

A TAXONOMIC STUDY OF PICEA MARIANA: P. CLAUCA  
IN THE LAKE ITASCA REGION IN MINNESOTA

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Black spruce and white spruce are frequently improperly identified. Key characters which are used to identify one species from the other often vary. In this study variations of 13 morphologic characters were compared to determine which characters were the most consistent in identifying each species and to determine if hybridization has occurred between species.

Itasca State Park lies within an undulating to hilly glacial till produced by the Wadena Lobe of the Wisconsin Glacier. Soils on the upland are medium textured forest soils predominantly Nebish loam and Rockwood sandy loam. Organic soils occupy depressional areas (Arneman, 63).

The climate of the region is characterized as continental with seasonal extremes in temperature and occasional drought periods. The mean annual temperature recorded at Park Rapids, 25 miles south of the study area, is 40.0° F. The seasonal means are: winter, 16° F.; spring, 55° F.; summer, 67° F.; and fall, 27° F. The growing season of approximately 100 days extends from May 30 to September 10 (USDA, 65). Annual precipitation averages 30.6 inches. Nearly 60% is received during the growing season (USDA, 65).

Vegetation in the region is characterized by a broad transition zone between fir-spruce (Abies balsamea-Firca glauca) forest region to the north and northeast and the sugar maple-basswood (Acer saccharum-Tilia americana) to the west and southwest (Buell and Martin, 61).

One hundred trees were selected from five areas in the Lake Itasca region. The beaver trail area, located in the northeast corner of Itasca State Park, is dry upland and the dominant plants are red pine (Pinus resinosa) and white pine (Pinus strobus). The LaSalle creek area, also located in the northeast corner of the park, is a raised bog. The dominant plants in this area are tamarack (Larix laricina), white spruce (Picea glauca), black spruce (Picea mariana), balsam fir (Abies balsamea), alder (Alnus rugosa), and bog birch (Betula pumila). Trees were also selected on upland slopes leading into the LaSalle creek area. The dominant plants on the slopes were aspen (Populus tremuloides), balsam fir, willow (Salix spp.), and white spruce.

The Mary Lake region southeast of Lake Itasca is upland which slopes toward the lake. The major vegetation is dying black spruce, young balsam fir, and young white spruce with an overstory of red pine and white pine. The bog D trail area south of Mary Lake is upland but slopes into typical pond bogs. The upland vegetation is similar to the Mary Lake site, while the bog vegetation is similar to the LaSalle creek area. The Iron Spring bog area north of Itasca State Park is a raised bog with vegetation similar to LaSalle creek bog.

The area location for each study tree is found on Table II.

#### MATERIALS AND METHODS

Picea mariana: Picea glauca differ with respect to 50

characters (Little and Pauley, 58). Five taxonomic texts (Fernald, 50), (Gleason, 58), (Rehder, 40), (Rosendahl, 55), (Sargent, 22) and field samples were used in this study to select 13 of the 50 possible morphological characters (Character List, Table I., Appendix).

Keys were developed to identify and to give numerical value for the variations of each character (Figure 1). These keys were made from 13 trees (6 Picea glauca and 7 Picea mariana) selected at random in park areas. The shape of cone key, for example, was made by selecting a representative cone from each tree. Ovoid cones were placed at one end of the key and ellipsoid cones at the other end with the intermediate types in between them. Five cones representing the range of shapes were selected for the key. The most ovoid cone, characteristic of black spruce, was given a score of one. The most ellipsoid cone, which was representative of white spruce, was given a score of five. This technique was used to develop the remaining keys. On all characters a low key score represented black spruce and a high key score represented white spruce. Table I gives the characters which were used to differentiate the two species. The score assigned for each character of each tree is given in Table II.

## RESULTS

Approximately one-half of the 100 study trees were specifically selected because they were intermediate types. The distribution of the study trees on the basis of the total score

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## RESULTS

Approximately one-half of the 100 study trees were specifically selected because they were intermediate types. The distribution of the study trees on the basis of the total score

for the 13 characters is shown on Figure 2. The graph shows a bimodal distribution. Two trees, numbers 12 and 85, with scores of 38 and 37 respectively may be hybrids. The distinct break between the 48 lower scoring black spruce and the 50 higher scoring white spruce supports evidence that hybrid trees are rare (Wright, 55).

A known hybrid, the Rosendahl spruce (Little and Pauley, 58) was used to check the keys accuracy for detecting hybrid trees. The Rosendahl spruce received a score of 43. This score is located between the scores received by the black spruce and white spruce and is in the same region with the two probable hybrid trees. The score assigned for each character of the Rosendahl spruce is found on the last page of Table II.

Records of a natural hybrid, the Rosendahl spruce, and of an artificial hybrid produced by early pollen forcing (Winton, 65) prove that hybrids are possible.

Reasons for probable hybrid trees occurring in the park area are: 1) both trees have the same number of chromosomes (Heinselman, 57), (Nienstaedt, 57); 2) unusual climatic conditions may force some trees of both species to pollenate at the same time; 3) many areas contain mixed stands of black and white spruce.

Another objective of this study was to determine which characters were the most consistent in differentiating black spruce from white spruce. Table III summarizes the consistency with which each character can be used to differentiate black

spruce from white spruce.

The cone characters were the most consistent of any group studied. Cone shape (Figure 6), cone stalk and cone length were excellent characters. They were the most consistent of the 13 characters studied. Cone color and cone scale margin (Figure 7) were fair identifying characters. Cone color was chosen because some references described the cone as brown for both black and white spruce. This study showed the black spruce cones to be black to grey-brown and the white spruce cones to be tan to brown.

Bark color (Figure 8) was another excellent identifying character. The outer scales of the bark were removed to expose new, unweathered scales. This technique was used because algae, moss, and lichen tended to mask the natural color. Probably for this reason references described the bark as grey-brown for both black spruce and white spruce. In this study the new bark of black spruce was tan to yellow-brown while white spruce was a grey to red-brown.

This study showed twig color to be only fair for identifying these species. Probable reasons for this were: 1) twigs varied in color with age, 2) twigs on the north side of the tree were darker than those on the south, 3) twigs at the top of the tree were lighter than those on the bottom.

The glabrous twig proved to be an excellent character for identifying white spruce as shown on Figure 3. None of the



black spruce possessed the glabrous stem. A score of 5 represents the glabrous twig while the scores 1 through 4 represent degrees of pubescence. Pubescence was a poor character for the identification of black spruce because one-fifth of the white spruce also possessed hair.

As shown by Figures 4 and 5, leaf length proved to be a good character for differentiating black spruce from white spruce. As shown in Table III, leaf curvature, location of stomata, leaf apex, and leaf location on the stem were poorer characters. Leaf curvature was exceptionally poor.

The relationship between growth rate and age for black spruce and white spruce is shown on Figure 9. Both species show a uniform rate of growth for the first thirty years, but in the succeeding years the black spruce growth rate decreases. The increment boring and circumference reading were taken at breast height.

The habitat for black spruce is normally marshy area while the habitat for white spruce is normally upland areas (Heinselman, 57), (Nienstaedt, 57). This study shows that identifying the species on the basis of habitat is not consistent because one-half of the white spruce used in this study were found in bogs and one-fifth of the black spruce were found on the upland.

