceae	H	+.2
15.	*Cornus controversa*	Cornaceae	T1	3.2
16.	*Cryptomeria japonica*	Taxodiaceae	H	+.2
17.	*Cyrtomium fortunei*	Dryopteridaceae	H	1.2
18.	*Daphne pseudo-mezereum*	Thymelaeaceae	S	+
19.	*Disporum sessile*	Liliaceae	H	+
20.	*Dryopteris erythrosora*	Dryopteridaceae	H	2.2
21.	*Fatsia japonica*	Araliaceae	S	1.1
22.	*Gynostemma pentaphyllum*	Cucurbitaceae	H	+
23.	*Hedera rhombea*	Araliaceae	H	1.2
24.	*Helwingia japonica*	Cornaceae	S	1.1
25.	*Hosta sieboldiana*	Liliaceae	H	+
26.	*Houttuynia cordata*	Saururaceae	H	1.1
27.	*Ligustrum japonicum*	Oleaceae	S	+

28.	*Ligustrum lucidum*	Oleaceae	T2	1.1
29.	*Liriope muscari*	Liliaceae	H	3.3
30.	*Lonicera japonica*	Caprifoliaceae	H	+.2
31.	*Machilus thunbergii*	Lauraceae	T2	2.1
32.	*Neolitsea sericea*	Lauraceae	H	+
33.	*Ophiopogon japonicus*	Liliaceae	H	1.1
34.	*Oplismenus undulatifolius var. japonicus*	Gramineae	H	1.2
35.	*Pleioblastus chino*	Gramineae	S	2.1
36.	*Prunus grayana*	Rosaceae	T1	2.1
37.	*Quercus myrsinaefolia*	Fagaceae	T1T2	2.2
38.	*Stachyurus praecox*	Stachyuraceae	T2	1.1
39.	*Stegnogramma pozoi ssp. mollissima*	Thelypteridaceae	H	+.2
40.	*Thea sinensis*	Theaceae	S	+.2
41.	*Trachycarpus fortunei*	Palmae	S	2.2
42.	*Viburnum plicatum var. tomentosum*	Caprifoliaceae	T2	1.1
43.	*Wisteria floribunda*	Leguminosae	T1	1.1
44.	*Quercus myrsinaefolia*	Fagaceae	T1	2.2
45.	*Quercus myrsinaefolia*	Fagaceae	T2	2.2
Shikinomori Park				
1.	*Acanthopanax spinosus*	Araliaceae	S	1.1
2.	*Achyranthes bidentata var. japonica*	Amaranthaceae	H	+
3.	*Akebia quinata*	Lardizabalaceae	H	1.2
4.	*Akebia trifoliata*	Lardizabalaceae	T2	+
5.	*Aphananthe aspera*	Ulmaceae	H	+
6.	*Arachniodes standishii*	Dryopteridaceae	H	+
7.	*Ardisia crenata*	Myrsinaceae	H	1.1
8.	*Ardisia japonica*	Myrsinaceae	H	+
9.	*Aucuba japonica*	Cornaceae	S	3.2
10.	*Broussonetia kazinoki*	Moraceae	S	+
11.	*Celtis sinensis var. japonica*	Ulmaceae	T2	+
12.	*Cimicifuga japonica*	Ranunculaceae	H	+
13.	*Cocculus orbiculatus*	Menispermaceae	S	+
14.	*Coniogramme japonica*	Parkeriaceae	H	+.2
15.	*Cornus controversa*	Cornaceae	T1	3.2
16.	*Cryptomeria japonica*	Taxodiaceae	H	+.2
17.	*Cyrtomium fortunei*	Dryopteridaceae	H	1.2
18.	*Daphne pseudo-mezereum*	Thymelaeaceae	S	+
19.	*Disporum sessile*	Liliaceae	H	+
20.	*Dryopteris erythrosora*	Dryopteridaceae	H	2.2
21.	*Fatsia japonica*	Araliaceae	S	1.1

