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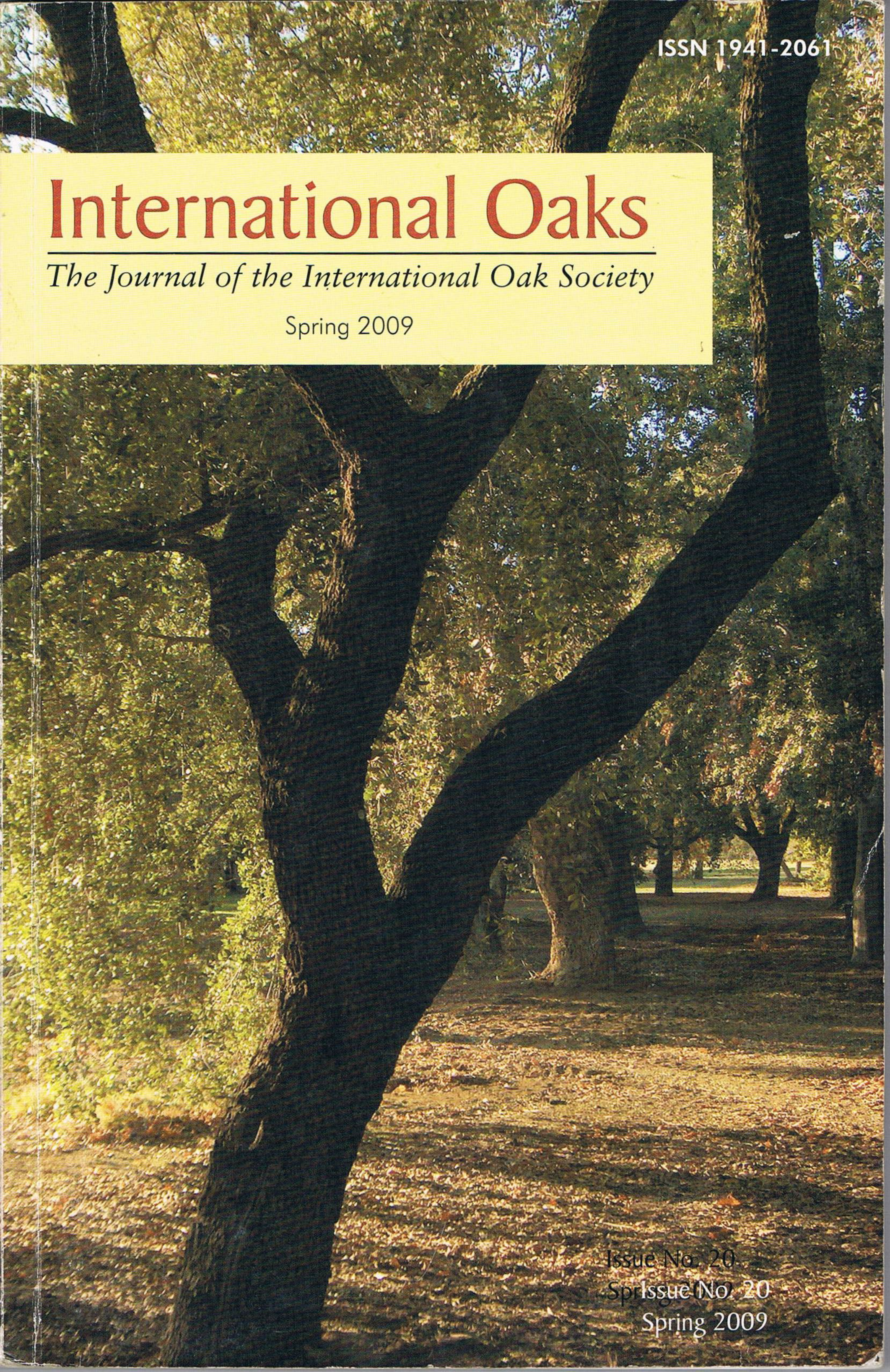
Spring 2009



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Spring 2009

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International Oak Society

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JOIN THE IOS TODAY !

Since 1992 the International Oak Society has been bringing together oak enthusiasts from around the world. Born from a shared desire to exchange *Quercus* seed, the IOS has grown in many directions. Our mission : to further the study, sustainable management, preservation, appreciation and dissemination of knowledge about the genus *Quercus* and its ecosystems.This website has been created in that same spirit : you can exchange plants and seeds, tell us about your arboreta/gardens and what species of oak you are growing, share your horticultural and botanical knowledge and questions and submit any kind of *Quercus* information you wish to share.

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6th International Oak Conference - Second Announcement

Wed, 08/20/2008 - 08:06 -- Béatrice

Dear members and oak lovers, we are delighted to announce that the Herbarium and Botanical Garden at Puebla University in Mexico will be hosting the 6th triennial Conference from 20 to 22 October 2009.

The Conference will last 3 days during which there will be a wide variety of presentations and posters as well as cultural and outdoor activities. If you are thinking to present a paper or poster, please let me know.

Two field trips are being planned in order to show attendees the diversity of oaks in Mexico. The Pre-conference tour is being planned for 2 days to the South of Mexico and the Post-conference tour will be in the central part of Mexico.

We invite you to send your pre-registration form, so we can have an idea how many of you are interested in visiting the country with the greatest number of oak species in the world! The link to fill the form will be posted in the IOS website.

We are looking for sponsors for the Conference, if you wish to assist us, please contact me macosta@siu.buap.mx or herbario.jardinbotanico@mail.buap.mx

Maricela Rodriguez-Coombes
Conference Chair

International Oaks

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The International Oak Society

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Anyone interested in joining the International Oak Society or ordering information should contact the membership office. Membership dues are U.S. $25 per year, and benefits include *International Oaks* and *Oak News and Notes* publications, conference discounts, and exchanges of seeds and information among members from approximately 30 nations on six continents.

International Oak Society Website:
http://www.internationaloaksociety.org

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Front: *Quercus brandegei* at UC Davis Arboretum
photo © Emily Griswold

Back: *Quercus dentata* bark, Harvestman
photo © Guy Sternberg

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Message from the President

This coming autumn, we all have a fabulous rendezvous in the city of Puebla, Mexico for the 6th International Oak Society Conference. Home to more indigenous species of oak than any other country or region of the world, Mexico is an oak-lovers destination if ever there was one. Working closely with the conference organisers, I am already convinced that this will be an unforgettable experience.

Along with the pleasures afforded every three years by our conferences comes, of course, a little responsibility for the membership. Soon you will all be receiving the Board elections package - in preparation, once again, by Diana Gardener, our indefatigable volunteer.

Several of our long-standing Board Officers who have held various positions over the years - some since the very beginnings of the Oak Society - will be retiring. Richard Jensen, Eike Jablonski, Doug McCreary, and Ron Lance will all be stepping down, and this inevitably represents great change. Perhaps the most important question that the Oak Society must answer for its future is, who will take on these responsibilities? At the very latest, the 2009 elections must provide us the answers to this question. There are many activities that an organisation like the Oak Society can and should develop - and then there are some without which we cannot function.

I am pleased to note already that several "new" faces have come forth as candidates for these elections. To those, and to others who are perhaps still considering being a candidate or volunteering for a committee, I would like to say that this is an exciting period of change for the Oak Society and that, in a very real sense, the future is in your hands!

Being a member of the Board of Directors is one way to contribute some of your time to the Oak Society. But it is not the only way. Volunteers who come forth for specific tasks - people like Diana Gardener, Rudy Light, Ed Holm, and David Richardson - as well as those who develop activities on their own initiative. Matt Strong, Anke Mattern, and all of those who have organized Oak Open Days, for example, are invaluable assets to the Oak Society. Volunteers bring a special spirit to any organisation. There are many directions for development of the organisation for which the active involvement of the membership is needed.

These are some of the many things we all need to discuss in Puebla. I look forward to seeing you there!

Allen Coombes, President

Introduction from the Editors

We always have tried to include a mix of scholarly work, general interest articles, and inspirational and informative illustrations. We are proud to do so again with this, the landmark twentieth issue of our journal.

You will find the now-traditional photo gallery, this time featuring our first Asian oak species. There will be intrigue, with a continuation of the controversy about the true identity of *Quercus ellipsoidalis* provided by Dave Shepard's decades of research. (For comparative background and another view, see Issue No. 18, pages 65-74.) We have the introduction of a new species by Allen Coombes, and molecular work by Lucia Vazquez. Then we provide profiles of some more ancient oaks, this time in Sweden (by Stefan Foconi) and in Russia (by Gennady Firsov).

