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An attempt at indicate factors crucial for adaptation of the selected Siberian tree species (from Altai) applied in landscape architecture in Poland

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Abstract: *An attempt at indicate factors crucial for adaptation of the selected Siberian tree species (from Altai) applied in landscape architecture in Poland.* The aim of this paper is to identify the natural conditions (microclimatic and topoclimatic) which allow certain Siberian tree species (*Pinus sibirica, Larix sibirica, Picea obovata)* domesticate in a new habitat in Poland. The experiment was based on comparison between general climatic conditions in which the trees naturally grow with the conditions in an Arboretum in Rogów (Poland). Then, the reasons for the Siberian tree species' poor condition were consulted with a number of specialists: phytopathologists, a dendrologist and a plant physiologist. The next stage of the research involved examining the annual shoots' growth as well as the height of the largest individual trees in Siberia (Altai) and those in the Rogów Arboretum. Based on the results of the examination, it was assumed that the probable reason for poor adaptation of the examined trees is the duration of the vegetation season in Poland (twice as long as in Siberia), which is due to temperature sum. Moreover, it was suggested that windy areas (northern side of buildings or hills) constantly humid with high levels of ground waters are the best spots to plant Siberian trees.

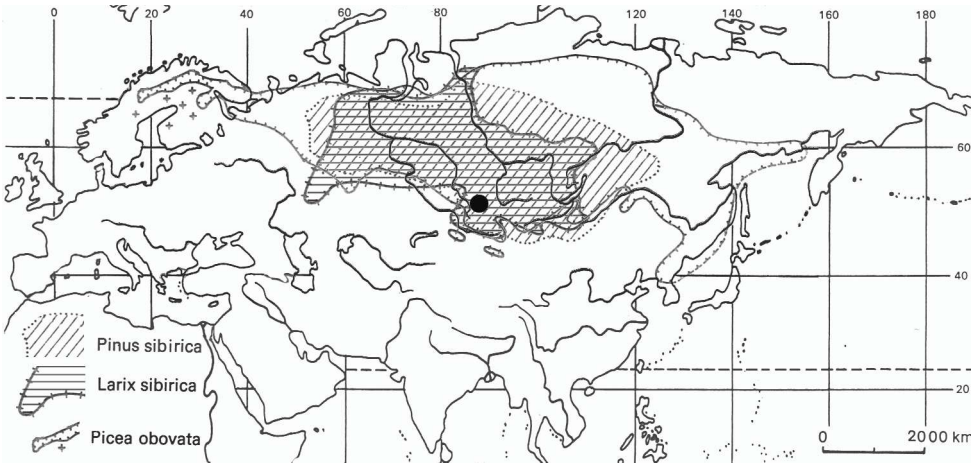
Key words: domestication, incidence, introduction, natural habitat, phonology

INTRODUCTION

A number of different tree species are used in landscape architecture in Poland and a significant part of them was artificially introduced. Most of them grow naturally in North America but also in Western Europe and Asia. It has not been discovered so far why some species adapt well in Polish climatic conditions while others suffer from them. Poorly domesticating trees are generally in a very bad condition, are quickly infected with plant disease and atrophy. The main reason for the poor condition of trees growing naturally in warmer temperature zones is freezing. But when it comes to tree species growing naturally in the cooler climate, there is no simple answer. Siberian trees such as Siberian stone pine *Pinus sibirica Du Tour*, Siberian larch *Larix sibirica* Ledeb or Siberian spruce *Picea abies subsp. obovata* (Ledeb.), whose natural habitat includes Central Siberia, poorly adapt in Poland and only few grow as long as 40 years. The research described in this paper was an attempt to identify factors crucial for adaptation of those tree species as well as answer the following question: *Is an landscape architect able to influence the condition of those tree species by creating more favourable microclimatic conditions?* Creating more favourable conditions is understood by identifying natural conditions (microclimatic and topoclimatic) in which Siberian trees should be planted: clear terrain or sheltered spots, northern or southern hillside, areas with high or low ground waters level, close to a water reservoir or in a dry spot, etc.

