

Effect of Urbanization on the Evergreen Broad-leaf Forest in Tokyo, Japan

by

Hiroshi TAODA

Asakawa Experimental Forest, Forestry and Forest Products
Research Institute (*formerly*: Government Forest
Experiment Station)

Introduction

The vegetations in the city area are affected by the peculiar environmental factor namely "urbanization". Many species of plants decrease with the progress of urbanization and are substituted by species adapted to the urban environments. The phytosociological alteration of rural and urban communities has been reported on certain cryptogamic vegetations (Taoda, 1975, 1976, 1977). It must be the same in the case of forest vegetation. In this paper I wish to report the phytosociological feature of the evergreen broad-leaf forest which is preserved in the highly urbanized area. This is a preliminary report on the investigation of the effects of urbanization on the forest ecosystem.

I. Area investigated

Twenty-one plots ($10 \times 10 \text{m}^2$) of developed evergreen broad-leaf forests were investigated in the following six sites: Hama-Rikyū Garden, Chūō-ku; Shiba-Rikyū Garden, Minato-ku; Rikugien Garden and Koishikawa-Kōrakuen Garden, Bunkyo-ku; Gakushūin University, Toshima-ku; Honmonji Temple, Ōta-ku. For the phytosociological comparison, 153 relevés (including the data obtained through literatures) of similar evergreen broad-leaf forests are also examined. Consequently, the area treated covers Chiba, Saitama, Tokyo and Kanagawa Prefectures.

II. Recognition and comparison of the vegetational units

The relevés from the urbanized area were classified into two communities according to the dominant species of tree layer and the floristic composition of undergrowth. The relevés from the rural area were identified with the established associations and one natural community. The principal elements of those communities were shown in table 1 with their frequency.

(A) *Persea thunbergii* forest (Table 1, A)

Persea (Machilus) thunbergii is dominant in the tree layer and characterized by *Ilex integra*, *Pittosporum tobira*, *Oplismenus undulatifolius*. This type of forest is found on flat, rather wet ground in the east part of Tokyo. The most of them have been maintained as a part of garden for a long time.

(B) *Castanopsis cuspidata* var. *sieboldii* forest (Table 1, B)

Table 1. Frequency of the urban and rural forest communities in Tokyo and its neighborhood

- A. *Persea thunbergii* Forest
 B. *Castanopsis cuspidata* var. *sieboldii* Forest
 C. *Polysticho-Perisetum thunbergii* Suz.-Tok. 1952
 D. *Ardisio-Castanopsietum sieboldii illicetosum* Suz.-Tok. et Hatiya, 1951
 E. *Ardisio-Castanopsietum sieboldii maetosum* Suz.-Tok. et Hatiya, 1951
 F. *Abies firma-Castanopsis cuspidata* var. *sieboldii* community
 G. *Castanopsis cuspidata* var. *sieboldii-Trachycarpus fortunei* community in the urban area
 H. Ditto in the rural area