Nurseryman Dirk Benoit gives us the basics of oak grafting, and APGA committee chairperson Emily Griswold presents the member oak collections and procedures of NAPCC. Rob Guest tells us more about a historic landmark date in the Forest of Dean. Bill Guion traces the oldest remaining oaks in the Live Oak Society. There also is more information about the hybrid complex involving *Quercus macrocarpa* in isolated stands peripheral to the native range, from the ongoing field work of Tim Buchanan and Allan Taylor. We are truly an organization of talented, energetic, knowledgeable people!

Finally, please see the reproduction of our new web site home page, with the conference announcement appended, on the inside cover. Our secretary and several other people have given a huge amount of their time and work to make this happen, so all members should become familiar with it and register. This is the window to our future. See *http://internationaloaksociety.org* . Members are invited to contribute to the web site by using the Create Content, found on the upper right-hand side of the screen. Contact Béatrice Chassé at *arboretum.pouyouleix@wanadoo.fr* with any questions.

We hope there will be something for everyone here. And we hope that you, our loyal Oak Society members and friends, will help us find additional noteworthy topics and authors for future issues of this journal. We must begin our work a year in advance to prepare this publication, so it's never too early to start sending us material. Please forward your papers, ideas, comments, and suggestions to us at: *Guy@StarhillForest.com.*

We are always grateful for volunteers. If you would like to help with copy editing, mailing, or other publication work, or just want to make a donation to help cover costs involved in printing the Oak Journal, please tell us that as well.

Hoping to see many of you in Puebla, Mexico this fall . . . and for those who really can't be there, we will try to bring as much of the conference as possible to you via the next journal issue.

– Guy Sternberg and Ron Lance

Clonal Oak Propagation by Grafting

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In this article I would like to share with you my experiences and observations with clonal oak propagation by grafting. We all know that the best way to propagate an oak is to gather acorns and to sow them. People who live in colder localities and at higher altitudes always should try to find acorns at higher altitudes or from the northernmost locations. Due to frequent hybridization and variation within each species, however, the result might be disappointing. Your oak will look slightly or completely different from the one from which you took the seed, especially when the acorns were not gathered from an isolated population. The only way to obtain a tree identical to the beautiful specimen that you are admiring is by clonal propagation.

Clonal propagation can be done by cuttings, layering or grafting. A very interesting technique of layering (mounding of etiolated shoots) has been developed at Cornell University by Georges Hawver and Nina Bassuk. You can read more about this technique in the proceedings of the Third International Oak Conference. (Issue No 12 of this journal.)

Let it be clear that we only choose grafting when all other means of propagation have failed or when they are too difficult or too cumbersome to execute commercially. Grafting becomes of interest when we want to maintain certain qualities such as some or all of the following:

- Leaf color: *Q. robur* 'Concordia', *Q. texana* 'New Madrid'….
- Leaf shape: *Q. dentata* 'Pinnatifida', *Q. velutina* 'Oakridge Walker'…and all hybrid oaks such as *Q.* x*hispanica* 'Waasland Select', *Q.* x*undulata* 'Kenton Blue', *Q. turbinella* x *mongolica* (Cottam Hybrid)…
- Habit: *Q. robur* 'Fastigiata', *Q. palustris* 'Green Pillar', *Q. castaneifolia* 'Green Spire'…
- Fall color: *Q. ellipsoidalis* 'Hemelrijk', *Q.* x*sargentii* 'Thomas'...
- Fall color and habit: *Q.* x*warei* 'Chimney Fire', *Q.* x*bimundorum* 'Crimschmidt'.
- Leaf shape and habit: *Q. robur* 'Salfast'.

Grafted trees sometimes perform better than trees propagated by seed. Recently we have begun experiments with the use of *Q. buckleyi* as a rootstock to overcome high PH chlorosis in the red oak group.

An important disadvantage of grafting is that graft incompatibility may occur in some cases. Most of the time this problem starts to show up in the nursery stage through excessive formation of basal shoots from the rootstock followed by separation of the graft. It is incorrect to claim that all grafts will eventually break. Graft incompatibility is more frequent in the red oak group (*Q. palustris, Q. marilandica, Q. rubra*….) but it also occurs in other groups. It is remarkable to observe that some grafted plants grow vigorously at first but soon start to produce an abundance of shoots from the rootstock, with ultimate separation of rootstock and scion. Peroxidase enzyme incompatibility is at least partly responsible for this problem, from the work of Dr. Frank Santamour, Jr. He found that there are several strains of this enzyme, roughly analogous to blood types in humans, and that incompatibility between different strains of the enzyme prevented lignification of some grafts in red oaks, accounting for the delayed failure of such grafts.

For success in grafting we need to choose the right rootstock. It is important to select, if possible, a rootstock that is genetically as close as possible to the clone that we wish to graft. In the case of a hybrid, seedlings of one of the parents might be useful. My practical experience is that in most cases other rootstocks of the same group can be used without any problem. For example, we use *Q. palustris* as a rootstock for *Q.* x *filialis* (*Q. phellos* x *velutina*) with a perfect long lasting result.

September graft.

Side Inlay Graft.

Oaks can be grafted at different times of the year and here at Pavia Nurseries most of our production is grafted in September. Here is the technique that we use. As rootstocks we use strong one year old seedlings which we pot up in the spring in small 9x9x13cm pots. We let them grow without much fertilizer until September, when they will be grafted.

The grafting techniques that we mostly use are cleft or wedge grafting and veneer side grafting. The scions are cut shortly before grafting, but if necessary they can be collected and held for several days. At all times the scions should be kept together with their labels, being careful not to mix up the different sorts. The scions should contain at least two or three buds. After we have made the cuts in the scion we quickly dip the cut section in a fungicide solution and then insert it into or onto the rootstock; The graft is then tightly bound with a small rubber band.

When oaks are grafted in September it is not necessary to cut away the leaves, although when the leaf is large it may be cut to half or a third of its normal size. We do not seal the scion and grafting point with paraffin or some other grafting wax. Before we put the grafted plants in a cool tunnel under a thin plastic sheet, we spray them with a combination of two fungicides. It is important that the plastic sheet be tightly closed so that no humidity can escape. The tunnel can be lightly shaded to avoid temperature peaks ABOVE 35 °C. Here in Belgium the temperature is still high enough at this time of year to allow the grafts to seal in from 6 to 8 weeks, depending on the cultivar.

Every other week, on a cloudy day, the plastic is removed for a few hours and the plants are again treated with a fungicide. Once the callus has progressed from white through green to brown we can gradually start to harden off the grafted plants. This is done by gradually uncovering the plants starting on cloudy days. Once hardened off, the plants can stay in the tunnel until spring. We supply heat when temperatures drop below freezing, but during the first 6 week it is best to not let the temperature go lower than 10 °C. In the spring we then pot up the successful grafts in 12x12x20cm pots, where they remain for one season. In early June they are staked with a small cane. Depending on the cultivar, the grafts can reach 30 to 120 cm by the end of the growing season.

For winter grafting we use our "Hot-Pipe Callusing Unit." With this technique we use oak seedling in plugs, which we bench graft using the same procedures as in September. We use rubber strips to hold the graft tightly together and we seal the scion and the grafted section with a special wax containing a fungicide. In this technique the scion may be a little longer because we have to cut off all the buds that are too close to the grafted section.

The Hot-Pipe Callusing Unit consists of an isolation tube approximately 8 cm in diameter in which we have cut slits where we can put the grafted section. Within this tube runs another tube (diameter 2 to 3 cm) with warm water or an electric cable connected to a thermostat. For *Quercus*, 18 to 21 days at 20°C are sufficient to heal the graft. The advantage of this technique is that only the grafted section of the plant is heated and the rest of the plant (roots, buds) stays dormant. If the buds at the base of the scions are not cut away they might start to develop inside the tube. The roots on the understock can be kept moist by covering them with some peat. The Hot-Pipe Unit can be placed in a cool but frost free building. After healing, the grafted plants are placed upright in peat in high nursery cases until they are potted up in spring.

In both techniques (September grafting and Hot-Pipe Callusing method) the rootstock is cut slightly off center, so that the cut does not pass through the pith. In my experience, this gives both better grafting success and better and quicker healing of the cuts.

Another technique that we sometimes use is Side Inlay Grafting on 2 year old established trees in the nursery row. Here one or two year old oaks are planted in the open ground in spring and then grafted in the spring of the following year. Here the scions should be cut in the dormant season and stored at -2°C (28°F) as previously described. One can start to graft about 10 days before the last possible frost. Here in Belgium this is usually around the first of May. By that time the rootstocks may already have started to leaf out, but that is not a problem. The technique that is employed is side inlay grafting: Two sloping cuts are made at the basal end on opposite sides of the scion, so that it gradually tapers to a wedge. An incision is made at the base of the rootstock. A downward cut diagonally should be made with the blade to form a flap that remains attached to the rootstock on one side. One day before grafting, the scions are taken out of the cool house to gradually thaw and to allow any moisture on them to dissipate. When dried off they are quickly dipped in hot paraffin and immediately put in cold water, after which they are again stored in plastic bags at 5°C until they are grafted.

