Growth analysis of planted *Picea maximowiczii* (Pinaceae)

Tatsuyuki Seino & Akihiro Inami (Yatsugatake Forest Station, Mountain Science Center, University of Tsukuba)

We analyzed the growth of *Picea maximowiczii* planted in Itabashi of Minamimaki, Nagano Prefecture of Japan. Some individuals were cut down in 2019 for some reason. Samples for stem analysis were collected from the harvested individuals, and growth analysis was conducted. The results showed that the tree grew rapidly up to a trunk diameter of 30 cm, at which size it grew to a height of 10 m quickly until it was nearly 20 years old. The results suggest that under growing conditions such as plantation without suppression, the growth characteristics of this species are similar to that of fast-growing species compared to the size that reaches the canopy.
Key words：*Picea maximowiczii*, growth analysis, stem growth, relative growth rate

Ⅰ Introduction

Picea maximowiczcii Regel ex Carrière (Pinaceae) is an evergreen coniferous tree distributed in central Honshu, Japan (*2, 3*). This tree is distributed only in the Southern Alps of Japan, the Yatsugatake Mountains, and the Chichibu Mountains (*2*, *3*). Due to the limited distribution area, the population size of this species is small, so that it is listed as an endangered species (VU) in the Red List by the Ministry of the Environment of Japan (*2*). Although there have been studies on the distribution area and locational conditions of this species, studies on its growth characteristics are few. Therefore, it is expected that examining the relationship between research information on the distribution area with habitat conditions and growth characteristics will clarify the ecological characteristics of this species and contribute to future conservation topics.

Fortunately, some trees planted as windbreak were harvested, and then disc samples were obtained to allow us to conduct a growth analysis with a destructive method. Here we report the basic information on the growth characteristics of *P. maximowiczii* based on the characteristics of stem growth.

Ⅱ Study site and methods

The study site was a windbreak forest of a private house in Itabashi of Minamimaki, Nagano Prefecture of Japan. The windbreak *P. maximowiczii* were densely planted in single row about 1.5 m apart. This windbreak was planted by the grandfather of the owner of the windbreak approximately 100 years ago (2022), and a part of the windbreak was cut down in March 2019 for some reason. In March 2019, we obtained discs at ground height from four cutting individuals. From one of the four individuals, we were able to collect disks at intervals of 2 m from the ground level to 14 m in height. In October 2022, 19 individuals in this windbreak were measured for diameter at breast height (DBH, cm) and tree height (*H*, m). DBH was determined by measuring the stem girth and dividing it by π. *H* was measured using Vertex III (Haglöf, Sweden). From the obtained discs, a stem analysis was performed. The relative growth rate of the stem was estimated from diameter growth by the period of five years after given diameter.

Ⅲ Results and discussion

The relationship between DBH and *H* of the windbreak trees is shown in Figure 1. The DBH varied slightly, at 48.9 ± 8.8 cm (mean ± SD), while the *H* was relatively similar at 28.3 ± 0.7 m (mean ± SD).

Figure 2 shows the accumulated radius widths of the four samples dating back to 2019. Annual ring widths increased steadily from 2019 to 50 years ago, except for sample #N, which tended to slow down thereafter. Sample #N showed steady growth even as size increased. The age information on the disk also revealed that the trees were planted in the grandfather's generation the owner of this windbreak, which is consistent with the tradition.

Sample #A was able to collect disks at 2 m intervals up to 14 m from the ground base, a stem analysis was conducted up to 14 m above ground level. Figure 3 shows a height growth curve based on this information. Sample #A grew at a rapid rate up to 10 m in height until it was nearly 20 years old, after which it showed a slower growth rate. Figure 4 shows the relationship between relative growth rate and size (stem diameter). The relative growth rate and stem diameter

清野達之*・井波明宏
植栽されたヒメバラモミの成長解析
seino.tatsuyuki.gw@u.tsukuba.ac.jp

tended to decrease in a size-dependent with a slowdown in growth beginning around 30 cm in stem diameter.

