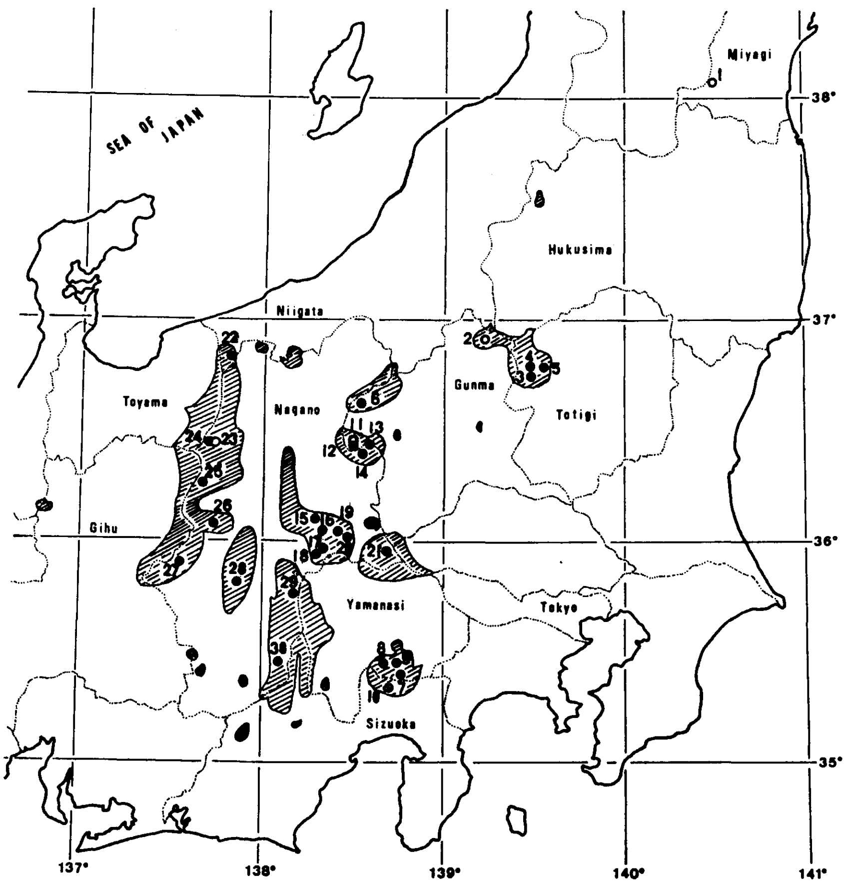

Fig. 1. — Natural distribution of Japanese larch and the locality of registered provenances. ○ designates the provenance where seeds were not or hardly harvested, and ⊙ designates the provenance where seeds were harvested but not sent to Germany (cf. *Table 1*).

Table 1. — Designated provenances (cf. *Fig. 1*)

Registration number		Name of provenances		Long.	Lat.	Alt.	Mean annu. temp.	Mean annu. precip.	Age	Mean height	Mean DBH
Jap.	Sch.	region	locality	(E)	(N)	(m.a.s.l.)	(°C)	(mm)	(yr)	(m)	(cm)
1	---		Mt. Manokamidake	140° 30′	38° 05′	1500	3.7	1400–1600	100–350	3.5	17.4
2	---		Ozegahara	139° 13′	36° 55′	1410	---	---	120–170	16.8	31.2
3	13	Nikkoo (Nikko)	Akanuma	139° 27′	36° 46′	1360	5.5	2250	60	20.4	44.0
4	14	Nikkoo (Nikko)	Kootoku	139° 27′	36° 47′	1480–1500	6.8	2470	110	27.2	57.1
5	15	Nikkoo (Nikko)	Yasyuubara	139° 33′	36° 47′	1700	5.3	2590	60– 70	14.9	42.3
6	16		Manza	138° 30′	36° 39′	1700–1800	4.7	1800	90	21.2	46.4
7	3	Mt. Huzisan (Fuji)	Oniwa	138° 43′	35° 23′	2350–2500	1.2	2500	60– 80	3.6	22.8
8	1	Mt. Huzisan (Fuji)	Tenzin pass	138° 04′	35° 26′	1320	6.2	1820	65– 85	16.6	38.8
9	2	Mt. Huzisan (Fuji)	Sangoome	138° 43′	35° 24′	1760	5.0	1760	75	18.9	34.7
10	---	Mt. Huzisan (Fuji)	Sizuoka	138° 42′	35° 19′	1600	6.1	2866	70	19.2	36.9
11	---	Mt. Asamayama	upper Mizunoto	138° 29′	36° 25′	2200	---	---	50	14.7	30.0
12	17	Mt. Asamayama	lower Mizunoto	138° 29′	36° 24′	1900	3.2	1890	60– 70	14.0	34.7
13	18	Mt. Asamayama	Kutukake	138° 34′	36° 24′	1400–1450	6.2	1400	100–120	22.4	38.6
14	19	Mt. Asamayama	Oiwake	138° 32′	36° 23′	1700	4.3	1570	50– 80	13.3	28.8
15	7	Yatugatake mountains	Tadesina	138° 17′	36° 06′	1600	5.1	1430	140	23.0	42.5
16	8	Yatugatake mountains	Toyohira	138° 20′	36° 03′	1700	5.4	1700	50– 70	20.0	35.3
17	10	Yatugatake mountains	upper Tatusawa	138° 20′	35° 57′	1750	6.1	1330	50– 60	20.6	38.1
18	9	Yatugatake mountains	lower Tatusawa	138° 19′	35° 56′	1450	6.8	1560	50– 60	19.6	42.3
19	5	Yatugatake mountains	Inago	138° 24′	36° 03′	1750–1800	6.1	1550	60	18.7	41.0
20	6	Yatugatake mountains	Uminokuti	138° 26′	36° 01′	1700–1800	5.4	1480	70	21.3	41.3
21	4		Mt. Kobusidake	138° 43′	35° 57′	1500	6.5	1360	40– 50	16.6	26.9
22	21		Mt. Rengedake	137° 48′	36° 48′	2180	1.1	3680	130–150	7.4	21.8
23	---		upper Takasegawa valley	137° 42′	36° 24′	2680	---	---	190	2.0	6.7
24	22		lower Takasegawa valley	137° 41′	36° 24′	1380	5.6	1670	50	11.9	24.9
25	20		Kamikooti	137° 40′	36° 15′	1620	5.0	2320	60–150	23.5	38.3
26	25		Mt. Hatimoriyama	137° 43′	36° 04′	1920	3.3	2300	100–130	18.5	49.6
27	24		Mt. Ontake	137° 33′	35° 54′	1380	6.9	2130	45– 67	26.7	79.4
28	23		Mt. Kiso-komagadake	137° 52′	35° 47′	1800	3.2	2380	100–140	22.6	54.3
29	11		Mt. Kai-komagadake	138° 13′	35° 45′	1500	6.5	1720	60– 80	17.8	30.8
30	12		Mt. Akaisi-oosawadake	138° 06′	35° 27′	1900–2100	4.0	2840	130	20.2	41.2

