論　文

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Distribution and crown shape changing of *Lindera praecox* under the artificial *Cryptomeria japonica* and *Chamacyparis obtusa* canopies

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Abstract: *Lindera praecox* is a woody plant of *Camphoraceae, Lindera* that has peculiar fragrance. It contains oily component and it has been used for firewood. Its fruit had made desk lamp oil, too. Natural distribution of *Lindera praecox* broads Honshu Island to Kyushu Island in Japan. It can grow on the floor and edge of artificial *Criptmeria japonica* and *Chamaecyparis obtusa* stands. However, the characteristic features of *Lindera praecox* under the canopies of *Cryptomeria* and *Chamaecyparis* stands has not been clear yet. Then, this study surveyed the condition of distribution, density, and tree shape variation of *Lindera praecox* under the canopies condition. The survey site was 50-year artificial *Cryptomeria* and *Chamaecyparis* stands located in 500 altitude in Kosuge village, Yamanashi Prefecture. The stand incline was approximately 25 degree. *Lindera praecox* formed second canopies under the canopies. Their crowns transformed their shape into two types that were vertical and horizontal direction. Their branches and leaves might develop stepped shape for light reception and corresponding the incline. These results suggested that the tree shape might be used as an indicator of the stand condition. It should keep *Lindera praecox* without cutting under the *Cryptomeria* and *Chamaecyparis* canopies at steep stands to prevent soil erosion.

Key word: under the canopies of *Cryptomeria japonica* and *Chamaecyparis obtusa, Lindera praecox, distribution,* characteristic features

スギ・ヒノキ人工林冠下におけるアブラチャンの分布と樹形変化

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要旨：アブラチャン（*Lindera praecox*）は、クスノキ科クロモジ属の樹木であり、特有の芳香を持ち、薪炭のほか、その実から採れる油は読書灯などに用いられてきた。アブラチャンは、本州～九州にかけての温帯に自生し、スギ、ヒノキなどの造林地の林縁、林床でもよく見られる。とりわけ林床の植生が貧弱になりやすいスギ・ヒノキ人工林の場合、アブラチャンの発生、分布は、土壌流亡抑制などの意味においても重要な意義を持っている。しかしながら、その林冠下の発生密度や分布の状況、また樹形の変化などについてはあまりよく知られていない。そこで本研究では、奥多摩源流の山梨県小菅村のスギ・ヒノキ人工林（標高約 500m）において、その林床のアブラチャンの分布状況と樹形の特徴を調べてみた。調査の結果、アブラチャンはスギ・ヒノキ林冠下に二層目となる低林冠を形成し、地形の傾斜に適応して樹冠を階段状に連ねて発達させ、また受光のために柔軟に樹形を変化させていることなどが明らかになった。これらのことから、スギ・ヒノキ林冠下のアブラチャンは除伐をせずに残存させ、土壌流亡抑止などに供すること、またその樹冠、樹形の形態から、林冠下の照度状況の指標ともなることなどが考えられた。

キーワード：ヒノキ林冠下、アブラチャン、分布、樹形特性

I Introduction

Lindera praecox is a woody plant of *Camphoraceae, Lindera*. It has peculiar fragrance and contains oily component. It has been used for firewood and its fruit had been used to make desk lamp oil, too (*1*). Its natural distribution broads Honshu Island to Kyushu

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Island in Japan. It can grow on the floor and edge of artificial *Criptmeria japonica* and *Chamaecyparis obtusa* stands. However, the characteristic features of *Lindera praecox* under the canopies of *Cryptomeria* and *Chamaecyparis* stands has not been clear yet. Recently, broad-leaf trees regeneration at artificial needle-leaf forests floor has become more important, because it is useful to increase diversity of vegetation and it sometimes makes mixed forests without planting, too (*2*) (*6*). Floor vegetation is also important for preventing soil erosion at steep location. Then, this study surveyed the condition of distribution, density, and tree shape variation of *Lindera praecox* under the canopies condition.

II Materials and Methods

1. Site The survey plots were set in an artificial 50-year *Criptmeria japonica* and *Chamaecyparis obtusa* stand. They were located in the 500m high from sea level in the Kosuge village, Yamanashi Prefecture. Each survey plot area was 100 ㎡ and totally 4 plots were surveyed in this study. Table1 shows average tree height, average DBH, stand density, crown area, and relative illumination in each plot.