After grafting, the grafted section should be tightly sealed with tape and cold grafters wax. About ten days after grafting, the upper part of the rootstock can be cut away in two stages, leaving about 10 cm of stem above the grafted section for use in stabilizing the scion if this is necessary or desirable. We trim the rootstock in two stages because we want to keep the sap stream active until the cuts are healed and the scion takes over and starts to grow. About one month after grafting, small canes can be inserted into the ground so that the new growth can be shaped as may be desired. When using the Side Inlay Grafting Technique plants sometimes grow more than a meter and a half during their first year. During the next winter, the rest of the stem of the rootstock above the graft that had been left for stabilization of the scion can be cut away so that a nice union can gradually form. We sometimes use Side Inlay Grafting in the open ground to obtain quick production of scion wood that we can then use for September grafting or for winter grafting on the Hot-Pipe Callusing Unit.

The advantage of these techniques is that the scions can be cut in the dormant season and stored. Longer storage is possible if the scions are packed in airtight plastic bags and held in a cool green house or refrigerator at -2C (28F). Scions of deciduous oaks can be shipped long distances without any problem if they are packed dry and airtight in plastic bags.

The fourth and last technique that we have tested is Chip-Budding. This is carried out in summer in the open ground on established rootstocks in the nursery row. Here the scion is a single bud that is cut out of a firm one year old shoot with a sliver of wood attached to it. A cut of identical shape is then made at the side of the rootstock to match the sliver with the bud. Everything is nicely covered with a special plastic strip while leaving the bud free. The plastic tie is cut away after 5 weeks to prevent girdling of the rootstock. The next season the rootstock is cut off, slightly above the grafted bud forcing the bud to break. In our cool and damp Belgian climate this technique has been a disappointment, but I've seen it used in France in the Orleans region with great success.

The last two techniques could be interesting for the hobby grafter because they don't require a greenhouse or other special installation.

With fruit trees it is important to plant the grafted tree with the grafted section above the ground. With oaks, however, I always advise people to plant the tree with the grafts below the ground surface for the reason that the scion often starts to produce roots of its own.

This is of course advantageous in case the graft should fail later. We have noticed this phenomenon with grafted *Q. pontica*, *Q. canariensis* and many other species. For this reason it is important always to graft as low as possible.

It may be that in the future other and better techniques of clonal oak propagation will make the grafting of oaks superfluous. But at the present time I can't think of a better method for commercial production of the thousands of plants

Author and one-year-old graft *Q. nuttallii* ‘New Madrid.’

that we require every year.

It is important, however, that we nurseryman not deny or neglect the problem of graft incompatibility and that we not graft cultivars that have been shown repeatedly to be prone to this problem.

More information, pictures, and drawings of grafting techniques can easily be found on the internet.

Finally I would like to say what a great joy it is to be a nurseryman and to do this kind of work: to look for new hybrids and new and interesting forms of trees, and to collect, graft and grow them. Many of the trees that we grow have a clonal parent somewhere else in the world, and seeing these trees in our garden and nursery brings back sweet memories of the times that we were actually there where we first recognized a promising new cultivar.

Editor's Note: For more interactive discussion of this topic, please go to the Propagation and Nursery Q&A page of the International Oak Society website.

Q. velutina 'Oakridge Walker'

Q. ×*warei* 'Chimney Fire'
photo © Guy Sternberg

Quercus tungmaiensis Y.T. Chang in cultivation

Allen J. Coombes[1] & **Zhou Zhekun**[2]
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[2] Kunming Institute of Botany,
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For several years, an unusual oak has grown in the National Collection of oaks at Chevithorne Barton, home of Mr Michael Heathcoat Amory. Tentatively listed as *Q. lanata*, but obviously different from that species, it had defied all attempts to identify it further. However, the first author recently discovered a perfect match for the Chevithorne plant in *Q. tungmaiensis* in the Chinese Virtual Herbarium (*http:www.cvh.org.cn/*). This invaluable resource provides access to images of numerous herbarium specimens, including types, held in Chinese herbaria.

According to the original description of *Q. tungmaiensis* (Chang, 1966) it is a deciduous tree to 27 m tall with densely hairy shoots and thinly leathery, lanceolate to oblong lanceolate leaves to 20 cm long and 4.5 cm wide and fruits that ripen the first year. Chang did not mention the affinities of the species when he described it, except that it was placed in subgenus *Quercus*, but it seems to be in section *Cerris*. The holotype was collected in Tung-mai (Tongmei), Tibet in 1965 (Y.T. Chang & K.Y. Lang 887, **PE**). Tongmei is a small town at about 2000 m in the Palong Tsangpo gorge about 90 km west of Bomi county in Tibet. *Q. tungmaiensis* grows here on the mountain slopes and can also be found in the Yalu Tsangpo gorge 50 km west of Tongmei.

Q. tungmaiensis, Rushforth 5565, at Chevithorne Barton.
Photo © Maricela Rodriguez-Coombes

Although the species was recognised by Huang et al. (1998) and Govaerts & Frodin (1998), Huang et al. (1999) regard *Q. tungmaiensis*, as well as *Q. leucotrichophora* A. Camus, as synonyms of *Q. lanata* Sm. Indeed, the holotype specimen of *Q. tungmaiensis* is annotated "Q. leucotrichophora A. Camus (Q. tungmaiensis Y.T. Chang)". While *Q. leucotrichophora* and *Q. lanata* are closely related, and possibly not distinct, at least at specific level, there is no doubt that *Q. tungmaiensis* is different from these and should be recognized as a distinct species.

The plant of Q. *tungmaiensis* at Chevithorne came as a rooted cutting from Tom Hudson at Tregrehan in Cornwall and derived from seed collected by Keith Rushforth in Tibet in October 1997. (Rushforth 5565). The locality for this collection was given as Pome, (Bomi) between Showa La and the confluence of the Yigrong Tsangpo and Po Tsangpo at 2100 m. It was described as a tree of 25 m. In cultivated plants the leaves are downy above with stellate hairs when young and strongly revolute as they unfold becoming more or less glabrous and glossy green. The lower surface of the leaf is glabrous even when young except for persistent hairs on the veins. A distinct feature of this species is the deeply impressed venation on the upper surface of the leaf. At Tregrehan and Chevithorne, plants have reached 2.5 m tall. Several other collections in the area by Rushforth in 1997 and 1999 may also be referable to this species.

Q. tungmaiensis seems to be one of a group of species related to *Q. engleriana*, of which the taxonomy is not completely resolved. Tom Hudson (pers. comm.) reports seeing a similar or identical plant in the Dulong Valley, in NW Yunnan and a similar plant is cultivated at the Hillier Gardens from seed collected at Pianma, near the Yunnan-Myanmar border, approximately 100 km further south.

References

Chang, Y.T. (1966). Novitates Sinenses Generis Quercus. Acta Phtytotax. Sin. XI, 3, 254-5

Govaerts, R. & D. Frodin (1998). World Checklist and Bibliography of Fagales. Royal Botanic Gardens, Kew

Huang, C., Y. Zhang & B. Bartholemew (1999) in Wu, Z. Y. & P. H. Raven, eds. July 1999. Flora of China. Vol. 4 (Cycadaceae through Fagaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis.

Huang, C., Y. Chang, Y. Hsu & H. Jen (1998). Fagaceae. In: W. Chun & C. Huang, eds. Fl. Reipubl. Popularis Sin. 22: 1-332.

The holotype of *Q*. *tungmaiensis* at Beijing

English Oak (*Quercus robur* L.) in Shakinskaya Dubrava, Russia

The Southeastern extent of its Natural Distribution

Gennady A. Firsov and Vjacheslav V. Byalt
Komarov Botanical Institute,
Government of St. Petersburg, Russia

English Oak (*Quercus robur* L.) is a major forest tree species in the European province of Russia. It is also one of the favorite trees of the Russian people, held sacred even before the era of Christianity. The northern border of its natural range passes near Saint-Petersburg, and reaches the Ural Mountains at the east. At the southeast, it reaches Saratov and Volgograd, and then reaches Novocherkassk and the mouth of Dnieper River. English oak is absent within the dry steppe, but appears again at the foothills of North Crimea and North Caucaus (Sokolov, 1951; Sokolov, 1977). At the northern part of its habitat it grows in river valleys, and to the south it occurs as well within watersheds as a component of mixed conifer-broadleaved forests, often with spruce (*Picea abies).* At the very south of its natural distribution it forms pure oak woodlands. At the steppe zone of Russia the English oak is the dominant forest tree and is very common in the afforested steppe ravines, on black soils (Figure 1). Associate tree species in such oak woodlands include *Tilia cordata* (more common in the east than west), *Acer platanoides*, *A. campestre*, *Ulmus campestris* and *Populus tremula*. Understory and shrub layers include *Corylus avellana*, *Euonymus verrucosus*, *E. europaeus*, *Prunus spinosa*, *Padus avium*, *Acer tataricum* and *Crataegus rhipidophylla*. The herb layer is diverse (Figure 2), with many species flowering before the appearance of spring foliage on the trees, finishing their annual growth cycles by the second half of summer – the forest floor then is covered with browned and fallen leaves and seems lifeless.