The results of this study indicate that planted individuals approximately 100 years ago grow simultaneously. This was supported by the current sizes of the trees are similar (Figure 1), and by the information on the origin of the windbreak. The results of the stem analysis revealed that the trees grow rapidly up to a DBH at 30 cm, and at that size, they grow up to 10 m in height. This suggests that even though the trees were planted, they have good stem growth even without suppression at a given size. The stagnation growth after that size is presumably the result of density-dependent growth inhibition due to the canopy closeness, i.e., inter-individual closeness.

The planted *P. maximowiczii* in this study were found to be relatively fast-growing and young for their size. In comparison with a study of the same spruce species in a natural forest in Hokkaido of Japan, the age of *Picea glehnii* (F.Schmidt) Mast. was approximately 250 years old when it reached a height of 30 m (*5*). A similar report was made for *Picea ajanensis* Fisch. ex Trautv. & C.A.Mey. in the Russian Far East (*1*). The planted *P. maximowiczii* did not grow in a dense and suppressed environment such as natural forests, and the growth rate of potential was relatively fast, indicating that the trees were young in a given size.

Ⅳ Conclusion

The growth analysis of *P. maximowiczii*, for which information has been scarce, revealed that it is a relatively fast-growing tree species under suppression-free conditions. Some of these species were not only found in natural forests, but also as left in a single tree in temples and shrines (*4*). These may also be young for their size. Further analysis of growth under natural conditions in natural forests will provide more information on the ecological characteristics and will be useful in guiding conservation for this endangered species.

Acknowledgments

We are grateful to Makoto Idezawa, Shigeaki Yokomori, and Masanori Sugiyama for their support in collecting the *P. maximowiczii* samples.

Literature cited

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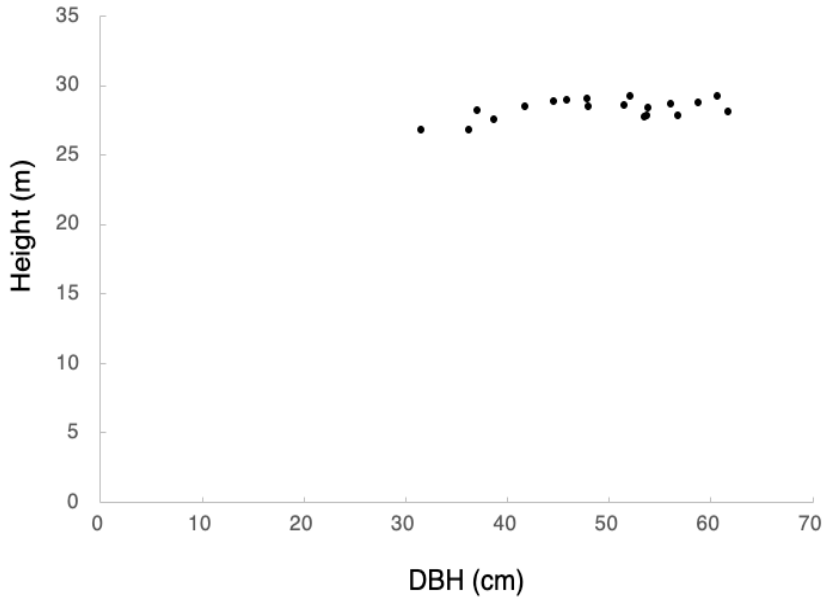

Fig 1. D-H relationship between DBH and height of windbreak *P. maximowiczii*.

