Survey of Basidiomycets and Insect Infested Roadside Trees

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Survey of Basidiomycete and Insect Infested Roadside Trees*

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Abstract

Some biotic and abiotic factors causal to the deterioration of roadside trees were surveyed in Fukuoka City on 23 species planted along 22 main streets. Various fruit bodies of basidiomycete, imperfect fungi and bacterial canker disease as well as insect pests were detected. Forty-six fungi strains were obtained in this survey. Aphyllophorales basidiomycete was the most abundant fungi found in surveyed raodside trees. Fruit bodies of 7 edible mushroom species were identified on the scaffold limbs, trunks and root collars of roadside trees. Population of all wood-inhabiting basidiomycetes from healthy and diseased trees were significantly different. *Robinia pseudoacacia* declined severely with mycerial development and fruit body formation of white rot fungi, *Fomitella fraxinea* on root collars. It is conceivable that low soil pH might be a major factor. Fifty-one species of tree insects were identified in this survey, major pests being two species of termites (Isoptera), *Reticulitermes speratus kyushuensis* and *Coptotermes formosanus* which significantly attacked ten tree species. Cerambycid beetles, *Anoplophora malasiaca* and *Eupromus ruber* severely damaged *Platanus orientalis* and *Machilus thunbergii,* respectively. Root damage status corresponded significantly to the degree of upper tree decline. Results clearly show differences between evergreen broad-leaved trees and deciduous broad-leaved trees in tolerance to wood-inhabiting basidiomycetes and tree-parasitic insects. Overall, this preliminary survey documents some biotic and abiotic factors may contribute to roadside tree decline in Fukuoka City.
Key words : roadside tree ; basidiomycete ; fruit body ; insect ; termite.

1. Introduction

Roadside trees are important in environmental conservation and the landscaping of the urban human environment. In Fukuoka City, 36,000 trees from 60 species such as

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* 大賀祥治・野村周平・井上　晋：街路樹への担子菌類および昆虫類の侵害

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Ginkgo biloba and *Elaeocarpus sylvestris*, 46,000 lower trees from 30 species such as *Camellia sasanqua* and *Ligustrum japonicum*, and 1,371,000 shrubs from 50 species such as *Phaphiolepis umbellata* and *Abelia* × *grandiflora* have been planted as roadside trees.

Recently unfavorable environmental conditions and poor soil have contributed to the decline of roadside trees. Biotic and abiotic factors may cause tree death and/or make necessary the replanting of roadside trees. *Agrocybe cylindracea* is a known pathogen in *Salix babylonica* trees over 40 years old planted in Ohori Park, Fukuoka City. There is no evidence, however, of involvement of this or other basidiomycetes and insects in the decline of roadside trees, either by predisposing them to bacterial canker or as primary pathogens. Moreover, it is not known to what extent other biotic and abiotic factors, together with tree management factors, contribute to the decline of roadside trees in Fukuoka City.

Although planting methods of roadside trees and suitable species have been discussed previously (Isa, 1974) (Hoshino, 1978), a decline in disease incidence has not been observed. The objectives of this study were to identify and quantify the wood-inhabiting basidiomycetes and plant-parasitic insects associated with roadside trees, and to determine if biotic and abiotic factors contribute to the decline of roadside trees.

2. Materials and Methods

2.1. Observation procedure

The study was conducted on 23 species of roadside trees planted along 22 streets in Fukuoka City located in southwestern Japan (Fig. 1). Total number of roadside trees from the 23 species was 34,000, representing approximately 95 % of all trees planted along the main streets in Fukuoka City. Species and number of examined trees are given in Table 1. Each street was investigated for wood-inhabiting basidiomycete and insects by examining individual trees for decay and invasion on lateral branches, scaffold limbs, trunks and root collars. Trees were categorized as healthy (no visible decay), less healthy, and diseased or declining. Trees obviously younger than others were classified as replants. Classification of the status of decomposition of trees was based on the type of fruit body and extramatrical mycelium observed, but not on detailed microscopical examination of sections. Damage by insects was evaluated according to position and extent (% of whole tree). Decline in each surveyed tree was assessed primarily on the basis of extent of damage and was rated as : 1 (very slight) ; 2 (slight) ; 3 (moderate) ; 4 (severe) ; 5 (severer), according to visible symptoms on each tree (Fig. 2).

2.2. Identification of basidiomycetes

Fruit bodies were identified by their morphology. Moreover, some spores were identified under a microscope (×1000). Fruit bodies were removed from trees and took back to the laboratory. The fruit bodies were dipped in NaClO (5 %) for 30 sec. After