## SUMMARY

On the basis of this study the spruce cones possessed the most consistent group of characters that identified black spruce from white spruce. Leaf length, glabrous twig and bark color were also very consistent. The pubescent twig proved to be an unreliable character for identifying black spruce because one-fifth of the white spruce were also pubescent. Leaf curvature was very inconsistent.

This study supports evidence that hybrid trees are rare. Out of 50 trees that were selected as possible intermediates between black spruce and white spruce only two appear to be hybrids.

## ACKNOWLEDGMENT

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APPENDIX

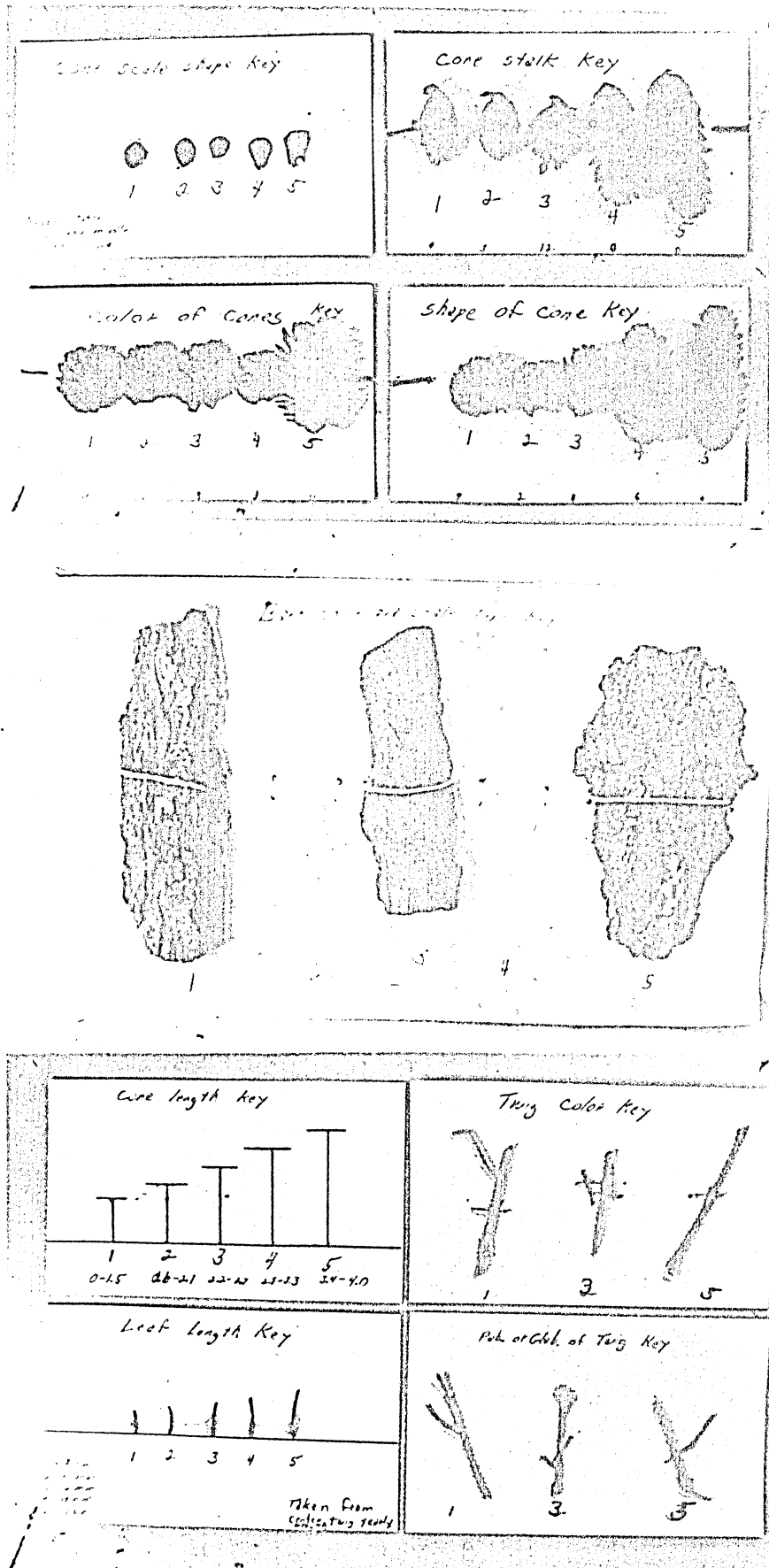


Fig. 1. Keys used to identify and to give numerical value for the variations of each character.

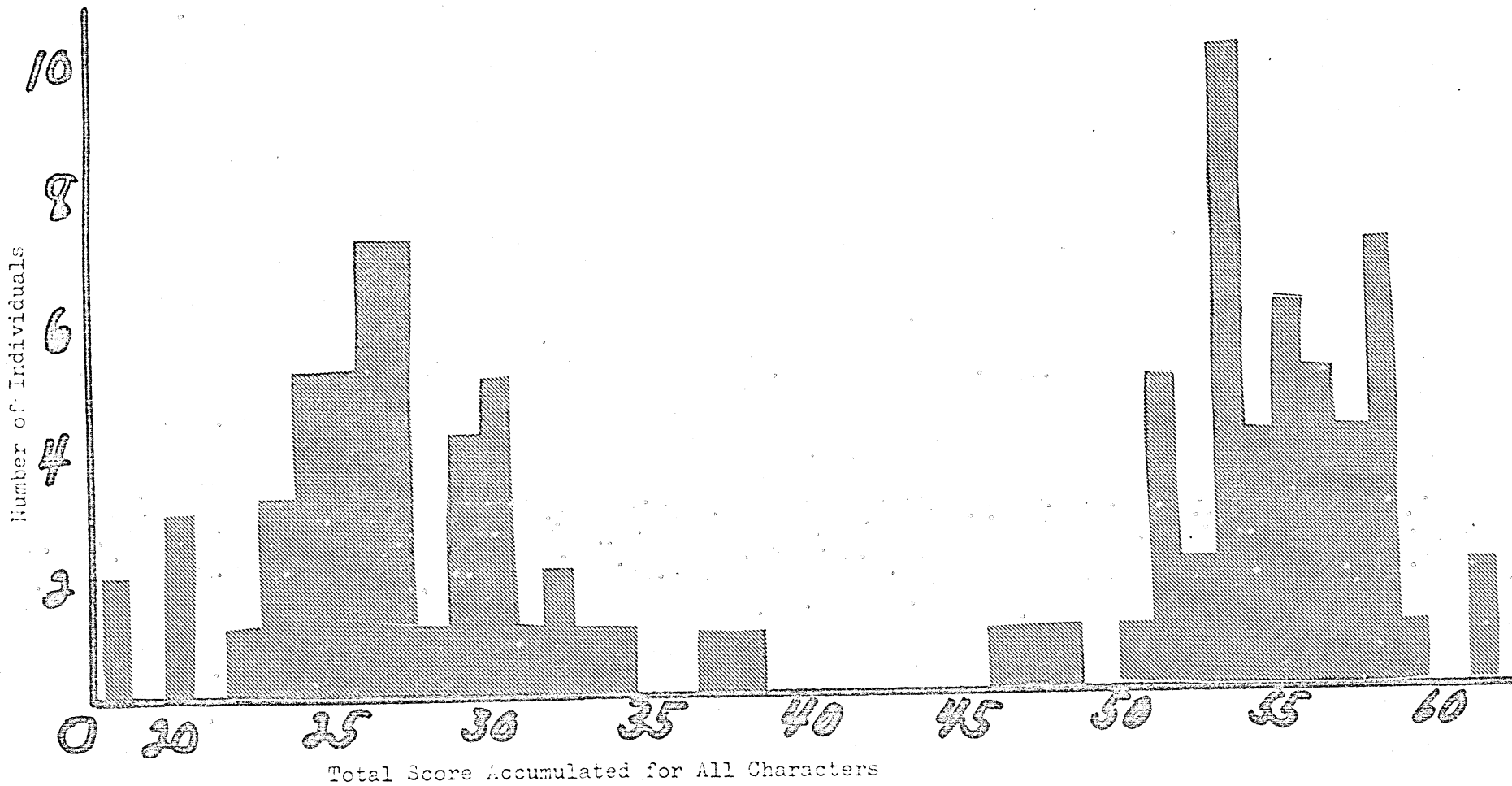


Fig. 2. Distribution of "black" and "white" spruce.

