FOLIA FORESTALIA POLONICA
seria B, zeszyt 32, 2001

EFFECT OF SITE FERTILITY UPON FORMATION OF HEARTWOOD IN TIMBER OF SCOTS PINE (*Pinus sylvestris* L.)

by Stanisław Spława-Neyman[1] *and Witold Pazdrowski*[2]

[1] Institute of Wood Technology in Poznań
[2] Department Forest Utilisation of A. Cieszkowski Agricultural University of Poznań

Sectional dendrometrical methods allow to obtain reliable results in determination of share of the heartwood and sapwood in tree stem. Appearing lately mathematical models such as "Lignum" presented in *Silva Fennica* are giving quite another results. In this paper presented are effects of the age and site fertility upon share of heartwood and sapwood in stems of Scots pine.

Key words: age of tree, site fertility, share of heartwood, mathematical model "Lignum"

INTRODUCTION

In presented article is applied term "site fertility" in the meaning of site type on Polish lowlands, described in publication on Site Base of Forest Breeding –Trampler et al. 1990.

The origin of heartwood in coniferous wood species still to this time is mystery.

There are a lot of theories on this problem. In book written by Krzysik 1974 ,we can find that it is connected with fertile the of site in such a way that the more fertile the site, the less we can find of heartwood in Scots pine wood .Only few authors are linking creation of heartwood with stadial growth of wood (Hillis 1987, Haygreen and Bowyer 1996).

Zimmermann and Brown 1971 links origin of heartwood with the limiting of water in cells of growing tree and increase of polyphenolic substances.

Tree is defined by Haygreen and Bowyer 1996 as one of nature's oldest living organisms. And so, one bristlecone pine (*Pinus aristata* Engelman.) living in the White Mountains – California USA is estimated to be the oldest living resident at a ripe old

age of about 4600 years. However plant tissue seldom remains live longer than several years.

Accordingly to Hillis 1987 the most common age at which transformation of in pine sapwood into heartwood occurs is reported to be 14-18 years.

The meaning of heartwood in timber is very important for timber use in construction and furniture industry.

Unique properties of heartwood can be listed as follows:

- heartwood may be darker in colour than sapwood
- it can be highly decay and insect – resistant
- it may be difficult to penetrate with liquids
- it may be difficult to dry, and it may have a slightly higher weight per unit volume than sapwood.

In their works on stadial growth of Scots pine and larch authors met with this problem – Spława-Neyman, Pazdrowski and Szczepaniak 2000, Spława-Neyman and Pazdrowski, 2000.

Therefore in this work it has been aimed to estimate the volume share of heartwood and sapwood in stems of Scots pines (*Pinus sylvestris* L.) growing on three forest site types ,and in various ages.

MATERIALS AND METHODS

Sample trees for evaluation of volume of sapwood and heartwood were cut in the III Natural Forest Region accordingly to Trampler et al. 1990.

At selection of sample trees has been applied dendrometry method acc. to Urich II (Grochowski 1973).

For the study were selected forest stands on forest sites : dry coniferous forest, fresh coniferous forest, and fresh mixed coniferous forest . The age of forest stands was 30, 40,60 and 100 years accordingly with the Forest Management Plan and certified by our own measurements. After felling down, trees were cut discs and 1 m long sections from merchantable bole. Said discs after slight drying (in aim to reveal heartwood were used for measurements of the rings of sapwood and rolls of heartwood), allowing thus to calculate total length of the whole volume of the stem.

RESULTS

Results of measurements of the heartwood and sapwood in stems of trees from various site types are given in Table 1. In the Table 2 there are presented coefficients of transformation of sapwood into heartwood. In the Table 1 it may be seen that in the young pines share of heartwood is rather small. It grows with the age of trees and great-

Table 1

Tabela 1

Formation of sapwood and heartwood share in stems of Scots pines in dependence upon age and forest site type

Kształtowanie się udziału bielu i twardzieli w strzałach sosen zwyczajnych w zależności od wieku i typu siedliskowego lasu

Forest site type Siedliskowy typ lasu	Part of tree Część drzewa	Age of trees (years) Wiek drzew (lata)			
		30	40	60	100
		Volume , objętość m^3/%			
Dry coniferous forest Bór sosnowy	Stem Strzała	0.01017 100	0.04526 100	0.07357 100	— —
	Sapwood Biel	0.00983 96.7	0.4280 94.6	0.06494 87.9	— 76*
	Heartwood Twardziel	0.00034 3.3	0.00246 5.4	0.00893 12.1	— 24*
Fresh coniferous forest Bór świeży	Stem Strzała	0.05969 100	0.10417 100	0.22407 100	— —
	Sapwood Biel	0.05816 97.4	0.09754 93.6	0.19843 88.6	— 68.8*
	Heartwood Twardziel	0.00153 2.6	0.00663 6.4	0.02563 11.4	— 31.2*
Fresh mixed coniferous forest Bór świeży mieszany	Stem Strzała	0.05637 100	0.14294 100	0.40552 100	— —
	Sapwood Biel	0.05464 96.9	0.13567 94.9	0.28232 69.6	— 59.9*
	Heartwood Twardziel	0.00173 3.1	0.00727 5.1	0.12320 30.4	— 40.1*

*Duda and Pazdrowski 1975

est values are obtained in the age of 100 years. It is evident that in age of sixty years percentage of heartwood was greatest in fresh mixed coniferous forest.