amount of seeds of known origin in Japan, because heavy crops of larch seeds occur only with intervals of several years. Fortunately, in 1956, the larch seed crops were extremely heavy at almost all localities of natural larch forests. Under the guidance of MITSUO IWAKAWA, the principal forest geneticist by then, the forest geneticists of the Government Forest Experiment Stadion made efforts in designating noticeable provenances and collecting graft scions and seeds there (*Fig. 1* and *Table 1*). Majority of collected seeds were sent to Germany, and from there they were distributed to all over the world by LANGNER (1958). The rest of seeds was distributed to several institutions in Japan and trial plantations were established (*Fig. 2* and *Table 2*). Scions were grafted and the clonal materials are kept at three localities, Komoro, Morioka and Nopporo. Some quantities of scions were also sent to LANGNER and SCHOBER.

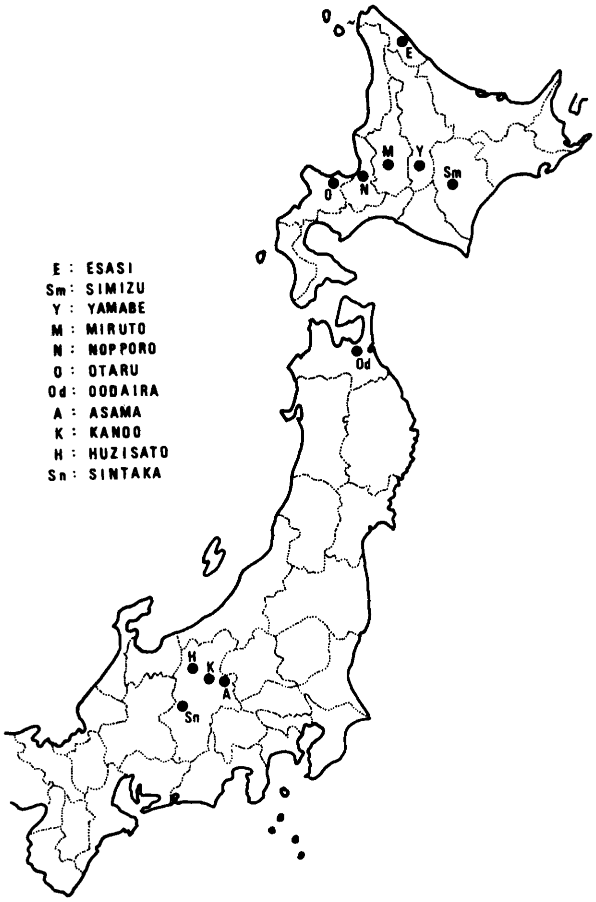

Fig. 2. — The provenance trial plantations of Japanese larch established in Japan (cf. *Table 2*).

