



FOREST RESEARCH INSTITUTE
FRI BULLETIN No.124

INTRODUCED
FOREST TREES IN NEW ZEALAND:
RECOGNITION, ROLE, AND SEED SOURCE



3. The larches

Larix decidua Miller

Larix kaempferi (Lambert) Carr.

Larix x eurolepis A. Henry

J. T. MILLER and F. B. KNOWLES

This FRI bulletin series was compiled for people with an interest in the introduced trees of New Zealand, such as foresters, farm foresters, nurserymen, and students. It includes:

1. *Pinus nigra* Arn. – European black pine
2. *Pinus contorta* Loudon – contorta pine
3. The larches – *Larix decidua* Miller, *Larix kaempferi* (Lambert) Carr., *Larix x eurolepis* A.Henry
4. *Pinus mugo* Turra – dwarf mountain pine; *Pinus uncinata* Mirbel – mountain pine
5. *Pinus attenuata* Lemmon – knobcone pine
6. The spruces – *Picea sitchensis* (Bong.) Carrière, *Picea abies* (L.) Karsten, ornamental spruces
7. The silver firs – *Abies* spp.
8. *Pinus pinaster* Aiton – maritime pine
9. The cypresses – *Cupressus* spp.; *Chamaecyparis* spp.
10. Ponderosa and Jeffrey Pines – *Pinus ponderosa* P.Lawson et Lawson, *Pinus jeffreyi* Grev. et Balf.
11. *Eucalyptus nitens* – (Deane et Maiden) Maiden
12. Radiata pine – *Pinus radiata* D.Don
13. The redwoods – *Sequoia sempervirens* (D.Don) Endl. - coast redwood, *Sequoiadendron giganteum* (Lindley) J.Buchholz – giant sequoia, and the related ornamental genera *Taxodium* and *Metasequoia*
14. Douglas-fir – *Pseudotsuga menziesii* (Mirbel) Franco
15. The willows – *Salix* spp.

**INTRODUCED FOREST TREES IN NEW ZEALAND:
RECOGNITION, ROLE, AND SEED SOURCE**

3. THE LARCHES

Larix decidua Miller - **European larch**
Larix kaempferi (Lambert) Carr. - **Japanese larch**
Larix X eurolepis A. Henry - **Hybrid larch**

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European larch stand in autumn

ABSTRACT

This booklet, the third in the Bulletin No. 124 series, provides an account of the larches, *Larix decidua*, *L. kaempferi*, and *L. X eurolepis* in New Zealand, referring to their introduction, history, and role as exotic forest species, their recognition in the field, and the location and quality of current local seed sources.

KEYWORDS: *Larix decidua*, *Larix kaempferi*, *Larix X eurolepis*, exotic species, New Zealand, taxonomy, seed sources, distribution

INTRODUCTION AND HISTORY

Larix (larch) is a deciduous coniferous genus of about 10 species endemic to the cooler regions and mountains of the northern hemisphere. European larch (*Larix decidua*) and Japanese larch (*L. kaempferi*) have been planted on a small scale as forest trees and on farms in several regions of New Zealand. A natural hybrid between the two species, *L. X eurolepis*, has arisen occasionally where the parent species are growing in proximity, mainly in the South Island. Trees raised from small amounts of imported hybrid seed have been planted experimentally. Several other species of larch have been recorded in New Zealand but are confined to arboreta and private collections.

Natural Distribution

European larch

Larix decidua has been cultivated in Europe for over 200 years, and it is difficult to define the boundaries of its natural distribution. The main area of its natural occurrence lies in the Alps of central Europe, from south-east France through Switzerland, northern Italy, southern Germany, and north-western Yugoslavia to near Vienna in Austria. Other significant areas of distribution occur in Czechoslovakia, in central and southern Poland, and along both sides of the border in the Sudeten and Carpathian Mountains. Further small isolated stands presumed to be wild occur in Romania and the Ukraine in the USSR. Its range extends from longitude 6°E to 26°E and from latitude 44°N to 53°N (see Fig. 1).

Throughout this discontinuous range variation occurs in characteristics such as tree form, growth rates, cone size and shape, and shoot colour, and attempts have been made to separate various races. However, only in Polish larch are the characteristics considered sufficiently constant and well defined to support varietal status and this form generally is recognised as variety *polonica* or subspecies *polonica*.

Japanese larch

Larix kaempferi occurs naturally only on the island of Honshu in central Japan. It occupies several sub-alpine areas (500-2300 m a.s.l.) within a relatively small range which spans 3° of latitude (35-38°N) and 4° of longitude (136°30 to 140°30 E) (see Fig. 2). Although provenance variation has been noted, no geographical varieties have been recognised in Japanese larch.