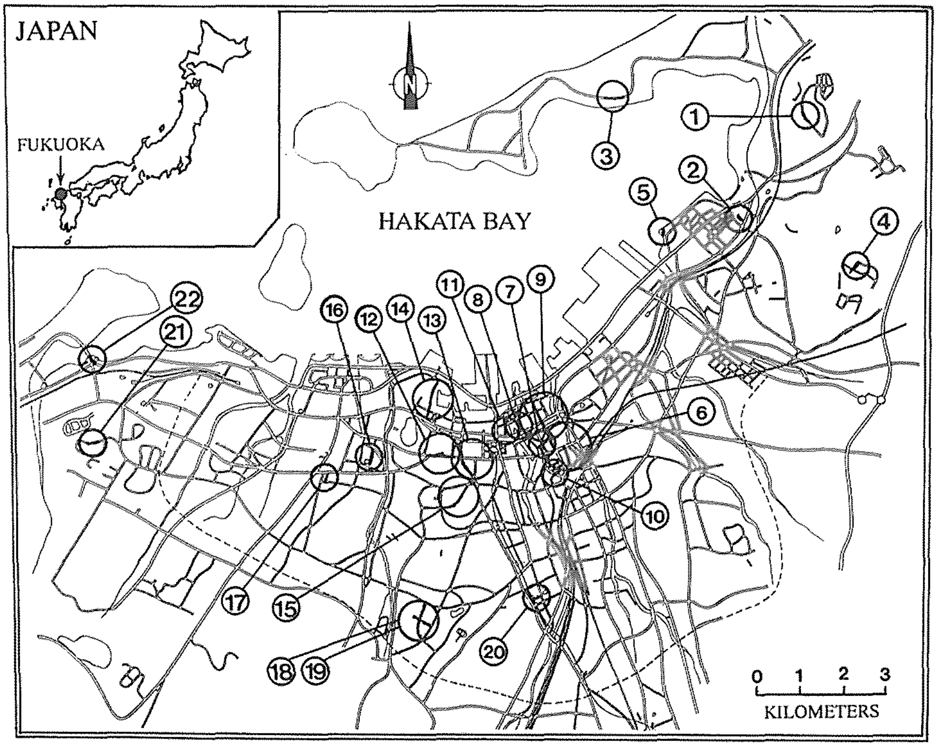

Fig. 1 Locations of streets checked for declining roadside trees in Fukuoka City. The inset shows Fukuoka City, the dotted area on the small map.

about 20 min, the fruit body was cut with a sterile knife and 1-to 2-mm-thick segments of exposed tissue were placed on potato dextrose agar medium (PDA, Difco) containing 1 ppm Benomyl in a Petri dish. The Petri dishes were incubated at 25°C in the dark for 10 days. Colonies developed around the segment were purified.

2.3. Judgment of decaying type

Decayed tissue was collected from the declining trees to classify the decay type. Segments were obtained by the same method as detailed above, and inoculated on the medium as reported by Nishida *et al.* (1988). This medium consisted of 0.02 % guaiacol, 2 % beech wood powder (100-mesh-pass) and 1.5 % agar, and pH was adjusted to 5.5. After incubation at 30°C for 7 days, color change in the medium was observed. Characterization of white rot fungi were identified by testing for medium brown coloration due to ligninolytic activity.

2.4. Identification of insects

Tree insects were collected and preserved in 70% ethanol, and identified by microscopic observation. Some immature insects were identified at the adult stage after

Table 1 Details of streets and roadside trees.

	Street[a]	Tree species	Trre age (years)	Tree height (m)	Tree dsh[b] (cm)	No. of checked trees	No. of damaged trees (fungi)	No. of damaged trees (insects)	Soil pH (H_2O)	Soil pH (KCl)	Soil hardness (kg/cm^2)
	East-ward										
1.	Takamidai lane	*Cinnamomun camphora* (E)[c]	30	6-9 (7.4)[d]	29.3-46.5 (36.4)[d]	99	6	31	6.9	5.9	23.3
2.	kashii river lane	*Prunus × yedoensis* (D)	40	4-7 (5.5)	18.1-34.5 (26.2)	37	16	15	8.5	7.0	13.5
3.	Uminonakamichi Park lane	*Machilus thunbergii* (E)	15	3-4 (3.7)	12.5-15.3 (13.5)	54	17	37	7.1	5.9	10.5
4.	Midorigaoka lane	*Magnolia kobus* (D)	15	4-4 (4.0)	8.8-10.5 (9.8)	37	11	3	6.7	5.3	13.8
5.	Shirohama nankin road	*Sapium sebiferum* (D)	20	3-5 (4.0)	9.8-21.4 (17.1)	76	11	8	8.4	6.9	16.8
	Hakata-ward										
6.	Shotenzen temple lane	*Ginkgo biloba* (G)	35	14-15 (14.7)	44.8-46.0 (45.0)	31	1	0	4.7	3.7	25.0
7-1.	Reizen elementary school lane	*Acer negundo* (D)	40	8-9 (8.3)	26.0-39.4 (32.9)	21	10	11	7.0	5.9	25.8
7-2.	〃	*A. buergerianum* (D)	40	7-9 (7.8)	26.0-32.5 (30.0)	19	3	2	7.6	7.2	23.8
8.	Kamisuzaki Town lane	*Elaeocarpus sylvestris* (E)	25	4-5 (4.6)	12.0-15.5 (13.4)	53	4	2	8.2	7.8	21.2
9.	Taihaku avenue	*Washingtonia filifera* (M)	34	10-12 (11.0)	64.0-104.0 (88.0)	68	34	27	6.7	5.7	14.7
10	Ward office south-north line	*Liquidamber styraciflua* (D)	30	9-9 (9.0)	25.0-40.0 (34.7)	49	13	30	6.3	5.3	17.5
	Central-ward										
11.	Tenjin kurumi road	*Pterocarya stenoptera* (D)	40	8-11 (9.7)	19.2-37.5 (25.7)	44	21	26	7.4	6.5	27.4
12.	Kokutai street	*Zelkova serrata* (D)	45	7-10 (8.6)	31.8-50.0 (42.6)	58	22	22	5.6	4.0	21.7
13.	Takamiya road	*Platanus orientalis* (D)	45	8-9 (8.3)	26.5-39.2 (34.5)	43	14	37	7.9	7.2	24.9
14.	Ropponmatsu-Aratsu lane	*Salix babylonica* (D)	45	6-7 (6.3)	12.9-32.8 (19.8)	60	23	34	8.1	7.4	18.1
15.	Jhousui road	*Sophora japonica* (D)	30	9-9 (9.0)	28.0-36.0 (33.0)	57	39	34	7.8	6.8	18.3
	Jhounan-ward										
16.	Torikai-Befu lane	*Ilex rotunda* (E)	20	4-5 (4.6)	14.8-21.7 (18.1)	55	4	1	7.2	6.3	23.5
17.	Jhounan Aisatsu road	*Prunus lannesiana* (D)	20	4-5 (4.3)	19.0-25.0 (22.7)	18	3	6	5.8	4.5	18.2
	South-ward										
18.	Nagazumi east-west lane	*Robinia pseudoacacia* (D)	45	6-9 (7.1)	11.1-31.5 (21.3)	49	38	35	6.9	5.7	14.8
19.	Nagazumi south-north lane	*Populus nigra* (D)	30	11-15 (12.7)	28.2-55.5 (41.3)	43	6	15	6.6	5.5	25.4
20.	Ohashi station north lane	*Magnolia grandiflora* (E)	15	5-8 (6.5)	19.0-25.0 (22.7)	40	17	3	6.9	6.3	23.0
	West-ward										
21.	Nokatadai route 1 lane	*Liquidamber formosana* (D)	15	6-7 (6.7)	22.0-26.0 (23.7)	27	2	2	5.0	4.0	22.8
22.	Nishinoura-Imajyuku cycle road	*Pasania edulis* (E)	15	3-4 (3.3)	11.0-21.0 (16.0)	29	19	12	7.3	6.1	22.3
						1067[e]	334[e]	393[e]			

