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Timing of Sprouting in Hamabiwa (*Litsea japonica* Juss.) Growing in a Coastal Dwarf Forest*

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Abstract

Morphology, age structure and growth of sprouts in Hamabiwa (*Litsea japonica* Juss.) growing in a coastal dwarf forest in northern Kyushu were investigated, and timing of sprouting was discussed in relation to activities of terminal buds.

Sprouts of Hamabiwa were collected and morphology of sprouts and their primordia were observed. On the stem surfaces of Hamabiwa, there were numerous suppressed buds with vascular traces connected to the pith. Similar vascular traces were observed at the base of sprouting positions. So, the primordia of sprouts in Hamabiwa were assumed to be suppressed buds.

67 sprouts from six clumps were randomly sampled for age structure analysis. Although there were large fluctuations in the frequency distribution of sprout age, sprouts existed in most age classes. The frequency distribution showed a gentle inverse-J shape indicating a high survival rate of sprouts.

Disks of stems of one clump with 7 sprouts were sampled for stem growth and sprouting analysis. Sprouting was observed in years when the height growth rate declined or in the following years. This result suggested that sprouting was closely related to the activity of terminal buds. However, there was no significant relationship between sprouting and volume or radial growth rates.

From these results, it was suggested that Hamabiwa growing in a coastal dwarf forest flushes sprouts constantly due to stress at terminal buds, and maintains their population at sites where seedlings are difficult to establish.
Key words : Hamabiwa (*Litsea japonica* Juss.), sprouts, suppressed buds, height growth rates, coastal dwarf forests.

1. Introduction

Most studies on natural forest dynamics have dealt with the regeneration process by seedlings. However sprouts flushed from the trunk base of canopy trees have not been extensively investgated. Recently, sprouts flushing constantly from the trunk base have been reported as contributing to the regeneration in *Fagus japonica*

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* 伊藤　哲：海岸風衝低木林におけるハマビワの萌芽の発生

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(Ohkubo, 1988; Peters and Ohkubo, 1990) and *Betula tremuloides* (Okitsu, 1985). Putz and Brokaw (1989) reported that sprouts play an important role as materials for recovery of canopy gaps.

In addition, trees in coastal dwarf forests in northern Kyushu often show a multi−stem structure consisting of several sprouts. This structure is most conspicuous in Hamabiwa (*Litsea japonica* Juss.) In these forests, formed on slopes of coastal cliffs, establishment of seedings is thought to be difficult because of severe environmental factors including steep slopes and the impact of salinity. However, a successful regeneration process can be expected since these forests have a closed canopy even in developed vegetation. It is therefore assumed that sprouts of Hamabiwa flushing from the trunk base contribute to forest regeneration. For the successful recruitment of sprouts as material for regeneration, sprouts should cover the temporal and spatial distribution of disturbance producing canopy gaps (Ito and Gyokusen, 1992). Therefore, the timing of sprouting and their survival are important factors in terms of their contribution to regeneration. Ito and Gyokusen (1992) investigated the mechanism of sprouting in Kunugi (*Quercus acutissima*) and suggested that the inhibitors formed in terminal or axillary buds are translocated through phloem, thereby inhibiting sprouting. In coastal dwarf forests, the death of terminal Hamabiwa buds, thought to be caused by salty winds, is often observed. In this study, the morphology, age structure and growth of sprouts in Hamabiwa was investigated in order to discuss the timing of sprouting in relation to the activities of terminal buds.

2. Materials and methods

The site under study was a dwarf forest (3.5m in vegetation height) on a coastal cliff (55° in slope) in Nagasaki prefecture, northern Kyushu. The forest was dominated by Hamabiwa and corresponded to Cyrtomio-Litseetum Ass. (Miyawaki,

Table 1 Number of sprouts and range of their age in sampled clumps of *Litsea japonica*.

Clump No.	Number of sprouts	Range of sprout age (year)
1	7	2 − 21
2	16	1 − 31
3	14	4 − 37
4	12	1 − 26
5	11	2 − 25
6	7	1 − 17

1981). The field survey was conducted in October, 1988. Six Hamabiwa clumps were randomly sampled from the forest. Cores of each sprout stem from sampled clumps were collected from the trunk base 10cm above their flushing positions where sprouts had become erect. The age of all 67 sprouts was determined by counting the annual rings on the cores. The number of sprouts and age range of sampled clumps are shown in Table 1. One clump with 7 stems (No. 6 in Table 1) was selected and disks of stems were sampled at 20cm intervals for stem growth and sprouting analysis. Other samples of sprouts were collected and the morphology of sprouts and their primordia were observed.