Table 1. Conditions of each survey plot

	A	B	C	D
Average tree height (m)	19	18.2	16.2	21
Average DBH (cm)	29	27.4	25.7	25
Stand density (number/a)	5	8	11	9
Volume (㎥/a)	3.6	4	5.4	5.2
Canopy area (㎡/a)	46	88	58	54
Average Relative illumination (%)	10	5.4	7.4	7.4

The stand slope was approximately 25 degree. All survey plots were on the north-facing stand. Forest soil was brown forest soil (7.5YR 6/5, 10YR 6/6: Manthel Colors) and soil pH was 4.5 to 4.9.

2. Appearance rate This research surveyed the appearance rate and space dominant condition of *Lindera praecox* under the canopies of *Cryptomeria japonica* and *Chamaecyparis obtusa*.

3. Chlorophyll amount (SPAD) This research surveyed chlorophyll amount of the *Lindera praecox* by measuring SPAD analyzer (Minolta SPAD-502). SPAD was measured twice per a leaf and totally 20 leaves were measured on each *Lindera praecox* seedling in each plot.

4. Surveying natural regeneration This research counted all regenerated seedlings of woody plant at each plot and measured all tree height of the each trees (above 0.1m).

III. Results and Discussion

1. Appearing species numbers of each plot

Table 2 shows the appearing species numbers and appearance percentage of *Lindera praecox* of each plots. The average appearance percsentage of *Lindera praecox* was about 20%.Table 3 shows the conditions of *Lindera praecox* at each plot.

Table 2. Appearing species numbers of each plots

Plot	A	B	C	D
Species numbers	16	12	7	10
Percentage of *Lindera* praecox (%)	21	19	26	20

Table 3. Conditions of *Lindera praecox* at each plot

	A	B	C	D
Average tree height (m)	0.46 (±0.3)	0.95 (±0.4)	0.75 (±0.4)	0.55 (±0.3)
Average DBH (mm)	14.5 (±9.1)	12.4 (±8.8)	18.2 (±9.6)	15.4 (±12.8)
Stand density (seedlings/100 ㎡)	23	24	20	19
Total canopy area (㎡/100 ㎡)	16	27	6.5	1.5

Next, Fig. 1 to 4 show the tree canopies of *Cryptomeria and Chamaecyparis obtusa* (left) and *Lindera* (right) of Plot A to D. Square shows 100 ㎡ and × shows the vertical shaped stand of *Lindera*.

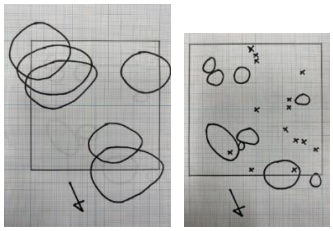

Fig. 1 Tree canopies of Plot A
(Left: *Cryptomeria* & *Chamaecyparis*, Right *Lindera*)

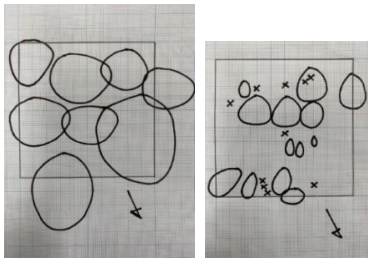

Fig. 2 Tree canopies of Plot B

(Left: *Cryptomeria* & *Chamaecyparis*, Right *Lindera*)

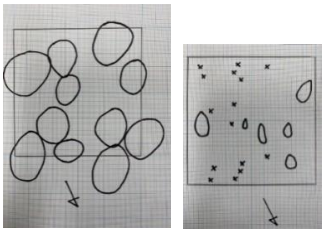

Fig. 3 Tree canopies of Plot C

(Left: *Cryptomeria* & *Chamaecyparis*, Right *Lindera*)

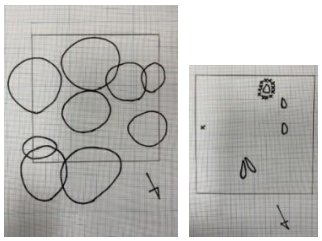

Fig. 4 Tree canopies of Plot D

(Left: *Cryptomeria* & *Chamaecyparis*, Right *Lindera*)

There was no correlation between high story canopies condition and appearance of *Lindera praecox*.

2.Space dominant conditions of each plot

Fig. 5 to 8 show space dominant conditions of each plots. Each figures show species over 0.1m height.

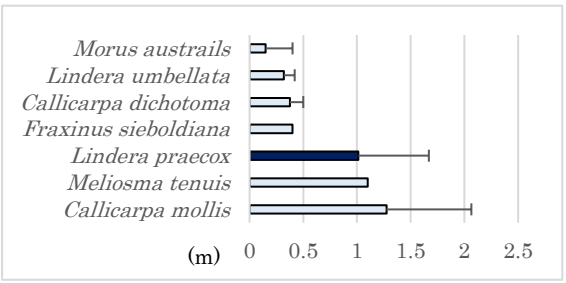

Fig.5 Space dominant conditions of plot A.