a) : See Fig. 1 for numbering.
b) : Diameter at stump height.
c) : Abbreviation in parenthesis: D, deciduous broad-leaf tree; E, evergreen broad-leaf tree, belonging to Angiospermae; G: Gymnospermae; M, Monocotyledoneae, respectively.
d) : Highest, lowest, and average values.
e) : Total number.

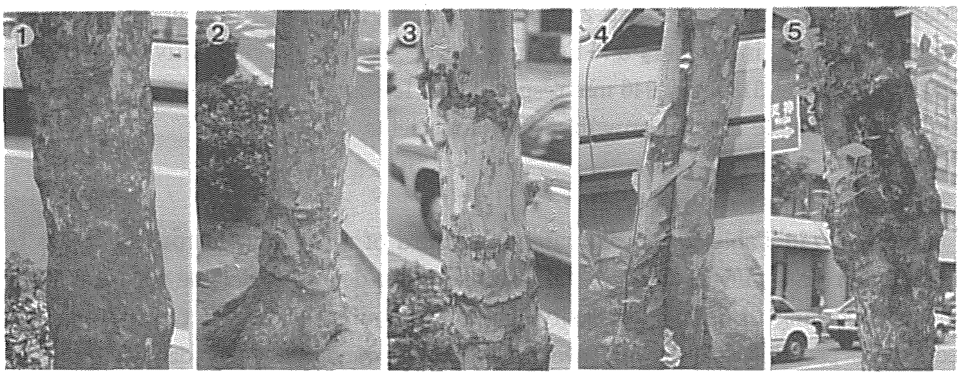

Fig. 2 Decline symptoms rated as 1 (very slight) ; 2 (slight) ; 3 (moderate) ; 4 (severe) and 5 (severer), respectively.

emergence from rearing. Galleries and other signs of insects were also examined. Natural enemies and associate insects were not included in this report.

2.5. Soil and root sampling

The herb layer was characterized as being between the canopy edge and the trunk from each tree. Soil pH was measured with a glass electrode in a 1 : 2.5 slurry of soil and distilled water or KCl which had stood for 15 min. Soil hardness was measured with a hardness tester at various depths in the soil profile. Root samples were collected from healthy and declining trees, respectively. In addition, the root samples of 6 different species were completely excavated with a shovel loader to a depth of 100-120 cm from severely declining trees.

3. Results and Discussion

3.1. Climatic view

Air temperature and rainfall data for Fukuoka City are summarized in Fig. 3.

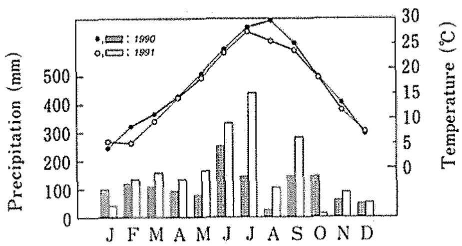

Fig. 3 Average temperature (shown as lines) and precipitation (shown as bars) in the study area.

Mean air temperature peaked at 29.6 and 27.4°C, in August and July, and mean minima were 4.0 and 5.0°C, in January and February, respectively. The cumulative rainfall from 1990 to 1991 was 1,318 and 1,946 mm respectively. It seems that weather conditions were relatively favorable for the growth of basidiomycetes.

3.2. Decline of the surveyed trees

As shown in Table 1, approximately one third of all examined roadside trees had various degrees of fungal and insect infestation. The degree of decline was ranked in 5 classes according to damage intensity (Fig. 2). Figure 4 shows that relatively minor decline was prominent. However, severe decline was found in 15 % of roadside trees. The percentage of trees that were damaged due to basidiomycetes varied with species (Fig. 5). At one study site, 78 % of roadside trees examined were visibly declining; at another study site, only 3 % were declining. It is clear that *Robinia pseudoacacia* and *Sophora japonica* declined severely due to fungal colonization (Figs 6-A and 6-B). On the other hand, 5 species including *Ginkgo biloba, Liquidambar formosana, Cinnamomum camphora, Ilex rotunda* and *Elaeocarpus sylvestris* are tolerant against fungal attack. Trees classified as healthy had no fruit body, and no hyphae were found using a hand-held microscope. It is clear that evergreen broad-leaved trees are more tolerant than deciduous broad-leaved trees to infection by wood decaying fungi and canker disease bacteria. The severity of canker disease was observed in numerous trees. The symptoms of this disease are similar to those reported by Canfield *et al.* (1986), resulting from infection with *Pseudomonas syringae*. Imperfect fungus, *Trichoderma* sp. was particularly isolated on the outer bark surface of *Liquidambar formosana* and *Sopium sebiferum*. The bark was mostly

