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Identifying Noble Fir Source From The Seed Itself:

A PROGRESS REPORT

by

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Mr. Franklin: I think everyone involved in planting programs has asked himself at times, especially when he was faced with plantation value or something of a similar nature, where did that seed I bought really come from?

Use of offsite seed or seedlings in reforestation programs can have serious consequences, ranging from reduced growth rates to outright failure, However, to properly match seed sources and reforestation site, the forester must know the origin of the seed. This is no problem when he supervises collection of the seed himself, but he rarely can do so. Therefore, the forester occasionally needs some way of verifying the source of cones or seed collected by others prior to purchase.

Previously, source verification has not been possible except in very general terms; e.g., distinguishing of coastal and interior seed sources. We now report a study which may provide a means for pinpointing from the seed itself noble and Shasta red fir source to within 50 miles or less.

In 1967, we started this cooperative Region 6 and Pacific Northwest Forest and Range Experiment Station study to determine if some seed or seedling features could be used to identify broad seed source localities for noble (Abies procera), California red (A. magnifica), and Shasta red (A. magnifica var. shastensis) firs. Although the study is only about half completed, cotyledon number and seed weight have proven very promising as source indices. The preliminary data reported here illustrate the potential of the verification method.

Methods

The study was designed around seed collected from many locations throughout the range of noble, Shasta red, and California red firs, with 8 to 20 trees individually sampled at each location. In 1967, cone collections were obtained from about 250 trees in 33 locations, ranging from southern Washington to the central Sierra Nevada in California. In 1968, a wider range of collections was obtained from about 450 trees in over 50 locations, including samples from northern Washington and the southern Sierra Nevada; seed weight and cotyledon data are not yet available for most of the 1968 material.

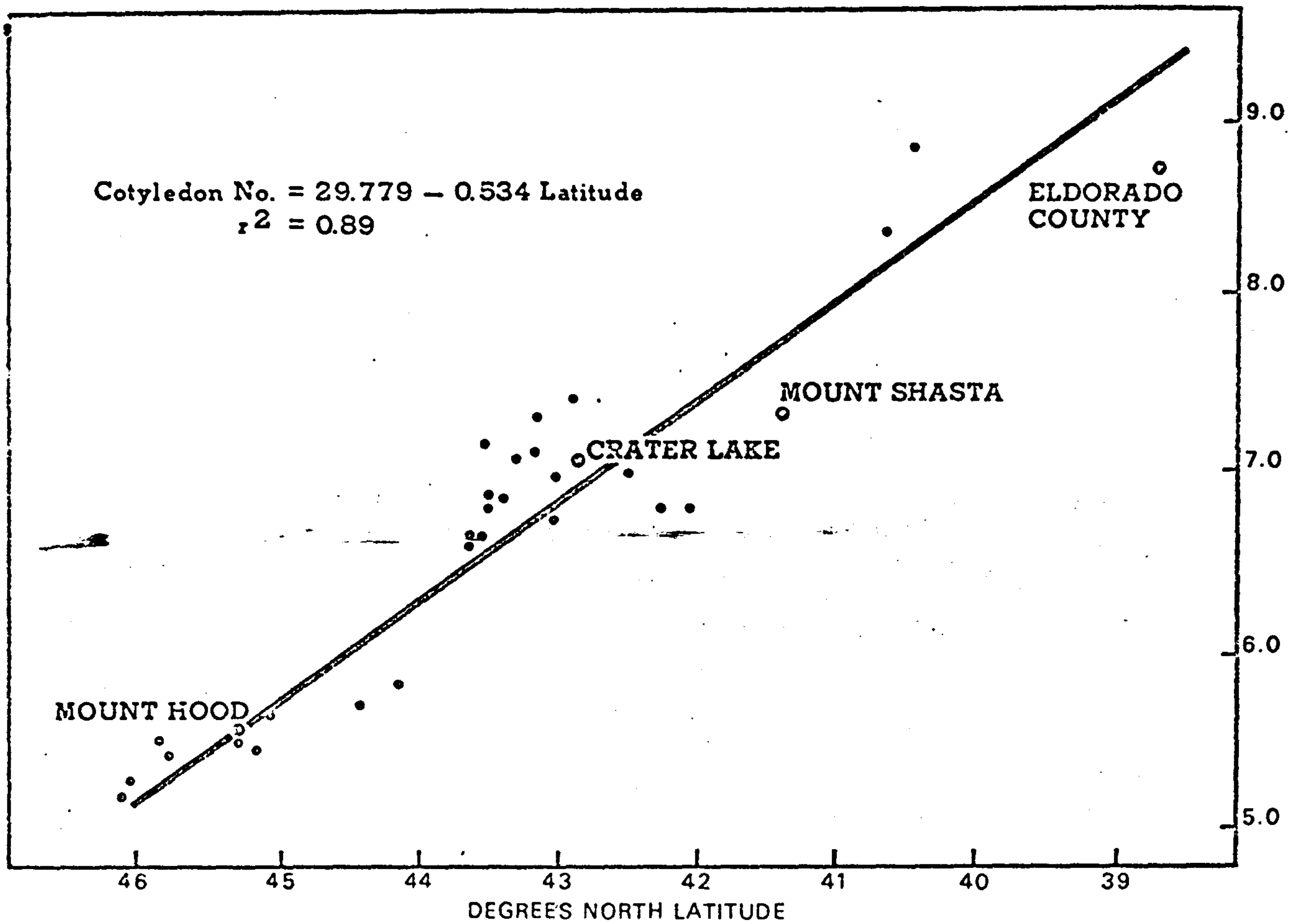
Seed was extracted, dewinged, and dried to about 8-per cent moisture content. Some of the extracted seed from each tree was X-rayed. On the X-rays, sound seeds were identified and separated from the remainder. Counted samples of sound seed were weighed and used to determine number of sound seed per pound. We obtained cotyledon counts by germinating or cutting the seed and counting embryonic cotyledons.