22.	*Gynostemma pentaphyllum*	Cucurbitaceae	H	+
23.	*Hedera rhombea*	Araliaceae	H	1.2
24.	*Helwingia japonica*	Cornaceae	S	1.1
25.	*Hosta sieboldiana*	Liliaceae	H	+
26.	*Houttuynia cordata*	Sauruaceae	H	1.1
27.	*Ligustrum japonicum*	Oleaceae	S	+
28.	*Ligustrum lucidum*	Oleaceae	T2	1.1
29.	*Liriope muscari*	Liliaceae	H	3.3
30.	*Lonicera japonica*	Caprifoliaceae	H	+.2
31.	*Machilus thunbergii*	Lauraceae	T2	2.1
32.	*Neolitsea sericea*	Lauraceae	H	+
33.	*Ophiopogon japonicus*	Liliaceae	H	1.1
34.	*Oplismenus undulatifolius var. japonicus*	Gramineae	H	1.2
35.	*Pleioblastus chino*	Gramineae	S	2.1
36.	*Prunus grayana*	Rosaceae	T1	2.1
37.	*Quercus myrsinaefolia*	Fagaceae	T1T2	2.2
38.	*Quercus myrsinaefolia*	Fagaceae	T1	2.2
39.	*Quercus myrsinaefolia*	Fagaceae	T2	2.2
40.	*Stachyurus praecox*	Stachyuraceae	T2	1.1
41.	*Stegnogramma pozoi ssp. mollissima*	Thelypteridaceae	H	+.2
42.	*Thea sinensis*	Theaceae	S	+.2
43.	*Trachycarpus fortunei*	Palmae	S	2.2
44.	*Viburnum plicatum var. tomentosum*	Caprifoliaceae	T2	1.1
45.	*Wisteria floribunda*	Leguminosae	T1	1.1
Rice Cultivated land(Shikinomori park)				
1.	*Monochoria vaginalis var. plantaginea*	Pontederiaceae	H	3.3
2.	*Oenanthe javanica*	Umbelliferae	H	+
3.	*Oryza sativa*	Gramineae	H	3.3
4.	*Persicaria hydropiper*	Polygonaceae	H	+
Shrub land (Shikinomori park)				
1.	*Akebia quinata*	Lardizabalaceae	S	+
2.	*Ampelopsis glandulosa var. heterophylla*	Vitaceae	S	1.2
3.	*Aralia elata*	Araliaceae	S	2.2
4.	*Artemisia princeps*	Compositae	H	1.2
5.	*Broussonetia kazinoki*	Moraceae	S	5.5
6.	*Dioscorea tokoro*	Dioscoreaceae	S	+
7.	*Dumasia truncata*	Leguminosae	S	+.2
8.	*Euonymus sieboldianus*	Celastraceae	S	+
9.	*Eupatorium chinense var. oppositifolium*	Compositae	H	+.2

10.	*Lonicera japonica*	Caprifoliaceae	S	+
11.	*Morus australis*	Moraceae	S	2.2
12.	*Paederia scandens*	Rubiaceae	S	+
13.	*Phyllostachys bambusoides*	Gramineae	S	1.1
14.	*Pleioblastus chino*	Gramineae	H	5.5
15.	*Rubus palmatus*	Rosaceae	S	2.3
16.	*Sambucus racemosa ssp. sieboldiana*	Caprifoliaceae	S	+
17.	*Smilax china*	Liliaceae	H	+
18.	*Thalictrum minus var. hypoleucum*	Ranunculaceae	H	+.2
19.	*Trichosanthes cucumeroides*	Cucurbitaceae	H	+
20.	*Viburnum dilatatum*	Caprifoliaceae	S	+
Garden (Shikinomori Park)				
1.	*Digitaria violascens*	Gramineae	H	+
2.	*Eleusine indica*	Gramineae	H	2.3
3.	*Juncus tenuis*	Juncaceae	H	1.1
Water body (Shikinomori Park)				
1.	*Persicaria hydropiper*	Polygonaceae	H2	+.2
2.	*Persicaria Thunbergii*	Polygonaceae	H2	+.2
3.	*Phragmites australis*	Gramineae	H1	5.5
4.	*Plantago asiatica*	Plantaginaceae	H	3.3
5.	*Poa annua*	Gramineae	H	+
6.	*Trifolium repens*	Leguminosae	H	1.2
Sakuragaoka Protected Forest				
1.	*Acer palmatum*	Aceraceae	T2	1.1
2.	*Acer palmatum*	Aceraceae	H	+
3.	*Achyranthes bidentata var. japonica*	Amaranthaceae	H	+
4.	*Aphananthe aspera*	Ulmaceae	S	+
5.	*Aphananthe aspera*	Ulmaceae	H	+
6.	*Ardisia crenata*	Myrsinaceae	H	+
7.	*Aucuba japonica*	Cornaceae	S	3.3
8.	*Aucuba japonica*	Cornaceae	H	1.2
9.	*Broussonetia kazinoki*	Moraceae	S	+
10.	*Carex pisiformis*	Cyperaceae	H	+
11.	*Chamaecyparis pisifera*	Cupressaceae	T1	1.1
12.	*Coniogramme intermedia*	Parkeriaceae	H	+
13.	*Cornus controversa*	Cornaceae	T1	5.5
14.	*Cornus controversa*	Cornaceae	S	+
15.	*Cyrtomium fortunei*	Dryopteridaceae	H	+
16.	*Daphniphyllum macropodum*	Daphniphyllaceae	S	+
17.	*Desmodium podocarpium ssp. oxyphyllum*	Leguminosae	H	+
18.	*Dryopteris erythrosora*	Dryopteridaceae	H	1.2