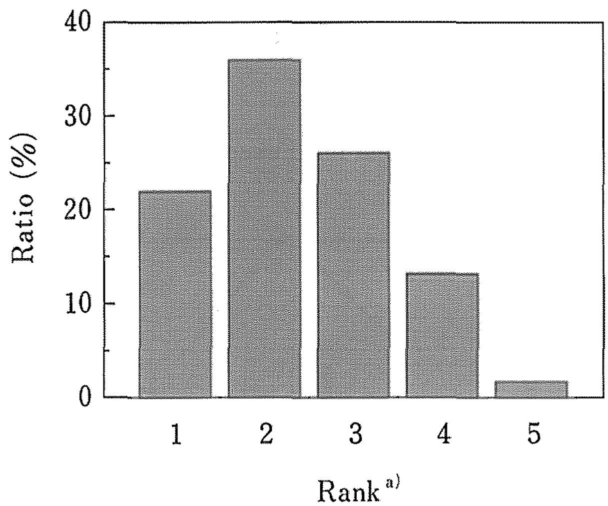

Fig. 4 Decline intensity of all damaged roadside trees.
a) : See Fig. 2 for rank.

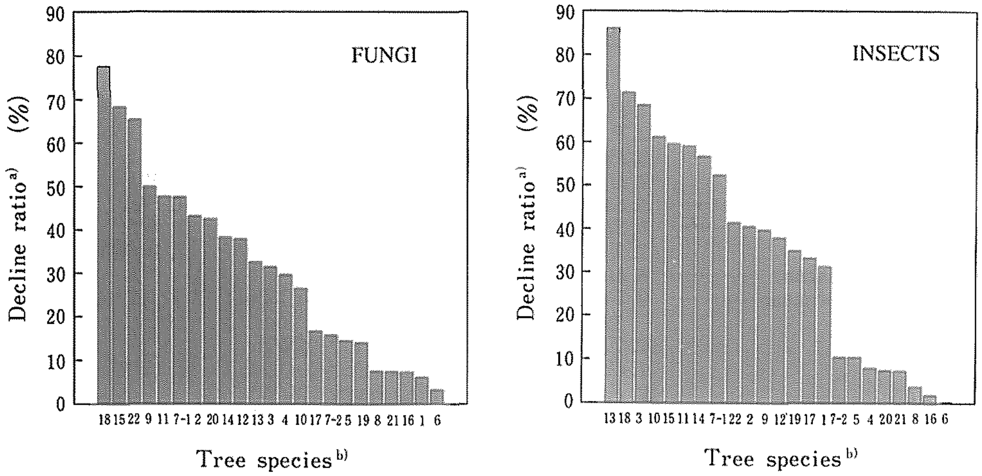

Fig. 5 Percentage recognized decline symptoms in various roadside trees.

a) : Decline ratio (%) $= \dfrac{\text{Number of damaged tree}}{\text{Number of observed tree}} \times 100$

b) : Numbering is the same as in Talble 1.

covered with blue-green colored spores.

Severe damage was caused by two species of termites (Isoptera, Rhinotermitidae) and Cerambycid beetles (Coleoptera, Cerambycidae). In this survey, ten species of trees were found to be infested by termites. In three tree species, *Pterocarya stenoptera, Salix babylonica* and *Robinia pseudoacacia* were severely damaged with numerous galleries in the trunks (Fig. 7-A). *Platanus orientalis* was severely attacked by the Cerambycid beetle, *Anoplophora malasiaca* (Fig. 7-B). The larvae, galleries under bark, emergence holes, frass on ground, etc. were observed in most trees. Many trees *Machilus thunbergii* were also markedly damaged by *Eupromus ruber* (Cerambycidae) with many emergence holes, frass, and its characteristic marks of egg laying on bark (Fig. 7-C). The leaves of *Cinnamomum camphora* and *Liquidambar styraciflua* were infested by the lepidopterous larvae, *Eumeta japonica* and *Hyphantria cunea*, respectively (Fig. 7-D).

It is significant that *Acea buergerianum* was more tolerant compared with *A. negundo.* Though these two species belong to the same genus and were planted along the same street, the decline ratio was obviously different (Fig. 5). This phenomenon was found in both basidiomycete and insect infestation. This may indicate the existence of various extractives against fungal and insect infection.

The evidence of the role of fungi and insects as precursors of decline and mortality at these sites is of serious concern given recent projections of car exhaust gases and shortage of sunlight in this area as a result of widespread urban development.

Table 2 Main fungi[a] species identified in the survey.

