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The effects of forest fragmentation on web spider communities in urban areas

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Abstract

Spiders are generalist arthropod predators living in all kinds of forests. Since food limitation appears to be widespread, this group may be influenced by forest fragmentation in various ways. We examined web spider communities in one continuous forest and 17 forest fragments surrounded by built-up areas in Yokohama and Tokyo, Japan. Smaller fragments had fewer species and lower density of individuals. For a given size fragment, those in Yokohama harbored more species than those in Tokyo, probably due to the lower degree of isolation from surrounding fragments in Yokohama. Large araneids were most sensitive to fragmentation in the sense of species loss, small araneids intermediate, and theridiids least sensitive. The body size of *Nephila clavata*, a common species in fragments, was smaller in smaller fragments. We propose that one important mechanism of species loss in web spiders is the lower abundance of large prey in small fragments. © 1998 Elsevier Science Ltd. All rights reserved.

Keywords: Species-area relationship; Fragmentation; Species richness; Species density; Community; Spider

1. Introduction

It has been widely known that forest fragmentation influences biological communities in various ways: species richness and population density decrease with fragment size (e.g. Askins et al., 1987; Van Dorp and Opdam, 1987; Klein, 1989; de Souza and Brown, 1994; Bellamy et al., 1996; Turner, 1996), and they decline dramatically after fragmentation (e.g. Lovejoy et al., 1986; Stouffer and Bierregaard, 1995a; Turner, 1996). Some studies have also shown that these effects differ among species or higher taxa, due to the differences in food habits and/or microhabitat preferences: some species are unaffected or even increase their densities in fragments (Lovejoy et al., 1986; de Jong, 1995; Stouffer and Bierregaard, 1995a,b; Bellamy et al., 1996; Turner, 1996). For example, while insectivorous songbirds showed a fragment-size effect, hummingbirds in the same fragment revealed little change, which was partly attributed to the difference in food resources. However, reasons causing these differences are not well understood, and most of these studies were biased to avian communities. To assess the overall impact of fragmentation on forest ecosystems, organisms belonging to various taxonomic groups and those having different life history characteristics should be examined.

Spiders are small generalist carnivores living in all kinds of forests. Web-building spiders are known to be food limited at both individual and population levels (e.g. Anderson, 1974; Wise, 1975, 1979, 1993; Miyashita, 1991, 1992a), while competitive interactions are not important for structuring communities (Wise, 1981; Riechert and Cady, 1983; Horton and Wise, 1983; Wise, 1993), probably because predation and other environmental factors limit populations below the levels at which competition for resources becomes important. Web spiders have several characteristics suitable for assessing the effects of forest fragmentation. First, due to the nature of generalist predators, their species richness and abundance may reflect the total abundance of their prey, including various herbivores, detritivorous, and some carnivorous arthropods which constitute a substantial portion of animal communities in fragments. Second, the general absence of interspecific competition may help understand the mechanisms of the change in community composition relatively easily, because when interspecific competition exists, as is often the case in other predators, it would complicate the mechanism structuring community. Third, because of the various

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life history characteristics among species, such as body size and foraging mode, they are suitable subjects for assessing which types of life styles are most sensitive to forest fragmentation. Fourth, field censuses can be performed easily and precisely, because each individual has its own web.

Apart from their importance from a conservation perspective, forest fragments can provide insight into pure ecology, because they provide large scale environmental gradients (e.g. habitat size) which are hard to create experimentally. For instance, the advantage of having large food niche breadth may be clearly shown when a particular type of prey is reduced by fragmentation.

In urban areas in eastern Japan, there are many small forests of various sizes isolated from each other by built-up areas with little vegetation. Web spiders are one of the most common animals in most of these forests. We examined species richness and population density of web spider communities and body size of one species in 17 fragmented forests and one continuous forest. We addressed the following questions: (1) Are the species richness, population density, and body size affected by fragmentation?; (2) What groups of spiders are most sensitive to fragmentation and why?

2. Study area and methods

We surveyed spiders in 10 forests within a 11×11 km area in Yokohama (35°20′–23′N, 139°30′–35′E) and in seven forests within a 5×10 km area in Tokyo (35°38′–43′N, 139°42′–46′E), eastern Japan. The woodlands in Yokohama are located about 40 km to the southwest of Tokyo. The fragment code, size, and vegetation type are shown in Appendix A. The forest Yokohama-1 is a large forest (≈5000 ha), and we treated it as a continuous forest in the present study. The upper layer of the vegetation was mainly composed of deciduous and evergreen oak *Quercus* spp. and dogwood *Cornus* in Yokohama, and of *Zelkova* (Ulmaceae) and *Castanopsis* (Fagaceae) in Tokyo. The shrub layer consisted mainly of *Aucuba* (Cornaceae) and *Pleioblastus* (Gramineae) both in Yokohama and in Tokyo.