RESEARCH METHOD

The issue was analysed on the basis of various data and information obtained as a result of theoretical (chamber) and outdoor research. The theoretical stage consisted of two parts, the first part involved identifying the natural habitat of Siberian stone pine *Pinus sibirica* (Korylov 1983; Podbielkowski 1991), Siberian larch *Larix sibirica and* Siberian spruce *Picea abies subsp. obovata.* Based on this information, general natural conditions (only climatic), in which the examined trees grow and develop, were identified (Komarov 1973, Podbielkowski 1991).



● - location of the field experiment

Fig. 1. Incidence of Siberian stone pine, Siberian larch and Siberian spruce (Komarov 1934; Korylov 1983; Podbielkowski 1991)

The climatic factors to be taken into consideration included: annual average temperature, the lowest monthly average temperature in Winter (January), the highest monthly average temperature in the Summer (July), annual amplitude, annual rainfall, duration of the vegetation season (days with average temperatures of at least 5° C)

Due to extensive incidence of the examined trees the following factors were not considered: climatic factors (latitude, wind's influence on plants), soil (chemical and physical characteristics, diversity of soil types), orthographic (height above sea level) since they correspond with the conditions in Rogów.

Having identified the general natural conditions in natural habitats of the trees, they were compared to natural conditions in Rogów Arboretum. The following grades were used to evaluate the conditions: -1 – not acceptable, 0 – borderline, +1 -acceptable.

The next stage of theoretical research involved consulting the reasons for poor condition of the examined Siberian tree species with the following specialists: Prof. Jan Dominik (phytopathologists), Prof. Andrzej Grzywacz (phytopathologists), Prof. Jerzy Tumiłowicz (dendrologist) and Prof. Jacek Oleksyn (plant physiologist).

The outdoor research involved measuring and comparing the length of annual shoots' growth as well as the height of the largest individual trees in Siberia (Altai) and those in the Rogów Arboretum.

In Altai, the measurements were taken during the first decade of August 2004 over five days and over the distance of 50 kilometres along a path (tourist trail). The measuring process began in Tingur village $50^0$10'N $86^0$18'E located at Katun river (origins of Ob river) 850 meters above sea level and was continued as far as Akkem lakes 49^0 55'N 86^0 33'E, 2100 meters a.s.l. Measures were taken from 180 Siberian stone pines *Pinus sibirica,*180 Siberian larches *Larix sibirica* and 140 Siberian spruces *Picea abies subsp. obovata*. Every 500 meters down the trail two largest individual trees of a given species were selected and measured on the spot (the height of a tree as well as annual shoots' growth from all sides of a tree). The smaller number of Siberian spruce described in the experiment is due to the fact that it is not to be found above 1400 meters a.s.l.

In Rogów Arboretum 51^0 49'N 19^0 53'E the measurements were taken during one day (the third decade of August 2004) from all trees of the examined species existing there at that time: 44 Siberian stone pines, 31 Siberian larches and 16 Siberian spruces. The trees' height and annual shoot's growth (from the four cardinal points of the tree) were measured and the trees' condition was described.

It should be noticed that during a discussion with Prof. J. Dolatowski, a taxonomy specialist, it was discovered that the trees in Rogów Arboretum were actually Archangels

larches *Larix archangelica* Lawson (their natural incidence is limited by Ural mountains), which had been wrongly identified as Siberian larches *Larix sibirica* Ledeb. Since the Arboretum's management had refused to admit to the mistake officially, the larches from Rogów were included in this analysis as Siberian larches. My research has proved that there were significant differences in the appearance of larches growing in Altai and those in Rogów Arboretum. The results of the measurement were compared having calculated their statistical as mean (arithmetical average), standard deviation, number of events, range.

RESULTS

The results of theoretical and outdoor researches are presented in Tables 1-2.

Table 1. Comparison of the natural conditions in the natural habitat (≈Syberia) of the examined trees (Siberian stone pine, Siberian larch and Siberian spruce) with the conditions in Rogów Arboretum.