3. Results and discussions

3.1. Morphology of sprouts

It is necessary to clarify the primordia of sprouts in order to discuss the timing of sprouting in relation to its mechanism (Ito and Gyokusen, 1992). On the stem surface of Hamabiwa, there are numerous buds which are thought to have originated from axillary buds. Figure 1a shows a schematic drawing of the longitudinal section of a

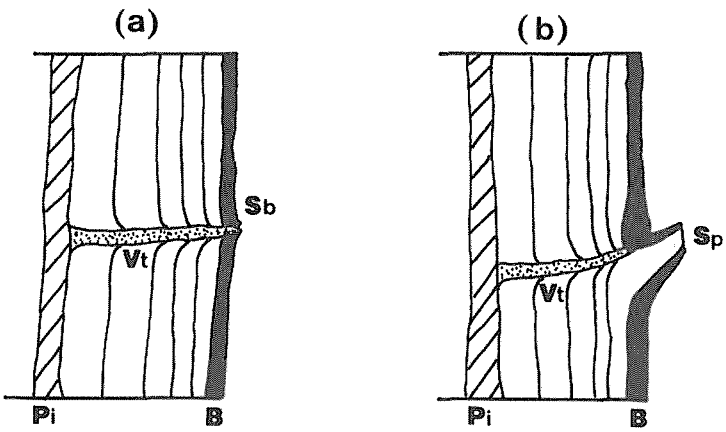

Fig.1 Schematic drawings of longitudinal sections of a suppressed bud (a) and a sprout (b) of *Litsea japonica* growing in a coastal dwarf forest (B, bark; Pi, pith; Vt, vascular trace; Sb, suppressed bud; Sp, sprout).

bud on the stem surface. There was a vascular trace extending from the base of the bud to the pith. This morphology was the same as for suppressed buds which had originated from axillary buds in Kunugi (*Q. acutissima*) observed by Gyokusen (1987). Therefore, these buds were assumed to be suppressed buds. Figure 1b shows a schematic drawing of a longitudinal section of a sprout. Similar vascular traces as in the suppressed buds were observed at the base of sprouting positions. This morphology was observed in sprouts flushed from either above- or under-ground parts of stems. As a result, the primordia of Hamabiwa sprouts were assumed to be suppressed buds.

3.2. Age structure of sprout stems

Figure 2 shows the age frequency distribution of the 67 sampled sprouts. There

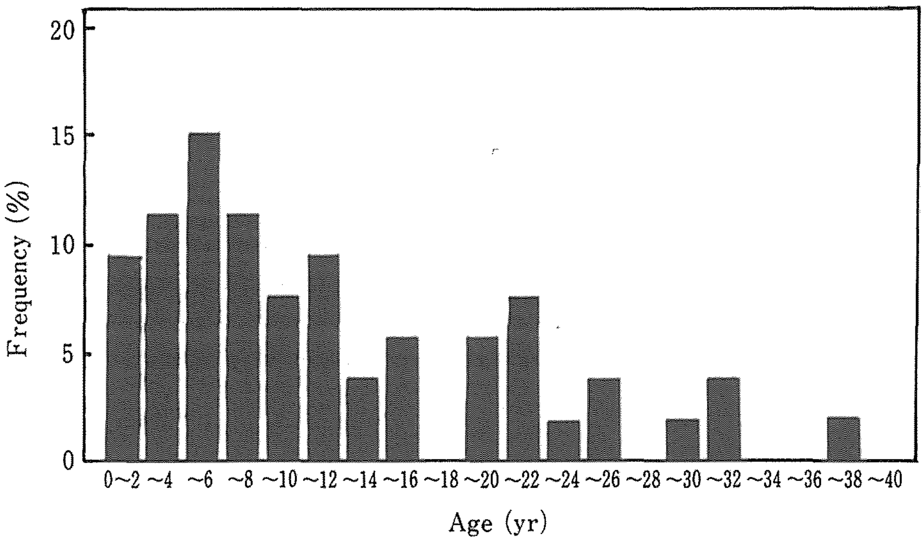

Fig. 2 Frequency distribution of sprout age of *Litsea japonica* growing in a coastal dwarf forest. Relative frequency was obtained for 67 sprouts of 7 clumps sampled randomly.

were large fluctuations in the frequency distribution of sprout age. Several age classes did not have any stems. However, sprouts existed in most age classes over the total range. The frequency distribution showed a gentle inverse-J shape which indicates a high survival rate of sprouts. From these features in the frequency distribution, it was thought that sprouts flushed constantly and that there is a high probability of their contributing to population regeneration.

