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Anomalous Patterns of Stand Development in Larch Forests of Siberia (Extended Abstract)

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1. Introduction

Models of the global climate have suggested that locations of major temperature increase during the next several decades will be the high latitude of northern hemisphere (Kahl, *et al.*, 1993) where the landscape is dominated by boreal forests and tundra. Therefore, it is logical to characterize the patterns of carbon sequestration in terms of the temporal development in biomass and carbon. Presence of growth layers (growth rings) in perennial trees in the boreal forests allows us to study the patterns of stand development in detail. Siberia is one of the areas in the high-latitudes, where rapid warming is predicted to occur by the climate models. We therefore chose to characterize patterns of stand development in the boreal forest of Siberia.

Materials and methods

Patterns of stand development were investigated intensively at one stand (plot 14) of *Larix gmelinii* (Abaimov *et al.*, 1998 ; Osawa *et al.*, 2000). The stand is located ca. 5 km north of the settlement of Tura at 64°19′N and 100°13′E, developed monospecifically after a stand replacing fire of 1901, and was 97-years-old when majority of the stem samples were taken for study in 1998. The area is underlain continuously with permafrost. A rectangular plot of 12 m × 18 m was established in an area of relatively dense *L. gmelinii* stand, where the dead stems are abundant indicating operation of active self-thinning. All living trees were numbered, and their DBH and other stand characteristics were measured. All dead trees in the plot were marked, and were cut at the ground level. A stem disc was sawed out from each tree at the ground level. The number of growth rings was counted in each disc to estimate the time of tree death. A difference between 97 and the number of rings was assumed to be the year before present when the tree died, since the stand is considered even-aged, and became established 97 years ago. Decomposition rate of the dead stems appeared very slow, which allowed examination of nearly all stems that were collected. A series of relatively dense stands of various ages was also selected in the study so that they represent the chrnosequence of forest development after a stand-replacing fire. Depth of the active layer and aboveground biomass were estimated in each stand. Aboveground biomass of the trees was calculated with the equations of Kajimoto *et al.*, (1999).

Results and discussion

The stand density was 4,120 trees/ha. Maximum tree height was 11.2 m. Maximum and mean DBH were 10.7 and 5.43 cm, respectively. Fig. 1 shows the tree mortality during development of plot 14. The mortality was estimated from the age analysis of the dead stems. The trees started to die in large number during 1930s, increased in mortality during 1940s and 50s. Then the mortality gradually declined. The pattern suggests that active self-thinning of the stand started in 1930s when the trees were 30-40 years old.

Fig. 2 shows the estimated tree mortality for a given DBH class between 1970 and the time of sampling in 1996 as being calculated by the number of trees that died during the period divided by the tree density for that DBH class. Not only small trees, but also many of the middle-sized trees died during the recent 26-year period. Smaller trees are to die first in general in self-thinning forests (Ford 1975). The present finding, therefore, differs strikingly from the ordinary thinning patterns.

Fig. 3 indicates development after a major fire of aboveground biomass and the depth of soil active layer. The aboveground biomass increases rapidly first, but levels off at stand age of *ca*. 30-40 years. The biomass tends to stay at a nearly constant level afterwards. The leveling-off of the biomass accumulation appears to correspond with the decrease in the active layer depth from over 100 cm to *ca*. 40 cm. Our conception of the generalized stand development patterns are contrasted and summarized for two ecosystems (Fig. 4); one is the larch forest growing on continuous permafrost, and the other is the non-permafrost coniferous forest ecosystem. The forest development during the initial 30-40 years is similar between the two. However, the soil active layer becomes shallow after that period, restricting both soil volume for root growth (Ka-

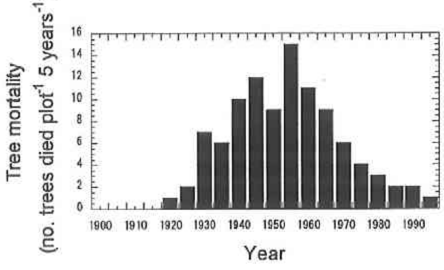

Fig. 1. Estimated tree mortality during development of plot 14.

