OBSERVATIONS ON A PLANTATION OF DUNKELD HYBRID LARCH IN NEW YORK

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The "Dunkeld hybrid larch" (*Larix eurolepis*, Henry), considered to be a cross between the Japanese larch (*Larix kaempferi*, Sarg.) ♀, and the European larch (*L. decidua*, Mill.) ♂, has been planted in Great Britain for some thirty years (5) where its vigor of growth, slender habit, and resistance to disease (4) have shown it to be highly desirable as a forest tree. During this period it has found its way to arboreta and private collections in America; but its use here, in forestry, has been more recent, (2), and limited to comparatively few plantations. The N. Y. State Conservation Department began experimenting with this tree in New York nearly a decade ago, and since 1934 has been raising stock in considerable quantity for use in the state reforestation program. For this reason, a description of the first planting which, though small, received a rather high degree of personal attention, may be of some interest at this time.

IN 1929 Dr. H. H. York, Forest Pathologist of the Conservation Department, received about an ounce of large seed from Dr. E. P. Meinecke, who had secured it while on a visit to Scotland in 1928. According to a communication from Dr. Meinecke to the senior author in 1934, the seed was obtained from the Duke of Atholl, and was collected from one or more of the Japanese larches growing near the mansion at Dunkeld, from which most of the known first generation hybrids have originated.

The seed was sown by Dr. York in the state nursery at Saratoga Springs in the fall of 1929 and the resulting plants, 190 in number, raised as seedlings for two years and then transplanted by the junior author in the spring of 1932. On October 29 of that year the senior author, assisted by E. W. Spaulding, set out 123 of the trees on an experimental tract in Montgomery No. 1 State Reforestation Area about 30 miles west of Albany. The area has an elevation of 1,300 feet above sea level. The soil is a rather heavy silt loam belonging to the Langford series, with a pH of about 5.5. The trees, at the time of planting were mostly from 12-24 inches in height. They were planted in dug holes with an 8 x 8 foot spacing, on a moderate westerly slope fully exposed to the prevailing winds.

The spring of 1933 was one of the severest on record for "frost heaving" in this locality and the Dunkeld larch suffered particularly, just having been planted the previous fall. Almost without exception the trees were heaved so as to partly or wholly expose the root system. Fortunately, this condition was detected almost immediately and the trees were reset in the wet ground, but with some losses. Survival at the end of the fifth growing season was 64 per cent, practically all the losses having occurred the first two years. As a precaution against the recurrence of heaving, rather drastic measures were taken in the fall of 1933 to prevent it. Hardwood leaf mulch was placed around each tree. This in turn was covered with ¾-inch mesh poultry netting and the whole weighted down with flat stones. This arrangement was not disturbed until the fall of 1935, when the removal of the stones was made necessary by the increased size of the tree stems.

No injury was noted as a result of the extremely low temperatures which occurred during the two following winters; and, in spite of the ensuing dry summers of 1933 and 1934, the trees appeared thrifty and had reached an average height of five feet by the fall of 1935.

On May 15 and 16, 1936, severe frosts

occurred throughout most of the state on two successive nights, with temperatures which must have reached at least seven degrees below the freezing point on the area under discussion. (Minima of 25° F. were recorded by cooperative observers of the U. S. Weather Bureau at the Cooperstown and Sharon Springs stations, which lie respectively at 1,200 and 1,360 feet elevation, within 45 miles of the planting area.) Among the conifers, larch, spruce and Douglas fir were noticeably damaged, by partial or total destruction of the new foliage.

The growing season of 1936 was further unfavorable due to abnormally low rainfall. From May 6 to August 5, the average precipitation recorded at five stations within fifty miles of the area totalled 5.44 inches as compared with a May-July mean of 11.07 inches for the same stations. Moreover, this precipitation came largely in the form of showers, with no extended periods of rainfall between the two dates mentioned.

As a result of this sequence of weather conditions, the appearance of the trees at the end of 1936 was very poor, with sparse foliage and growth rate cut down to a fraction of that which had occurred the year before. In 1937, precipitation was abundant and well distributed throughout the growing season, and the trees resumed their normal rate of growth. However, they still had a somewhat scrawny appearance due to the failure of the spur shoots on the 1936 internodes to produce leaves in anything approaching normal abundance. In fact, the development of many of these appeared to have been completely arrested.

