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STATUS OF *QUERCUS* × *LEANA* AND *QUERCUS* × *RUNCINATA* (FAGACEAE) IN ILLINOIS

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ABSTRACT

The oak hybrids *Quercus* × *leana* Nutt. (*Q. imbricaria* × *Q. velutina*) and *Q.* × *runcinata* (A. DC.) Engelm. (*Q. imbricaria* × *Q. rubra*) are occasionally encountered as scattered individuals throughout Illinois. Populations consisting of many individuals of these two hybrid taxa are not known in Illinois, and only rarely have suspected backcross individuals been found. A Principal Components Analysis (PCA) involving the parent taxa and the supposed hybrids indicates that little introgression occurs, each taxon appearing as a distinct cluster on the PCA graph. A study involving hybrid specimens encountered in the herbaria of the state indicates that *Q.* × *leana* is the most common taxon, being found in 31 counties, *Q.* × *runcinata* being known from only 11 counties.

RESUMEN

Los robles híbridos *Quercus* × *leana* Nutt. (*Q. imbricaria* × *Q. velutina*) y *Q.* × *runcinata* (A. DC.) Engelm. (*Q. imbricaria* × *Q. rubra*) se encuentran ocasionalmente como individuos esparcidos por todo Illinois. Se conocen en Illinois poblaciones que se componen de muchos individuos de estos dos taxa híbridos, y sólo raramente se han encontrado individuos que se sospeche que son retrocruzamientos. Un Análisis de Componentes Principales (PCA) de los taxa parentales y los supuestos híbridos indica que ocurre poca introgresión, ya que cada taxon aparece como un cluster diferente en el gráfico del PCA. Un estudio de los especímenes híbridos encontrados en los herbarios del estado indica que *Q.* × *leana* es el taxon mas frecuente, encontrándose en 31 condados, mientras que *Q.* × *runcinata* se conoce sólo de 11 condados.

INTRODUCTION

Oak woodlands, whether savanna, open woodlands or mixed forests of oak and hickory or oak and pine are found throughout the northern hemisphere and southward into India and the higher elevations in tropical America (Stearns 1991). In North America oaks dominate a variety of community types, from the extensive oak-scrub communities of California, to the oak savannas of the prairie peninsula, to the oak dominated forests of the eastern United States. Overall, about 400 species are recognized in the western hemisphere, the United States claiming 90 species, with numerous hybrids being reported (Sargent 1933; Stearns 1991; Nixon 1997).

Because oaks are wind-pollinated many hybridize readily. Extensive populations of oak hybrids are uncommon, the individual hybrids being comparatively rare as wild plants (Palmer 1948). In Illinois, both *Quercus* × *leana* Nutt.,

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a hybrid involving *Q. imbricaria* Michx. and *Q. velutina* Lam., and *Q.* × *runcinata* (A. DC.) Engelm., with the parents being *Q. imbricaria* and *Q. rubra* L., are occasionally found in the wild; Biagi and Jensen (1995) reported them to be the most frequently encountered oak hybrids in Indiana. Herbarium collections of these hybrids are usually from the edge of woods, along fencerows, in open pastures, and other relatively open, disturbed habitats. The present study was undertaken to determine the distribution of *Q.* × *leana* and *Q.* × *runcinata* in Illinois, their morphological variation, and their habitat preferences.

METHODS AND MATERIALS

The distribution of *Quercus* × *leana* and *Q.* × *runcinata* in Illinois was determined by examining specimens from the following herbaria (A, DEK, EIU, F, GH, KNOX, ILL, ILLS, ISM, MO, MOR, MWI, SIU), consulting literature sources, and contacting many of the state's field botanists. Also, both authors made efforts to locate additional specimens on their numerous field trips through much of Illinois during the past two years. These specimens were studied to determine the geographic ranges and morphological variation of the probable hybrids. Where there was sufficiently detailed information, some sites where these hybrids had been recorded, were visited between 1998 and 2000 and searched for the presence of oak hybrids. In appendix 1 the Illinois counties where each hybrid taxon is known are listed with a representative specimen that we have annotated. For a few counties where *Quercus* × *runcinata* has been reported we have not seen a specimen, we list the specimen cited by Jones and Fuller (1955).