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Fig. 1 - Natural distribution of *Larix decidua* Miller (based on McComb 1955)

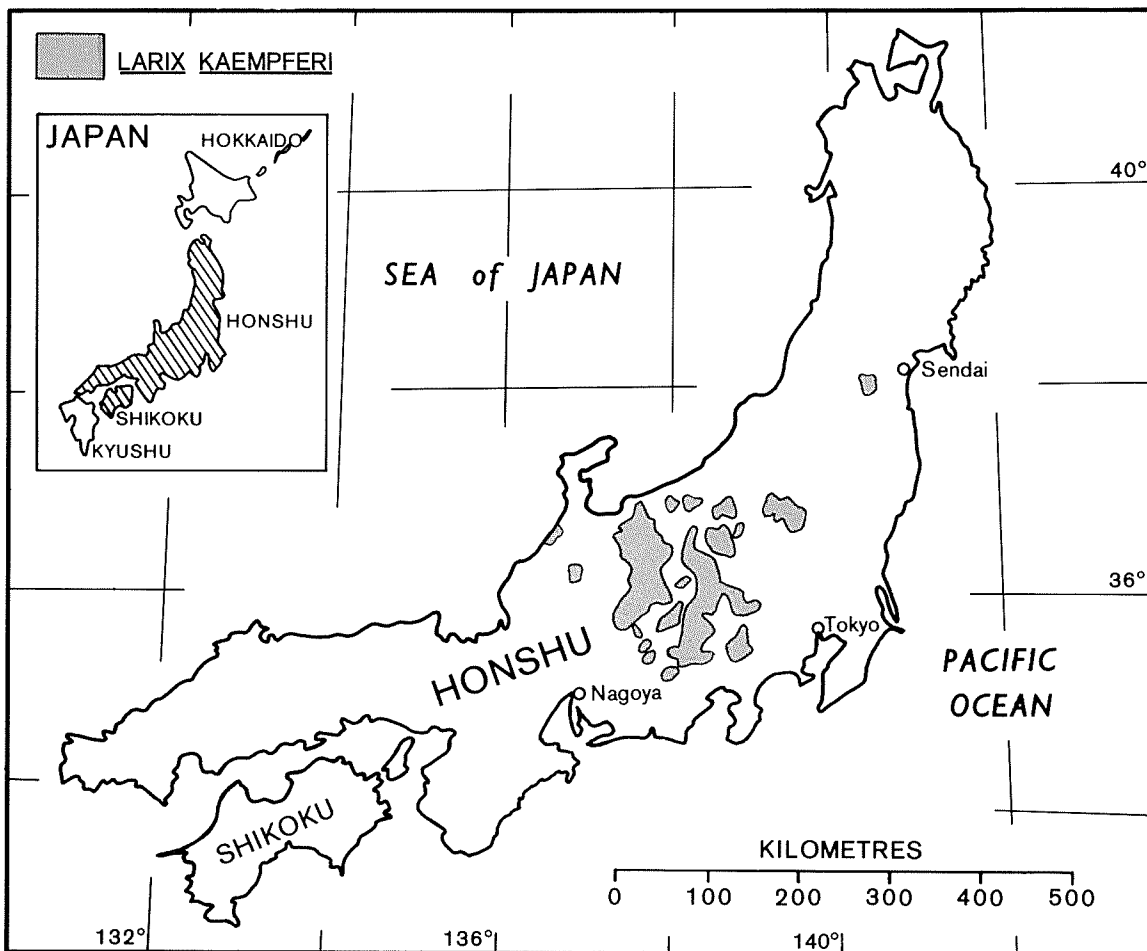


Fig. 2 - Natural distribution of *Larix kaempferi* (Lambert) Carr. (based on Katayama et al. 1964)

History in New Zealand

European larch

Because of its long history of cultivation in Europe, European larch had already acquired an established reputation as an important forest and timber species when first introduced into New Zealand in about 1850. It was planted initially at several localities in Canterbury, Nelson, and Southland, and then c. 50 years later was established at Waiotapu Forest in the North Island (Weston 1957). It proved easy to raise in nurseries and early growth rates were comparable to those obtained overseas. By 1912 it had become the major species in afforestation programmes, the total area in plantations being about 2400 ha, about 700 ha more than exist today.

Attacks on European larch by needle cast fungi and the larch canker fungus *Lachnellula wilkommii* were reported at about the same time widely throughout Britain. Although larch canker never reached New Zealand, it was feared that it might. Furthermore, the more rapid early growth of some other species, notably radiata pine, was having an increasing impact on the choice of exotic species. Consequently European larch fell into disfavour and has not been planted extensively since.

Typically, most early plantings were made according to the European custom of close spacing (4 x 4 feet). Neglected for years thereafter, apart from instances where a light thinning was carried out, the plantings turned into stands of crowded, poorly crowned trees. Although these stands gave a false picture of the potential of the species their poor quality helped to discourage further planting.