In Russia, contrary to Western Europe, there are still large expanses of oak woodland intact. It is well known that the English oak is a highly valuable tree, very important for common people in everyday life and having a variety of utilitarian uses. The oak is a very decorative tree and often planted in different places throughout the European part of Russia. It is used in forestation projects in steppe zones and in creation of forest belts to protect agricultural fields. The dispersion of English oak has long been connected with human activity. After the Second World War there was Stalin's plan of nature transformation, a period when millions of hectares of artificial forests were planted, including plots of oak forest. It was at that time when the majority of forest belts of different political levels (from local to all-Union significance) were established. The English oak was among the most important of all planted trees.

Shakinskaya Dubrava (Shakinsky Oak Wood) is a place where the English oak grows in the wild, not far from the southeast border of its natural distribution, and in this locale helps to promote a rich set of local flora. Here is upland forest, in contrast to floodplains (where *Quercus robur* is also one of the main tree species). Shakinskaya Dubrava represents a large massif of forest, about 15 x 20

Figure 1. Powerful Oak in the Shakinskaya Dubrava.

km, occupying 6340 hectares. This is a local monument of nature with regional significance, and it is one of the highlights of the newly established Lower Choper Nature Park (Ponomareva et al., 2004; Firsov, Ponomareva, 2004; Byalt et al., 2007; Byalt, Firsov, 2007). The Dubrava is situated at the northwestern part of the Volgograd region, at Kumilzhensky administrative district, near Khutor (Cossack village) Shakin, 270 km north-west of Volgograd, penetrating into the territory of adjacent Rostov region. Since 2003, it is part of the newly established Lower Choper Nature Park, with geographic coordinates 49°42’ - 49°49’ N and 42° 06’- 42° 14’ E.

Figure 2. *Tulipa biebersteiniana* in the Shakinskaya Dubr.

Shakinskaya Dubrava is the southern plot of oak forests in Volgograd region, containing certain trees more than 200 years old. The place is situated at the south-western edge of the Kalach Hills, about 150 m elevation (maximum height is 202 m elev, close to Dubrava) and characterized by extensive soil erosion. Shakinskaya Dubrava is supervised by the Shakinsky Forest of Kumilzhensky Experimental Forest Enterprise. *Quercus robur* dominates among the native trees, while *Pinus sylvestris* is another common species, being introduced and widely planted here in the southeastern border of its natural distribution (Figure 3). There are also associates such as *Fraxinus excelsior*, *Acer campestre*, *A. tataricum*, *Malus praecox*, *Tilia cordata*, *Salix alba*, *Alnus glutinosa* and *Ulmus glabra*. In most of the oak forests, rich growths of grasses occur, including species such as *Dactylis glomerata*, *Melica picta*, *Poa nemoralis*, *Carex pilosa* and *C. michelii* (Figure 4). There are considerable quantities of *Ulmus campestris*, *Acer tataricum* and *Rhamnus cathartica* on ravines and *Alnus glutinosa* along wet places and streams. At the borders with steppe area, there are oak stands of low productivity, apparently due to intensive cattle grazing and cutting. The stock of oak timber is about 70-90 cubic m per hectare, and of pine the stock is somewhat greater, about 110-150 cub. m/ ha.

This forest is very unusual for a steppe zone with dry continental climate. The rich and unique flora has not been fully investigated till recently. Some plant rarities found here include the orchid *Epipactis atrorubens*; bulbs *Fritillaria ruthenica*, *Scilla sibirica* (Figure 5), *Ornithogalum kochii* and *Tulipa biebersteiniana*; perennials *Iris pumila*, *Gladiolus tenuifolius*, *Pulsatilla patens*; the succulent *Sempervivum ruthenicum*; trees and shrubs such as *Crataegus ambiqua*, *Cerasus fruticosa* and *Chamaecytisus ruthenicus*. Common western

Figure 3. Landscape of the Shakinskaya Dubrava

European trees such as *Acer campestre*, *A. platanoides* and *Salix caprea* grow here at the southeastern border of their natural distribution.

Oak woods of the steppe zone of Russia have been considerably touched by cutting in recent decades and centuries, when the area along Choper and Don rivers began to be settled actively by Cossack people since the 16th and beginning of the 17th centuries. Most of the oak trees now exist in a rather poor state, in second- to third-growth or more vegetative generations, reproducing themselves vegetatively after cutting. There are not so many old oak trees originating from natural seed reproduction, but several such oaks we were able to find at Shakinskaya Dubrava,

Figure 4. Shakinskaya Dubrava, an open glade in summer.

Figure 5. *Scilla Sibirica* in the Shakinskaya Dubrava.

Figure 6. Slava Byalt near an old large stump of dead oak.

apparently more than 200-250 years old. It is often possible to see, under the canopy of forest or on the glades, huge dead stumps, cut off and dead long ago, more than 1.5 m in diameter; apparently these trees were of great age (Figure 6).

The influence of large forest tracts among the dry and hot open steppe and the presence of varied ecological conditions provide a basis for the rich diversity of vegetation. It is here the steppe and forest species grow close to each other, which is absolutely not typical for more northern oak woodlands (Figure 7). It is here where the range borders of many species lie (Byalt, Firsov, 2006; Firsov, Byalt, Grishin, 2007; Firsov, Byalt, 2007).

It should be stressed that the floral significance of Shakinskaya Dubrava comes from a presence of species which are more typical for more northern territories. These include woody species such as *Rubus saxatilis*, *Frangula alnus*, *Sorbus aucuparia* and *Berberis vulgaris*. Common rowan *(Sorbus aucuparia)* is widely cultivated throughout, but very rare in the wild at this territory; apparently, Shakinskaya Dubrava is the southern point of its natural distribution. This is also true for perennials such as *Filipendula ulmaria*, *Campanula latifolia*, *Mycelis muralis*, and many others. There are interesting cryptogamous plants as well,

Figure 7. Old Oak at the edge of the Shakinskaya Dubrava.

rare for the steppe region. These include horse-tails *(Equisetum sylvaticum, E. hyemale)* and ferns *(Cystopteris fragilis, Dryopteris carthusiana, D. cristata, D. filix-mas, Pteridium aquilinum, Athyrium filix-femina).*

The general flora of Shakinskaya Dubrava is unique. As for groups of rather rare angiosperm plants which are rather fully represented at Dubrava, we can enumerate *Echium maculatum, Scilla sibirica, Orobus vernus* and *Adonis wolgensis*. There are also many rare and threatened bulbs, orchids and perennials which are officially listed to the Red Data Book of the Volgograd region: *Anemonoides ranunculoides, Muscari neglectum, Laser trilobum, Epipactis atrorubens, E. helleboline, Platanthera bifolia*. This place is obviously interesting for botanists, and it has been visited by botanists from Volgograd, Moscow and Rostov at intervals. Several interesting articles were published on interesting botanical discoveries (Drobov, 1906; Zozulin et al., 1968; Skvortsov, 1971; Sagalaev, 2004a, 2004b). The authors of this article also visited Shakinskaya Dubrava many times in 1999-2007 to study its flora. The work was partly supported by Fauna and Flora International (project 99/50/1) and the Rufford Small Grant (project 41.01.05). More than 800 herbarium specimens were collected. Following analysis of all available data, including literature searches and the Herbarium of the Main Botanic Garden in Moscow (MHA), the preliminary list of vascular plants of Shakinskaya Dubrava has been compiled. At present this list includes about 650 species, of 5 divisions *(Polypodiophyta, Equisetophyta, Gnetophyta, Pinophyta, Magnoliophyta)*, including 71 families and 268 genera.