Initially, the herbarium specimens were separated into probable hybrid taxa based on the morphological characteristics listed in Table 1. After removal of duplicate, incomplete, and immature specimens, 25 specimens of *Quercus* × *leana* and five specimens of *Q.* × *runcinata* were available for subsequent analysis. These specimens, as well as 22 randomly selected specimens of each of the probable parents (*Q. imbricaria, Q. rubra, and Q. velutina*), from throughout their known ranges in Illinois, were scored for the seven vegetative characteristics listed in Table 2. Only vegetative characters could be used as few of the hybrid specimens had fruits attached, and only specimens collected in late summer and with mature leaves were scored. All characters were measured for each specimen (usually three or more measurements) and the measurements from the probable parental species plotted to confirm that gaps existed in order to permit the use of scored characters. Of these characters, the number of bristles present was determined by picking the side of the blade with the most bristles, while the angle of the major vein to the midvein was determined using a major vein that extended into the blade lobe. The data were analyzed by principal components analysis (PCA) using NTSYS-pc version 1.70 (Rohlf 1993). All characters were standardized, the PCA was performed using a correlation matrix, and the data were transformed by a square root transformation (Sokal & Rohlf 1969).

TABLE 1. A morphological comparison of *Quercus* × *leana*, *Q.* × *runcinata*, and their purported parental taxa.

Character	Quercus velutina	Quercus × leana	Quercus imbricaria	Quercus × runcinata	Quercus rubra
Terminal bud pubescence	densely pubescent	lightly pubescent	glabrous & ciliate	glabrous & ciliate	glabrous & ciliate
Petiole length	>30 mm	18–30mm	<15mm	18–30mm	>30mm
Blade apex	acuminate	acute to acuminate	obtuse to acute	acute to acuminate	acuminate
Blade sinuses	>25 mm deep	<25 mm deep	none	<25 mm deep	>25 mm deep
Blade width/ length ratio	0.70–1.00+	0.38–0.65	0.25–0.40	0.43–0.65	0.70–1.00+
Bristles on one side of blade	15–26	2–7	0	2–7	15–26
Major vein angle	34–45°	34–45°	50–65°	35–45°	35–49°

TABLE 2. Characters scored for the principal component analysis involving specimens of *Quercus imbricaria*, *Q. rubra*, and *Q. velutina* and the probable hybrids of these taxa.

1. Terminal bud scales pubescence (1 = glabrous and ciliate, 2 = lightly pubescent and ciliate, 3 = densely pubescent and ciliate).
2. Petiole length (mm).
3. Blade apex shape (1 = obtuse to acute, 2 = acuminate).
4. Blade lobing (1 = not lobed, 2 = shallowly lobed, the sinuses mostly less than 25 mm deep, 3 = deeply lobed, many sinuses more than 30 mm deep).
5. Blade width at widest point/length ratio.
6. Bristles present on one side of the blade (1 = a single terminal bristle, 2 = 2–6 bristles, 3 = 8 or more bristles).
7. Angle of major lobe vein to midvein (1 = >50°, 2 = <50°).

RESULTS AND DISCUSSION

Quercus × *leana* has an extensive geographic range throughout much of the eastern United States from Pennsylvania to Michigan, and south to Missouri, North Carolina, and Maryland (Palmer 1948). The type specimen was collected in Cincinnati, Ohio by T. G. Lea in 1842 (GH!). Jones and Fuller (1955) reported *Quercus* × *leana* for seven Illinois counties (Clay, Cook, Fulton, Peoria, Richland, Sangamon, and Will). The present study indicates that this taxon is relatively common, occurring in 31 Illinois counties (Fig. 1). Of the more than 100 herbarium specimens of this taxon examined, only three had sufficient label information to allow relocation of the original tree. Also, hybrids were found at

