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Population variability of vegetative organs of Dahurian larch in Eastern Transbaikalia

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Abstract

The available information on the morphological diversity and localization of the morphological forms of Dahurian larch (*Larix gmelinii*) in Siberia is currently insufficient. This research seeks to fill the knowledge gaps to some extent. The paper describes the population variability of vegetative organs of *Larix gmelinii* growing in Eastern Transbaikalia, Russia. The problem is approached by studying a complex of morphological characters of natural *Larix gmelinii* populations along the Transbaikalian rivers. Also, the habitat conditions of Dahurian larch coenopopulations were recorded for further analysis of the connection between the morphological characters and the habitat parameters. The study established the values of morphological characters and their variability limits and traced the localization patterns of the morphological forms of Dahurian larch in the river basins. Moreover, the morphological characters of larch vegetative organs were found to relate to the location and the habitat conditions of the coenopopulations. The research materials can be useful for correcting the larch seeding zones in Transbaikalia, establishing larch genetic reserves, and introducing new morphological forms into the selection for urban beautification and protective plantations. The study provides additional information on the morphological variability patterns of *Larix gmelinii* for the area of species in general.

Keywords: Eastern Transbaikalia, *Larix gmelinii*, vegetative organs, population variability

Introduction

Larch forests are widespread in Russia, especially in Siberia. The extensive range of larch, having various growing conditions, determined its species diversity, population variability and growth-form diversity (Bobrov 1972, Bobrov 1978, Abaimov and Koropachinsky 1979, Abaimov and Koropachinsky 1984, Abaimov and Milyutin 1995, Milyutin 2003, Zhuravlev et al. 2010, Milyutin 2016). Knowledge about the biodiversity of larch makes it possible to discover the evolutionary and geographical patterns of ecotype formation, to localize populations (ecotypes) that are valuable for a number of useful features and properties, and to properly organise their protection and management.

The morphological diversity of Dahurian larch (*Larix gmelinii*), growing in certain areas of Eastern Transbaikalia, was studied by Karpel (1975), Cruklis et al. (1977), Makarov (2005, 2010) and his team (Makarov et al. 2002, 2010), and Barchenkov (2008, 2011a, 2011b) in co-authorship with Milyutin (2007, 2008) and Jamiyansuren (2012). Many recent works have been devoted to the genetic diversity of larch species and particularly *Larix gmelinii* (Hu and Ennos 2001, Larionova and Yakhneva 2003, Yakhneva 2004, Larionova et al. 2004, 2007, Katyshev et al. 2006, Semerikov and Polezhaeva 2007, Oreshkova 2009, 2012, Zhuravlev et al. 2010, Oreshkova et al. 2012, 2013a, 2013b, Zhang et al. 2013). However, morphological variability of *Larix gmelinii* in the greater part of Transbaikalia remains understudied. This paper aims to fill in some knowledge gaps and to supplement the available research material on the variability of vegetative organs of *Larix gmelinii*.

Materials and methods

The research was conducted in Transbaikalia (Zabaikalsky Krai, Russia), from 2007 to 2012. Naturally scattered timber of *Larix gmelinii* with sparse crown closure was chosen for investigation in order to reduce the influence of competitive interactions between the trees on organ formation. The studied timbers were more often located on the southern slopes of ridges and in river floodplains. The research comprised a total of 37 forest communities having *Larix gmelinii* (Figure 1).

We recorded the geographical coordinates, elevation above sea level (a.s.l. BES), steepness and direction of the slopes, and hydrotope according to Pogrebnyak (1955),

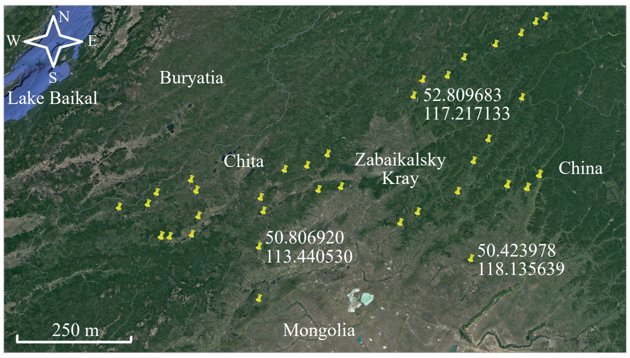

Figure 1. Location of the studied plots having *Larix gmelinii* in Eastern Transbaikalia

depth of soil and soil texture, type of the plant community, and general description of the forest stand. The studied plots were located at an elevation from 480 to 1,014 m a.s.l. BES; the steepness of the slopes reached 40 degrees. The average age of the timber stand was 50–60 years; the average diameter was 30–35 cm and the average height was 17–20 m. The crown closure varied from 5 to 50%.