3.3. Growth of sprouts and timing of sprouting

Figures 3, 4 and 5 show the growth history of seven sprout stems from one clump (No.6 in Table 1). Sprouts 2, 3, 4, and 7 had flushed from main stem 1. Sprouts 5 and 6 had flushed from sprout 3. As shown in Fig. 3, volume growth rates declined with fluctuations over a period of 4 years. Sprouting tended to be observed in years when the volume growth rates of mother stems declined or in the following years. However, this tendency was not very clear. As shown in Fig. 4, radial growth rates

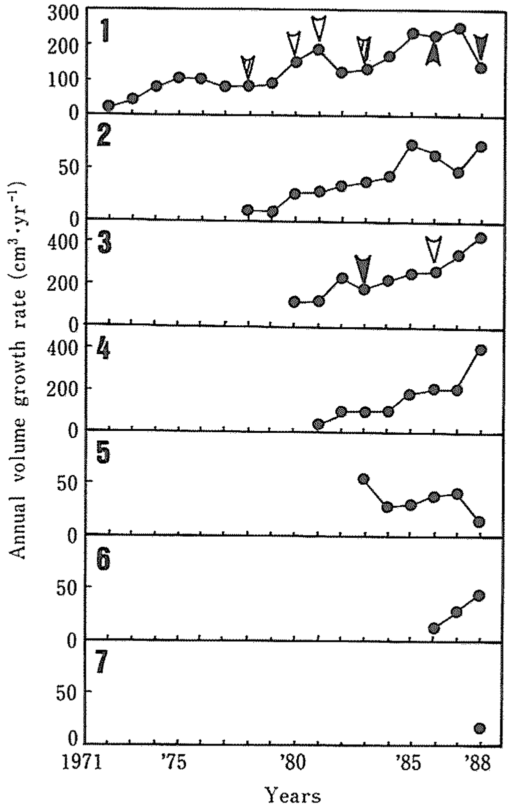

Fig. 3. Annual volume growth of each sprout from a clump of *Litsea japonica* growing in a coastal dwarf forest. Sprouts 2, 3, 4 and 7 had flushed from main stem 1. Sprouts 5 and 6 had flushed from sprout 3. Arrows indicate the timing of new sprouting. Closed arrows indicate the growth rate decline during the year. Striped arrows indicate that the growth rate in the previous year declined. Open arrows indicate that the growth rate did not decline either in the year or the previous year.

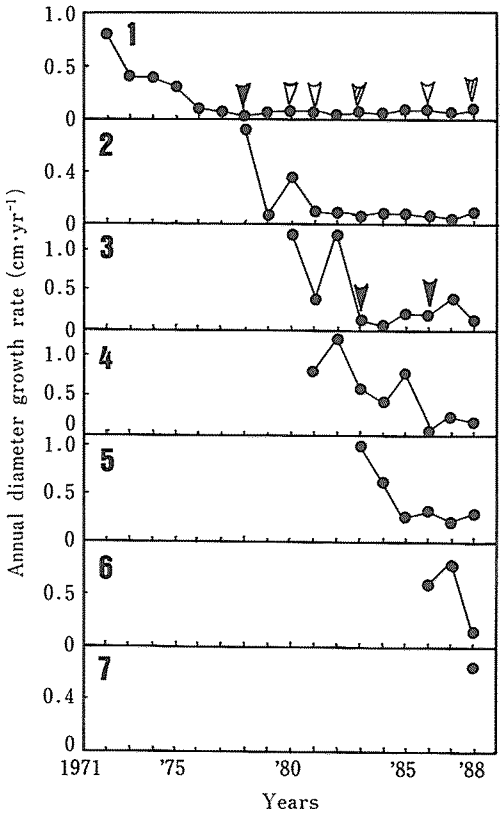

Fig. 4. Annual radial growth of each sprout within a clump of *Litsea japonica* growing in a coastal dwarf forest. Sprout numbers and arrows are the same as in Fig. 3.