Observations made in October 1937, showed that 79 of the original 123 trees had survived. Of these, all but one appeared to be permanently established and in a vigorous condition. The exception was only two and one-half feet in height and had a dead top. It will quite probably die within a year or two or become permanently stunted, hence is not included in the various tabulations appearing below. Excluding this tree, the average height of the plantation was 8.7 feet, with a range of 3.5 to 13.5 feet. Internodal measurements showing a comparison of the leader growth in the years 1935, 1936 and 1937 respectively, are given in Table 1.

In spite of the severe reduction in height growth for 1936, the total average height compares favorably with Hunt's (7) figure of 8.3 feet (by interpolation) for European larch of similar age on Site I in New York and New England, and is considerably higher than the average (6.2 feet) of seven plantations eight years old from seed which the same writer (6) examined in various localities in New York.

As early as the second year in the field a segregation into three distinct genetic types was evident. The first, which was designated "kaempferi" type, had the reddish twig color of the Japanese larch and appeared to be growing much more slowly than the others; the second, designated "decidua" type, had the characteristic grayish or yellowish twigs of the European larch and showed a comparatively rapid growth; the third, or "intermediate" type was the typical hybrid, with twigs slightly reddish, more or less glaucous

TABLE 1

HEIGHT GROWTH OF 78 DUNKELD HYBRID LARCH PLANTED IN THE FALL OF 1932 IN THREE SUCCESSIVE GROWING SEASONS

Year	Average annual height growth	Average height at end of season
1935	2.3	5.1
1936	0.6	5.7[1]
1937	3.0	8.7[2]

[1]In three trees, the leader had been completely killed back in 1936, resulting temporarily in a stag-headed condition.

[2]Two trees made an annual growth in height of 5.0 feet in 1937.

on the current shoots, and with a growth rate approximately the same as the "decidua" type.

In taking height measurements, the data were summarized on the basis of the three types. The results are shown in Table 2.

Five of the trees in the plantation bore cones in 1937. In order to determine whether the segregation of types would be evident in the cone characteristics, an analysis of the cones of these five trees was made. The results are shown in Table 3.

Figure 1 shows the differences in the various cone types. The cone from tree No. 31 has scales reflexed equally with the *L. Kaempferi* cone while the cones from trees 23 and 46 are more definitely hybrid types. Those who have had occasion to refer to the photographic illustration in Henry and Flood's monograph or to the excellent drawings by Blanche Ames which accompany Anderson's note (1) on the Dunkeld larch at the Arnold Arboretum will have no difficulty in identifying the cone from tree No. 46 as being typical *L. eurolepis.*

The variation in the progeny of the famous Japanese larches at Dunkeld has been commented upon by several authors. Murray (9), describing a 7-year-old plantation of these trees at Murthly (from which most of Henry and Flood's material was later obtained) recognized three types based on twig color which he designated: (1) leptolepis, (2) intermediate, (3) europea. While admitting the possibility that the "leptolepis" type might be pure Japanese larch resulting from selfing or from cross pollination between the "mother" trees, Murray also considers a second possibility, namely, the segregation into parental and intermediate types, even in the F_1 generation, due to the close relationship, botanically, of the two species involved. In any event, he considers the presence of the "europea" type an indisputable evidence of hybridization.

TABLE 2

COMPARATIVE HEIGHTS AT END OF THE 5TH GROWING SEASON, OF DUNKELD LARCH TREES, CLASSIFIED ACCORDING TO GENETIC TYPES

	Kaempferi type	Decidua type	Intermediate type
No. trees	32	20	26
Av. height	7.3	10.0	9.5
Max. height	10.5	13.0	13.5

Henry and Flood (*op. cit.*) apparently noticed no variation among the first generation seedlings, but state that hybrids of the F_2 generation "were very varied in size and appearance, suggesting Mendelian segregation." (In this connection, the junior author of the present paper made a count of 1,117 2-0 seedlings at Saratoga nursery in 1936, grown from seed obtained from a plantation of F_1 hybrids in Scotland, and found them segregated as follows: *kaempferi* type 7 per cent; *decidua* type 48 per cent; intermediate type 45 per cent.)