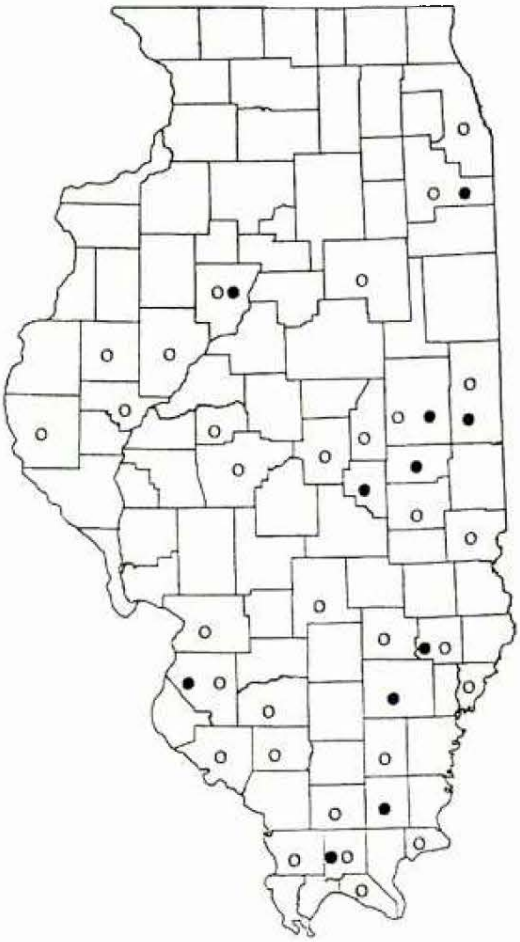

Fig. 1. Illinois map showing the known distribution of *Quercus* × *leana* (○) and *Q.* × *runcinata* (●).

four new sites. At six of these sites, only one hybrid individual was found, while two trees were found at one site. All were in disturbed habitats (fence row, forest edge, open field) with the probable parents nearby.

Quercus × *runcinata* also has an extensive geographic range, being reported from throughout most of the northeastern and north central United States in Kentucky, Illinois, Indiana, Maryland, Missouri and Pennsylvania (Palmer 1948). In Illinois this hybrid was reported for only six counties (Champaign, Johnson, Richland, St. Clair, Wayne, and Will) by Jones and Fuller (1955), while an update of this work added Peoria County (Winterringer & Evers 1960). During the present study specimens were recorded from four additional counties (Douglas, Moultrie, Saline, and Vermilion), bringing the total to 11 counties (Fig. 1). No living hybrids were found during the present study, but information on her-

barium labels indicates that only individual trees were found, and that they were associated with disturbed habitats.

In our PCA involving specimens of the three purported parental taxa (*Q. imbricaria*, *Q. rubra*, and *Q. velutina*), and all of the probable hybrid specimens scored, the first two principal components accounted for 72% and 15%, respectively, 87% of the total variance. In the resulting plot the 96 specimens separate into five distinct groups, three representing the parental taxa, the remaining two representing the two hybrid taxa (Fig. 2). The extent of blade lobing and blade width/length ratio (characters 4 and 5) are most important in determining OTU scores on the first principal component. The extent of pubescence on the terminal bud and the number of bristles on the blade (characters 1 and 6) are most important in determining OTU scores on second principal component.

The five clusters in the PCA plot are distinct, well-separated, and do not contain recognizable subgroups (Fig. 2). In this plot OTU's representing *Quercus* × *leana* fall between those representing *Quercus imbricaria* and *Q. velutina*. The compact nature of this group suggests that the specimens are probably F1 hybrids and probably do not represent backcrosses to either parent. Similar results are obtained for *Q.* × *runcinata*, OTU's representing that taxon are located between those representing *Q. imbricaria* and *Q. rubra* (Fig. 2).

