A NEW SPRUCE HYBRID - PICEA SCHRENKIANA X P. GLAUCA

by D. P. Fowler[1]

Picea schrenkiana Fisch and Meyer is a relatively unknown central Asiatic species confined to the Ala Tau and Thian Shan mountains of Turkestan. Morphologically the species is most closely related to *P. spinulosa* (Griff.) Henry and, to a lesser degree, to *P. obovata* Ledeb. (Wright 1955).

The genetic relationship between *P. schrenkiana* and other spruce species is unknown. A review of the literature failed to turn up any attempts to produce interspecific hybrids with this species. No reports of natural hybrids with *P. schrenkiana*

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Materials and Methods

In the spring of 1947, six *P. schrenkiana* seedlings were obtained from the nursery of Hillier and Sons, Winchester, England. These were planted as specimen trees at the Southern Research Station, Maple, Ontario. Subsequently one seedling died. The remaining five specimens are winter hardy but relatively slow growing (largest tree 17 feet at 18 years).

All five trees produced male and female strobili for the first time in 1964. The female strobili were isolated when they were still partially enclosed by bud scales and before the strobili scales had begun to separate (see Nienstaedt 1958). The isolation

technique was similar to that used by Mergen, Rossol, and Pomeroy (1955) for southern pines except that the sausage casing bags were coated 0; one side with aluminum paint. The painted side of the bag was positioned so that it shaded the strobili and enclosed foliage during mid-day.

Pollen of P. *omorika* (Pantie) Purkyne (1 tree), *P. glehnii* (Fr. Schmidt) Masters. (3 trees), and P. *jezoensis* (Sieb. and Zucc.) Carr. (1 tree) was obtained from trees located in the Durand-Eastman Park, Rochester, N.Y. In addition, pollen of P. *koyamai* Shirasawa (6 trees), *P. mariana* (Mill.) B.S.P. (10 trees), and P. *glauca* (Moench) Voss. (10 trees) was collected from trees growing at the Southern Research Station. Pollen was also collected from each of the five P. *schrenkiana* trees. In each instance, male strobili were collected just prior to natural pollen shedding and dried in paper boxes. The pollen was extracted by passing it through a 60-mesh Tylor screen.

Pollinations were made, using an aspirator type device, when the scales of the female strobili were well separated. A list of the attempted pollinations is given in table 1. The isolation bags were removed after the cone scales had closed. Fiberglas bags were placed over the cones in August and the cones were allowed to ripen on the trees. The ripe cones were collected in October, the seed extracted, and the full and empty seeds were separated by flotation in absolute alcohol. The full seeds were stratified for 30 days at 35-40°F on moist sand in Petri dishes, and germinated at 80°F in the laboratory. The germinated seeds were transplanted into individual plastic pots in a greenhouse, where they were raised under an 18-hour photoperiod with a 60°F night temperature and a 75-80°F day temperature.

One week after planting in the greenhouse, the seedlings of one population of *P. schrenkiana* × *P. glauca* were arranged in a test where they could be compared with three P. *glauca* and two *P. schrenkiana* populations. The three P. *glauca* populations resulted from controlled cross-pollinations of three of the trees used as male parents of the hybrids. The two P. *schrenkiana* populations resulted from self- and open-pollination of the female parent of the hybrids. The test consisted of a random row design (13 seedlings per row) replicated five times for a total of 65 seedlings from each of the six populations.

At approximately 6 weeks of age, all the seedlings were examined and the following observations were recorded: hypocotyl color, cotyledon share. and cotyledon length. Munsell Color Charts

Table 1.--Summary of pollination results

FEMALE PARENT (PICEA SCHRENKIANA)	MALE PARENT: OPEN	SELF	P. GLAUCA (10)[1]	P. MARIANA (10)[1]	P. OMORIKA (1)[1]	P. GLEHNII (3)[1]	P. JEZOENSIS (1)[1]	P. KOYAMAI (6)[1]
S 32		1 42.0 100.0 42	1 2.0 100.0 2	2 0.0 — —	2 0.0 — —			
S 33	3 14.0 95.2 40	12 29.2 99.0[2] 198	12 0.9 90.9 10	12 0.0 — —	12 0.0 — —	12 0.2 0.0 —	12 0.0 — —	9 0.0 — —
S 34		6 39.8 98.5 197[2]	7 0.1 100.0 1	3 0.0 — —	4 0.0 — —	5 0.0 — —		7 0.1 100.0 1
S 35	62 31.2 89.3 268	16 41.0 95.0[2] 190	11 1.6 38.9 7	7 0.0 — —	5 0.0 — —	6 0.3 50.0 1	13 0.0 — —	13 0.0 — —
S 36	53 57.1 92.3[3] 277	13 89.1 99.0[2] 198	16 27.6 94.8 418	14 0.0 — —	12 0.0 — —	15 0.0 — —	14 0.0 — —	14 0.0 — —

CONTROLLED POLLINATIONS THAT YIELDED VIABLE SEEDS

— No. CONES POLLINATED
— No. FULL SEEDS/CONE
— PERCENT GERMINATION
— No. SEEDLINGS AT 2 MO.

[1] No. MALE PARENTS USED
[2] 200 SEEDS GERMINATED
[3] 300 SEEDS GERMINATED

(Munsell Color Co. 1952) were used to score hypocotyl color. When the seedlings were approximately 9 weeks old, total height and cotyledon number were recorded for the seedlings in the replicated test. Total height was again recorded for these seedlings at 15, 18, and 22 weeks.