Class, order and family	Genus and species (host tree species[b]/decaying type[c])
Eubasidiomycetes	
Aphyllophorales	
Corticiaceae …………	1. *Polyporus arcularius* Batsch. : Fr. (7-1/W)
	2. *P. alveolarius* (DC. : Fr.) Bond. et Sing. (15/W)
	3. *Peniophora quercina* (Pers. : Fr.) Cooke. (2/W)
	4. *Mycoacia copelandii* (Pat.) Aoshi. et Furu. (15/W)
Steccherinaceae………	5. *Steccherinum ochraceum* (Pers.) S. F. Gray. (2/W)
Stereaceae ……………	6. *Stereum hirsutum* (Willd. : Fr.) S. F. Gray. (2/W)
	7. *Xylobolus spectabilis* (Klotz.) Boiden. (7-1, 17, 18/W)
Meruliaceae …………	8. *Merulius tremellosus* Fr. (22/W)
Polyporaceae …………	9. *Trametes (Coriolus) versicolor* (Fr.) Quel. (2, 11, 12, 14, 15, 17, 19/W)
	10. *T. gibbosa* (Pers.) Fr. (7-1, 7-2/W)
	11. *Coriolus hirsutus* (Walf. : Fr.) Quel. (2, 11, 12, 15/W)
	12. *Fomitella fraxinea* (Fr.) Imaz. (18/W)
	13. *Fomitopsis pinicola* (Fr.) Karst. (7-1/B)
	14. *F. nigra* (Berk.) Imaz. (7-1, 12/B)
	15. *Pycnoporus coccineus* (Fr.) Bond. et Sing. (8, 17/W)
	16. *Lenzites betulina* (L. : Fr.) Fr. (12, 13/W)
	17. *Gloeophyllum sepiarium* (Wulf. : Fr.) Karst. (22/B)
	18. *Daedaleopsis tricolor* (Bull. : Fr.) Bond. et Sing. (3, 10/W)
	19. *Daedalea dickinsii* (Berk.) Yasuda (12/B)
	20. *Laetiporus versisporus* (Lloyd) Imaz. (12/B)
	21. *Microporus vernicipes* (Berk.) Imaz. (2/W)
	22. *Oligoporus tephroleucus* (Fr.) Gilbn. et Ryv. (15/B)
	23. *Porodisculus pendulus* (Schw.) Murr. (8, 20/W)
	24. *Cerrena unicolor* (Fr.) Murr. (12, 18/W)
	25. *Phaeolus schweinitzii* (Fr.) Pat. (18/B)
Ganodermataceae……	26. *Elfringia applanata* (Pers.) Karst. (2, 8, 12, 18/W)
	27. *Ganoderma lucidum* (Leyss. : Fr.) Karst. (12/W)
Hymenochaetaceae …	28. *Phellinus igniarius* (L. : Fr.) Quel. (12/W)
	29. *P. gilvus* (Schw. : Fr) Pat. (2, 17/W)
	30. *Hymenochaete yasudai* Imaz. (22/W)
	31. *Inonotus xeranticus* (Berk.) Imaz. et Aoshi. (15/W)
	32. *I. mikadoi* (Lloyd) Imaz. (2/W)
	33. *Cyclomyces fuscus* Fr. (22/W)
Agaricales	
Pleurotaceae …………	34. *Pleurotus ostreatus* (Jacq. : Fr.) Kummer (12, 14, 15/WE)
	35. *Schizophyllum commune* Fr. (2, 12, 15, 17/W)
Tricholomataceae……	36. *Resupinatus trichotis* (Pers.) Sing. (12/W)
	37. *Panellus stypticus* (Bull. : Fr.) Karst. (12/W)
	38. *Oudemansiella mucida* (Schrad. : Fr.) Hohnel (15/WE)
	39. *Mycena haematopoda* (Pers. : Fr.) Kummer (9/W)
	40. *M. galericulata* (Scop. : Fr.) S. F. Gray (15/WE)
Coprinaceae …………	41. *Coprinus atramentarus* (Fr.) Fr. (9/WE)
	42. *C. disseminatus* (Pers. : Fr.) S. F. Gray (9/W)
Pluteaceae ……………	43. *Pluteus atricapillus* (Batsch) Fayod (15/WE)
Strophariaceae ………	44. *Naematoloma fasciculare* (Hudson: Fr.) Karst (12, 15/WP)
Bolbitiaceae …………	45. *Agrocybe cylindracea* (Fr.) Maire (13, 14/WE)
Heterobasidiomycetes	
Auriculariales	
Auriculariaceae………	46. *Auricularia auricula* (Fr.) Quel. (7-1, 8, 13, 15/WE)

a) : All fungi listed in this Table are classed in Basidiomycotina. Ascomycotina such as *Hypocrea* sp., *Hypoxylon* sp. and *Bisporella citrina* (Batsch.) Korf et al. were observed in this experiment.

b) : Numbers are represented in Table 1.

c) : Abbreviation in parenthesis: W, white rot fungus; B, brown rot fungus; E, edible fungus; P, poison fungus. Judgement of decaying type, W or B were determined according to the method as described in Materials and Methods.

