

## STADIAL GROWTH AND ITS INFLUENCE UPON SELECTED PROPERTIES OF EUROPEAN LARCH ( *Larix decidua* Mill. ) WOOD

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Density, compression along the grains, and resulting from them strength quality coefficient are closely related to the stages of growth. Said growth stages are revealed in wood of a tree as juvenile wood, transient wood and mature wood. The oldest part of the stem is known as the "pith wood". In general, the other division of timber along the macroscopic features is applied in naming them as "heartwood" and the "sapwood". The new attitude towards wood tissue classifies it along the age of origin.

**Key words:** stadial growth, wood tissue, juvenile wood, transient wood, mature wood, density, compression strength along the grains, strength quality coefficient

### INTRODUCTION

In the forest-timber literature we often meet with following terms: *juvenile wood*, *mature wood*, and sometimes with the term *transient wood* (Rendle 1960, Hejnowicz 1973, Splawa-Neyman and Szczepaniak 1999).

The ontogenesis is the characteristic aspect of plants growth, in that also of trees. The development of trees in majority of cases determines on the properties of wood as the reproducible material of plants origin. Without look on the growth of wood at pines, Sanyo in 1872 formulated his law – "Sanyo law", which states, that parallel with the distance from stem centre at Scots pine trees increases length of tracheids (after Thörnquist 1993). This author was not linking this phenomenon with the stage growth of tree as a plant. However in the contemporary literature we can find opinions, that mentioned above zones of wood, that is *-juvenile*, *mature* and *transient* wood are closely linked with particular stages of wood growth, and are essentially different as

concerns properties and anatomical structure (Haygreen and Bowyer 1996). Such situation is one of important factors of ununiformity of wood tissue in bole or stem of wood.

The share of *juvenile wood* (juvenile tissue) in cross-section of stem increases with the height, where in top part of tree it is 100% (Helińska-Raczkowska and Fabisiak 1994). The period of origin of juvenile wood variously forms at various tree species, and to the great extent depends from conditions of growth and development of trees (Bosshard 1974, Baas, Schmid and Heuven 1986).

Differentiation of properties and build up of wood tissues :juvenile, transient and mature in the stem of trees increases and just so unwanted ununiformity of properties of timber (Bendtsten 1978, Gorman 1985, Senft 1986, Lewark 1986, Helińska-Raczkowska 1993).

Probably the one of most important factors of variability of wood tissue at various wood kinds and species is occurrence and ratio of juvenile wood towards mature wood in stem or bole of trees (Thornquist 1993).

Larch belongs to the most important, accordingly to current opinions of foresters, admixture species in Polish forests. It adds to the proper content and structure of forest stands, and co-decides on the breeding effects (Rożkowski 2000).

However in Mongolia larch forms solid forest stands. It is Sibirian larch (*Larix sibirica* Ledeb.) of Mongolian provenance. The standing stock of this species is 435,3 millions of m<sup>3</sup>, what is 72% of total raw material stock of timber in accessible Mongolian forests (Luwsandorż 1993). It is therefore worth of thinking, if present attitude adopted by the majority of Polish foresters about "admixture character of larch" is properly founded.

The larch as well in previous times as at present is the object of interest, mainly due to valuable wood, and great dynamics of growth, particularly in first stages of forest stand development.

This predisposes this kind of trees for use in establishment of plantations with short term cycles of production. Accordingly to Zabielski (1998) larch is one most of the future wood species, proper for plantation breeding in Poland, where from many years it is introduced with good results.

The scope of this article is attempt to determine what an influence have tree stages of growth that is juvenile, transient, and mature wood upon selected properties of wood at European larch (*Larix decidua* Mill.).

## MATERIAL AND METHODS

Studies were carried out on the terrain of Great Poland-Pomeranian Region in ripe forest stands. They have had grown in condition of forest type – mixed coniferous forest. Forest stands, in which were executed studies, were created by Scots pine (*Pinus sylvestris* L.) with admixture of European larch (*Larix decidua* Mill.). In chosen forest stands were established trial

areas, where were measured breast diameters of all trees and their heights proportionally to their frequencies in adopted (2 cm) degrees of thickness. When characteristics of thickness-height were obtained with the use of dendrometrical Urich's II method (Grochowski 1973), then were calculated sample trees, (in total 9 trees) and then selected in terrain. After felling of the sample trees, from each of them were taken out discs, and 1 m long logs from their stems, starting from 1.30 m above ground (breast diameter). Obtained raw material was used for cutting out samples, on which were determined density of wood, compression strength along the grains, and was determined strength quality coefficient at compression along the grains.