The forest is a refuge for many threatened species (Byalt, Firsov, 2006; Byalt et al., 2007; Byalt, Firsov, 2007). There are 14 species in common with the Red Data Book of the Volgograd region (2006), which contains about 9%

of total amount of protected plants (157 species): *Bulbocodium versicolor*, *Muscari neglectum*, *Epipactis helleborine*, *E. atrorubens*, *Iris aphylla*, *I. pumila*, *Campanula rapunculus*, *Allium regelianum, Platanthera bifolia*, *Sempervivum ruthenicum*, *Pulsatilla pratensis*, *P. patens*, *Fritillaria ruthenica* and *Gladiolus tenuis*. Moreover, 5 of these are also found in the Red Data Book of Russian Federation (1988): *Allium regelianum*, *Bulbocodium versicolor*, *Fritillaria ruthenica*, *Iris aphylla*, *I. pumila*. The sixth species of the Red Data Book of Russia, *Tulipa schrenkii*, grows close by to Dubrava, at surrounding steppe areas of the right bank of the Choper River. Among plants of Dubrava there are endemics and threatened species, disappeared in many other places of the European section of Russia, not yet officially included in the Red Data books of Volgograd region and of Russia. As a rule, these are species which grow at the border of their natural habitat. We can enumerate *Campanula trachelium*, *C. persicifolia*, *C. latifolia*, *Lysimachia verticillaris*, *Peplis alternifolia*, *Geranium robertianum*, *Centaurium meyeri*, *Elatine alsinastrum*, *Dianthus squarrosus*, *Impatiens noli-tangere*, *Asarum europaeum*, *Allium savranicum* and *Ornithogalum kochi*. Such rare species as *Campanula cervicaria* and *Allium scorodoprasum* may be particularly recommended for inclusion to the Red Data Book of Volgograd region. In general, the human pressure is currently low, flora is rich and deserves to be conserved and further studied.

Certain old oak trees throughout Shakinskaya Dubrava have been found following careful examination; currently all of these are protected. A considerable portion of prominent trees has yet to be discovered, checked and mapped. Several old trees grow close to Shakin village, while others are far from the people's sight, hidden in the thicket of wood. In August 2005, one such magnificent and very old tree was kindly shown to us by a local forest man and forest guard, the enthusiastic nature lover Mr. Vladimir Kharitonov (Firsov, 2006). He discovered the tree recently while hunting for wild boar, several kilometres from Khutor Shakin (Figure 8). We visited the tree in a shortened excursion during the dangerous fire season, and were not able to measure this tree, only to be amazed and take pictures (Figure 9). One can imagine of what immense age it may be, keeping in mind that it likely has grown very slowly at the border of its natural habitat, and at extremely dry and severe conditions. Several other very old trees we discovered in the next two field seasons of 2006-2007, during botanical excursions crossing Dubrava in different directions.

As for other oak species, only one of them, *Quercus rubra*, the introduced

Figure 8. Vladimir Kharitonov near the oak which he discovered.

Figure 9. Largest oak in the Shakinskaya Dubrava.

Figure 10. Old Oak in the Shakinskaya Dubrava at the beginning of the summer.

oak from North America, is used in forestation in very limited scale. We discovered it only once at Nekhaevsky district, at the northern part of the Park, planted as a small forest belt at the upland forest along right bank of the Choper River. There is only the native *Quercus robur* seen in plantings of streets, parks and gardens of local Cossack settlements; we have never seen any other oak species. Such low oak diversity may be apparently explained by an absence of arboreta and botanic gardens at the northwestern Volgograd region. Only recently has the situation begun to change. The new private nursery of local enthusiast Mr. Sergey Grishin has been established at Chunosov village, and he wishes to expand the local assortment of trees and shrubs in settlement plantings.

Shakinskaya Dubrava was considerably damaged after the Second World War. It was then partly afforested using pines instead of oaks. After the Stalingrad Battle in the Second World War, when Stalingrad (now Volgograd) was completely destroyed and laid in ruins, most old oak trees at Shakinskaya Dubrava were cut by German prisoners of war to rebuild Stalingrad. Luckily, certain oak trees escaped such fatal fate and nowadays, more than 60 years later, there is an interest (maybe with help from The International Oak Society), to estimate and measure the condition and age of these surviving old oaks and aid their conservation. The oldest and largest of these unique trees deserve to be included into the European data base for significant ancient trees.

Literature

Byalt V.V., Firsov G.A. Predvaritelnie itogi floristicheskogo obsledovanija Shakinskoj dubravi (Volgogradskaya oblast) // Muzei-Zapovednik: ecologia i kultura. Mater. vtoroi nauch.-pract. konf. (st. Veshenskaya, 13-16 sentjabrja 2006 goda). Veshenskaya, 2006. P. 198-201.

Byalt V.V., Firsov G. A. Analiz adventivnoj flori "Nizhnehoperskogo prirodnogo parka." // Adventivnaya i sinantropnaya flora Rossii i stran blizhnego zarubezhja: sostojanie i perspectivi. Materiali III mezhdunarod. nauch. konf. (Izhevsk, 19-22 sentjabrja 2006 g.). Izhevsk, 2006. P. 23-25.

Byalt V.V., Firsov G.A., Ponomareva T.G., Sagalaev V.A. Conservation news from the Lower Choper Nature Park, Russia // FFI, Oryx, 2007. Vol. 41, N 2. P. 133-134.

Byalt V.V., Sagalaev V.A., Firsov G.A. Krasnoknizhnie vidi rastenij v Nizhnehoperskom prirodmon parke Volgogradskoi oblasti // Teoreticheskie I prikladnie aspekti introdukzii… Minsk: Edit VV. 2007. P. 337-339.

Byalt V., Firsov G. Liliaceous plants in the Nizhnekhopersky Nature Park, Russia // Lilies and Related Plants 2007-2008. The Royal Horticultural Society Lily Group. London, 2007. P. 104-122.

Drobov V.P. Kratkij ocherk rastitelnosti yuzhnoi chasti Hoperskogo okruga Donskoi oblasti // Tr. SPb. obschestva estestvoispitatelei. 1906. Vol. 35. Vip. 3. P. 1-20.

Firsov, G.A., Ponomareva T.G. // First steps for the Lower Choper Nature Park, Russia. 2004 FFI, Oryx 38 (2). P. 135.

Firsov, G.A. Eine beeindruckende alte Eiche in Shakinskaya Dubrava, Russland // Der Palmengarten 70/1. 2006. S. 48-49.

Firsov, G.A., Byalt V.V., Grishin S.S. Redkie rastenija Nizhnehoperskogo prirodnogo parka (Volgogradskaya oblast) // Bot. Journ. 2007. Vol. 92. N 4. 102-108.

Firsov, G.A., Byalt V.V. Dekorativnie rastenija v nizovjah Hopra // Zvetovodstvo. 2007. N 2. P. 16-20.

Krasnaya kniga RSFSR. Rastenija. M.: Rosagropromizdat. 1988. 590 p.

Krasnaya kniga Volgogradskoi oblasti. Volgograd. 2006. Vol. 2. Rastenija i gribi. 236 p.

Ponomareva T., Sagalaev V., Jascheritsina L. Prirodny park Nizhnekhopersky. Volgograd, 2004. 21 p.

Sagalaev V.A., Skvortsov A.K., Anfimova M.V., Baluk T.V., Kantemirova E.N., Matveev D.E. Redkie i interesnie vidi vo flore Nizhnehoperskogo prirodnogo parka // Povolzh. ecol. vestn. Volgograd: VolGU, 2004a. Vip. 10. P. 46-52.

Sagalaev V.A., Skvortsov A.K., Baluk T.V., Kantemirova E.N., Matveev D.E., Anfimova M.V. K flore Volgogradskogo Prihoperja i Nizhnehoperskogo prirodnogo parka // Izvestija VolGPU, ser. estestv. i fiz.-mat. nauki, 2004b. N 4 (09). P. 77-85.

Skvortsov A.K. Materiali k flore Volgogradskoi oblasti // Flora i rastitelnost evropeiskoi chasti SSSR. Tr. Bot. sada MGU. M.: MGU, 1971. Vip. 7. P. 35-68.

Sokolov S. Ja. *Q. robur* L. – d. chereshchaty // Derevja i kustarniki SSSR. M.,L.: AN SSSR, 1951. P. 468-474.

Sokolov S.Ja.. Rod *Quercus* L. - Dub // Areali derevjev i kustarnikov SSSR. L.: Nauka. 1977. P. 116-125, map. 85A.

Zozulin G.M., Seledez V.P. , Abramova T.I. Novie i redkie vidi rastenij v basseine reki Dona v Rostovskoi i Volgogradskoi oblastjah // Bot. issledovanija. Rostov-na-Donu. 1968. P. 18-26.

The Mighty Oak of Kvill

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After an excessive traditional dinner on various forms of eel, down on the southeastern coast of Skåne, and a long breakfast the following morning, my brother and I enter the car that will bring us back towards the north and the area around Vimmerby, a region in the province of Småland that is today well known for two things: Astrid Lindgren, the author of children's books, and the mighty Oak of Kvill -- The Rumskulla Oak, as it is also called.