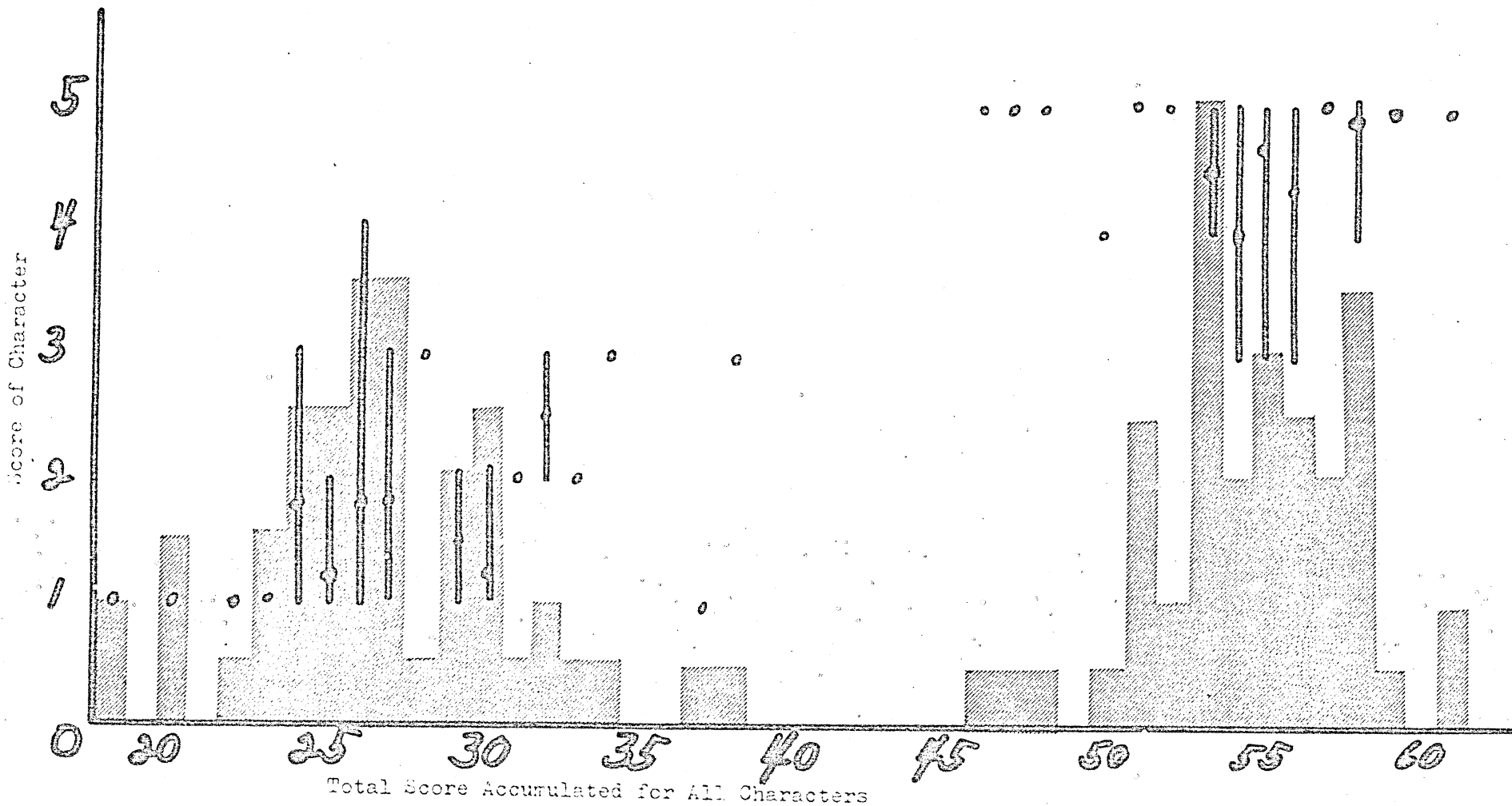


Fig. 3. Pubescent-glabrous showing range and average.



