SCIENTIFIC SEED COLLECTION.

By Adrian C. Thrupp.

Tree seed collection was generally considered to be a mere matter of gathering the ripe seed in the cheapest way possible. The only care taken was to secure the right species - even then the average commercial seed collector was not always overly particular. The results may be seen in Europe where the same tree may be often found under different names, or different trees under the same name. Perhaps much of the confusion about specific differences has been due to careless seed collection.

But now more and more the users of seed are specifying seed from some particular locality. Or they may want "green Douglas Fir", var. *viridis*, or var. *caesia*, or var. *glauca* as the case may be. This is very confusing, as most of these varieties were not named by men in the field, but have been created in Europe, by the examination of herbarium specimens, reported to have been collected from certain localities. While it should be quite a simple matter to collect Douglas Fir, the rub is, what kind of Douglas Fir is wanted? It is a very cosmopolitan tree. Its range extends over thirty degrees of latitude from northern Mexico, 25 degrees north latitude, to Tacla Lake, in B.C., about 55 degrees 10 minutes north latitude; it grows from sea-level to eleven thousand feet elevation, in places where the temperature never goes anywhere near zero Fahrenheit, and where it goes to 50 degrees below; it is used to summer extremes of over 105 degrees in some places, and in others extremes of but 85 degrees Fahrenheit; it flourishes with precipitation varying from 12 to over 100 inches annually; it is found where there is snow on the ground for six or seven months in the year, and where snow but rarely falls; in one part of its range, it grows to a diameter of but 12" in 175 years, and again in another part, it will attain 60" in the same time; 60 feet trees are tall in some parts, in others 200 to 240 foot trees are quite usual.

Again, Western Yellow Pine (*pinus ponderosa*) seed is ordered. It is almost as hard a problem. This Pine has almost as big a range as the Douglas Fir. It grows from northern Mexico to the Caribou, over 25 degrees of latitude; it is found from near sea-level to over nine thousand feet up, where the rainfall is only eight inches, and again where it is fifty inches; it stands winters of 45 to 50 degrees Fahrenheit below zero, and summer extremes of 115 degrees, and it grows in places where zero is rarely reached and also where 85 degrees is the summer maximum.

Those are extreme examples, and are given to show the great variation in the conditions under which one species grows. It is therefore very important to state the exact origin of every batch of seed collected, the geographical strain of the species it belongs to, and to furnish an accurate description of the climatic and other site

18

factors of the locality where their parent trees were growing. While only some of the consumers of forest tree seed are specifically asking for this information, they are nearly all asking for seed from trees growing under conditions somewhat similar to the place where the seed is to be planted. It will probably not be long before nearly all the users of tree seed will require not only seed of exact origin but also accurate descriptions of all the factors affecting the site.

Collections of tree seed can be roughly classified into three groups according to the purpose for which the seed is required, as follows:-

1. For artificial regeneration within its natural range.
2. For planting in its own country outside its natural range.
3. For use in a foreign country.

The requirements for each class of collection are somewhat different but in each case exact knowledge of the site conditions where the seed is to be planted, is required, so the collection can be made from trees growing under similar conditions. What are these factors? There are three main factors:-

1. Temperature.
2. Precipitation.
3. Altitude.

The data on temperature which are needed include the mean annual temperature, the summer maximum, the winter minimum the monthly means for the summer months, or if available, the monthly means for the whole year, should be included as they give an idea as to the length of the growing season. It is also a good thing to have the monthly extreme maxima and minima, to show the length of the frost-free season and the winter conditions.

With regard to precipitation, merely the total number of inches per annum is not sufficient. Its distribution is important whether there is a long dry season in the summer or in the winter, and what percentage falls as snow. If possible, the average monthly precipitation should be given. Ice storms or heavy falls of wet snow, if common, are factors that should not be ignored.

Perhaps the altitude is the site factor that has the most influence on all the others. # O. Enoroth reports that large scale experiments in Sweden to test the effects of seed source on forest plantation showed that altitude was very important. A difference of 200 meters between the place of seed source and the planting site was found to lead to a 35% decrease in healthy plants, and the effects will probably prove to be greater with increasing age.

