Present status of remnant forests in Obihro, eastern Hokkaido, Japan

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Remnant forests are scatted both in urban and rural areas in Obihiro. They occupy 4.3 % of the total area surveyed. Remnant forests have more native species than crop fields and meadows, though the remnant forests are smaller than the crop fields and the meadows in area. Improvements of drainage to raise agricultural production in wet soiled area have allowed a dwarf bamboo (*Sasa charactacea*) to invade into those forests. Because the dwarf bamboo is highly competitive, less competitive forest herbaceous plants probably decrease in abundance and some of them may be excluded from the forests. A decline in seed set ratio for *Corydalis ambigua* occurs in forests in urban area. The decline is caused by paucity of bumblebee's visits to *C. ambigua* flowers. Because *C. ambigua* can not vegetatively reproduce, the decline in seed set ratio raises extinction risk of *C. ambigua* from remnant forests

Keywords: landscape change, remnant forest, competitive exclusion, fail of seed set

1. INTRODUCTION

Small populations of organisms have higher risk to be extinguished than large ones. If a small population is isolated from the others, as is often the case, the risk is even higher. Plants that are native to the remnant forests in man-dominated landscapes are frequently threatened by human activities, such as habitat destruction and degradation. They can also easily face to threat of extinction due to smallness of their populations and remoteness from the other populations. The smallness and remoteness for the populations in remnant forests are brought about by the fact that most remnant forests in man-dominated landscapes are small and scattered within matrices of residences, crop fields and meadows.

Forests in the urban and rural areas in Obihiro share the features of smallness and remoteness with other areas in North America (Auclair, 1976; Curtis, 1959), Europe (Darby, 1956) and tropics (Gomez-Pompa *et al*., 1972). Because land development for agriculture is relatively recent, 120 years before now, no forest plant species have become extinct, but this could occur in the future. due to

habitat fragmentation. Therefore it is important to analyze potential causes of extinction and devise protective measures that reduce extinction potential.

I will here report (1) landscape change, (2) where native plants grow in urban and agricultural landscapes, (3) threat to forest plants to be competitively excluded, (4) decrease in fruit set ratio for a forest plant in Obihiro, eastern Hokkaido, Japan.

2. LANDSCAPE CHANGE

Extensive and intensive conversion of forests into crop fields and meadows began in 1883 in Obihiro when the first massive colonization took place. Before the colonization in Obihiro, the Ainu people inhabited the area with small population. Fig. 1 illustrates the decrease in forest area after the colonization in Obihiro (Kato, 1991).

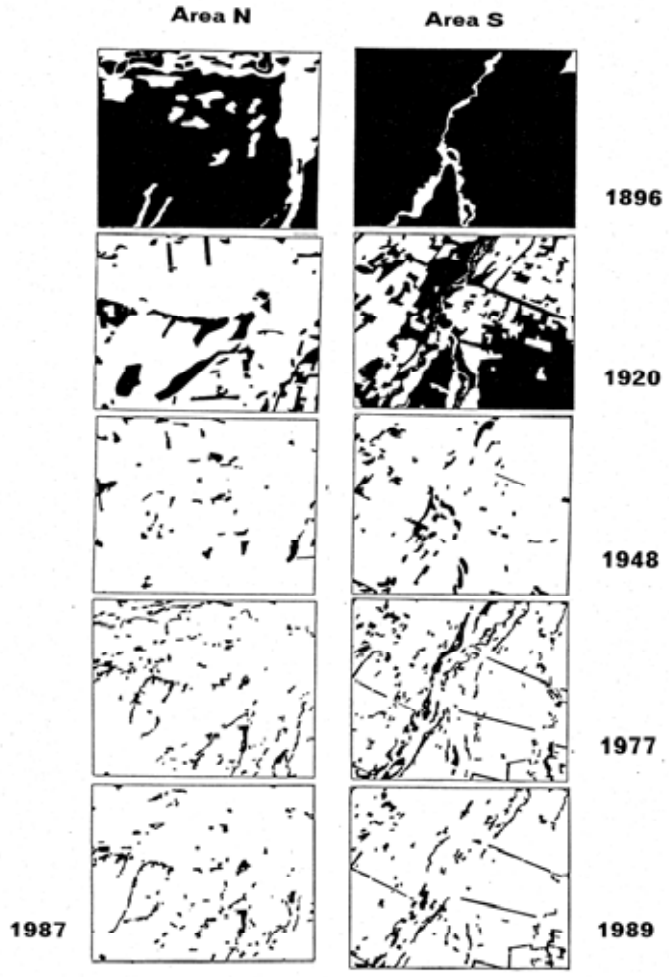

Figure 1. Change in forested area in northern part (Area N) and southern part (Area S) of Obihiro from 1896 to 1989. A rectangular map is 10 x 10 km in area. The northern part includes the downtown, residential area and cultivated area, and the southern part exclusively consists of cultivated area. (From Kato 1991).

