

LEAF CHARACTERISTICS OF TWO HYBRID JUNIPERS

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The purpose of this study has been to compare and contrast the whip and scale leaves of two junipers in a natural population located approximately seven and one-half miles south of Carbondale, Illinois on limestone outcroppings on a hill near U. S. Highway 51. The stand of trees from which the two specimens were selected is a genetically mixed "swarm hybrid population" (Hall, 1952) of *Juniperus virginiana* L. (eastern red cedar) *J. Ashei* Buchh. (Ozark white cedar). The tree indicated as "*virginiana*" was chosen to represent the maximum combinations of the more typical eastern red cedar growth habit; the other tree, indicated as "*hybrid*", exhibits more apparent Ozark white cedar characteristics. Macroscopic as well as microscopic differences in leaf structure were studied.

According to Florin (1931, 1951), species of *Juniperus* exhibit four kinds of leaves: cotyledons, juvenile, transitional and mature. The transitional and mature types are frequently referred to as the whip and scale leaves respectively. Combinations of certain leaf structures of juvenile, whip and scale leaves for *J. virginiana*, and other combinations for *J. Ashei* have been assembled by Hall (1952). Structural variations of leaves from trees in natural stands deviating from these two sets of combinations are interpreted as indicators of hybridity. The combined degree of deviations

is expressed as a greater or lesser tendency to resemble one or the other original parent in the presumed cross (Anderson, 1949). The selection of the two segregates used in this study rests on the assumption that it is advantageous to have plants from a similar genetic background. The two trees are the same ones sampled to point out the differences in types of shoot apices (Kaeiser, 1960). Specimens from collections are on deposit in the Herbarium of Southern Illinois University.

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MATERIALS AND METHODS

Fresh as well as herbarium collections were used for macroscopic studies and for those under low magnification (X10-X50). For microscopic study leaves and branches were killed and fixed in F.A.A., aspirated, dehydrated in the *tertiary* butyl alcohol series and embedded in paraffin. Sections were cut approximately 10 microns in thickness and were stained in the usual manner with Safranin O and Fast Green FCF.

Figure 1 shows the general mode of branching pattern of *J. Ashei*

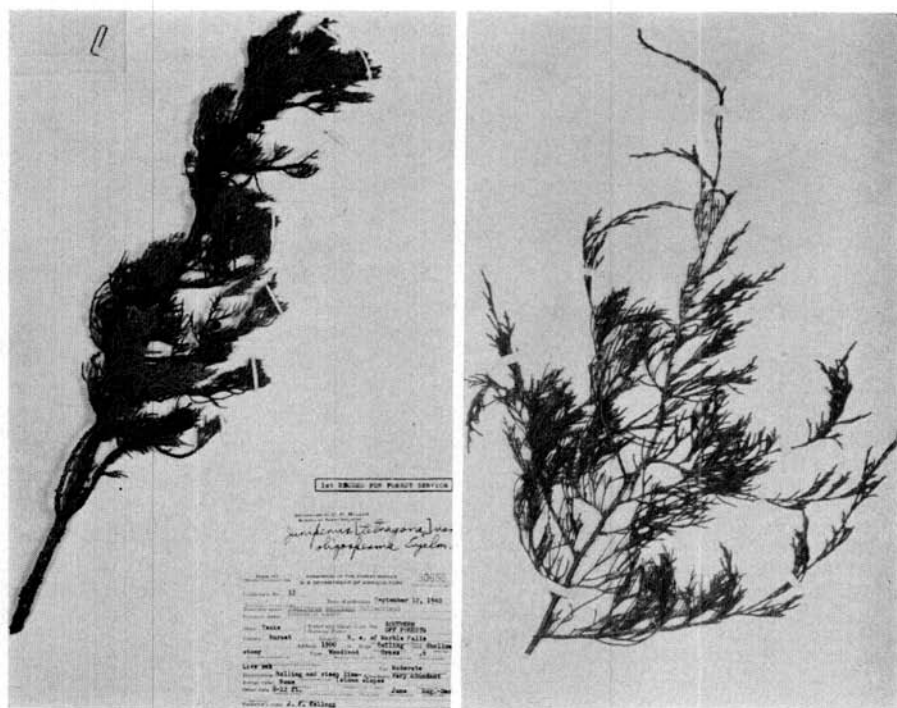


FIG. 1.—Left, *J. Ashei*; and right, *J. virginiana*.