Japanese larch

Japanese larch was introduced into New Zealand in about 1900, somewhat later than many other exotic conifers. It was planted first in Canterbury, and later at widely separated localities in both the North and South Islands. Planting remained on an experimental scale until the 1950s when interest in the species was revived temporarily, resulting in plantings of 15 ha in Canterbury, c. 100 ha in Nelson, and 20 ha in the central North Island. In some areas of Golden Downs Forest it was planted in mixture with Douglas fir, primarily to achieve fuller site utilisation but also to broaden management options and improve control of branch size in the Douglas fir. Following this phase of interest, its use diminished and, as with European larch, it has not been planted widely since.

Provenance Variation

Extensive provenance trials of European and Japanese larch were established in 1957 and 1959 to study general variation of these species in New Zealand (Miller and Thulin 1967). Japanese larch, originating from discontinuous zones within a rather compact area of Honshu, emerged as the more uniform species, showing only small differences in height, diameter, and malformation. European larch proved more variable, the most vigorous lots being from Czechoslovakian sources (Sudeten and Tatra Mountains), closely followed by those from Poland and the eastern Alps. Trees of western alpine provenances, as a group, were clearly slower growing than the rest. In general the growth of both species in New Zealand was similar to that in their homelands. However, the Japanese species grew best on certain sites from Rotorua to Nelson, exceeding the growth of European larch planted there. The best growth of European larch occurred mainly in the eastern and central parts of the South Island, from North Canterbury to western Otago, where it out-performed Japanese larch.

The trials included representative provenance lots of both species from New Zealand plantations and these grew very well, compared with trees from the overseas provenances. European larch introduced into New Zealand before and at the turn of the century is presumed to have originated from Switzerland or Austria directly, or indirectly via Scotland. In the trials it grew faster than trees of the eastern alpine provenances, which it might have been expected to resemble. Although the early introductions of Japanese larch into New Zealand are also of unknown origin (one import was received via Austria), there is little natural variation in this species. Growth of Japanese larch from New Zealand seed sources was as good as, or better than, that from the overseas provenances.

It was concluded that the trees previously introduced into New Zealand were of good genetic quality, and that there would be no advantage in making further seed imports of either species.

The natural hybrid between European and Japanese larch, *Larix X eurolepis*, first arose in Dunkeld, Scotland, in about 1885. In Britain and Europe it has been cultivated under the name "Dunkeld larch". The hybrid has since been produced artificially. Two hybrid progenies derived from selected Danish parent trees were included in the 1957/59 New Zealand provenance trials. On all sites they grew faster, produced greater volumes, and were straighter than any of the trees raised from provenances of the pure species (Table 1). This superiority was more pronounced at northern New Zealand sites; in Southland their height growth was little faster than that of trees from the best provenance of European larch.

The good performance of these particular hybrids owes much to the outstanding quality of the parents selected in Denmark. By comparison, examples of the original "Dunkeld" hybrid larch from Scotland have grown at only average rates in New Zealand plantations. Production of superior hybrid larch from selected New Zealand parents has been attempted. Both seed and cuttings have already been produced experimentally, but resulting stock has not yet been evaluated.

**TABLE 1: Mean heights of larch provenance trials in New Zealand
18 years after planting**

Species	No. of origins	Provenance group	Mean height (m)
Hybrid*	2		14.7
Japanese (natural stands)	13		12.7
European(natural stands)	4	Tatra Mt	12.6
	3	Sudeten Mt	12.3
	4	E. Alps	11.6
	5	Poland	11.3
	2	W. Alps	8.6
	(plantations)	2	New Zealand
	6	Europe	12.2

* Danish 'elite' hybrid progenies

Pests and diseases

European and Japanese larch are affected by a similar range of pests and diseases. The larch canker fungus, *Lachnellula wilkommii*, the cause of the major larch disease in Europe, has not been found in New Zealand. However, several fungi appear regularly, including the needle fungus, *Meria laricis*, which attacks both larch species sometimes causing severe, but temporary, defoliation. Both larches are also hosts to *Dothistroma pini* and, consequently, were once subject to restrictions on movements of nursery stock around the country in accordance with quarantine regulations. They are secondary hosts to a poplar rust, *Melampsora larici-*

populina, although this is probably of minor significance. Occasional attacks by *Armillaria* spp. and *Phomopsis* spp. have also been recorded. In the 1960s an unidentified heart rot was found in European larch at Cheviot in the South Island.

Insects attacking the larches include a looper caterpillar, *Pseudocoremia suavis*, and certain tortricids. The manuka beetle, *Pyronota festiva*, which can build up to enormous numbers in mid-summer, defoliates larch. There are also reports of sporadic attack by wood borers of several species, including *Ernobius mollis* and the huhu grub, *Prionoplus reticularis*.