A brief description on natural distribution of Japanese larch and the designated provenances

HAYASHI (1951), who studied the natural distribution of Japanese conifers, concluded that the northern extreme of Japanese larch occurred at the Mt. Manokamidake, Miyagi prefecture, where longitude, latitude, and altitude were 140^0 30' E, 38^0 05' N and 1550 to 1580 metres above sea level. This is also the eastern extreme at the same time, and is a very much isolated provenance being remote from any other locality of larch stand. The population is very small and only fifteen wind-suppressed dwarf individuals were counted at the investigation made in May, 1976. All of these individuals were recently propagated vegetatively, for their clonal conservation.

HAYASHI also described that the southern and western extremes were Mt. Tenguisiyama (138^0 10' E, 35^0 08' N, 1366 m.a.s.l.), Sizuoka prefecture, and Mt. Hakusan (136^0 50' E, 36^0 10' N, 1600—2200 m.a.s.l.), Isikawa prefecture, respectively. However, the larch forest at Mt. Hakusan seems to have been lost already, because expeditions sent several times since 1956 have all failed to find it out. Therefore, the western extreme of present natural larch forests seems to be somewhere in the Hida mountains.

The localities of the principal natural forests are illustrated on *Figure 1* after HAYASHI (1951). Their occurrence is almost always at the altitude of 1400 to 1800 metres; on Mt. Huzisan (Fuji), however, larch trees occur as high as

Table 2. — Trial plantations of Japanese larch porvenances established in Japan (cf. *Fig. 2*)

Name and abbreviation		Region	Makeup of the plantation: provenances	replication	plants per plot	type of design	Time of planting	Organization responsible for the management
Asama	A	Nagano prefecture	25	4	144	lattice	Apr. 1959	Govt. For. Exp. Sta.
Huzisato	H		24	3	84	lattice	Apr. 1959	Govt. For. Exp. Sta.
Sintaka	Sn		24	3	84	lattice	Nov. 1958	Govt. For. Exp. Sta., Kiso Branch
Kanoo	K		16	3	120	lattice	Mar. 1962	Govt. For. Exp. Sta.
Oodaira	Od	Aomori prefecture	20	3	60	randomized blocks	Apr. 1959	Oji Inst. For. Tr. Imp.
Nopporo	N	Hokkaido	25	3	126	lattice	Oct. 1959	Govt. For. Exp. Sta., Hokkaido Branch
Esasi	E		25	3	126	lattice	Oct. 1959	Govt. For. Exp. Sta., Hokkaido Branch
Simizu	Sm		19	3	126	lattice	May 1960	Govt. For. Exp. Sta., Hokkaido Branch
Miruto	M		18	3	100	randomized blocks	May 1961	Hokkaido For. Exp. Sta.
Otaru	O		21	3	126	randomized blocks	Oct. 1958	Oji Inst. For. Tr. Imp.
Yamabe	Y		20	1	220	line planting	May 1959	Univ. of Tokyo, Hokkaido Forest

2500 metres of altitude, where they are completely suppressed by wind.

Thirty localities were designated as the representative provenances as shown in *Figure 1* and in *Table 1*, covering almost whole range of larch distribution. Four provenances among them, however, supplied no or very few seeds because of poor crops in these stands. In each of other provenances, twenty to twenty-two individuals served as mother trees. Seed from one provenance, Huzisan-Sizuoka (No. 10), was not included in those sent to Germany but the reason is unknown[3]). Thus the number of provenances distributed from Schmalenbeck was twenty-five in all, and each of them carried Schmalenbeck number, which is also shown in *Table 1*. However, in this article, we will refer to them by original Japanese numbers.

Graft scions were collected in all the thirty provenances, from ten ortets in each. The ortets were selected independently from the selection of seed trees. Only at the No. 1 provenance, Mt. Manokamidake, selected ortets were as few as three by then, but, later, all the individuals in this provenance were conserved as clones, as stated previously.

Observations in the nurseries

Phenological observations were chiefly made in the nurseries, and the variation in winter hardiness was also recognized.

Variation in the dates of bud opening

Variation in bud opening dates was studied at Nopporo, Hokkaido, by YANAGISAWA (1961). The number of open buds in comparison with the total number of buds was investigated several times during April 19 to May 23, and average percentages of open buds were calculated separately for apical buds and lateral buds. Apical buds opened slightly later but in close correlation with the opening dates of the lateral buds. There was a wide variation in the dates of bud opening among the provenances, but no correlation was found between this trait and the latitude or altitude of the localities of provenance. However, there was a slight correlation between this trait and the date of autumn colouring, which was, as stated later, significantly correlated with the latitude of provenances. Plants of the early opening provenances tended to change the needle colour into yellow in autumn later.

Provenances of early bud opening were No. 21 Mt. Kobusidake, No. 15 Yatugatake mountains-Tadesina, and No. 29 Mt. Kai-komagadake, while those of extremely late opening were No. 22 Mt. Rengedake, No. 19 Yatugatake mountains-Inago, and No. 3 Nikkoo-Akanuma.

Autumn colouring of the foliage.

