Safe sites of larch seedlings in the lightly burnt forest in Eastern Siberia

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1. INTRODUCTION

In eastern Siberia, forest fire has considerable significance on the structure and dynamics of larch forest. The wildfire disturbs the forest and accelerates the recruitment of larch seedlings at the same time (Cherbakov 1979, Osawa 1993, Abaimov *et al.*, 1997).

Generally, it is difficult to recruit for larch seedlings on the forest floor where covered by thick litter layer and vegetations. According to Cherbakov (1979), larch seedlings can recruit only on the mineral soil or on thin litter layer, less than 1cm. However, the litter layer thickness in undisturbed forest is more than 5cm, usually. Additionally, the forest floor is covered by vegetation, mainly by loganberry (*Vaccinium vitis-idaea*) a shrub species that grows to 15 cm height. Saito *et al.* (2001) found the negative correlation between coverage of loganberry and density of current larch seedlings. They concluded that loganberry prevents natural recruitment of larch in mature forest. Forest fire can reduce or remove these obstacles and introduce recruitment. Additionally, combustion of live and dead fuels or removal of litter layers may result in enhanced nutrient availability.

Strong fire removes the litter layer and floor vegetation, completely. However, the effects of weak or intermediate fire are not spatially uniform on the forest floor (Zasada *et al*. 1983). Intensity of the fire is varied among situation; *e.g.* amount and type of fuels, air temperature and humidity, wind speed and its direction (Johnson 1992). In Siberian larch forest, the spatial diversity of fire effects depends on the forest floor vegetation. Usually, loganberry is more combustible comparing to moss (Cherbakov 1979). A spatial diversity of the post-fire forest floor would be emphasized in light burnt forest.

Spatial diversity of fire effects on the lightly burnt forest floor suggests that safe sites of larch recruitment lie scattered on the lightly burnt forest floor. Cherbakov (1979) point out that mineral soils, base of standing larch trees, burnt log, and burnt stump can be safe sites of larch seedlings. However, their function and contribution have not been discussed, quantitatively. In this report, we surveyed safe sites and recruitments of larch seedlings on the lightly burnt forest floor after three years later from the last fire.

2. MATERIALS AND METHODS

2.1 Site description

Recruitment of larch (*Larix cajanderi* Mayr., syn. *L.gmelinii* var. *cajanderi* (Mayr.) Silba.) seedling was surveyed in mature larch forest in 2005. Study site was located in Neleger forest

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station near Yakutsk (62˚19'N, 129˚30'E), Russian Federation. Stand age was over 200 years. Stand density of larch trees were 1624 trees/ha. Leaf and aboveground biomass of this forest was estimated as 2.40 and 99.84 ton/ha, respectively (Yajima *et al.* 1997). In the summer of 2002, surface fire occurred. The fire removed all understory vegetation, but did not remove litter layer, completely. The surface of litter layer was lightly burnt. In the autumn of 2002, seed dispersal was observed by seed trap method (Saito *et al*., unpublished data). Recruited larch seedlings and vegetation were observed in 2003.

2.2 Field survey

We surveyed seedling recruitment in autumn of 2005. At first, we categorized forest floor into six type; 1.Litter (vegetation coverage was less than 30%), 2.Grass, 3.loganberry, 4.moss, 5.base of standing larch tree, and 6.burnt log or stump. We installed plots (1m^2) of each type on the forest floor, and surveyed number and age of seedlings.

3. RESULTS AND DISCUSSION

The probability of recruitment in each type was shown in Table 1. All observed seedlings are three years old, suggesting that seedlings recruited just after forest fire. In the litter-covered subplots, recruitments of larch seedlings were rare (13%, table 1). Litter thickness was nearly 1.5cm in this lightly burnt forest floor, while more than 5cm in un-burnt forest floor. Our results support the hypothesis that litter is a defense of recruitment (Cherbakov 1979).

In the vegetation-covered subplot (loganberry, grass, and moss), the recruitment ratio was 10%, 0%, and 0%, respectively. Loganberry had recovered their vegetative organs by sprouting, quickly, and covered forest floor. Grass has invented into forest floor covered by thin litter layer. These vegetations have covered the area where larch could not recruit, and turned to be additional defense against the larch recruitment.

Base of standing tree was also safe site for larch seedlings (Cherbakov 1979). In this study, larch seedlings were found around 64% of the standing trees (Table 1). Some of them were growing along the coast living root, which surface was partially burnt. This phenomenon was not observed in the un-disturbed forest. The reason why base of tree could be safe-site has not been clear. Observation is necessary on this phenomenon in details. The boundary between litter layer and coarse root might be bypass to mineral soil.

Burnt log and stumps was also safe site of larch recruitment. These site characterized by high recruitment probability (100%) and high seedling density (Table 1). There was thin and new

Table 1. Occurrence of larch seedlings at different forest floor properties in a lightly burnt mature larch forest.

Forest floor category	Surveyed plot (Number)	Success plot (Number)	Ratio of success (%)	Seedling density (seedling/ha)
Litter covered	30	4	13%	1.3
Vegetation covered				
grass	10	0	0%	
loganberry	10	1	10%	1.0
moss	10	0	0%	
Base of mature tree	28	18	64%	2.3 *
Charcoal of burnt stump and fallen log	15	15	100%	6.8 **

*,**: data was calculated from 10 and 4 plots, respectively

litter layer, less than 0.5cm. Seedlings rooted on charcoal, directory. Cherbakov (1979) also referred to burnt logs as micro site of recruitment. He thought that burnt log and stumps make a micro-hollow on the ground, where turn to be wet. We observed newly recruited moss and *Chamerion angustifolium* (L.) Holub have invaded on the burnt stumps (Fig.1). Because both of them prefer wet place, it is suggested that the burnt stumps had turned to be wet. The wet place will help survival and growth of larch seedlings, also. The function of burnt log and stump is supplement of local wet patches in dry forest floor. Additionally, loganberry has not invaded into burnt logs and stumps. Small population of competitors also helps larch recruitment and development.

Fig. 1. Larch seedlings (allow) on the charcoal of burnt stump with *Chamerion angustifolium* (L.) Holub (allow head).
Small black blocks are charcoals.

Our results suggest that type of safe site and their contribution depend on the fire intensity. On the severely burnt forest floor, the exposed mineral soil is the most important safe site of larch recruitment. However, on the lightly burnt forest floor, the base of standing tree, burnt log, and burnt stump were the representative safe site.

In mature forest, negative spatial correlation was observed between small and large trees (Shirota *et al* in press). This size-spatial structure suggests that the growth of seedlings around the large standing tree will not be well, relatively. Therefore, from the viewpoint of long-term regeneration, the burnt log and stump would be more important site for regeneration than the base of standing tree.

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