We determined the area and the degree of isolation for each fragment using topographical maps (1:10 000) made by the Geographical Survey Institute of Japan. Isolation from other forests was calculated using the method proposed by Askins et al. (1987), i.e. the proportion of woodland area within 500 m of the boundary of the fragment. The distance of 500 m was determined arbitrarily, but if we used 1000 m or more, several fragments would have had a similar isolation value, which seemed to be less sensitive for evaluating the effect of isolation.

Each woodland was visited in late May and late September 1995. Since most web spiders mature in late spring or early autumn in Japan, the two visitations should have covered most of the spiders living in the forests.

We censused spider communities in two ways. First, we walked along the paths in the forest and recorded species of web spiders on their webs within 2 m of the ground. Because we walked along as many paths as possible in each fragment, we believe that most species dwelling there were recorded by this census. The number of species found by this census is called 'species richness' in this paper. Kleptoparasitic spiders *Argyrodes* spp. and a mimetid spider (spider killer) were included because they are derived from web-bearing araneoidae (Yaginuma, 1986). Second, we set two strip transects (50×2 m) in each forest (except Tokyo-4) and recorded the number of species and the number of individuals within 2 m of the ground. These estimates provided standardized species richness and density of spiders, which we hereafter refer to as 'species density' and 'density', respectively. Since agelenid spiders were small in body size and were numerous in number at the time of the censuses, an accurate count of this group was extremely laborious. We, therefore, excluded these spiders from the density estimate.

To learn the effects of fragment size on body size parameters in spiders, we sampled females of *Nephila clavata* in September. This species was one of the largest and most common species in the study area. This sampling was performed in eight fragments and in the continuous forest in Yokohama, and in two fragments in Tokyo. All individuals were preserved in 70% alcohol. The carapace width was measured for each individual under the microscope.

Table 1
Results of multiple regression analysis for species density as a dependent variable

(A) Fragments in Yokohama ANOVA: $F(2,6)=8.200$, $p=0.019$, $R^2=0.643$				(B) Fragments in Yokohama and Tokyo pooled ANOVA $F(2,12)=14.98$, $p<0.001$, $R^2=0.666$			
Variable	β^a	t	p	Variable	β^a	t	p
Area	0.671	2.23	0.067	Area	0.417	2.64	0.022
Isolation	0.237	0.79	0.461	Isolation	0.655	4.15	0.001

[a] Standardized partial regression coefficient.

3. Results

3.1. Species richness and species density

Combining the census data in May and in September we obtained species richness and species density in each fragment. In the present paper, both correlation and regression analyses were employed due to the following reasons: (1) regression analysis is commonly used for expressing species–area relationships, but (2) including the continuous forest is inappropriate because of its much larger forest size, (3) hence, non-parametric correlation analysis was performed for data including the continuous forest, and regression analysis was made excluding the continuous forest.

Species richness increased significantly with fragment size in Yokohama ($\tau = 0.828$, $n = 10$, $p < 0.001$, two-tailed) and tended to increase in Tokyo ($\tau = 0.683$, $n = 7$, $p < 0.07$, two-tailed) (Fig. 1). The regressions in Yokohama as well as in Tokyo were highly significant (Yokohama: $y = 0.188x + 1.299$, $F = 25.4$, $p < 0.002$; Tokyo: $y = 0.243x + 1.038$, $F = 39.5$, $p < 0.002$, where y and x are the number of species and fragment size, respectively). ANCOVA showed that species richness was higher in Yokohama, taking fragment size into account ($F = 43.1$, $p < 0.001$).

We also found a significant positive correlation between fragment size and species density in Yokohama ($\tau = 0.675$, $n = 10$, $p < 0.01$, two-tailed), while the correlation in Tokyo was not significant ($\tau = 0.690$, $n = 6$, $p > 0.1$, two-tailed) (Fig. 1). The regressions between fragment size and species density were significant in Yokohama ($y = 0.147x + 1.109$, $F = 16.7$, $p < 0.005$) and in Tokyo ($y = 0.161x + 0.815$, $F = 19.9$, $p < 0.02$). ANCOVA showed that species density was higher in Yokohama, taking fragment size into account ($F = 79.9$, $p < 0.001$).