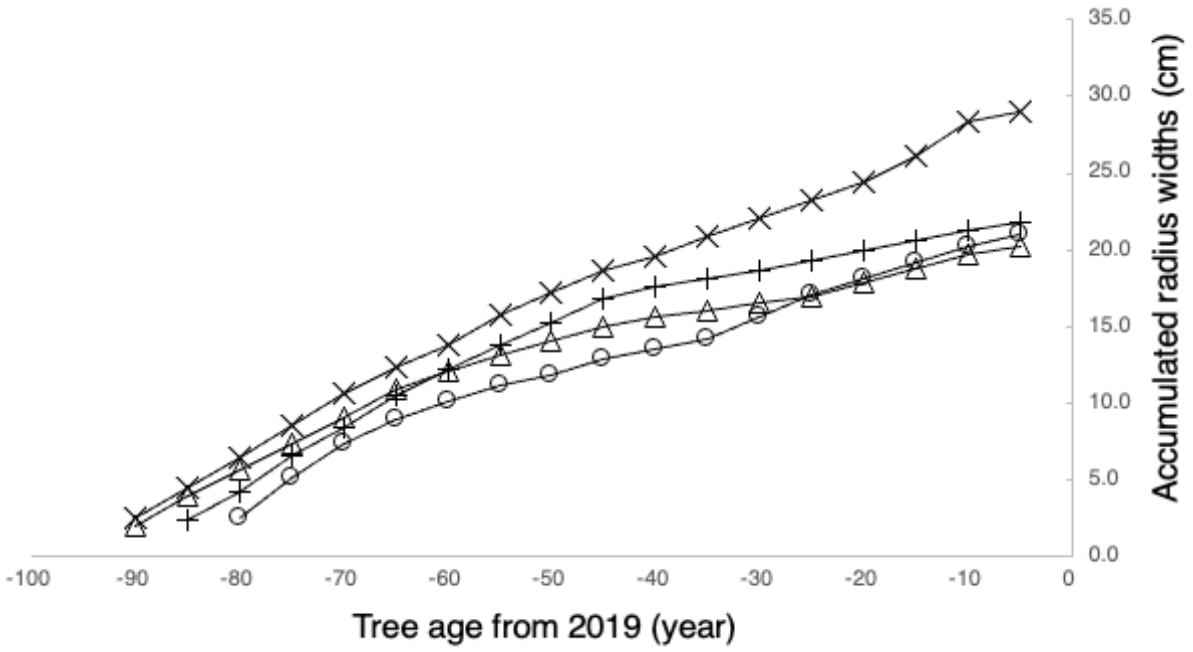

Fig.2 Growth of accumulated radius width of the four samples during dating back to 2019. The legend in the figure indicates sample#A for circles, sample#D for triangles, sample#F for pluses, and sample#N for crosses, respectively.

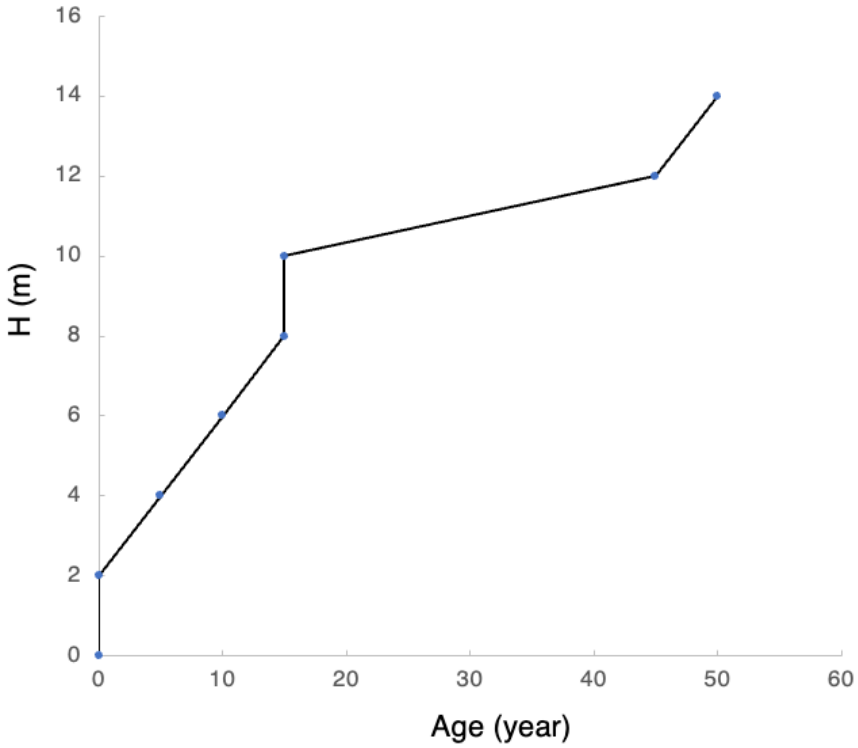

Fig. 3 Stem analysis of sample#A.