As a rule, 30 trees per plot were examined. Parameters measured included the girth of the trunk at breast height, the height of the trunks (using an altimeter), the angle of branch attachment in the middle part of the crown, the thickness of the boughs in the lower part of the crown, the trunk straightness (on a five-score scale, where 5 – straight monocormic; 4 – straight bifurcate; 3 – slightly crooked monocormic; 2 – slightly crooked bifurcate; 1 – very crooked in more than one dimension), and the length and width of the crown.

Larch needles were sampled from 10 trees on 2- and 3-year shoots, growing on the southeast side of the middle part of the crown. The number of needles was counted in 10 bundles. In the laboratory, the length of 10 randomly selected needles was measured; the crown shape (width/length) and the relative crown length (crown length/trunk height, %) were calculated. The variability of characters was assessed according to Mamaev's scale (Mamaev 1973).

Results

Relative height. This research revealed that the average relative height of *Larix gmelinii* in Eastern Transbaikalia was 53.1 ± 1.7, and the value of the silvicultural characteristics varied significantly (Figure 2).

Reliable differences in the value of the characteristics were observed in river basins. The relative height in the larch populations in the Onon basin was reliably lower while in the Argun basin it was reliably higher (Figure 3).

The average population variability of the characteristics was rather high (CV = 23.5%). In the basins of the Onon and Argun rivers, there was observed a moderate level of variability (CV = 19.5–20.0%), and in the basins of the Ingoda, Khilok and Shilka rivers the variability was found to be rather high (CV = 21.6–29.2%).

The quality, or straightness, of the trunk. In the studied plots in the Eastern Transbaikalia, there were observed 57% of straight monocormic trees, 34% of slightly crooked trees, 2% of very crooked in more than one-dimension trees, 4% of slightly crooked bifurcate trees, and 3% of straight bifurcate trees. The average quality of the trunk in *Larix gmelinii* was 4.1 scores on the applied scale.

In the river basins, the quality of the trunk varied significantly and can be characterized as follows: the reliably high percentage of straight trees in the forest stand was noted in the Ingoda basin (70.3%); the smallest percentage of straight trees was observed in the Khilok basin (40.9%); the highest percentage of slightly crooked monocormic trunks was found in the Khilok basin (46.2%); bifurcate (both straight and slightly crooked) trees appeared rather common in the Onon basin (13.9%); very crooked in more than one dimension trees appeared more common in the Khilok basin while no such trees were noted in the Shilka basin (Figure 4).

According to Mamaev's scale (Mamaev 1973), the average variability of the characteristics was rather high (CV = 27%). It featured a high variability in the trunk quality the basins of the Onon and Khilok rivers (CV = 31%).

The thickness of the boughs. In the studied plots, the average thickness of the boughs in the lower part of the crown was 5.3 cm. At that, the minimum mean value was recorded in the Argun basin (4.8 cm) while the maximum one, in the Ingoda basin (5.9 cm). The variability of the

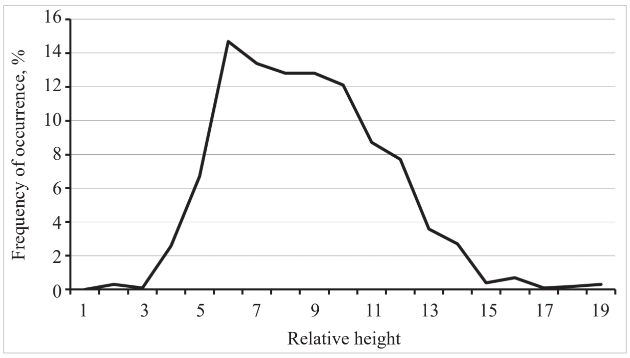

Figure 2. Limits of relative height variability of *Larix gmelinii* in Eastern Transbaikalia

