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| Author(s) | MARTINSSON, Owe; TAKATA, Katsuhiko |
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International Family Test of Eurasian Larch Species

MARTINSSON Owe^{1*} and TAKATA Katsuhiko²

¹ Swedish University of Agricultural Sciences,

Jamtland County council Institute of rural Development 840 73 Bispgården, Umeå, Sweden

² Institute of Wood Technology, Akita Prefectural University 11-1 Kaeizaka, Noshiro 016-0876, Japan

Abstract

Larch (*Larix sp.* Mill.) is a natural element of the boreal forest. Different species of *Larix* dominates the boreal forests of Eurasia. Larch also had a natural distribution in Scandinavia nine thousand years ago but disappeared for unknown reasons in prehistoric time. It was reintroduced by man in the 18th century and has for a long time attracted interest from forestry in Scandinavia. One major obstacle for reintroduction of Siberian larch in Scandinavia has been availability of seed sources for establishing test plantations. A co-operation between three Russian research institutes on one side and two organisations in Scandinavia on the other started in 1996. Seed was collected from 1005 individual trees distributed over 17 regions and 45 larch stands from Kamchatka in the east to Onega in the west. Seedlings were produced in 2002 and family field tests of 1005 families were established in Sweden and Norway in 2003. In addition to 7 family test plantation areas in Scandinavia similar test plantations are being established in northwest Russia (Komi and Archangelsk), China, Japan, Alaska, Saskatchewan, Minnesota, Quebec, Iceland and Finland. The results of this seed collection in Russia and establishment of international test plantations will be of big importance for the optimal selection of seed source, ecologic adaptation and economic use of Siberian larch species in the northern hemisphere.

Key words: International family test, Larch (*Larix sp.* Mill.), survivability, growth rate, adaptation

Introduction

Larch (*Larix sp.* Mill.) is a natural element of the boreal forest. Different species of *Larix* dominates the boreal forests of Eurasia (Milyutin & Vishnevetskaya 1995, Putenikhin & Martinsson 1995, Abaimov *et al.* 1998). Larch also had a natural distribution in Scandinavia nine thousand years ago but disappeared for unknown reasons in prehistoric time (Kullman 1998). It was reintroduced by man in the 18th century and has for a long time attracted interest from forestry in Scandinavia (Martinsson 1992). One major obstacle has been availability of seed sources for establishing test plantations. A co-operation between four Russian research institutes on one side and two organisations in Scandinavia one in Japan and one in the USA on the other started in 1996 (Table 1).

The objectives of this study were to report the details of the three test plantations established in Sweden and to evaluate survivability and growth performance after two growing seasons. This paper is a sequel of the previous report (Abaimov *et al.* 2002).

Materials and Methods

In phase 1 of the project seed was collected in 17 regions and 1005 individual trees from Kamchatka in the east to Onega in the west (Figure 1). Although there are several different definitions of scientific name for larch species in Siberia (Schmidt 1995), we obeyed the definition described by Abaimov *et al.* (1998).

Materials for the Swedish and Norwegian field experiments were brought up in 2002 in Alstahaug nursery in central Norway. In addition to this, seed of the same material was distributed to 9 more participants resulting in a circumpolar participation of this progeny series of Eurasian larch species (Table 2).

In the spring of 2003, one-year-old container-seedlings were planted on three main sites and ten small sites in Sweden. The three main sites for field experiments in Sweden are located in Österbymo, Särna and Järvträsk. The properties of the three sites are explained in Table 3.

Each experimental sites were established as 60 sub-plots of 30x40 m on each site. 300 seedlings, representing one region, were planted in each subplot with spacing 2x2 m (Figures 2, 3 and 4). One family (progeny of one selected tree) was represented by 3 or 4 seedlings. All regions were replicated three times in three sub-plots. Three commercial Swedish and Finnish seed sources and two Russian collections (No 18-22) were included as standards in the experiments. All seed sources and their origins are explained in Table 4.

Results and Discussion

In October 2004 the survival rate was recorded (Table 5). In Österbymo also the tree height was assessed. However the period is still too short for this estimation, only two growing seasons after plantation.