Results

Cotyledon Number

Average number of cotyledons increased from north to south (table 1 and fig. 1). Lowest average numbers observed (4.88) were in collections from the Stevens Pass area at the north end of the noble fir range. Cotyledon counts averaged 5.51 to 5.76 on the Mount Hood and northern Willamette National Forests. South of the McKenzie River, counts increased sharply to around 6.0 at 44° north latitude and 6.6 at 43° 40'. Populations to the south in Oregon consistently had seedlings averaging between 6.7 and 7.4 cotyledons. Shasta red fir trees from Mount Shasta averaged only 7.37 cotyledons, but California red fir populations to the south reached as high as 8.82 cotyledons. There are indications that cotyledon number again declines (to around 7.0) in the southern Sierra.

These data confirm our preliminary observations that there is a latitudinal gradient or cline in cotyledon number in this species complex (fig. 1). The regression of cotyledon number on latitude for the 1967 collections is highly significant ($r^2 = 0.89$), explaining all but 11 percent of the variation.



RELATION OF COTYLEDON NUMBER TO LATITUDE, PRELIMINARY DATA FROM 1967 COLLECTIONS

Table 1.—Number of cotyledons and seeds per pound for selected populations of noble, Shasta red, and California red fir (preliminary data, based on at least 250 cotyledon tallies at each location)

Vicinity	Latitude	Average cotyledon number	Number seeds per pound
Stevens Pass, Washington	47°45'	4.88	13,760
Red Mountain, Washington	45°55'	5.56	9,210
Lookout Mountain, Wash.	45°49'	5.47	9,180
Government Camp, Oregon	45°18'	5.58	10,880
Mount Wilson, Oregon	45°05'	5.67	9,800
Iron Mountain, Oregon	44°24'	5.76	10,460
Roaring River Ridge, Oregon	43°55'	6.00	8,040
Wolf Mountain, Oregon	43°37'	6.64	6,350
Logger Butte, Oregon	43°34'	6.68	6,910
Reynolds Ridge, Oregon	43°24'	6.90	5,380
Hershberger Mountain, Oregon	43°02'	7.01	5,860
Cavern Creek, Oregon	42°54'	7.44	5,210
Crater Lake, Oregon	42°53'	7.10	6,060
Huckleberry Mountain, Ore.	42°52'	7.15	5,640
Blue Rock, Oregon	42°32'	7.01	6,200
Mount Baldy, Oregon	42°15'	6.93	7,000
Dutchman Peak, Oregon	42°02'	6.82	6,580
Mount Shasta, California	41°22'	7.37	5,430
Mount Lassen, California	40°38'	8.38	5,490
Swain Mountain, California	40°25'	8.82	4,420
Lake Tahoe, California	38°38'	8.77	4,560
Inyo County, California	36°46'	6.94	4,470

The frequency distribution of embryos with different cotyledon numbers changed with the mean count (table 2). North of the McKenzie River, seedlings with eight cotyledons were rare or absent and only one with nine cotyledons has been tallied. In southwestern Oregon, seedlings had four to 11 cotyledons, but those with four are rare (none were encountered in most populations), and those with five make up 0 to 4 per cent of the total. Seedlings with eight cotyledons are common and those with nine generally make up 1 to 8 per cent of the total. The range in cotyledon numbers was greatest in California – five to 13. There, excepting the Mount Shasta and Inyo County collections, seedlings with five or six cotyledons were rare or absent and eight or nine cotyledons were typical.