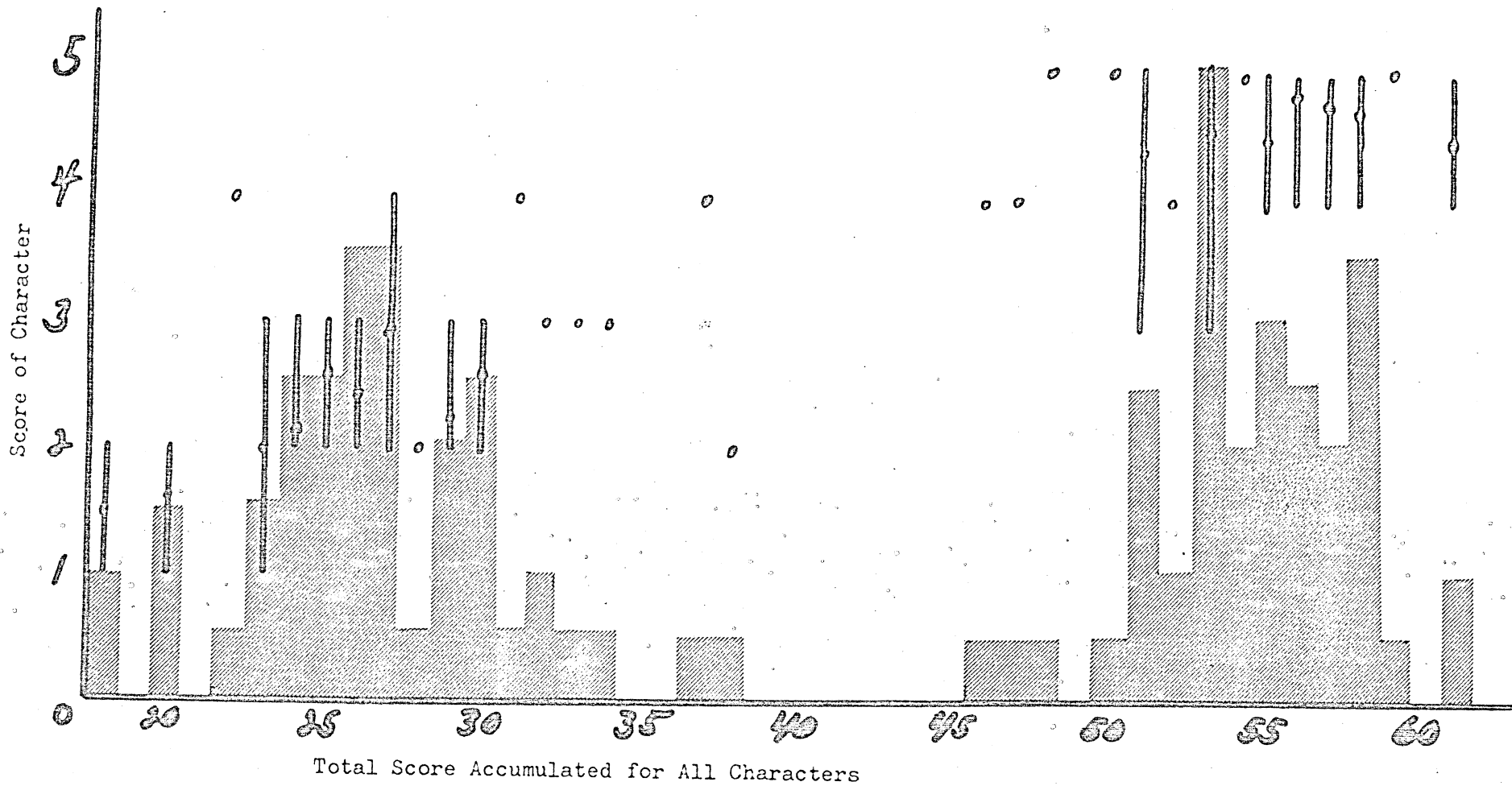


Fig. 6. Cone shape showing range and average.

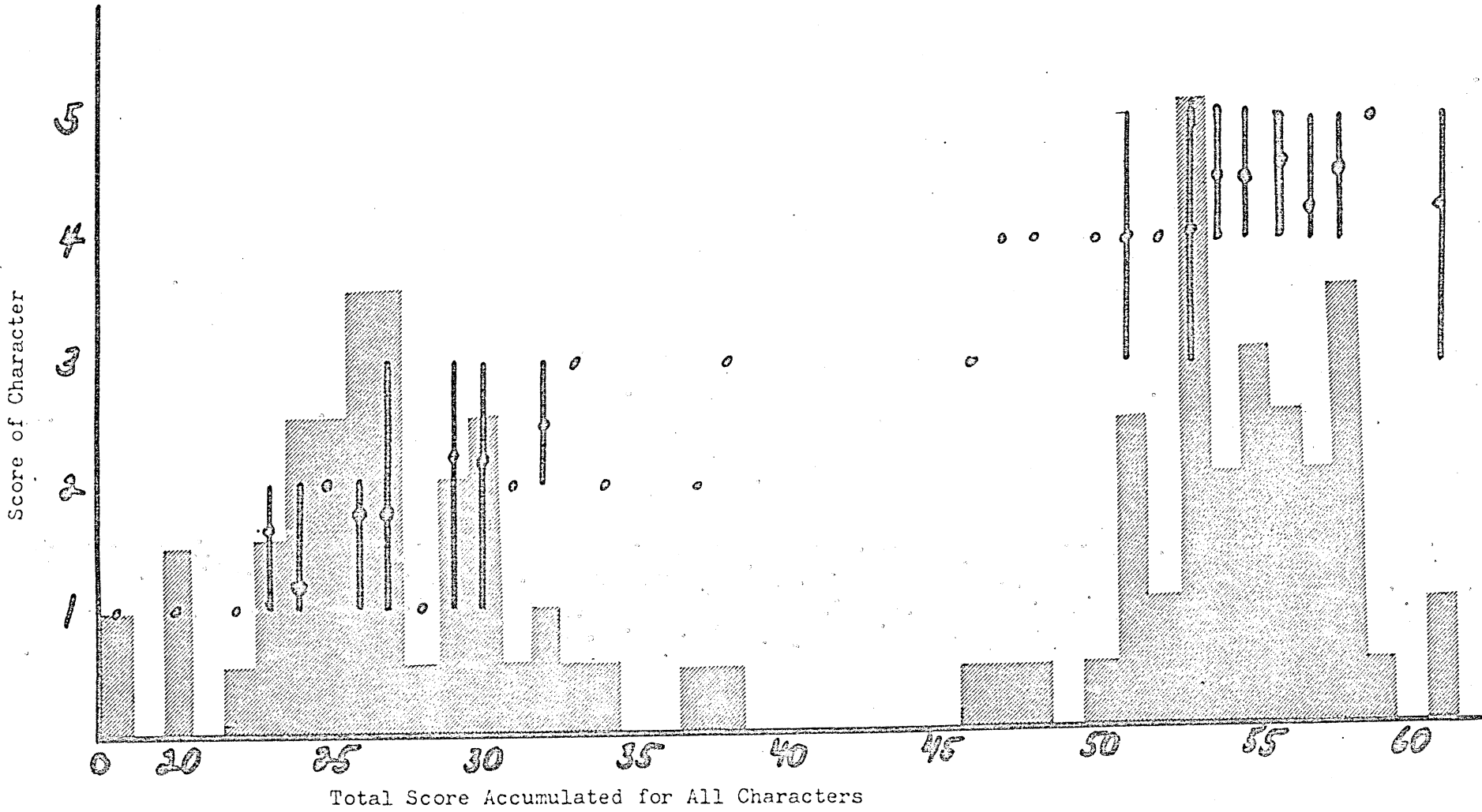


Fig. 7. Cone scale margin showing range and average.