The mentioned above discs allowed for determination of the share of spring wood and summer-wood in the growth ring, and for determination of zones of juvenile, transient and mature wood.

Determination of properties of wood were executed accordingly to the recommendations of proper standards (see references). Used standards were: PN- 77/D-04100, PN -68/D-04101, PN -79/D-04102. Density of wood was determined on absolutely dry wood while the compression strength along the grains at 12% of moisture content level. The base of wood tissues as juvenile, transient and mature has been determination of densities of wood accordingly to the suggestion of Tassisa and Burkhart (1997) and biometrical features of tracheids and above all their length (Grzeczynski and Sława-Neyman 1980). The obtained empirical material was analysed with the use of methods of statistical analysis.

## RESULTS

In dependence upon the period of life (age) of trees, the larch wood is showing various density, that is in the heart zone consisting of juvenile wood it is the lowest one, while in transient zone and above all in mature zone it is highest. From numerical values characterising this physical property, presented in Table 1, results univocally, that density of juvenile wooden tissue is in average 15% lower from the density of mature tissue, and about 12% lower than density of transient tissue. While the variability of this feature is highest in juvenile wood- 16.3%, and in case of transient zone wood and

Table 1

Tabela 1

Statistical characteristics of density of wood of the European larch (*Larix decidua* Mill.)

Charakterystyka statystyczna gęstości drewna modrzewia europejskiego (*Larix decidua* Mill.)

Measures of position and distribution Miary położenia i rozproszenia		Zone of wood growth Strefa wzrostu drewna		
		juvenile młociane	transient przejściowe	mature dojrzałe
Arithmetic mean	[kg/m <sup>3</sup> ]	480	550	560
Srednia arytmetyczna	[%]	85	98	100
Standard deviation	[kg/m <sup>3</sup> ]	77.50	40.10	55.10
Odczylenie standardowe				
Variability coefficient	[%]	16.3	7.3	9.9
Współczynnik zmienności				

zone of mature wood it is much lower. Calculated coefficients of variability were respectively 7.3 % and 9.9% (Table 1).

In the table 2 are presented numerical values characterising formation of compression strength along the grains of European larch wood in dependence upon the growth zone of wood tissue. The juvenile wood and transient wood have shown in average lower strength than mature wood. In the first case this difference reached 32% in the second 3% (Table 2). The calculated coefficients of variability characterising above values were 24.6% in case of juvenile wood, and 20.9% in the zone of transient wood, and 23.7% in zone of mature wood.

Table 2  
Tabela 2

Statistical characteristics of the compression strength along the grains of the wood of the European larch (*Larix decidua* Mill.)  
Charakterystyka statystyczna wytrzymałości na ściskanie wzdłuż włókien drewna modrzewia europejskiego (*Larix decidua* Mill.)

Measures of position and distribution Miary położenia i rozproszenia	Zone of wood growth Strefa wzrostu drewna		
	juvenile młodociane	transient przejściowe	mature dojrzałe
Arithmetic mean [MPa] Średnia arytmetyczna [%]	26.4 68	37.8 97	39.1 100
Standard deviation [MPa] Odchylenie standardowe	6.50	7.90	9.26
Variability coefficient [%] Współczynnik zmienności	24.6	20.9	23.7

The technical value of timber is so higher the higher is its strength and lower its density. The above evaluation is possible due to the strength quality coefficient established on the base of the ratio between strength and wood density. The statistical characteristic of the coefficient of the strength quality of European larch wood is presented in Table 3. The value of the strength quality coefficient is presented as well in absolute units (km) and relative (%). This coefficient in case of juvenile wood tissue was lower than in mature about 16%. Between transient wood and mature wood these difference were considerably lower and reached only 3% (Table 3). The variability of this coefficient in juvenile wood reached about 58%, in transient wood 16.7% and in mature wood 17.9%.