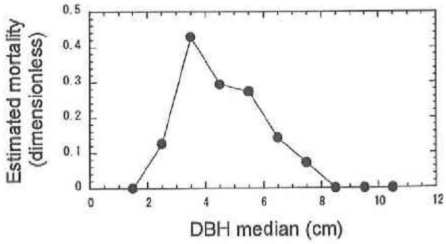

Fig. 2. Estimated tree mortality between 1970 and 1996 in plot 14 in relation to DBH class of the trees in 1970.

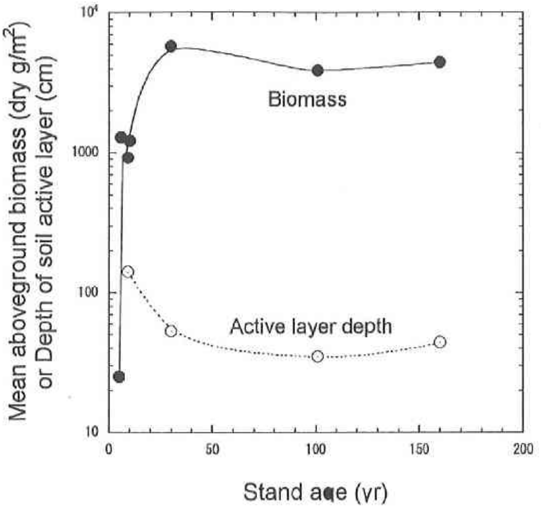

Fig. 3. Temporal development of aboveground biomass and depth of soil active layer in Larix gmelinii stands estimated from a chronosequence study.

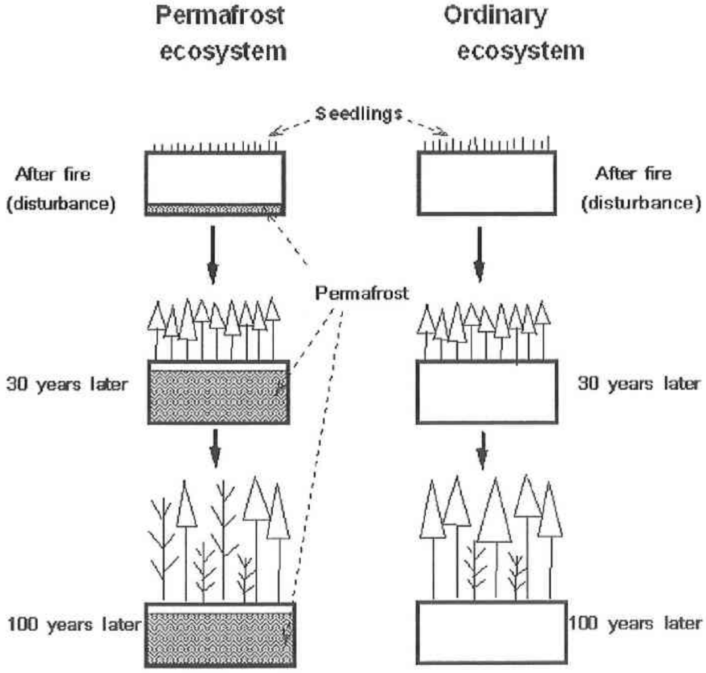

Fig. 4. Forest dynamics in relation to presence or absence of permafrost, and the rise of the permafrost over time.

jimoto *et al. in press*) and nutrient availability (Matsuura and Abaimov 2000). A peculiar tree mortality pattern is likely to develop due to this growth restriction in the permafrost ecosystem. Our findings suggest that overall pattern of structural development may differ dramatically in the permafrost ecosystems as compared to the forests on non-permafrost soils. The appearance of the constant aboveground biomass at a relatively young stand age, and its lasting effect in older stands (Fig. 3) is an example.

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