YANAGIHARA *et al.* (1961) reported their observations on the variation among provenances in dates of autumn colouring at the nurseries in Nagano prefecture. The dates of the initiation of colour change were investigated in 1957 and 1958, and the results were very parallel in the two succeeding years. However the difference between the earliest and latest provenances was six days in the first year, while it was thirteen days in the second year. The earliest colouring provenances were No. 3, No. 4 and No. 5 of the Nikkoo area, No. 6 Manza, No. 12 Mt. Asamayama-lower Mizunoto, and No. 22 Mt. Rengedake, while the latest colouring provenances were No. 8, No. 9 and No. 10 of Mt. Huzisan, and No. 15 to No. 20 around Yatugatake mountains except No. 17 lower Tatusawa. No. 21 Mt. Kobusidake was also included in the latest group. It is noticeable that the northern provenances are generally earlier in the initiation of autumn colouring.

The dates of the finish of colour change were studied only in 1957, and it was revealed that the early colouring plants tended to finish their colour change in a shorter period.

IIZUKA and ARAI (1966) made the follow-up studies on this trait and confirmed that the tendency was not changed up to the seventh year in the plantations.

In Hokkaido, YANAGISAWA (1961) studied the variation in the time of autumn colouring by the method of ranking at the standard days. The results fairly coincided with those reported by YANAGIHARA *et a.* (1961).

In 1968, CHIBA and NAGATA (1972) sowed stored seeds, which were retained from the original lots of provenance seeds, in Hokkaido, and studied the time of autumn colour change with the similar method to that of YANAGISAWA (1961). The results well coincided with the two previous papers. KURAHASHI *et al.* (1972) also confirmed that the tendency was not changed in the Yamabe plantation, at the tenth year after planting.

Ceasing of annual height growth

YANAGISAWA (1961), as well as CHIBA and NAGATA (1972), investigated the dates of ceasing of height growth, while IIZUKA and ARAI (1966) studied the rates of seedlings carrying visible winter buds every four days during a certain period. They were all successful in revealing the differences among the provenances in the ceasing time of height growth and the close correlation of this trait with the dates of autumn colouring and further with the latitude of the provenances.

Winter hardiness

YANAGISAWA (1961) reported that there was a variation in the rate of shoot damages in winter among the provenances when the plants were out-planted in early autumn. This variation correlated with the earliness or retarding of growth ceasing, and the northern provenances were more healthy.

Unpublished data from the Kiso Branch of the Government Forest Experiment Station clearly show the variation in the susceptibility to early frost. On September 29, 1960, an early frost of four degrees C below zero attacked the seedlings of the twenty provenances in the sowing beds. The results are shown in *Figure 3*, and we can recognize the close correlation with the time of growth ceasing and with the latitude of provenances.

Juvenile performance in the plantations

Growth in the young stage, stem crookedness, branching habit, juvenile flowering, spiral grain of the wood, and the resistance against some diseases have been studied.

Height growth

Performances in some trial plantations in Nagano prefecture during the first few years were briefly reported by YANAGIHARA *et al.* (1961) and IIZUKA and ARAI (1966). Later, MIKAMI (1971) summarized the results in the same plantations, Asama, Huzisato and Sintaka, being based on the tree height measurements of twenty-five provenances,

[3])In fact, this provenance was additionally and supplementarily selected and was thought less important at the time of seed collection. Probably this was the reason of why it was excluded. (After IWAKAWA's talk).

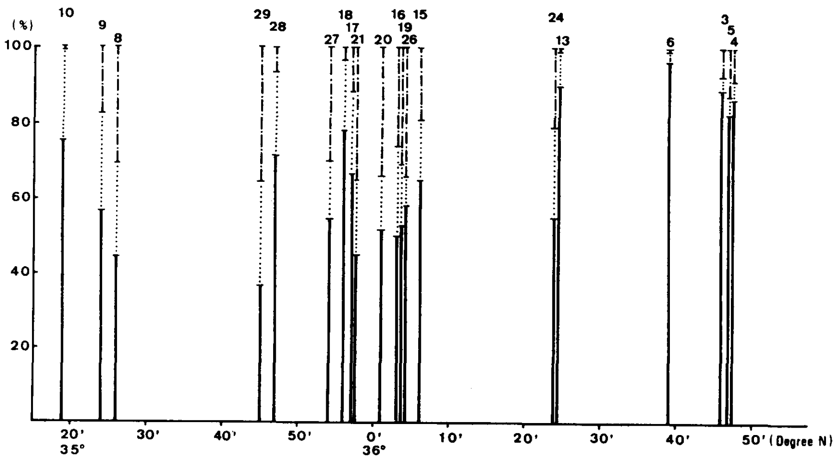

Fig. 3. — Variation in frost hardiness among provenances. Percentages of healthy, damaged and killed seedlings after an early frost are shown by the solid, dotted and dot-dash broken lines, respectively. Provenances are arranged by latitude, and the reference is made with their registration number.

nine years after planting. In each plantation, he classified provenances into five categories, namely "very good", "good", "normal", "poor" and "very poor", separated by the values m $\pm 2\sigma$ and m $\pm 2/3\,\sigma$, where m and σ stand for the mean value and the standard deviation. Some provenances were recognized as "very poor" but no provenance was "very good" in these trials. He noticed that the following provenances were "superior" because they were "good" in two or more plantations and above average in the rest: No. 4 and No. 5 of Nikkoo area, No. 8, No. 9 and No. 10 of Mt. Huzisan, No. 19 and No. 20 around Yatugatake mountains, No. 21 Mt. Kobusidake, and No. 27 Mt. Ontake. Similarly, the provenances were assessed to be "inferior" when they were "poor" or "very poor" in two or more plantations and below average in the remaining one. "Inferior" provenances were No. 6 Manza, No. 12, No. 13 and No. 14 of Mt. Asamayama, No. 26 Mt. Hatimoriyama, No. 28 Mt. Kiso-komagadake and No. 30 Mt. Akaisi-oosawadake.