The regression between isolation of the fragment and species density was significant in Yokohama ($y = 0.908x + 0.891$, $F = 7.28$, $p < 0.04$, where x is the percentage of forested area), but not in Tokyo ($F = 0.174$, $p > 0.6$) (Fig. 2). We performed a multiple regression analysis by using size and isolation of the fragment as two independent variables in Yokohama (Table 1). The multiple regression was significant and the size of the fragment tended to be significant, whereas isolation was not. Thus, the positive relation found in Yokohama (Fig. 2) appears to be spurious, coming from the correlation between size and isolation of the fragments ($r = 0.617$, $p < 0.05$). However, the degree of isolation might explain the difference in species density between Yokohama and Tokyo. Consequently, we also performed the same multiple regression analysis by pooling the data in Yokohama and in Tokyo (Table 1). In this case, both size and isolation became significant. These results suggest that the effect of isolation appears to be important when fragments having quite different degrees of isolation were compared.

3.2. Area-sensitive groups

As web-building spiders have various life styles, sensitivity to forest fragmentation can differ among species. Araneidae and Theridiidae were the two dominant taxonomic groups (Appendix B). These two groups differ in their prey capture strategies: Araneid spiders construct orb webs, while Theridiid normally make irregular webs. Furthermore, Araneids show large variation in adult body size among species and consequently should have quite different energetic requirements. To know which group is more sensitive to area, we examined the relationship between fragment size and percentage species of a given group to the

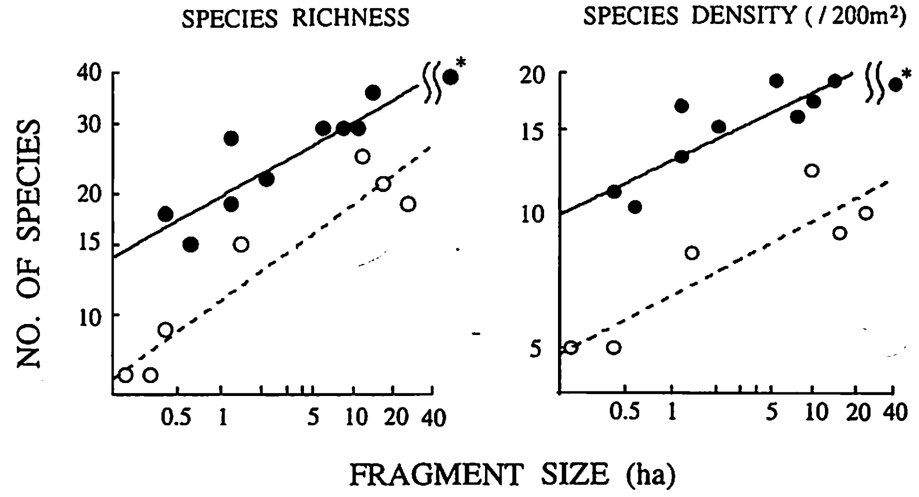

Fig. 1. Relationships between fragment size and species richness (left), and between fragment size and species density (right) in Yokohama (closed circles) and in Tokyo (open circles). A plot with an asterisk represents a continuous forest.

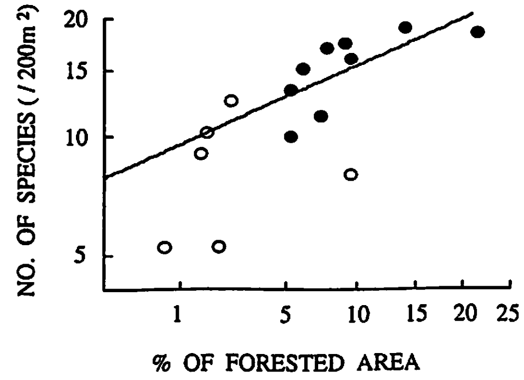

Fig. 2. Relationship between percentage of forested area surrounding a fragment and species density. The regression line is for fragments in Yokohama. Symbols as in Fig. 1.

overall species richness in three groups of spiders: large Araneidae ($\geqslant 10$ mm adult body length, 11 spp.), small Araneidae (< 10 mm adult body length, 9 spp.), and Theridiidae constructing irregular webs (*Anelosimus*, *Achaearaneae*, and *Enoplognatha*, 7 spp.)(Fig. 3). Other theridiid species which do not make irregular webs and feed exclusively on spiders (*Theridion sterninotatum*), ants (*Dipoena* spp.), male Cecidomyiidae (*Phoroncidia altiventris*) or prey on other spider's web (*Argyrodes* spp.) were excluded for the analysis. We used percentage species in this analysis because it may reflect sensitivity to fragmentation of a given group *relative* to other groups.