The pressure is high and the sky clear, and my brother, who's behind the wheel, insists on driving all the way with the top down, even though nobody else does so in mid October. At least we're suitably dressed and certainly wearing woolen caps.

I go through my questions again. When we arrive at a junction, just before the oak, the expert on forestry Thorsten Ungsäter, in his capasity as local connoisseur has had the kindness to meet us and answer some of my questions. I have never before seen the oak, only through the years imagined what it would be like. I am now referring to the oldest organism of Sweden – the oak with perhaps the widest girth in the whole of Europe, measuring at chest height not less that 14.11 meters!

The experts estimate the age of this oak to be roughly one thousand years. There are older ones abroad, according to various sources, but if there are oaks outside of Europe with an even wider circumference than the giant I am just about to meet I do not know. Anyhow, in Europe it is exceptional, and for more than one reason, as I will soon try to explain.

Thanks to the Gulf Stream there are no oaks worldwide growing further north than in Scandinavia. There are two indigenous species in Sweden, *Quercus robur* and *Q. petræa* respectively, as well as hybrids between the two. Approximately one percent of the wooded area is covered by oak, a high figure for a country that by european standards is fairly large and 55 percent covered by forest. *Q. robur* grows in fertile clay soil with good access to water, while *Q. petræa* prefers drier and more stoney ground. The northern border of *Q. robur* is traditionally put at the river Dalälven, situated on the 60th latitude (today it even goes further north), but in Norway it reaches all the way along the coast up to Trondheim. In a plantation there is a mature *Q. robur* thriving up in Haparanda, almost on the 66th latitude, proof of an extreme adaptability for a genus that has tropic origin. During the warmest period after the last Glacial Epoch, about 6000 years ago, the oak (like all other broad-leaved trees) penetrated much further towards the north.

The Oak of Kvill is a *Q. robur*, though its appearance today is as far away from the pollarded, emblematic ”bank oak” as you might possibly get, a lot more original and certainly more marked by age; in one word, unique.

When we reach the settled meeting point, after a rather airy drive, I change to Thorsten Ungsäter's car, so that I can use the slow final route on dirt roads for immediate interrogation.

From a dendrological point of view, the area around Vimmerby is rather amazing, since within the radius of 10 kilometers you could spot not only the mightiest oak of Europe, but also the thickest birch, apple tree, maple and hazel of Sweden, plus the second thickest lime (linden). The rural district of Rumskulla is further brim full of interesting natural phenomena like faults, erratic rock blocks, and giant kettles.

The Oak of Kvill got its name after the pasture where it happens to grow, called Northern Kvill, an ex-lieutenant's house; or, the Oak of Rumskulla, since the parish is Rumskulla, situated in the county of Kalmar. The name Rumskulla is derived from the older form Romfarakulla (meaning literally: Rome + travel + hill), that is this district was a stopover and a resting place for pilgrims that were off for Rome. The prefix ”kvill” is connected to the verb ”kvillra”, onomatopoia for the gentle sound of water in motion; hardly surprising, given the vicinity of the small river Stångån. According to local oral tradition the tree is called The Oak of Christ, because it was said to have sprouted from an acorn that fell at the time of the birth of Christ. The oak has been placed under protection since 1928, but was regarded as preservable already in 1905, by the placing out of six stones surrounding the trunk. Detailed accounts from the 18th Century tell us that the trunk was already then hollow at the base; apart from caused by the obligatory invasive fungi, perhaps further aggravated by the farmers' habit of building fires of branches and miscellanous rubbish at the foot of oaks. This is information I've picked up from reading and listening to Thorsten, but now its time to get out of the cars and finally have a look at the tree in real life!

From the parking lot a narrow trail leads to the giant. We are not alone. Some German tourists – the area is rather popular with Danish, German, and Dutch cabin owners – have also found their way over here. Approximately 50,000 persons a year visit this place. The first impression is the present shortness of the oak. We estimate its height to 12 or 13 meters. The oak of Kvill has obviously once been much more statuesque, but during the severe winter of 1708-09 the crown was reported to have withered away, and since that time the oak has crouched down considerably more. It is also lacking leaves.

Deciduous oaks are no doubt renown for holding on to their leaves well into the winter (*Q. petræa* even until the emergence of the following season's leaves), but the Oak of Kvill is now the only oak in the domain that has already shed its leaves, as well as the acorns that it still emits in large quantities during masts. This, although it's only the 18th of October today, and the autumn has been mild.

We approach closer. The next thing that is striking about the Oak of Kvill is the furrowed and ridged trunk; or I should rather talk about its enormously crusty and coarsely cracked, rugged bark. It looks almost as if lava had suddenly erupted from a volcano, but since long ago stiffened into ash-grey tuffa. Due to the hollowing out of the centre, the rest of the trunk is more like a thick skin. Before protection, this cavity was used by the farmers as a toolshed. The opening of the trunk goes straight in a northern-southern direction.

How could it live for so long? Why wasn't it cut down for timber? How can a protected tree be allowed to wear two sharp and non-elastic bands of metal around it? These are some of my most haunting questions, along with the following one: how could the Oak of Kvill grow that big when it stands in such poor soil?

The ground surrounding us is pastoral, with plenty of browsing cows, and typical for the province of Småland, full of boulders and with a shallow layer of mould. The most characteristic tree in this biotope is the juniper (*Juniperus communis*). It completely dominates the landscape no matter in what direction you´re looking. For the time being the Oak of Kvill receives undeserved competition for nutrition, and more importantly light, from a mere 60-70 year old offspring that has been allowed to grow up only some ten meters towards the northwest. Thorsten and I agree that this ”suckling” should be removed immediately, in order not to further put stress on the giant. Oaks as old as the Kvill one not only need a maximum amount of light, but also free entry for the wind, so that fungi specializing in attacking rotten wood are not activated in the extreme.

I step over the iron chain that surrounds the tree at ground level and place myself in the midst of what was once the very centre of the trunk. Green moss is plentiful, like some kind of belt made of velvet, reaching from my waist up to about three meters high. The same part of the interior wood is in many places full of circular holes, drilled by insects, with a diameter of one millimeter. It is the abundant quantity of bitter tannins in the wood, as well as in the leaves, that in the shorter perspective makes both less than tasty for many vermin. In combination with the deep roots, these are the factors making the longevity of oaks possible. But this doesn't hinder older trees from attracting hoards of parasites, not the least being fungi that thrive on decomposing wood (particularily the oldest parts in the centre). The brownish-black mass that is formed, the mulm, is the home of innumerable insects that live off the fungi. Many birds in their turn eat the insects that are specially adapted to oaks. It is in various cavities in the tree that the mulm is created, consisting of sawdust like residuum of gnawing, manure, dead animals, bird nests, etc.

When I step out from the interior my head is full of thoughts about what the oak might have experienced in terms of changes during its enormous life span. Not that trees are able to think, but in its late capacity as tree champion, this oak must have been exposed to a whole lot of extra attention from humans. It has, for example, appeared in many documentaries on television, as well as being featured in a movie that was quite famous in the late 1960s (not the least because of its sex scenes) called “I Am Curious Yellow/Blue,” respectively, both by Vilgot Sjöman. The reason behind the choice of the Oak of Kvill for erotic exercises might stem from the fact that the director happend to have been raised in the area. Whatever one thinks of film director Sjöman's taste when it comes to connecting explicit scenes with the famous oak, it is nevertheless fairly innocent in comparison with all the human sacrifices and hangings that mankind has so often willingly used thick branches of oak for.

The number of species that directly or indirectly depend on old oaks for their existence is mind-boggling. It's one thing that tropical trees in a rain forest are the hosts of very large numbers of individual species, not yet even labeled by the scientists, but here – from the perspective of biodiversity – in a rather poor corner of northern Europe, *Q. robur*, being regarded as a biotope, is completely in a class of its own. Fifty years ago scientists thought that 500 species of insects, fungi, moss, and lichen might be living off the oak, and later this figure was upgraded to something like one thousand. Nowadays, many experts regard the figure of 1500 as more likely, with most of these not existing anywhere else and birds and bats not counted. One should keep in mind that the complete flora and fauna of a country like Sweden contains not more than circa 50,000 species all in all. From an ecological point of view it is important that the distance between old oaks is not too far, since the parasitical species existing on these long-lived and hence relatively stable creatures for that very reason are not themselves adapted to a life of motion. It is the shear volume and age of mature and aging oaks that create the multiplicity of micro-enviroments. We are now talking about dead wood in various phases of decomposition, the living wood, the roots, the crown with its leaves and acorns, the sunny side of the trunk with its inumerable crannies and cracks as well as the shady side, with a considerably cooler climate, plus dry fallen branches that should be allowed to remain on the ground, withering away. Each of these niches are homes of separate species.

