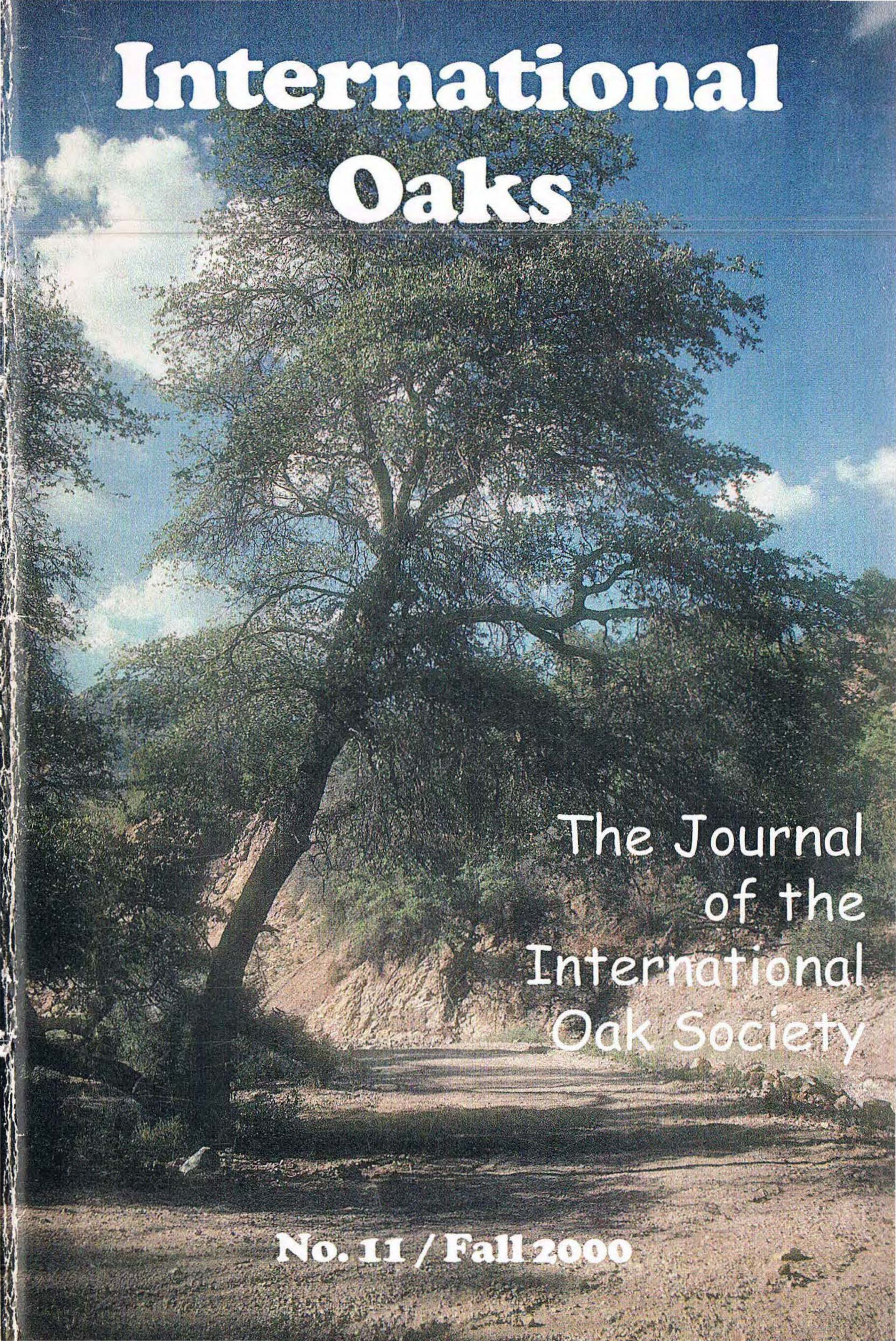
International Oaks



The Journal of the International Oak Society

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International Oaks is edited and designed by Russell K. Stare, Auburn, Illinois

About the Cover

Our cover shot this issue features a *Q. emoryi* located in the Lost Canyon of the Gila River, New Mexico. Elevation 4,600 ft. Oak specimens in the Gila River area and other parts of the Chihuahuan Desert Region are highlighted in Michael Melendrez' article beginning on page 21.

Anyone interested in joining the International Oak Society or ordering information should contact the membership office.

Membership dues are U.S. $15 per year, and benefits include publications, conferences, and exchanges of seeds and information among members from 30 nations on six continents.

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Remembering

by Guy Sternberg
Starhill Forest Arboretum
NAPPC Oak Reference Collection
Petersburg, Illinois USA

The first paper that appears in this issue of *International Oaks* was condensed from the 54-page doctoral dissertation of our late member Dr. Augustin Stanciu, who died shortly after its completion. A synopsis of this research was published in 1997 by the Museum of Deva, Romania in Acta Musei Devensis, Sargetia Series Scientia Naturae XVII, as *Oak Tree Hybrids in the Bejan Forest, Deva: Reactualization and Genetic Prospections*. This publication was very helpful in translation. The original title of Dr. Stanciu's dissertation, completed in Romanian for the University of Transylvania in Brasov under the supervision of Professors Stanescu and Sofletea, is *Cercetari Taxonomice, Morfologice si Ecologice Privind Hibrizii Genului Quercus din Rezervatia Stiintifica Bejan, Deva, Judetul Hunedoara.*

The Scientific Reserve Forest of Bejan is famous for the broad association of oak species and hybrids found there, and has been mentioned in

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Augustin Stanciu (left) with Stelian Radu (center) and Guy Sternberg (right) in Forest Bejan, Jud Hunedoara, Romania, June 1995.

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Remembering . . .

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several previous issues of International Oaks. Probably no other forest in Europe contains such a rich and genetically diverse oak flora; and certainly no other person knew the oaks of Bejan better than Augustin Stanciu, Romsilva's Chief Inspector there.

In the summer of 1995, my wife Edie and I visited the Bejan Forest with Augustin, Dr. Ing. Stelian Radu, and forest guard Dumitru Pirlia. The trip began with an all-day ride from the airport of Bucharest north through Ploiesti to Brasov, then west past Risnov and Bran, the famous home of the legendary Vlad Dracula. We passed through the ancient cities of Sibiu and Sebes, tucked into the Carpathian Mountains of Transylvania, then turned north for a slight detour through historic Alba Iulia. That night we found ourselves in Deva, at the home of Stelian and Anette Radu. During the next few days we took sightseeing trips to the Medieval citadels of Hunedoara and Deva, the 1000-year-old church at Hateg, and the Roman ruins of Sarmizegetusa. We also botanized in Retezat National Reserve and at the National Arboretum at Simeria, for which Dr. Radu served as Director.

But then we saw something that easily was the equal of all of these other magnificent places, at least in the eyes of an oak student. We picked up Augustin, traveled north to Bejan, and met Dumitru at the entrance to the forest reserve. The rest of that day was spent examining oak tree after oak tree, with Augustin bursting forth with information in Romanian and Stelian doing his best to keep up in translation. In all, we saw eight different native oak species, and hybrids of most of them, in this remarkable forest area of less than one square mile.

We knew at the time that Augustin was not well. Erika told us in a letter the following March that he was even using extract from yucca plants to attempt a cure. But with the helpful oversight of his two supervising professors, Victor Stanescu and Nicolae Sofletea, he completed his dissertation before he died. It was accepted in 1997 by the Ministerul Invatamantului at Brasov in fulfillment of his degree.

Augustin and Erika had presented one of the original copies to me, together with a rough translation, and it is summarized here in English. We are honored to share it with you now, both for its valuable insights into oak hybridization and as a posthumous tribute to the enthusiasm, knowledge, and perseverance of Dr. Augustin Stanciu.

Oak Tree Hybrids in the Bejan Forest

by Dr. Augustin Stanciu
Advisors: Profs. Victor Stanescu and Nicolae Sofletea

The Bejan Forest, located near Deva in the Western Transylvania Region of Romania, has been well known since the last century as a unique ecological reserve supporting numerous hybrids of indigenous oaks. The literature cites the following oak hybrids in the Bejan Forest:

- *Q.* x*tabajdiana* Simonk. (*Q. frainetto* x *Q. polycarpa*)
- *Q.* x*tufae* Simonk. (*Q. frainetto* x *Q. petraea*)
- *Q.* x*dacica* Borb. (*Q. polycarpa* x *Q. pubescens*)
- *Q.* x*haynaldiana* Simonk. (*Q. frainetto* x *Q. robur*)
- *Q.* x*kerneri* Simonk. (*Q. pubescens* x *Q. robur*)
- *Q.* x*budensis* Borb. (*Q. pubescens* x *Q. virgiliana*)

In addition, some varieties of these hybrids are also mentioned:

- *Q.* x*dacica* var. *tiszae* Simonk. et fekete
- *Q.* x*haynaldiana* var. *heuffelii* Simonk.
- *Q.* x*kerneri* var. *devensis* (Simonk.)

Our investigations, performed in 1988, 1989 and 1990, revealed a series of new hybrids and varieties not previously recorded in the Bejan Forest. This is not surprising, since no less than eight of the nine indigenous oak tree species of Romania occur in an area covering only 200 ha, providing many opportunities for interfertilization. The newly identified taxa are:

Q. x*rosacea* Beschst. (*Q. robur* x *Q. petrea*)
Q. x*rosacea* var. *petraeiformis* Beldie.
Q. x*rosacea* var. *feketei* Simonk.
Q. x*rosacea* var. *jahnii* Simonk.

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*Q.*x*pseudodalechampii* Ctrtz. (*Q.robur* x *Q. dalechampii*)

Q. x*pseudodalechampii* var. *cretzoui* Pascovschi

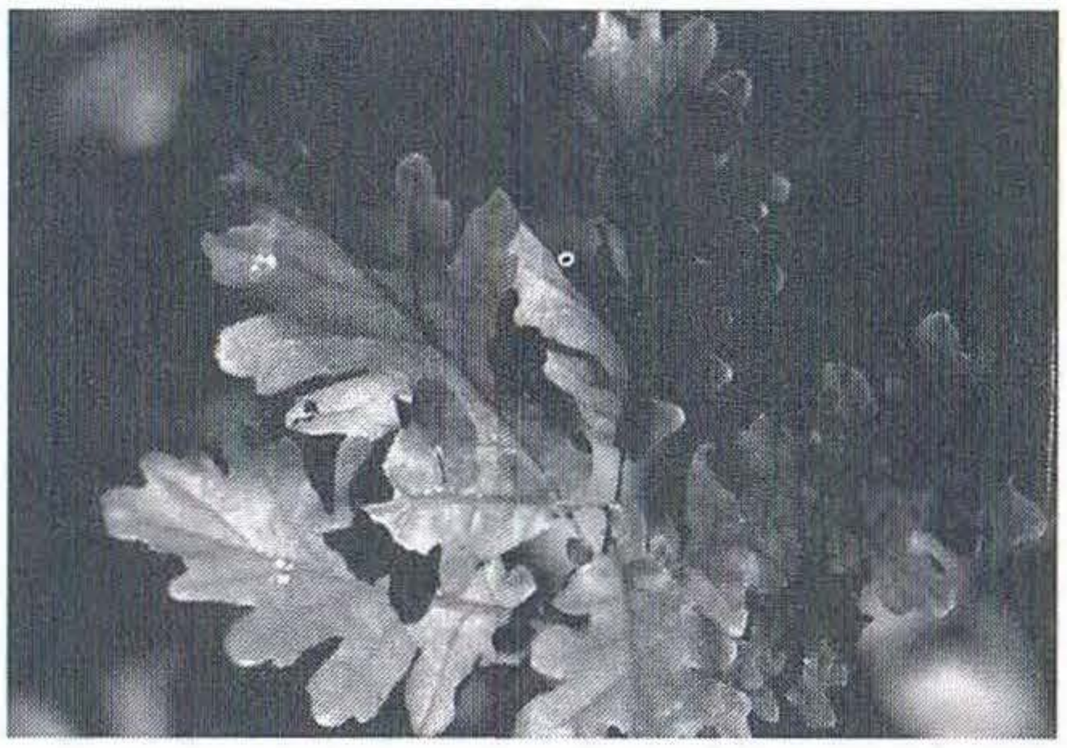
*Q.*x*csatoi* Borb.(*Q.robur* x *Q. polycarpa)*

Q. x*diversifrons* Borb. (*Q. petrea* x *Q. virgiliana)*)

*Q.*x*cazanensis* Pascovschi (*Q. dalechampii* x *Q. virgiliana*)

The differences between these new hybrids have been established, in general, using the diagnostic criteria in *Flora Romaniei* (*Flora RSR*) and *Monografia Stejarilor din Romania*. For hybrids between the *Sessiliflorae* Series and *Q. virgiliana*, the diagnoses are original. For instance, in *Q.* x*diversifrons*, leaves are intermediate between the two parent species, but closer to *Q. petraea* (not having alternate characters). The shape of cup scales also shows traits of *Q. petraea*, in addition to *Q. virgiliana*: short peduncles (0.5-0.8 cm) and no sessile cups.

Since oak species such as *Q. petraea, Q. dalechampii* and *Q. polycarpa* are in direct contact in the Forest, but the Forest itself is somewhat isolated, we believe the hybrids we have investigated are true hybrids and not subspecies or varieties, as sometimes has been proposed. This



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Q. xtufae (Q. frainetto x Q. petraea) *in the Bejan Forest near Deva, Romania (tree #695-5).*

conclusion is reinforced by the observation that there is a consistent morphological stability among these hybrids. Thus, the following hybrids have been provisionally described:

- *Q. petraea* x *Q. dalechampii*
- *Q. petraea* x *Q. polycarpa*
- *Q. dalechampii* x *Q. polycarpa*

The characteristics of the leaves of these hybrids are intermediate between those of the parent trees (leaf shape, lobation, form, etc.), or closely resemble one of them (coriaceousness and shininess), the same case being true with fruits (cups partially flat and partially globular). However, for all of these hybrids, diagnoses are provisional and should be supplemented by subsequent investigations of material derived from other trees.

A special place in the study of Bejan Forest is occupied by hybrids resulting from repeated backcrossing, and the double or multiple hybrids confirm the very remarkable ability to hybridize within mixed populations of local oak trees. This has produced the hybrids between *Q. petraea* and *Q.* x*rosacea*, between *Q.* x*tufae* and *Q. frainetto* (introgressive), and between *Q. petraea* and *Q.* x*pseudodalechampii* (multiple hybrids). There are, no doubt, other series of secondary hybrids in the Bejan Forest. Figure 1 is a diagrammatic representation of all known hybrids in the Forest.

Nevertheless, we have to mention that in our field research and in the material previously collected (leaves and fruits harvested by Augustin Stanciu, working under the auspices of Romsilva's Forest District Inspectorate for Hunedoara), we failed to find the following hybrids previously cited in the Bejan Forest:

Q. x*tabajdiana* Simonk. (*Q. frainetto* x *Q. polycarpa*)
Q. x*haynaldiana* Simonk. (*Q. frainetto* x *Q.robur*)
Q. x*haynaldiana* var. *heuffelii* Simonk.
Q. x*kerneri* Simonk. (*Q. frainetto* x *Q. polycarpa*)
Q. x*kerneri* var.*devensis* Simonk.
Q. x*dacica* var. *tiszae* Simonk. et Fekete (*Q. polycarpa* x *Q. pubescens)*
Q. x*szechenyana* Borb. (*Q. frainetto* x *Q. pubescens*), cited by A. Savulescu (unpublished).

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Q. polycarpa x Q. dalechampii *in the Bejan Forest near Deva, Romania (tree #695-13).*

Another problem resulting from the hybridization of oak trees in the Bejan Forest involves the combinations with genitors from the *Lanuginosae* Series (*Q. pubescens* and *Q. virgiliana*). Since these species possess a broad polymorphism, some uncertainty is introduced in the diagnoses of *Q.* x*dacica*, *Q.* x*szchnyana*, *Q.* x*cazanensis*, *Q.* x*kerneri* (*Q. pubescens* x *Q. petraea*), and *Q.* x*kanitziana*.

Genetic Prospects of Oak Hybrid Populations

From data collected in the field and from the literature, we have concluded that among the various indigenous oak tree species in the Bejan Forest, except for *Q. cerris*, there probably is full genetic compatibility for hybridization. Therefore, we also expect to identify other hybrids in addition to those described in the literature, or those described previously by us. In fact, we can speak of a series of oak hybrids, within

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which various forms can be distinguished, some being closer to one or the other genitor.

The hybridization phenomenon in oak trees in the Bejan Forest is also complicated by the possibility of introgression and double or multiple hybridizations. This is the case already mentioned for the hybrid between *Q.* x*pseudodalechampii* and *Q. petraea*. However, it should not be concluded from these results that there are not limits to interfertilization in the Forest. Our data show that hybrids congregate around their genitors; thus, true interfertilization circles can be distinguished, circumscribed by the reduced distances that most pollen granules move. However, the actual dimensions of these interfertilization circles need further investigation.

In this sense, it would be helpful to determine the ecological component in the process of natural selection of hybrids of various orders. The study of hybrid oak populations in the Bejan Forest offers valuable data on establishing relationships between genes in descendants, as related to genitors, as well as in relation to the nature of genetic control over some characters. Thus, by extrapolating relationships between allele genes from intraspecific hybrids to interspecific ones, the following types of relationships can be distinguished in oak trees:

Dominance: Manifest in typical or nearly typical characters of one of the two genitors in descendants. This is the case with the shape of the *Q. robur* oak leaf in the hybrid *Q.* x*rosacea*: with the base of the oak leaf in the same hybrid; with the hairiness of leaves and stems of most hybrids having *Q. pubescens* or *Q. virgiliana* as one parent; and with coriaceousness and shininess of the upper surface of leaves in hybrids with *Q. polycarpa* as a parent.

Semi-Dominance: Represented by intermediate characters between the genitors. Examples are *Q.* x*rosaea* var. *cretzoui* and *Q.* x*csatoi*, with pedunculate, short acorns, characters intermediate between sessile-flowered and pedunculate oaks. Semi-dominance is also present in *Q.* x*dacica* and *Q.* x*dacica* var. *tizsae* as leaf and stem pubescence — up to disperse pubescent — although in other cases, pilosity remains a dominant character.

Co-Dominance: Having characters of both genitors in the same organ, such as hybrid leaves resembling those of one genitor, *Q. petraea*, in the upper distal part, and resembling the other genitor, *Q. dalechampii*, in the basal part; or as in the *Q.* x*cazanensis* hybrid, with *Q. virgiliana* scales in the upper part of the cup (flat, lanceolate) and *Q. dalechampii*

scales (tuberculate) in the lower part.