Morphological characteristics of the leaves were important in separating both *Quercus* × *leana* and *Q.* × *runcinata* from the parental taxa since nearly all of the specimens examined were sterile (Table 1). In both hybrid taxa the leaves are similar, with petioles between 18 and 30 mm long, blades shallowly 3- to 9-lobed with the sinuses mostly less than 25 mm deep, a width/length ratio of less than 70%, an acute to acuminate blade apex, and between 2 and 7 bristles on each side of the blade (Fig. 3). In *Q. imbricaria* the entire margined leaves are not lobed, the petioles are usually less than 15 mm long, and the obtuse to acute blade apex has a single terminal bristle. In contrast, the leaves of both *Q. rubra* and *Q. velutina* have petioles that commonly exceed 30 mm in length, deeply lobed blades with some sinuses more than 30 mm deep, a blade width/length ratio above 70%, an acuminate blade apex, and commonly 15 to 26 bristles on each side of the blade (Table 1).

Though the leaves of *Quercus rubra* and *Q. velutina* are very similar, these two taxa are easily separated. Generally the clustered terminal buds of *Q. velutina* are 4-angled, 7–10 mm long, and with densely pubescent and ciliate scales; those of *Q. rubra* ovoid, less than 6 mm long, and the scales mostly glabrous and lightly ciliate (Mohlenbrock 1986; Gleason & Cronquist 1991). Terminal bud characteristics are also useful in separating the two hybrid taxa. In both the terminal buds are fairly short, mostly less than 6.5 mm long. In *Q.* × *leana* the buds are commonly slightly 4-angled and the scales are lightly to densely pubescent and ciliate. *Quercus* × *runcinata*, in contrast, has ovoid buds