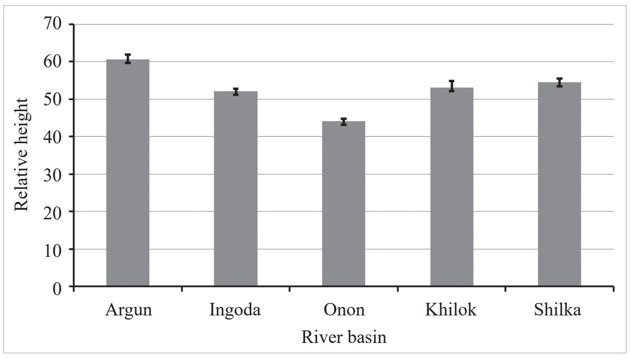

Figure 3. Relative height of *Larix gmelinii* in the basins of the Eastern Transbaikalian rivers

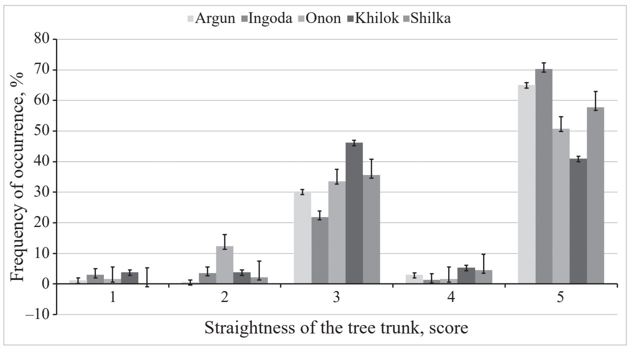

Figure 4. Quality (straightness) of the tree trunks in the basins of the Eastern Transbaikalian rivers

Scores: 5 – straight monocormic; 4 – straight bifurcate; 3 – slightly crooked monocormic; 2 – slightly crooked bifurcate; 1 – very crooked in more than one dimension

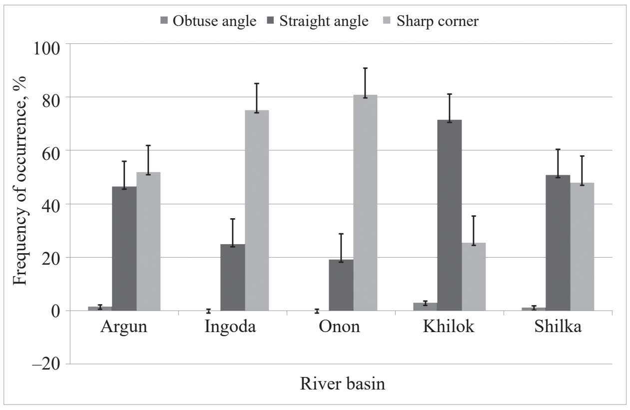

Figure 5. Occurrence of larches with different angles of branch attachment in the river basins

character appeared high and very high ($CV > 40\%$). The limits of bough thickness variability were 1.0–23.0 cm in the Argun basin; 2.0–13.0 cm in the Ingoda basin; 2.0– 15.0 cm in the Onon basin; 3.0–15.0 cm in the Khilok basin, and 2.0–20.0 cm in the Shilka basin.

For the dry hydrotopes, the thickness of the boughs in the lower part of the crown averaged to 7.4 cm, which was reliably 1.6–2.8 cm more than for the fresh, wet and moist habitats. The smallest thickness was found in the fresh hydrotopes (4.6 cm); slightly higher in the moist (5.6 cm) and wet habitats (5.8 cm).

The angle of branch attachment. This study found the average angle of branch attachment, relative to the trunk axis, to be 80 degrees. The variability of this character was very low (5%) in the Argun basin, low (7–8%) in the basins of the Ingoda, Onon and Khilok rivers, and medium (13%) in the Shilka basin.

In the studied plots, trees with an acute angle of branch attachment (62%) prevailed; trees with a right angle of branch attachment reach 37%, and trees with at an obtuse angle (drooping branches) only 1%.

In the river basins, the ratio of trees with acute, straight and obtuse angles of branch attachment varied. In the basins of the Argun, Ingoda and Onon rivers, larches with acute angles predominate, while in the basins of the Khilok and Shilka rivers there were more trees with horizontally formed branches (Figure 5).

The angle of branch attachment tended to decrease from dry to wet habitats. In the wet habitats the angle was significantly less than in dry ones. In dry habitats, the angle was equal to 82 ± 1.5 degrees, while in the wet habitats it was 79 ± 2.5 degrees.