Alternate Co-Dominance: Revealed by the appearance, rather frequent in oak hybrids, of characters of both genitors in the same organ, but on different branches, as in *Q.* x*rosacea* var *jahnii*, *Q.* x*tufae,* etc.

Linkage

The genetic control of characters appears independent for characters such as leaf shape and lobation, on one hand; and shape and lobation of leaf, versus glabrous character or pilosity of leaf surface, on the other hand. This means that the controlling genes of these characters are located either at large distances on the same chromosome, reducing the likelihood of linkage, or are located on different chromosomes.

In other situations, characters tend to

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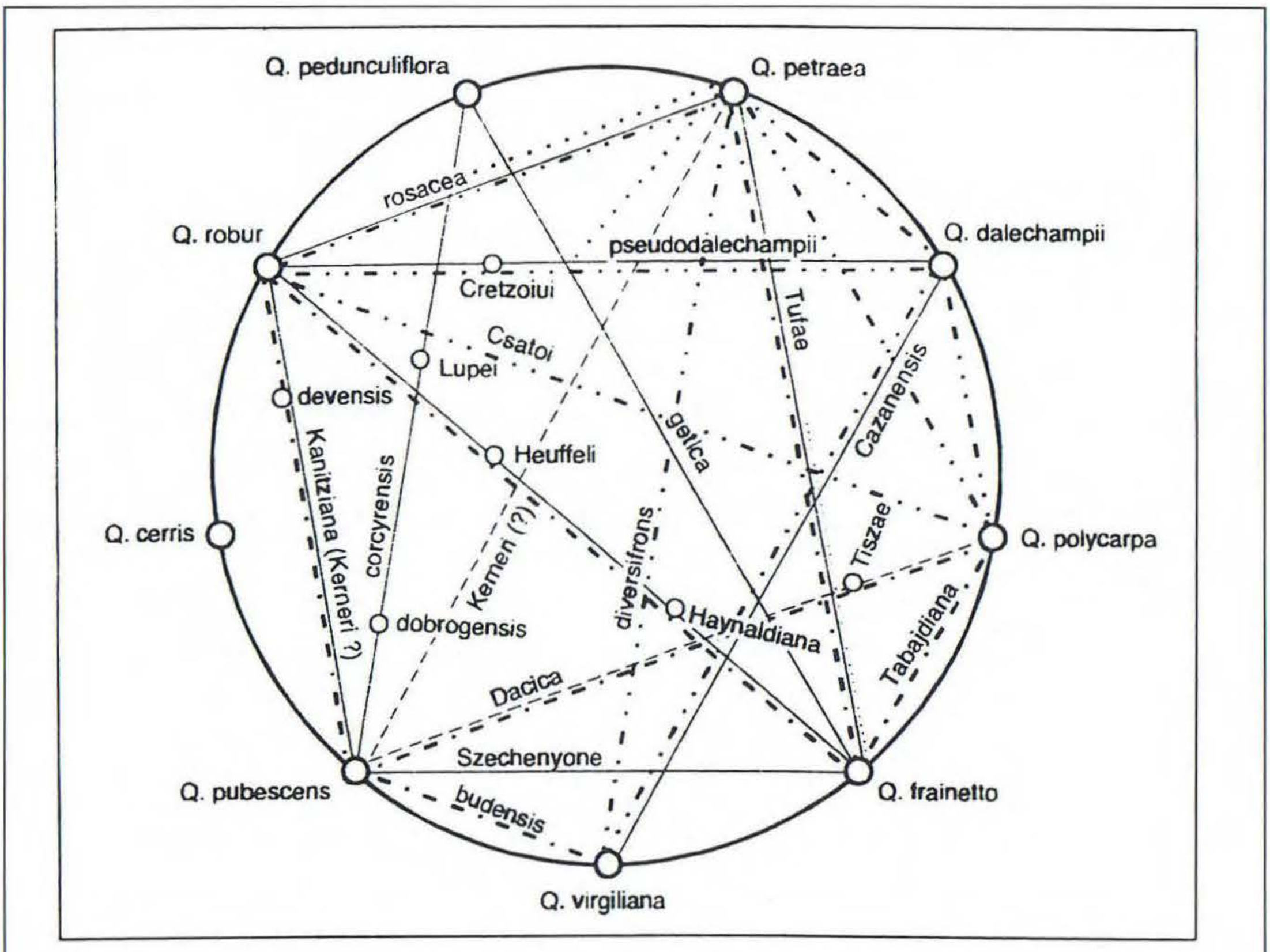

Fig. 1 - Diagram of **Quercus** *genus hybrids (after C.C. Georgescu and I. Moraru) with data added from Flora României and our own investigations in the Bejan Forest)*

LEGEND:

———— Hybrids in flora of our country mentioned in „Monografia stejarilor din România".

– – – – Hybrids occurring in the Bejan Forest, after „Flora României"

– . – . – New hybrids in the Bejan Forest (already described in literature)

– .. – .. – New hybrids in the Romania's flora (for science?) identified in the Bejan Forest

– ... – ... Multiple hybrid and introgressive hybrids identified in the Bejan Forest

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be transmitted in association, such as leaf shape with lobation, lobation with length of petiole, coriacity and shininess with leaf pilosity and shape of scales of cups, etc. These characters could be controlled by linkage or even by supergenes.

However, linkage or crossing-over relations are hidden in hybrids by the presence of genes derived from both parents, so that in these instances, the use of some direct methods of investigation are required.

Conclusions

Oak hybridization in the Bejan Forest, which is almost devoid of genetic interspecific constraints, is a remarkable phenomenon. Further studies are needed from taxonomic, ecological, physiological, and of course, genetic standpoints. The ecological circumstances allowing interfertilization of oaks in the Bejan Forest need particular attention. Nevertheless, due to the frequency of local introgression, one can conclude that the hybrids are fertile, at least partially.

Besides the phytogeographical influence of species interaction, phenological differences exist. They are related to timing of growth initiation, flowering, pollen production, and fertilization and could also affect hybridization. These should be investigated further.

Hybridization of oak trees in the Bejan Forest, of course, is not just a recent phenomenon. It is possible that hybrids of various orders appeared at different times, with natural selection preserving the most balanced heterozygotes.

The hybrid populations in the Bejan Forest offer an opportunity to establish the relationships between the allele genes from descendants (dominance, semi-dominance, co-dominance, alternate co-dominance). However, this study of *Quercus* hybrids does not offer sufficient conclusive data on the linkage and crossing-over relationships, hidden in hybrids by the relationships between the allele genes derived from the two genitors. But the valuable germplasm existing in the Bejan Forest demands the establishment of special ecological and genetic preservation and conservation strategies. New investigations on local vegetation and biotypes should also be undertaken.

References Cited in this Synopsis

Georgescu, C. C., and I. Morariu, 1944. *Monografia Stejarilor din Romania*, ICES, seria 11, Bucharest, Romania

***, 1952. *Flora RSR*, vol. I, Ed. Academy of Bucharest

(Note: 90 additional citations are listed in the original dissertation)

The Great Oak of the Landis Arboretum

by Fred Lape
former Director, Landis Arboretum

The following article is taken from the Landis Arboretum Newsletter *covering April, May, and June of 1982. In it, Fred Lape, who passed away in 1985, describes a huge oak, called the "Big Oak" that, at that time, was designated the official Logo of the Landis Arboretum by the Board of Trustees. It remains the Logo to this day, but is now called the "Great Oak." The George Landis Arboretum is located on a hillside above the village of Esperance, New York, and overlooks the Schoharie River Valley. Its 97 acres are home to more than 2,000 species of trees, shrubs and herbaceous plants. The Arboretum demonstrates the unity and diversity of plant life through its living collections and educational programming.*

The Big Oak of the Landis Arboretum is an Eastern White Oak (*Quercus alba*). The species ranges from Maine to Georgia, but flourishes best in the section from southern Connecticut and Long Island through eastern Pennsylvania where it is often the dominant tree. It is not common in New York State north of the Mohawk Valley.

The Big Oak must have been an outstanding forest tree when the land, now the Arboretum, was cleared about 1840, for it was singled out by the first owner to be left standing in the open. My first memory of the tree dates from about 1910, when I was getting old enough to pay attention to trees. It seems to me now in memory that its trunk was as large then as it is now, but early life memories usually magnify with time. There were already two lightning scars, which wriggled like gigantic snakes down the

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east and south faces of the trunk; the traces of which still remain.

It was probably one of the features of the farm that induced my father to buy the property, for he loved far views. He immediately named the place Oak Nose Farm, and always took visitors to see the views up and down the Schoharie Valley, which one gets from the knoll upon which the oak stands. The knoll itself is part of a glacial moraine that was dumped across the valley during the last glacial retreat.

We have never taken borings of the tree here at the Arboretum to ascertain its age. From comparing the size of the trunk and branch spread with that of certain famous oaks in southern New England and on Long Island, whose ages are roughly known from certain historical events which happened near or under them, we guess the Big Oak to be from 350 to 500 years old.

It was a flourishing tree until 1940. Then a natural disaster overtook it. That year there was an ice storm. It rained steadily and heavily day and night for three days, the rain freezing as it fell. By the end of the storm, every blade of dead grass in the fields was coated with solid ice to the thickness of a man's thumb, and all the branchlets of trees were equally coated.

I have never lived through a major earthquake, nor a tornado or hurricane. The last night of the ice storm was the greatest natural disaster I have ever experienced. Few persons on these hills slept that night. From late afternoon of the third day, when the large limbs of trees began to give way, and all through the night to the next morning, there was a constant bombardment from the crashing of limbs as they broke loose from trees and fell.

On the fourth morning the storm had ended and the sun came out. I walked over toward the Big Oak to see the damage. On the way up to the knoll one looks over a section of the wood-lot that had always been the sap bush, with large maple trees that had furnished sap for maple syrup for a hundred years. There was not a single large maple left standing, only the stripped tops of trunks and the mass of fallen branches glistening in the sun. The Big Oak lost all of its branches on the northeast side, about half of its crown.

If, at the time, I had either the money or the experience to repair the damage after the storm, the tree could probably have recovered completely, for it was then a vigorously growing tree. I had neither and did nothing. So in a few years the open wounds left along the trunk by the pulled out bases of the falling limbs began to rot inward. Once water was able to reach be-

yond the growing layer of the wood, the rotting inward and down accelerated, and has continued ever since. Coons began to nest inside the hollow trunk.

In the meantime the tree has continued to grow vigorously. But during the last four years, large lower branches have broken off without even a high wind or a heavy snow to cause the break; merely the weight of the branches overpowering the now shallow moorings which they have in the trunk. Whether anything could be done now that is worth doing is doubtful. The very lower section of the trunk still seems solid, but the upper section is completely hollow, and one can look up from the lower holes to light in the upper ones.

Even as it stands, the tree may live another hundred years, for the white oak is a vigorous species. However, the climax of its life definitely came at the end of three days of freezing rain in the winter of 1940, and from then on its way has been downward.

Thanks to arborist Fred Breglia of the Landis Arboretum for funishing this story and photograph. Fred reports that the tree is still strong, more than a half century after the big ice storm.

Reprinted with permission, Landis Arboretum Newsletter, *May-June, 1982.*

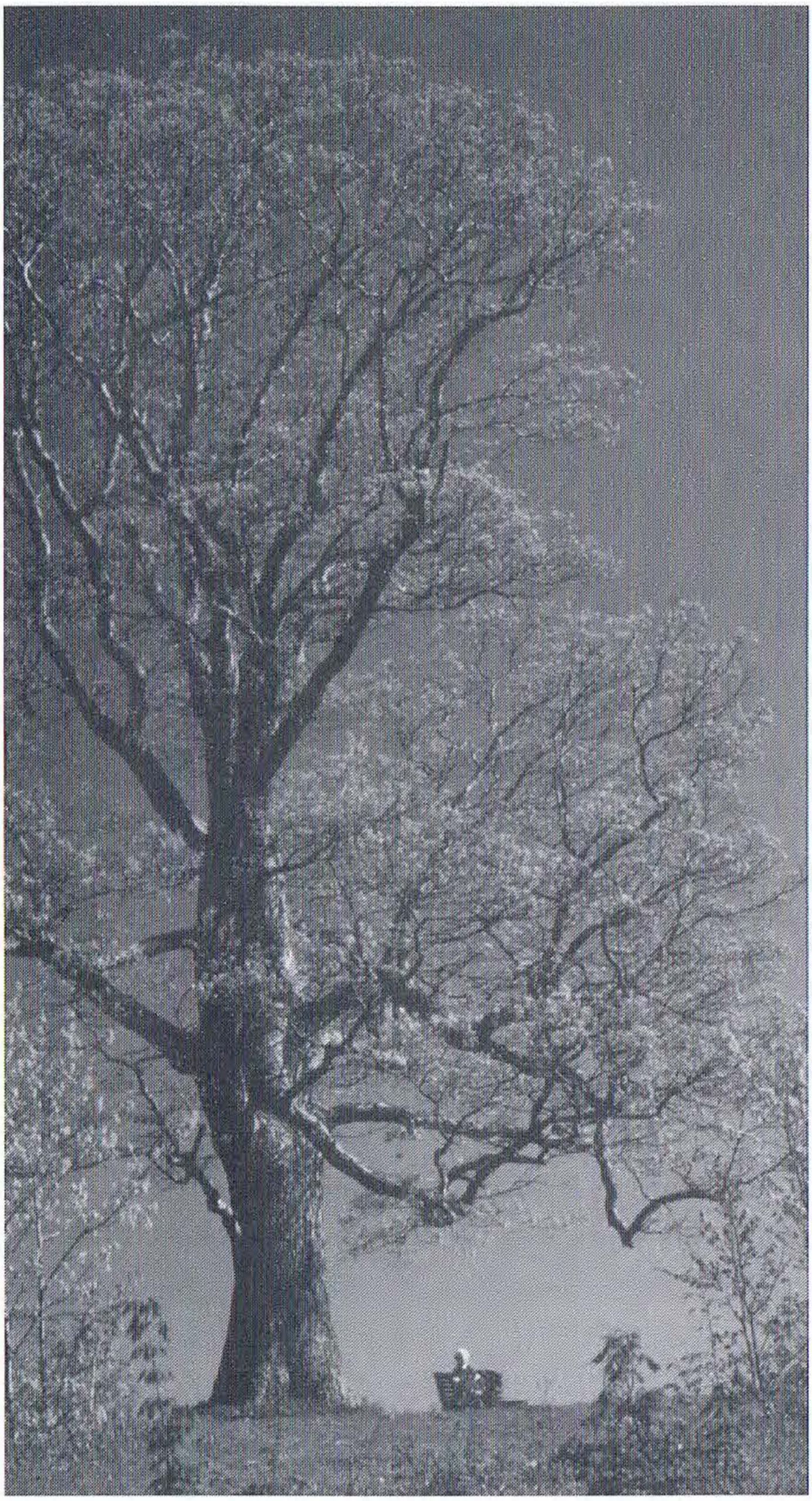

photo by Fred Breglia

The Great Oak in Landis Arboretum.

An Oak Wilt Primer

by Jennifer Juzwik
Research Plant Pathologist
USDA Forest Service, North Central Research Station
St. Paul, Minnesota, USA

Oak wilt, caused by the fungus *Ceratocystis fagacearum* (Bretz) Hunt, is an important disease of oaks (*Quercus* spp.) in the eastern United States. The disease occurs in 22 states and is considered the most important forest disease problem in Illinois, Iowa, Minnesota, Texas and Wisconsin. The pathogen causes mortality of thousands of native oaks annually in urban and natural forests in the north-central United States and in Texas.

Over 33 species and varieties of *Quercus* are known to be susceptible to *C. fagacearum*. In addition, three species of *Castanea*, one species of *Castanopsis*, and one species of *Lithocarpus* are also susceptible. Within the subgenus *Quercus*, members of the section *Erythrobalanus* (= section *Lobatae*) (the red oak group) are very susceptible while members of the section *Quercus* (the white oak group) range from quite susceptible to highly resistant.

Oaks are a dominant component of the expansive oak-hickory forests of the central USA that prevail from the northern boreal forest region to the states bordering the Gulf of Mexico. The oak species group is the most important aggregation of hardwoods in the United States. In the US, oaks are important for providing food for birds and mammals, wood for lumber and veneer, cooperage for the beverage industry, and as landscape trees.

Oak wilt was officially identified and the causal fungus was described in the early 1940s. However, accounts of similar oak problems suggest the occurrence of the disease as early as the mid- to late 1800's in Minnesota and Wisconsin. The disease is

now known to occur within the area delineated from Minnesota east to Pennsylvania, south to South Carolina and Tennessee, west to northern Arkansas and eastern Oklahoma, and north through eastern Kansas and Nebraska to Minnesota. A significant southern extension of the oak wilt range was recognized in the early 1980s when the disease was confirmed in northeastern and central Texas where it has since become increasingly important.