Survival

The average survival rate two growing seasons after plantation was between 70 and 90 %. The highest average survival rate was recorded in Österbymo and the lowest in Särna. The lower survival in Särna and Järvtträsk was mainly due to attack by *Hylobius abietis*. The material planted on these two sites were not treated with *Hylobius* repellents, while the material of Österbymo was treated in the nursery and two times in the summers of 2003 and 2004. Another reason, especially in Särna, was care of plantation. In several cases the seedling was planted outside the site prepared spot in Särna.

Height growth

Estimated mean heights for provenances in Österbymo were between 20 and 100 cm, two growing seasons after plantation. Shortest mean height had Yakutiya and the five tallest mean heights were provenances 14. Chabarovsk, 1. Nishnij Novgorod, 21. Maglehem, 6. Perm and 15. Sachalin. The tallest individual tree, 175 cm, was found in provenance 14. Chabarovsk.

Conclusion

Only two growing seasons is a too short period for estimation of survival, growth rate and adaptation to the three sites. The survival rate is so far very good in the most southern site Österbymo and acceptable in the two sites Särna and Järvtträsk. The seedlings from provenances 17. Evenkia and 5. Salechard were already at nursery smaller than average and this may have influenced the survival. The local hybrid larch 21. Maglehem does not fit in the northern locations and has therefore a low survival. Larch from 12. Yakutiya and 17. Evenkia are adapted to a more continental climate than anywhere in Sweden. The very fast growth and vitality of 14. Chabarovsk, 16. Kamchatka and 15. Sachalin are interesting. The long term vitality and fast growth of these provenances should be followed up carefully before any assessment can be done.

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Table 1. Participating organisations of phase 1 of the Russian-Scandinavian Larch Project – Seed Collection 1996-2001.

| Organisations | Countries |
|--|-----------|
| Swedish University of Agricultural Sciences, Umeå | Sweden |
| Helegland Forest Society | Norway |
| V N Sukachev Institute of Forest, Krasnoyarsk | Russia |
| Arkhangelsk State Engineering Society | Russia |
| Institute of Northern Biological Problems, Magadan | Russia |
| Bashkirian Botanical Garden Institute, Ufa | Russia |
| Kyushu University, Fukuoka | Japan |
| The University of Minnesota, Minneapolis | USA |

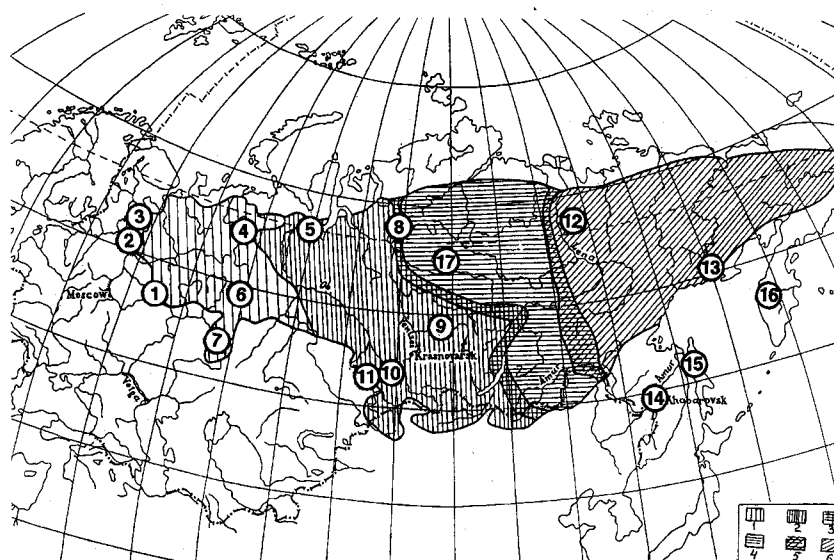


Fig. 1. 17 seed collection regions in Russia. The six different patterns are indicating larch species and their hybridisation zones 1= *Larix sukaczewii* Dyl., 2= *Larix sibirica* Ledeb., 3= *Larix czekanowskii*, 4= *Larix gmelinii* Rupr., 5= *Larix gmelinii* x *Larix cajanderii*, 6= *Larix cajanderii* Mayr.