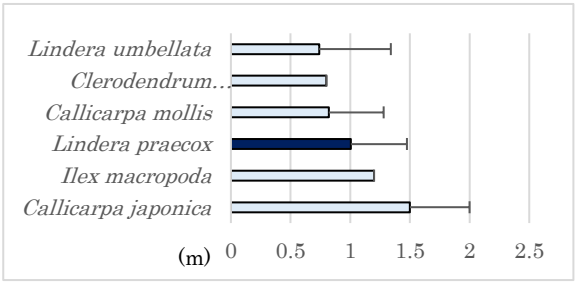

Fig.6 Space dominant conditions of plot B

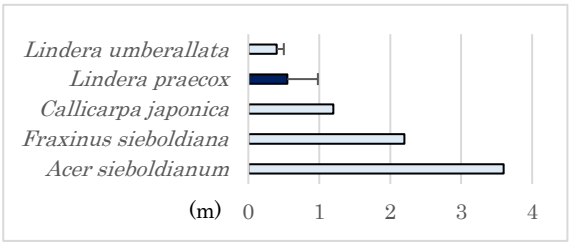

Fig.7 Space dominant conditions of plot C

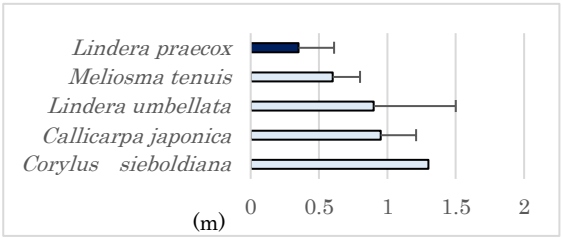

Fig.8 Space dominant conditions of plot D

3.Relative illumination of the places of *Lindera praecox* appearance

There was no correlation between relative illumination and appearance of *Lindera praecox*.

4. Chrolophyll amount (SPAD) of each plots

Table 4 shows chrolophyll amount (SPAD) of *Lindera praecox* on each plots. There was no correlation between SPAD and relative illumination, density, and tree height of *Lindera praecox*. SPAD datas also showed no significant difference at the stories. These results suggested that *Lindera praecox* thoroughly contributes chlorophyll regardless of light condition.

Table 4 Chrolophyll amount (SPAD) of each plots

Plot A	40.0 (±3.6)
Plot B	39.5 (±3.4)
Plot C	37.9 (±3.2)
Plot D	40.8 (±1.4)

5. Soil Moisture Content

Table 5 shows soil moisuture content. These results showed that distribution of *Lindera praecox* is controled by the soil moisture, too (R=0.7378).

Table 5. Soil moisture content (%)

	A	B	C	D
Soil Moisture Content (%)	38.5 (±5.1)	31.8 (±7.5)	32.4 (±2.3)	36.5 (±6.9)
Number of *Lindera praecox*	23	24	20	19

6.Other features

Lindera praecox formed second canopies under the canopies. Fig. 9 showed the stepped shapes and horizontal shapes of *Lindera praecox.* It seems that *Lindera praecox* can change the tree shape to adopt the light condition under the canopies. There are two types of tree shape which are vertical and horizontal (Fig.10). There were sprout regenerations in each plots, too. *Cryptomeria japonica* and *Chamaecyparis obtusa* stands sometimes easily lose floor vegetation. Natural regeneration is sometimes more effective to keep vegetation at the difficult stands and it is easier to adapt the stand condition (*2*) (*3*) (*4*) (*5*). Therefore, *Lindera praecox* is one of the important plants for preventing soil erosion and keeping floor vegetation. On the silvicultural point of view, it should keep *Lindera praecox* without cutting at steep location of *Cryptomeria* and *Chamaecyparis* stands.

Fig.9 Tree shapes of *Lindera praecox* under the canopies of *Chamaecyparis obtusa*.

Fig. 10 Two types of tree shape.
(left: vertical shape, right: horizontal shape)

Fig.11 showed the root system of *Lindera praecox.* Roots are mainly supportive roots and hair roots were few.

Fig.11 Root system of *Lindera praecox*

Ⅳ. Conclusion

This research showed the appearance percsentage of *Lindera praecox* was about 20% under the artificial *Cryptomeria japonica* and *Chamacyparis obtusa* stand. It might thoroughly contribute chlorophyll regardless of light condition. It can grow under the tree shade of *Cryptomeria* and *Chamacyparis obtusa* by changing their tree shapes. Therefore, the tree shape can be an indicator of the stand condition, too.

Next step is considering how to promote the growth and cultivation of *Lindera praecox* on the artificial forest floor.

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