The length of the crown depends on the height and age of the tree, illumination in the habitat, and the inheritable ability to self-prune. The average length of the larch crowns in the studied plots reached 13.5 m and varied in the river basins. The maximum mean length of the crowns was noted in the Ingoda basin (14.8 m), and the minimum one (11.8 m) in the Onon basin. The variability of the character is rather high *(CV* = 21–28%). The minimum length of the crown (3.0 m) was noted in the Argun basin, and the maximum one (26.0 m) in the Ingoda basin (Table 1).

The width of the crown. The average width of the *Larix gmelinii* crown was 7.8 m. In the river basins, the character ranged from 6.3 to 8.4 m, however, along the Khilok river it was notably less (6.3 ± 0.2 m). The coefficient of crown width variation was rather high (CV = 21–27%) in the basins of the Ingoda, Onon and Shilka rivers and high (CV = 31–35%) in the basins of the Argun and Khilok rivers. The minimum width of the crown was 3.0 m, and the maximum one, 20.0 m, was found in the Argun basin (Table 2).

The crown shape. In this study, a simplified approach was applied: the ratio of the length of the crown to its width. Conditionally, the crowns were divided into three groups: *domed* if the length to width ratio is less than 1; *spherical* if the length to width ratio is approximately equal to 1; and *elliptical* if the length to width ratio is equal to 2. In general, the length to width ratio in the studied plots was as follows: ellipsoidal crowns prevail with 70.2%, spherical crowns reach 29.6%, and domed crowns amount only 0.2%. In the river basins, the length to width ratio differs markedly. The domed shapes were very rare; they were found only in the Shilka basin (1%). Spherical shapes were the most common in the Onon basin (57%). Ellipsoi-

Table 1. Crown length of *Larix gmelinii* in the basins of the Eastern Transbaikalian rivers

Indicator	Argun	Ingoda	Onon	Khilok	Shilka
$x_{av} \pm m_x$	14.1 ± 0.3	14.8 ± 0.2	11.8 ± 0.2	13.1 ± 0.3	13.1 ± 0.2
n	129	306	182	132	240
Limit	5.5–21.7	9.5–26.0	5.5–17.5	6.0–20.0	3.0–23.2
CV (%)	23.0	21.0	26.0	22.0	28.0

Table 2. Crown width of *Larix gmelinii* in the basins of the Eastern Transbaikalian rivers

Indicator	Argun	Ingoda	Onon	Khilok	Shilka
$x_{av} \pm m_x$	8.3 ± 0.3	8.2 ± 0.1	8.4 ± 0.2	6.3 ± 0.2	7.7 ± 0.1
n	129	306	182	132	240
Limit	4.0–20.0	3.2–14.0	3.0–14.0	3.0–14.0	3.5–15.7
CV (%)	35.1	21.0	29.0	31.2	27.3

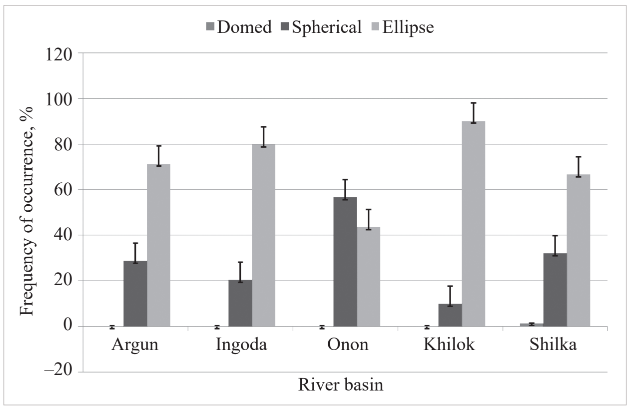

Figure 6. Distribution of the crown shapes of *Larix gmelinii* in the basins of the Eastern Transbaikalian rivers

dal shapes prevailed in the basins of the Argun, Ingoda, Khilok and Shilka rivers (Figure 6).

The larch crowns differed markedly in the basins of the Onon and Hilok rivers. The average length to width ratio was reliably higher in the Khilok basin (2.2 ± 0.1) and reliably less in the Onon basin (1.5 ± 0.0). The population variability of the character is moderately high (CV = 25– 30%) in the basins of the Ingoda and Onon rivers and high (CV = 31–35%) in the basins of the Argun, Khilok and Shilka rivers (Table 3). No connection was found between the crown shape and the hydrotope.

The relative crown length. The average value of relative crown length of *Larix gmelinii* was 83%. A greater value as compared to the data from the literature can probably be explained by the low density of stand.