See Current Forestry Literature, Dominion Forestry Branch.
Volume 11, No. 2. page 7.

There are also a number of lesser factors as follows:-

- (a) Mechanical composition of the soil.
- (b) Chemical composition of the soil.
- (c) Wind condition.
- (d) Sunshine.
- (e) Humidity.
- (f) Aspect.

Those are all important and have all a modifying effect on the three chief factors. They operate independently and though of lesser importance than the first, none of them can be omitted from a complete site description.

The mechanical composition of the soil is perhaps more important than its chemical constituents. Often a tree that will flourish on a well-drained sandy loam, will not grow at all well on a heavy clay site that is rather poorly drained, though the climatic and other conditions are the same, except that, of course, the temperatures are higher in the sandy soil. There is also a great variation in the water-holding capacity of different soils, and this must be noted in conjunction with the precipitation. Chemical constituents need not be considered very much except perhaps the lime content. Some trees generally do not do well in a limestone country, and it would not be advisable to gather seed for planting on such a site from a tree strain growing on sandy soil underlaid by granite country rock.

Seed for planting in a very windy location should generally be gathered from trees growing in a like situation, if possible from those specimens which show the least damage.

Sunshine is also to be considered. Localities with the same average temperatures may have very great differences in the amount of sunshine. A strain transported from a place where there was very little sunshine might suffer from sunscald, either of foliage or bark if planted in a locality with strong sunshine, and a greater diurnal range of temperature.

Humidity is important, for a tree that will thrive where there is a low precipitation but much fog and therefore high humidity, would be a failure where the humidity was less and fog unknown.

The aspect again should be taken into consideration, as it affects the sunshine, humidity and the amount of moisture in the soil. Land at low elevation with a steep northern aspect is equivalent to level land with greater precipitation.

Perhaps in the future much of this detail will be resolved into site classes, or forest types, as indicated by the associated vegetation. Cajander and others in Finland have worked on the problem from a yield and forest management view-point, particularly in connection with mensuration. Whether or not there are any trees on the area, they have divided the land into site classes or types,

20

from an ecological-biological view-point, according to the associated vegetation. The general application of this method might mean that if an area of a certain type was to be planted, care would be taken to see that the seed was collected from the same forest type, as indicated by the vegetation.

This method may also be used to a certain extent, for collection for a foreign country, if the types can be correlated to some extent. In the recent collections for Finland, descriptions of the associated vegetation have been furnished, along with the climatic and other data for Lodgepole Pine, Douglas Fir, Western Cedar and Hemlock, and this practice will gradually be extended.

¹¹/₁₇ Bates, in the Journal of Forestry, goes into much detail, and brings out many of the points mentioned here, about the different climatic strains. He does not, however, lay sufficient stress upon altitude, and makes no mention at all of the forest sites or types. He stresses that seed should come from average sites from those trees that show unusual cleanness or vigour. Perhaps it will be found in the future that it is a great mistake to plant Site I seed on Site IV land. Taking for example our tentative Lodgepole Pine types, seed from what is called the best strain of Lodgepole, in the Pachystima type or better, as found in the transition belt east of Kamloops, would not be likely to do as well in the Arctostaphylos type, or even in the poorer Calamagrostis types, even though the rainfall and other conditions were the same as seed gathered from the best trees in the same site. I might state that the Pachystima site yields as much in about 90 years as the poorer sites would in around 150 to 200 years, if ever.

Mention has been made of the great range covered by two of our species, Douglas Fir and Western Yellow Pine, but it is probably not realized what a large number of climatic strains there may be in a comparatively small area, particularly in mountainous country. Yellow Pine in the interior of British Columbia will be found at 700 feet elevation in the Fraser canyon, and over 4,000 feet up only a few miles away, and the trees are very different in appearance. At the high elevation there will often be a considerable percentage of two-needled bundles in the foliage, which is extremely rare lower down. The needles are shorter, and the tree has not the same vigour. At the Salmon River nursery, elevation 2,300 feet, the seedlings from seed gathered at an elevation of 2,200 feet, right near the nursery, were about 50% larger than those from seed gathered only 40 miles away but at an elevation of around 3,200 feet above sea-level.