Larsen (8) not only recognized two distinct types in the F_1 hybrids, but was able to correlate their botanical characteristics with growth rate. One form, which

TABLE 3

ANALYSIS OF VEGETATIVE AND CONE CHARACTERISTICS OF FIVE DUNKELD HYBRID LARCH TREES

Tree No.	Height in feet	Type of twig	Number of cones	Cone scales
23	13.0	Decidua	9	Slightly reflexed
31	8.0	Kaempferi	13	Strongly reflexed
39	7.5	Kaempferi	47	Strongly reflexed
46	10.0	Kaempferi	8	Intermediate
61	10.5	Kaempferi	5	Slightly reflexed

he calls "light bark" type, he regards as the true hybrid, while the other, or "red bark" is considered, presumably, to be composed of purely *L. Kaempferi* individuals. The "light bark" type grew much more rapidly, both in the seed bed and in a 10-year old plantation and, in addition, more closely resembles the European than the Japanese parent. As Larsen points out, the fact that the true hybrid type can be distinguished from the others as early as the second year in the nursery may be of considerable practical value in the selection of planting stock.

One further point that might be raised is whether *all* the individuals showing the characteristics of the ovulate parent are necessarily pure Japanese larch. The presence, in the same group, of individuals which resemble the staminate, or *L. decidua*, parent so closely as to be hardly distinguishable from it, superficially, perhaps would indicate the possible occurrence of "kaempferi dominant" hybrids as well. That hybridity, in *Larix*, is determinable with a high degree of precision by examination of minute anatomical characteristics has been shown as regards leaf structure by Henry and Flood (*op. cit.*); as regards wood fibers, by Chowdhury (3); and as regards chromosome phenomena by Sax (10). Hence the positive identification of hybrid individuals should be entirely possible, and might throw additional light on this interesting genetical problem. For practical purposes, however, it seems safe to say that best silvicultural results will be obtained, when using "Dunkeld hybrid" stock, by selecting those seedlings in which the twig color and form of the staminate parent (*L. decidua*) are rather strongly exhibited.

Summary

1. A plantation of 123 "Dunkeld hybrid larch" trees was established in Montgomery County, N. Y., in October 1932, with 2-1 stock raised from seed of the historic Japanese larches growing at Dunkeld, Scotland.

2. In spite of being subjected to a number of unfavorable climatic influences (frost heaving, drouth, excessively low winter temperatures, and particularly severe late spring frosts), the 78 surviving trees had reached an average height of 8.7 feet in October, 1937. This would be considered satisfactory growth for European larch of similar age in the same region.

3. The detrimental effect of late spring frosts followed by an extended period of drouth in 1936 was shown by the fact that the average height increment for that year was only 0.6 feet as compared with

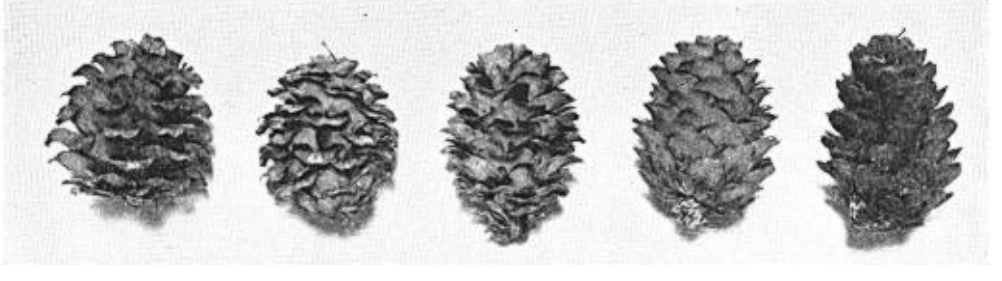

Fig. 1.—Cones from a five-year old plantation of Dunkeld hybrid larch in Montgomery County, N. Y., in comparison with those of Japanese larch (left) and European larch (right).

2.3 feet in 1935. The completeness of the recovery from this set-back is shown by an average height growth of 3.0 feet in 1937.

4. Of the three genetic types recognized, the "kaempferi" (or Japanese) type made a significantly slower growth than either the "intermediate" or the "decidua" (European) type.

5. The cone scales of cones produced in 1937, were reflexed to a greater or lesser degree. This variation appeared to be directly proportionate to the extent of similarity to the Japanese larch in the matter of growth rate and reddish coloration in the twigs.

6. The results of this study agree with those of previous investigators that in any given lot of "Dunkeld hybrid larch" a varying proportion of the individuals may have either hybrid or nearly pure *L. decidua* characteristics, while others resemble Japanese larch entirely, and may, in fact, not be hybrids at all.

7. The question of the possible occurrence of "Kaempferi dominant" as well as "decidua dominant" hybrids in the F_1 generation is raised.

8. Since "decidua dominant" and "intermediate" types appear to grow more vigorously, and since these types can be recognized even as 2-year seedlings, a selection of them in the nursery would appear to be of considerable practical value.

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