Community	A	B	C	D	E	F	G	H
Number of relevés	9	12	17	46	17	7	49	17
<i>Aucuba japonica</i> Thunb.	S*	V	V	V	V	III	100	94
<i>Ophiopogon japonicus</i> (L. f.) Ker-Gawl.	H	V	V	II	IV	V	87	94
<i>Castanopsis cuspidata</i> (Thunb.)Schottky var. <i>sieboldii</i> (Makino) Nakai	T1-T2	IV	V	III	V	V	91	88
<i>Fatsia japonica</i> (Thunb.)Decne. et Planch.	T2-S	V	V	IV	III	I	91	88
<i>Trachycarpus fortunei</i> (Hook.) H. Wendl.	T2-S	V	IV	•	I	I	84	65
<i>Arundinaria chino</i> (Franch. et Sav.)Makino	H	IV	V	II	II	I	80	88
<i>Dryopteris erythrosora</i> (Eat.) O. Ktze.	H	IV	III	IV	V	II	73	76
<i>Neolitsea sericea</i> (Blume) Koidz.	T2	II	III	IV	III	II	49	47
<i>Eurya japonica</i> Thunb.	T2-S	II	III	II	IV	V	56	94
<i>Persea thunbergii</i> (Sieb. et Zucc.)Kosterm.	T1	V	I	V	IV	IV	62	88
<i>Ilex integra</i> Thunb.	T1-S	IV	I	II	V	II	60	59
<i>Pittosporum tobira</i> (Thunb.) Ait.	T1-S	IV	I	V	II	I	20	35
<i>Oplismenus undulatifolius</i> (Ard.)Reom. et Schult.	H	V	I	II	I	I	29	24
<i>Ligustrum ovalifolium</i> Hassk.	S	IV	I	I	I	•	24	0
<i>Dicranella heteromalla</i> (Hedw.) Schimp.	M	II	•	—	—	—	—	—
<i>Ligustrum japonicum</i> Thunb.	S	•	V	I	II	I	73	53
<i>Cornus controversa</i> Hemsl.	T1-S	I	III	I	I	•	33	0
<i>Isopterygium pohliaecarpum</i> (Sull. et Lesq.) Jaeg.	M	•	III	—	—	—	—	—
<i>Polystichum polyblepharum</i> (Roem.) Pr.	H	•	•	V	I	I	9	18
<i>Piper kadzura</i> (Chois.) Ohwi	H	•	•	III	I	I	0	6
<i>Arachniodes sporadosora</i> (Kunze)Nakaike	H	•	•	•	I	III	0	6
<i>Maesa japonica</i> (Thunb.) Mor. et Zoll.	S-H	•	•	I	I	V	0	6
<i>Abies firma</i> Sieb. et Zucc.	T1	•	•	II	II	III	0	6
<i>Quercus glauca</i> Thunb.	T1-T2	•	I	II	II	III	2	35
<i>Ardisia japonica</i> (Thunb.) Blume	H	•	•	II	III	III	0	82
<i>Trachelospermum asiaticum</i> (Sieb. et Zucc.) Nakai	H	•	•	III	IV	IV	16	88
<i>Ardisia crenata</i> Sims	H	•	•	I	III	II	2	59
<i>Dendropanax trifidus</i> (Thunb.) Makino	T2-S	•	•	II	III	I	0	41
<i>Liriope platyphylla</i> Wang et Tang	H	•	•	II	II	II	0	53
<i>Podocarpus macrophyllus</i> (Thunb.)D. Don	T2-S	•	•	II	II	I	2	41
<i>Ficus erecta</i> Thunb.	T2-S	II	•	III	III	IV	16	24
<i>Hedera rhombea</i> (Miq.) Bean	H	I	I	III	III	III	44	88
<i>Camellia japonica</i> L.	T2-S	II	I	V	IV	IV	56	71
<i>Kadsura japonica</i> (L.) Dunal	H	I	II	II	I	I	47	47
<i>Quercus acuta</i> Thunb.	T1	I	I	I	I	II	51	29
<i>Euonymus japonicus</i> Thunb.	S	II	•	II	II	I	4	29
<i>Cinnamomum japonicum</i> Sieb. ex Nees	T2-S	II	•	IV	III	II	22	53

*Main layers in which the species occur.

Roman numerals show the frequency class of five degrees. Arabic numerals show the frequency percentage.

Castanopsis cuspidata var. *sieboldii* is dominant in the tree layer and characterized by *Cornus controversa* and *Ligustrum japonicum*. This type of forest is found on the narrow plateau or on its slope in the central part of Tokyo. Most of them seem to be "preserved." natural forests

(C) Polysticho-Perisetum thunbergii (Polysticho-Machiletum thunbergii) Suz.-Tok. 1952. (Table 1, C)

The relevés belonging to this association was determined by the presence of *Persea thunbergii*, *Polystichum polyblepharum* and *Aucuba japonica*. They were found in the seaside districts of Chiba and Kanagawa Prefectures.

(D) Ardisio-Castanopsietum sieboldii (Bladhio-Shiietum sieboldii) ilicetosum Suz.-Tok. et Hatiya 1951. (Table 1, D)

The relevés belonging to this subassociation were determined by the presence of *Ilex integra* and *Dryopteris erythrosora*. They were found in the seaside and inland districts of Chiba, Tokyo and Kanagawa Prefectures.

(E) Ardisio-Castanopsietum sieboldii maetosum Suz.-Tok. et Hatiya 1951. (Table 1, E)

The relevés belonging to this subassociation were determined by the presence of *Maesa japonica* and either *Arachnioides sporadosora* (= *Polystichopsis pseudoaristata*) or *A. aristata* (= *P. aristata*). They were found in the southern district of Chiba Prefecture (Bōsō Peninsula).

(F) *Abies firma*-*Castanopsis cuspidata* var. *sieboldii* community (Table 1, F)

This community is a group of relevés which were found in the inland (western) district of Tokyo and Saitama Prefectures. *Abies firma*, *Ardisia japonica* and *Quercus glauca* are abundant. The floristic feature of this community reflects its geographical situation.

