STRENGTH AND RELATED PROPERTIES OF A SCOTS PINE TREE OF RUSSIAN ORIGIN GROWN IN ALBERTA

by

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FOREST RESEARCH LABORATORY
CALGARY, ALBERTA
INFORMATION REPORT A-X-27

CANADIAN FORESTRY SERVICE
DEPARTMENT OF FISHERIES AND FORESTRY
SEPTEMBER, 1969

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INTRODUCTION

Approximately 55 years ago Mr. G. Bugnet established a plantation of native and exotic trees around his farm home near Rich Valley, Alberta. The geographical location of the plantation is 59°51' latitude, 114°21' longitude at an elevation of 2300 feet (1). The site has a mean annual temperature of 37°F and a mean annual precipitation of 18 inches (7). Included in this plantation were some trees from a Russian provenance of Scots pine (Pinus sylvestris L.). Recently the exceptional height and diameter growth of these Scots pine was detected (Fig. 1). These outstanding characteristics of this race prompted the evaluation of its utilization potential. This one-tree study provides some information about the tree's mechanical and physical properties.

METHODS

The sample was restricted to an average tree which measured 55 feet in height and 17.9 inches in diameter O.B. at breast height, because a limited number of the Russian Scots pine were available. Specimens from the lower 4-foot portion of the tree were used for strength tests.

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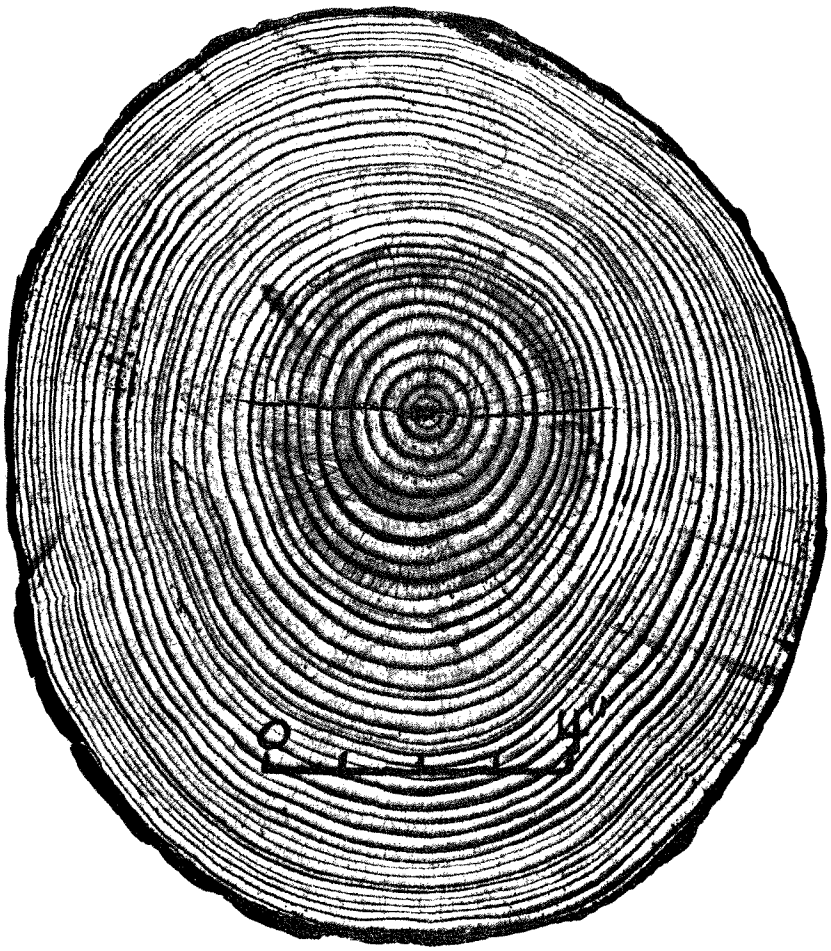

FIGURE 1 - Transverse section from the Scots pine sample tree showing the fast annual growth rate.

The strength tests, performed in the Vancouver Forest Products Laboratory, followed the standard specifications on testing of clear specimens given by A.S.T.M. Standard D-143-52 (1965) (2). Because there was a limited amount of sample material available, tests were conducted only on specimens in the green condition. The tests were limited to those of static bending, compression parallel and perpendicular to the grain and shear parallel to the grain.