Environmental factors	**≈ Siberia** [Walter and Lieth 1960)	**Rogów** [Bednarek 1993]	**Grade**
average temperature in January	-20-30 °C	-3,2 °C	-1
average temperature in July	13-20 °C	17 °C	0
min. temperature	-77,8 °C	-34 °C	-1
max. temperature	31 °C	35 °C	0
average annual amplitude	33-50 °C	20 °C	-1
max. annual amplitude	108,8 °C	69,2 °C	-1
rainfall	300-700 mm	595,6 mm	+1
Duration of the vegetation season (days with average temperature of at least 5^0C)	90-150 days	215 ±15 days	-1

Table 2. Specialists' opinions about the reasons for poor domestication of the examined Siberian tree species in Poland

Specialist	**Opinion- reasons for poor domestication of Siberian trees**
Prof. Jan Dominik (phytopathologists), Prof. Andrzej Grzywacz (phytopathologists)	One of the reasons could be the danger from the domestic entomofauna and microflora. However, research shows that both domestic and alien species are exposed to this danger in similar ways (Dominik 1998)
Prof. Jerzy Tumiłowicz (dendrologist)	Different character of year seasons and resulting phonological phenomena; longer Spring and Fall season
Prof. Jacek Oleksyn (plant physiologist)	Too high temperature sum in Rogów, probable lack of growth-stopping mechanisms (photoperiodic mechanism, inability to transport photosynthates)

The photos below present the shoots (stone pine, larch and spruce) of two comparable trees growing in Altai and Rogów (Fig. 2-4).

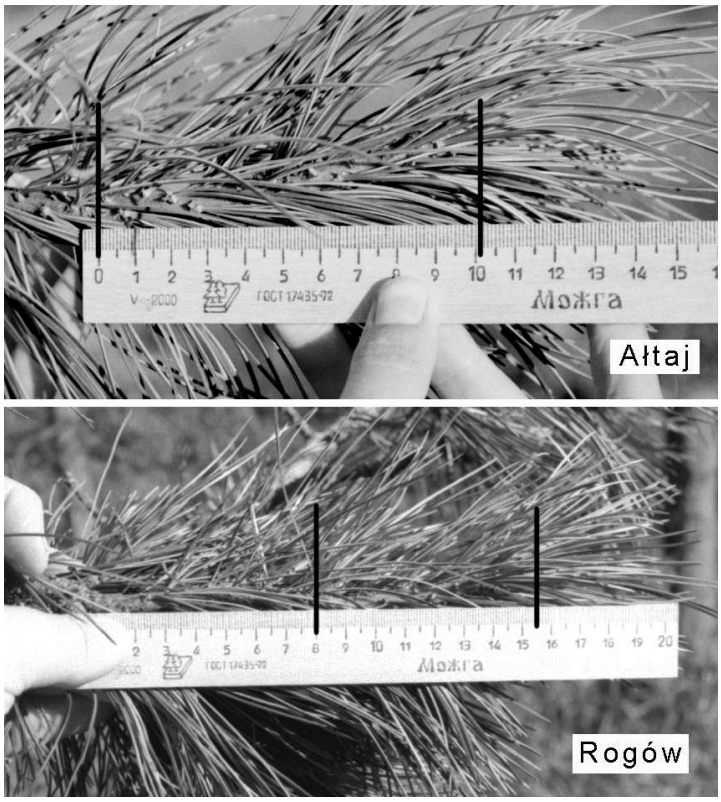


Fig. 2. Comparison between the annual shoots' growth of Siberian stone pine in its natural habitat (Altai) and in Rogów Arboretum. Black lines mark the ends of a shoot.