Symptoms

Oak wilt is easily identified in members of the red oak group by the rapid wilting of affected trees. After symptoms first appear, a red oak may wilt completely within four to six weeks. The trees wilt from the top of the crown downward, and individual leaves wilt from leaf tip and margins to the bases, turning bronze to brown. Fallen leaves are often green at the base. In contrast with the red oak group, infected white oaks usually die slowly, a branch at a time, often surviving for many years. Leaf discoloration of affected white oaks resembles autumn colors. Affected live oak leaves in Texas exhibit inter-veinal yellowing and browning during late spring and summer. In species of both the red and white oak group, the outer ring of springwood vessels will be plugged with brown material (tyloses and gums) and streaks of brown may be obvious on the outside of the wood. The vascular discoloration is most easily seen

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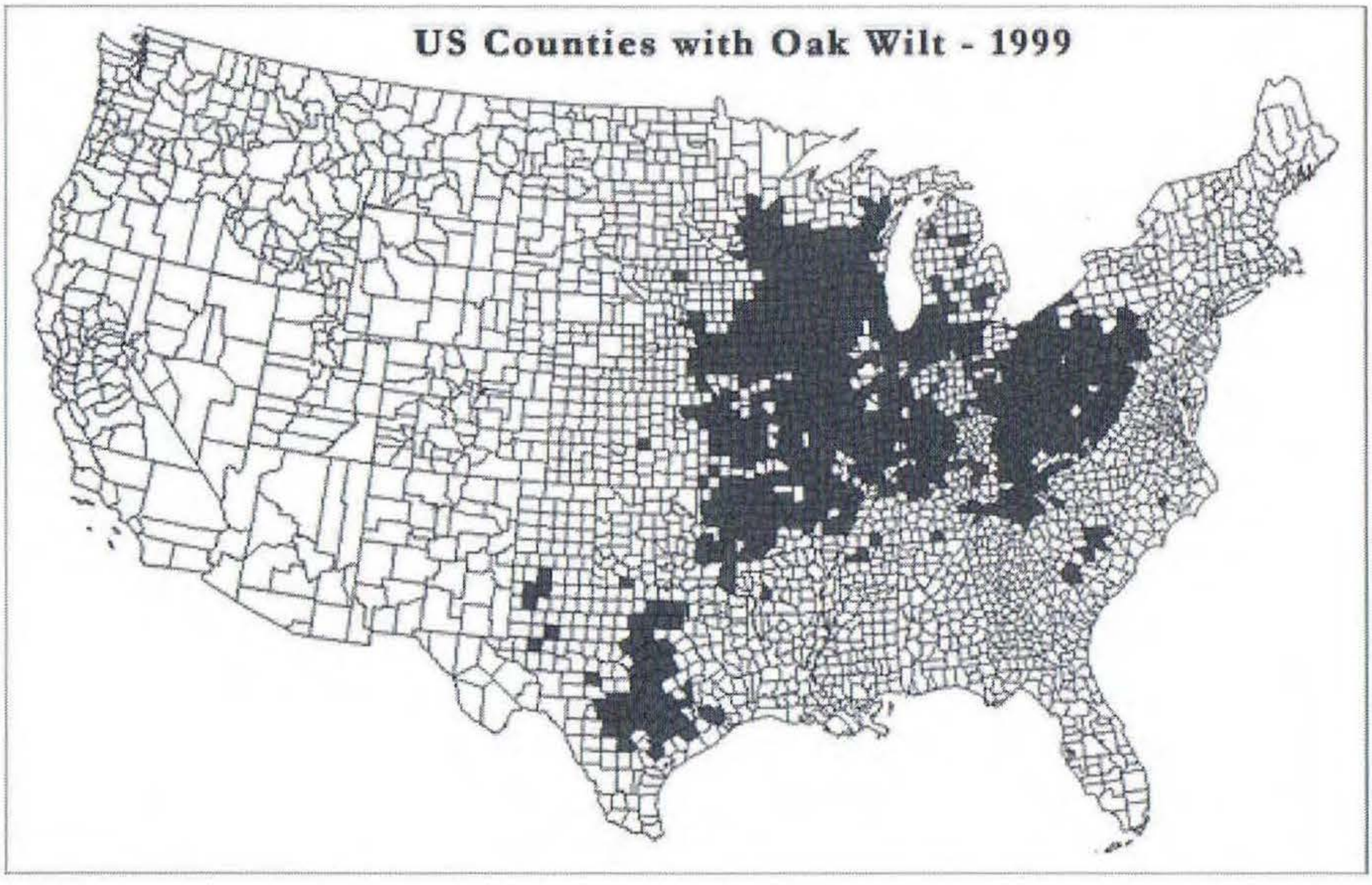

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in cross sections of infected branches of white oaks, and less readily observed in infected red oak branches.

Disease Development and Spread

The causal fungus reaches healthy oaks through roots grafted between diseased and healthy trees or via insect vectors that carry spores of the fungus on their bodies. Once introduced, the mycelium of the fungus grows into the water-conducting cells of the xylem. Secondary invasion of the ray cells may follow.

The fungus physically plugs the cells of the xylem, as do tyloses formed by the tree in response to fungal invasion. This plugging prevents the upward translocation of water and minerals to the foliage, resulting in wilting of the leaves. In the spring or fall immediately following tree death, the fungus aggregates on the inner phloem and outer xylem of the trees forming mirror-image structures known as oak wilt mats. Mats may form on in this manner on main stems and branches that over 6cm in diameter. Spores of the fungus are produced on the mats. Specialized, compact tissue called pressure pads also form within each mat. Pressure exerted by the growing, opposing pads often forces open the bark, causing a vertical crack through which insects may enter.

Above ground spread of oak wilt is accomplished by insect vectors which have acquired viable spores of the oak wilt fungus. The fungus spores are then transmitted to healthy oaks. Insect transmission is significant in the establishment of new infection centers in adjacent as well as distant forest stands, and is the only way the fungus can cross highways, rivers, and open fields. In the Upper Midwest in the US, sap beetles of the insect family Nitidulidae are considered the primary vectors of *C. fagacearum*. In other parts of the oak wilt range, oak bark beetles (*Pseudopityopthorus* spp.) and ambrosia beetles have been implicated as important vectors of the causal fungus, although the relative importance of each insect vector group is not known in these areas. Two species of sap beetles (*Carpophilus sayi* and *Colopterus truncatus*) have recently been identified as the principal insects involved in successful transmission of *C. fagacearum* to healthy trees in Minnesota. Sap beetles are commonly attracted to the sporulating mats produced between April and early July on red oaks that wilted the previous summer. This is also the same period of time during which red oaks pro-

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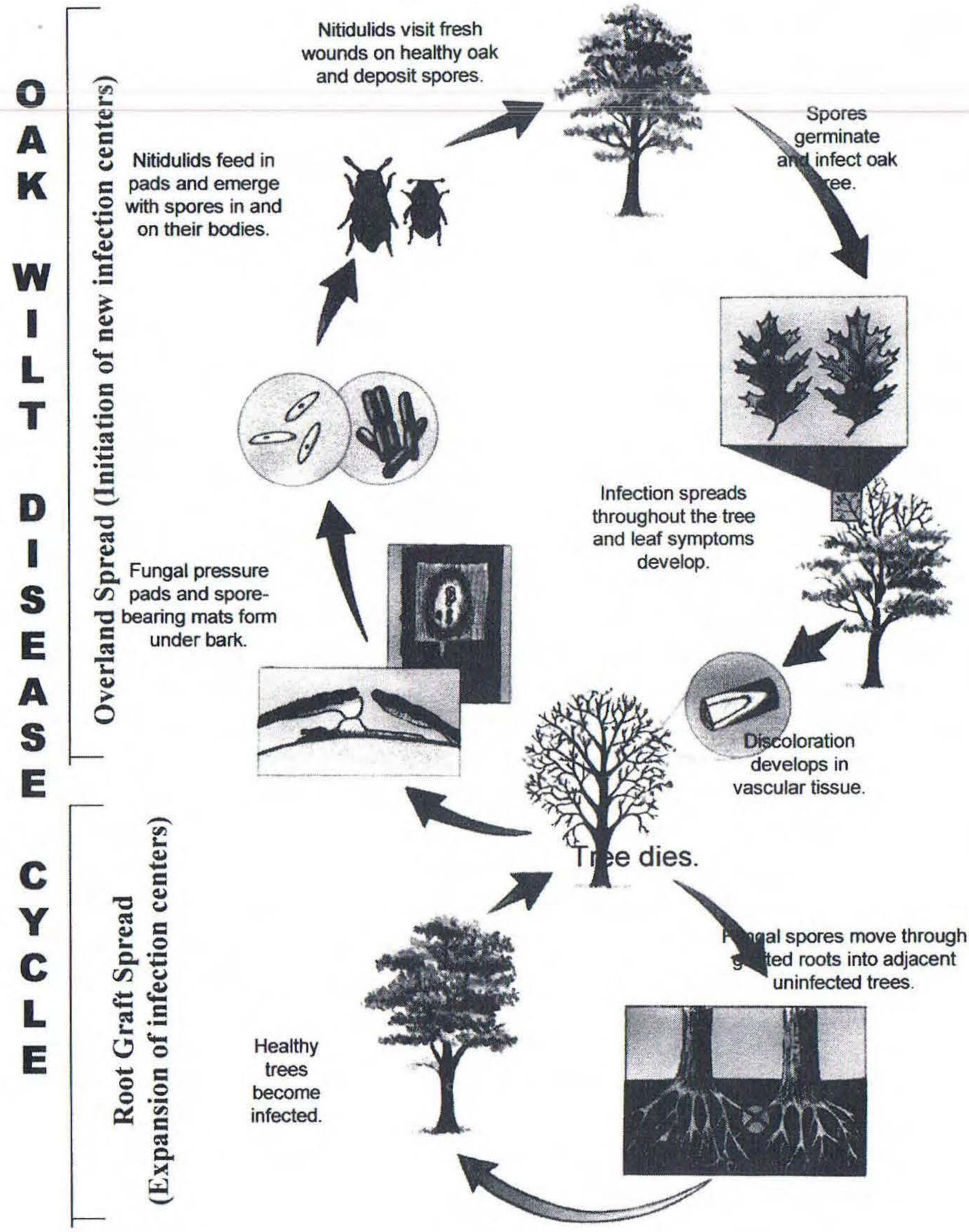

drawing courtesy of United States Department of Agriculture Forest Service, Northeastern Area, State and Private Forestry

Oak Wilt . . .

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duce large springwood vessels and thus are particularly susceptible to infection. Several species of the same sap beetles are also attracted to fresh (generally less than 48 hours old) wounds on healthy oaks during spring (e.g. from early April to early July in Minnesota). Visitation of such wounds by *C. fagacearum*-contaminated beetles results in oak wilt infection.

Once a tree in an otherwise oak wilt-free stand becomes infected via insect transmission, the fungus moves to adjacent trees through grafted roots. This is the means by which the highest proportion of oaks becomes infected. Grafting between trees within a *Quercus* species may be common, but frequency is influenced by distance between trees, presence of other species, soil type, and topography. In Texas, live oaks in a stand are generally all inter-connected via a common root system due to the sucker-reproduction habit of the species. Occasionally root grafts may occur between different species of oaks. Outward spread of the fungus via root grafts from the initially infected tree often leads to irregular circular patches of dead and dying trees called infection centers.

Disease Management

Stopping spread of *C. fagacearum* through common root systems or grafted roots in existing infection centers is an important part of an oak wilt control program. Disruption of root grafts can be accomplished mechanically using a vibratory plow with a 1.5 m (5-foot) blade, or with a trenching machine that reaches depths of 1.2 m (4 feet) or greater. If buried utilities are present, manually dug trenches or a chemical soil sterilant (Vapam) can be used to disrupt roots, but neither is nearly as effective as the mechanical methods. Root graft barrier lines must be positioned between oak wilt infected and non-infected trees. Often, two lines are recommended: a primary line outside a ring of apparently healthy trees that may actually have early infections, and a secondary barrier outside of every obviously infected tree. The fungus can be in a tree for 2 – 3 weeks without leaf symptoms appearing. Barrier placement requires experience and requirements vary by region. In the Upper Peninsula of Michigan, a model based on tree size and two soil types has been developed to place lines such that they have 95 percent and 99 percent probability of preventing root graft transmission (summarized in Cummings-Carlson and Martin, 1994). The oldest model for the region (as in French and Juzwik, 1999) has been shown to be 85 percent to 93 percent effective when experienced arborists place

lines. In Texas, root graft barriers are established 30 m beyond the last infected tree, and the remaining living oaks between the infection center and the barrier are rogued. Herbicide treatment of living oaks surrounding infected trees is a method currently being investigated as an alternative to mechanical disruption methods where topography, location, etc., may prevent their use. In high value white (subgenus *Quercus*) and live oaks, systemic injection with propiconazole by a qualified arborist may prevent infection of trees adjacent to oak wilt infected ones.

Preliminary data also suggests that high value red oaks (subgenus *Lobatae*) may also be similarly protected. Propiconazole treatment of white oaks exhibiting early crown symptoms of oak wilt (i.e. theraputic treatment) can also prevent further disease development within infected trees for at least two years in species of this subgenus.

Aboveground transmission of the oak wilt fungus is less readily controlled than belowground spread. Current efforts in established control programs include the removal of recently killed red oaks prior to formation of oak wilt mats in the spring. In Minnesota and Wisconsin, for example, such trees should be removed and properly disposed of or treated prior to April. In forest stands where a large number of trees may be involved or where location prohibits tree removal, mat formation can be limited or prevented by girdling the infected oaks as they begin to wilt. Successful use of this method requires early disease detection and treatment of infected trees in early stages of wilting. Girdling trees into the outer xylem weakens the standing tree making it more susceptible to toppling by wind. Liability issues prevent the use of this method in residential settings. Infected white oak (*Q. alba*) do not need to be removed because the fungus rarely sporulates on this species.

Oaks should not be wounded or pruned during the critical spring months (e.g. April through June in Minnesota) or warm winter and spring months (e.g. November through April in Texas) when the sap beetles are active and oak wilt mats are present. If trees are accidentally wounded or pruning is unavoidable during these high susceptibility periods, the wounds should be immediately painted with water-based paint or shellac to prevent direct contact of the beetles to exposed wood. Tree climbing irons should never be used on living oak trees.

Oak wilt mats may form on logs cut from wilting or recently wilted trees and should not be moved in any form (including firewood) to areas where oak wilt is not present. Oak wilt mats may form on these logs. Long distance movement of firewood obtained from such logs has accounted for the establishment of oak wilt centers in areas of Michigan, Minnesota, and Texas that previously had been unaffected by the disease. European countries require chemical fumigation (e.g. with methyl bromide) of oak logs before im-

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portation from counties in the USA with known oak wilt infection centers.

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Editor's Note: As this issue of *International Oaks* was going to press, Professor Juzwik contacted us with some news about the Sudden Oak Death (SOD) disease that has been killing oaks in California. Suspected by some to be a variant of Oak Wilt, new research results have found instead that the problem apparently is caused by an as-yet unidentified species of the *Phytophthora* genus of fungi.

The epidemic affecting tanoaks, coast live oaks, and California black oaks was first noticed in Mill Valley, California in 1995. Thousands of trees in the area from Santa Barbara to Humboldt counties have become infected. Trees ooze a dark, viscous fluid when the fungus penetrates the bark and begins to kill the tree's phloem.

David Rizzo, a plant pathologist at the University of California at Davis, identified the pathogen as a new *Phytophthora* species which does not match any of the 60 known *Phytophthora* species anywhere else in the world. It can be spread in soil (on shoes, tires, etc.) or in infected wood.

For more information on SOD, refer to the following web site: http://camfer.cnr.berkeley.edu/oaks/ and review the other information available through the links page of the International Oak Society web site: http://www.saintmarys.edu/~rjensen/wwwsites.html

Oaks of the Chihuahuan Desert Region

by Michael Martin Melendrez
Los Lunas, New Mexico

Presented below are 23 species of white oak, six of black oak, and two intermediate, or golden oaks, found in the southwestern United States (primarily New Mexico, Arizona, and western Texas). These numbers may be disputed by some oaks students. Differences of opinion exist as to the true boundaries of the Chihuahuan Desert, the potential hybrid status of some of the oaks, and their delineation. Also, new oaks not previously known to occur in the area are continually discovered. Counting the additional oaks found in the adjacent Mexican State of Chihuahua, there are more than 60 species. The Chihuahuan Desert Region is truly *The Land of Oaks*.

The production nursery industry of our area has started, on a small scale, the introduction of oaks with a limited species selection. Unfortunately, the southern live oak (*Quercus virginiana*) usually is the first one to be grown and sold, and it is commonly promoted as the best oak for the desert cities of the Southwest. The species of oak native to this arid part of the country are much

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Author Michael Melendrez standing below Q. arizonica *in Catwalk Canyon, Gila National Forest, New Mexico.*

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better adapted here, and thus make better choices for shade trees than the southern live oak.

At our nursery production program in Los Lunas, New Mexico, at 4,900 feet elevation and USDA Zone 6b, the native oaks outperform the southern live oak in speed of growth, heat tolerance in a container, and over-wintering success. In fact, we are unable to winter the southern live oak outdoors, but with the native oaks we can. We also must be aware of potential problems with live oaks (and red oaks) that have been harvested or collected from areas of Texas where oak wilt has been found, as well as the potential danger of spreading fire ants.

The following introduction to the oaks of the Chihuahuan Desert Region of the United States is intended to illustrate the vast diversity of our native oak resource.

White Oaks — Section *Quercus* (formerly *Lepidobalanus*)

This group displays bark that typically is light gray and scaly (but black and furrowed in escarpment live oak). Tyloses are present in summer wood (absent in escarpment live oak), and lobes of leaves are rounded, except for *Q. turbinella* and *Q. hinckleyi* (which both have sharp, mucronate lobes) and *Q. pungens* var. *vaseyana* (with almost bristly tips).

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Acorns of Q. arizonica *collected at elevation 5,200 ft. along the Gila River in New Mexico.*

1. *Q. arizonica* - Arizona white oak

Description: A medium-sized tree of the southwestern United States and adjacent Mexico, 30 to 60 feet or more in height, and 2 to 3 feet in trunk diameter, with irregular spreading crown of stout branches. Leaves obovate or oblong, 1-3 inches long, short-pointed or rounded at apex, heart-shaped or rounded at base, edges slightly wavy-lobed and toothed toward apex, thick and stiff, above dull blue-green and nearly hairless and with veins sunken, beneath paler and densely hairy and with prominent raised veins, shedding gradually in spring as the new leaves unfold, except in colder parts of its range where it will defoliate in the late fall or early winter. Often, in colder climates, they will display good fall colors resembling burgundy wine. Acorns are

3/4 to 1 inch long, with shallow cups, mild to sweet nut-like flavor, particularly in those found on the east slopes of the Organ Mountains.

Distribution: Common in Arizona and in southwestern New Mexico, grading into gray oak in the south-central highlands of New Mexico, and perhaps in Texas in the Franklin and Hueco Mountains. In the Manzano and Sandia Mountains this species is mixed with gray oak and scrub live oak, which can be quite confusing, with possible hybrid swarms. The habitat is oak woodlands in foothills and mountains from 5,000 to 7,600 feet elevation. Often this species is listed as the largest of the southwestern evergreen-type oaks, but this is not true, because Emory oak becomes a larger tree.

2. *Q. carmenensis* - Delcarmen oak

Recently reported in the Chisos Mountains by Professor Mike Powell of Alpine, Texas, who found only one specimen about 3 feet tall. Cornelius Muller considered this scrub oak a hybrid.

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Foliage of Q. arizonica *in Cave Creek Canyon, Coronado National Forest, Arizona. Elevation 5,500 ft.*

3. *Q. chihuahuensis* - Chihuahua white oak

A tree to 40 feet tall with tardily deciduous leaves, greatly variable. Reported as being in the Quitman Mountains. I've yet to find this species, so I'm unable to offer personal observations.

4. *Q. depressipes* - Mexican dwarf oak

An evergreen shrub to 10 feet, found in high grasslands or montane chaparral. It is found in the United States at the northwest summit of Mt. Livermore in the Davis Mountains of the Trans-Pecos Region of Texas.

5. *Q. fendleri* (*Q.* ×*fendleri*?) - Fendler oak

Also called Capitan blue oak.