In Hokkaido, Kishida *et al.* (1972) analyzed the data from three plantations, Nopporo, Simizu and Esasi, up to ninth year since planting. Only the data of nineteen provenances were utilized because the other provenances were absent in some of the plantations. Analysis of variance showed the large variation among the trial plantations and replications, but less significant variation among provenances. The results of partition into categories "superior", "intermediate" and "inferior", by the similar method to that by Mikami (1971), were very variable year after year; generally speaking, provenances of Mt. Huzisan and around Yatugatake mountains were "superior" and those of Mt. Asamayama and from southern alpine regions were "inferior".

Chiba and Nagata (1972) reported the growth in the Otaru plantation at the tenth year after planting, where significant variation of growth due to provenance was observed. Briefly speaking, provenances of Mt. Huzisan and Nikkoo area were good in juvenile growth, and those of Mt. Asamayama and southern alpine areas were poor. Provenances of Yatugatake mountains and Kiso area were variable in their performance.

The Oodaira plantation in Aomori prefecture was seriously damaged by the needle cast and shoot blight diseases and had to be excluded from the materials of discussing growth (Chiba and Nagata, 1972).

Considering the seven trial plantations cited above, three in Nagano prefecture and four in Hokkaido, provenances being always better than average were No. 4 and No. 5 from Nikkoo area, No. 9 and No. 10 of Mt. Huzisan, No. 19 around Yatugatake mountains, and No. 21 Mt. Kobusidake. On the other hand, provenances always showing inferior results below average were No. 24 Takasegawa, No. 28 Mt. Kiso-komagadake, and No. 30 Mt. Akaisi-oosawadake.

Stem crookedness

Crookedness of a stem is a very important trait to be strictly avoided. Because there seemed to be a variation among provenances in this trait, an investigation was planned (Mikami, 1971). Plants were classified into three categories: straight, slightly crooked, and heavily crooked. Crookedness index was calculated for each provenance in each plantation, and the results are shown in *Figure 4.*

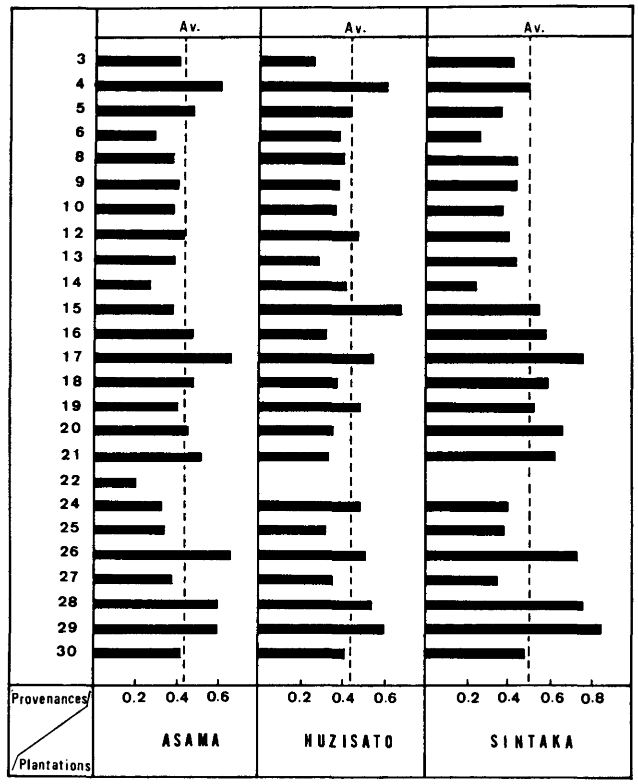

Fig. 4. — Crookedness index calculated in each provenance in plantations. The formula being

$$(0 \times n_1 + 1 \times n_2 + 2 \times n_3) / (n_1 + n_2 + n_3)$$

where n_1, n_2 and n_3 represent the number of straight, slightly crooked and heavily crooked trees, respectively.

Provenances of more straight stems, showing indices smaller than average in all of the three plantations were No. 3 from Nikkoo area, No. 6 Manza, No. 8, No. 9 and No. 10 of Mt. Huzisan, No. 13 and No. 14 of Mt. Asamayama, No. 25 Kamikooti, No. 27 Mt. Ontake and No. 30 Mt. Akaisi-oosawadake. On the other hand, those with more crooked stems were No. 17 from Yatugatake mountains, No. 26 Mt. Hatimoriyama, No. 28 Mt. Kiso-komagadake and No. 29 Mt. Kai-komagadake.