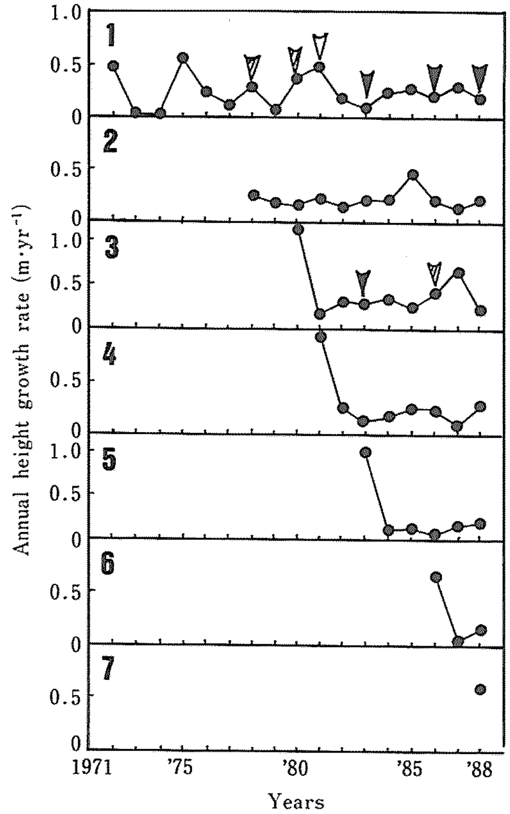

Fig. 5. Annual height growth of each sprout within a clump of *Litsea japonica* growing in a coastal dwarf forest. Sprout numbers and arrows are the same as in Fig. 3.

declined in the first 5 to 7 years and became stable. There was no clear relationship between sprouting and radial growth in mother stems. As shown in Fig. 5, although height growth rates declined for a few years after flushing, there were large fluctuations in large size stems which make up the canopy layer (main stem 1 and sprout 3). Sprouting was observed in years when height growth rates declined or in the following years.

Ito and Gyokusen (1992) suggested that existence of upper current buds inhibits sprouting in Kunugi. With regard to this result in relation to Kunugi, the correspondence between timing of sprouting and decline of height growth rates (Fig. 5) suggests a possibility that sprouting was related to the activities of terminal Hamabiwa buds. There was no clear sprouting tendency in relation to volume and radial growth rates (Fig. 3 and 4). If volume or radial growth rates are related to sprouting, an effect of extent or activity of the photosynthetic organ on sprouting can be expected. However, Ito and Gyokusen (1992) reported that Kunugi seedlings from which photosynthetic organs had been removed did not flush sprouts. Thus, they hypothesized that neither growth nor the extent of photosynthetic organs affects sprouting directly. This hypothesis can explain why there is no clear relationship between sprouting and volume or radial growth in Fig. 3 and 4.

Hamabiwa sprouts flushed constantly (Fig. 2). One of the reasons for constant sprouting is assumed to be the species specific balance between inhibition and stimulation of sprouting (Ito and Gyokusen, 1992). However, the death of terminal buds is often observed in Hamabiwa trees growing in coastal dwarf forests. The intermittent but frequent disturbance to terminal buds is assumed to be an important factor in constant sprouting. It is, therefore, suggested that Hamabiwa trees in coastal dwarf forests maintain their population by sprouting due to frequent stress at terminal buds at sites where seedlings are difficult to established.

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* The title in parentheses are tentatively translated from the original Japanese title by author.

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海岸風衝低木林におけるハマビワの萌芽の発生

伊　藤　　哲

要　　　約

本研究では，海岸風衝低木林に生育するハマビワの萌芽幹の齢構成と成長を調査し，萌芽の発生を頂芽の活性に関連させて考察した．

海岸風衝林群落内からハマビワの萌芽幹を採取し，萌芽の形態を観察した．また萌芽株6個体を任意に抽出し，成長錐で全萌芽幹（67本）のコアを採取して萌芽幹の樹齢を調査した．また，その中で7本の萌芽幹をもつ株を伐倒し，20 cm 間隔で円盤を採取して樹幹解析を行った．

ハマビワの樹幹表面には髄まで連結する維管束状の組織を持つ抑制芽が存在した．萌芽発生部位にも抑制芽と同様な維管束状の組織が観察された．したがって，ハマビワの萌芽の原基は腋芽由来の抑制芽であると考えられた．萌芽の樹齢頻度分布は，樹齢による変動が大きいもののほぼ連続しており，萌芽が常時発生していることが示された．さらに，萌芽の樹齢頻度分布は緩やかな逆J型を呈し，萌芽の生残率が高いことを示した．

萌芽の発生は伸長成長が低下した年あるいはその翌年にみられた．この結果は，常時塩風にさらされる海岸風衝林において，頂芽の活性と萌芽の発生が密接に関連する事を示唆していた．しかし，萌芽の発生と材積成長，肥大成長との関連は明瞭には認められなかった．これらの結果から，海岸風衝林に生育するハマビワは，頂芽にストレスを受けることによって抑制芽からほぼ連続的に萌芽を発生し，実生の定着が困難な立地で個体群を維持していると考えられた．

キーワード：ハマビワ，萌芽，抑制芽，樹高成長，海岸風衝低木林．