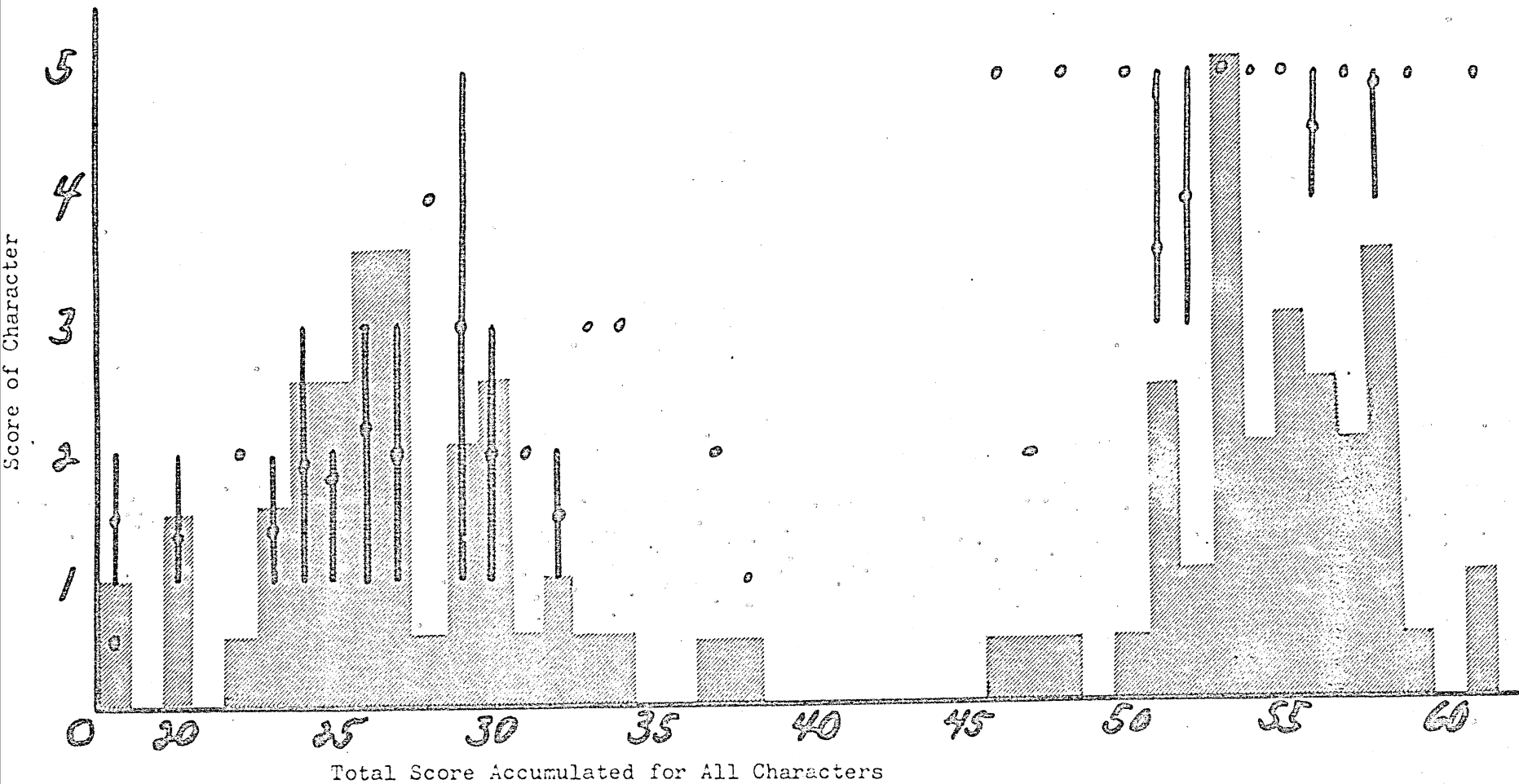


Fig. 8. Bark color showing range and average.

Circumference in Centimeter

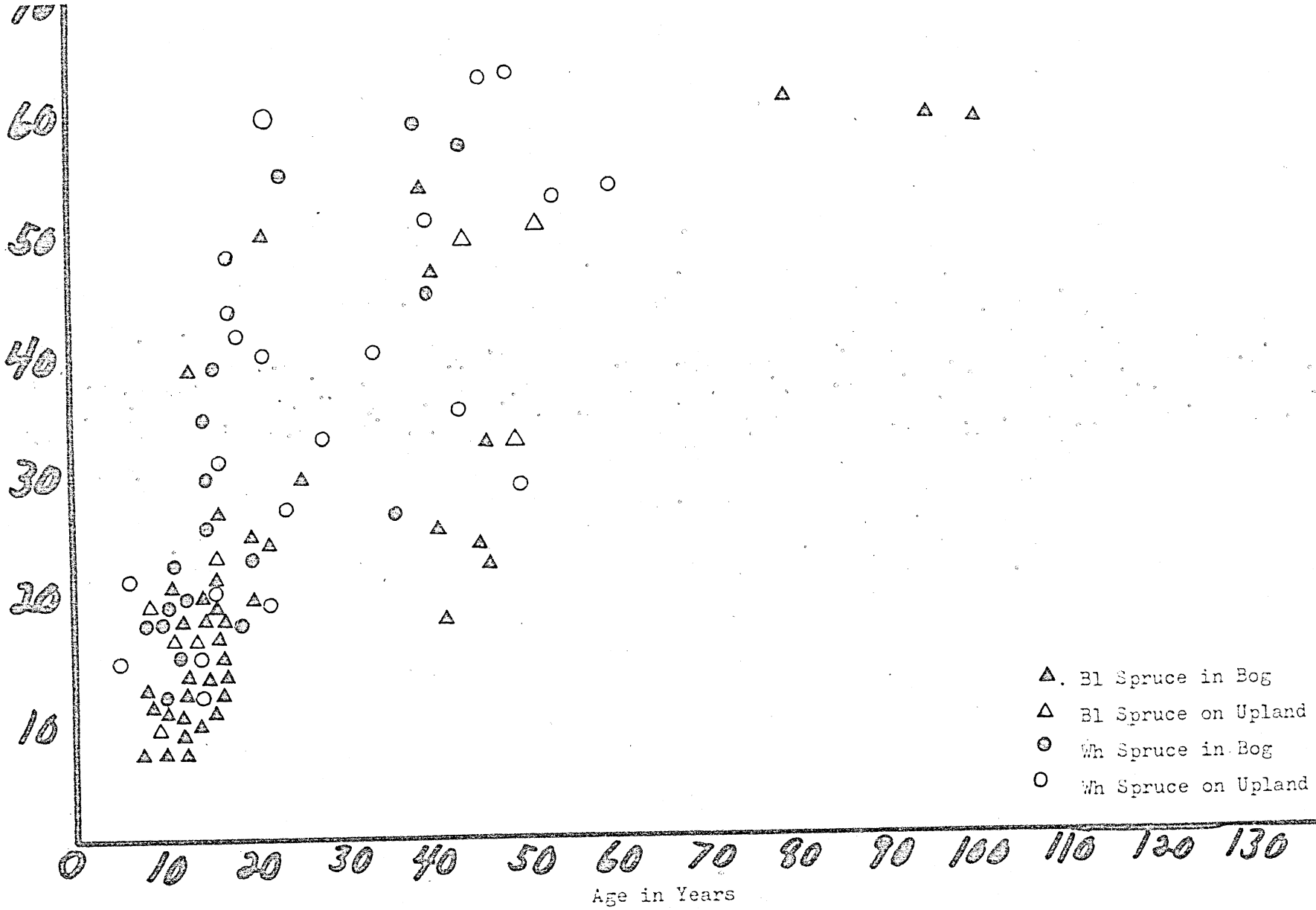


Fig. 9. "Black" spruce and "white" spruce showing relationship between age, growth, and habitat.