Seed Weight

Seed weight, with number of sound seed per pound as an index, varied in a similar pattern. Seed was lightest in the north, averaging 9,000 to 14,000 sound seeds per pound. In southwestern Oregon (south of the Willamette River) there were 5,100 to 6,900 sound seeds per pound. California red fir seed was heaviest with only 4,400 to 5,400 seeds per pound. The maximum number of seeds per pound was 23,000 on two trees near Mount Hood. The minimum was 3,190 on a tree at Lake Tahoe.

The increase in seed weight with decreasing latitude is also statistically significant. Preliminary analysis of the 1967 data indicates a highly significant curvilinear regression line ($r^2 = 0.69$). However, much as with cotyledon number, there is a rather abrupt seed weight increase between the McKenzie and Willamette Rivers.

Table 2.—Percentage of seedlings by cotyledon number at selected collection sites (preliminary data, based on at least 250 cotyledon tallies at each location)

Location	Number of cotyledons										
	3	4	5	6	7	8	9	10	11	12	13
	Percent of seedlings										
Stevens Pass	0.5	24.9	60.9	13.3	0.4	....	....	....	....	....	....
Red Mountain	....	1.3	46.5	47.5	4.5	....	0.3	....	....	....	....
Lookout Mountain	....	3.5	50.1	41.8	3.9	0.6	....	....	....	....	....
Government Camp	0.1	1.1	44.6	49.6	4.6	....	....	....	....	....	....
Mount Wilson	....	2.8	36.5	53.1	7.6	....	....	....	....	....	....
Iron Mountain	....	1.1	33.5	54.0	9.9	1.5	....	....	....	....	....
Roaring River Ridge	....	1.0	21.7	52.2	22.4	2.1	.5	0.1	....	....	....
Wolf Mountain	....	....	4.3	40.2	43.4	11.8	.8	....	....	....	....
Logger Butte	....	....	1.6	40.4	40.0	8.8	1.2	....	....	....	....
Reynolds Ridge	....	.5	1.0	29.6	51.9	16.0	1.0	....	....	....	....
Hershberger Mount.	....	....	1.4	25.7	48.8	21.4	2.5	.2	....	....	....
Cavern Creek	....	....	.5	12.7	40.5	37.1	7.7	1.4	0.1	....	....
Crater Lake	....	....	.8	19.0	50.5	26.7	3.0	....	....	....	....
Huckleberry Mountain	....	....	....	16.3	52.6	26.2	4.9	....	....	....	....
Blue Rock	....	....	2.7	29.0	45.4	19.6	3.3	....	....	....	....
Mount Baldy	....	....	1.1	34.5	47.8	15.4	1.2	....	....	....	....
Dutchman Peak	....	....	1.5	26.9	50.5	19.9	1.2	....	....	....	....
Mount Shasta	....	....	.9	14.2	39.9	33.8	10.5	.6	.1	....	....
Mount Lassen	....	....	.2	1.0	13.8	37.4	34.5	10.9	1.8	0.4	....
Swain Mountain	....	....	....	....	4.0	33.3	47.2	13.8	1.1	..	..
Lake Tahoe	....	....	....	.4	7.2	35.9	34.7	19.0	2.5	.2	0.1
Inyo County	....	....	2.9	25.7	47.1	22.9	1.4	....	....	....	....

Use in Seed Source Verification

The data presented here are preliminary; complete cotyledon tallies for some of the 1967 collections and most of those from 1968 are not yet available. Analysis and interpretations of the data are even more incomplete. However, even with these limitations, they can still be useful in broad seed zone verifications.

The procedure is simple once you know the average cotyledon numbers of noble or red fir in a given district or tree seed zone. It requires only (1) a representative sample of the seed from which cotyledon counts are obtained, and (2) comparison of data with those for known populations in the designated locale.

We can obtain cotyledon counts of the representative seed sample in two ways — by germinating the seed or, much more quickly, by counting cotyledons on the cut embryo. The latter technique is not as difficult as it sounds. Embryonic cotyledons are well developed in mature seed. To count them:

(1) cut the seed in half as close to the base of the embryonic cotyledons as possible with a razor blade or sharp knife — a hand lens (10X will usually do fine) will facilitate counting the cotyledons; or

(2) slice the seed lengthwise and remove the embryo from the endosperm — use a hand lens and peel the cotyledons back with a probe as they are counted.

The first method is easier but the other is more accurate, especially when one is dealing with embryos typically having more than seven or eight cotyledons (southwest Oregon and California).

When cotyledons have been tallied for 100 or more embryos or seedlings and an average count has been calculated, a comparison is possible. Does the average compare favorably with average cotyledon counts for noble or red fir populations which have been studied in the tree seed zone or district it is supposed to have come from? With our present state of knowledge, an average cotyledon count within ± 0.3 cotyledon of known sources would seem to be at least an acceptable comparison. For example, an average cotyledon count between 5.4 and 5.8 on a lot identified as being from Mount Hood (Government Camp) seems reasonable (table 1). On the other hand, an average count of 5.0 or 6.0 cotyledons is unlikely and warrants further investigation.