The relative crown length was reliably higher in the Argun basin (89.0 ± 0.6%). The distribution of larches into

Table 3. Crown shapes of *Larix gmelinii* in the basins of the Eastern Transbaikalian rivers

Indicator	Argun	Ingoda	Onon	Khilok	Shilka
$x_{av} \pm m_x$	1.8 ± 0.1	1.9 ± 0.0	1.5 ± 0.0	2.2 ± 0.1	1.8 ± 0.0
n	129	306	182	132	240
Limit	0.8–4.4	1.0–3.4	0.8–3.8	1.1–4.5	0.4–3.7
CV (%)	32.0	25.0	30.0	31.0	35.0

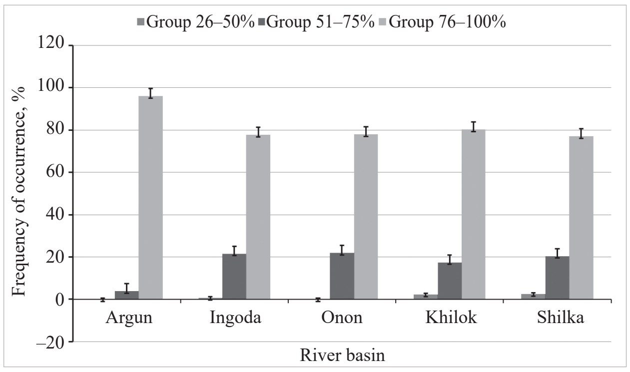

Figure 7. Distribution of larches into three groups according to the relative crown length in the basins of the Eastern Transbaikalian rivers

three groups (26–50%; 51–75%; 76–100%) according to the relative crown length pointed to the dominance of the third group (76–100%). In the basins of the Ingoda, Onon, Khilok and Shilka rivers, the share of such trees reached 77–80%. The Argun basin stood out with 96% of such trees. The share of the second group (51–75%) was 17–22%, except for the forest stands in the Argun basin where there were only 4% of such trees. The share of the first group (26–50%) is very small (from 0.0 to 3.0%) (Figure 7).

The variability of this character in the studied plots ranged from very low in the Argun basin (7.0%) to the medium in the Shilka basin (15.0%). In the basins of the Ingoda, Onon and Khilok rivers, it was characterized by a low level (11.0%).

Analysis of the relation to hydrotope showed that the relative crown length tends to decrease as the habitat moisture level improves.

The length of needles. The average needle length of *Larix gmelinii* was 22.0 ± 0.5 mm. The minimum length (16.4 mm) was noted in the Onon basin (mixed forest, the Erman mountain range, Transbaikalia) and the maximum length (27.8 mm) in the Ingoda basin (riverbed forest, the Edakuy-Talachinsky tributary). The variation coefficient was rather high (CV = 23.0%).

The needle length varied significantly along the Eastern Transbaikalian rivers. The needles of *Larix gmelinii* in the Ingoda basin were 25.3 ± 0.3 mm long, which is notably longer than in other studies plots. The minimum mean length of the needles was found in the Shilka basin, 19.5 ± 0.7 mm (Table 4).

The variability of needle length in the studied river basins is rather high (CV = 21–26%), except for the Ingoda basin where the variability of the character was medium (CV = 20.0%).

The needle length tended to increase as the habitat moisture level improves: in the dry hydrotopes the average needle length was 21.2 ± 0.8 mm, while in the wet ones, 23.0 ± 1.3 mm.

The number of needles in a bundle of *Larix gmelinii* was 26.9 ± 0.2 pcs. In the river basins, this value varies

Table 4. Needle length of *Larix gmelinii* in the basins of the Eastern Transbaikalian rivers

Indicator	Argun	Ingoda	Onon	Khilok	Shilka
$x_{av} \pm m_x$	21.2 ± 0.5	25.3 ± 0.3	22.3 ± 0.5	20.4 ± 0.5	19.5 ± 0.7
n	129	306	182	132	240
Limit	8–48	7–40	7–47	6–35	7–36
CV (%)	26.0	20.0	23.0	24.0	21.0

Table 5. Number of needles per bundle of *Larix gmelinii* in the basins of the Eastern Transbaikalian rivers

Indicator	Argun	Ingoda	Onon	Khilok	Shilka
$x_{av} \pm m_x$	29 ± 0.2	32 ± 0.2	21 ± 0.3	21 ± 0.2	31 ± 0.2
n	790	999	519	501	800
Limit	13–51	14–78	7–47	6–35	16–54
CV (%)	21	22	30	24	22