Table 2. Participants of the International Progeny test of Eurasian Larch Species.

| Country, province | Organisations, city | Contact persons |
|-------------------|---|-------------------------------------|
| Norway | Helgeland Forest Society, Mosjøen | Jaap Buitink Gisle Skaaret |
| Sweden | SLU; Umeå | Owe Martinsson |
| Arkhangelsk | NFRI, Arkhangelsk | Natalia Demidova Vladimir Barzut |
| Komi | Komi Science Centre, Syktyvkar | Aleksey Fedorkov |
| Japan | Akita Prefectural University, | Katsuhiko Takata |
| China | Beijing University, Beijing | Shen Xi Huan |
| Alaska | U S Forest Service, Alaska, Fairbanks | John Alden |
| Saskatchewan | Agriculture and Agri-Food Canada, Indian Head, Saskatchewan | Bill Schroeder |
| Minnesota | University of Minnesota | Andrew David |
| Quebec | Ministry of Forest, Quebec | Gaston Lapointe |
| Iceland | Iceland Forest Service | Thröstur |

Table 3. Localities and site properties of the three main test sites in Sweden.

| Locality | Latitude, Longitude, Altitude, | | | Topography | Soil |
|-----------|--------------------------------|--------|-----|-----------------------|-----------------|
| | N | E | m | | |
| Österbymo | 57°47' | 15°37' | 250 | Slight southern slope | Gravelly morain |
| Särna | 61°31' | 13°00' | 540 | Slight western slope | Stony morain |
| Järvträsk | 65°11' | 19°31' | 410 | Steep eastern slope | Sandy morain |