Description: Some students of oaks will lump this oak into the undulata hybrid group without much thought given to the gross morphological differences between the two. Fendler oak is an evergreen or tardily deciduous species with oblong, sharply lobed leaves that are a metallic blue green. Bark is smooth and gray on young trees, turning to nearly black and checkered with age.

Distribution: Native elevation range is 5,500 to 6,000 feet near the Capitan Mountains of south-central New Mexico. Under cultivation, Fendler oak is rapid growing and very ornamental, able to grow well in high pH clays. Fendler oak

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can grow into a 40 to 50 foot single-stem tree, with no habit of suckering.

6. *Q. fusiformis* - escarpment live oak
Also called New Mexico live oak.
Description: Evergreen to semi-evergreen small tree, usually to 25 feet in the wild with a crown spread of 30 to 35 feet. Leaves lance-shaped, 2 to 3 inches long and 1/2 to 1 inch wide, with short, spiny lobes on young, fast-growing trees. Fall color can occur on trees in colder climates, and can continue as winter color. Acorns are small and much like those of the Emory oak, 1/2 to 1 inch long and narrow, forming in clusters (southern live oak has a larger, bulb-shaped acorn borne singly or in pairs). Bark is dark gray on young, fast-growing trees, turning a rough black with age, as is typical of many black oaks.

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Q. fusiformis, *a cultivated tree in Tulsa, Oklahoma. North of the natural range.*

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Q. fusiformis *near Quartz Mountain, Oklahoma. This is at the northernmost natural population of the species.*

Distribution: Not always distinguished from the southern live oak in the literature. Lacking the tyloses of other white oaks, this species sometimes is assigned to the black oak group. This distinctive evergreen tree is perhaps most ecologically suitable for the high, cold desert. Provenances of greater cold tolerance can be found in eastern New Mexico (on the Caprock formation east of Roswell, at 4,000 feet elevation), in Garza County, Texas (at 2,200 feet elevation), and in Greer County, Oklahoma (in the Quartz Mountains). A common failure of growers in the Southwest is not being careful with the seed source of this species, resulting in growing southern live oak and calling it escarpment live oak in error. If planted in the Albuquer-

que (USDA Zone 7a) area, only the New Mexico material will prove to be evergreen and dependable.

7. *Q. gambelii* - Gambel oak

Also called Utah white oak or Rocky Mountain white oak. Names sometimes considered as synonyms include *Q. carmenensis*, *Q. confusa*, *Q. gunnisonii*, *Q. leptophylla*, *Q. media*, *Q. novomexicana*, *Q. obtusifolia*, *Q. pauciloba*, *Q. rydbergiana*, *Q. submollis*, *Q. undulata*, *Q. utahensis*, *Q. venustula*, *Q. vreelandii*.

Description: A deciduous tree to 60 feet in wild stands and 80 feet under cultivation. A rare component of the Madrean oak woodlands and more common in the Pine Transitional and Mixed Conifer zones. The largest trees are found at 8,000 feet in the grassland parks of the Gila National Forest of southwestern New Mexico, with trees commonly 60-100 feet in size. In Texas it occupies only the highest altitudes. I've found it difficult to locate in Texas, except in the Guadalupe Mountains and a small population in the Franklin Mountains near El Paso. In the Organ Mountains, near Las Cruces, it is common from 8,900 feet elevation on down to 5,700 feet. In the Mogollon Mountains of the Gila National Forest, it can be found as low as 4,700 feet, with large, healthy populations. It occurs from the Mexican States of Chihuahua and Coahuila north to Colorado, west to southwestern Wyoming, Utah, and southern Nevada. Gambel oak is the only native oak of Colorado and is the only common tree oak in the northern parts of New Mexico (excluding the Sandia, Zuni and Manzano Mountains). Another interesting note on this species is that it will occur at lower elevations in the southern part of its range than it can up in Colorado or Wyoming. Gambel oak is easily recognized by the deeply lobed leaves, which are larger than those of the evergreen to semi-evergreen Southwestern oaks. It is quite polymorphic and according to many authors is involved in the parentage of many hybrids. Some of the oaks with which it crosses are *Q. arizonica*, *Q. grisea*, *Q. havardii*, *Q. mohriana*, *Q. muhlenbergii*, and *Q. turbinella*. The resulting hybrid grex is called *Q.* x*undulata* - wavy leaf oak. When we have attempted propagating the so-called wavy leaf oak, the progeny do not hold true, which suggests the hybrid theory

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International Oak Society members Michael Melendrez (left), Guy Sternberg (center), and Tom Burleson with a large Q. gambelii *at Iron Creek in the Mimbres Mountains of New Mexico. Elevation 6,800 ft.*

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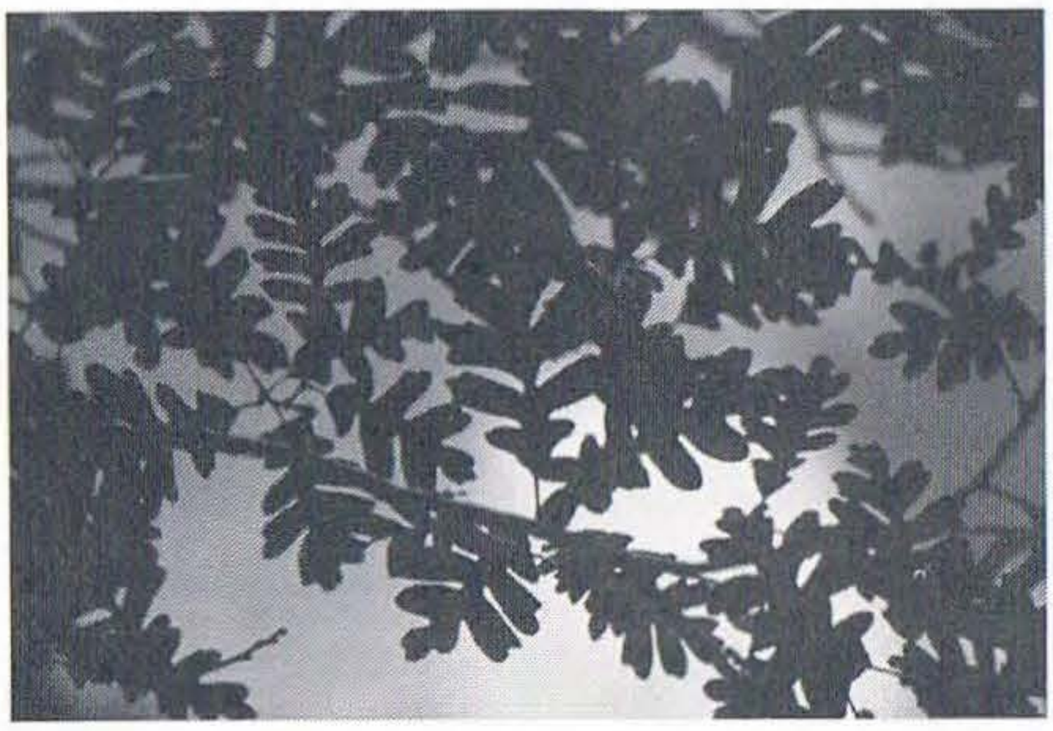

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Foliage of Q. gambelii *in Catwalk Canyon, Gila National Forest, New Mexico.*

is valid. It's important to note that some of the larger Gambel oaks found in southern New Mexico do not have the habit of suckering or forming clonal groves, and progeny grown from seed collected from those single trees hold true to the parent. Likewise, seed collected off the lignotuberous types also hold true, having a suckering habit.

8. *Q. grisea* - gray oak

Description: Usually a small, low, scrubby evergreen tree or shrub, or in better sites a medium-sized tree to 65 feet in height with deciduous leaves when occurring at higher and colder sites. It occurs with Emory oak in the Madrean Oak Woodlands of the desert edge. I've found gray oak in the mountains of central New Mexico with nearly evergreen habit, and leaves that are so hairy that you could say they are furry. Others, near Glenwood, New Mexico could easily be mistaken for *Q. oblongifolia*. It is a common oak of the desert grasslands, chaparral and oak woodlands of the Chihuahuan Desert, becoming less common in the Transitional Pine Forest of central New Mexico at elevations above 8,400 feet. Gray oak can grow in a wide range of soil types, from heavy saline clays to gravel or sand conditions. It seems always to be a rapid grower under cultivated conditions. Gray oak is perhaps the most widespread oak species of the desert edge in New Mexico, occurring as far north as the Zuni, Sandia and Manzano Mountains and south into all the southern mountain ranges. In the Zunis it occurs with

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Michael Melendrez among the trunks of a large Q. grisea *in the Tularosa Mountains of New Mexico. Elevation 7,000 ft.*

Gambel oak and the hybrid called *Q.* x*undulata,* or wavy-leaf oak. The largest trees I have found that can be viewed from a car occur at Cloverdale Park in the extreme southwestern corner of New Mexico, where they reach 50 -70 feet tall and wide. If viewing this grove, please remember that this is private land — stay on the road bed. Leaves are elliptic to ovate, 3/4 to 2 inches long, blunt or short-pointed at apex, rounded or slightly heart-shaped at the base, edges without teeth (except with young seedlings) or with a few teeth toward the apex, thin and firm, gray-green or blue-green, shiny and sparsely hairy above, beneath densely hairy. Bark is fissured and with shaggy plates, light gray.

9. *Q. havardii* - Havard shin oak

Also known as scrub oak, shinnery oak, and sand oak.

Description: A shrub to six feet tall, characteristic of the deep sands and sandy grasslands around the eastern borders of the Chihuahuan Desert in New Mexico, Texas and into Oklahoma. This is a true grassland oak, spreading by extensive rhizomes forming the largest continuous oak "forests" in the western half of the United States. When planted in a soil of decomposed granitic clays, it grows rapidly into a 15-foot tree with little rhizome habit. Of interest are the large, sweet, annual acorns.

10. *Q. hinckleyi* - Hinckley oak

Description: A rare, endangered species of limestone soils in Presidio County, Texas. This small oak, growing to only 3-5 feet tall, is known from only a few locations in the United States, but is believed to be in Mexico also. It is evergreen, spreads underground, and forms thickets on some of the most awful, dry, hot, sloped areas you will ever see in the Southwest. It is an oak of the true desert scrub formation. Leaves are much like those of *Q. turbinella,* with sharp spine-tipped lobes.

Guy Sternberg picking seed of Q. hinckleyi *(a federally endangered species) near Shafter, Texas. Elevation 4,100 ft.*

11. *Q. intricata* - Coahuila scrub oak

Description: A thicket-forming oak to 10 feet tall under cultivation, with small evergreen leaves having silvery indumentum on the underside. It is a part of the chaparral and the oak woodlands formation. Found in Texas at the Laguna Meadows of the Chisos Mountains and in the Eagle Mountains in Hudspeth County.

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12. *Q. laceyi* (often confused with *Q. glaucoides*) - Lacey oak

Description: A beautiful oak to 25 feet tall with blue-green deciduous leaves. Fall color is a smokey pink with some orange and yellows. A rather rare tree found in the chaparral, grama grasslands, canyon scrub of Texas, and temperate areas of northern Mexico. In the Trans-Pecos Region it is found on hard limestone in Terrell County, in the left-land shut-up of the Solitario and in Mouse Canyon in the Chisos Mountains of Big Bend National Park. In New Mexico there are Lacey-like oaks growing in the south-central mountains that look like non-evergreen Mexican blue oaks. This may be the case with some of the so-called Mexican blue oaks reported to be in Texas. Lacey oak grows well for us in a heavy clay soil, adding two feet or more in height each year. Some fine examples of it can be viewed at the Living Desert Museum in Carlsbad, New Mexico where it grows rapidly into a fine tree. It has high heat and drought tolerance, and is perhaps the best of all the southwestern oaks for landscape use.

13. *Q. macrocarpa* - bur oak

This species is a rare find in New Mexico, with a relict population occurring near the same area that *Q. fusiformis* can be found.

Description: Bur oak is more often found as a large deciduous tree of eastern and mid-western savannas. In eastern New Mexico it is found in shin oak savanna swells called buffalo wallows. This is a large, fast-growing tree with spectacular leaves of over 12 inches in length. In the Roswell, New Mexico area there are examples of this plant growing in yards of long abandoned homesteads, where the only water is from the natural precipitation of less then 10 inches per year. I suspect these plants were collected from nearby relict stands, giving them the natural adaptation for this high desert climate. If this is not a low-water tree, then I don't know what is!

14. *Q. mohriana* - Mohr oak

Description: A tree to 40 feet tall, characteristic of the grasslands and montane chaparral of the limestone soils of Texas and New Mexico. This is a thicket former and is one of the more widespread of the Chihuahuan Desert oaks in the Trans-Pecos. Leaves are tardily deciduous, gray on top and much lighter on the underside, close to those of the gray oak. Benny Simpson, the famous oak expert from Texas A&M University, felt that Mohr oak was worthy of cultivation as an amenity plant and should be used

more widely. I'm not sure its been used at all, at least on purpose, but it may have useful applications in high and dry landscapes of the desert edge. Where Mohr oak and Havard shin oak grow adjacent to each other, a common hybrid occurs that forms a 20-foot grove which is useful as a wildlife shelterbelt or as a windbreak. Examples of this hybrid can be seen off Interstate Route 40 from Shamrock, Texas heading into western Oklahoma, in areas of deep sand.

15. *Q. muhlenbergii* - chinquapin oak

Description: This is a tree growing to 60 feet tall in the Chihuahuan Desert, but much larger in the more humid areas to the east. This is one of America's most regal oaks, and seed from this desert provenance should be widely planted in Arizona, New Mexico and western Texas.
Distribution: In our area it is a tree of the oak woodlands and montane chaparral, and it has the broadest natural geographic and habitat range of any of the Temperate-Zone oaks of the United States. Chinquapin oak ranges in the United States from northwestern Florida north to Vermont, west to Wisconsin and Iowa, and South to Texas. It is very rare and local in mountain canyons of southeastern and south central New Mexico, bordering the eastern plains. In New Mexico this species is found growing in the Capitan and Guadulupe Mountains associated with the bigtooth maple, alligator juniper, sandpaper oak, and sotol. Its elevation range in New Mexico is from 4,000 feet up to 7,000 feet, with a precipitation range of 12 - 18 inches per year. It is not found in Arizona, but can be found in small numbers in the Davis Mountains and the Chisos Mountains of West Texas. It is noteworthy because of its unusual distribution and isolated New Mexico localities westward of the limits of continuous distribution in western Oklahoma and central Texas. Leaves are oblong or broadly lance-shaped, 3 to 10 inches long and 1 to 6 inches wide, short or long-pointed, usually rounded at the base; edges wavy to slightly lobed with curved teeth, dark glossy green above, paler and finely hairy beneath. Acorn 1/2 to 1 1/4 inches long, oblong, half enclosed by a deep cup, dark chocolate brown. Bark thin, fissured and flaking on stems greater then 3 inches in diameter, light gray to a creamy white.

16. *Q. oblongifolia* - Mexican blue oak

Description: A small tree to 30 feet with trunks up to 1.5 feet in diameter and with a spreading, rounded crown, or a shrub at higher elevations.

Distribution: In Arizona and in New Mexico this oak is a part of the canyon desert scrub-grassland formation, as well as the montane chaparral and oak woodlands associations. In the low-elevation mountains of extreme southwestern New Mexico (the Gray Ranch area of the New Mexico panhandle) this is a common oak of the Coronado National Forest from 4,500 feet to 6,000 feet

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in elevation. It also occurs in the northern Mexico states of Chihuahua and Sonora. This is a confusing tree in Texas because few of the major floras listed it. Yet Sargent described it in 1905 as being in the Chisos Mountains of western Texas, but comparatively rare in this area.

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Author Michael Melendrez stands under a large Q. organensis *in the arroyo below Dripping Springs, in the Organ Mountains of southern New Mexico. Elevation 6,100 ft.*

It has been reported in the Bofecillos Mountains of Texas which are adjacent to the Chisos. The only oaks that I've seen in the Bofecillos or the Chisos that look like Mexican blue oak are in fact Lacey oaks, which are not evergreen. Large examples of this oak can be found at Cloverdale, New Mexico, with some trees growing up to 70 feet tall. Leaves are oblong, 1-2 inches long, rounded at both ends or heart-shaped at the base, edges without teeth (except on fast-growing juvenile growth), thin and firm, without hairs, blue-green in summer and turning more blue during winter months. The bark is unique among all the western white oaks, with small, fissured, square plates, and is light gray in color.

17. *Q. organensis* (*Q.* x*organensis*?) - Organ Mountain white oak

See *Q. polymorpha* below. Found growing in only one small population on the west slope of the Organ Mountains east of Las Cruces, New Mexico. In the wild, the parent plants have large evergreen leaves (up to 5 inches x 2 inches), smaller than those of the Mexican *Q. polymorpha,* but much larger then either the Arizona white oak (*Q. arizonica*) or gray oak (*Q. grisea*). It has been suggested that it is a natural hybrid of *Q. arizonica* x *Q. grisea*, but our work in propagating it suggests the progeny are more similar to *Q. polymorpha*. Unlike most other oak hybrids, the Organ Mountain white oak is very stable, with the progeny holding true.

18. *Q. polymorpha* - Monterrey white oak

This is a newly discovered oak for the United States and the Chihuahuan Desert at Dolan Falls, Texas.

Description: A tree to 70 feet tall with irregular crown. Leaves are evergreen to tardily deciduous, large, glossy above,

rusty floccose beneath. Distribution: a wide distribution in Mexico, and south to Guatemala. Found in Val Verde County, Texas in only one location thus far, near Dolan Falls on the Dolan Falls property of the Texas Nature Conservancy. There are three large trees that appear pure and several up and down a rocky creek that could be hybrids. Young, vigorous growing trees in our nursery resemble an evergreen chinquapin oak, but with a more hooded, waxy leaf. Seedlings of the Organ Mountain white oak look identical to *Q. polymorpha* seedlings of equal age and treatment, even without rapid juvenile growth. Organ Mountain white oak (*Q. organensis*) often has been considered a hybrid of *Q. arizonica* and *Q. grisea*, but the progeny, when given equal treatment with *Q. polymorpha*, suggest to me that it may not be a hybrid of those species, or a hybrid at all.

19. *Q. pungens* var. *pungens* - sandpaper oak

This is a tree sometimes reaching 20 feet tall, but usually a shrub, much lower and thicket forming. The evergreen to sub-evergreen leaves are small, undulate, crisped, with mucronate tips and a definite sandpaper feeling, and with a blue-gray cast. This is a shrub-tree of the desert scrub, canyon scrub and montane chaparral associations. It is thicket forming in the grassland and chaparral. The easiest place to see sandpaper oak is to the left of the entrance to the Lincoln National Forest on New Mexico Route 137 out of Carlsbad. Fall color can be a crimson red that is long lasting. This could be one of the most ornamental high desert trees for the smaller landscapes of cities.