Table 6. Correlation of the larch characters with the location and the environmental conditions, where 0.3 or less is weak correlation, 0.31–0.50 is moderate correlation, 0.51–0.70 is strong correlation

Character	Latitude	Longitude	Level	Elevation above sea level	Direction of slope	Steepness of slope	Canopy closure
Relative trunk height	0.30	0.51	–0.33	–0.19	–0.11	0.17	0.33
Trunk straightness	0.04	0.09	–0.26	–0.20	0.12	0.20	0.07
Thickness of boughs	–0.04	0.09	–0.006	–0.05	0.28	0.00	0.02
Angle of branch attachment	0.02	0.09	0.05	–0.16	0.10	0.35	0.20
Crown length	–0.27	–0.33	0.07	–0.12	0.29	0.51	–0.02
Crown width	–0.36	–0.09	0.12	–0.10	0.28	0.30	–0.11
Crown shape	0.01	–0.21	0.00	–0.05	0.01	0.20	0.14
Needle length	0.32	–0.17	–0.32	0.12	0.06	–0.10	0.19
Needles per bundle	0.15	–0.02	0.13	–0.09	–0.09	–0.01	–0.05

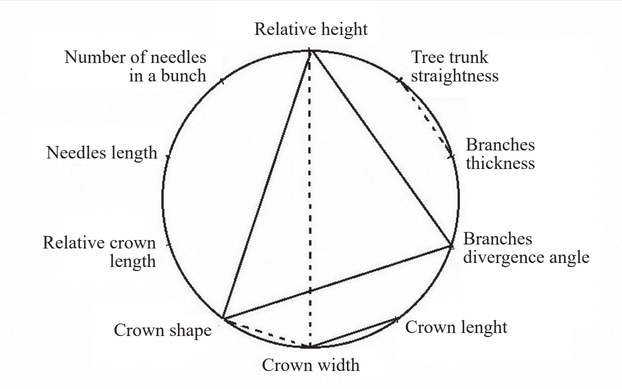

Figure 8. Moderate correlations (r = 0.31–0.50): solid line – positive, dotted line – negative

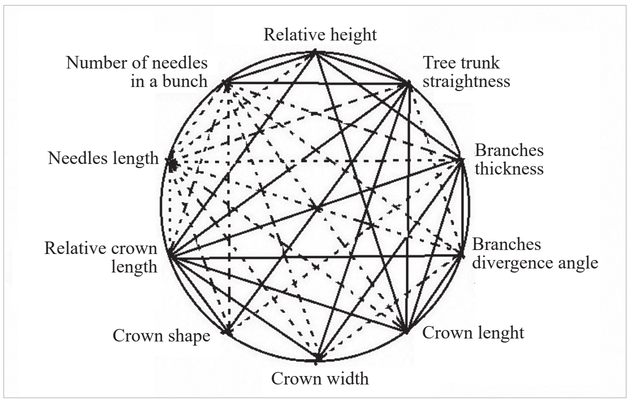

Figure 9. Week correlations (r < 0.30): solid line – positive, dotted line – negative

significantly: in the Ingoda basin it was 32 ± 0.2 pcs and in the basins of the Onon and Khilok rivers it did not exceed 21.0 ± 0.3 pcs. The variability of the character along the rivers was rather high (CV = 21–30%) (Table 5). No connection was found between the number of needles and the hydrotope.

Character correlation. There appears to be a correlation of the characters of vegetative organs of *Larix gmelinii* with the environmental conditions and the location. For example, we established a moderate positive correlation of the latitude of habitat with the relative height of the tree and the length of needles and a negative correlation with the crown width. The longitude of habitat has a significant positive correlation with the relative height of the tree and a moderate negative correlation with the crown length (Table 6).

Also, an internal correlation was found between the characters of vegetative organs of *Larix gmelinii*. A strong positive correlation can be observed between the length and the shape of the crown (r = 0.60). A moderate positive correlation (r = 0.31–0.50) is revealed between the relative height, the crown shape and the angle of branch attachment, as well as the width and relative crown length. A moderate negative correlation is found between the relative height and width of the crown, between the straightness of the trunk and the thickness of the boughs, and also between the shape and width of the crown (Figure 8).

Other characters appeared to have week correlation (r < 0.30). Interestingly, the needle length correlates with other characters only negatively (Figure 9).