Neither larch species shows marked susceptibility to any particular insect or fungal pathogens; attack can sometimes be related to improper siting. In some forests where small or isolated stands of larch have been planted among pine, possums have singled out the larch for browsing, occasionally causing severe damage by ringbarking older trees high in the crown. In general, however, both European and Japanese larch are relatively healthy compared with many other exotic forest species in New Zealand. Japanese larch is probably the more trouble free of the two.

RECOGNITION

Larix decidua Miller - European larch

Habit: Tree up to 35 m or more in height in New Zealand. In young, actively growing trees, crown conical and fairly symmetrical becoming more irregular with age, especially in open grown trees (Fig. 3). Upper branches ascending or level, and basal branches often descending with upturned tips. Branchlets often long and pendulous. In New Zealand stands, typically slender-stemmed with a light open crown (Fig. 4). Lean and butt sweep occur frequently, especially in older stands.



Fig. 3 - The growth habit of open grown European larch

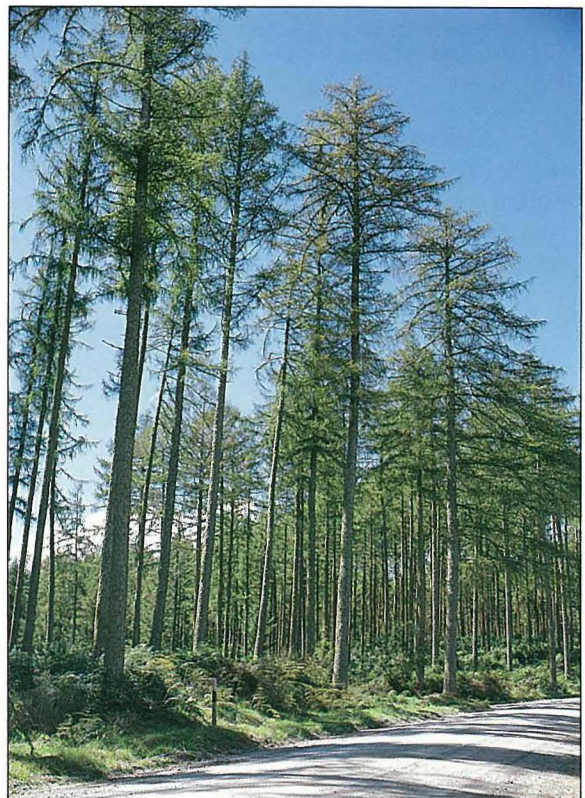


Fig. 4 - Mature stand of European larch. Note slender stems and light open crowns.

Bark: In young trees thin and smooth; greenish to grey-brown, becoming greyish or yellowish brown to red-brown in older trees; fissured with scaly ridges which shed small plates with pinkish under-surfaces. In older trees becoming very thick especially near the base (Fig. 5; cf. *L. kaempferi* bark in Fig. 6).



Fig. 5 - Typical bark of mature European larch



Fig. 6 - Typical bark of mature Japanese larch

Foliage: Leaves deciduous, spirally arranged on the longer main shoots; in bundles or fascicles of 30-65 on the short shoots; 1.5-4 cm long, 0.5-0.9 mm wide; flattened, thin, and soft; fresh light green when they emerge in spring, becoming darker green. Under-surface with two greenish bands of stomata (Fig. 7; cf. foliage of *L. kaempferi* in Fig. 8). Leaves turning yellow to orange-yellow in autumn before dropping (see frontispiece).



Fig. 7 - Foliage and typically straw coloured branchlet of European larch

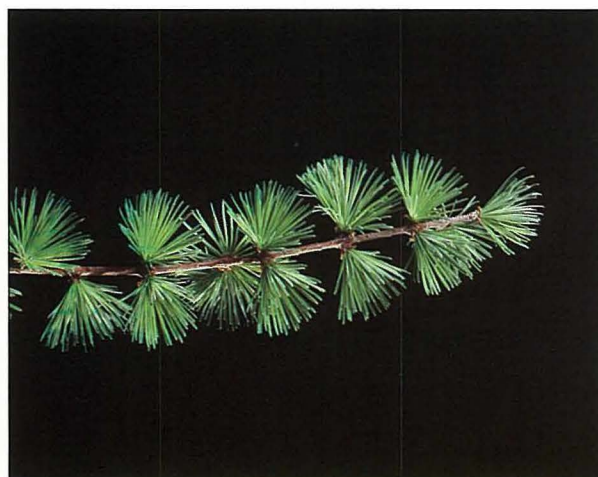


Fig. 8 - Foliage and typically purplish brown, waxy branchlet of Japanese larch

Branchlets: At first typically straw coloured or pale yellowish brown (Fig. 7; cf. *L. kaempferi* in Fig. 8) (occasionally pinkish or brownish grey), becoming grey to grey-brown in the second year; furrowed and grooved with well spaced leaf scars. Hairs usually absent or a few long hairs may be present at first.