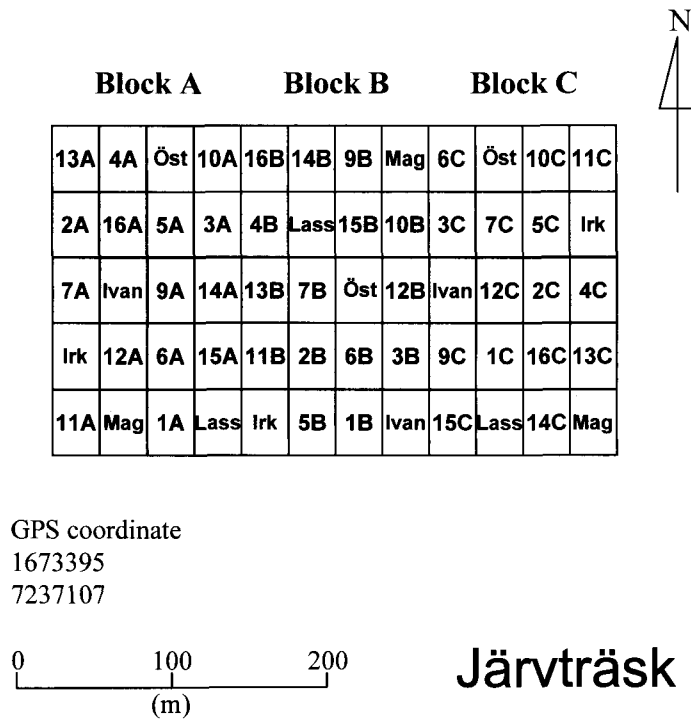


Fig. 2. Design of experimental plot in Järvträsk

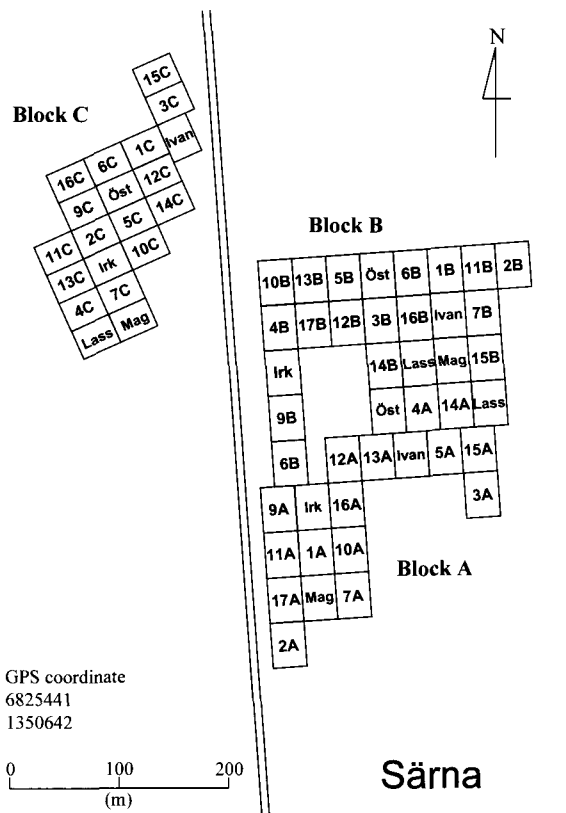


Fig. 3. Design of experimental plot in Särna.

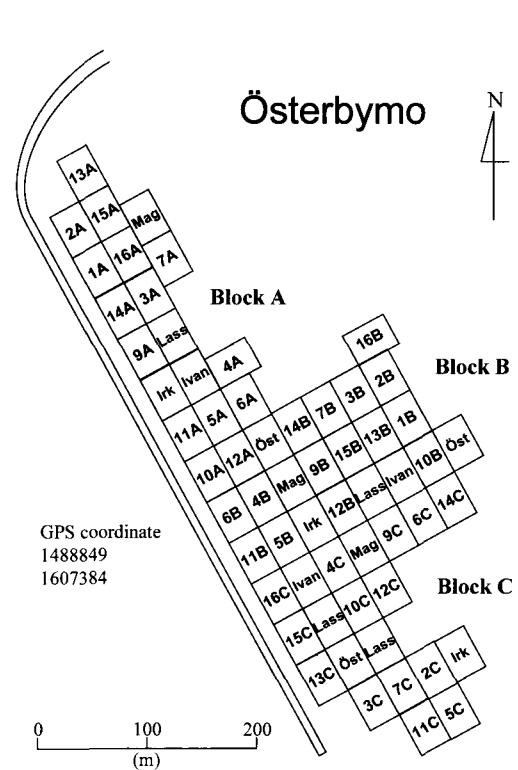


Fig. 4. Design of experimental plot in Österbymo.

Table 4. Seed sources and their origins in the three Swedish main test sites, Österbymo, Särna and Järvtträsk.