KURAHASHI *et al.* (1972) studied the stem crookedness in the Yamabe plantation, in which they assessed the trait into four grades instead of three. The results showed that provenances of more straight stems were No. 3 and No. 5 from Nikkoo area, No. 6 Manza, No. 9 of Mt. Huzisan, No. 13 of Mt. Asamayama, and No. 16 and No. 19 around Yatugatake mountains, while those of more crooked stems were No. 17 from Yatugatake mountains, No. 28 Mt. Kiso-komagadake, and No. 29 Mt. Kai-komagadake.

It can be concluded that the crookedness and straightness of the stems are more dependent on heredity than on the specific environmental conditions at certain sites.

Branching habit and crown types

IIZUKA and ARAI (1966) noticed that there were variations of the following items among the provenances or the groups of provenances: crown diameter; relative thickness of limbs; and the coarse or slender types of crown. Although they did not show the details of the study, they summarized that, in the Huzisato plantation, provenances from Mt. Huzisan and Mt. Kobusidake were generally provided with thinner branches and those on Mt. Asamayama with thicker ones. Percentage of coarse crown type was high in provenances of southern alpine areas and those of Mt. Huzisan, while it was extremely low in provenances from Nikkoo area. The last statement was also confirmed by KURAHASHI *et al.* (1972) in the Yamabe plantation, Hokkaido.

Juvenile flowering

In the trial plantations in Nagano prefecture, only plants of Mt. Huzisan provenances (Nos. 8, 9, 10) bore flowers in some special cases that they were strangulated by vines or suffered from root-rot caused by *Armillaria mellea* (FR.) QUÉL. (IIZUKA and ARAI, 1966; MIKAMI, 1971). KURAHASHI *et al.* (1972) also noticed in the Yamabe plantation, that plants of Mt. Huzisan provenances (Nos. 8, 9, 10) significantly bore both male and female strobili and those from Mt. Asamayama provenances (Nos. 13, 14) did less abundantly.

Spiral grain of the wood

Japanese larch logs of smaller diameter show a serious defect that they significantly warp and twist when they are sawn and dried. This defect is due to the spiral arrangement of tracheids which is most significant in the annual sheaths near the trunk axis and gradually decrease in the outer sheaths. It is known that the intensity of warping is well correlated with the angle of spiral grain.

MIKAMI and NAGASAKA (1974) studied the variation of spiral angles using thinned logs of twenty-five provenances from the Asama plantation and of ten provenances from the Kanoo plantation. There were significant variations among the provenances and the correlation between the two plantations was very high. Smallest angles were observed in the provenance No. 5 Nikkoo-Yasyuubara, and the largest were in No. 28 Mt. Kiso-komagadake, which showed extraordinarily large angles.

Susceptibility to some diseases and other damages

Needle cast disease, caused by *Mycosphaellera laricileptolepis* ITO et SATO, and shoot blight disease, caused by *Guignardia laricina* (SAWADA) YAMAMOTO et ITO, are the most serious ones among the biological infestations in larch plantations in Japan. MIKAMI (1971) summarized the observations in the plantations in Nagano prefecture, that the plants from the provenances No. 8, No. 9 and No. 10 of Mt. Huzisan, No. 13 and No. 14 of Mt. Asamayama, and No. 22 Mt. Rengedake were more resistant to needle cast disease, while the provenances No. 15, No. 16 and No. 17 of Yatugatake mountains, No. 29 Mt. Kai-komagadake and No. 30 Mt. Akaisi-oosawadake were more susceptible.

In the Oodaira plantation in Aomori prefecture, plants were badly damaged by both of the mentioned diseases, and the relative susceptibility of the plants from different provenances was investigated by SATO and his colleagues. Results of their studies were partly published in their own article (1971), while the unpublished data were cited by CHIBA and NAGATA (1972) from the informally circulated materials. The results can be summarized that provenances of No. 8, No. 9 and No. 10 Mt. Huzisan were the best resistant against needle cast disease, followed by No. 3 and No. 5 Nikkoo area, as well as No. 29 Mt. Kai-komagadake. On the other hand, provenances of Mt. Huzisan (Nos. 8, 9, 10) were extremely susceptible to the shoot blight, while the more resistant provenances were No. 3 and No. 5 Nikkoo area, No. 6 Manza, No. 14 Mt. Asamayama-Oiwake, No. 26 Mt. Hatimoriyama, and No. 27 Mt. Ontake.

MIZUNO, (1973) studied the relative resistance against shoot blight in the Nopporo plantation, and the results generally coincided with SATO and others (CHIBA and NAGATA, 1972). Disagreement between them was considered as the influences of different environmental conditions.