In Yokohama, large Araneidae showed a significant positive correlation ($\tau = 0.782$, $p < 0.001$, two-tailed) and Theridiid tended to have a negative correlation ($\tau = -0.494$, $p < 0.06$). In Tokyo, only large Araneidae tended to show a positive correlation ($\tau = 0.621$, $p < 0.07$). To detect the overall trend, we calculated the blocked τ (T) which is the weighted average of each τ (Korn, 1984). Large Araneids and Theridiids showed a significant positive ($T = 0.732$, $p < 0.002$) and negative correlation ($T = -0.492$, $p < 0.02$), respectively, while small Araneids had no significant value ($T = -0.286$, $p > 0.10$). This means that large Araneidae are the most sensitive and Theridiidae the least sensitive to fragment size in the sense of species loss.

3.3. *Density of individuals*

Fig. 4 shows the relationships between density of spiders and fragment size in May and in September. It appeared that the relationship in Yokohama could be expressed by a saturation curve, so we fitted the formula $y = a(1 - \exp(-bx)) + c$ to the data, where y and x are density and fragment size, respectively, and a, b, and c are constants. Continuous forest was not included in this analysis. As shown in Fig. 4, the formula fitted the data very well (May: $y = 0.267(1 - \exp(-3.462x)) + 1.665$, $r^2 = 0.958$; September: $y = 0.255(1 - \exp(-3.221x)) + 1.940$, $r^2 = 0.816$, where y is the density). The density of spiders decreased abruptly when the size of the fragment becomes less than 1 ha.

3.4. *Body size*

Fig. 5 shows the relationship between fragment size and carapace width of *Nephila clavata* females. Although there was large variation in each fragment, the correlation between fragment size and mean carapace width of each forest was highly significant ($\tau = 0.600$, $n = 11$, $p = 0.005$, one-tailed), implying that *Nephila* spiders inhabiting larger fragments have a larger body size.

4. Discussion

It has been shown that smaller forest fragments often have fewer species for the same effort of observation than larger fragments or continuous forests (reviewed

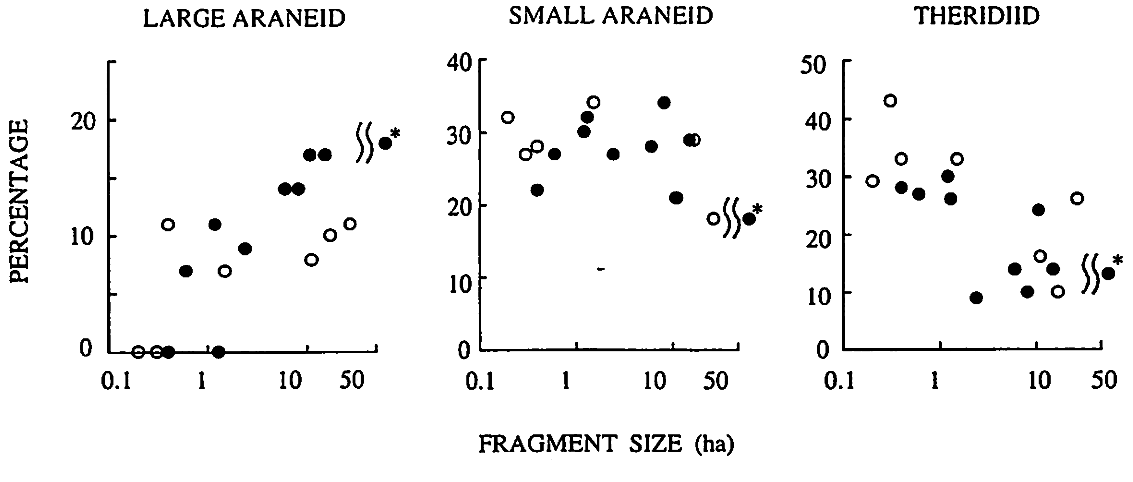

Fig. 3. Relationship between fragment size and percentage species of a group of spiders to the species richness. Symbols as in Fig. 1.