On the other hand, the Shuswap Lake strain of Douglas Fir produced seedlings in the Salmon River nursery which in turn were 50% larger than those from the local seed. The nursery is irrigated, and the soil very rich, and so the greater inherent vigour of the Shuswap strain of interior wet belt Douglas Fir was apparent from the start. This behaviour perhaps points a way to improve the

See "Better Seeds, Better Trees", by Carlos Bates, Journal of Forestry, February, 1927.

yield of our forests, that was apparently overlooked by Mr. Bates. This is the transfer of a more vigorous climatic strain to the best sites in a region where the tree is generally of lesser vigour. This is being done experimentally in the interior of British Columbia, where Shuswap Lake Douglas Fir has been planted on a very good Aspen site, in the dry belt alongside native fir growth for comparison.

To give an idea of the different climatic conditions in the interior of British Columbia, a table is given below giving the elevation, precipitation, mean annual temperature and the species found at seven different places:-

Place.	Elevation. Feet.	Total Precipitation. Inches.	Mean Annual Temp. °F.	Species found.
Lillooet	800'	12"	50 deg.	Yellow Pine, Douglas Fir
Kamloops	1200'	11"	47.2 deg.	Yellow Pine, Douglas Fir
Salmon Arm	1200'	19"	46 deg.	Yellow Pine, Douglas Fir, Cedar, Engelmann Spruce, Larch.
Salmon River nr. Grande Prairie	2200'	17"	43 deg.	Yellow Pine, Douglas Fir, Lodgepole Pine, E. Spruce.
Louis Creek	2600'	18"	42 deg.	Douglas Fir, Cedar, Engelmann Spruce, Lodge- pole Pine.
Larch Hills	3000'	24"	40 deg.	Douglas Fir, E. Spruce, Cedar, Hemlock, Larch, Lodgepole Pine and Alpine Fir (<i>A. lasiocarpa</i>)
Trout Lake	4200'	17"	38 deg.	Douglas Fir, E. Spruce, Lodgepole Pine, Alpine Fir.

Trout Lake is 22 miles south from Kamloops; Louis Creek 25 miles northeast; Salmon River about 35 miles southeast from Kamloops; Larch Hills about 8 miles east of Salmon Arm, B.C.

It will be noted that Douglas Fir is found in all the places and under conditions that vary a great deal.

Perhaps some will say that a little difference will not matter much, that they get their seed only 50 miles away where collection is much cheaper, and the elevation is only a few hundred feet lower and so on. It may therefore be of interest to give an example from seed of our own collection planted in Finland. This

22

Douglas Fir seed was from four localities, two of which are mentioned above, within a radius of 60 miles and a difference in elevation of about 1400 feet. It was all crop 1923, and this report on frost damage from C.G. Tigerstedt, of Korva, Finland, dated March 5th, 1927, covers therefore three seasons' experience with the different strains. Below is tabulated the elevation, mean annual temperature, and the precipitation of each locality, together with the records of the percentage of the plants damaged every year by early frosts:-

Locality.	Elevation.	Precipitation.	Mean Annual Temperature.	Percentage of Plants frost damaged.
Shuswap Lake	1200'	24"	about 45 deg.F	15-25% vigorous growth.
Craigellachie	1400'	30"	about 44 deg.F	10-20% vigorous growth.
Salmon River	2200'	17"	about 43 deg.F	about 5% growth less vigorous.
Louis Creek	2600'	18"	about 42 deg.F	very few plants damaged.

It is noticed that there is quite a difference. The place where the seed was collected on Shuswap Lake is only 20 miles west from Craigellachie, while Salmon River is only 30 miles south of Louis Creek. Both the localities are only about 40 miles in a straight line from the Shuswap Lake collecting area. They are quite close.