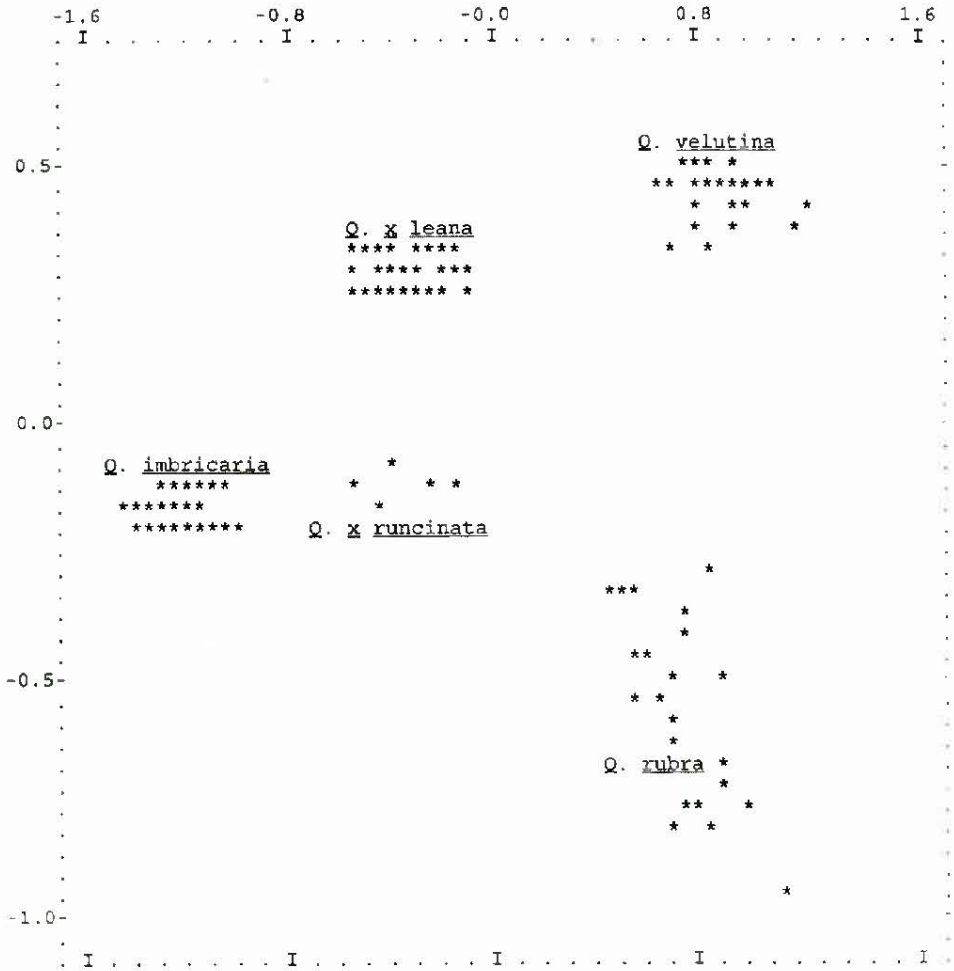

Fig. 2. Plot of axis 1 vs. 2 of a principal component analysis using 7 variable for 22 specimens of *Quercus imbricaria, Q. rubra* and *Q. velutina* along with 30 specimens of their probable hybrids.

with scales that are glabrous with lightly ciliate margins, similar to the terminal buds found in both *Q. imbricaria* and *Q. rubra* (Table 1).

Few of the hybrid specimens bore mature acorns. Acorns of *Quercus* × *leana* were similar to, but slightly smaller than those of *Q. velutina*, the caps of both with loose, pubescent scales. Also, acorns of *Q.* × *runcinata* were similar to, but smaller than those of *Q. rubra*. Both taxa have glabrous to lightly puberulent, tightly appressed scales.

The present study suggests that the oak hybrids *Quercus* × *leana* and *Q.* × *runcinata* are uncommon, usually occurring as isolated individuals in disturbed habitats. Palmer (1948) mentions that these hybrids have been grown from seed, and that the mature foliage and fruits of these offsprings are intermediate be-