| Number of region | Name of region | Site | Nearest village | Latitude N | Longitude E | Elevation, m | Number of selected seed trees | Species of larch |
|------------------|------------------|------|----------------------|------------|-------------|--------------|-------------------------------|-------------------------|
| 1 | Nizhnij Novgorod | A | Vetluga | 57° 30' | 45° 10' | - | 7 | <i>Larix sukaczewii</i> |
| | | B | " | 57° 30' | 45° 10' | | 29 | <i>Larix sukaczewii</i> |
| | | C | " | 57° 30' | 45° 10' | | 17 | <i>Larix sukaczewii</i> |
| | | D | " | 57° 30' | 45° 10' | | 13 | <i>Larix sukaczewii</i> |
| 2 | Plesetsk | A | Emtsa | 63° 05' | 40° 21' | 100 | 20 | <i>Larix sukaczewii</i> |
| | | B | Korasi | 63° 00' | 40° 25' | 120 | 25 | <i>Larix sukaczewii</i> |
| | | C | Sheleksa | 62° 09' | 40° 19' | 120 | 18 | <i>Larix sukaczewii</i> |
| 3 | Onega | A | Leskhoz Onezhskii | 64° 01' | 38° 15' | 110 | 7 | <i>Larix sukaczewii</i> |
| 4 | Petchora | A | Usinsk | 66° 00' | 57° 48' | | 64 | <i>Larix sukaczewii</i> |
| 5 | Salechard | A | Beloyarsk | 63° 41' | 66° 44' | 60 | 20 | <i>Larix sukaczewii</i> |
| | | B | Kharp | 66° 56' | 65° 45' | 130 | 20 | <i>Larix sukaczewii</i> |
| | | C | Labytnangi | 66° 28' | 66° 39' | 40 | 20 | <i>Larix sukaczewii</i> |
| 6 | Perm' | A | Okhansk, Yugo-Kamsky | 57° 19' | 55° 27' | 160 | 20 | <i>Larix sukaczewii</i> |
| | | B | Nyazepetrovsk, Uzaim | 56° 09' | 59° 32' | 460 | 20 | <i>Larix sukaczewii</i> |
| | | C | Kyshtym | 55° 43' | 60° 27' | 480 | 20 | <i>Larix sukaczewii</i> |
| | | D | Nizhnij Tagil | 57° 30' | 59° 48' | 350 | 12 | <i>Larix sukaczewii</i> |
| | | E | Sotrimo | 59° 27' | 60° 59' | 110 | Mix of 30 trees | <i>Larix sukaczewii</i> |
| 7 | Ufa | A | Maginsk | 55° 45' | 56° 58' | 370 | 20 + mix of 10 | <i>Larix sukaczewii</i> |
| | | B | Miass | 54° 58' | 60° 07' | 380 | 20 + mix of 10 | <i>Larix sukaczewii</i> |
| | | C | Zlatoust | 55° 07' | 59° 30' | 600 | 20 | <i>Larix sukaczewii</i> |
| | | D | Ziliar | 52° 13' | 57° 25' | 550 | Mix of 10 trees | <i>Larix sukaczewii</i> |
| | | E | Bolshoy Iremel | 54° 33' | 58° 57' | 1200 | 10 | <i>Larix sukaczewii</i> |

| | | | | | | | | |
|----|-----------------------------|---|-------------------------|-----------|----------|----------|----|--|
| 8 | Norilsk | | | | | | | <i>Larix sibirica</i> |
| 9 | Boguchany | A | Boguchany | 58° 39' | 97° 30' | 158 | 27 | <i>Larix sibirica</i> |
| | | B | Karabula | " | " | 96 | 25 | <i>Larix sibirica</i> |
| | | C | | " | " | -- | 23 | <i>Larix sibirica</i> |
| 10 | Novokuznetsk | A | | 53° 48' | 88° 00' | mountain | 20 | <i>Larix sibirica</i> |
| | | B | | 54° 12' | 88° 42' | " | 20 | <i>Larix sibirica</i> |
| | | C | | 52° 48' | 87° 24' | | 20 | <i>Larix sibirica</i> |
| 11 | Altai | A | Kosh-Agash | 50° 16' | 87° 54' | 1630 | 26 | <i>Larix sibirica</i> |
| | | B | Kosh-Agash Karnagalu | 50° 12' | 87° 47' | 1580 | 26 | <i>Larix sibirica</i> |
| | | C | Kosh-Agash, Turgune | 50° 14,5' | 87° 3' | 1630 | 26 | <i>Larix sibirica</i> |
| 12 | Yakutiya | A | Zhigansk | 66° 45,5' | 123° 22' | 70 | 20 | <i>Larix cajanderi</i> |
| | | B | Zhigansk | 66° 51' | 123° 21' | 80 | 20 | <i>Larix cajanderi</i> |
| | | C | Zhigansk | 66° 45' | 123° 22' | 90 | 20 | <i>Larix cajanderi</i> |
| 13 | Magadan | A | | 59° 30' | 150° 15' | 60 | 25 | <i>Larix cajanderi</i> |
| | | B | | 59° 20' | 152° 30' | 100 | 25 | <i>Larix cajanderi</i> |
| | | C | | 59° 30' | 148° 30' | 80 | 25 | <i>Larix cajanderi</i> |
| 14 | Khabarovsk | A | Vaninskyi | 49° 08' | 149° 00' | 90 | 20 | <i>Larix gmelinii</i> var <i>olgensis</i> |
| | | B | Vaninskyi | 49° 09' | 149° 00' | 100 | 20 | <i>Larix gmelinii</i> var <i>olgensis</i> |
| | | C | Vaninskyi | 49° 12' | 149° 00' | 125 | 20 | <i>Larix gmelinii</i> var <i>olgensis</i> |
| 15 | Sachalin (missing data) | | | | | | 60 | <i>Larix gmelinii</i> var <i>japonica</i> |
| 16 | Kamchatka (missing data) | | | | | | 60 | <i>Larix gmelinii</i> var <i>kamchatica</i> |
| 17 | Evenkiya | A | Tura | 64° 19' | 100° 13' | 285 | 25 | <i>Larix gmelinii</i> |
| | | B | Tura | 64° 19' | 100° 14' | 310 | 25 | <i>Larix gmelinii</i> |
| | | C | Tura | 64° 17' | 100° 16' | 270 | 25 | <i>Larix gmelinii</i> |
| 18 | Lassinmaa | | Seed orchard (Fi) | | | | | <i>Larix sukaczewii</i> |
| 19 | Ivanov | | Seed stand (Ru) | | | | | <i>Larix sukaczewii</i> |
| 20 | Irkutsk | | Seed stand (Ru) | | | | | <i>Larix sibirica</i> |
| 21 | Maglehem | | Seed orchard (S) | 55° 46' | 14° 10' | 20 | | <i>Larix eurolepis</i> |
| 22 | Östteg | | Seed orchard (S) | 63° 48' | 20° 16' | 10 | | <i>Larix sukaczewii</i> |