Discussion and conclusions

Relative height is the ratio of the height of the tree to its girth (diameter) of the trunk at breast height (N/d). This indicator was suggested by arborist Medvedev (1884) who believed that this characteristic is hereditarily fixed by selection and can characterize the shade tolerance of tree species. Vysotsky (1962) notes that the relative height is not only an indicator of the connection of tree species and plantations with environmental conditions, but also an indicator of the growth intensity, the density of trunks and the development of forest stands.

The quality, or straightness, of the trunk is the most important characteristic of tree species. A straight trunk is crucial to obtain high-quality wood, while larches with crooked trunks can be used to create decorative plantings. The straightness of the trunk depends on the growth conditions and the hereditary features.

Usually larches have straight trunks; however, exposed to climatic, soil and phytocoenotic factors, they undergo various changes. Thus, high in the mountains in the conditions of extremely severe climate and strong winds, a single standing larch or a small group of larches, scattered among rocks and detritus above the tree line, would often feature very crooked, bent trunk and sometimes creep on the ground (Dylis 1947).

In the geographical cultures of larch in Transbaikalia, by the example of four climatypes of *Larix gmelinii* from the Amur Region, Khabarovsky Krai and Zabaykalsky Krai, the quality of trunks was estimated to average 2.5–3.9 scores. The larch climatype from the Mogochinsky forestry (Mogocha, Zabaykalsky Krai, Russia) had a low quality of the trunk while the one from the Chitinsky forestry (Chita, Zabaykalsky Krai, Russia) had a better quality of the trunk. A very high individual variability of the characteristic was noted in the larch climatype from the Mogochinsky forestry (CV = 58.8%), and a moderately high variability manifested itself in the climatype from the Amgunsky forestry (Amur Region, Russia) (Makarov et al. 2002, Makarov 2005).

The thickness of the boughs describes the general quality of timber and can be important for procurement and processing of wood. It is known that the thickness of larch boughs is, to a certain extent, determined by the age of stand, the genotype of specimens, and the density of plantation. Even if loosely arranged, larches can form boughless trunks, mostly with branches of medium thickness (Debrinyuk 2011).

The angle of branch attachment is a key characteristic when planning the planting density and selecting the desired shape of the crown in artificial plantations. Due to the thin crown, Siberian larch (*Larix sibirica*) usually has branches coming out from the trunk at right angles. This is apparent in old, free-growing trees with strong and long boughs (Dylis 1947). There are studies on the connection between the angle of branch attachment and the seed production of *Larix sukaczewii* Dylis in Arkhangelsk Region, Russia. Trees with good seeding rates were observed to have branches, attached to the trunk at an obtuse angle, while low seeding rates appeared to be typical of trees with branches appressed or attached at an acute angle (Eliseev 2002).

Debrinyuk associates the angle of attachment in European larch (*Larix decidua*) with age, growth rate and bonitet (site quality, yield class): as the angle of attachment increases to 80 degrees, the bonitet of larch reduces (Debrinyuk 2011).

The width of the crown is determined by the growth conditions and the hereditary characteristics of trees. It is important to consider the potential width of the larch crown when establishing artificial plantations.

Some researchers note a positive correlation between the width of the crown and the height and diameter of the trunk. Wide-crowned larches are observed to grow faster (Cruklis and Milyutin 1977). Nagaev (1972) points to a direct relationship between the yield of cones and the volumes of larch crowns.

The crowns of Czekanowski's larches (*Larix × czekanowskii* Szaf.) in the Transbaikalian IV–VI age class forest stocks are usually 3.5–5.0 m wide. The population variability of the crown width depends largely on the specific conditions of a particular plantation, so it varies considerably from medium to high (CV = 16–36%) (Cruklis and Milyutin 1977).

The crown shape (the ratio of the length of the crown to its width) is relevant when selecting the plants for landscaping. This characteristic largely depends on the age and the growth conditions. Barchenkov (2008) links the crown shape of *Larix gmelinii* in the Stanovoy Highlands (Transbaikalia, Russia) mainly to the altitudinal zonation. At higher altitudes the crown shape changes from ovoid to columnar (Barchenkov 2008), and this characteristic can be inheritable (Cruklis and Milyutin 1977). The crown shape of *Larix gmelinii* varies significantly (Sukachev 1912, Abolin 1929, Pozdnyakov 1975) and can take conic, ellipsoidal, spherical, domed shape, etc. (Dylis 1961, Pozdnyakov 1975).

The relative crown length (the ratio of the crown length to the trunk height) depends on the habitat conditions, the age, the inheritable ability to self-prune from the lower branches. This characteristic is an important when selecting forms of larch for industrial, protective or decorative artificial plantations.