When it comes to the iron bands around the Oak of Kvill, the first was put on as early as 60 years ago by a blacksmith called Fransson, on request from local authorities. A generation later, in 1992 to be precise, this was supplemented with another band, higher up on the trunk, this one added by the son and grandson of the first smith. Standing by the oak today, it is easy to observe that the bands are cutting into a still growing tree. Back in 1913, for example, the circumference was ”only” 12.75, as opposed to today's 14.11 meters. The Oak of Kvill thus continues to expand at an average pace of more than 1.3 centimeters each year, obviously only from the exterior, which is identical with the layer that is affected by the iron bands. These bands are already in the process of being walled over by the oak. In fact they were removed in an attack in 2002 by a person who thought he was doing the tree a service, only to be put back again immediately. However, as my cicerone puts it, today it is already too late to remove the bands without installing better cabling and bracing first, since especially the lower one, with an iron wire attached to it, is what – strangling or not strangling – holds the oak together. Without support, the Kvill Oak would hardly be able to stand on its own any more, since the part of the trunk facing south would then fall out and possibly drag the rest of the tree along with itself in the fall. As long as this is not happening, the oak should be able to get by for another century, especially given the fact that it looks considerably healthier today than it did after the severe drought in 1959, when it was about to give in.

The hurricane Gudrun, which in January 2005 turned over hundreds of millions of trees all over northwestern Europe (in the southern part of Sweden alone 75 million square meters of wood, the same quantity as the total take out of three years of ordinary industrial activity), didn't affect the giant at all, even though mature oaks are somewhat vulnerable to wind.

How could the Oak of Kvill grow so large, granted that the hunger after boards of oak for the use of the navy was immense, and for centuries? First of all, the Oak of Kvill happened to start growing on a less than optimal spot. This was not where people were looking for large oaks. Secondly, it has had good access to water, even though it has in all likelihood been browsed by cattle. But, on the other hand, for the same reason probably during its entire life it has been protected from the woods growing too close. It is surrounded by big stones, which might mean that it sprouted on a spot that was difficult to get at for the animals, on top of it being surrounded by junipers, something that should have increased the possibilities for the tree in its youth to be spared the axe and the muzzle.

The oaks of Sweden were the propriety of the State, and because of this loathed by the peasants, who didn't have much to gain themselves from having oaks on their land. Consequently, in all secrecy, they tried to get rid of small oaks as soon as they appeared, in marked contrast to the aristocracy's contrary need to adorn their parks with as many mighty oaks as possible. For the peasants, oaks were simply associated with nobility and the authoritarian repression of the State. An edict concerning the preservation of oaks was put forward already in 1347, included in the national law of King Magnus Eriksson. These restrictions were further enhanced by King Gustav Vasa in 1558, only to be accentuated even further during the era of Sweden as a great power, when it was directly called for to actively plant oaks. From 1746 the oaks were owned by the State, even if they grew on the private land of individual farmers, and since the farmers needed boards of oak themselves for larger constructions, most probably a lot of trees were chopped down outside the villages. This was a crime that was severly punished, making the oak even more hated, especially since the ones that grew out in the pastures and on the meadows diminished the output of crops by casting shadows and absorbing nutrition; not to mention that they also embittered the soil with leaves that take their time to decompose. It wasn't until 1830 that peasants could buy the oaks growing on their own grounds. The requirement of the State didn't end until 1875, with the exception of the land owned by the church. The authorities kept control well into the 20th century. For the majority of the population, the advantages of growing oaks were – at least legally – solely the use of acorns as food for pigs (and during famines for the humans too, for sure), the tannins in the bark for the preparation of leather, the production of various medicial treatments, and for the making of ink.

Oaks have more often than other trees been in demand for the construction of warships. In order to build a large flagship in the 17th Century, about 2000 mature oaks were utilized. On top of this, the erection of castles and churches swallowed enormous amounts of larger oaks, preferably cut down when they had reached the age of 150 years, with a diameter of 75 centimeters. It might be a bit difficult for somebody living today to fully understand the number of large oaks that were used. According to the Ministry of Forestry there are even today approximately 14,000 oaks, only in Sweden, with a circumference above four meters, especially in the provinces along the Baltic Sea. This is a low figure – and one that is going to diminish even further – as opposed to in the old days. During the 18th Century the navy counted that within one single parish there would be 38,500 oaks to be eventually cut down, and the oaks belonging to the church and aristocracy, as being excluded from the state monopoly, were not counted. As soon as the monopoly on oaks was terminated, the amount of larger oaks was increasingly dwindling away, since the individual peasant gladly got rid of the trees that were standing on his fields and competing with the crop for light and water. This tendency is continuing today. The elderly giants have fewer and fewer successors.

The Oak of Kvill is pretty much the same age as Christianity in Sweden. It is difficult not to mention that the oak in the pre-Christian era was looked upon as holy – as the tree directly associated with Thor, god of lightning (a Scandinavian version of the olympic Zeus or Jupiter). After the breakthrough of Christianity, elderly oaks were no longer protected, in fact rather being regarded with suspicion, as symbols of heathen superstition, still clearly visible in the landscape itself.

In order to understand how extremely rare an oak like the one in Kvill truly is, I might perhaps concludingly put forward the fact that the second largest oak in the country, in terms of girth, measures ”only” 11.08 meters.

As we all know, some of the oldest trees in the world are growing in places a lot warmer than Scandinavia. But if I may speculate a bit, one could perhaps add a few lines about the influence of climate on wood as well on the surrounding flora and fauna. It's not by coincidence that the oldest wooden buildings in the world are standing in Scandinavia, namely the more than one thousand year old Norwegian stave churches, built exclusively of oak boards. In tropical areas, on the other hand, to go to the other extreme, there are hardly any examples of wooden buildings older than a century. Well before that age, they usually are already being destroyed, and even eaten by termites and other thermophile vermin. Dead wood and living are certainly different things, but are there any oaks in tropical or subtropical zones as old as the Oak of Kvill? Is it by chance that the perpetual battle between the powers of decomposition and reconstruction that we call by the name of nature, precisely at the very outskirts of the oaks area of geographic extensiveness, has manifested itself in a Methuselah like the Kvill Oak?

Stefan Foconi is a writer of fiction and an amateur oak collector with some 30 species of *Quercus* in his Norwegian garden, situated on the 61st latitude. He is interested in trying various hardy species of oaks and would like to have contact with members who share his interest and would be willing to exchange acorns or experiences. Please contact him via email: *sfoconi@hotmail.com*

Conserving Oaks in North American Plant Collections: A Collaborative Approach

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As much as any ardent collector would love to comprehensively represent the variety of the genus *Quercus* in her garden, the great taxonomic diversity, range of natural habitats, and large mature size of oaks make that virtually impossible. With that in mind, a new cooperative group of American public gardens has recently formed with the goal of representing the oak diversity of North America in its collections. The 15 member gardens were recently recognized as the first multi-institutional collection of the North American Plant Collections Consortium (NAPCC). The members of the multi-institutional *Quercus* collection include:

Chicago Botanic Garden – Glencoe, Illinois - 48 taxa
Cornell Plantations – Ithaca, New York - 77 taxa
Denver Botanic Gardens – Denver, Colorado - 61 taxa
Holden Arboretum – Kirtland, Ohio - 64 taxa
Landis Arboretum – Esperance, New York - 14 taxa
Missouri Botanical Garden – Saint Louis, Missouri - 40 taxa
Morris Arboretum of the University of Pennsylvania – Philadelphia, Pennsylvania - 58 taxa
The Morton Arboretum – Lisle, Illinois - 67 taxa
Mount Auburn Cemetery – Cambridge, Massachusetts - 25 taxa
New York Botanical Garden – Bronx, New York - 46 taxa
Rancho Santa Ana Botanic Garden – Claremont, California - 27 taxa
Scott Arboretum of Swarthmore College – Swarthmore, Pennsylvania - 52 taxa
UC Davis Arboretum – Davis, California - 92 taxa
University of California Botanical Garden – Berkeley, California - 71 taxa
University of Washington Botanic Gardens – Seattle, Washington - 86 taxa

A program of the American Public Gardens Association, the NAPCC is a coordinated network of public gardens dedicated to preserving and expanding the plant diversity represented in gardens for the purposes of conservation, research, education, and public enjoyment. The program celebrates the value of plant collections and promotes high standards of plant collection management. In cooperation with the USDA Agricultural Research Service germplasm repository program and the US National Arboretum, the NAPCC recognizes and supports plant collections of national significance. To date, 42 public garden institutions in North America have committed to holding one or more NAPCC Collections, which together represent a broad variety of species and cultivars of woody and herbaceous ornamental plants.