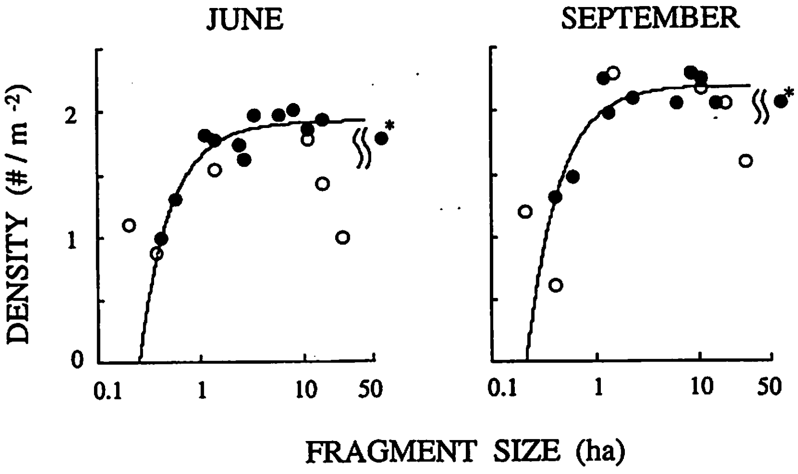

Fig. 4. Relationship between fragment size and density of spiders in May and September. Symbols as in Fig. 1. The curve is fitted to the Yokohama data only. See text for the curvilinear equation.

by Turner (1996)), although there are a few exceptions (Loman and von Schantz, 1991; Luczak, 1991; Punttila et al., 1994). Turner (1996) proposed several mechanisms of species loss in forest fragments: human disturbance during and after deforestation, the reduction of population size, the reduction of immigration rates, forest edge effects, change in community structure (second- and higher-order effects) and the immigration of exotic species. The relative importance of these mechanisms remains obscure and probably depends on the taxon of target organisms.

The web spiders in the present study also showed lower species richness per unit area in smaller fragments. Let us explore possible mechanisms causing this pattern. If smaller fragments are more isolated from adjacent forests than larger ones, lower species density could be due to the lower immigration rate, not size per se, since immigration rate appears to be a function of isolation. In Yokohama, the correlation between fragment size and isolation was significant, but multiple regression analysis showed that only size was significant for species density (Table 1). When the data of Yokohama and Tokyo were pooled, both size and isolation became significant (Table 1). Therefore, size effect is still important, taking the isolation effect into account.

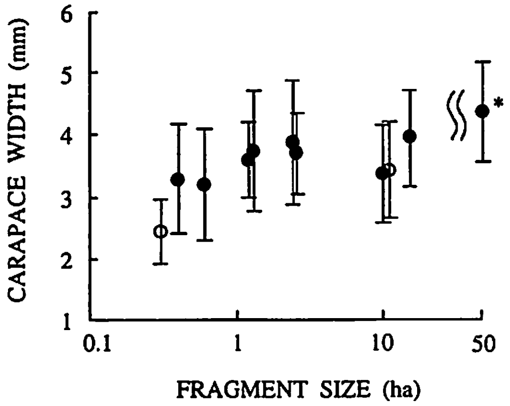

Fig. 5. Relationship between fragment size and mean carapace width (± standard deviation) of *Nephila clavata*. Symbols as in Fig. 1.

The effects of exotic species seem to be irrelevant, because we found no exotic predators or competitors. The reduction in population size is probably important, because the density of spiders decreased in smaller fragments (Fig. 4). Also, second- and/or higher-order effects may have been operating. Generally, the body size of spiders reflects prey availability in the habitat and is highly correlated with fecundity (e.g. Miyashita, 1992a; Wise, 1993). The present study demonstrated that the body size of *Nephila clavata* was smaller in smaller fragments (Fig. 5). This implies that a decreased reproductive rate via a lower abundance of flying insects, an indirect effect of fragmentation, might have caused extinction of some species. This inference may be supported by the evidence that the abundance of flying insects was lower in 1 ha fragments than in 10 ha fragments (Miyashita, 1990). We have no circumstantial evidence for or against the effects of human disturbance or that of the forest edge.