The foregoing *Persea thunbergii* forest and *Castanopsis cuspidata* var. *sieboldii* forest can be united to a community, *Castanopsis cuspidata* var. *sieboldii*-*Trachycarpus fortunei* community, characterized by the occurrence of *Trachycarpus fortunei*, *Aucuba japonica*, *Ophiopogon japonicus*, *Fatsia japonica* and *Arundinaria chino*. This community was found not only in the urban area but also in the rural area. The vegetational units G and H of table 1 are determined by the presence of more than four species of the five character species mentioned above. The relevés from the urban area are included in the unit G and those from the rural area are included in the unit H. The frequencies in these two units are shown in percentage for the discussion of the floristic alteration.

III. Discussions

1. Status of the urban community

The *Persea thunbergii* forest in Tokyo is not identical with the established natural association, Polysticho-Perisetum thunbergii, but similar to Ardisio-Castanopsietum sieboldii ilicetosum. The invasion of *Trachycarpus fortunei*, *Arundinaria chino*, *Oplismenus undulatifolius* and *Ligustrum ovalifolium* must have been caused by the unstable environments of the urban area. *Persea thunbergii* forest is considered to be a variant of Ardisio-Castanopsietum sieboldii. *Castanopsis cuspidatum* var. *sieboldii* forest seems to be different from Ardisio-Castanopsietum sieboldii. The decline of *Persea thunbergii*, *Pittosporum obira*, *Oplismenus*

undulatifolius and *Ligustrum ovalifolium*, however, may be due to the geographical reasons. This community is considered to be another variant of *Ardisio-Castanopsietum sieboldii*.

From another stand point, *Persea thunbergii* forest and *Castanopsis cuspidata* var. *sieboldii* forest should be combined as a community, as mentioned in the former chapter. This community is found not only in the urban area of Tokyo but also found throughout the rural area of southern Kantō District. The most characteristic species, *Trachycarpus fortunei*, is not a native plant. It is, however, naturalized throughout the warm-temperate region in southwestern Japan. It seems to be very tolerant to both the man-made environment and the low light intensity.

Okuda (1970) has reported *Castanopsis cuspidata* var. *sieboldii-Quercus acuta* community from the southern district of Tokyo. Though this is characterized by the abundant *Quercus acuta*, *Ilex integra*, *Ligustrum japonicum* etc., this must be included in the present *Castanopsis cuspidata* var. *sieboldii-Trachycarpus fortunei* community.

2. Effect of urbanization on the floristic composition

The urbanization affects the frequency of constituent species as shown in table 1 (G, H). Plants which decrease with the urbanization are *Ardisia japonica*, *Trachelospermum asiaticum*, *Ardisia crenata*, *Dendropanax trifidus* and *Liriope platyphylla*. What is the cause of decline of these popular undergrowth plants? It may be partly due to the direct human impacts and partly due to the structure of the urban forests. In the urban forests rather few species of plants form dense vegetational layers, so that the light intensity of the forest floor is lower than that of the rural forests which have complicated but loose vegetational layers. Especially, the luxuriant growth of *Trachycarpus fortunei* and *Aucuba japonica* (they are very tolerant to the low illumination) in shrub layer inhibits the development of herb layer.

Ligustrum species and *Corunus controversa* seem to increase with the urbanization. Their preference to the urban environment, however, cannot be definite, yet.

Summary

Evergreen broad-leaf forests in the urban area of Tokyo were investigated in order to know the effect of urbanization on the forest vegetation. Two types of forest, *Persea thunbergii* forest and *Castanopsis cuspidata* var. *sieboldii* forest are recognized as the urban variants of the natural association, *Ardisio-Castanopsietum sieboldii* Suz.-Tok. 1952. The comparison of the floristic composition of urban forest community with rural one shows the decline of the following plants: *Ardisia japonica*, *Trachelospermum asiaticum*, *Ardisia crenata*, *Dendropanax trifidus* and *Liriope platyphylla*.

Literature

- OKUDA, S. 1969. Die Vegetation des Naturrests in der Stadt Tokyo 1. Miscellaneous Reports of the National Park for Nature Study 1: 19-24, Tokyo.

- OKUDA, S. 1970. Über die Vegetation der Umgebung des Naturparkes für Naturstudien im südwestlichen Teil der Stadt Tokyo. *Die Vegetation der Naturreste in der Stadt Tokyo* 2. ditto 2: 9-15, Tokyo.
- TAODA, H. 1975. *Bryum argenteum*-*Sagina japonica* community in the urban area. in Numata, M. (ed.): *Studies in Urban Ecosystems*. 32-37, Chiba.
- 1976. Bryophytes as indicators of air pollution. in *Science for better environment*, Proc. Intern. Congr. Human Envir. (Kyoto, 1975) 292-301, Tokyo.
- 1977. Bryophytes in the urban ecosystem. in Numata, M. (ed.): *Tokyo Project Interdisciplinary Studies of Urban Ecosystems in the Metropolis of Tokyo*. 99-117, Chiba.