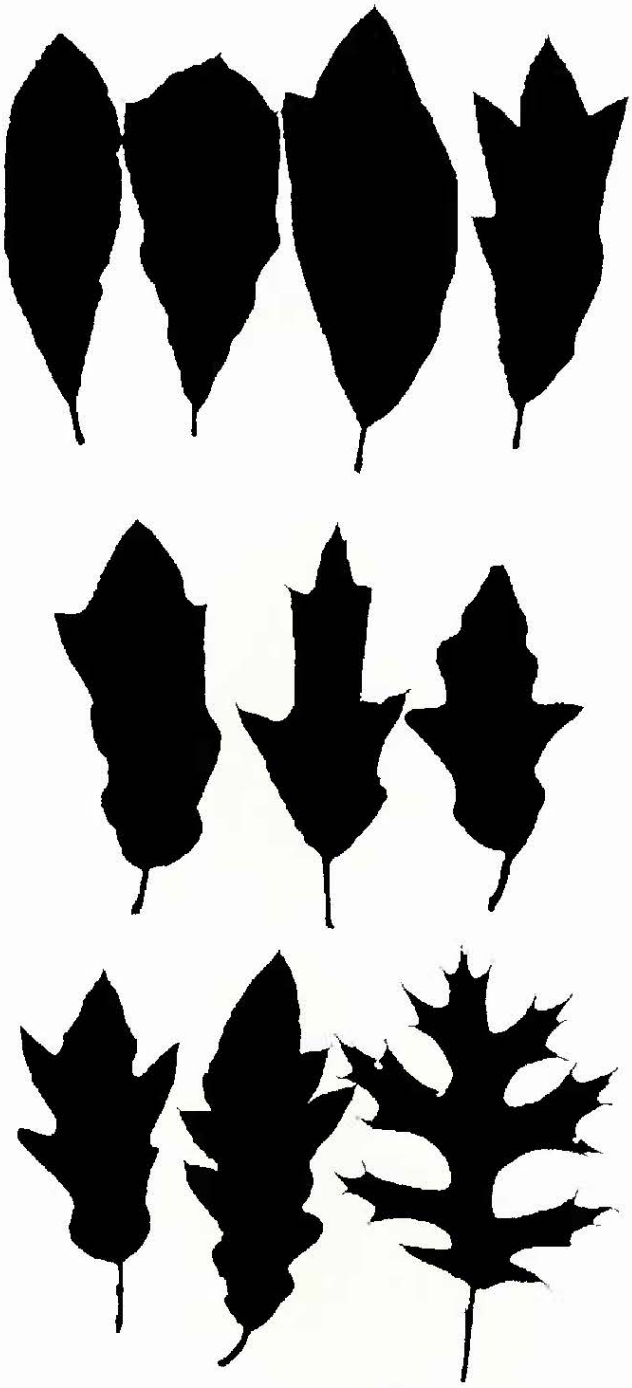

FIG. 3. Leaf variation found in Illinois specimens of *Quercus* × *leana*. The upper left leaf represents *Q. imbricaria*, the one at the lower left *Q. velutina*, the remainder showing the variation found on various specimens of *Q.* × *leana*.

tween the purported parents. During the present study one tree was found that bore large numbers of acorns. Of the 250 acorns collected from beneath this tree, only 14 appeared to be of firm and of normal size, but none germinated. The remaining acorns were smaller, had a relatively soft pericarp, and lacked a fully developed embryo. The small number of viable fruit suggests that seedlings rarely develop.

APPENDIX 1

Illinois counties where *Quercus* × *leana* and *Q.* × *runcinata* have been found with a representative collection from each county giving locality, date collected, collector, and herbarium where the specimen is deposited.

Quercus × **leana** Nutt. **Adams Co.:** wooded bluff, W section Siloam Springs State Park, 29 Sep 1961, *R.A.Evers 71960* (ILLS). **Champaign Co.:** bluff top of Sangamon River, N of Mahomet, 18 Jun 1953, *R.A.Evers 38112* (ILLS). **Clark Co.:** woodland border, SW of Moriah, 3 Sep 1970, *R.A.Evers 103546* (ILLS). **Clay Co.:** woodland border, N of Louisville, 4 Jun 1953, *R.A.Evers 37511* (ILLS). **Coles Co.:** EIU campus, Panther Trail, W of football stadium, Charleston, 9 May 2000, *G.C.Tucker 12022* (EIU, ILLS, MOR). **Cook Co.:** woods, Columbia Woods Forest Preserve, Willow Springs, 17 Jul 1963, *R.A.Evers 77205* (ILLS). **Fayette Co.:** edge of lowland old field, N side of Becks Creek, Dean Hills Nature Preserve, 8 mi E of Ramsey, NE1/4 S10 T8N R2E, 29 Aug 2000, *D.T.Busemeyer, M.A.Faust, & R.L.Phillippe 306* (ILLS). **Fulton Co.:** Bemadolte, *J.Wolf s.n.*(ILL). **Hamilton Co.:** roadside S of Dahlgren, 14 Sep 1951, *R.A.Evers 32566* (ILLS). **Hardin Co.:** wooded bluff, 4 mi S of Karbers Ridge, 8 Jul 1958, *R.A.Evers 57806* (ILLS). **Johnson Co.:** open uplands, sandy soil, Simpson, 3 Oct 1919, *E.J.Palmer 16670* (MO). **Livingston Co.:** roadside, 10 mi N of Rowe, 22 May 1945, *G.D.Fuller 10351* (ISM). **Macon Co.:** Spitler Wood State Park, 14 Oct 1965, *R.A.Evers 86074* (ILLS). **Madison Co.:** woodland, Godfrey, 1 Oct 1953, *H.E.Ahles 7599* (ILL). **Massac Co.:** floodplain of Ohio River, 6 mi N of Metropolis, near Rocky Branch, 18 Oct 1973, *W.McClain 853* (EIU). **McDonough Co.:** top of dry ridge, Pleasant Valley, 18 May 1948, *R.M.Myers 516* (ISM, MWI, SIU). **Menard Co.:** woods, Lincoln New Salem State Park, 23 May 1963, *R.A.Evers 76017* (ILLS). **Peoria Co.:** wooded edge of parking lot, W of visitor center near power lines, Wildlife Prairie Park, NW1/4 S29 T9N R7E, 2 Jul 2000, *G.C.Tucker 12124* (EIU, ILLS). **Perry Co.:** edge of woods, 8 Jul 1953, *J.O.Neill s.n.* (ILLS). **Piatt Co.:** woodland border, Lodge Park, S of Lodge, 3 Jun 1971, *R.A.Evers 105252* (ILLS). **Randolph Co.:** bottomland woods, 1 mi S of Leanderville, 8 Jul 1953, *R.A.Evers 38991* (ILLS). **Richland Co.:** flat uplands, near Olney, 15 May 1923, *E.J.Palmer 22626* (MOR). **Sangamon Co.:** Washington Park, Springfield, 15 Apr 1945, *V.S.Eifert 9958* (ISM). **Schuyler Co.:** 6 Sep 1849, *S.B.Mead s.n.* (KNOX). **St. Clair Co.:** near Aldolf Engelmann's farm, 4 Jun 1874, *G.Engelmann s.n.* (MO). **Union Co.:** roadside woods, 1 mi S of Jonesboro, 9 Jul 1956, *F.B.Buser 6461* (ILLS). **Vermilion Co.:** edge of upland woods, Middle Fork Nature Preserve, W edge of Kickapoo State Park, NW1/4 S5 T19N R12W, 16 Oct 2000, *J.E.Ebinger 29400* (EIU). **Wabash Co.:** edge of woods and road, Beall Woods Nature Preserve, 2 mi E of Keensburg, S11 T2S R13W, 6 Jun 2000, *J.E.Ebinger 28583* (EIU). **Washington Co.:** uncommon hybrid along railroad tracks along IL 177 at Venedy, 26 Jun 1993, *M.A.Basinger & C.Giedeman 5878* (ILLS). **Will Co.:** edge of woods, Marley, 22 Jun 1987, *A.Chase 26* (ILL, MO). **Williamson Co.:** pasture woodland N of Marion, 21 Sep 1950, *R.A.Evers 27868* (ILLS).