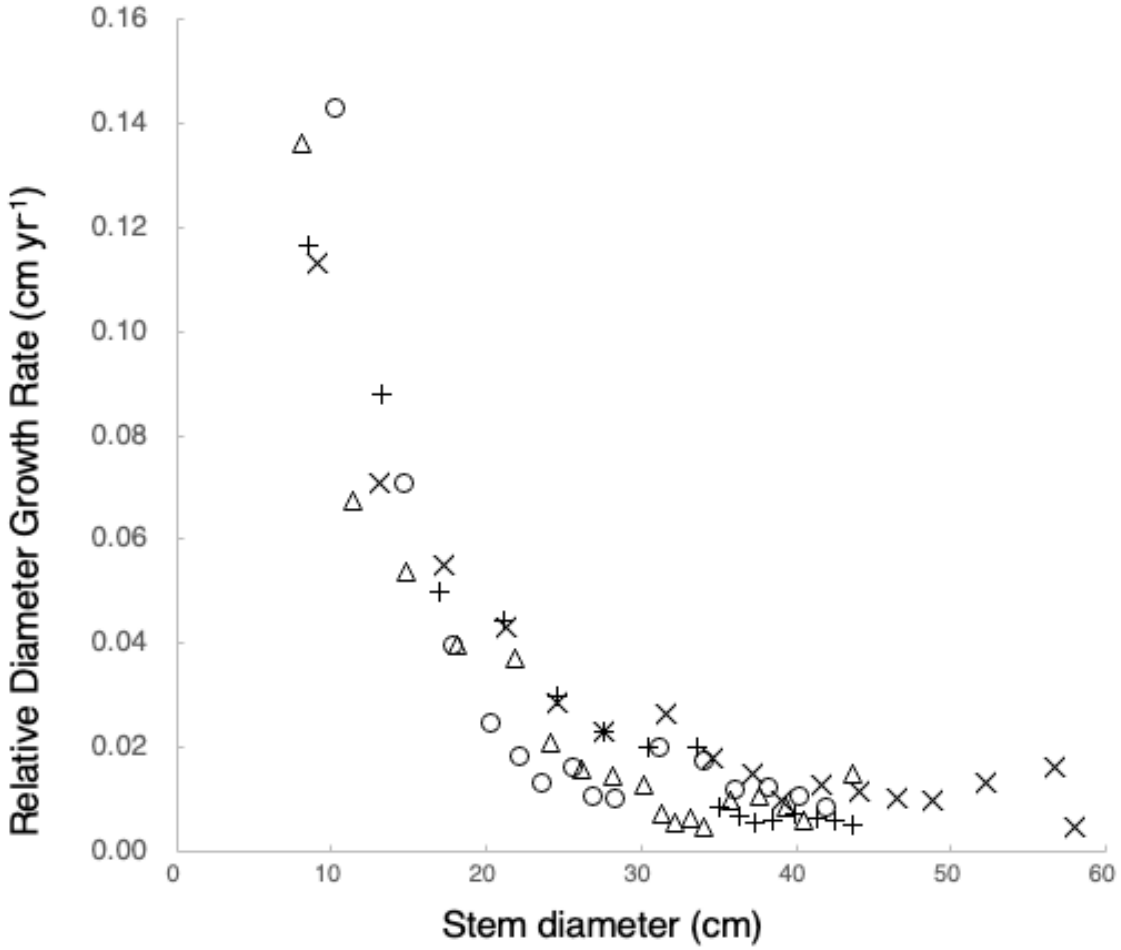

Fig.4 Relationship between stem diameter and relative diameter growth rate. The legend in the figure indicates sample#A for circles, sample#D for triangles, sample#F for pluses, and sample#N for crosses, respectively.