and *J. virginiana* growing at the Kas-kaskia Experimental Forest (Shawnee National Forest) in Hardin County, Illinois. Known seed source was from near Lebanon, Tennessee. Other materials of *J. Ashei*, as indicated in Table 1, were provided by G. J. Goodman from the Arbuckle Mountains of Oklahoma. Herbarium materials collected by W. W. Ashe in Arkansas and verified by Buchholz (1930) in his proposed naming of the species have been studied. Living specimens growing in Oklahoma, Arkansas and Missouri have also been observed. "Near *Ashei*" material from McVey Knob, Ozark County, Missouri was provided by Hall. The two young trees listed in

Table 1, together with the mature trees indicated as "*virginiana*" and "*hybrid*", were all growing in the same stand. The older trees were approximately thirty feet in height.

Ranges in lengths of sheaths and blades of leaves found in specimens of unmixed populations of *J. Ashei* and *J. virginiana* are given by Hall. The measurements were used for comparison in the present analysis.

Figure 2 represents surface, median longitudinal and median transverse aspects of the mature stomatal apparatus on the abaxial surfaces of spur leaves of the "*hybrid*" and "*virginiana*" trees used in the study. Terminology follows that of Florin.

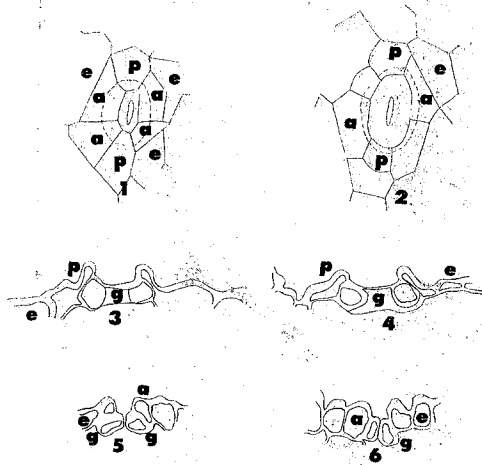


FIG. 2.—Diagram of surface view of mature stomatal apparatus of "*virginiana*." 1. From the dorsal surface of spur leaf: a, auxiliary cell lateral to guard cell; e, encircling cell; p, polar cell. X292. 2. "Hybrid." 3. Longitudinal median section through mature stomatal apparatus of "*virginiana*." Guard cell, g. X292. 4. "Hybrid." 5. Transverse section of mature stomatal apparatus of "*virginiana*." From the dorsal surface of spur leaf: a, auxiliary cell; e, encircling cell; g, guard cell. X292. 6. "Hybrid."

OBSERVATIONS AND DISCUSSION

Among the most easily observable field characteristics in a mixed population of eastern red and Ozark white cedar are: 1) the color of foliage, 2) the proportionate lengths of the whips or terminal branches and 3) the relative amount of crowding of the lateral branches (Fig. 1; Table 1). The yellow-green rather than blue-green color, the much shorter whip branches and the very crowded appearance of lateral branches are all notable features of *Ashei* influence, and are features in the "*hybrid*" specimen chosen for detailed study. Consistent with these

characteristics there are also other structural features of the whip and spur leaf types, as summarized in Table 1.

Color of foliage alone is often deceptive, and in young trees with only juvenile foliage it is not a reliable character. The relatively crowded appearance of lateral branches, as pointed out in an earlier study, is correlated with relative size and rate of growth of the shoot apices. In whip branches the shoot apex in this "*hybrid*" in vigorously growing shoots, has a wider diameter, the pith tissue is closer to the apex, and the flanking tissue (derivatives of which contribute to leaf primordia) is closer to the apex than in the "*virginiana*" specimen (Kaiser, 1960).