Forests covered the most area in 1896 just after the commencement of colonization, because the Ainu people did not develop land for agricultural use. However, the forest area decreased to less than 3 % of the total surveyed area at 60 years after the first massive colonization occurred (Fig. 2) (Kato 1991). Forest area gradually recovered toward 1977, but declined further after that. Remnant forests accounted for 4.3 % of the total area and averaged 3.5 ha per individual forest in 1989 (Fig. 3) (Kato 1991). They have become small and scattered. Those remnant forests were left for collecting firewood and lumber, for windbreaks or because they were difficult to exploit due to steep slope or excessive wet soil. Forest recovery after 1948 was caused by a shift in fuel sources from wood to coal and oil. The recent decrease was caused by development of residential areas and expansion of cultivated fields.

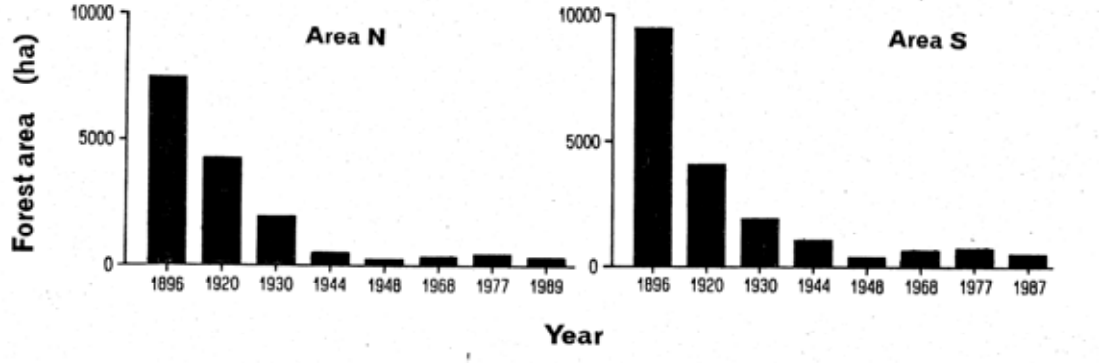

Figure 2. Decrease in total area of remnant forests. (From Kato 1991)

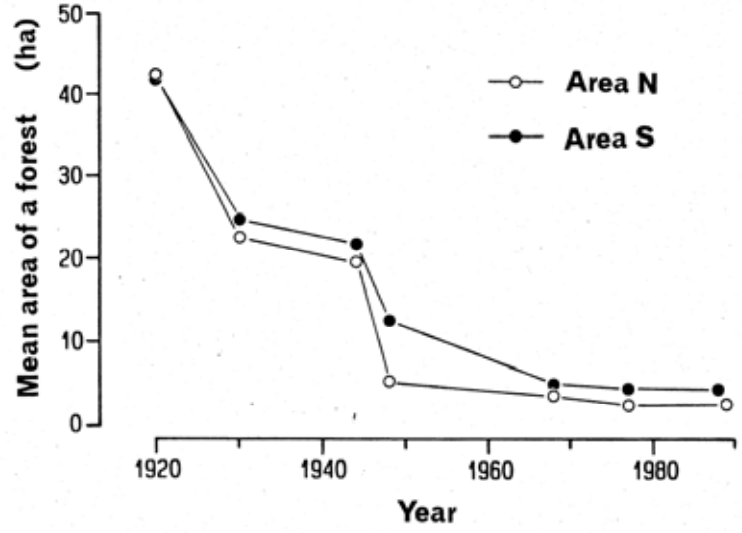

Figure 3. Decresae in mean area of a remnant forest. (From Kato 1991)

3. CONCENTRATION OF NATIVE PLANT SPECIES ON REMNANT FORESTS

Native plant species mainly grow in forests, abandoned fields and rivers (Table 1) (Ichimura, 2000). A landscape was studied in Obihiro by setting up two long lines with 1 m width (total 5094 m in length). The lines intersected 14 types of landscape unit (LU). The wet forest LU contained the most plant species among all types of the landscape units. It had three times more species than the crop field LU and meadows LU though the wet forests LU occupied a smaller area than the latter two LUs. The difference increases when the number of native species is compared, because aliens species occurred with higher ratio in the crop field and meadow LUs. Besides wet forestLU, fallow field riverside forest and riverbed LUs also have many native species for a relatively small area. In conclusion, the places on which native species concentrate are the landscape units that are currently not used by man.