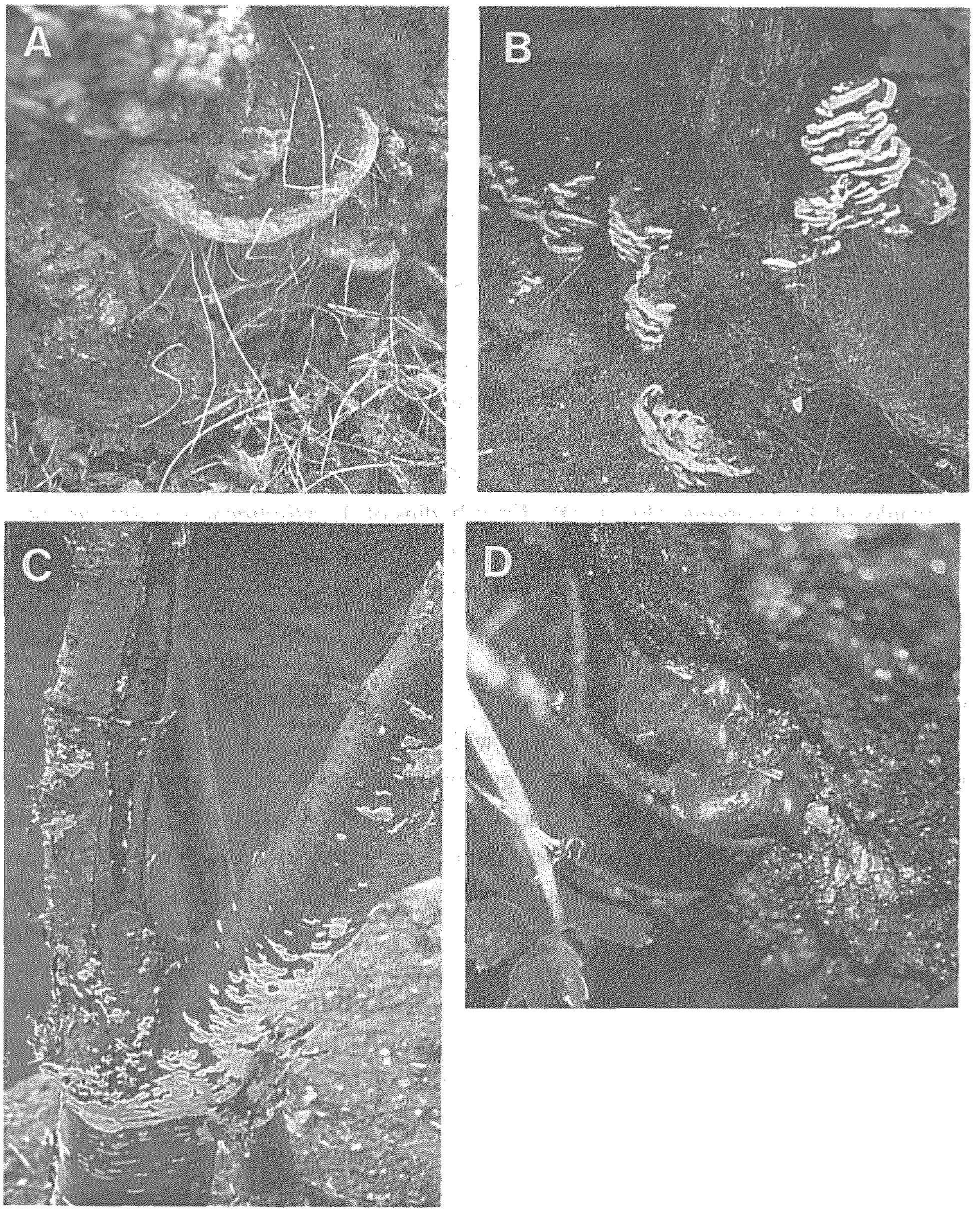

Fig. 6 Roadside trees infested with various wood-inhabiting basidiomycetes ; A, Fruit bodies of *Elfvingia applanata* (Pers.) Karst. growing on the root collar of *Sophora japonica* Linn. ; B, Fruit bodies of *Fomitella fraxinea* (Fr.) Imaz. growing on the root collar of *Robinia pseudoacacia* Linn. ; C, *Peniophora quercina* (Pers. : Fr.) Cooke developing on the outer bark surface of scaffold limbs of *Prunus* × *yedoensis* ; D, Fruit bodies of edible mushroom, *Auricularia auricula* (Hook.) Underw. growing on the trunk of *Acer negundo* Linn.

3.3. Fruit body observation of various basidiomycetes

Basidiomycetes were associated with both dieback and decline of roadside trees. A total of 46 strains were isolated at various locations and times, from 23 species of roadside trees (Table 2). Aphyllophorales basidiomycetes were dominant in this survey. *Robinia pseudoacacia* produced fruit bodies of *Fomitella fraxinea* on the root collars (Fig. 6-B). *Sophora japonica* produced fruit bodies of *Elfvingia applanata* on the root collars (Fig. 6-A). Periodic observation indicated an increasing number of fruit bodies with *F. fraxinea* over time, and these survived until winter. *Peniophora quercina* and *Stereum hirsutum* were identified on the lateral branches of *Prunus* × *yedoensis* (Fig. 6 - C). *Phellinus igniarius* was identified on the root collar of *Zelkova serrata*. Seven species of edible mushroom fruit bodies were found during the experimental period. *Agrocybe cylindracea* was observed on the base of scaffold limbs and trunks of *Platanus orientalis* (Fig. 2-4), *Pleurotus ostreatus* on the trunks of *Zelkova serrata*, and *Auricularia auricula* on the trunks of *Acer negundo* (Fig. 6-D). Fruit bodies of *A. cylindracea, P. ostreatus* and *A. acricula* lasted only 1 or 2 weeks, but were regularly replaced from the many primodia visible in decayed sections. A poison mushroom, *Naematoloma fasciculare* was observed on the root collar of *Z. serrata.*

3.4. Insect fauna on the declining trees

Fifty-one species of insect associated with the surveyed trees were found as shown in Table 3. They were classified into 3 groups according to food habits: xylophagous, phytophagous (mainly leaf eating or sucking insects) and polyphagous insects. The xylophagous group includes the most important pests from the viewpoint of tree management. Two species of termites, *Reticulitermes speratus kyushuensis* and *Coptotermes formosanus* infested the woody part of various trees (Fig. 7-A). *Anoplophora malasiaca* (Coleoptera, Cerambycidae) fed on 5 tree species, especially in this survey *Platanus orientalis* (Figs. 2-2 and 7-B). *Eupromus ruber* in high density was specific to *Machilus thunbergii* (Fig. 7-C). These cerambycid beetles were important as pioneers, because they attacked the sound parts of the tree, their tunnels becoming available for secondary invaders such as ants, termites and fungi.

Larvae of phytophagous Lepidoptera, *Eumeta japonica* and *Hyphantria cunea* occurred on many species of broad-leaved trees and in many individuals of certain tree species. However related damage was considered to be minor in each individual tree. *Iridomyrmex itoi, Lasius niger* and other ants (Hymenoptera, Formicidae) often nest in the cavities of trunks or the slits of bark, but their impact was negligible.

3.5. Correlation of fungal infection and insects detection ratio

There was a highly significant relationship between fungal infection and insect detection ratio. It was also highly significant that wood-rotting fungi were always found around tunnels and holes drilled by various insects. A more extensive survey is necessary

Table 3 Insect species identified in the survey.