Male Cones: Appear in the spring, commonly on the underside of weak pendulous shoots; opening as whitish flat-topped discs, often pale purple round the edge, becoming pale yellow as the centre expands and pollen is shed.

Female Cones: Appear early in spring before the leaves; usually towards the end of strong shoots; at first typically reddish purple or pink (occasionally green or white), later turning pale green with purplish scale margins and bright pink or occasionally green bracts between the scales; bracts not reflexed (Fig. 9; cf. cones of *L. kaempferi*, Fig. 10). Ripening to light brown, and weathering to greyish; ovoid to cylindrical, 1.5-4.5 cm long, c. 2-3.5 cm wide when open. Shape and size of cone to a large extent reflects origin, in general grading from big conic cones in trees originating from the western alpine provenances to small ovoid cones in var. *polonica* or ssp. *polonica* from Poland. Scales straight or incurved, downy at the base, bracts between the scales slightly exerted or hidden.



Fig. 9 – Mature and immature cones of European larch



Fig. 10 – Mature and immature cones of Japanese larch. Note reflexed scale tips.

Seeds: Small, 3.5-5 mm long, and about the same in width; pale yellowish brown to reddish brown, mottled; ovoid. Wing membranous, up to 12 mm long, light chestnut brown or yellowish brown (Fig. 11). Seeds ripen in the first year and are shed in autumn or early in the following spring. Seed is very difficult to extract, except from var. *polonica*.



Fig. 11 – Winged seeds (right, above) and dewinged seeds (right, below)

Larix kaempferi (Lambert) Carr. - Japanese larch

Habit: Quite similar to that of *L. decidua*, but tending to have a slightly denser crown and less pendulous branchlets (Figs. 12 and 13) than *L. decidua*.



Fig. 12 - Mature stand of Japanese larch



Fig. 13 - Young, open grown Japanese larch

Bark: In young trees reddish, becoming red-brown to grey-brown, later shedding in flakes or strips, typically remaining thin (Fig. 6).

Foliage: Leaves deciduous, spirally arranged on the main or long shoots, densely crowded especially near the tips; in fascicles or bundles of 40 or more on short shoots; 1.5-4 cm long, 0.6-1.0 mm wide, typically slightly wider than those of *L. decidua*; flattened, thin, and soft; usually blue-green with two conspicuous whitish or greenish grey bands of stomata on the undersurface (Fig. 8). Leaves turning yellow to orange-yellow in autumn before falling.

Branchlets: Typically reddish brown to purplish brown (Fig. 8) occasionally yellowish, usually with a glaucous or bloomy covering, frequently covered with soft brown hairs, sometimes without hairs; leaf scars usually very close together.

Male Cones: Appear in the spring, prolifically from an early age, along the underside of all but the main shoots; yellow; becoming elongated and droplet shaped, smaller than those of *L. decidua*.

Female Cones: Appear early in the spring before leaves; usually on strong shoots; at first typically pink and cream but sometimes green or yellow; bracts strongly reflexed, usually with a purplish pink centre and cream edges, occasionally dark red, pink, or yellow. Ripening to light brown and weathering to greyish; ovoid or globose, 1.5-3.5 cm long, 1.5-3.5 cm wide, typically with strongly recurved scales giving the cones a rosette-like appearance. Scales slightly downy on the outside; bracts mostly hidden (Fig. 10).



Seeds: Small, 3-4 mm long; very pale greyish brown to dark brown; ovoid. Wing 9-11 mm long, membranous, pale yellowish brown to chestnut-brown (Fig. 14). Seeds ripen in the first year and are easy to extract from the cone (unlike those of *L. decidua*).

Fig. 14 - Seeds of Japanese larch, typically slightly smaller and paler than European larch

TABLE 2: Summary of differences between European and Japanese larch

	<i>L. decidua</i> European larch	<i>L. kaempferi</i> Japanese larch
Habit	Open foliage, very long pendulous branchlets	Denser foliage, less pendulous branchlets
Bark	Becomes thick and fissured with scaly ridges as tree matures	Typically remains much thinner
Leaves	Usually bright green, with pale greyish green bands below	Usually blue-green, with conspicuous white bands below
Shoots: 1st year	Typically straw coloured, shiny, with no waxy bloom or wax	Typically reddish to purplish brown, with waxy bloom
2nd year	Greyish	Reddish
	Leaf scars well spaced	Leaf scars close together
Male cones	More or less globular, usually not prolific	Elongated or droplet shaped, prolific from an early age
Female cones	Very young cones typically pink, red, or purple	Very young cones typically greenish; bracts green, with pink edge, or occasionally plain green
	Bracts not reflexed	Bracts usually strongly reflexed
	Mature cones usually conical	Mature cones usually globular
	Scales straight or incurved	Scales usually strongly recurved
Seed extraction	Difficult except in small-coned Polish form	Easy

Differences between the larches

The hybrid between *L. decidua* and *L. kaempferi*, *L. X eurolepis* A. Henry, is very variable but usually intermediate between the parents in habit and botanical characteristics (see Table 2). Sometimes, however, hybrid larch may resemble one parent more than the other. Young trees are usually distinguishable in the nursery from those of the parent species by faster growth and longer leaves, especially on the leading shoot.