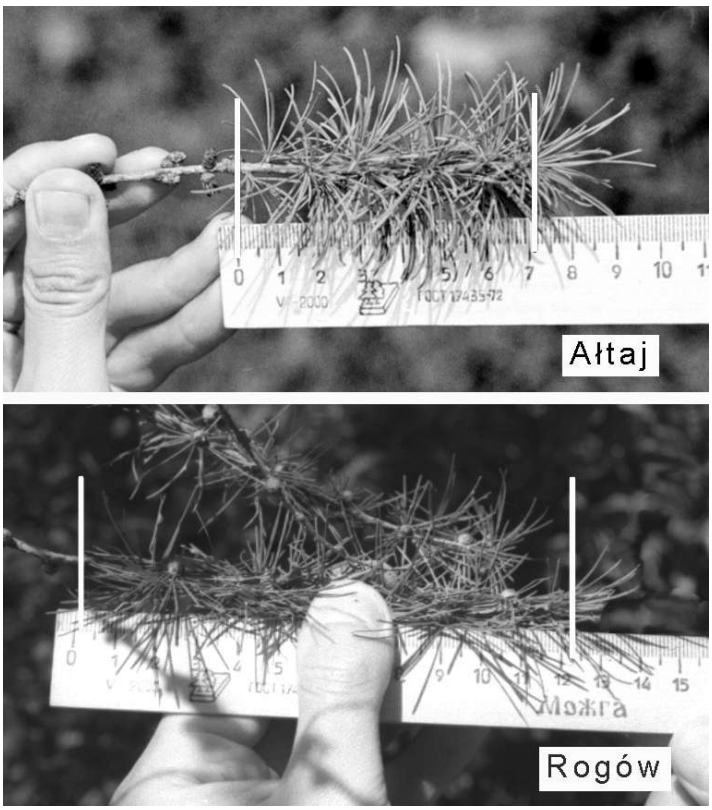


Fig. 3. Comparison between the annual shoots' growth of Siberian larch in its natural habitat (Altai) and in Rogów Arboretum. White lines mark the ends of a shoot

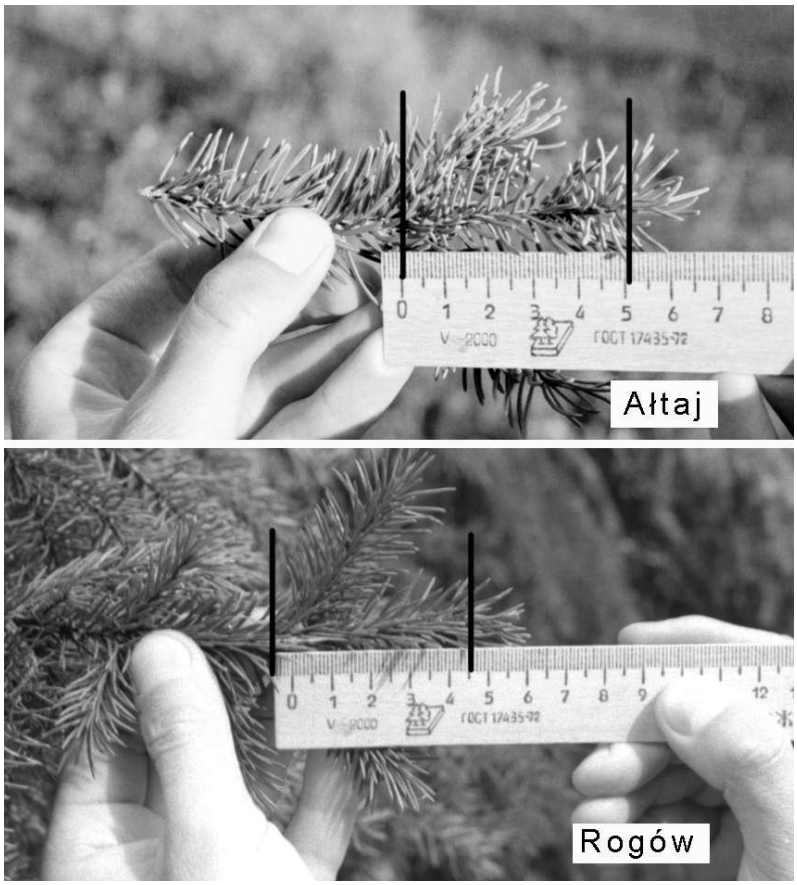


Fig. 4. Comparison between the annual shoots' growth of Siberian spruce in its natural habitat (Altai) and in Rogów arboretum. Black lines mark the ends of a shoot

Even rough analysis of the photos (Fig. 2-3) shows the difference in length of annual shoots of both Siberian stone pine and Siberian larch in their natural habitat (Altai) and in Rogów Arboretum. Photos of Siberian spruce do not show significant differences in annual shoots' growth, which was proved by statistic calculations.