Order and family	Genus and species (host or associated tree[a]/food habit[b])
Blattaria	
Blattidae	1. *Periplaneta americana* (Linnaeus) (11/PO)
	2. *Periplaneta* sp. indet. (13, 14/PO)
Isoptera	
Rhinotermitidae	3. *Reticulitermes speratus kyushuensis* Morimoto (11, 13, 14/X)
	4. *Coptotermes formosanus* Shiraki (7-1/W)
	3 or 4 (1, 2, 5, 7-1, 10, 11, 12, 13, 14, 18)
Homoptera	
Cicadidae	5. Gen. et sp. indet. (17/PH)
Aphididae	6. Gen. et sp. indet. 1 (19/PH)
	7. Gen. et sp. indet. 2 (3/PH)
Pseudococcidae	8. *Phenacoccus pergandei* Cockerell (4/PH)
	9. Gen. et sp. indet. 1 (11/PH)
	10. Gen. et sp. indet. 2 (13/PH)
	11. Gen. et sp. indet. 3 (14/PH)
Coccidae	12. *Ceroplastes ceriferus* (Fabricius) (4, 16/PH)
Heteroptera	
Plataspidae	13. *Megacopta punctatissima* (Montandon) (12/PH)
Pentatomidae	14. *Halyomorpha picus* (Fabricius) (18/PH)
	15. *Erthesina fullo* (Thunberg) (11, 12, 15/PH)
Anthocoridae	16. Gen. et sp. indet. (18/PH)
Coleoptera	
Scarabaeidae	17. *Anomala cuprea* (Hope) (17/PH)
Buprestidae	18. Gen. et sp. indet. (2/X)
Tenebrionidae	19. *Promethis valgipes* (Marseul) (2/X)
Cerambycidae	20. *Anoplophora malasiaca* (Thomson) (7-1, 12, 13, 14, 18/X)
	21. *Eupromus ruber* (Dalman) (3/X)
	22. Gen. et sp. indet. 1 (2/X)
	23. Gen. et sp. indet. 2 (12/X)
	24. Gen. et sp. indet. 3 (14/X)
	25. Gen. et sp. indet. 4 (19/X)
	26. Gen. et sp. indet. 5 (10/X)
Hymenoptera	
Formicidae	27. *Brachyponera chinensis* (Emery) (9/PO)
	28. *Crematogaster matsumurai matsumurai* (Forel) (4, 5, 13, 15, 22/PO)
	29. *Leptothorax* sp. indet. 1 (11, 12/PO)
	30. *Leptothorax* sp. indet. 2 (20/PO)
	31. *Tetramorium caespitum* (Linnaeus) (9, 14, 15, 19/PO)
	32. *Pristomyrmex pungens* Mayr (3, 17, 22/PO)
	33. *Vollenhovia emeryi* Wheeler (2, 5/PO)
	34. *Iridomyrmex itoi* Forel (5, 9, 18, 20, 22/PO)
	35. *Lasius niger* (Linnaeus) (1, 10, 11, 12, 13, 14, 15, 17, 21, 22/PO)
	36. *Lasius* sp. (13/PO)
Diptera	
Sciaridae	37. Gen. et sp. indet. 1 (18/X)
	38. Gen. et sp. indet. 2 (3/X)
Lepidoptera	
Psychidae	39. *Eumeta japonica* Heylaerts (1, 7-1, 8, 11, 12, 18/PH)
Limacodidae	40. *Parasa sinica* (Moore) (7-1, 7-2, 11, 12, 18/PH)
Pyralidae	41. *Botyodes principalis* Leech (19/PH)
Geometridae	42. *Ascotis selenaria cretacea* (Butler) (11/PH)
	43. Gen. et sp. indet. (7-2/PH)
Lasiocampidae	44. *Dendrolimus spectabilis* (Butler) (3/PH)
Saturniidae	45. *Caligula japonica japonica* (Moore) (5/PH)
	46. *Samia cynthia pryeri* (Butler) (16/PH)
Lymantriidae	47. *Lymantria dispar japonica* (Motschulsky) (7-1, 11, 18/PH)
	48. Gen. et sp. indet. (19/PH)
Arctiidae	49. *Hyphantria cunea* (Drury) (7-1, 10, 11, 13, 14/PH)
Noctuidae	50. *Lagoptera Juno* (Dalman) (11/PH)
	51. *Arcte coerula* (Guenee) (11/PH)

a) : Host or associated trees are abbreviated by the number of Table 1 in the brackets.
b) : Food habits of the insect species are shown in the brackets by the following abbrebiation: X, xylophagous; PH, phytophagous (mainly leaf eater or sucking insects); PO, polyphagous.