Other species of larch are rare in New Zealand. Attempts to grow Western larch (*L. occidentalis* Nutt.) have been largely unsuccessful, because few plants have survived the nursery stage. *Larix occidentalis* is distinguishable from *L. decidua*, *L. kaempferi*, and *L. X eurolepis* by its whitish young shoots and very distinctive cones with long protruding, straight, or slightly recurved bracts.

ROLE OF THE SPECIES

Present Extent

Currently there are approximately 3400 ha in plantations formerly owned by the Forest Service, divided almost equally between European and Japanese larch (Table 3), representing a timber resource in excess of 2 million cubic metres. The area of larch under private ownership in New Zealand is estimated to be less than 400 ha. Mixed stands in which larch is the predominant component occupy a further 2000 ha.

TABLE 3: Area of state planting in European and Japanese larch

	European larch (ha)	Japanese larch (ha)	Mixtures (ha)
North Island	1078	1379	622
South Island	644	272	1533
Total	1722	1651	2155

A large proportion of the European larch resource is in age classes from 60-80 years and is gradually being harvested and replaced with faster-growing species. The annual production of sawn larch between 1974 and 1978 averaged 23 000 cubic metres. This resource will probably be utilised gradually, except where trees are retained for their landscape value.

Growth and Yield

In both species, early height growth is fairly vigorous, being 0.5-1.0 m per year over the first 5-6 years. In the forest, young trees are slender, with little taper. By age 30, typical stand trees are 16-20 m high, with breast height diameters of 25-30 cm. Older trees (i.e., 60-80 years) reach 35 m or more in height and 40-50 cm in diameter when given sufficient space. Larches are deep-rooting trees, and windthrow is uncommon. However, butt sweep is evident in many older New Zealand stands, being most noticeable on exposed sites. It is less evident among naturally regenerated trees or more recent stands which have had a better start, in terms of nursery stock, establishment practice, or shelter.

There are difficulties in quantifying optimal growth and yield in New Zealand because, without exception, older stands have been grossly neglected during most of the rotation. A comparison of the performance of unthinned European larch in New Zealand with that of unthinned plantations in Europe was made by T.T.C. Birch (see Table 4) in 1930 (Forest Service unpublished data). Despite the difficulties inherent in such a task Birch concluded that larch grows well in New Zealand.

TABLE 4: Comparison of unthinned stands of European larch in New Zealand with thinned stands in Europe

	Age (yr)	Mean height (m)	Mean d.b.h. (cm)	Stems/ha	Total standing volume (m ³ /ha)
New Zealand ⁽¹⁾	45	28	25	852 ⁽³⁾	441
Europe ⁽²⁾	45	23	27	729	298

⁽¹⁾ Based on growth rate for New Zealand site class I: 18 m at 25 yrs.

⁽²⁾ Based on growth rate for United Kingdom site class I: 24 m at 50 years

⁽³⁾ "Crop trees" only.

Weston (1957) estimated, optimistically it seems, that under a suitable regime European larch could yield 105 m³/ha of round produce at first thinning (at height: 12 m), 315 m³/ha over two or more subsequent thinnings, and a final crop of sawlogs of 350 m³/ha. Measurement of stands of various ages has shown Japanese larch to be generally similar in yield to European larch. At Whakarewarewa Forest a 41-year-old, unthinned stand yielded 450 m³/ha on clearfelling. The first yields of roundwood from the thinning (at 13-15 years) of provenance trials at Hanmer showed that European and Japanese larch were very similar (Table 5). The Danish hybrid larch performed significantly better, having 40% more residual volume after thinning.

TABLE 5: First roundwood yields from a Hanmer trial thinned at age 13-15 years

Larch	No. of provenances	Extracted			Residual			
		No. of posts per ha	No. of stays per ha	Volume (m ³ /ha)	Mean height (m)	Mean d.b.h. (cm)	Basal area (m ² /ha)	Volume (m ³ /ha)
Hybrid*	2	1762	1950	83	13	15	18	94
Japanese	15	1160	216	28	11	13	14	67
European	11	1107	274	29	11	13	14	66

*Danish 'elite' hybrid progenies.