Table 5. Rate of survival on three experimental sites two growing seasons after plantation.

| Number | Region/Provenance | Österbymo | | Järvträsk | | Särna | |
|--------|-------------------|-------------|------------------------|-------------|------------------------|-------------|------------------------|
| | | Survival % | N of planted seedlings | Survival % | N of planted seedlings | Survival % | N of planted seedlings |
| 18 | Lassinmaa | 93.6 | 900 | 86.9 | 885 | 87.4 | 900 |
| 3 | Onega | 95.6 | 524 | 88.4 | 524 | 81.5 | 524 |
| 19 | Ivanov | 97.3 | 823 | 88 | 900 | 76.4 | 900 |
| 10 | Novokuznetsk | 97.4 | 900 | 90 | 900 | 72.7 | 900 |
| 9 | Boguchany | 96 | 900 | 87.3 | 900 | 75.7 | 900 |
| 2 | Plesetsk | 98.7 | 900 | 84.8 | 900 | 75.2 | 900 |
| 16 | Kamchatcka | 97 | 900 | 82 | 900 | 78.7 | 900 |
| 7 | Ufa | 96.4 | 900 | 87.8 | 900 | 72.6 | 900 |
| 11 | Altai | 91.8 | 900 | 90.2 | 900 | 74.6 | 900 |
| 13 | Magadan | 94.8 | 900 | 87.3 | 900 | 70.4 | 900 |
| 4 | Petchora | 86.8 | 900 | 81.7 | 900 | 80.9 | 900 |
| 6 | Perm | 96.6 | 900 | 82.7 | 900 | 68.8 | 900 |
| 5 | Salechard | 79 | 900 | 89.2 | 900 | 79.6 | 900 |
| 15 | Sachalin | 96.6 | 900 | 80.3 | 900 | 68.3 | 900 |
| 1 | Nishnij Novgorod | 94.7 | 900 | 85.2 | 900 | 62.3 | 900 |
| 20 | Irkutsk | 93.7 | 900 | 87.7 | 448 | 56.2 | 450 |
| 22 | Östteg | 90.9 | 900 | 84.1 | 900 | 62.3 | 900 |
| 14 | Chabarovsk | 97.8 | 900 | 80.1 | 900 | 42 | 900 |
| 21 | Maglehem | 87.1 | 900 | 70.1 | 448 | 26 | 450 |
| 12 | Yakutiya | 38.3 | 900 | 79.4 | 900 | 63.4 | 900 |
| 17 | Evenkia | | | | | 26.8 | 235 |
| | Total | 90.9 | 17547 | 84.9 | 16705 | 69.4 | 16959 |