In every case the share of heartwood increased with the age of trees. It is known that the share of heartwood reaches 45% of the whole tree (Kollmann and Cote' 1968). But studies made in Finland (Sievanen, Nikinmaa and Pertunen 1997) on the senescence of sapwood have shown quite another results. Said authors using mathematical model LIGNUM have calculated that on the less fertile forest stands quantity of heartwood increases. In the Table 2 where are presented coefficients of dynamics of transformation of the sapwood into heartwood situation is alike. They show that with the increase of site fertility and age of trees, tends to increase the volume of heartwood in stems of Scots pine.

Table 2

Tabela 2

Coefficients presenting dynamics of transformation of sapwood into heartwood in stems of Scots pines in dependence upon age and forest site type

Współczynniki przedstawiające dynamikę przemiany bielu w twardziel w strzałach sosen zwyczajnych w zależności od wieku i siedliskowego typu lasu

Type of forest site Siedliskowy typ lasu	Age of forest stand (years) Wiek drzewostanów (lata)			
	30	40	60	100
Dry coniferous forest Bór sosnowy	2912	389	105	13.7
Fresh coniferous forest Bór świeży	616	136	31	5.1
Fresh mixed coniferous forest Bór świeży mieszany	547	119	5.8	1.8

RECAPITULATION

It was evident that the transformation of the sapwood into heartwood is not easy to predict. However it can not be studied with the use of model LIGNUM because that model may lead to false conclusions.

In aim to obtain reliable results, for the foresters and wood technologists remain well known dendrological methods .

With the use of "sections" method , in this study ,it has been shown, that with the increase of age of trees and fertility of the habitats increases share of heartwood in the stems of Scots pine (*Pinus sylvestris* L.).

Received in June 2001

REFERENCES

Duda J., Pazdrowski W. (1975): Procentowy udział twardzieli i bielu w 100 letnich sosnach zwyczajnych (*Pinus sylvestris* L.) rosnących w różnych warunkach siedliskowych. Sylwan 11: 57-64.

Haygreen J. G., Bowyer J. L. (1996): Forest products and wood science. An introduction. Iowa State University Press.

Hillis W. E. (1987): Chemical aspects of heartwood formation. Wood. Sci. Technol. 2(4):241-259.

Grochowski J. (1973) Dendrometria PWRiL Warszawa.

Kollmann F. F. P., Cote' W. A. (1968): Principles of wood science and technology. Springer-Verlag New York.
Krzysik F. (1974): Nauka o drewnie. PWN Warszawa.
Sievanen R., Nikinmaa E., Pertunen J. (1997): Evaluation of importance of sapwood senescence on tree growth using the modell lignum. Silva Fennica 31(3):329-340.
Spława-Neyman S., Pazdrowski W., Szczepaniak J. (2000): Axial cyclical heterogeneity of Scots pine (*Pinus sylvestris* L.) wood. Prace ITD 3(163):.3-15.
Spława-Neyman S., Pazdrowski W. (2000): Stadial growth and its influence upon selected properties of european larch (*Larix decidua* Mill.) wood". Folia Forestalia Polonica ser. B 31:111-118.
Trampler T. (1990): Siedliskowe podstawy hodowli lasu. PWRiL Warszawa.
Zimmermann M. H., Brown C. L. (1971): Trees: Structure and function. Springer-Verlag New York.

WPŁYW ŻYZNOŚCI SIEDLISKA NA POWSTAWANIE TWARDZIELI W DREWNIE SOSNY ZWYCZAJNEJ (*PINUS SYLVESTRIS* L.)

Streszczenie

Badano dłużyce sosnowe z drzew próbnych pozyskanych w drzewostanach wyrosłych na siedliskach :boru suchego , boru świeżego i boru mieszanego świeżego. Wiek drzew wynosił 30,40,60,i 100 lat.Pomiar twardzieli i bielu wykonano metodą sekcyjną, stosując odstępy 1 m długości.

Uzyskane rezultaty wskazują na zdecydowany wzrost udziału twardzieli w strzałach drzew wraz ze wzrostem ich wieku i żyzności siedliska na których wyrosły .

Author's adresses:
doc. dr inż. Stanisław Spława-Neyman
Instytut Technologii Drewna w Poznaniu
Zakład Badania Drewna i Materiałów Drewnopochodnych
60-654 Poznań, ul. Winiarska 1

prof. dr hab. inż. Witold Pazdrowski
Akademia Rolnicza im. A. Cieszkowskiego w Poznaniu
Katedra Użytkowania Lasu
60-625 Poznań, ul. Wojska Polskiego 71A
POLAND