For a given area of fragment, fragments in Yokohama had a higher species richness than those in Tokyo (Fig. 1). We suggest two reasons for this. First, the larger degree of isolation of fragments in Tokyo may partly explain the lower species richness, as the degree of isolation had a significant effect on species richness when fragments in Tokyo and Yokohama were pooled (Table 1). *This effect, which was absent either in Yokohama or in Tokyo*, became significant probably because the degree of isolation differed greatly between fragments in Yokohama and in Tokyo. Second, the elapsed time since fragmentation may be important. Much more time has passed since fragmentation in Tokyo than in Yokohama. If species extinctions gradually accumulate with time, this seems to be a plausible mechanism.

However, no evidence for long term decline in species richness is available at present, although relatively short term results (less than 10 years) have been reported (Stouffer and Bierregaard, 1995b).

We found that large araneids are most prone to extinction by fragmentation, small araneids intermediate, and theridiids are least prone (Fig. 3). Turner (1996) showed that organisms which are large, sparsely or patchily distributed, or very specialized and intolerant of the vegetation surrounding fragments are particularly prone to local extinction. In this context, it is not surprising that large araneids are rare in small fragments. However, large web spiders are much smaller than vertebrates, and unlike large birds and mammals, which require large home ranges, web spiders probably require little space to live. Thus, we need to seek reasons other than body size per se. Miyashita (1990) showed that flying insects larger than 5 mm in body length were relatively scarce in a small urban woodland. Since large spiders depend on relatively large prey (e.g. Murakami, 1983; Craig, 1987; Tanaka, 1991; Miyashita, 1992b), they may experience food shortages, resulting in a decreased reproductive rate, which may eventually cause extinction. Theridiid spiders are the smallest among the three groups: the mean body length (standard deviation) is 4.6(1.9) mm, while it is 7.7(2.0) mm in small araneids (calculated from values presented by Chikuni (1989)). Consequently, they may survive with only small prey. Another characteristic of theridiids is that they often capture crawling arthropods such as isopods and ants, in addition to flying insects, as their trap threads are attached tightly to the substrate (Yoshikura, 1987; Tanaka, 1989; Foelix, 1996). Although no evidence is available, crawling arthropods might not be scarce in small fragments.

Although the body size of *Nephila clavata* decreased with decreasing fragment size, it was the only orb web species which was found in all fragments (Table 3). Its adult body length is one of the largest (ca. 20–25 mm, Miyashita (1992a)); hence, it should be asked how a species with such a large food requirement can survive in all environments. Miyashita and Shinkai (1995) showed that the web of this spider had a small mesh size, and was capable of capturing small prey as well as large prey. Consequently, this species appeared to escape from extinction due to the shortage of large prey.

Apart from this study, there has been only one example to our knowledge showing decreased body size of organisms in small fragments: dung and carrion beetles in 1 and 10 ha forest fragments were smaller than those in a contiguous forest (Klein, 1989). As with *Nephila clavata*, Klein suggested that the small size of the beetles might be associated with the shortage of food, i.e. dung and carrion of vertebrates which disappeared rapidly from small fragments. Food resources are normally a limiting factor for spiders, as well as for dung beetles (e.g. Wise, 1993; Peck and Forsyth, 1982), reflecting their predatory and scatophagous nature. It appears that these arthropods are prone to extinction due to fragmentation and deserve more attention as subjects of forest fragmentation studies.

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Appendix A. Code, size, and predominant vegetation for each fragment in Yokohama and Tokyo

Code		Size (ha)	Vegetation	
			Upper	Lower
Yokohama	-1	Continuous	*Quercus, Cornus, Prunus*	*Aucuba, Dryopteris, Morus*
	-2	15.1	*Quercus, Prunus, Chamaecyparis*	*Pleioblastis, Aucuba, Eurya*
	-3	11.0	*Quercus, Cornus, Prunus*	*Pleioblastus, Aucuba*
	-4	8.4	*Zelkova, Quercus, Cornus*	*Aucuba, Dryopteris*
	-5	6.0	*Carpinus, Quercus, Cornus*	*Aucuba, Eurya, Dryopteris*
	-6	2.4	*Quercus, Cryptomeria, Cornus*	*Aucuba, Pleioblastus*
	-7	1.3	*Quercus*	*Aucuba, Pleioblastus*
	-8	1.2	*Quercus, Carpinus*	*Pleioblastus, Aucuba*
	-9	0.6	*Quercus, Zelkova*	*Pleioblastus, Aucuba*
	-10	0.4	*Quercus, Zelkova, Cryptomeria*	*Aucuba, Eurya, Dryopteris*
Tokyo	-1	27.0	*Castanopsis, Quercus, Cinnamomum*	*Aucuba, Euyra, Fatsia*
	-2	17.0	*Zelkova, Castanopsis, Cornus*	*Aucuba, Eurya*
	-3	11.0	*Quercus, Zelkova, Aphanathe*	*Aucuba, Pleioblastus*
	-4	1.5	*Zelkova, Cornus, Prunus*	*Pleioblastus, Aucuba*
	-5	0.4	*Zelkova, Cornus*	*Pleioblastus, Rhododendron*
	-6[a]	0.3	*Zelkova, Castanopsis*	*Eurya, Rhododendron*
	-7	0.2	*Castanopsis, Cinnamomum*	*Aucuba, Pleioblastus*