Table1. Number of species in landscape units. Two parallel belts with 1 m width and 5094 m total length were set up from the River Satunai to the River Urikai.

	Area		No. of species		
Landscape unit	(m^2)	(%)	Total	Native	Alien
Wet forest	762	14.95	172	158	14
Mesic forest	70	1.37	50	45	5
Riverside forest	160	3.14	106	92	14
Brook in forest	70	1.37	14	14	0
Riverbed	260	5.1	89	71	18
Crop field	1775	34.85	64	42	22
Meadow	949	18.63	50	36	14
Brook in field	75	1.47	55	47	8
Fallow field	291	5.71	97	78	19
Wind Break	140	2.75	76	62	14
Road in field area	220	4.31	70	49	21
Residence	20	0.39	38	25	13
Road in residential area	25	0.49	42	27	15
Lawn	278	5.45	60	46	14
Total	5094	100.00	262	225	37

4. COMPETITIVE EXCLUSION EXERTED OVER FOREST HERBACEOUS PLANTS

Competition among organisms is one of the major forces to shape community structure (Grime 1979). MacArthur 1(972) pointed out the importance of competition as a factor promoting extinction of less competitive species in islands. The role of competition should hold for remnant forests, because island and remnant forest are analogous in smallness and remoteness. Recently, competitive exclusion over forest herbs by an invading dwarf bamboo (*Sasa charactacea*) in remnant forests on wet soil concerns us.

Improved drainage in wetter areas is desiccating remnant forests in this area. The ongoing desiccation has allowed a dwarf bamboo to invade the wet forests that were formerly unsuitable habitat for the dwarf bamboo to inhabit, because it prefers dry-mesic sites to wet sites. So far, its distribution in the three remnant forests surveyed is confined to the periphery of the forests. The result indicates that the desiccation and invasion are in progress and the forests are desiccating from the outside to the inside. In Japan, dwarf bamboos grow vigorously in extensive areas and are known for their highly competitive excluding ability (Konno, 2001, 2002; Makita, 1992; Nakshizuka, 1988). Therefore, plants that grow where dwarf bamboo have invaded probably decrease in abundance and some of them may be out-competed by the invading dwarf bamboo.

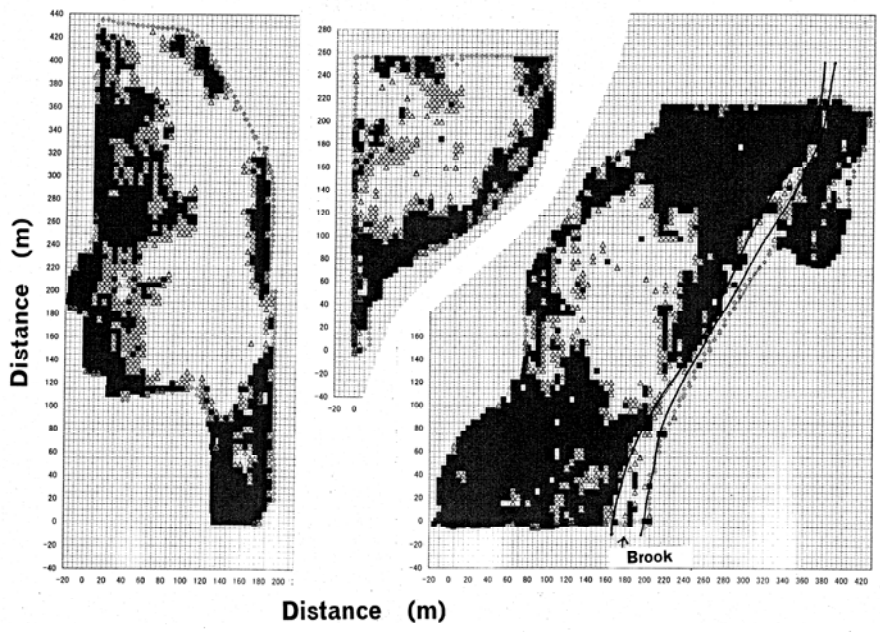

Figure 4. Remnant forests invaded by a dwarf bamboo. Meshes are 5 x 5 m. Closed rectangular represents a mesh with >10 % cover of the dwarf bamboo, and open triangle < 10 % cover of it.