Hall (1952) has shown that typical *Ashei* whip leaves have sheaths 4.0 mm and blades 3.0 mm in length, in contrast to typical "*virginiana*" whip leaves with sheaths 9.0 mm and blades ranging from 4.0-5.0 mm in length. Spur leaves of *Ashei* show 1.5 mm for sheath and 1.5 mm for blade lengths, whereas typical "*virginiana*" spur leaves have sheaths 1.0 mm and blades 3.0 mm in length. These are averages occurring in unmixed populations. When the proportionate ratios of sheath to blade lengths of whip leaves of the two trees are compared (Table 1), there is no significantly close correlation. However, there is a decided tendency exhibited in the "*virginiana*" specimen to have consistently longer whip leaves, so that total length is more closely related to typical eastern red cedar. Furthermore, there is a lack of any ser-

TABLE 1.—External Features of Leaves of Selected Specimens of *Juniperus*.

General	JUVENILE LEAF						WHIP (TRANSITIONAL LEAF)						SPUR (MATURE) LEAF							
	Long Whips	Lateral Branches Crowded	Ternate	Length of Sheath (mm)	Length of Blade (mm)	Keel	Oblong	Raised	Amphistomatic	Decussate	Length of Sheath (mm)	Length of Blade (mm)	Serrate	Keel	Oblong	Round	Raised	Amphistomatic		
<i>J. Ashei</i> Buchh. Arb. Mtns. Murray Co., Okla.	—	+																		
"Near <i>Aster</i> " McVey Knob Ozark Co., Mo.	—	+																		
"Hybrid" Jackson Co., Ill.	—	+							+	4.0	2.5	+	+	+	+	+	+	+	+	
" <i>virginiana</i> " Jackson Co., Ill.	+	—							+	5.5	3.5	—	—	—	+		—	+	+	
Juvenile 2 1/2 Jackson Co., Ill.	—	+	+	6.0	7.5	+	+													
Juvenile 6' Jackson Co., Ill.	+		+	5.0	8.0	+	+		+	3.0	3.0	—	—	—						

ration on this kind of leaf, and an absence of keels on the sheaths. The presence of the latter two features are Ozark white cedar characteristics.

When the proportionate ratios of sheath to blade lengths of the spur leaves are compared, this type of leaf is found to be more like *Ashei* in both specimens. Other structures when compared indicated that the "hybrid" spur leaves occasionally showed both round and raised glands and had blades slightly but detectably humped. All of these characteristics are indicative of *Ashei* and all are absent in the "virginiana" specimen.

Both of the young trees tended to show more eastern red cedar characteristics in: 1) greater total lengths of juvenile leaves; 2) proportionate lengths of sheath to blade; 3) lack of serration; 4) lack of keels; 5) lack of round glands; and 6) glands not raised.

Aside from the differences in shoot apices referred to above, there are also consistent differences in the mature stomatal apparatus on the dorsal surfaces of the spur leaves. In following Florin's terminology the apparatus is of the haplocheilic type, and within this category is classified as amphicyelic. Surface views always disclose two polar cells, and generally two lateral auxiliary cells on either side of each pair of guard cells (Figure 2). Surrounding all of these are the encircling cells. All cells mentioned belong to the apparatus. The tendency for greater over-arching of both polar and lateral auxiliary cells in "virginiana" can be seen readily from Figures 3-6. There is also a ten-

dency for greater size of this apparatus in the "*Ashei*" specimen. This is consistent with other measurements taken of ordinary epidermal cells of the dorsal surfaces of spur leaves of known *J. Ashei*.

SUMMARY

1. In the two mature trees selected, i.e. "*virginiana*" and "*hybrid*", the former showed the tendency for whip leaves to resemble those of the genetically unmixed eastern red cedar in being of greater total length. The spur leaves, although with proportionately shorter blades than eastern red cedar, were unhumped and possessed oblong, unraised glands, all "*virginiana*" features. The "*hybrid*" whip leaves were shorter in length, some exhibiting serration and keels on the sheaths, all Ozark white cedar features. The spur leaves exhibited occasionally round and raised glands, and blades at least slightly humped, all *Ashei* features.
2. Both young trees selected tended to show more "*virginiana*" characteristics, the older one especially, as evidenced by the assemblage of six detectable morphological similarities.
3. The mature stomatal apparatus from the dorsal surfaces of spur leaves of the "*virginiana*" specimen were smaller in size than in the "*hybrid*"; both the polar and lateral auxiliary cells overarched the guard cells more in the former than in the latter. The stomatal apparatuses of "*virginiana*" are more similar to those of east-

ern red cedar, while those of the "hybrid" specimen correspond closely in both size and shape to those of Ozark white cedar.

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