20. *Q. pungens* var. *vaseyana* (synonym *Q. vaseyana*) - Vasey oak

A tree to almost 50 feet, but usually a thicket-forming shrub. Seen in its purest form on the Edwards Plateau and entering the Chihuahuan Desert in Terrell, Crockett and Val Verde counties, Texas, it intergrades with sandpaper oak, especially in Brewster County and Eddy County, New Mexico. The leaves of Vasey oak are not rough like sandpaper, are not nearly as pungently crisped, and are a bright, pea green. Like sandpaper oak its leaves are tardily deciduous, and both species give the appearance of small holly (*Ilex*) trees, not oaks. The Eddy County, New Mexico population of this species will turn a bright crimson late-Fall color it holds all winter. In the lower Blue Creek Canyon of the Chisos Mountains, Vasey oak is seen in pure form weeping over the dry stream bed at 4,500 – 5,000 feet elevation, looking somewhat like a white-oak version of *Q. graciliformis*, which is nearby. Vasey oak is a member of the grasslands, desert scrub, and oak woodlands associations, and is not found in Arizona.

21. *Q. rugosa* - netleaf oak (synonyms: *Q. reticulata* and *Q. diversicolor*)

Description: An evergreen tree to 40

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feet tall with a broad, rounded crown, or a shrub. Leaves are beautiful and rugose, obovate, elliptic, gray-green to bright green. This species can vary quite a lot in the size and shape of the leaves, from a large *Q. polymorpha*-like form, to a small *Q. turbinella*-like form, but without mucronate lobes.

Distribution: An oak of the montane chaparral and oak woodlands at relatively high elevations. It is a rare oak in Texas, but more commonly in the Black Range, Diablo Mountain and the Mogollons of the Gila National Forest of New Mexico and found in all the southeastern mountains of Arizona bordering New Mexico. Acorns are attached to long peduncles. The bark of the netleaf oak is similar to that of the chinquapin oak, with a flaking habit on small branches. *Q. rugosa* may be the most ornamental small evergreen tree in the Southwest, with the potential of being used into USDA Zone 5 of the Midwest. Netleaf oak shares with chinquapin oak the ability to grow well in heavy, moist clay soils of high pH.

22. *Q. toumeyi* - Toumey oak

Description: A tree or shrub up to 30 feet tall. Leaves are small, entire, ovate, and evergreen. Acorns 1/2 to 3/4 inch long, with shallow cups. Bark thin, scaly or flaky, dark brown.

Distribution: 4,000 to 7,000 feet elevation, Mexican Border region, found in the montane chaparral and oak woodlands associations of Arizona and New Mexico. In Arizona it forms an open forest on the Mule Mountains in Cochise County and in Texas Canyon east of Benson; in New Mexico, in the chaparral and oak woodlands of the Peloncillo Mountains in Hidalgo County. I have not seen it in Texas but Cornelius Muller placed it in the Franklin Mountains and the Quitman Mountains. Richard Spellenberg has reviewed those specimens from the Franklins, and does not concur. Van Devender and Riskind found *Q. toumeyi* debris to be very common to abundant in packrat middens at Hueco Tanks State Park, dating back to the late Pleistocene to early Holocene, 13,000-8,000 BP.

23. *Q. turbinella* - scrub live oak

Description: An evergreen shrub to a small tree of 15 feet, with some exceptional trees reaching 30-35 feet. Scrub live oak is an attractive small oak, and one that people in the Southwest are more familiar with because it's found closer to Albuquerque and El Paso than other native oaks. Leaves are small, elliptic or oblong, one-half to one inch long, short-pointed, edges with spine-like teeth, thick and stiff, above blue-green with a bloom and

nearly hairless, beneath yellowish green and finely hairy.

Distribution: Lowest elevation occurrence: Organ Mountains at 5,000 feet, Sandia Mountains at 5,700 feet, Gila National Forest at 4,400 feet. It is common in the chaparral and oak woodlands of Arizona and New Mexico. A fine location for viewing this species is on the west slope of the Sandia Mountains (outside of Albuquerque) on the Juan Tabo picnic grounds road. In Texas its greatest occurrence is in the Franklin Mountains, but it can also be found in the Eagle and Quitman Mountains of Hudspeth County. It should be used much more widely in the Chihuahuan Desert and in other areas where drought tolerance is sought. It may be the hardiest of the evergreen oaks in cold winter areas.

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An old treehouse built in a Q. emoryi *located in Glenwood, New Mexico serves as a perch for author Michael Melendrez.*

BLACK OAKS or RED OAKS
(Section *Lobatae*, or Subgenus *Erythrobalanus*)

Bark black and furrowed, leaves, if lobed, with bristle (aristate) tips, wood without tyloses. Acorns take two years to mature (except for *Q. emoryi* and *Q. canbyi*, that mature the first year, and *Q. hypoleucoides*, which mature either the first or second year), acorn cups tomentose inside, acorns quite bitter compared to white oaks (except for those of *Q. emoryi*, which are sweet). It has been said that red oaks in general are not as drought resistant as the white oaks, although some claim the reverse is true.

24. *Q. canbyi* - Canby oak

This species of red oak is found at high elevations in the mountains of northeastern Mexico. It looks a lot like the Langtry oak and the graceful oak (*Q. graciliformis*). The acorns mature in one season. We have a specimen that was grown from an 8,000-foot provenance, and it is performing well at our arboretum. With rapid growth adding about 4 to 5 feet each summer, and the last flush of growth taking place in late September, it still seems to harden up enough for the first hard frost of October. It is semi-evergreen here and gives a maroon winter color that can last for months. It is reported to grow well on soils of alkaline limestone origin.

25. *Q. emoryi* - Emory oak

Also called bellota (acorn) oak, black-jack oak and black oak.

Description: A tree typically 40 to 60 feet tall, except in western New Mexico where specimens can be found up to 100

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feet tall and with trunks over 7 feet in diameter. Large trees look much like the southern live oak of the Southeast, with large horizontal branches swooping down to the ground, but with taller, domed crowns reaching as high as 100 feet. A typical large specimen may reach 60 feet tall by 100 feet wide. I've counted over 600 annual rings on some branch cuts that are 4 feet in diameter. This slow growth is a result of the aridity of this region. Leaves are evergreen to tardily deciduous, dark green, holly-like, sometimes entire or with heavily toothed tips. Acorns are produced annually and are sweet; they can be eaten out of hand and are valued food of the Apache people and a favorite food of all wildlife. I've planted this species at 8000 feet elevation near Chama, New Mexico at our high elevation test plot (winter temperatures = USDA Zone 4), and it seems to be doing well, remaining evergreen.

Little is known of the cultural needs of this plant and what can be done to speed up its growth. In the wild it can be found

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Melendrez sits in the fork of Q. emoryi *near Glenwood, New Mexico. Elevation 5,000 ft. This specimen is 18 feet in circumference, and may become the new national champion for this particular species.*

in a wide arrangement of soils or rock types, from fine alluvial fills to gravel and cobble arroyos, limestone to granite, and sandstone hilltops that are excessively draining with no topsoil development. The potential is there for an excellent large tree for the high and dry landscapes of the Southwest and West Coast.

Distribution: Occurring in Catron, Dona Ana, Hidalgo, Luna and Sierra Counties, New Mexico, in open desert scrub/grassland sites starting at 4,000 feet elevation and extending up into the canyons of the montane chaparral and oak woodlands above 6000 feet elevation. Emory Oak is common in Arizona, southwestern New Mexico, and Trans-Pecos Texas from 4000 to 6500 feet elevation. In the Chisos Mountains of Big Bend National Park this tree apparently has hybridized with the Chisos red oak (*Q. gravesii*), giving us *Q.* x*robusta*, a tree with larger leaves then the typical Emory oak and similar to the oracle oak of California.

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and Lamb in *Oaks of North America*. This oak is found in canyons or mountain slopes in montane chaparral and oak woodland at about 5,000 feet or higher in the Chisos, Del Norte and Glass Mountains, in Brewster County, Texas. Also in the Davis and Vieja Mountains, in Jeff Davis County; in the Madera Mountains, in Pecos County; and perhaps in Val Verde County. Chisos red oak can be found on both igneous and limestone soils, and trees from each edaphic provenance do well at the Texas Agricultural Research and Extension Center at Dallas.

28. *Q. hypoleucoides* - silverleaf oak
Also called white-leaf oak.
(synonym: *Q. hypoleuca*)

Description: A small to medium tree 35-40 feet in height, with some exceptional trees in the Gila Wilderness being over 80 feet tall. Trunks in the deep canyons of the Gila can be single stem, with clear boles of 30 feet or more and diameters of 3 to 5 feet. It is sometimes a clump-forming shrub 6 to 20 feet tall on dry, south-facing scree slopes. Leaves are lance- to willow-shaped and evergreen, to 1 inch wide and 4 inches long. Leaf edges are revolute (rolled under), and the blades are smooth, blue-green on top and silvery tomentose on the undersides. Acorns are annual (or sometimes biennial), 1/2 to 3/4 inch long, pointed, one-third enclosed in a thick cup that is hairy inside, and colored a light grayish green when ripe.

Distribution: A beautiful oak of the high canyons in the oak woodlands, generally above 7,000 feet, in southeastern Arizona and southwestern New Mexico, but found as low as 4,000 feet and as high as 9,000 feet in New Mexico. Found in Texas only in the Davis Mountains of the Trans-Pecos region.

29. *Q.* (x?) sp.- Langtry red oak

This is a controversial evergreen red oak to about 50 feet tall, found in the head canyons of the Rio Grande River just below the confluence of the Pecos River. When Major Emory did the Mexican boundary survey in the early 19th century, this oak was found in at least one head canyon of the Rio Grande and was reported as *Q. coccinea* var. *microcarpa*. Cornelius Muller said this specimen is clearly representative of *Q. gravesii*, and he postulated that it was probably collected in the mountains farther west. After over 100 years, the oak was found again, and Muller once again tentatively identified it as *Q. gravesii*. However, after growing this oak out in New Mexico and seeing it at the Texas Agricultural Experiment Station at Dallas, it appears to be a completely different species. International

Oak Society member Pat McNeal of McNeal Growers feels that there are several populations of oak that all could be Langtry oaks. Pat has probably seen more examples of this oak (in the wild and under cultivation) then anyone else alive, and feels it is unique when compared to the other red oaks of the region. I trust Pat and accept his opinion that the Langtry oak is a distinct species and not just a hybrid.

GOLDEN OAKS

Section *Protobalanus* (formerly subgenus *Protobalanus*)

30. *Q. chrysolepis* - canyon live oak

Native to the mountains of California, Arizona and southwestern New Mexico, this species is variable in form, size and leaf.

Description: Evergreen shrub to large tree, growing up to 50 feet or taller in the mountains of California but usually a small tree to 25 feet in the Southwest. It can have a tall, pole-like structure with strong apical dominance and short horizontal branches. Larger trees in California may be multi-trunked with a wide spreading, massive structure. Leaves are entire on most mature trees, ovate, 1 to 2 inches long, blunt or short-pointed at the apex, firm, with a dark, shinny green surface and light whitish-green underside. On seedlings or rapid growing juvenile trees, the leaves can be spiny toothed much like the Palmer oak. Acorns are 5/8 to 1 1/2 inches long, broad, maturing in 2 years. The large cup is a spreading, turban-like cap sometimes reaching 1/4 inch or more out from the acorn surface. The inside surface of the cup is covered with a fine golden coat of hairs. The bark is fissured into narrow scales and flakes, gray or dark gray.

Distribution: Q. chrysolepis grows from the coastal and transverse mountains of California into the southwestern mountains of New Mexico in Catron and Grant Counties. It is never common in southeastern Arizona or New Mexico, but can be found easily in California, in areas as cold as the north shore of Lake Tahoe near the Cal-Neva Hotel. In canyons and on mountainsides it often forms low-growing thickets or woodlands, from elevation 3,500 up to 7,000 feet.

31. *Q. palmeri* - Palmer oak

Also called the Canyon live oak.

(*Q. chrysolepis* var. *palmeri*, *Q. dunnii*)

Description: An evergreen shrub or small tree, usually 6 to 25 feet tall and up to 6 to 10 inches in trunk diameter, with a dense, bushy, wide-spreading crown. Leaves are spiny-toothed, elliptic to ovate, 1 to 2 inches long, edges crisp and leathery, shiny yellow-green to dark green above and slightly yellowish to white beneath. Acorns are 5/8 to 1 inch long, broad, maturing in the second year. The

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cup is spreading (but not as turban shaped as that of the canyon live oak), with fine golden hairs covering the inside.

Distribution: Canyons and mountainsides of the Southwest, elevations 3,500 to 6,000 feet; New Mexico in Catron, Hidalgo, Grant, Luna and Sierra Counties; Arizona in the mountains of southeastern and central parts; south and west of the Mogollon Rim. Also found in southern Nevada, southwestern Utah and southern California. Palmer oak has spiny, evergreen leaves resembling the juvenile foliage of the canyon live oak and spiny forms of the holly oak (*Q. ilex*) of Spain. All three can display entire leaf margins with slower growth at maturity. Under nursery cultivation, they easily can be confused. All can be rapid growers under cultivation, adding 3 feet or more each year.

Quercus rotundifolia Lam. and its forms in Extremadura, Spain

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A total of eight ecotypes of Quercus rotundifolia *occurring in Extremadura, Spain, are described. The differences between them are based on the external morphological characteristics of the fruits. Also included is a key to the identification of the different forms and a description of each one, including its distribution within the region.*

Key words: Quercus rotundifolia, ecotype, acorn, cupule, form, Extremadura, distribution

Because of the large interest in keeping pigs in Extremadura, Spain, the dehesa ecosystem is based on making use of the fruits of local trees. During 1988, a project was carried out to identify the most notable characteristics of the fruits of the oaks. Initially the project was only de-

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Quercus rotundifolia *as seen in southern France.*

signed to make an illustrated catalogue of the fruits to show their shape, size, color and weight. However, ecotypes were detected that clearly defined different types of trees.

According to the data obtained through fieldwork, the morphological characters studied in the laboratory, and the literature consulted, the existence of a group of ecotypes was discovered, which are perfectly differentiated by the external morphology of their fruits.

The main part of this work concerns the infraspecific taxa of *Quercus rotundifolia* Lam. in Extremadura, and shows the characteristics which differentiate them and their distribution. A key to distinguish the different taxa is also included.

Methodology

The method of study was based on the collection of material in Extremadura according to the National Forestry Inventory in Extremadura and aerial photographs (1984) existing in the Agricultural Research Service. Collections were made between April 1988 and June 1990. Some specimens of f. *pilosella* were collected between 1995 and 1997. Branches bearing leaves and inflorescences were collected from 10-25 trees at each locality. This material was pressed, dried, and then studied in the laboratory. Data on leaf morphology and stem and flower characteristics were recorded. Whole fruits (cupule and acorn) were collected and weighed fresh and dry after 24 hours at 100°C, and data on their weight and morphology were recorded. Tables of the characters were made from the data and a description was made for each of the variants found. These were then compared with descriptions in the literature.

Results

The official description of the species includes the following.

Q. rotundifolia Lam., Encycl. 1: 723 (1785)
Q. ballota Desf., Observ. Phys. 38: 375, pl. 1 (1791).

Q. ilex L. subsp. *ballota* (Desf.) Samp., Bol. Soc. Brot. 24: 102 (1908-1909).
Q. ilex subsp. *smilax* (L.) C. Vicioso., Rev. Gén. Quercus España 166 (1950).
Q. ilex sensu Brotero, Fl. Lusit. 2: 33 (1804); B. Gomes, Cond. Florest. Port. 60 (1876); Laguna, Fl. Forest. Esp. 1: 252 (1883); P. Coutinho, Bol. Soc. Brot, 6: 94 (1888).
Q. ilex susbp. *rotundifolia* (Lam.) O. Schwarz ex Tab. Morais, Bol. Soc. Brot. Ser. 2, 14: 122 (1940).

Tree to 20 m tall with an erect, cylindrical trunk, grey bark, broken into small plates and a broad, rounded head, often modified by pruning. Young shoots densely stellate-tomentose. Buds small, ovoid, obtuse with oval scales, brownish tomentose. Stipules caducous. (Vicioso, 1950; Schwarz, O., 1964. *Quercus* L. in Tutin et al., 1969; Valdés, 1987). Leaves 1-5 x 1.5-3.5 cm, petiole 3-14 mm, coriaceous, persistent, pale green when young, grey-hairy on both sides; adult leaves with upper surface green, glabrous, white-tomentose beneath, very variable in shape even on the same tree; ovate-lanceolate, elliptic, somewhat orbicular, ovate-rounded, acute or obtuse at the apex, rounded to cuneate or attenuate at the base, entire or dentate, sometimes slightly mucronate; juvenile leaves usually with spiny teeth on their margins. Secondary veins in 5-8 pairs. Male flowers in dense or somewhat lax yellow catkins, 3-6 cm long with a tomentose rachis, and hairy, lanceolate-acute bracts; perianth with 3-5 broad, obtuse lobes, stamens with mucronate anthers. Female flowers solitary or in clusters of up to 4, on pubescent pedicels, perianth with 6 hairy lobes. Stigmas commonly 3, occasionally 4. (Maire, 1961).

Fruits solitary or clustered, sessile or on a tomentose peduncle to 1.5 cm; cupules grey, tomentose, hemispherical or somewhat attenuate at the base, 0.5-2.5 cm across, more or less covering part of the acorn; scales adpressed, flat or slightly thickened, ovate-triangular, obtuse, narrowed to the base on the proximal part of the cupule where they are lanceolate to somewhat acute. Acorns very variable, ovoid, ovoid-oblong, oblong-cylindric, or subglobose, 11-50 mm long, 12-22 mm diam. With a tomentose endocarp and weighing 0.2-8 g when mature and dry. Flowering February to May, fruits maturing from October to November the same year.

General distribution: It is distributed from Portugal and Spain to southern France, and North Africa.

Peninsular distribution - The Iberian Peninsula is where it finds its ecological optimum and it occurs over all the territory. It is generally the dominant tree in forests less than 1,000 m in elevation. It is also found in parts of the South of France and in some parts of the Cordillera Cantabrica, the Pyrenees and Cataluña.

Distribution in Extremadura - In

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Quercus rotundifolia . . .