In addition, MIKAMI (1971) made mention of relative susceptibility to *Armillaria* root-rot and to snow damages. He described that No. 13 and No. 14 Mt. Asamayama, No. 20 Yatugatake mountains-Uminokuti, and No. 25 Kamikooti were more resistant to the root-rot, while No. 21 Mt. Kobusidake, No. 27 Mt. Ontake, No. 28 Mt. Kiso-komagadake and No. 30 Mt. Akaisi-oosawadake were more susceptible. Snow damages were more frequently seen in the provenances No. 15, No. 16, No. 19 and No. 20 around Yatugatage mountains and in No. 26 Mt. Hatimoriyama, and they were less frequent in provenances of No. 3, No. 4 and No. 5 Nikkoo area, No. 6 Manza, No. 24 Takasegawa and No. 30 Mt. Akaisi-oosawadake.

General assessment

Considering these information items altogether, provenances from the Nikkoo area appear to be the best in the juvenile stage of the life cycle. Provenances of Mt. Huzisan are good in growth and resistant against needle cast disease, but they are very susceptible to shoot blight and also less hardy in winter. Provenances occurring at the southwestern alpine part of the distribution area appear to be less favourable ones for establishing plantations.

Genetic differentiation between provenances

MIKAMI (1973) studied the electrophoretic patterns of peroxidase isozymes in foliage of ten provenances at the Asama plantation, at the age of twelve years. Thirty individuals were sampled in each provenance. Fifteen isozyme bands were recognized in total, and individual trees were provided with four to ten bands. Differences were found among provenances in the average number of bands

Table 3. — Indices of genetic differentiation between provenances based on peroxidase isozymes

Provenances		Mt. Huzisan		Nikkoo	Manza	Mt. Asamayama			Mt. Rengedake	Takasegawa valley	Mt. Hatimoriyama
		Sangoome	Sizuoka	Kootoku		Mizunoto	Kutukake	Oiwake			
Mt. Huzisan	Sangoome	---	5.15	25.72	34.90	32.84	32.35	32.08	36.87	30.43	22.60
	Sizuoka		---	27.05	36.86	35.65	34.26	36.11	40.98	30.47	25.28
Nikkoo -	Kootoku			---	18.81	21.60	18.43	19.35	21.69	14.90	13.87
Manza					---	12.67	13.40	14.59	17.61	19.04	16.52
Mt. Asamayama	Mizunoto					---	15.15	14.45	16.45	22.84	15.82
	Kutukake						---	11.59	17.52	22.27	12.18
	Oiwake							---	13.76	27.19	10.88
Mt. Rengedake									---	27.50	18.30
Takasegawa valley										---	21.72
Mt. Hatimoriyama											---

per individual and the frequency of occurrence of each specific isozyme band.

An index of differentiation D was calculated for the paired combinations among the investigated provenances by means of the following formula:

$$D_{jk} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_{ij} - X_{ik})^2}$$

where N was total number of separate bands, and X_{ij} and X_{ik} were the frequency of i-th band in the j-th and k-th provenances, respectively.

The results are shown in *Table 3,* where we can see that two provenances of Mt. Huzisan are almost similar in their genetic nature, and the three provenances of Mt. Asamayama are not much different but not so similar to each other as the Huzisan provenances are. On the other hand, the largest differences are seen between the provenances Mt. Huzisan (Nos. 9, 10) and Mt. Rengedake (No. 22).

Conclusions

Japanese larch has only a minor importance in Japanese and European forestry, however, still it has a steady position in the man-made forests of northern temperate zone being not replaceable with other trees. Although its natural distribution is very restricted, regional variation in morphological traits and plantation performance has often been noticed in Japan. However, there have been various obstacles in Japan for establishing well-planned provenance trial plantations, so we are very much grateful to Professor Dr. W. Langner for his efforts taking the initiative of the provenance studies of this species. Without his efforts, we have probably had no opportunity to establish a network of trial plantations as such including so good a collection of provenances. At the same time, we ourselves are satisfied with and proud of the works done by us which were of the great assistance to the programme of Langner.

The trial plantations have already become over ten years of age, and various observations have been published. They are briefly reviewed in this article, and the following conclusions can be stated.

1. There are differences in phenological traits of seedlings and young plants among the selected provenances, and the variation is fairly related to the latitude of the provenances. This is important in relation to the cold and frost damages of the planting materials.

2. There are significant variations in responses to the diseases. Among the provenances studied, Mt. Huzisan provenances are the most remarkable ones in these traits, because they are the best resistant against needle cast disease while they are, at the same time, the worst susceptible to shoot blight. Provenances of the Nikkoo area are moderately or remarkably resistant against both of the two diseases.

3. Significant variation was also observed in the vigour of plant growth, but the juvenile growth cannot be relied on in relation to the final achievement at the rotation age. Therefore, too much attention should not be paid on this trait.

4. Miscellaneous traits, such as crown types, branching habit, straightness or crookedness of the stem, and the spiral grain of the wood, are also significantly varied among provenances. They cannot be dismissed in the practice of selecting provenances for commercial plantations.

5. As far as judged from the juvenile achievements in various traits stated above, the provenances from the Nikkoo area appear to be the best for plantations in Japan. However, this statement is only tentative, and may be revised by the future observations. The circumstances are the same for the statement that the provenances of southwestern alpine region are generally inferior to other provenances.