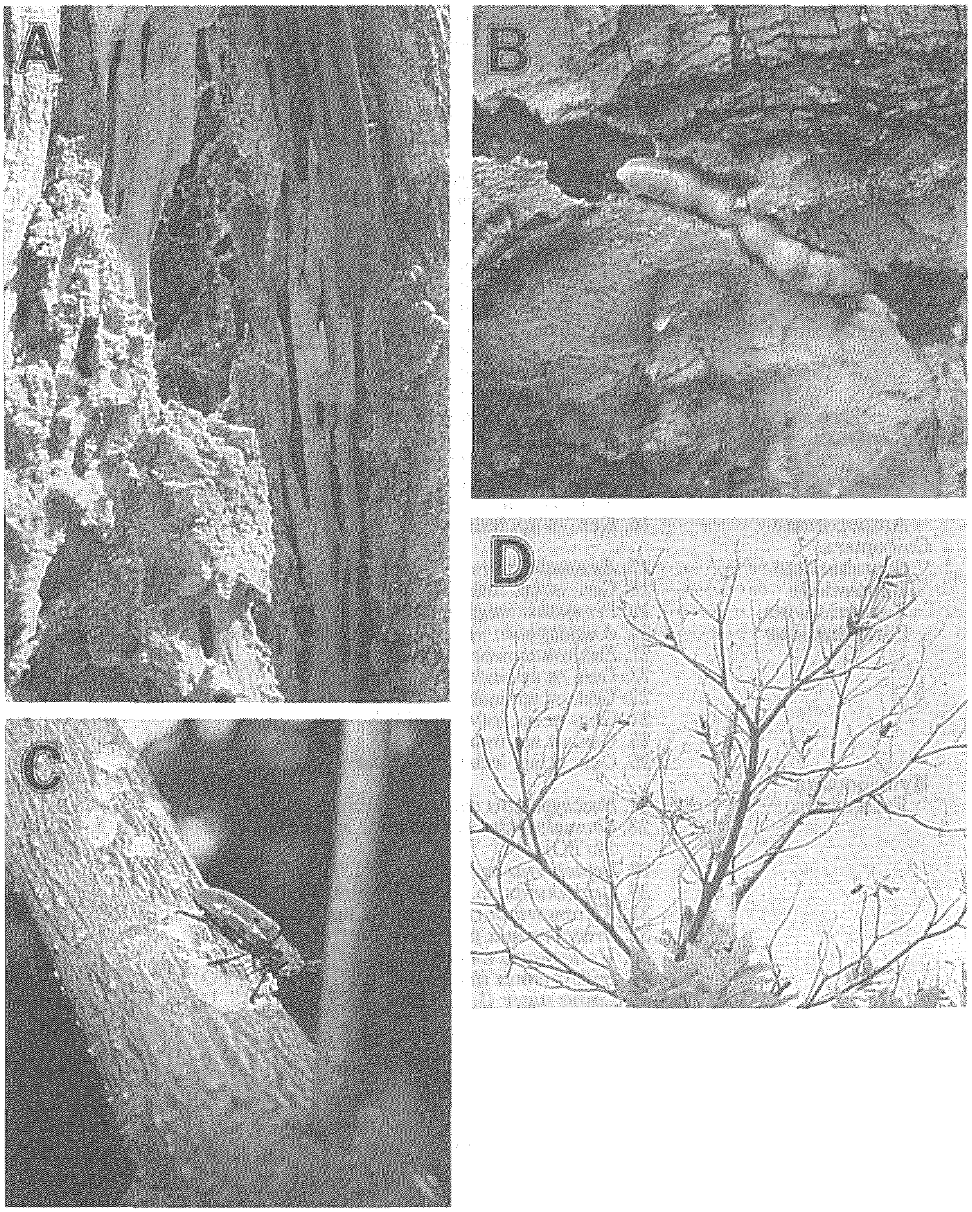

Fig. 7 Roadside trees invaded by various insects ; A, *Pterocarya stenoptera* D. C. damaged by the termite, *Coptotermes formosanus* Shiraki ; B, Mature larva of the cerambycid beetle, *Anoplophora malasiaca* (Thomson) and its tunnel on the trunk of *Platanus orientalis* Linn. ; C, *Machilus thunbergii* Sieb. et Zucc. attacked by the cerambycid beetle, *Eupromus ruber* (Dalman) (making for the egg laying) ; D, *Cinnamomum camphora* Presl. damaged by Psychid moth, *Eumeta japonica* Heylaerts.

to confirm whether this correlation is a common feature in roadside tree decline.

3.6. Soil and root survey

Fungal infection is very responsive to environmental factors, and a strong correlation exists between moisture content around the root collar and mycelial growth. Areas in surrounding stands were checked for the absence of ground cover except for *Robinia pseudoacacia* and *Washingtonia nigra*. These two species severely declined due to fungal infestation. From this data it appears that sad grass, *Zoisia* sp., planted as ground cover contributes to fungal growth. The soils were mostly welldrained, sandy to sandy loam, having a sandy texture and low water-retention capacity. Soil pH (water extraction) values were well below 6.5. Low soil pH values were a common factor to several streets and may have contributed to the observed decline problems. Low pH affects the intake and availability of nutrient elements. Therefore, it is conceivable that nutritional deficiencies may contribute to an overall decline in roadside tree health. Raising and maintaining pH at recommended levels may increase the capacity of trees to resist or at least withstand infection by pathogens.

A clear association was found between the degree of root and trunk decline. Infection by pathogens was detected in all tree roots, where fruit bodies of basidiomycete were detected on branches and trunks. Mycelia developed on the main roots, and fine roots were extensively damaged.

The chemical characteristics of the surface layer of roadside soil were radically altered by contamination from the road and traffic (Harrison *et al.*, 1981). It can be assumed that various toxic metals in car exhaust will continue to accumulate in roadside soil. There was evidence that roadside metal contamination had adversely affected tree functions, though effects on individual components and levels remain undetermined.

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街路樹への担子菌類および昆虫類の侵害

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要 約

福岡市内の主要22路線に植栽されている23種の街路樹について，木材腐朽性担子菌および昆虫による衰微を調査した．全調査木 1,067 本のうちの約 3 分の 1 の街路樹で被害が認められた．担子菌のヒダナシタケ目サルノコシカケ科に属するものの子実体が頻繁に観察された．同定された担子菌46種のうち 7 種の食用担子菌の子実体が認められた．枝条部や樹幹部に子実体が認められたものは樹勢の衰えが顕著で，形成層や辺材部で二次菌糸が単離された．調査した23樹種のうちでは，特に，ニセアカシア，エンジュの衰弱が著しく，その根ぎわ部分に白色腐朽菌のベッコウタケ子実体の着生がみられ，被害の激しいものは心材部まで二次菌糸の蔓延が認められた．昆虫では，寄生，共生および補食性昆虫を除き合計51種が確認された．特にシロアリ，カミキリムシ等の食材性昆虫の被害が顕著であった．そのうちシナサワグルミ，シダレヤナギおよびニセアカシアでは枯死に到る被害が見いだされた．またプラタナスではゴマダラカミキリの，タブノキではホシベニカミキリの激しい加害が認められ，幼虫のトンネルにアリ，シロアリおよび菌類の二次的侵入が認められた．また，土壌酸性度の低下が著しく，伐根調査の結果，細根部が強く侵害を受け主根部まで二次菌糸が蔓延していることが分かった．根系部の衰弱は樹木の地上部の侵害度と高い相関性を示した．今回の調査の結果，樹種や土壌要因等が街路樹の衰微に大きな影響をおよぼしているものと考えられた．

キーワード：街路樹，担子菌，子実体，昆虫，シロアリ