In Yakutia, the relative crown length of *Larix gmelinii* varies between 40 and 60% of larch height, depending on the growth conditions and the density of stand (Pozdnyakov 1975). The relative crown length of Czekanowski's larches (*Larix × czekanowskii* Szaf.) in Transbaikalia is usually about 40% of the trunk height, and the fluctuations of the character are very significant – from 10 to 90%. Siberian larch (*Larix sibirica*) and Dahurian larch (*Larix gmelinii*) in Transbaikalia have approximately the same fluctuations in the crown length. The population variability of this character is reported to be high (CV = 30–42%) (Cruklis and Milyutin 1977).

The length of needles is an important characteristic responsive to the habitat conditions; it characterizes the photosynthetic activity and has a diagnostic and decorative significance.

Milyutin was apparently the first researcher to measure the needles of Czekanowski's larch (*Larix × czekanowskii* Szaf.), Siberian larch (*Larix sibirica*), and Dahurian larch (*Larix gmelinii*) (Cruklis and Milyutin 1977). He noted a clear dependence of the characteristic on habitat conditions, location on the shoot and species specificity. For example, needles of Siberian larch are, as a rule, longer than the needles of Dahurian larch. The longest needles of *Larix gmelinii* were noted in some Transbaikalian populations (the Khilok basin, village of Zagarino: 25 mm; the Shilka basin, Zilovo station: 23 mm). The shortest needles of *Larix gmelinii* were found in the populations in the Nizhnyaya Tunguska basin (village of Tura: 16 mm) and some areas of Buryatia (village of Sosnovoozersk: 18 mm).

In the Stanovoy Highlands, Barchenkov indicated the needle length of 13.9 ± 0.4 mm for the mid-mountain ecotype and 16.7 ± 0.5 mm for the floodplain ecotype. The coefficients of variation are 13.9% and 15.4%, respectively (Barchenkov 2008).

The number of needles in a bundle depends on the growth conditions and the age of the plant. It constitutes an important diagnostic characteristic. According to Milutin, *Larix gmelinii* has a larger number of needles in a bundle than *Larix sibirica*. The researcher also notes that in Transbaikalia *Larix gmelinii* was observed to have a maximum number of needles in a bundle near Nerchinsk (30 pcs) and Zagarino (31 pcs) and a minimum number near Chita (23 pcs), near Mogocha (23 pcs) and in the Nizhnyaya Tunguska basin near Tura (24 pcs) (Cruklis and Milyutin 1977).

In the Stanovoy Highlands, Barchenkov indicated 22.2 ± 0.5 needles per bundle for the mid-mountain ecotype and 23.7 ± 0.5 needles per bundle for the floodplain ecotype. The coefficients of variation are 13.3% and 12.3%, respectively (Barchenkov 2008).

To summarize, *Larix gmelinii* in Eastern Transbaikalia demonstrates: a very high population variability of the thickness of the boughs (CV = 52.2%); a high variability of the crown shape (CV = 30.6%); a rather high variability of the relative height, the straightness of trunk, the crown length, the needle length and the number of needles in a bundle (CV = 23.0–28.8%); a low population variability of the angle of branch attachment and the relative crown length (CV = 8.0–11.0%). The characters of morphological organs and the population variability vary significantly in the studied river basins.

There is a correlation of the characteristics of vegetative organs of *Larix gmelinii* with the environmental conditions and the location. For example, the angle of branch attachment and the relative crown length correlate with the slope steepness: r = 0.35 and r = 0.51, respectively. The relative height, the crown width and the needle length correlate with the latitude of the habitat (r = 0.30, –0.36, 0.32). The relative height and the crown length correlate with the longitude of the habitat (r = 0.51, –0.33). The relative height and the needle length correlate with the altitude above sea level (r = –0.33, –0.32), the relative height, and with the canopy closure (r = 0.33).

A number of morphological characters of *Larix gmelinii* form a significant moderate correlation between each other. For example, the straightness of the trunk correlates with the thickness of the boughs (r = –0.38). The angle of branch attachment correlates with the relative height (r = 0.42) and the crown shape (r = 0.37). The crown length correlates with the width (r = 0.37) and the shape of the crown (r = 0.60). The crown width correlates with the relative height (r = –0.36) and the crown shape (r = –0.49). The crown shape correlates with the relative height (r = 0.40).

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