Uses

European larch produces a light coloured wood (Fig. 15) of moderately high density (560 kg/m³ at 12% moisture content). Japanese larch wood is slightly lower in density (496 kg/m³). The strength properties of the two species are very similar, as are their uses. An abrupt transition between earlywood and latewood results in alternating soft and hard bands in successive growth rings, but the wood has excellent toughness and stiffness; it is as good as or better than Douglas fir. Sawing is straightforward, but the timber has a slight tendency to splinter and "pick out" at knots during machining. The knots themselves are small,

numerous, and tight. Care is required in seasoning. Generally, larch air dries readily. With care it can be kiln-dried from the green state, although there is a tendency to check, cup, or bow if dried too rapidly. Sapstain is uncommon. There is a high proportion of heartwood even in trees of small diameter. However, contrary to initial expectations based on European experience, the heartwood has not proved durable in contact with the ground in New Zealand. Larch heartwood cannot be impregnated with preservatives but the sapwood is penetrable to oil-type preservatives under pressure. Larch has a slight corrosive action on iron nails and shows some tendency to end-splitting. To obtain the best results it should be drilled before nailing.

The National Timber Grading Rules (NZS 3631) for larch provide for a Dressing Grade, a Standard Building Grade, and Box Grade, but not an Engineering Grade. Larch has been approved as a framing timber since 1975. It is popular for roof tile battens because of its small knot size and has been used for floors, scaffold planks, beams, columns, and other exacting uses where toughness is needed. It is suitable for lamination.



Fig. 15 - Centre sawn log of European larch (75 yr). Note narrow sapwood band, coloured heartwood, small knots, and prominent grain.

Fig. 16 - (below) Log house built in 1986 mainly of European larch



Larch is an attractive decorative timber for feature walls and ceilings. It may be sawn as shiplap or tongue and groove, and sand-blasted to accentuate the contours of its surface grain. Larch roundwood is popular for rustic work and larch weatherboards for exterior cladding, picket fences, and wicket gates.

A recent and successful application for larch is in the construction of log houses (Fig. 16). Requirements for this are moderate sized logs (20-35 cm small end diameter) with minimal taper, which are readily available in some under-thinned New Zealand stands. For this use, resistance of the timber to insect or borer attack is a natural advantage of larch, as is its inherent strength. Care must be taken in preparation of the logs, ensuring that debarking and seasoning are accompanied by anti-sapstain treatment and followed by an effective general preservative treatment (e.g., applications of zinc naphthanate diluted with turpentine). The house illustrated is mounted on a platform of ground-retention treated poles of radiata pine.

Larch kraft pulps have high tear factor and reasonable tensile strength. In many respects they resemble those from Douglas fir or from radiata pine slabwood, and could probably be used in admixture with radiata pine. Larch pulp would be suitable for end-uses where a high tear factor is required, such as packaging papers.

Larches are especially favoured for their landscape value in exotic forests and in the countryside. Being mountain trees, they suit landscape planting in upland situations with wide perspectives in which their seasonally contrasting foliage and winter branch colours may be used effectively. As farm shelter, larch is particularly useful for east-west shelterbelts because of its deciduous habit, which minimises winter shading and frosting.

Silviculture

Both European and Japanese larch should be grown without check during the rotation. The objective is to do so economically, avoiding overstocking, unsaleable thinnings, and invasion by weeds. Larch is both space demanding and light demanding: overcrowding results in attrition of the crown, from which recovery is very slow. Traditional overseas tending schedules for larch include early and regular thinnings, which depend upon ready markets for a variety of intermediate produce. Such opportunities are limited in New Zealand, although efforts to produce roundwood and firewood commercially have met with some success in the past.

A suggested approach to growing larch in New Zealand is to select sites where weed invasion (especially from gorse and broom) is unlikely. Plant at 1250 stems/ha (4 x 2 m) with high quality stock, reducing this to the best 400 stems/ha at a top height of 8-10 m, pruning to 3 m at the same time. Sheep and cattle may be grazed in stands as soon as trees are big enough to withstand damage but, as larch foliage is highly palatable and slender trees can be pushed over, the timing and intensity of grazing require careful consideration. Subsequent thinnings should be carried out aiming at a final stocking of 200 stems/ha (rotation length: 60-80 years).

Both species of larch have been used in mixed stands with other species such as Douglas fir, western red cedar (*Thuja plicata*), and grand fir (*Abies grandis*). Mixtures should not be more integrated than three-row bands of each species. Underplanting of well-established, older larch with shade tolerant species, including Douglas fir, may be effective provided that the larch is at a low density (not more than 200 stems/ha). For example, both western red cedar and hemlock (*Tsuga heterophylla*) have regenerated naturally under larch in Hanmer Forest. The longevity of larch (80-100 years or more) is well established. In mixed stands, the aim usually will be to carry a final crop of larch through to the end of the rotation of the underplanted species. On the other hand there may be scope to use larch simply as an expendable component in a self-thinning mixture, e.g., with Douglas fir, its effect then being to reduce the branch size of the latter species.