19.	*Dryopteris lacera*	Dryopteridaceae	H	+
20.	*Elaeagnus glabra*	Elaeagnaceae	S	+
21.	*Eriobotrya japonica*	Rosaceae	S	+
22.	*Eurya japonica*	Theaceae	T2	1.2
23.	*Eurya japonica*	Theaceae	H	+
24.	*Fatsia japonica*	Araliaceae	S	2.2
25.	*Ficus erecta*	Moraceae	S	+
26.	*Hedera rhombea*	Araliaceae	H	1.2
27.	*Kadsura japonica*	Schisandraceae	S	+
28.	*Kalopanax pictus*	Araliaceae	H	+
29.	*Ligustrum lucidum*	Oleaceae	S	1.1
30.	*Ligustrum lucidum*	Oleaceae	H	+
31.	*Machilus thunbergii*	Lauraceae	T2	1.1
32.	*Machilus thunbergii*	Lauraceae	S	1.1
33.	*Machilus thunbergii*	Lauraceae	H	+
34.	*Microlepia marginata*	Dennstaedtiaceae	H	+
35.	*Neolitsea sericea*	Lauraceae	T1	1.2
36.	*Neolitsea sericea*	Lauraceae	T2	2.2
37.	*Neolitsea sericea*	Lauraceae	S	1.1
38.	*Neolitsea sericea*	Lauraceae	H	+
39.	*Ophiopogon jaburan*	Liliaceae	H	+
40.	*Ophiopogon ohwii*	Liliaceae	H	+
41.	*Ophiopogon planiscapus*	Liliaceae	H	+
42.	*Oplismenus undulatifolius var. japonicus*	Gramineae	H	+
43.	*Pleioblastus chino*	Gramineae	S	+
44.	*Sarcandra glabra*	Chloranthaceae	H	+
45.	*Stegnogramma pozoi ssp. mollissima*	Thelypteridaceae	H	1.1
46.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	S	+
47.	*Trachelospermum asiaticum f. intermedium*	Apocynaceae	H	+.2
48.	*Trachycarpus fortunei*	Palmae	S	2.2
49.	*Trachycarpus fortunei*	Palmae	H	+.2
50.	*Viola hondoensis*	Violaceae	H	+
51.	*Zanthoxylum piperitum*	Rutaceae	H	+

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Appendix

Table 1. : Sampling table for tree layer species of Shikinomori Park.