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Extremadura it is widely distributed, but is absent from some parts of the North and South where it is replaced by *Q. pyrenaica* Willd. in the highest and coldest areas; elsewhere it occurs in the shady and acidic zones in the Sierra de San Pedro and Jerez de los Caballeros with *Q. suber* L. It is threatened by deforestation in La Serena, Tierra de Barros, Llanos de Cáceres and Vegas del Guadiana. Sometimes it appears mixed with some individuals of *Q. coccifera* L. in calcareous areas, and very locally with *Q. faginea* L., mainly in south and central Badajoz (Tentudía, Jerez de los Caballeros and Tierra de Barros), and south and central Cáceres (Villuercas, Monfragüe and Alcántara).

Forms of *Q. rotundifolia*

Based on the data collected, eight forms or taxa of *Quercus rotundifolia* were identified. They are listed below:

f. *rotundifolia*
f. *brevicupulata*
f. *avellaniformis*
f. *expansa*
f. *crassicupulata*
f. *calcyna*
f. *macrocarpa*
f. *pilosella*

The following key was developed to differentiate among these eight taxa. It is based entirely on characteristics of the fruit.

1. Pericarp pubescent in the apical 1/3 ..... f. ***pilosella***
1. Pericarp glabrous or only pubescent at the acute apex 2
2. Acorns less than 15 mm long, not or hardly exserted from the cupule ..... f. ***avellaniformis***
2. Acorns more than 20 mm long, clearly exserted from the cupule 3
3. Cupules less than 16 mm long 4
3. Cupules more than 16 mm long 6
4. Cupules less than 8 mm long, cup-shaped, floral peduncles short, less than 0.5 mm..... f. ***brevicupulata***
4. Cupules more than 10 mm long, hemispherical, peduncles of variable length, sometimes more than 1 cm 5
5. Acorns at least 3 times as long as broad, cupules somewhat thickened and hazelnut-shaped, with a small ring in the lower part ..... f. ***crassicupulata***
5. Acorns less than 3 times as long as wide, very variable in shape, cupules hemispherical, truncate, rounded or somewhat acute at the base, without a ring in the lower part ..... f. ***rotundifolia***
6. Cupule broad, bell-shaped, thickened and folded at the margin which resembles a ring .....f. ***expansa***
6. Cupule broad or narrow, sometimes

bell-shaped but with the margin smooth, not thickened 7
7. Acorns up to 37 mm long and 15 mm across, with cupules covering at least 2/3 of their length, turbinate at the base ..... f. ***calcyna***
7. Acorns more than 39 mm long and 19 mm across, with hemispherical cupules truncate or somewhat rounded at the base and covering at most 1/3 of the length of the acorn .....f. ***macrocarpa***

Descriptions follow of the various forms mentioned in the diagnostic key. Synonyms are included for each of the forms recognized, as well as drawings to show differentiating characters useful to separate one form from another.

Q. rotundifolia Lam. f. ***rotundifolia***

Q. ballota var. *parviflora* Colmeiro & E. Boutelou, Exam. Encin. 10 (1854).
Q. ballota var. *obovatifolia* Colmeiro & E. Boutelou, Exam. Encin. 10 (1854).
Q. ballota var. *grandifolia* Colmeiro & E. Boutelou, Exam. Encin. 10 (1854).
Q. ballota var. *mascula* Colmeiro & E. Boutelou, Exam. Encin. 10 (1854).
Q. ilex f. *oleifolia* Laguna, Fl. For. Esp., 1:255 (1883).
Q. ilex f. *microcarpa* Laguna, Fl. For. Esp., 1: 257 (1883).
Q. ilex var. *ballota* f. *vulgaris* Cout., Bol. Soc. Brot. 6: 94 (1888).
Q. ilex var. *ballota* f. *oleoides* Cout., Bol. Soc. Brot. 6: 94 (1888).
Q. ilex var. *ballota* f. *macrophylla* Maire, Fl. De L'Afrique du Nord. 7: 123 (1961).
Q. ilex var. *ballota* f. *microphylla* Maire, Fl. De L'Afrique du Nord. 7: 123 (1961).

Foliage and fruit of Q. rotundifolia *f.* rotundifolia.

Q. ilex var. *ballota* f. *laurifolia* Maire, Fl. De L'Afrique du Nord. 7: 123 (1961).
Q. ilex var. *ballota* f. *latifolia* Maire, Fl. De L'Afrique du Nord. 7: 122 (1961).
Q. ilex var. *ballota* f. *coutinhoi* Maire, Fl. De L'Afrique du Nord. 7: 123 (1961).
Q. ilex var. *ballota* f. *pendula* Maire, Fl. De L'Afrique du Nord. 7: 123 (1961).

Trees of very variable size and shape, hairiness of leaves, and in the habitats in which they are found. Cupules 9-15 mm long, hemispherical, somewhat cup-shaped, truncate or rounded at the base, 1 or 2 on each peduncle, bracts triangular-acute at the base, becoming linear towards the base of the cupule, flat, to-

contd. on pg. 44

Quercus rotundifolia . . .

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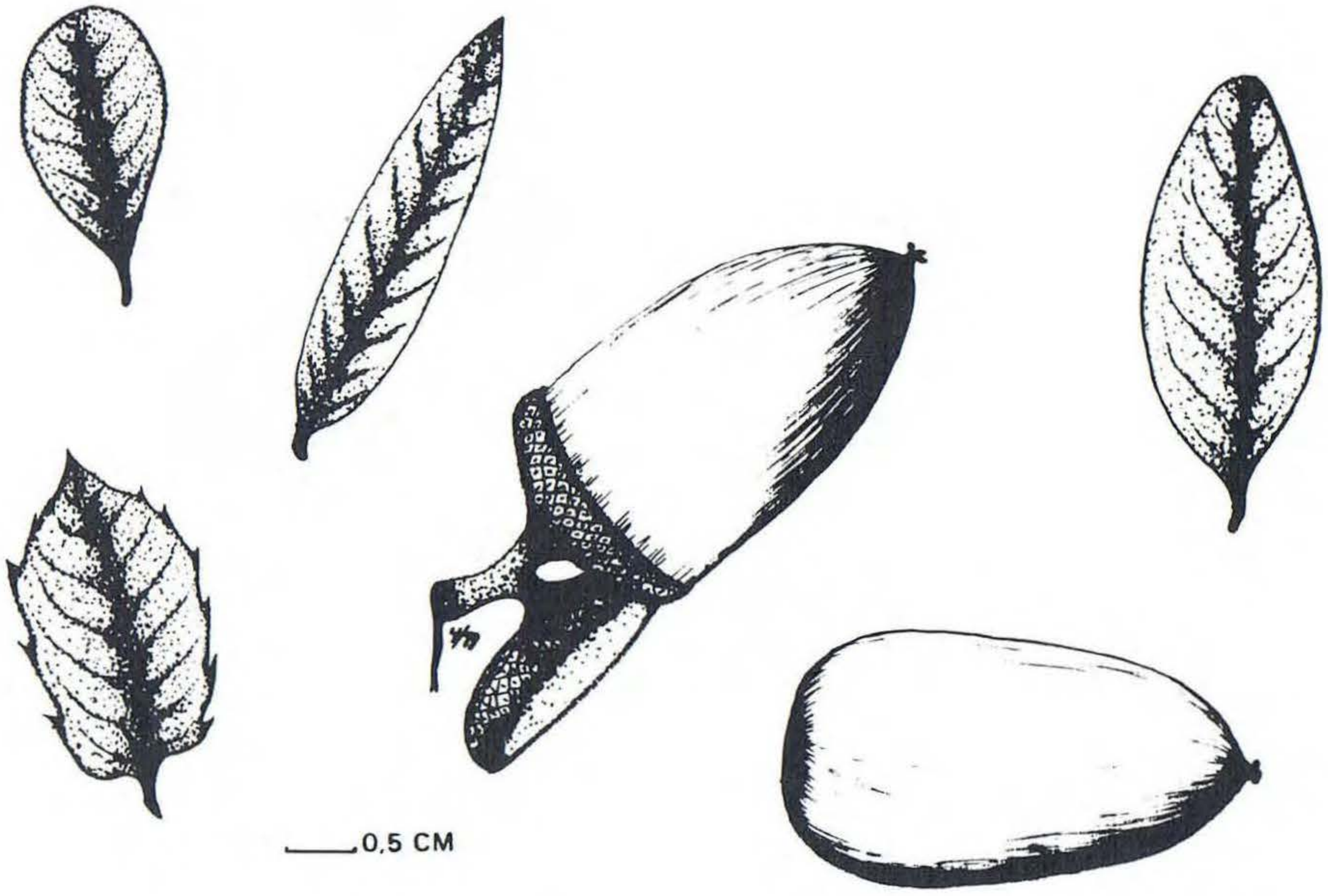


Foliage and fruit of Q. rotundifolia *f.* brevicupulata.

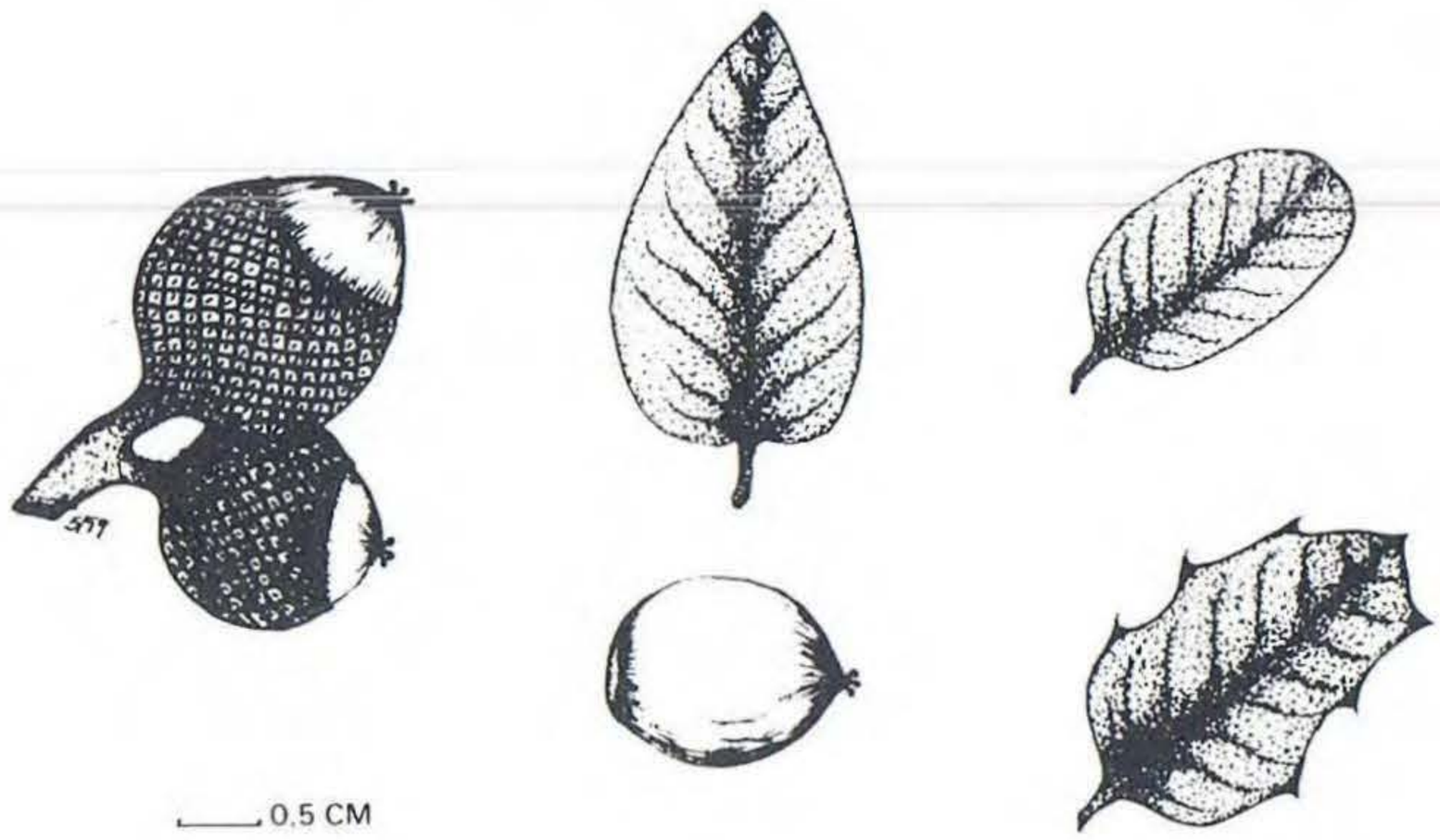
mentose. Leaves very variable in shape and size on the same tree. Acorns variable, 30-40 (45) mm long, 12-17 (20) mm across, 1/4-2/3 covered by the cupule. Weight 1.5-5 g when mature and dry. (Vicioso, 1950; Maire, 1961).

Distribution in Extremadura - Its distribution is the same as that given for the species. It is the form widely distributed and it is indifferent to soil and ecological conditions, occurring in the higher zones, planes, in sunny and shady sites on steep slopes etc.

Q. rotundifolia Lam. f. ***brevicupulata*** (Laguna) F.M. Vázquez, Semillas de Quercus: Biología, Ecología y Manejo, 83, 1998.
basionym: *Q. ilex* f. *brevicupulata* Laguna, Fl. For. Esp. 1, 256 (1883)
Q. ilex subsp. *smilax* C. Vicioso var. *brevicupulata* (Laguna) C. Vicioso, Rev.

Gen. Quercus España 172 (1950).

Tree of variable size found in many different habitats. Cupule cup-shaped, very broad, with an erect margin, without a ring, (15) 17-19 (21) x (5.0) 6.5-7.0 mm, on a short peduncle no more than 0.5 mm or sessile, with flat scales not thickened as in f. *macrocarpa*, closely adpressed, tomentose, triangular-acute. The cupule only covering the base of the acorn. Leaves oval to elliptic or orbicular, not useful for identification. The leaves can be spiny when juvenile, but then only weakly (Laguna, 1883). Acorns oblong, truncate at the base, 28-30 (34) x (15) 16-18 mm pale brown when dry (C. Vicioso, 1950). Weight 2-5 g when mature and dry.



Foliage and fruit of Q. rotundifolia *f.* avellaniformis.

Distribution in Extremadura - It is very widely distributed in the region, but still has not been found north of the area of Sierra de San Pedro and of Villuercas, or in the small areas of forest which are still present in Llerena and Tierra de Barros.

Q. rotundifolia Lam. f. ***avellaniformis*** (Colmeiro & E. Boutelou) F.M. Vázquez, Semillas de Quercus: Biología, Ecología y Manejo, 83, (1998).
basionym: *Q. avellaniformis* Colmeiro & E. Boutelou, Exam. Enc. 9 (1854)

Q. ilex var. *avellaniformis* (Colmeiro & E. Boutelou) Cout., Bol. Soc. Brot. 6, 95 (1888).

Large to small tree with thick bark and tomentose shoots; cupules (12) 13-14.5 (16) x 14.5-15.5 mm, peduncles 8-15 mm, bearing 1 or 2 fruits. Scales lanceolate, acute and adpressed, very tomentose. Cupule hemispherical, somewhat narrowed to the base where the scales are smaller and less tomentose (Colmeiro & Boutelou, 1854). Leaves weakly hairy when young, ovate, varying to subelliptic, entire, subobtuse, but juvenile leaves can be acute and spiny. Veins very prominent on the undersurface of the leaf. Acorn shaped like a hazel nut, very small, 12-14 (16) x (8.5) 9.5-10.5 mm, with a very sweet taste, almost completely covered by the cupule and difficult to extract from it (C. Vicioso, 1950). Weight

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Quercus rotundifolia . . .

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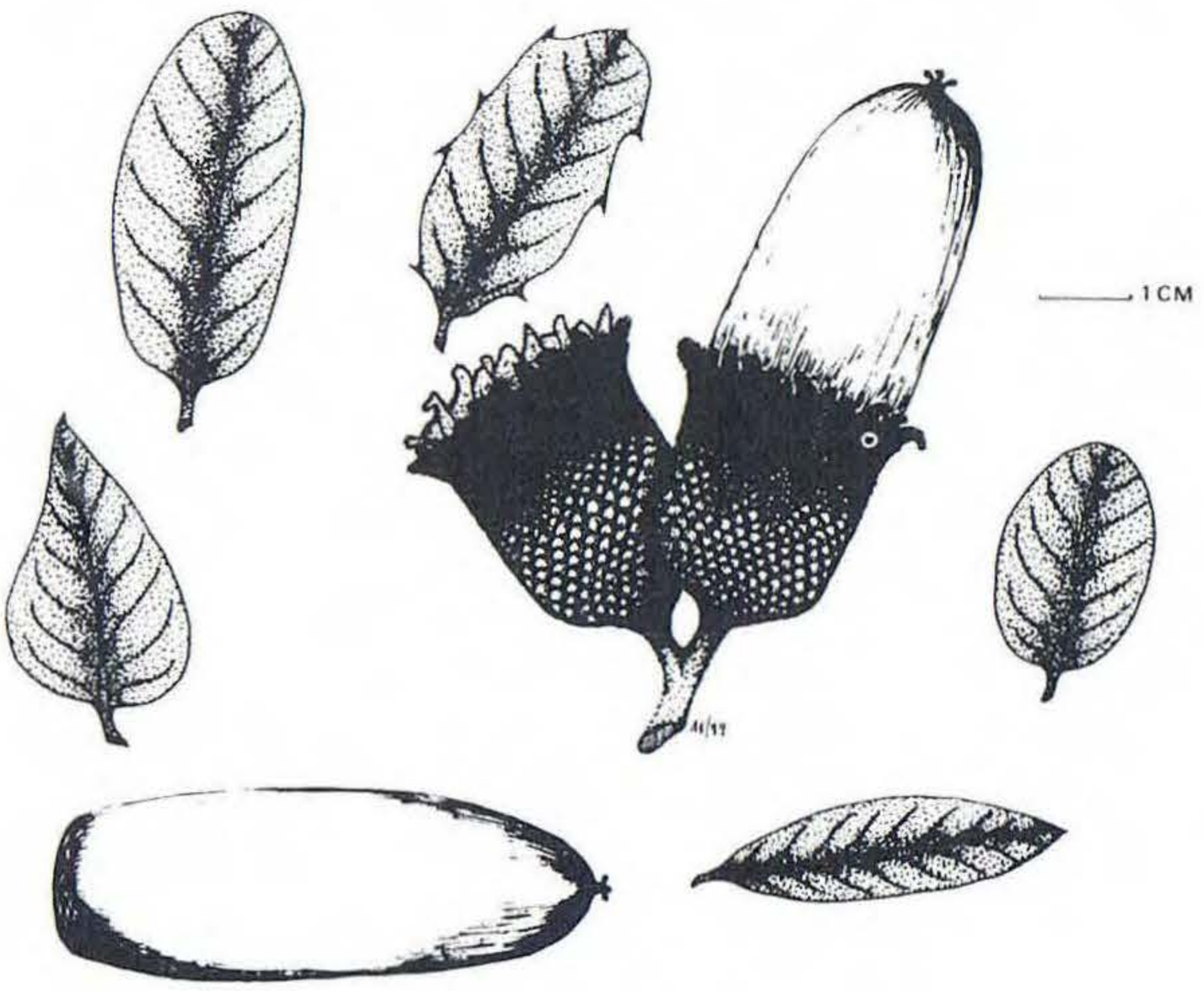
0.2-0.5 g when mature and dry.