It is noted that while the Louis Creek strain is frost-hardy, it is not so vigorous. The question is, can the vigour of the trees be maintained combined with the frost hardiness? Mr. Tigerstedt thinks so, if the seed is gathered between 2500' and 3000', in the vicinity of Shuswap Lake. This will still keep the vigour of the Interior Wet Belt Douglas Fir, together with the frost-hardiness due to its being used to a much shorter growing season, at the higher elevation. This seed has been collected and the results will be known this fall. The late Dr. A.F. Tigerstedt reported a difference the first season and this is confirmed for two successive years, and while they might become acclimatized it would be much better to secure seed of a strain that was hardy from the first. Of course selection from the less hardy strain by seed from those plants that escaped all frost injury might in time enable one to develop a hardy strain and yet retain the vigorous growth. But this would be a slow process, and it is much better to secure the right seed to begin with.

Another interesting example is with Red Oak at both the Salmon Arm, and Salmon River nurseries. Acorns were secured from Dresher, near Philadelphia, Pa., not much above sea-level, from Mont Alto, about 1000' elevation, and from Petawawa, Ontario, about 800' elevation.

The results are best tabulated as follows:-

Source of seed.	Petowawa.	Dresher.	Mont Alto.
Height 1st year	3"	18"	12"
Behaviour at Salmon Arm 1400'	Absolutely hardy, growth slow.	About 50% killed back first winter. Not reliable.	None killed back at all 1st winter. Thriving.
Behaviour at Salmon River 2300'	Absolutely hardy, growth slow.	All cut back 1st winter. Most died. None thrived 2nd yr.	A few had termin- al buds killed 1st year. Fairly hardy.

Now Dresher and Mont Alto are only about 60 miles apart, but the two stocks show considerable differences, and apparently the Mont Alto stock will be all right for the low elevations in the interior wet belt, but is not quite hardy enough higher up.

An exotic is often condemned from the first trial without bothering to find out where the seed came from or if, in any part of the tree's natural range, climatic conditions will be considered similar to those where it is to be tried out. It cannot be considered that a species has really been tested in a new locality until seed from all parts of its range have been tried out. Again a tree may be thought to be hardy enough, but of too slow growth to bother with, whereas the truth is that a very inferior strain of seed was employed, probably from near the northern limit of the tree's range.

In the Journal of Forestry, Joseph S. Illick rather misses the point when he speaks of the superior strain of Scotch Pine that they have at Mont Alto. He assumes that this one should be used extensively, but it would be very unwise to assume that the same strain would thrive as well in Ontario or Michigan. Again, if taken too far south it might not like the heat and might be scrubby, or start secondary growth every fall that would winter-kill. It may be that the reason for plantations not thriving is more often due to a good strain of seed planted under unsuitable climatic conditions than to seed of poor heredity.

Further developments in the future will probably go far beyond the selection of seed from individual trees of exceptional vigour, as pointed out by Bates, and will go on to experiments in tree breeding, the production of hybrids and also the crossing of widely separated strains of the same species. A start was made in this direction by Professor Augustine Henry, of Dublin, in the crossing of poplars, and this work is being continued on a larger scale backed by the Oxford paper company. Dr. A.B. Stout, New York Botanic Gardens, Ralph H. McKee, of Columbia and E.J. Schreiner are carrying on this work, according to a recent number of the Science News Letter.

See, "A few Trends in Pennsylvania Forestry", by Joseph S. Illick, Journal of Forestry, March, 1927. (page 346 et seq.)

With conifers, a start has been made by the Eddy Tree Breeding Station, at Placerville, California, directed by Lloyd Austin. They are concentrating on Western Yellow Pine, and using seed from all parts of the tree's range to find out which strains are the most vigorous. They are also carrying on pollination experiments, using pollen from British Columbia and other parts of the tree's range to see if the crossing of the different strains will produce seedlings of greater vigour. Until all the climatic and other site factors are taken into careful consideration, all introduction of exotics, and even artificial regeneration of our native species, will be more or less haphazard and the results will be unreliable.

Scientific seed collection will be the basis of the silviculture of the future, and will be an important factor in increasing the yield of our forests both in quantity and quality.