Disks 4 inches thick were also removed from the stem at 1, 8, 24, 40 and 50 feet above ground level. These disks were used to obtain information about ring width, per cent summerwood and variation in specific gravity. Each disk was cut along the average radius to yield a sample for measurements of ring width and summerwood. The ring width and summerwood width were measured to the nearest 0.001 inch with a tree ring analyser (5).

The ring-width sample was cut, beginning at the bark, into a 2-year growth increment and the specific gravity was determined by the green-volume-oven-dry-weight method for small samples (4).

RESULTS AND DISCUSSION

The results of the four strength-tests are presented in Table I. The reliability of the numerical values of all properties could be improved with more intensive sampling, which was impossible at this time. The properties of Russian Scots pine nearly matched those of white spruce and lodgepole pine except for growth rate (rings per inch) and compression perpendicular to the grain.

TABLE I. STRENGTH AND RELATED PROPERTIES OF RUSSIAN SCOTS PINE PROVENANCE GROWN IN ALBERTA

Properties	Russian Scots pine	White spruce[1]	Lodgepole pine[1]
Average Ring Count (per inch)[a]	6.2	15	25
Average Moisture Content in %[b]	81.6 (Green)	green	green
Specific Gravity (O.D. Volume / O.D. Weight)[c]	0.402	0.39	0.46
Specific Gravity (Green Volume / O.D. Weight)[h]	0.351	0.35	0.40
Static Bending			
Stress at Proportional Limit	2,415 psi	2,800 psi	3,000 psi
Modulus of Rupture	5,038 psi	5,100 psi	5,700 psi
Modulus of Elasticity	1,014,673 psi	1,150,000 psi	1,270,000 psi
Work to Proportional Limit[e]	0.32 in. lb/cu.in.	0.39 in. lb/cu.in.	0.40 in. lb/cu.in.
Compression Parallel to Grain			
Stress at Proportional Limit	2,137 psi	1,820 psi	2,220 psi
Maximum Crushing Stress	2,274 psi	2,470 psi	2,860 psi
Modulus of Elasticity[f]	1,103,757 psi	1,310,000 psi	1,420,000 psi
Compression perpendicular to Grain			
Stress at Proportional Limit[g]	342 psi	240 psi	280 psi
Shear Parallel to Grain			
Maximum Stress	718 psi	670 psi	720 psi

Note: a, b and c based on 16 samples.
d, e, f and g based on 4 samples.
h, based on 79 samples.

(1) Kennedy, E. I., Strength and Related Properties of Woods Grown in Canada. Department of Forestry Publication No. 1104. 1965. pp. 8-9. The data is given only for comparison.

The data indicate that Russian Scots pine is able to produce almost the same quality of wood as white spruce and lodgepole pine (4). Therefore, when we consider the growth rate of Russian Scots pine, this provenance may produce as much wood, on a 30 per cent shorter rotation, as white spruce and lodgepole pine can on a normal 80-year rotation. Based on average ring width, the Russian Scots pine may produce, on equivalent rotations, twice as much wood as white spruce and approximately 4 times as much as lodgepole pine. Further silvicultural investigation is required to verify this information.

Table II presents data pertaining to important physical properties of the tree sampled. The specific gravity (within the tree) is quite uniform except near the pith and in the stump where it is about 0.1 higher than the average for the tree (Fig. 2). Both of these irregularities are common for pine and caused by high resin content.

The average number of rings per inch for the entire tree is slightly higher than that found in the mechanical-property samples. The exceptional uniformity of the specific gravity indicates that the standard relationship $S = aG^n$ (3) between specific gravity (G) and strength properties (S) should hold with minimum variation at any height within the tree, which makes this species very suitable for products requiring uniform strength, e.g. pulp and fiber products.

The physical and mechanical properties of Russian Scots pine provenance indicated that it is recommendable for propagation in Alberta, and perhaps in other areas of Canada.

TABLE II. PHYSICAL PROPERTY VARIATION WITHIN THE STEM OF A RUSSIAN SCOTS PINE

Properties	Mean	Minimum	Maximum	Standard error	Coefficient of variability (%)
Specific gravity	.351	.294	.528	0.00602	15.23
Ring width[1] (inches)	.317	.157	.585	0.01223	34.29
Rings per inch[1]	7.41	3.84 (.384)?	13.80	0.30736	36.86
Summerwood (per cent)	16.30	5.54	43.65	0.80747	44.03

- Data presented in this table are based on 79 observations -

[1] Observations were obtained by averaging two ring values.