Quercus × **runcinata** (A. DC.) Engelm. **Champaign Co.:** woods, Crystal Lake Park, Urbana, 18 Oct 1960, *R.A.Evers 68121* (ILLS). **Douglas Co.:** edge of woods, Kaskaskia River near Chesterville, 13 Oct 1970, *A.Jones 2886* (ILL). **Johnson Co.:** upland woods, limestone outcrops, Simpson, 3 Oct 1919, *E.J.Palmer 16666* (MO). **Moultrie Co.:** tree 40–50 ft tall along edge of small woods by the Illinois Central RR, 1.5 mi NW of Allenville, NE1/4 SE1/4 S17 T13N R5E, 25 Jun 1973, *L.Dennis 1547* (EIU). **Peoria Co.:** in Peoria, drive overlooking Illinois River, 27 Sep 1949, *G.S.Winterringer 19434* (ISM).

Richland Co.: Turkey Creek, *R.Ridgway 26*. **Saline Co.:** sandstone outcrop on Murray Bluff, S of Carrier Mills, 30 Jul 1954, *R.A.Evers 45369* (ILLS). **St. Clair Co.:** upper edge of bluff road, vic. Southern rr, 20 Nov 1960, *J.O.Neill 15529* (ISM, MO, SIU). **Vermilion Co.:** Kickapoo State Park, 24 Jul 1971, *D.Seigler 4726* (ILL). **Wayne Co.:** near Sannon Bridge, 21 Oct 1914, *R.Ridgeway 91*. **Will Co.:** property of Mrs. Koneeny, rt. 1, Mokena, Oct 1961, *F.A.Swink s.n.* (MOR).

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