150

140

130

120

110

100

90

80

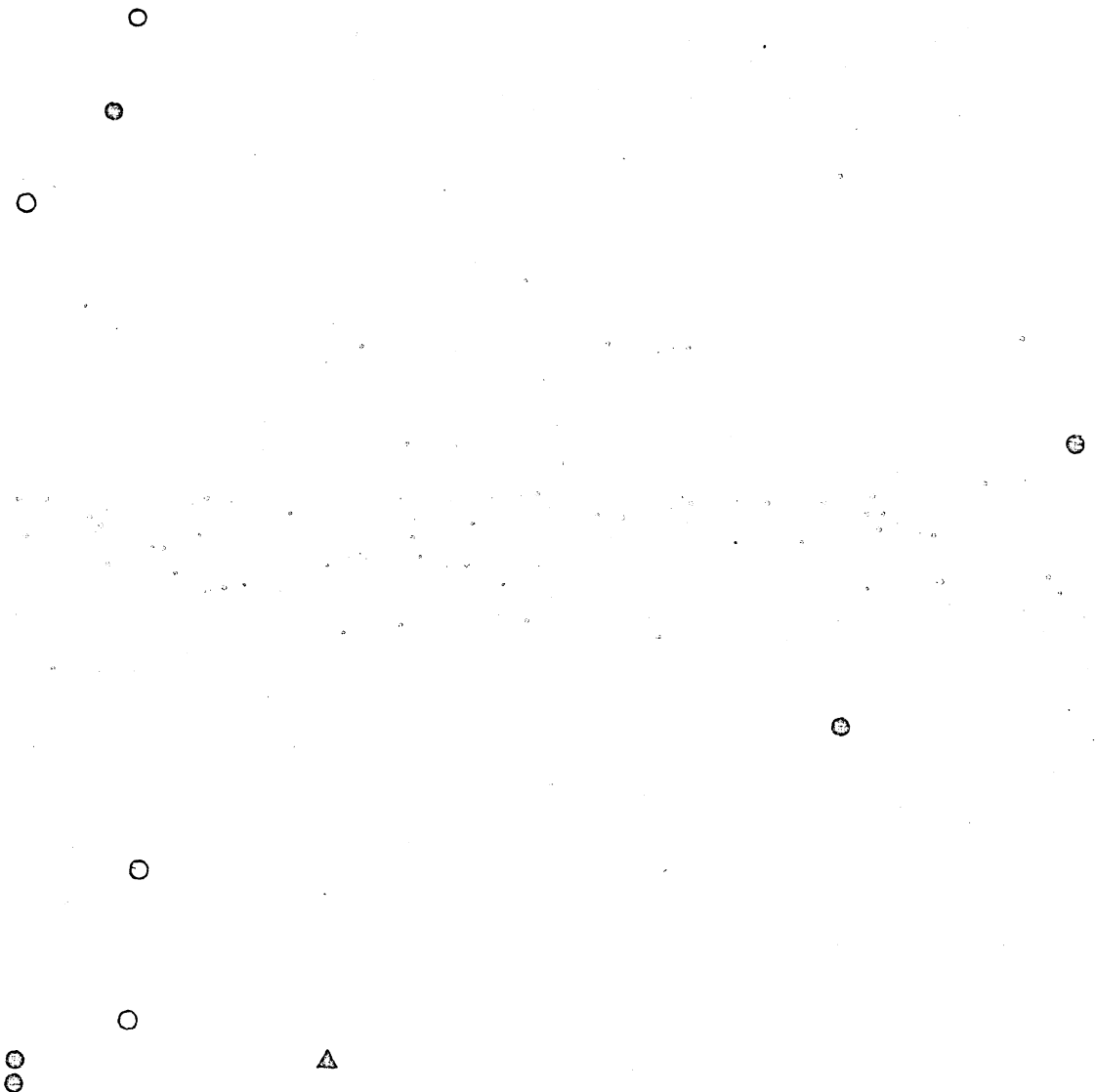


Table I. Character assignments that represent differences between "black" spruce and "white" spruce.

Character	To Represent Black Spruce	To Represent White Spruce
Twig Color	Dark brown to black	Tan to yellow white
Fubescant: Glabrous	Fubescant	Glabrous
Leaf Length	Short (8-11 mm)	Long (11-18 mm)
Stomata Location	3-4 rows on top of leaf 1-2 rows on bottom of leaf	3-4 rows on all sides of leaf
Leaf Curvature	Curved	Straight
Leaf Apex	Blunt	Very sharp
Leaf Location on Stem	Evenly distributed around stem	Crowded on top of stem
Cone Shape	Ovoid	Ellipsoid
Cone Color	Black to grey-brown	Tan to brown
Cone Scale Margin	Erose Pointed	Entire Flattened
Cone Stalk	Recurves	Straight
Cone Length	Short (1.5-2.7 cm)	Long (2.7-5 cm)
Bark Color	Tan to yellow-brown	Grey to red-brown

Table II. General information and scores of characters for individual trees.

Tree Number	1	2	3	4	5	6	7	8	9	10	11	12	13
Age	53	43	14	11	50	49	6	5	8	10	11	11	9
Height (m)	11	11	5	5	10	8	4	3	4	8	4	4	3
Circumference (cm)	53	49	17	17	90	81	22	15	16	18	20	21	10
Soil Type <sup>1</sup>	S	S	S	S	S	S	S	S	S	P	P	P	S
Drainage <sup>2</sup>	U	U	U	U	U	U	U	U	U	B	B	B	U
Location <sup>3</sup>	BT	BT	BT	BT	LB	LB	LB	LB	LB	LB	LB	LB	BT
Twig Color	1	1	3	1	5	5	5	5	1	5	5	3	1
Fubescent: Glabrous	1	1	1	3	5	5	5	5	1	5	5	3	1
Leaf Length	2	1	2	2	5	4	4	4	1	5	5	2	2
Stomata Location	1	1	1	1	5	5	5	5	1	5	5	3	3
Leaf Curvature	3	5	3	5	1	3	5	3	1	5	5	5	2
Leaf Apex	1	1	3	3	3	3	5	5	1	5	5	5	3
Leaf Location on Stem	3	3	3	3	5	5	5	3	1	3	5	3	1
Cone Shape	1	2	2	3	4	4	4	5	1	3	4	2	4
Cone Color	2	4	4	2	5	4	4	3	3	3	5	1	4
Cone Scale Margin	2	3	1	2	5	5	4	4	1	3	3	3	1
Cone Stalk	2	3	3	3	4	5	4	4	1	3	4	3	1
Cone Length	3	2	2	3	5	5	4	2	3	3	5	4	2
Bark Color	1	3	1	1	5	5	4	3	2	3	5	1	2
Total Score	23	30	29	32	57	58	58	51	18	51	61	38	22

<sup>1</sup>S = Sand, P Peat.

<sup>2</sup>U = Upland, B Bog.

<sup>3</sup>BT = Beaver Trail, LB LaSalle Creek Bog, ML Mary Lake  
BD Bog D Trail, IB Iron Spring Bog.

Table II. Cont.

Tree Number	14	15	16	17	18	19	20	21	22	23	24	25	26
Age	15	18	41	60	54	65	80	17	11	11	12	14	15
Height (m)	4	7	22	9	16	16	16	9	5	2	6	5	5
Circumference (cm)	20	42	132	54	73	77	61	44	22	10	38	18	30
Soil Type	S	S	S	S	S	P	P	S	P	F	F	P	P
Drainage	U	U	U	U	U	B	B	U	B	B	B	B	B
Location	ML	ML	ML	ML	ML	ML	ML	ML	LB	LB	LB	LB	LB
Twig Color	5	5	5	3	3	1	1	3	5	1	3	2	5
Pubescent: Glabrous	3	5	5	5	5	1	3	5	5	3	1	1	3
Leaf Length	3	4	4	5	3	3	3	5	5	2	3	2	3
Stomata Location	5	1	1	3	3	3	1	5	4	1	1	2	3
Leaf Curvature	5	3	3	3	3	5	3	3	3	3	3	3	4
Leaf Apex	5	3	3	5	5	3	3	5	4	2	3	2	4
Leaf Location on Stem	5	5	5	5	5	3	1	3	3	1	2	2	5
Cone Shape	4	5	5	5	4	3	2	5	5	4	3	2	5
Cone Oolor	4	5	4	5	5	2	1	5	4	3	4	2	3
Cone Scale Margin	4	4	4	5	4	1	1	5	5	2	1	3	5
Cone Stalk	3	4	4	4	5	2	2	4	4	1	2	2	4
Cone Length	4	4	5	5	4	2	2	5	5	3	3	3	5
Bark Color	5	3	5	5	3	1	1	5	4	1	1	3	5
Total Score	55	51	53	58	52	30	24	58	56	27	30	29	54



Table II. Cont.