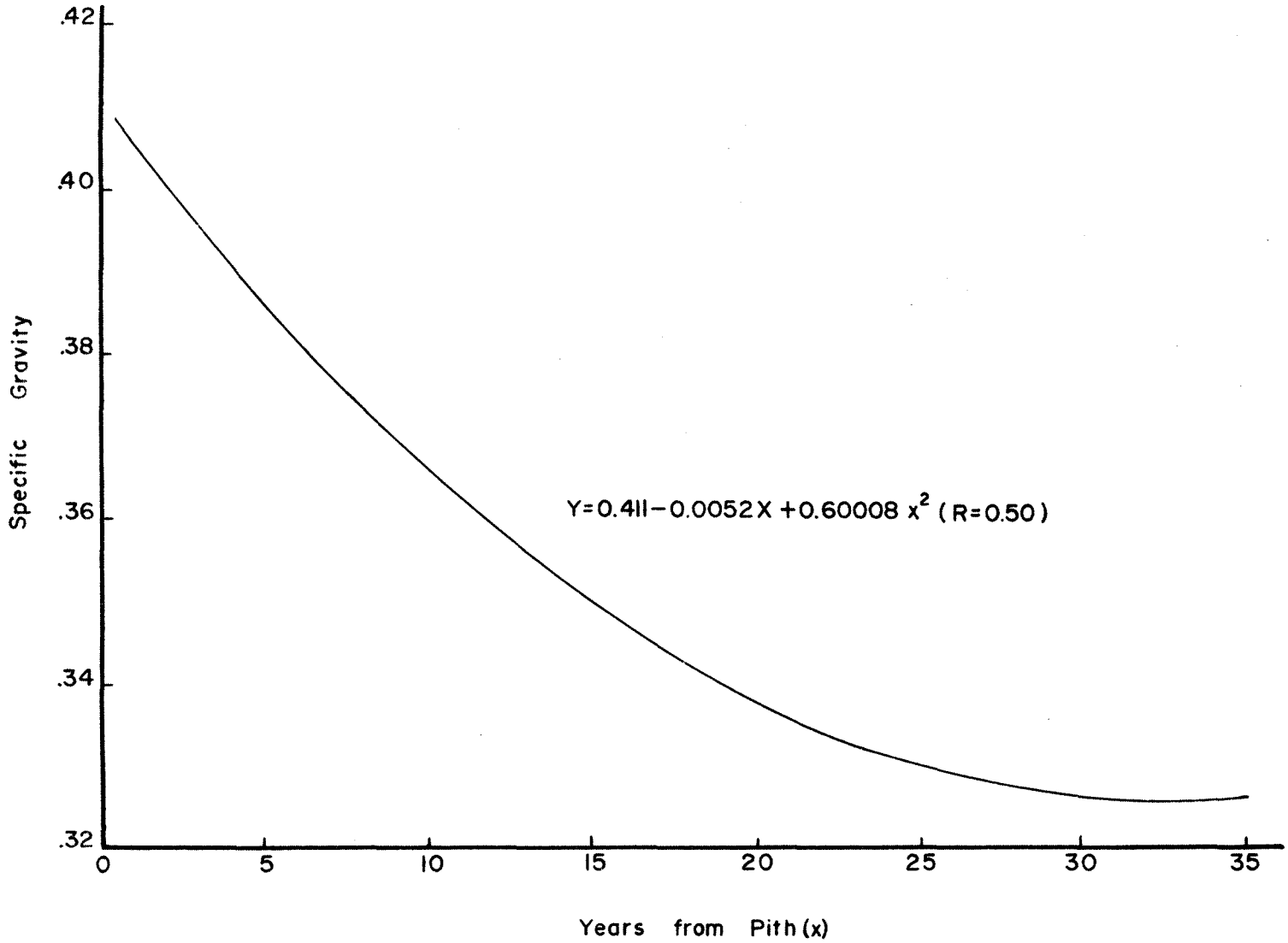

Figure 2. Specific gravity variation within the tree (green volume–oven dry weight.)

ACKNOWLEDGEMENTS

Acknowledgements are due the Engineering Section of the Vancouver Forest Products Laboratory for assistance in this study; Dr. J. P. Howe, College of Forestry, Wildlife and Range Sciences, University of Idaho, for loan of a tree ring measuring instrument; and Mr. J. Soos for providing historical information about the provenance and submitting sample materials for analysis.

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