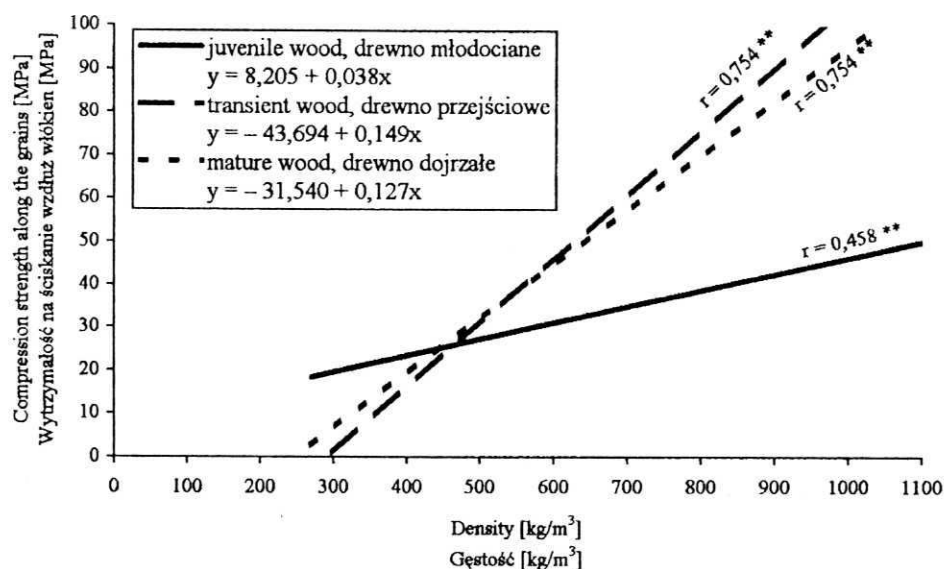
In presented article the dependence of strength of wood on compression along the grain of juvenile, transient and mature wood was characterised by correlation coefficient ( $r$ ), and by regression equations (Fig. 1). In results from them, that linear effects are very essential, and said dependence has right linear character and directly proportional. The high correlation coefficients occurred in case mature wood and transient wood, and their value very close and was +0.754. The lowest coefficient (+0.458) was found testing discussed correlation in respect towards juvenile wood. From the

Table 3  
Tabela 3

Statistical analysis of strength quality coefficient of the European larch (*Larix decidua* Mill.)  
determined at compression strenght along the grains

Charakterystyka statystyczna jakości wytrzymałościowej drewna modrzewia europejskiego  
(*Larix decidua* Mill.) określony przy ściskaniu wzdłuż włókien

Measures of position and distribution Miary położenia i rozproszenia		Zone of wood growth Strefa wzrostu drewna		
		juvenile młodociane	transient przejściowe	mature dojrzałe
Arithmetic mean Średnia arytmetyczna	[km] [%]	5.9 84	6.8 97	7.0 100
Standard deviation Odchylenie standardowe	[km]	3.4	1.14	1.25
Variability coefficient Współczynnik zmienności	[%]	57.6	16.7	17.9



\*-significant, istotny; \*\* very significant, bardzo istotny

Fig. 1. Dependence of the compression strength along the grains upon the density of wood of European larch (*Larix decidua* Mill.)

Rys. 1. Zależność wytrzymałości na ściskanie wzdłuż włókien od gęstości drewna u modrzewia europejskiego (*Larix decidua* Mill.)