Tree Number	27	28	29	30	31	32	33	34	35	36	37	38	39
Age	16	47	15	26	23	22	17	18	21	20	20	14	16
Height (m)	7	16	5	6	8	8	8	8	8	6	2	6	4
Circumference (cm)	31	137	26	30	56	51	41	48	59	19	23	35	14
Soil Type	S	P	P	P	P	P	P	S	S	P	P	P	P
Drainage	U	B	B	B	B	B	B	U	U	B	B	B	B
Location	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB
Twig Color	5	3	5	2	5	2	5	5	5	1	5	5	1
Fubescant: Glabrous	5	5	5	1	5	2	5	5	3	3	5	4	3
Leaf Length	3	5	4	1	4	2	5	4	5	3	4	4	2
Stomata Location	4	5	4	1	3	1	3	3	5	1	5	3	1
Leaf Curvature	4	3	3	4	3	3	4	3	3	3	3	3	3
Leaf Apex	4	3	5	1	5	2	3	3	5	2	3	3	4
Leaf Location on Stem	4	4	5	1	5	3	2	4	3	2	3	5	2
Cone Shape	4	5	3	3	4	3	5	5	5	2	5	5	2
Cone Color	5	4	5	4	4	3	4	4	4	2	4	5	3
Cone Scale Margin	4	5	3	3	4	3	5	4	5	1	4	4	3
Cone Stalk	4	4	3	3	4	3	4	3	4	2	4	3	2
Cone Length	4	4	3	3	4	3	5	5	4	2	4	5	2
Bark Color	5	5	5	3	5	3	5	5	5	4	5	5	2
Total Score	55	55	53	30	55	33	55	53	56	28	54	54	30

Table II. Cont.

Tree Number	40	41	42	43	44	45	46	47	48	49	50	51	52
Age	15	12	16	17	16	15	13	14	102	12	16	15	21
Height (m)	6	2	6	8	6	4	3	6	12	4	8	4	5
Circumference (cm)	18	9	21	27	22	19	13	18	57	15	23	15	19
Soil Type	F	P	P	P	P	P	F	F	P	P	S	S	S
Drainage	B	B	B	B	B	B	B	B	B	B	U	U	U
Location	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	LB	BD	BD
Twig Color	2	1	1	1	1	2	3	1	1	3	2	5	5
Pubescent: Glabrous	2	1	1	1	1	1	1	1	1	4	2	5	5
Leaf Length	3	2	1	1	2	1	1	2	1	1	1	4	4
Stomata Location	1	1	1	1	1	1	2	1	1	1	1	5	5
Leaf Curvature	3	3	4	3	3	3	3	3	3	3	3	3	3
Leaf Apex	2	3	3	2	2	2	2	2	1	2	2	5	4
Leaf Location on Stem	1	2	2	2	2	1	3	1	2	1	3	5	4
Cone Shape	3	3	2	3	2	3	2	3	2	2	4	5	5
Cone Color	2	3	3	2	3	3	3	2	4	2	3	5	4
Cone Scale Margin	3	2	2	2	1	2	3	1	2	2	2	5	5
Cone Stalk	1	2	2	3	1	2	1	1	2	2	3	4	4
Cone Length	3	2	2	2	2	3	1	3	2	2	3	5	5
Bark Color	3	2	1	2	2	3	2	3	1	1	2	5	5
Total Score	29	27	25	25	24	27	27	24	23	26	31	61	58

Table II. Cont.

Tree Number	53	54	55	56	57	58	59	60	61	62	63	64	65
Age	51	50	41	96	45	46	20	41	15	12	32	40	46
Height (m)	22	8	6	16	8	8	6	9	4	2	8	9	8
Circumference (cm)	143	29	18	59	24	24	24	25	13	13	40	51	31
Soil Type	S	S	P	P	P	P	P	P	P	S	S	S	P
Drainage	U	U	B	B	B	B	B	B	B	U	U	U	B
Location	BD	BD	BD	BD	BD	BD	BD	BD	BD	ED	BD	BD	BD
Twig Color	2	5	1	2	2	1	1	1	1	5	3	4	2
Pubescent: Glabrous	1	5	1	1	1	1	2	1	3	4	5	5	2
Leaf Length	4	4	1	1	1	1	1	2	1	4	4	3	1
Stomata Location	5	4	1	1	1	1	1	1	1	5	4	4	1
Leaf Curvature	3	3	3	3	3	2	3	3	3	3	3	3	3
Leaf Apex	4	5	1	1	1	1	4	2	1	4	4	2	2
Leaf Location on Stem	4	4	2	1	2	3	3	1	2	5	5	5	3
Cone Shape	5	5	2	1	3	2	3	2	2	5	5	5	2
Cone Color	5	4	2	2	3	2	2	1	3	4	5	5	2
Cone Scale Margin	4	4	1	1	2	1	1	1	1	4	4	5	2
Cone Stalk	4	4	1	2	2	2	2	2	2	4	5	4	1
Cone Length	5	5	1	2	2	2	2	2	2	4	5	5	3
Bark Color	5	5	1	2	2	1	2	1	2	5	5	5	1
Total Score	53	57	18	20	25	20	27	20	24	56	57	55	25

Table II. Cont.

Tree Number	66	67	68	69	70	71	72	73	74	75	76	77	78
Age	21	23	43	47	50	27	41	43	46	40	40	109	38
Height (m)	9	4	11	11	9	6	11	11	14	14	9	16	11
Circumference (cm)	40	26	36	64	33	33	46	56	63	78	46	98	59
Soil Type	S	S	S	S	S	S	P	P	P	P	P	P	P
Drainage	U	U	U	U	U	U	B	B	B	B	B	B	B
Location	BD	BD	BD	BD	BD	BD	IB	IB	IB	IB	IB	IB	IB
Twig Color	5	5	5	4	2	5	5	4	5	5	2	4	3
Pubescent: Glabrous	5	4	4	4	1	5	5	5	5	5	2	5	5
Leaf Length	5	3	5	3	1	3	3	3	3	3	2	4	3
Stomata Location	4	1	4	3	1	4	4	4	5	4	1	4	4
Leaf Curvature	3	3	3	3	3	3	3	3	3	3	3	3	3
Leaf Apex	4	5	5	4	2	5	3	4	3	3	3	4	3
Leaf Location on Stem	5	4	5	4	1	4	4	4	2	3	2	5	4
Cone Shape	5	5	5	5	3	5	4	5	4	5	2	5	5
Cone Color	4	3	4	5	3	5	5	5	3	4	2	5	5
Cone Scale Margin	5	4	4	5	2	4	4	4	5	4	2	5	4
Cone Stalk	4	4	4	4	2	4	4	4	4	4	1	4	4
Cone Length	5	4	5	5	2	5	4	3	4	5	2	5	4
Bark Color	5	5	5	5	3	5	5	5	5	5	5	5	4
Total Score	59	50	58	54	26	57	53	53	51	53	29	53	51

Table II. Cont.