5. DECREASE IN SEED SET RATIO FOR A FOREST HERB

Seed set failure has been reported for isolated populations (Aizen & Feinsinger, 1994; Jennersten, 1988; Washitani *et al*. 1994). Destruction of mutual relation system between pollinators and flowers is one of the important causes for seed set failures.

Corydalis ambigua is a common herb in wet forests in Obihiro. It is a typical spring ephemeral plant, flowering and fruiting in spring (late April to early June) and disappearing from above ground before summer. Bumblebees are the major pollinators of *C. ambigua*. It is self-incompatible, thus visitations of bumblebees are necessary for it to bear seeds (Yasaka et al 1994, 1988; Konno 1999). The seed set ratio of *C. ambigua* was surveyed in ten remnant forests: five in urban area and five in rural area (Fig. 5). The seed set ratio was lower in the urban area than in the rural area (Fig. 6) (Yasaka 1994). The paucity of flower visits by bumblebees was suggested as the cause of the failure in fruit set in the urban area. Frequency of flower visits can be indicated by `the visit trace ratio' that is the ratio of flowers with visited trace left by bumblebees on the stigma of a flower. The fruit set ratio decreased with decrease in the visit trace ratio (Fig. 6). This result suggests that lack of flower visits causes the decrease in seed set ratio. Because *C. ambigua* does not propagate vegetatively, the decrease in seed set should raise the risk for *C. ambigua* of extinction from the remnant forests.

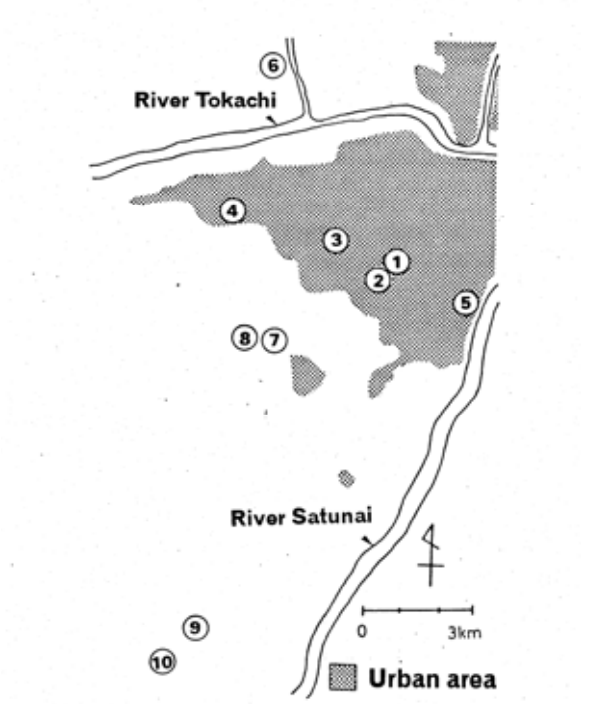

Figure 5. Location of 10 surveyed populations of C. ambigua. Population number 1-5 are in urban area and 6-10 are in rural area.

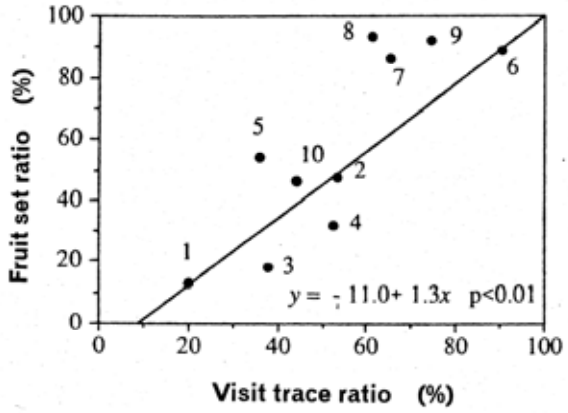

Figure 6. Fruit set ratio increases with visit trace ratio, which is the ratio having the visit trace to all flowers checked. The traces of flower visit by bumblebees are left on C. ambigua flowers. Numbers correspond to those in Fig. 5.

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