	Q1(NO.2)		Q2(No.3)		Q3(No.4)	
SPECIES	NO.INDIVIDUALS	DBH	NO.INDIVIDUALS	DBH	NO.INDIVIDUALS	DBH
Quercus myrsinaefolia	4	40,46, 20,10	1	29	3	42,43,45
					8	26(AV.)
Chamaecyparis obtusa	1	12				
Quercus serrata			2	38,45		
Cornus macrophylla			2	31,42		
Kalopanax pictus			2	16,14		
Prunus grayana			2	25,35	1	33
Prunus jamasakura			2	46,37		
Quercus myrsinaefolia			3	18,17 ,20		
Styrax japonicus			2	16,20		
Cornus controversa					2	38,34
Machilus thunbergii					1	15
Ligustrum lucidum					1	10
Stachyurus praecox					1	11
Celtis sinensis var. japonica					1	10
Viburnum plicatum var. tomentosum					1	8

Appendix

Table 2. Sampling table for Shrub layer species present in quadrats at Shikinomori Park

	Q1(NO.2)	Q2(No.3)	Q3(No.4)
SPECIES	NO.INDIVIDUALS	NO.INDIVIDUALS	NO.INDIVIDUALS
Acanthopanax spinosus			3
Aucuba japonica	17		30
Broussonetia kazinoki			1
Callicarpa japonica	1	2	
Cocculus orbiculatus			1
Daphne pseudo-mezereum			1
Dendropanax trifidus	1		
Eurya japonica	1		
Fatsia japonica			8
Hedera rhombea	1		
Helwingia japonica	1		3
Ilex crenata	1	1	
Ligustrum japonicum	4		1
Lindera umbellata	2		
Osmanthus heterophyllus	2		
Pleioblastus chino			50
Quercus myrsinaefolia	4		
Stachyurus praecox	2	2	
Stephanandra incisa	1	1	
Thea sinensis			1
Trachelospermum asiaticum f. intermedium	2		
Trachycarpus fortunei	5		6
Viburnum erosum	1		
Wisteria floribunda(cl.)	1		1

Table 3. Herb layer species present in Shikinomori Park

	Q1(NO.2)	Q2(No.3)	Q3(No.4)
SPECIES	NO.INDIVIDUALS	NO.INDIVIDUALS	NO.INDIVIDUALS
Acanthopanax nipponicus		1	
Achyranthes bidentata var. japonica			1
Akebia quinata		1	3
Akebia trifoliata		2	
Aphananthe aspera		1	1
Arachniodes standishii			1
Ardisia crenata		1	1
Ardisia crispa		5	
Ardisia japonica	3		1
Berberis thunbergii		1	
Carex duvaliana		30	
Carex lenta		2	
Cephalanthera longibracteata	1		
Cimicifuga japonica			1
Coniogramme japonica			1
Cryptomeria japonica			1
Cymbidium goeringii	1	1	
Cyrtomium fortunei			3
Daphne pseudo-mezereum		1	
Desmodium podocarpium ssp. oxyphyllum	3	2	
Dioscorea japonica		1	
Dioscorea tokoro		1	
Disporum sessile		1	1
Dryopteris erythrosora	10	1	4
Dryopteris uniformis	3	1	
Dryopteris varia var. setosa	2		
Elaeagnus macrophylla		4	
Euonymus sieboldianus		2	
Euscaphis japonica		1	
Fatsia japonica		3	
Gynostemma pentaphyllum			1
Hedera rhombea	25	4	1
Hosta sieboldiana			1
Houttuynia cordata			2
Kalopanax pictus		1	
Lindera glauca		1	

Lindera umbellata		1	
Liparis nervosa	1		
Liriope muscari		1	6
Lonicera japonica			1
Mahonia japonica		1	
Morus Australis		1	
Neolitsea sericea		1	1
Ophiopogon japonicus		2	2
Ophiopogon ohwii	40		
Oplismenus undulatifolius var. japonicus		3	3
Osmunda japonica		1	
Parthenocissus tricuspidata	2		
Pertya scandens		7	
Pleioblastus chino		7	
Quercus myrsinaefolia	26	30	
Quercus serrata		10	
Smilax china		1	
Stegnogramma pozoi ssp. mollissima		1	1
Syneilesis palmata		1	
Trachelospermum asiaticum f. intermedium	36		
Viburnum dilatatum		1	
Viola grypoceras		1	
Viola hondoensis		1	
Wisteria floribunda	4	7	

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