[a] Species density and density not estimated.

Appendix B. Web spiders found in each fragment (data in May and September combined)

Family name	Scientific name	Fragments in Yokohama-										Fragments in Tokyo-						
		1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7
Uloboridae	*Uloborus* sp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		
	Hyptiotes affinis			+	+	+							+					
	Miagrammopes orientalis	+	+		+	+	+	+				+	+	+				+
Dictynidae	*Dictyna felis*												+					
	Dictyna sp.												+					
Pholcidae	*Pholcus crypticolens*												+					
Mimetidae	*Ero japonica*										+			+				
Theridiidae	*Anelosimus crassipes*	+		+	+			+	+		+							
	Achaearanea tepidariorum[a]	+	+	+			+		+	+	+	+	+	+	+	+	+	+
	A. culicivora	+	+	+	+	+		+	+	+	+	+		+	+		+	
	A. angulithorax		+									+			+	+	+	
	A. japonica[a]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
	A. asiatica							+										
	Enoplognatha transversifoveata	+		+		+						+						
	Theridion sterninotatum			+					+		+							
	Dipoena castrata					+			+	+								
	D. punctisparsa			+				+	+						+			
	D. flavomarginata		+															
	D. sp.													+				
	Phoroncidia altiventris								+									
	Argyrodes saganus	+																
	A. fissifrons	+	+	+									+	+				
	A. bonadea	+	+	+	+	+	+			+		+	+	+				
	A. cylindratus	+																
	A. miniaceus	+																
	A. fur	+	+			+												
	A. cylindrogaster	+	+	+	+	+	+	+	+			+	+	+				
Linyphiidae	*Linyphia oidedicata*	+					+											
	L. yunohamensis	+			+	+	+											
	gen. sp.	+									+							
Araneidae	*Araneus ventricosus*	+	+	+			+					+	+	+	+	+		
	A. uyemurai	+																
	A. macacus	+																
	A. pentagrammicus	+	+			+							+					
	A. abscissus		+															
	A. semilunaris				+													
	A. punctigera		+	+								+						
	A. mitificus	+	+	+	+	+			+	+		+	+	+				
	A. sp.				+	+			+									
	Neoscona scylla	+	+	+	+	+			+									
	N. scylloides	+	+	+	+	+	+	+	+	+	+	+		+				+
	N. mellotteei	+	+	+	+	+		+	+	+	+	+		+	+			
	Zilla sachalinensis	+	+	+	+	+	+	+	+				+	+				
	Argiope bruennichii	+	+	+	+													
	A. minuta	+	+		+	+	+		+		+		+	+	+			
	Cyclosa octotuberculata	+	+	+	+	+	+		+	+				+				
	C. laticauda		+															
	C. argenteoalba[a]		+		+	+	+	+	+					+	+	+	+	+
	C. sedeculata	+	+	+	+	+	+	+	+	+	+	+	+	+	+			
	Chorizopes nipponicus				+													
	Acusilas coccineus	+	+	+	+	+	+	+	+									
Tetragnathidae	*Nephila clavata*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Tetragnatha praedonia	+	+			+			+			+	+	+				
	T. squamata						+	+	+		+							
	Leucauge sp.	+	+	+	+	+	+	+	+	+	+		+	+	+			
	L. subgemmea		+	+			+							+				
	Metleucauge yunohamensis		+															
	Meta reticuloides	+			+	+												
Theridiosomathidae	*Ogulnius pullus*	+																
Anapidae	*Conoculus lyugadinus*	+																
Agelenidae	*Agelena limbata*	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	
	A. opulenta[a]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	Coelotes sp.		+	+	+						+							

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[a] Also living in small gardens and hedges in built-up areas.