At some upland sites in the South Island, European larch spreads freely by natural regeneration. However, spreading is uncommon in the North Island, perhaps because of poorer seed set (see Cone Collection in Section A of Seed Users' Guide). Japanese larch has regenerated in the vicinity of parent stands at Hanmer. As with some other introduced trees with a similar propensity, occasional heavy grazing pressure appears to prevent the spread of regeneration.

Siting

Larch is capable of growing at moderately high altitudes in New Zealand. In experimental work at Craigieburn Forest Park, European larch has been grown up to 1100 m a.s.l., and has shown production forestry potential up to 900 m a.s.l. Japanese larch is less amenable, and its use above 600 m a.s.l. is not recommended.

Unfortunately the tolerance of larch to higher altitudes has sometimes obscured its broader siting requirements. These include shelter from excessive wind and free drainage in soils which nevertheless provide sufficient moisture in spring to permit annual replenishment of foliage. Adverse sites for larch include coastal sands or dry, stony, lowland flats. It does not thrive on sites with impeded or imperfect drainage, but will grow on fertile clay soils with a reasonable rooting depth. It is very susceptible to frosting at the time of flushing, and hence sites lacking air drainage during late frosts should be avoided.

Future Role of the Species

Japanese and European larches are challenging species to manage profitably in New Zealand and are unlikely to assume more than minor importance. However, they are assured of an enduring place in the countryside. They provide variety and colour in New Zealand plantations and in certain scenic areas where they are environmentally compatible. Fears for their health have so far proved unjustified, and uses have been found for their timber. A steady demand for seed in small quantities, about 2-3 kg of each species annually, is evidence of a sustained interest in larch.

SEED SOURCE

Seed of European and Japanese larches is available through Proseed New Zealand, P.O. Box 1946, Rotorua. All such seed originates from registered seed sources representing the best genetic quality available.

Choice of larches as afforestation species should be based on an understanding of special siting requirements, their poor weed suppression capability, and their need for regular thinning. If these aspects are resolved their tough, versatile timber, sawn or used as roundwood, and their attractive, seasonally variable appearance may appeal to the grower.

SEED USERS' GUIDE

A. Collection and extraction of larch seed

	European larch	Japanese larch
Age of first flowering	8-10 years	10-15 years
Seed available in quantity	15-20 years	20 years
Pollen production	Late Sept to early Oct	Mid Aug-Sept; always a little earlier than European larch
Cone maturation period	6-7 months	
Cone collection	As soon as seed ripens, March-June. Assess ripeness by cutting test. Ripe seed coats are hard. Note that cone development tends to proceed whether seed is fertilised or not. Many empty seeds occur in some North Island collections of European larch. Spent cones of both species persist on tree.	
Periodicity of crop	Some cones usually produced every year	Good crops at 2-5 year intervals
	Good crops irregularly at 2-4 year intervals	
Harvesting	Climbing and branch hooks	
Mature cone recognition	Light brown colour; avoid persistent old cones, which are dull grey-brown	
Seed extraction	Usually kilning (8 hrs at 50°C)	
	Sometimes needs tumbling or grinding	Easier to extract than European larch
Seed per hectolitre of cones	0.8-2.5 kg	0.9-1.2 kg
No. of seeds per kg	130 000-170 000	250 000-300 000
Storage conditions	Dry store at 4°C	
Storage duration	3-5 years	3-4 years
Stratification	Not essential with fresh seed, 0-4°C for 20-60 days for older seed	
Expected germination	20-60%	35-50%

B. Nursery practice

Sow seed in beds under cover in October-November. Uncover beds promptly after seed germination is complete. Plant as 2/0, well-wrenched stock.

C. Recommended seed sources

Seed source no.	Locality	Year planted	Area (ha)	Provenance and description
European larch				
CY26	Cpt 58 Hanmer Forest, Canterbury	1959	19.3	Seedlot CY57/287. Second generation Hanmer stock. Ancestry unknown; presumed to be Austrian. Imported c.1900.
CY5	Cpt 12 Omih Forest, Canterbury	1949	0.6	Seedlot C47/181 collected from Hanmer SFP. Ancestry presumed to be Austrian. Imported c. 1900.
Japanese larch				
NM5	Cpts 203/204 Golden Downs Forest, Nelson	1963	21.8	Seedlot HO60/480 imported from Nagano-Ken, Japan. Blanked with similar seedlot HO 62/491.
CY27	Cpt 58 Hanmer Forest, Canterbury	1959	3.4	Seedlot HO 57/447, a commercial seedlot from Kyoto, Nagano, Japan.

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