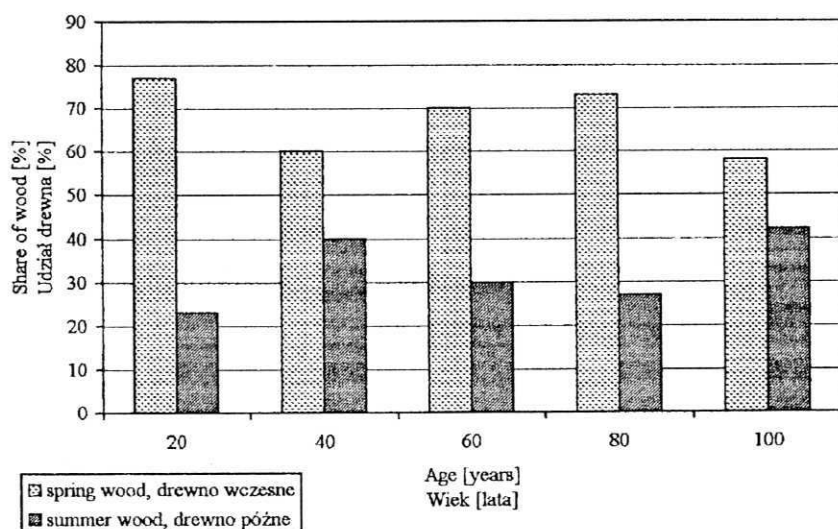


Fig. 2. Share of spring and summer wood in growth ring at European larch (*Larix decidua* Mill.) in dependence from the period of life (age) of trees

Rys. 2. Udział drewna wczesnego i późnego w słoju rocznym u modrzewia europejskiego (*Larix decidua* Mill.) w zależności od okresu życia (wieku) drzew

course of regression lines results, that wood tissue of transient and mature wood is characterised by close and simultaneously better properties, that is in the range of density and compression strength, while juvenile wood differs from them in the essential way in minus (Fig. 1).

Wood density and also its strength are closely related in the proportional way with the share of summer wood, that is with the occurrence in the growth ring of anatomical elements (tracheids) with thick walls. On the Fig. 2 presented is formation of the share of springwood and latewood in average growth ring in subsequent periods of life of trees of the European larch (*Larix decidua* Mill.).

Results from that, that in growth rings of juvenile wood zone the share of thick walled tracheids was smaller (23%), than in wood of transient and mature zones (27% and 42% properly). This fact among others allows to state, that the juvenile wood is the material of much more worse technical value mature wood, and also transient wood.

Accordingly to Splawa-Neyman and Szczepaniak (1999) the mentioned zones are differing not only with properties but also with anatomical structure.

## CONCLUSIONS

1. Stadal growth of trees and wood of the European larch (*Larix decidua* Mill.) have essential influence upon density of wood and compression strength along the

- grains, and also upon strength quality coefficients at compression. Density of juvenile wood was lower than of mature wood about 15%, and compression strength along the grains about 32% and in the same time coefficient of strength quality about 16%.
2. Density compression strength along the grains and strength quality coefficient at compression the grains of juvenile wood have greater variability in comparison with mature wood and wood of transient zone. Variability of those quality features at juvenile wood was 16.3% for density, 26.6% for compression strength and 57.6% for strength quality coefficient, at mature wood and wood from transient zone they were properly: 7.3 to 9.3%, 20.9 to 23.7%, and 16.7 to 17.9%.
  3. The obtained results of studies allow to state, that the juvenile wood tissue is the material of much worse technical value than the mature and transient tissue. This fact is to be taken into consideration at rational use of larch wood obtained in course of thinning and other breeding operations.

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## STADIALNOŚĆ WZROSTU DRZEW I JEJ WPŁYW NA WYBRANE WŁAŚCIWOŚCI DREWNA MODRZEWIA EUROPEJSKIEGO (*Larix decidua* Mill.)

### Streszczenie

W prezentowanych badaniach podjęto próbę ustalenia jaki wpływ mają stadia (strefy) wzrostu, to jest młodociane, przejściowe i dojrzałe na wybrane właściwości drewna modrzewia europejskiego (*Larix decidua* Mill.).

W świetle wyników przeprowadzonych badań okazało się, że drewno młodociane ma zdecydowanie gorsze właściwości od drewna przejściowego i dojrzałego. Ten fakt został potwierdzony statystycznie i matematycznie ustalony. Okazało się, że drewno młodociane jest lżejsze, słabsze i ma odmienną budowę anatomiczną. Dotyczy to głównie wymiarów cewek, zwłaszcza ich długości, które są mniejsze i zdecydowanie mniej grubościennie. Ten fakt należy brać pod uwagę przy stosowaniu młodego drewna modrzewia europejskiego zwłaszcza w konstrukcjach.

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