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科名	和名	Fragment Yokohama										Fragment Tokyo								
		y1	y2	y3	y4	y5	y6	y7	y8	y9	y10	t1	t2	t3	t4	t5	t6	t7	large>=10mm	
	ha	CO	15.1	11	8.4	6	2.4	1.3	1.2	0.6	0.4	27	17	11	1.5	0.4	0.3	0.2		記録地点数
ウズグモ科	ウズグモの一種	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				15
	オウギグモ			+	+	+							+							4
	マネキグモ	+	+		+	+	+	+				+	+	+						9
ハグモ科	ネコハグモ												+							1
	ハグモの一種												+							1
ユウレイグモ科	ユウレイグモ												+							1
センショウグモ科	センショウグモ										+			+						2
ヒメグモ科	アシブトヒメグモ	+		+	+			+	+		+									6
	オオヒメグモ	+	+	+			+		+	+	+	+	+	+	+	+	+	+		14
	カグヤヒメグモ	+	+	+	+	+		+	+	+	+	+		+	+		+			13
	ツリガネヒメグモ		+									+			+	+	+			5
	ヒメグモ	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		16
	キヒメグモ							+												1
	カレハヒメグモ	+		+		+						+								4
	ムナボシヒメグモ			+					+		+									3
	ボカシミジングモ					+			+	+										3
	シモフリミジングモ			+				+	+						+					4
	キベリミジングモ		+																	1
	ミジングモの一種													+						1
	ハラダカツクネグモ								+											1
	ヤリグモ	+																		1
	チリイソウロウグモ	+	+	+									+							4
	シロカネイソウロウグモ	+	+	+	+	+	+			+		+	+	+						10
	トビジロイソウロウグモ	+																		1
	アカイソウロウグモ	+																		1
	フタオイソウロウグモ	+	+			+														3
	オナガグモ	+	+	+	+	+	+	+	+			+	+	+						11
サラグモ科	ヘリジロサラグモ	+					+													2
	ユノハマサラグモ	+			+	+	+													4
	サラグモの一種	+									+									2

コガネグモ科	オニグモ	＋	＋	＋			＋					＋	＋	＋	＋	＋			large	9
	ヤマオニグモ	＋																	large	1
	ヤエンオニグモ	＋																	large	1
	アオオニグモ	＋	＋			＋							＋						large	4
	キザハシオニグモ		＋																	1
	マルヅメオニグモ				＋															1
	コゲチャオニグモ		＋	＋								＋							large	3
	ビジョオニグモ	＋	＋	＋	＋	＋			＋	＋		＋	＋	＋					large	10
	オニグモの一種				＋	＋			＋											3
	ヤマシロオニグモ	＋	＋	＋	＋	＋			＋										large	6
	サツマノミダマシ	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋		＋				＋	large	13
	ワキグロサツマノミダマシ	＋	＋	＋	＋	＋		＋	＋	＋	＋	＋		＋	＋					12
	カラフトオニグモ	＋	＋	＋	＋	＋	＋	＋	＋				＋	＋						10
	ナガコガネグモ	＋	＋	＋	＋														large	4
	コガタコガネグモ	＋	＋		＋	＋	＋		＋		＋		＋	＋	＋				large	10
	ゴミグモ	＋	＋	＋	＋	＋	＋		＋	＋				＋					large	9
	キジロゴミグモ		＋																	1
	ギンメッキゴミグモ		＋		＋	＋	＋	＋	＋					＋	＋	＋	＋	＋		11
	ヨツデゴミグモ	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋					14
	ヤマトカナエグモ				＋															1
	ハツリグモ	＋	＋	＋	＋	＋	＋	＋	＋											8
ジョロウグモ科	ジョロウグモ	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋		17
アシナガグモ科	アシナガグモ	＋	＋			＋			＋			＋	＋	＋						7
	ウロコアシナガグモ						＋	＋	＋		＋									4
	シロカネグモの一種	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋		＋	＋	＋					13
	キララシロカネグモ		＋	＋			＋							＋						4
	メガネドヨウグモ		＋																	1
	ヤマジドヨウグモ	＋			＋	＋														3
カラカラグモ科	ヤマジグモ	＋																		1
ヨリメグモ科	ヨリメグモ	＋																		1
タナグモ科	クサグモ	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋		＋	＋	＋	＋			15
	コクサグモ	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋	＋		17
	ヤチグモの一種		＋	＋	＋						＋									4
																				0
	種数合計	39	35	29	29	29	22	19	27	15	18	19	21	24	15	9	7	6		