Table 3. Statistic calculations length of annual shoots' growth of the examined trees in their natural habitat (Altai) and in Rogów Arboretum

	Altai				**Rogów**			
	Mean	SD	n	Range	Mean	SD	n	Range
Siberian stone pine	10,5	0,67	180	7,0-13,6	7,5	0,87	44	5,2-8,8
Siberian larch	7,1	0,25	180	6,2-8,9	12,1	0,34	31	10,3-14,5
Siberian spruce	5,2	0,32	140	3,9-7,0	5,4	0,23	16	3,8-6,1

Table 4. Statistic calculations of maximum height of the examined trees in their natural habitat (Altai) and in Rogów Arboretum

			Altai				**Rogów**	
	Mean	SD	n	Range	Mean	SD	n	Range
Siberian stone pine	22	0,53	180	14-25	12	0,77	44	6-14
Siberian larch	25	0,65	180	16-28	19	0,37	31	16-21
Siberian spruce	23	0,18	140	20-25	12,5	0,29	16	11-14

The condition of Siberian larches and Siberian spruces in Rogów Arboretum was normal, although some shrivelled branches (up to 15%) could be spotted. Certain morphological differences concerning their condition could be spotted. All Siberian stone pines grown in Rogów Arboretum lost 2/3 of their conifer and branches and only 1/3 of a tree (from the top downwards) held its conifer in August (as opposed to trees in their natural habitat).

Fig. 5. Condition of Siberian stone pine grown in Rogów Arboretum – lack of conifer and branches on 2/3 of the tree

CONCLUSIONS

1. The reason for deteriorated condition and smaller size of the examined Siberian trees in Poland has not been discovered. Probably it could have been caused by longer vegetation season in Rogów (twice as long as in Siberia) and consequently twice as high temperature sum.
2. Prof. J. Oleksyn's theory concerning the inability to transport photosynthates by the trees planted in Rogów could not be considered a potential reason since the respective differences in annual shoots' length do not confirm that.
3. Poor condition of Siberian stone pines could have been caused by little water available to them. Although the annual rainfall in both Altai and Rogów is similar, more water is preserved on the surface of earth in Siberia and the tree's habitat is often marshy or swampy (due to permafrost).

4. Spring ground frost definitely could not be one of the reasons for Siberian stone pine's poor domestication in Poland. In natural environment those trees grow as high as 2400 meters above sea level (Seneta 1981; author's own research) where ground frosts occur even in the middle of the Summer.
5. Based on the results of the research, landscape architect is able to identify favourable conditions for planting Siberian trees. The temperature sum in the selected spot should be a bit lower than in the rest of the area. In practice, the spots would be located on the northern side of hills (buildings), windy, constantly humid and with high level of ground waters.

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Streszczenie: *Próba wskazania czynników decydujących o adaptacji wybranych gatunków drzew syberyjskich (Ałtaj) stosowanych w architekturze krajobrazu w Polsce*. Praca miała na celu wskazania warunków środowiskowych (mikroklimatycznych i topoklimatycznych) w jakich sadzone badane drzewa syberyjskie (*Pinus sibirica, Larix sibirica, Picea obovata)* będą lepiej aklimatyzować się w Polsce. Badania polegały na porównaniu ogólnych warunków klimatycznych jakich naturalnie rosną drzewa z warunkami w arboretum w Rogowie. Następnie konsultowano przyczyny złej kondycji badanych gatunków drzew syberyjskich ze specjalistami: fitopatologami, dendrologiem i fizjologiem roślin. W kolejnym etapie porównano długości przyrostów rocznych pędów oraz wysokości największych egzemplarzy badanych drzew na Syberii (Ałtaj) z arboretum w Rogowie. Na tej podstawie określoną, że prawdopodobną przyczyna złej adaptacji badanych drzew jest dwukrotnie dłuższy okres wegetacji w Polsce, co związane jest z wyższą sumą temperatury efektywnej. Ponadto wskazano, że miejsca wietrzne, po północnej stronie wzgórz (budynków), raczej stale wilgotne, o wysokim poziomie wód gruntowych najlepiej nadają się do sadzenia drzew syberyjskich.

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