Tree Number	79	80	81	82	83	84	85	86	87	88	89	90	91
Age	38	40	132	36	12	14	10	12	10	10	13	58	16
Height (m)	11	14	18	6	5	4	2	3	2	3	4	12	3
Circumference (cm)	54	77	116	26	14	15	8	12	8	9	15	52	14
Soil Type	P	P	P	F	F	F	P	P	P	P	P	S	P
Drainage	B	B	B	B	B	B	B	B	B	B	B	U	B
Location	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB	IB
Twig Color	2	4	2	4	1	3	3	2	3	2	2	5	2
Fubescens: Glabrous	2	5	5	5	2	5	1	2	3	2	2	5	1
Leaf Length	2	4	4	2	2	3	2	1	1	1	1	5	2
Stomata Location	1	3	1	2	2	4	3	1	3	1	1	4	1
Leaf Curvature	3	3	3	3	3	3	3	3	3	3	3	3	3
Leaf Apex	1	4	3	3	2	3	2	1	3	2	2	4	2
Leaf Location on Stem	2	4	4	3	2	4	5	1	2	5	2	4	2
Cone Shape	4	4	5	4	2	4	4	2	3	3	3	5	2
Cone Color	3	4	4	4	3	4	4	4	3	4	3	5	2
Cone Scale Margin	1	4	4	3	1	4	2	2	2	2	1	4	2
Cone Stalk	2	4	4	4	2	4	3	1	3	3	2	4	2
Cone Length	3	4	4	4	2	4	3	3	2	2	2	5	2
Bark Color	1	5	5	5	3	2	2	3	3	2	2	5	1
Total Score	27	52	48	46	27	47	37	26	34	32	26	58	24

Table II. Cont.

Tree Number	92	93	94	95	96	97	98	99	100	R
Age	20	15	10	11	9	10	13	9	13	-
Height (m)	8	3	4	4	4	2	5	4	5	-
Circumference (cm)	24	19	10	12	16	12	17	12	18	-
Soil Type	P	P	P	P	P	P	P	P	P	-
Drainage	B	B	B	B	B	B	B	B	B	-
Location	1B	1B	1B	1B	1B	1B	1B	1B	1B	-
Twig Color	2	5	1	2	4	4	2	1	4	3
Pubescent: Glabrous	1	5	1	1	4	5	1	1	5	3
Leaf Length	2	4	2	2	4	3	1	1	2	3
Stomata Location	1	4	1	1	4	5	1	1	3	3
Leaf Curvature	3	3	3	3	3	3	3	3	3	3
Leaf Apex	2	3	2	2	3	3	3	3	4	4
Leaf Location on Stem	3	5	1	1	4	4	3	1	5	3
Cone Shape	3	4	3	3	5	5	2	3	4	3
Cone Color	1	5	3	3	5	5	3	1	4	4
Cone Scale Margin	1	5	2	2	4	4	2	1	5	3
Cone Stalk	1	4	3	2	4	5	1	2	4	3
Cone Length	3	5	2	2	4	5	2	3	5	5
Bark Color	3	4	2	1	5	5	2	2	5	3
Total Score	26	56	26	25	53	56	26	23	53	43

Table III. The Consistency of characters to identify "black" spruce from "white" spruce.

	<u>Twig Color</u>				
Value	1	2	3	4	5
Number of black spruce with this value	24	19	7	0	0
Number of white spruce with this value	0	1	7	10	32
Specie each value represents <sup>1</sup>	B1	B1	?	Wh	Wh
Number of trees correctly identified to specie by each value	24	19	0	10	32
Percent of trees correctly identified by all values			85		

	<u>Pubescent:Glabrous</u>				
Value	1	2	3	4	5
Number of black spruce with this value	30	12	7	1	0
Number of white spruce with this value	1	0	3	6	40
Specie each value represents	B1	B1	?	Wh	Wh
Number of trees correctly identified to specie by each value	30	12	0	6	40
Percent of trees correctly identified by all values			88		

	<u>Leaf Length</u>				
Value	1	2	3	4	5
Number of black spruce with this value	24	21	5	0	0
Number of white spruce with this value	0	2	15	21	12
Specie each value represents	B1	B1	Wh	Wh	Wh
Number of trees correctly identified to specie by each value	24	21	15	21	12
Percent of trees correctly identified by all values			93		

<sup>1</sup>B1= Black Spruce, Wh= White Spruce

Table III. Cont.

Value	<u>Stomata Location</u>				
	1	2	3	4	5
Number of black spruce with this value	42	3	5	0	0
Number of white spruce with this value	4	1	10	18	17
Species each value represents	B1	?	?	Wh	Wh
Number of trees correctly identified to species by each value	42	0	0	18	17
Percent of trees correctly identified by all values			77		
Value	<u>Leaf Curvature</u>				
	1	2	3	4	5
Number of black spruce with this value	1	2	42	2	3
Number of white spruce with this value	1	0	41	3	5
Species each value represents	?	?	?	?	?
Number of trees correctly identified to species by each value	0	0	0	0	0
Percent of trees correctly identified by all values			0		
Value	<u>Leaf Apex</u>				
	1	2	3	4	5
Number of black spruce with this value	11	21	15	2	1
Number of white spruce with this value	0	1	21	15	13
Species each value represents	B1	B1	?	Wh	Wh
Number of trees correctly identified to species by each value	11	21	0	15	13
Percent of trees correctly identified by all values			60		



Table III. Cont.

Value	<u>Leaf Location on Stem</u>				
	1	2	3	4	5
Number of black spruce with this value	15	18	14	1	2
Number of white spruce with this value	0	2	8	18	22
Specie each value represents	Bl	Bl	?	Wh	Wh
Number of trees correctly identified to specie by each value	15	18	0	18	22
Percent of trees correctly identified by all values				73	

Value	<u>Cone Shape</u>				
	1	2	3	4	5
Number of black spruce with this value	3	22	20	5	0
Number of white spruce with this value	0	0	2	15	33
Specie each value represents	Bl	Bl	Bl	Wh	Wh
Number of trees correctly identified to specie by each value	3	22	20	15	33
Percent of trees correctly identified by all values				93	

Value	<u>Cone Color</u>				
	1	2	3	4	5
Number of black spruce with this value	5	16	19	10	0
Number of white spruce with this value	0	0	5	22	23
Specie each value represents	Bl	Bl	Bl	Wh	Wh
Number of trees correctly identified to specie by each value	5	16	19	22	23
Percent of trees correctly identified by all values				85	

Table III. Cont.

Value	<u>Cone Scale Margin</u>				
	1	2	3	4	5
Number of black spruce with this value	20	22	8	0	0
Number of white spruce with this value	0	0	4	28	18
Species each value represents	Bl	Bl	?	Wh	Wh
Number of trees correctly identified to species by each value	20	22	0	28	18
Percent of trees correctly identified by all values				88	
Value	<u>Cone Stalk</u>				
	1	2	3	4	5
Number of black spruce with this value	13	25	16	0	0
Number of white spruce with this value	0	0	5	41	4
Species each value represents	Bl	Bl	Bl	Wh	Wh
Number of trees correctly identified to species by each value	13	25	16	41	4
Percent of trees correctly identified by all values				95	
Value	<u>Cone Length</u>				
	1	2	3	4	5
Number of black spruce with this value	3	28	18	1	0
Number of white spruce with this value	0	1	3	19	27
Species each value represents	Bl	Bl	Bl	Wh	Wh
Number of trees correctly identified to species by each value	3	28	18	19	27
Percent of trees correctly identified by all values				95	

Table III. Cont.

Value	<u>Bark Color</u>				
	1	2	3	4	5
Number of black spruce with this value	18	18	12	1	1
Number of white spruce with this value	0	1	4	4	41
Species each value represents	Bl	Bl	Bl	Wh	Wh
Number of trees correctly identified to species by each value	18	18	12	4	41
Percent of trees correctly identified by all values				93	

Taxonomic Study

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