The percentage distribution of seedlings by number of cotyledons should also be considered. For example, from the McKenzie River (44° 10' north latitude) north, occurrence of more than 1 per cent of seedlings with eight cotyledons or 0.1 per cent of seedlings with nine cotyledons seems highly unlikely (table 2). From the Willamette River (43° 40') south, occurrence of more than 0.5 per cent of seedings with four cotyledons or 10 per cent of seedlings with five cotyledons is questionable.

Other seed and seedling characteristics are going to be useful for further verification. The usefulness of seed weight is obvious from even the preliminary data (table 1). For example, seed from Inyo County, California, has about the same cotyledon count as many southwestern Oregon sources (table 1); the heavier seed distinguish it, however. Other characteristics such as seed color, are going to be of interest, too. Thus far, trees with cream-colored seed have been encountered only in some parts of southwestern Oregon and on Mount Shasta.

These are interim data; there are still many thousands of cotyledons to be tallied and seeds to be weighed before the basic data will be complete. Statistical analyses necessary to provide confidence limits for cotyledon number within individend tree seed zones remain to be calculated. Perhaps, however, this progress report will give you at least some idea of the excellent possibilities for identifying noble and Shasta red fir source from the seed itself.

It should be noted in closing that cotyledon number may prove useful for some other purposes. Prediction of where planned seed movements are warranted or desirable may be possible as well as identification of unwanted movements or erroneous source labeling of seed. Variation in cotyledon number is also shedding new light on the long-standing taxonomic question regarding the status of and relationships between noble, California red, and Shasta red firs.

Mr. Burch: Thank you very much, Jerry. Are there any questions concerning Jerry's speech?

(No questions.)

Mr. Burch: I think if you will join with me we had better give each one of these speakers a round of applause.

(Applause.)

The next subject is "Mud-Pack Treatment of Douglas Fir Planting Stock" by A. H. Bamford, who is number two in charge in the reforestation division of the Forest Service and who, we in British Columbia, consider as Mr. Reforestation. Unfortunately, Alf could not be here today, but Ian Cameron, Assistant Chief Forester of the B. C. Forest Service, has consented to give his paper and present the slides.

Please, Ian.

Mud-Pack Treatment of Douglas Fir Planting Stock

by

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Read by Ian Cameron

Mr. Cameron: Thank you, Gerry. I am sorry Alf couldn't be here today because he is more closely associated with this topic than I am. However, I will read his paper.

(Slides were shown throughout this paper)

The concept of encasing the roots of conventional nursery stock in a protective covering is not a new one. At the 1966 Reforestation Workshop in Haney, British Columbia, J. W. Ray reported on a method of packaging or rolling seedlings in a mixture of commercial peat soil and local soil, all of which was rolled in a paper hand towel much as a cigarette is made. This method has been used on a production basis on the Gifford Pinschot National Forest for over 10 years with good results.

The system as presently employed in British Columbia was developed by Forester Norm Pelton while working for Weldwood of Canada Ltd. to try to lengthen the very short planting season and obtain acceptable survival on rocky high elevation sites on their Squamish Valley Tree Farm License. Variously known as the encapsuled seedling, mud-cap or mud-pack, the process consist of encasing the roots of seedlings in a mud composed of clay and peat moss. Rather than being rolled the mud is compressed into a compact cylindrical form by a short piece of plastic anchored to a base at one end and a flat piece of metal with a handle at the other end. The first trials done in 1967 used a pack 3/4 inch by 8 inches and weighing about one fifth of a pound for 2-0 Douglas fir and about 6 inches long and weighing one tenth of a pound for 1-0. In 1968 the size of the 2-0 pack was reduced to about 5/8 inch by 7 inches. To date all the mudpacking has been done in a plant which Norm Pelton set up at Mission. The actual job is done by women who can prepare from 1,000 to 1,200 per day. These are subsequently dried for about 24 hours at 70 to 75° and 60 to 80% relative humidity in order to make them firm enough for handling and packing. Packing is normally 300 2-0 to a 12 x 16 x 24 inch carton. Present cost for mudpacking is three cents per tree for a hand operation. Norm believes this could be reduced by mechanization.

The first tool developed for planting mudpacks was fairly expensive and proved to have some drawbacks. It has now been generally replaced by the simple dibble pictured here.

In attempting to assess the results of the various trials of mudpack planting we have established two criteria. First that less than 50% survival is considered a failure and second that comparisons on the effectiveness of different methods should be based on the cost per surviving tree.

The summer of 1967 could be classified as a hard