Distribution in Extremadura - Very locally distributed. It has only been possible to find specimens in the South of Badajoz, always in places very close to Sierra Morena and in zones with a very high tree density. We agree with Coutinho (1888) in the distribution South of the Peninsula.

Q. rotundifolia Lam. f. ***expansa*** (Poir.) F.M. Vázquez, Semillas de Quercus: Biología, Ecología y Manejo, 83, (1998).
basionym: *Q. expansa* Poir., Encycl. Bot. Suppl. 2, 216 (1811)
Q. ilex f. *expansa* (Poir.) Laguna, Fl. For. Esp. 1: 256 (1883)
Q. ilex var. *expansa* (Poir.) A. Camus, Monogr. II, 57 (1939)
Q. ilex subsp. *smilax* C. Vicioso var. *expansa* (Poir.) C. Vicioso, Rev. Gen. Quercus España 171 (1950).

Trees differ from other forms in their cupules 16.5-20 x 18-19 (22) mm; broad and bell-shaped, the margin covered in folds giving it a more or less prominent ring-shaped appearance. Pedicels more than 1.5 mm long, of medium hairiness, with scales ovate-triangular but somewhat lanceolate towards the base of the cupule, always obtuse. Fruits in groups of 2-3 on the peduncle (Laguna, 1883).

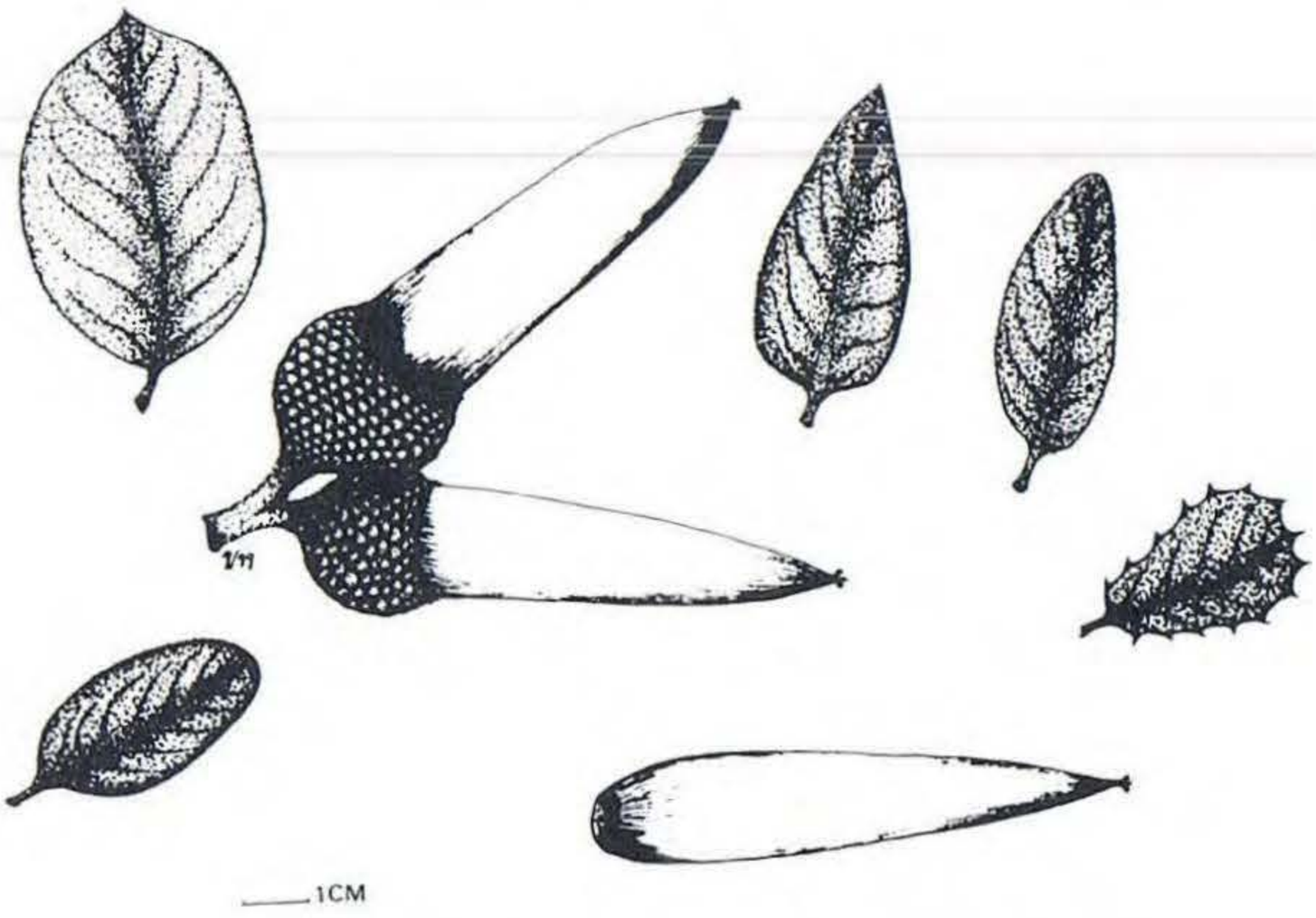


Foliage and fruit of Q. rotundifolia *f.* expansa.

The leaves show the general characteristics of the species and are very variable. Both ovate spiny and entire leaves are found in the juvenile and adult states. Acorns 33-40 x 14-16.5 mm, ovoid-cylindrical, slightly truncate at the base, 1/2 covered by the cupule, very sweet tasting. Weight 2.5-5.0 g when mature and dry (Vicioso, 1950).

Distribution in Extremadura - Examples have been found mainly

in the valleys of the Guadiana river and in some places close to Ciudad Real. It is a very localized plant with a distribution concentrated in the central forested zones in Extremadura.



Foliage and fruit of Q. rotundifolia *f.* crassicupulata.

Q. rotundifolia Lam. f. ***crassicupulata*** (Cout.) F.M. Vázquez, Semillas de Quercus: Biología, Ecología y Manejo, 83, (1998).

basionym: *Q. ilex* L. var. *ballota* f. *crassicupulata* Cout., Bol. Soc. Brot. 6, 95 (1888).

Q. rotundifolia f. *dolychocarpa* P. Silva, Broteira XII (XXXIX) Fasc. II 76-80 (1943)

As described by Pereira Coutinho (1888), this form has very large, thick fruits. It is also distinguished by its triangular-acute bracts, which are very adpressed and flat, but at the margin of the cupule they are lanceolate and obtuse, always tomentose. The shape of the cupule is somewhat angled, slightly hazel-nut shaped with a small ring in the basal part where the scales curve slightly inwards. The cupule is (10) 12-16 mm long and 12-14 (17) mm across and covers 1/5-1/6 of the acorn (Coutinho, 1888). The leaves, as in forms described above, are not useful for identification but show peculiarities in their variability such as: juvenile leaves spiny, mucronate, mature leaves lanceolate. Acorns oblong-lanceolate, attenuate at the base, very slender, (9) 10-11.5 x 32-37 (44) mm, more than 3 times as long as broad, ochre-coloured and of sweet taste, weight 1.5-3.5 g when mature and dry.

Distribution in Extremadura - It is distributed mainly in the central western part of the Autonomous Community, characteristically in densely wooded areas. Some individuals have been found in the Sierra de San Pedro, on the border with Portugal, and the center of Cáceres province.

Q. rotundifolia Lam. f. ***calcyna*** (Poir.) F.M. Vázquez et al., comb. et stat. nov.

basionym: *Q. calcyna* Poir., Encycl. Bot. Suppl. 2, 216 (1811).

Q. ilex L. subsp. *smilax* (L.) C. Vicioso var. *dolichocalyx* C. Vicioso, Rev. Gen. Quercus España 170 (1950).

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Quercus rotundifolia . . .

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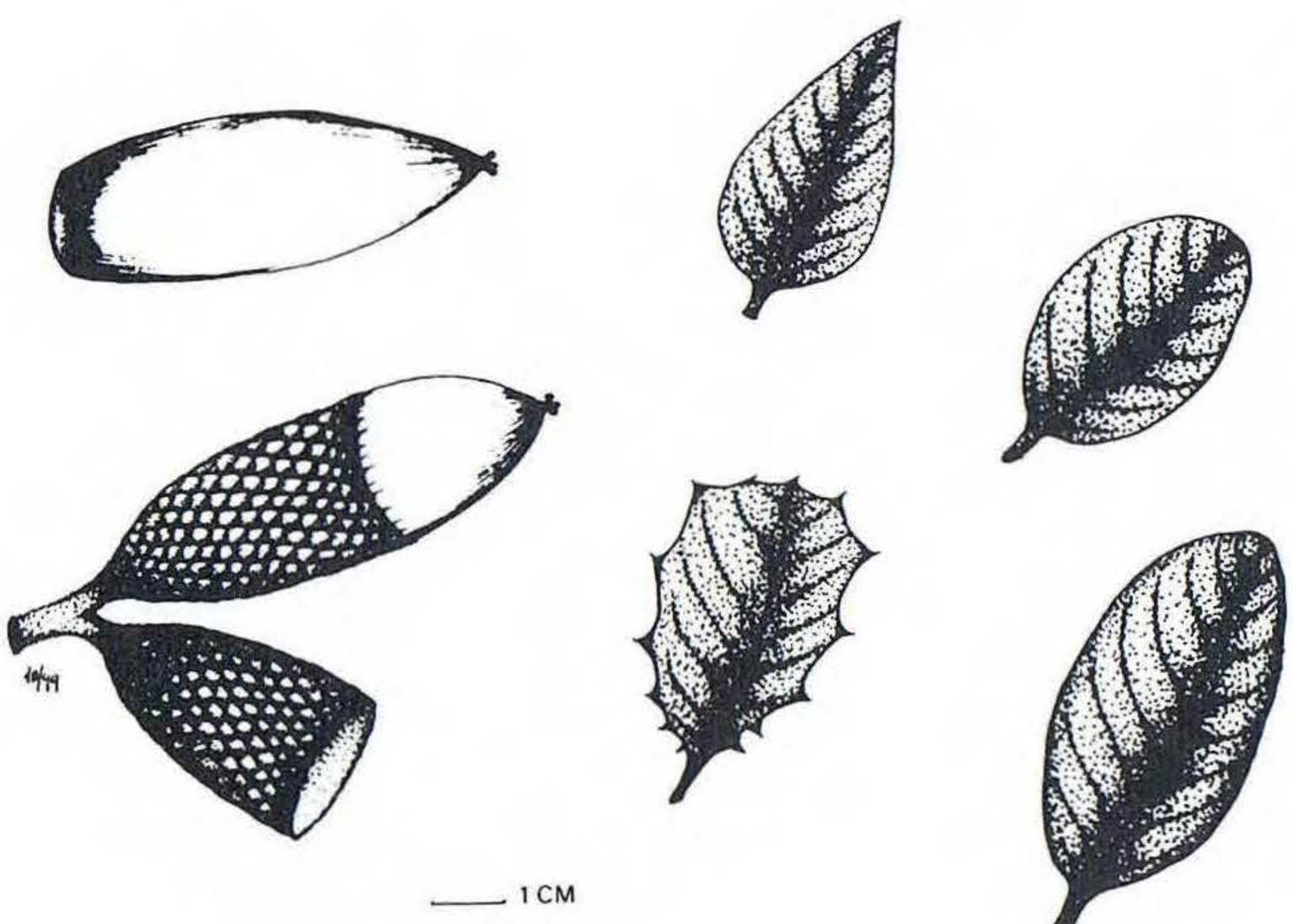

Foliage and fruit of Q. rotundifolia *f.* calcyna.

Q. rotundifolia Lam. f. *dolichocalyx* (C. Vicioso) F.M.Vázquez, Espárrago, Jaraquemada & López-Marques, Descr. *Q. rotundifolia* Extremadura 13 (1992).
Q. ilex L. f. *calycina* (Poir.) Laguna, Fl. For. Esp. 1: 256 (1883) nom.illeg.

Tree with the same external morphological characteristics as f. *rotundifolia*. It differs in its cylindrical cupules 17-25 (27) x 15-19 (23) mm, which cover at least 2/3 of the length of the acorn, with ovate-triangular, closely adpressed scales; those of the margin are slightly lanceolate-acute. Towards the base, irregularities sometimes appear associated with diverse grades of hairiness of the scales. Pedicels 3-4 mm long. The leaves do not have distinguishing characters, but show diverse shapes found in other forms (C. Vicioso, 1950). Acorns ovoid-elliptic, obtuse at the base, with a sweet taste and with weight 3.5-6 g when mature and dry.

Distribution in Extremadura

- It is found in almost all the territory, more frequently in areas of extensive and dense oak forests, as it occurs in the Sierra de San Pedro, Villuercas, Sierra Morena and on the border with Portugal.

Q. rotundifolia Lam. f. ***macrocarpa*** (Cout.) F.M. Vázquez, Semillas de Quercus: Biología, Ecología y Manejo, 83, (1998).
basionym: *Q. ilex* L. var. *ballota* f. *macrocarpa* Cout., Bol. Soc. Brot. 6, 95 (1888)
Q. ilex subsp. *smilax* var. *macrocarpa* (Cout.) C. Vicioso, Rev. Gen. Quercus

España 169 (1954).

This is distinguished from other forms by its large cupules and acorns. However, between this taxon and f. *rotundifolia* there is a continuous range of ecotypes and more than one different taxon in a normal representation of frequency. We could refer to all of these as f. *rotundifolia*. This form, f. *macrocarpa,* corresponds to those individuals at one extreme of the range. We have considered it as a different taxon because of the high frequency of individuals that show very clearly the characteristic dimensions of the fruits and cupules.

Within the same variation between extremes come the small fruits and small cupules of *Q. ilex* f. *microcarpa* Laguna (here regarded as a synonym of *Q. rotundifolia* f. *rotundifolia*) which is the same as *Q. ballota* var. *obovatifolia* Colmeiro & E. Boutelou. This form is characterized by its oval leaves and its small fruits and is found only in areas south of Badajoz in the same places as f. *avellaniformis*, which was also described by Colmeiro and Boutelou. It is possible that *Q. ilex* f. *microcarpa* Laguna and *Q. ballota* var. *obovatifolia* Colmeiro & E. Boutelou are no more than crosses between f. *rotundifolia* and f. *avellaniformis* because their fruits are intermediate between one and the other, but closer to those of the latter. Regarding their leaves, even though the majority are oval in shape, on the same tree we can find variations, with some more oblong and some more orbicular.

After these considerations, we can say that this taxon has a hemispherical-cylindrical cupule of 16-20 x 22-26 mm. It has triangular-acute scales, except the ones on the margin which are very weakly lanceolate, strongly adpressed and flat, even when sometimes they are thicker, and ash-grey in colour, with a long pedicel of 0.5 to more than 1.0 cm in length and with a internal diameter of 19-22 mm (Coutinho, 1888). Generally the leaves are not constant in shape, even though they are oval in shape, rounded, with exception of the ones exposed to sun,

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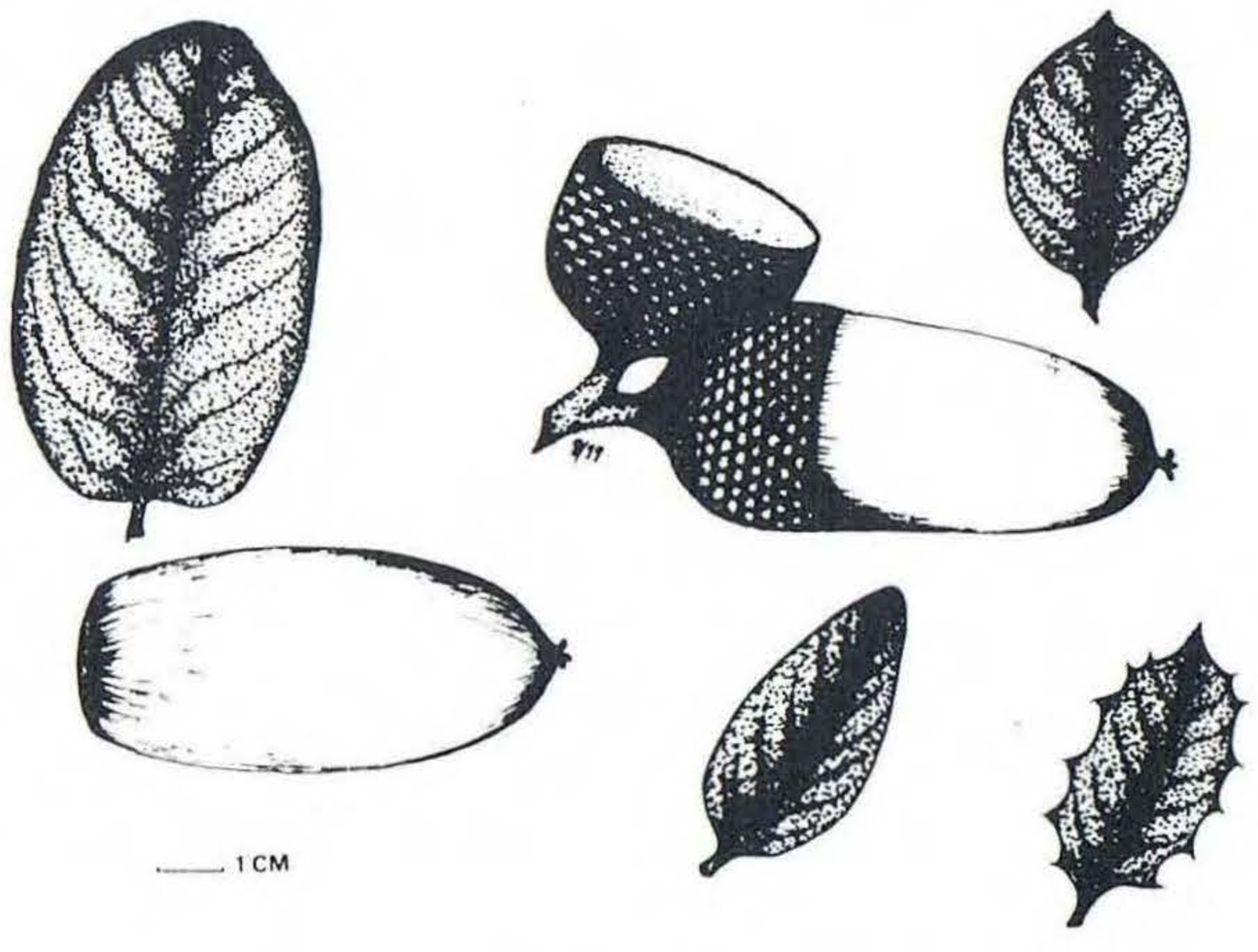

Foliage and fruit of Q. rotundifolia *f.* macrocarpa.