Summary

Natural distribution of Japanese larch and the selection of provenances for the study project planned by Langner are explained. Using the residual seeds of those sent to Germany, eleven trial plantations were established in Japan, and several authors reported their observations in them. Variation in phenological traits such as the dates of autumn colouring or cease of elongation is well correlated with the latitude of provenances except in the bud opening dates. This is very important in relation to the hardiness of plants. Relative resistance and susceptibility to the two serious diseases also vary among provenances, and it is noticeable that the provenances of Mt. Huzisan (Fuji) are the most resistant to needle cast disease but, at the same time, the worst susceptible to shoot blight. On the other hand, those from the Nikkoo (Nikko) area are highly or moderately resistant to both of the two diseases. There are also variations among provenances in crown types, branching habit, stem straightness, and spiral grain of wood, which must be taken into consideration for the selection of planting materials. Of course, variation is also found in juvenile growth of the plants, but it cannot be relied on in relation to the final performance of them at the end of the rotation

period. Genetic affinities between some of the provenances were studied by means of the frequency distribution of peroxidase isozymes.

Key words: Japanese larch; provenance study; phenology; disease resistance; juvenile growth; stem crookedness; spiral grain; peroxidase isozyme.

Zusammenfassung

Im Jahre 1955 hat LANGNER der japanischen Forstverwaltung einen gemeinsamen Studienplan zur Erforschung der natürlichen Verbreitung der japanischen Lärche und ihrer Variation auf der Basis von Herkunftsversuchen vorgeschlagen. Daraufhin wurden in Japan 11 Provenienzversuche dieser Baumart angelegt, die heute über 10 Jahre alt sind.

Aus diesen Versuchen geht hervor: Die Variation der phaenologischen Merkmale Herbstverfärbung und Abschluß des Längenwachstums ist mit der geographischen Breite korreliert, jedoch nicht diejenige der Austreibedaten im Frühjahr, von denen die Frostresistenz der Provenienzen maßgeblich bestimmt wird. Die Anfälligkeit gegen Nadelschütte war bei den Herkünften vom Mt. Fuji am geringsten. Herkünfte aus dem Nikko-Gebiet waren sowohl gegen Nadelschütte als auch gegen Triebsterben weitgehend resistent.

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Unterlagenwahl als Mittel zur Beeinflussung der Blüte und des Samenertrages bei Fichte

Von D. KRUSCHE[1]) und G. H. MELCHIOR[1])

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Einleitung

Um an Obstarten bestimmte Wirkungen zu erzielen, werden im Obstbau seit langem definierte Unterlagen benutzt (s. z. B. DE HAAS und HILDEBRANDT 1967). So kann durch Unterlagenwahl das vegetative Wachstum gehemmt (s. z. B. TUBBS 1967, 1974 c, VISSER 1964, 1970 a, 1973) die Jugendphase verlängert oder abgekürzt (s. z. B. LOEWEL und SAURE 1963, PASSECKER 1964, SAURE 1972, TYDEMAN and ALSTON 1965, VISSER 1973, ZIMMERMANN 1971, 1972), die Blütezeit verfrüht oder verzögert (z. B. GRIGGS *et al.* 1969, 1972) und Blütenansatz (TUBBS 1974 a, 1974 d) und Ertrag erhöht werden (s. z. B. SUSZKA 1971, SCHMADLAK 1974, VISSER und DE VRIES 1970). Andere Unterlagenwirkungen werden von DE HAAS und HILDEBRANDT (1967) zusammengefaßt. Wechselwirkungen zwischen Unterlage und Reis spielen dabei eine hervorragende Rolle (s. z. B. TUBBS 1973, 1974 b), deren Erforschung im Obstbau seit den zwanziger Jahren durch VYVYAN's (1955) Untersuchungen stimuliert wurde. Die Züchtung von Pfropfunterlagen und ihre Wahl nimmt deshalb im Obstbau eine wichtige Stellung ein.

Auch für die Regulierung wichtiger physiologischer Vorgänge an Waldbäumen durch die Wahl entsprechender Unterlagen liegen erfolgversprechende Ergebnisse vor (z. B. AHLGREN 1962, 1972, ALLEN 1967, BRYNDUM 1965, SMIDTLING 1969). Da Waldbäume sicher keine Ausnahme im Pflanzenreiche darstellen, sollte wie an Obstbäumen auch an Waldbäumen durch Unterlagenwahl eine ähnliche Beeinflussung möglich sein. Ein wichtiges Ziel stellt dabei der nachhaltige Ertrag von Pfropflingen in forstlichen Samenplantagen bei leichter Beerntbarkeit dar. Von LANGNER wurden in den 50er Jahren Versuche angelegt, die u. a. Hinweise über die Variation des Pfropfreises in Abhängigkeit von der Unterlage zu geben vermögen. Über zwei solcher Versuche mit Fichte soll hier berichtet werden.

[1]) Aus der Bundesforschungsanstalt für Forst- und Holzwirtschaft Hamburg-Reinbek, Institut für Forstgenetik und Forstpflanzenzüchtung, Siekerlandstr. 2, 2070 Großhansdorf-Schmalenbeck.