Pollination Results

The pollination results are presented in table 1. *P. mariana, P. omorika,* and P. *jezoensis* failed to produce any viable seeds when used as male parents on P. *schrenkiana. P. glehnii* and P. *koyamai* produced only one viable seed each when used as male parents. The authenticity of these hybrids is questionable. Of the six interspecific crosses attempted, only the cross P. *schrenkiana* × *P. glauca* can be considered reasonably successful. All five trees, used as female parents, produced some viable seed following pollination with *P. glauca;* but the success of this cross differed markedly between the five parents. Only one of the five trees could be considered to be moderately cross-compatible (27.6 viable seeds per cone).

P. schrenkiana would appear to be a fairly self-fertile species. Self-pollination resulted in a higher percentage of viable seed per cone than open pollination. The low percentage of full seed in the open-pollinated cones probably was the result of inadequate pollination. Further tests are required before a valid comparison of self- and cross-pollination can be made.

Description of Hybrid P. schrenkiana x P. glauca

Seedling hypocotyl color at 6 weeks of age was found to be a useful attribute for distinguishing hybrid seedlings from non-hybrid seedlings of the female parent. *P. schrenkiana* seedlings then had yellow hypocotyls (Munsell Color Chart 5.OY 7/8), while the seedlings of P. *glauca* had red hypocotyls (Munsell Color Chart 2.5R 4/8). At 6 weeks the hybrids had red hypocotyls (Munsell Color Chart 2.5R 4/6) which faded to a yellowish yellow-red (7.5YR 6/6) when the seedlings were 8-10 weeks old. The hybrids were similar to the female parent in respect to cotyledon length and were intermediate between the two parents in respect to cotyledon shape. P. *schrenkiana* seedlings had strongly upcurved cotyledons, whereas those of *P. glauca* were almost horizontal and straight. The cotyledons of the hybrids were slightly curved upward. The terminal shoots of the P. *glauca* seedlings were strongly curved upward. The terminal shoots of the P. *glauca* seedlings were strongly orthotropic, while those of P. *schrenkiana* were plagiotropic. The hybrids were intermediate in respect to this attribute.

The seedling height data obtained from the replicated test were subjected to a variance analysis and to a Duncan Range test (Duncan, 1955). The summarized results are presented in figure 1. Figure 2 shows an average seedling from each of the six populations at 12 and 22 weeks of age.

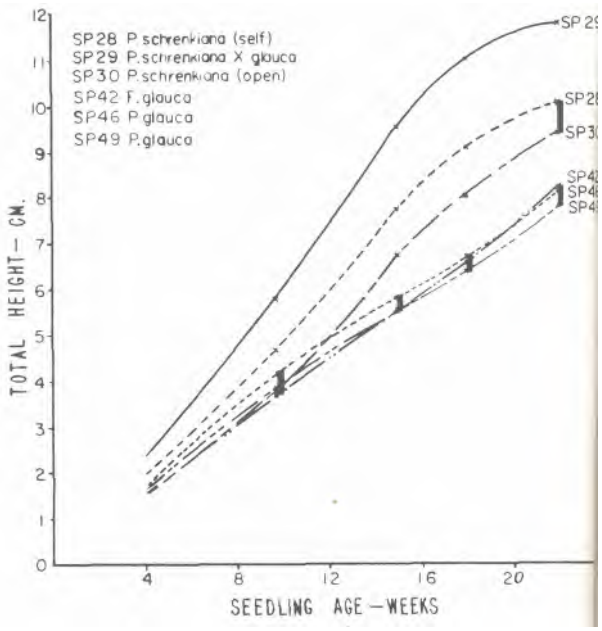

FIGURE 1. — Seedling height in relation to age. Any two points on the growth curves which are connected by the same vertical line are not significantly different at the 1-percent level.

The hybrids did not differ significantly from the female parent in respect to number of cotyledons. They were clearly superior to either parent species in respect to total height at 9, 15, 18 and 22 weeks. Under the conditions of this experiment, the hybrids exhibit heterosis.

Relationship of P. *schrenkiana* to Other Spruce Species

The phylogenetic relationship between *P. schrenkiana* and the other spruces is obscure although it appears to be fairly closely related to *P. glauca. P. schrenkiana is* certainly an exception to the general pattern of crossability reported by Wright (1955) in that it is geographically and morphologically widely separated from P. *glauca.*

Wright (1955) considered *P. jezoensis* to be the most probable connecting link between the Old World and the western American spruces in that it is similar taxonomically to P. *sitchensis* (Bong.) Carr. and P. *engelmanni* (Parry) Engelm., and crosses easily with P. *glauca.* If P. *jezoensis* were the connecting link between the Old World and the western American spruces, one would expect the cross P. *schrenkiana* × *jezoensis* to be more successful than P. *schrenkiana* × *glauca.* This was not found to be true in this experiment. *P. jezoens is* failed to produce any viable seed when used as male parent with *P. schrenkiana.* As pollen from only one *P. jezoensis* was used on only three *P. schrenkiana* trees, it is still quite conceivable that the two species can be crossed (see Langner 1959).

FIGURE 2. — Average seedlings at 12 (top) and 22 (bottom) weeks of age. Parentage from left to right: *P. schrenkiana* (self), *P. schrenkiana* (open), *P. schrenkiana* x *glauca*, *P. glauca*, *P. glauca*, and *P. glauca*.

In addition, the cross *P. glauca* x *P. koyamai is* reasonably successful (Wright 1955) and yet in this study the cross P. *schrenkiana* x *P. koyamai* was unsuccessful.

The preceding suggests that P. *glauca* and not *P. jezoensis* is the connecting link between the Old World and the western American spruces.

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