Quercus rotundifolia . . .

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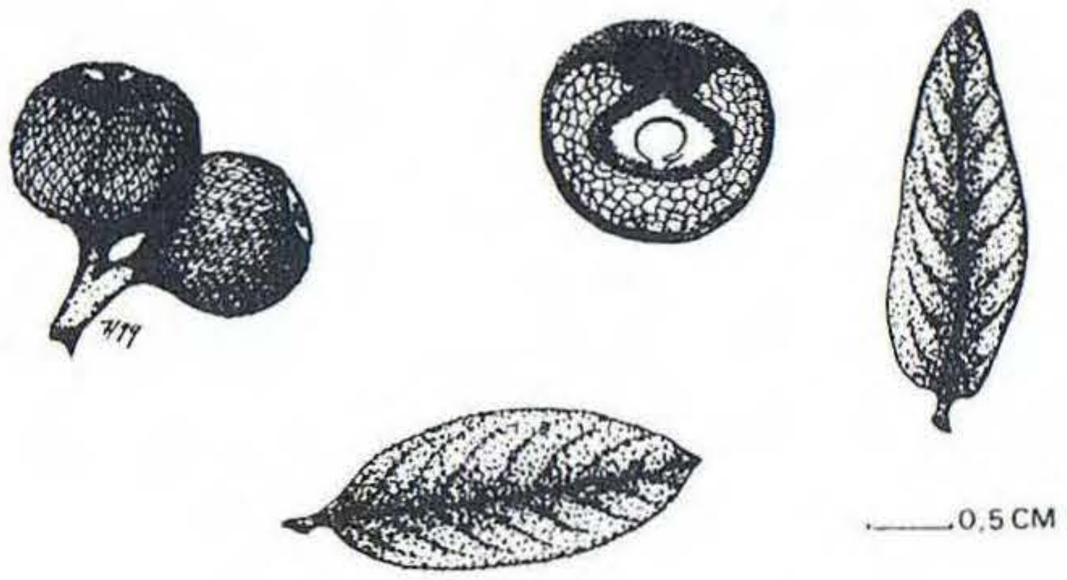
which are slightly lanceolate and weakly mucronate (C. Vicioso, 1950). For this taxon the acorns are a very important taxonomic character. Their dimensions range between 38-50 x 19-22 mm, with an ovoid-cylindrical shape, a sweet taste and a weight which varies between 6-8 g when they are mature and dry.

Distribution in Extremadura - This form was described for the Portuguese Flora by Coutinho (1939) from material from the border with the south of Extremadura. Groups of examples have been found only in two places; one in the south of Badajoz and the other in the region of La Serena. We also believe that there is a continuous distribution between these two zones.

Q. rotundifolia Lam. f. ***pilosella*** F.M. Vázquez, Semillas de Quercus: Biología, Ecología y Manejo, 84, (1998).

This form differs from the others mentioned in the pubescent pericarp. Small trees to 6 m tall; leaves small, entire or with spiny margins, stellate-pubescent on the abaxial and adaxial surfaces. Cupule 10-12 mm long, subspherical, rounded at the base, with a short peduncule up to 6 mm, 1-3 on each peduncule; bracts triangular, flat, tomentose. Acorns 20-37(-40) mm long, 8-12(-15) mm across, 1/3-1/2 covered by the cupule. Weight 1.2-4 g



Sterile form of Q. rotundifolia *originally described as* Q. ballota *var.* mascula *Colmeiro & E. Boutelou, here regarded as a synonym of* Q. rotundifolia *f.* rotundifolia.

when mature and dry.

Distribution in Extremadura - This is the typical taxon of the south and east forest of Badajoz province. It can be found in closed forest, with low levels of human disturbance or with an equilibrium between man and medium (forest). It grows in mountainous areas with indifferent soils, at moderate altitudes (500-700 m) and rainfall (400-800 mm/year).

Discussion

From the start of this project, we found no consistent differences among the various taxa in their leaves, scales, pedicels, bark morphology or canopy. Some of the taxa were described, based on these characters, and so the different variants and forms based on descriptions of foliar morphology have not been taken into account, even though we

found these possible taxa. It has been proved in the material sampled that leaf morphology varies according to the phenotypic variability of the genotype due to environmental variation such as the exposure to light, rainfall, kind of soil, substrate, etc.

We realize that the classification we propose is artificial and forced, because the genus *Quercus* in the Iberian Peninsula has a very wide ecological range. It is found from 1500 - 1300 m to sea level in all parts; consequently it is adapted to every microclimate. In addition, as stated by E.F. Galiano in *Flora Andalucia Occidental* (vol. 1, p. 160), "The genus *Quercus* shows a very large variability in many of its characters, particularly those of the leaves and fruits, because of the ease of introgressive hybridization between several of the species." Because of this, every one of the forms we have identified could be regarded as a cross between different species that occupy different localities. As a result of introgression between individuals, small differentiating characters in some examples would not be true genetic variants, but would have been produced by crossing processes brought about by the type of pollination (by wind) present in this family.

In this work we only make reference to *Q. rotundifolia* Lam. In Extremadura, seven more species in the genus *Quercus* are also found. These are *Q. pyrenaica* Willd. in Cáceres and some parts of Badajoz; *Q. faginea* Lam. in almost all the province; *Q. canariensis* Willd. in some mountainous parts of Badajoz and Cáceres with higher rainfall (>800 mm/year); *Q. coccifera* L. in the warmer parts of Extremadura; *Q. suber* L. in some areas with acid substrates and an annual precipitation over 600-650 mm; and *Q. robur* L. and *Q. lusitanica* Lam. in the south of Badajoz and north of Caceres in closed valleys of mountainous areas with higher annual rainfall (>900 mm/year).

Wind pollination between the different species gives a series of hybrids that need taxonomic study in order to differentiate them from the stable taxa, and to determine their origin. We have been able to detect in the areas of mixing between encinares (*Q. rotundifolia*) and alcornocales (*Q. suber*), individuals with a leaf color similar to that of the alcornoque, but with bark and floral characters very similar to those of the encina. There were also examples of cupule and acorn specimens very similar to those of the alcornoque, even though their taste is sweet, and with bark and leaf color very similar to the encina. Because of this, we believe it was not appropriate to study these individuals because we consider them *Q. suber* L. x *Q. rotundifolia* Lam., (*Q.* x*morisii* Borzi), commonly called "mestos".

We also found some trees of *Q. rotundifolia* that had aborted (sterile) female flowers and male flowers in large numbers, corresponding to *Q. ballota* f. *mascula* Colmeiro & E. Boutelou. We have not treated these as independent taxon because they have no progeny

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Quercus rotundifolia . . .

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and so do not have continuity. However, these individuals could pollinate other trees, which would then be able to produce viable acorns, which in turn could produce trees with the same characteristics. This would be the only way these characters could be preserved, and without it, the oaks with aborted female flowers would not be able to reproduce.

All of this demonstrates that there are enormous opportunities for research in the Extremadura Region, with considerable economic implications. We consider it fundamental to maintain the present research line and to also develop other parallel areas of study on other varieties, forms and existing hybrids.

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Translation by Maricela Rodriguez and Allen Coombes

Oaks in Belgium

Text of a Slide Presentation Made at the Arboretum Trompenburg July 3, 1999

by Philippe de Spoelberch
Belgium

Belgium is a small country, and these notes would probably apply to most of the Netherlands and northern France. The temperature can vary at any given time by 6°C between the western coast and the higher eastern region which reaches elevations of up to 600 m. Temperatures will rarely fall below -20°C, and only for a couple of days. But this will happen at least once in a decade. Otherwise, the prevailing westerly winds result in a typical maritime climate. Frosts may start in late October and occur periodically until mid May. These are often damaging to oaks from the more continental climates of the world.

There are only two indigenous Belgian oaks: *Quercus robur* and *Q. petraea*. The oak forests of Belgium are concentrated along a narrow band in mid Belgium at a lower altitude than the beech and conifer forests. There are 80,000 ha of mixed deciduous forests spread over that region, with various combinations of *Quercus* spp., *Fraxinus* spp., *Acer pseudoplatanus*, etc. Oaks command the highest price for commercial timber.

Between 1985 and 1991, members of the Belgian Dendrology Society conducted a survey of remarkable trees in approximately 800 parks, gardens, and arboreta in Belgium. A total of 13,500 trees were measured and identified. The results of the work were

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Oaks in Belgium . . .

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published in 1992 under the name *Bomen in België / Arbres de Belgique*. The resulting inventory includes 1,067 oaks, belonging to approximately 100 taxa. But more significantly, only 18 taxa were identified more than ten times, 43 taxa were found in only two to ten locations, and 41 taxa were found only once in a single location, and most probably in one of the specialist collections (although these were not intensely researched).

Common beech (*Fagus sylvatica*) was the most frequently encountered remarkable tree in the 800 parks, and *Quercus robur* was a distant second. More precisely, *Q. robur* was found in 322 locations. It was followed by *Q. rubra* in 155 locations, *Q. robur* f. *fastigiata* in 81 locations, *Q. cerris* in 57 locations, *Q. palustris* in 44 locations, *Q. petraea* in 41 locations, *Q.* x*turneri* in 21 locations, and *Q. frainetto* in 20 locations.

Wild and cultivated plants originating from Europe and introductions from America have dominated the 19th century plantations. Smaller oaks, which may have been introduced from Asia in the 20th century, remain very rare and limited to specialist collections. Several dendrological collections were established starting at the end of the 19th Century. The most complete are without doubt the Geographical Arboretum at Tervuren and Groenendaal. The more recent introductions are found in the collection at Hemelrijk (established by Robert and Jelena de Belder), which has 200 specimens of 83 taxa. There are also good oak collections at Bokrijk, Herkenrode and Mariemont. The most complete, albeit on very limited space, is without doubt the collection established by Michel Decalut at Arboretum Waasland. He has also developed a nursery, and his worldwide connections allow him to offer for sale a selection of approximately 250 taxa.

The following are results of a survey of a number of successful oaks found in Belgium, representing taxa which eventually may be useful for future plantings in parks and gardens. Most of the measurements of girth (made at 1.5 m height) date back to the 1985-1991 inventory period. Some of the trees may have died or been cut without our knowledge since then. A few measurements may have been updated since the original survey. Obviously, more recent introductions have not been evaluated, and it may be possible that hardier origins more adapted to our climate might justify the inclusion of further taxa into such a list of those considered useful.

Q. acutissima was reported only twice,

and the champion tree (184 cm) was found in the old botanical garden in Brussels. Unfortunately, it has lost many lower branches recently for lack of light. It is a most decorative and hardy species, at least in mid and low Belgium. This taxon should be planted more frequently.

Q. alba is a difficult plant to grow here, but where successful it can reach good heights. Six significant trees were identified; the best one (232 cm in girth) is in the Stadspark at Tienen. It has grown to good size in a cramped position between other major trees. Autumn color is outstanding and these plants really deserve to be isolated on a lawn or open space to show off their purple coloring early in October, well before our native oaks.

Only two plants of *Q. aliena* were found. They are unhappy, suffering frequently from the effect of spring frost.

Q. bicolor is a much better plant here. Approximately 12 plants have been found. All are growing in lower (westerly) Belgium.

Q. castaneifolia has been reported six times. This tree is also frequently damaged by spring frost, but it will end up, if isolated, as a beautifully formed specimen. The champion tree at Groenendaal has reached 246 cm in girth.

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Guy Sternberg standing with the Gros Chene de Liernu, a 1,000 year old Quercus robur *in Liernu, Belgium.*

Oaks in Belgium . . .

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Q. cerris is quite frequent in collections. The girth of the largest specimen is well above 400 cm. This tree is found in most areas of Belgium with the exception of the very high altitudes. In the Ardennes, it will frequently be damaged by frost and the stem will bear the marks of such wounds. There are a number of cultivars in old landscape gardens. These plants often have reverted to the type on most of the crown, but the variations are still visible at the end of some lateral shoots. Recently, a large tree (293 cm) of *Q. cerris* 'Aureomarginata' was identified, but the tree had reverted to the type on more than 95 percent of its crown. This cultivar was apparently not in cultivation anymore. Specimens of *Q. cerris* 'Laciniata', 'Marmorata', 'Pendula', and 'Argenteovariegata' have been found in some of the parks.

Although *Q. coccinea* has been mentioned several times, one is never very sure of its identification. It is my feeling that *Q. coccinea* is not that hardy here, and that many plants are stock of *Q. palustris* or possibly *Q. palustris* hybrids. *Q. coccinea* 'Splendens' definitely is not hardy; many young plants have been tried, and died at an early age.

Plants of *Q. faginea* have been found, with two significant specimens (320 cm and 154 cm) in northern Belgium. This rare plant from the Iberian Peninsula could be planted more frequently in specialist collections. It is a hardy and elegant tree, as demonstrated by the two specimens that were discovered.

Q. falcata is not hardy here, and only one young plant has been identified in specialist collections.

Q. frainetto is probably one of the better exotic trees to plant in our parks and gardens; 20 remarkable trees were identified, with five having girths of more than 400 cm.

Q. ×*heterophylla* has been found in seven old parks; it is a rare plant here, and all specimens have reached significant size. There are no young plants; it seems that it is not propagated much at the present time. The champion tree stands at 412 cm. Most plants are in the northern province of Antwerp; it is a good grower, as you would expect given its two parents (*Q. phellos* and *Q. rubra*).

Q. ×*hispanica* (*Q. suber* × *Q. cerris*) is a very rare tree; only two trees of significant size were found. However, there are today many young plants in specialist collections.

Q. ilex is a rarity and not completely hardy in Belgium. One plant of reasonable size has survived in a park in Brussels, and without doubt it enjoys the benefit of the warm microclimate of the

city environment.

Q. imbricaria is very much at home in our Belgian parks and gardens. It grows to a significant size, and is similar to *Q. palustris* in its shape and aspect. The Belgian champion is 332 cm in girth and grows at the arboretum of the Agronomic Institute at Gembloux.

Q. x*leana* is more common than its parent *Q. imbricaria*; significant plants have been found, and one may guess that most of these were grown as *Q. imbricaria* seedlings, pollinated by *Q. velutina*. Several trees are above 400 cm in girth, with a champion at 457 cm.

Q. macranthera was found in only one location. Young plants can be found in specialist collections. It is not hardy here and frequently is damaged by spring frost.

Q. macrocarpa is a better plant here, growing to significant size like *Q. palustris*. Several trees have reached 200 cm in girth; they may be hybrids of other oaks of the *Quercus* section.

Q. palustris has been found in close to 50 locations, with at least 40 significant trees reaching sizes above 400 cm in girth. If they are well isolated from an early age, they will withstand any storms; but in forest plantations, when openings occur, they will fall over in the face of strong winds after reaching a certain height. They contribute significantly to the autumn coloring of our parks and woodland.

Q. petraea is our second indigenous oak tree. Remarkable specimens were found in approximately 41 gardens. This is a surprisingly low number considering the fact that this is an indigenous plant. It nevertheless has reached significant size, with a champion at 692 cm (in the center of the country, at Dave). As would be expected for long-cultivated species, there are several cultivars, with 'Mespilifolia' the most frequent, represented by several trees well above 300 cm in girth.

Q. phellos and its hybrids (particularly *Q.* x*schochiana*) have been found in several parks and gardens in lowland Belgium. It is not completely hardy here and suffers in our maritime climate from autumn and spring frosts. It will sometimes hold on to its leaves well into January. This is especially the case on young trees. The autumn color is a little disappointing.

Q. pubescens might be indigenous in the southern warm hills in the region of Chimay, but I know of no spontaneous wild trees. A couple of big trees have been found in a number of parks, with a champion at 435 cm in the center of the country. This elegant oak should be used more frequently in our parks.

Q. pyrenaica is a rare plant. Six good specimens were found, mostly in the north of the country. A champion tree at 310 cm grows in the city of Liège, and is probably the most northerly plant of this species in Europe. The cultivar 'Pendula' is found at least as frequently as the type.

Q. robur was found in close to half of

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the parks and gardens. The largest Belgian tree, at Liernu (985 cm), is a very damaged tree. It has lost most of its crown and is completely hollow. It is a well-known tree, the object of many stories and cults, and well looked after by a number of folklore societies. For this indigenous oak, many cultivars have been found, including 'Albomarmorata' (4 plants), 'Atropurpurea' (3 locations), 'Cucullata' (9 locations), and 'Tortuosa' (4 locations). The most frequent of the selections is *Q. robur* f. *fastigiata*. There are clearly several forms of this oak and it is the third most frequently encountered taxon in the Belgian parks and gardens (81 locations).

Q. x*rosacea*, the hybrid between our two indigenous oaks, is quite frequent, with 16 big trees found all over the country; the champion tree has reached 500 cm in girth.

Q. rubra is the second most frequent oak encountered. It shows rapid growth and good adaptation to most of low and middle Belgium. Its autumn color and commercial value justify its presence; but it also is an invasive plant, seeding itself in the many woodland areas and displacing the existing vegetation. It has become a pest in several parks, and can actually destroy the woodland structure if care is not taken to eliminate the young seedlings. Many of the largest trees are greater than 500 cm in girth, with a champion of 672 cm. *Q. rubra* 'Aurea' contributes significantly to spring color. The golden coloring will remain for several weeks, well into June and July, if there is good growth and plenty of sun.

Q. x*turneri* is a favorite of many gardens. It was found more than 20 times in many parks and botanical gardens. It is a spectacular evergreen tree, especially when planted as an isolated specimen. The champion plant has reached 285 cm in girth. It is obviously hardy here, and is found all the way to the city of Liège, but of course not in the higher elevations of the country.

Q. velutina has been found in approximately 15 parks. It is often confused with *Q. rubra*. It reaches significant girth (455 cm); the autumn color is somewhat rusty red, surely less flamboyant than that of *Q. rubra,* but of a warmer coloring.

EDITOR: This paper was presented at the 75th Anniversary Symposium of the Dutch Dendrology Society, Rotterdam.

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