Establishing the NAPCC Multi-Institutional *Quercus* Collection took nearly two years of leadership and diligent effort on the part of Dennis Collins, horticultural curator at the Mount Auburn Cemetery. Collins started in 2005 by exploring the murky waters of *Quercus* nomenclature and developing a comprehensive list of accepted names and synonyms using regional floras and floristic databases

The UC Davis Arboretum chose to celebrate their oak collection's induction into the North American Plant Collections Consortium with an official ceremony. Emily Griswold (center) and Neil Van Alfen (right), dean of the UC Davis College of Agricultural and Environmental Sciences, presented a copy of the NAPCC certificate to John M. Tucker, a lifelong oak scholar and Arboretum supporter.
Photo by Dawn Spinella

from around the world as arbiters. Through this process, he came up with a list of accepted names for naturally occurring oak species, subspecies, varieties, and hybrids worldwide. He then began searching for large oak collections in North American public gardens using word of mouth, an old national inventory of public garden collections, and garden websites as guides. According to Collins, "my goal was finding 10-15 institutions with the broadest taxon diversity, the strongest institutional commitment, the widest geographic representation and a variety of institutional strengths and missions." After successfully convincing 15 such institutions to participate, Collins compiled inventories from the candidate gardens and compared them to his accepted names list. This allowed him to quantify the proportion of North American and world oak diversity represented in the group's collections and to identify gaps of unrepresented taxa. After this first multi-institutional collection application to NAPCC was submitted and 15 site reviewers confirmed that each institution met collection management standards, the collection was accepted into the NAPCC program in August of 2007.

As of July 2008, an updated inventory of the multi-institutional *Quercus* collection included more than 7,500 specimens representing 169 naturally occurring taxa (species, subspecies, varieties, and hybrids). The collection represents 132 oak species, 96 of which are from North America (including Mexico). Of the naturally occurring oak subspecies, varieties and hybrids, the collection includes 37 infraspecific taxa, including 31 from North America. The collection also includes

The rare *Quercus brandegei* Goldman from Baja California, Mexico grows in the collection at the UC Davis Arboretum. Mild winters allow the garden to successfully grow oaks from Mexico and Central America outdoors.

Photo by Emily Griswold

486 specimens of cultivated taxa, including named cultivars and several unnamed artificial hybrids. The nomenclature for this group of plants is still in need of systematic review.

The diversity of the collection is also reflected by the diversity of strengths and interests of the member institutions. Two institutions focus on a particular geographic region of the oak's range: the northeastern United States in the case of Landis Arboretum and the California floristic province in the case of the Rancho Santa Ana Botanic Garden. At the Morris Arboretum, an active international collecting program has resulted in a rich collection of wild-origin hardy oaks from China and around the world. The mild climates at the University of California gardens in Berkeley and Davis allow these institutions to grow a diversity of more tender Mediterranean, Mexican, and Central American oaks. Cornell Plantations houses a variety of experimental oak hybrids, and the collection supports an active breeding research program. In addition to oaks collected elsewhere, several of the institutions are also home to beautiful heritage oaks native to their sites. For example at Mount Auburn Cemetery, where historic preservation of the landscape and monuments are a major focus, 30 of their current oak specimens predate the founding of the cemetery in 1831.

One of the greatest benefits of the multi-institutional *Quercus* collection is the potential for greater collaboration among the member institutions to achieve goals that wouldn't be possible individually. Representative staff from each institution

Luxuriant evergreen foliage of *Quercus rhysophylla* Weath., a Mexican native, at the University of California Botanical Garden at Berkeley.

Photo by Paul Licht

makes up the NAPCC *Quercus* Curatorial Group, which meets annually and has a rotating coordinator position currently held by the author. The group has identified six major goals:

- Conserve germplasm for the genus *Quercus* with an emphasis on North American taxa
- Elevate curatorial standards and improve the credibility of collections-based programs in public gardens
- Determine strategic targets for new acquisitions and acquire new material to expand the collection
- Enhance research into oak taxonomy, hardiness, disease-resistance, and breeding
- Promote collaborations among different institutions and organizations
- Promote public awareness of and appreciation for oaks

Guided by these goals, the NAPCC *Quercus* Curatorial Group has taken on a series of initiatives, one of the first of which was to create a webpage that would serve as a public portal to the collection. The webpage contains a written profile of the collection, links to each member institution, a downloadable spreadsheet of the annually updated collection inventory, and links to online oak references of interest. Ultimately the group hopes to develop an online searchable database of the inventory that will facilitate research use of the collection. An initiative to raise the curatorial standards of member gardens and increase documentation of the collection calls for creating voucher herbarium specimens. Each of these dried, pressed specimens serves as a permanently preserved record of a plant in the living collection and can be sent to expert botanists to verify the plant's identification. Duplicate voucher specimens will be centrally housed at the Liberty Hyde Bailey Hortorium at Cornell University and the US National Arboretum Herbarium, where they will support a larger national project to create a Cultivated Flora of North America.

One of the most important and ambitious initiatives of the NAPCC *Quercus* Curatorial Group is to expand the collection to represent all naturally-occurring North American oak taxa. This will need to be accomplished not only through the expansion of collections at existing member gardens, but also through the recruitment of new member gardens with complementary collections. The group has a target list of unrepresented taxa that was developed by comparing the accepted names list Collins developed with the complete collection inventory. Several member gardens have committed to acquiring specific taxa (with a likelihood of surviving in their climate) from the target list within the next three years. Large gaps remain on the target list for species from the southeastern and southwestern US and species from Mexico. No member gardens currently exist in these regions, and the oaks from these areas generally are not hardy enough to survive in the colder northern climates where most of the member gardens are located. The group is currently seeking gardens with large oak collections in the southeastern US, Texas, and Mexico to join the multi-institutional collection and would appreciate assistance from the International Oak Society membership in locating such gardens.

In order to join the NAPCC, each member garden goes through an application and site review process coordinated by NAPCC Manager Pam Allenstein, an employee of the American Public Gardens Association (APGA). The NAPCC program is intended to promote the long-term preservation of high quality, publicly accessible plant collections. To be eligible for participation, a garden must have:

- A unique, diverse collection with records on the origin of the plants;
- Long-term institutional commitment to collect, document, grow, and maintain the living plants in the collection and conserve their germplasm;
- The governing body's support, including provision for adequate and sustained resources for the long-term care of the collection;
- Maintenance of the collection in accordance with professional horticultural and curatorial standards with a designated curator and collections policy;
- Reasonable access to the collection for research, evaluation, and introduction;
- And an active membership with APGA.

Those with an interest in joining the NAPCC are encouraged to contact Pam Allenstein for additional information and guidance. A regional network of mentors and recruiters throughout the United States can also assist gardens that are considering submitting applications to the program. Over the past year, four International Oak Society members with extensive oak collections have approached the NAPCC with an interest in joining the multi-institutional *Quercus* collection. The NAPCC *Quercus* Curatorial Group looks forward to expanding the collection to include more of these gardens and a greater diversity of oaks.

The International Oak Society and NAPCC *Quercus* Curatorial Group share many overlapping goals, and collaboration has great potential for mutual benefit.

A magnificent eastern black oak (*Quercus velutina* Lamarck) specimen at the New York Botanical Garden.

Photo from New York Botanical Garden (photographer unknown)

A formal allée of swamp white oak (*Quercus bicolor* Willd.) at the Scott Arboretum at Swarthmore College.

Photo from the Scott Arboretum (photographer unknown)

A heritage scarlet oak (*Quercus coccinea* Münchh.) grows among the monuments at Mount Auburn Cemetery, where preserving the historic landscape is important.

Photo from Mount Auburn Cemetery (photographer unknown)

Curatorial group members have been encouraged to join the International Oak Society, and several are planning on attending the 2009 conference in Puebla, Mexico. Oak taxonomy is notoriously challenging, and the curatorial group is interested in partnering with IOS members to promote research and share new information in this area. Sharing of information has the potential to be useful in all sorts of ways from sharing interesting stories that can enliven garden educational programs and promote oak conservation to sharing expertise about propagation tips or fruitful collecting locations that can help diversify private and public gardens. The member gardens of the NAPCC *Quercus* Collection can benefit IOS members as public reference sites for oak identification, potential sources of acorns (with permission), and places for oak research and study. IOS members can help support the NAPCC member gardens by contributing their expertise as volunteers to oak curation, maintenance, or educational programs. Last but not least, collaborative collecting trips and acorn exchanges have the potential to result in rich collections and experiences for all parties involved.

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Web Resources:

NAPCC webpage:
http://www.publicgardens.org/web/2006/06/napcc_home.aspx

NAPCC Multi-Institutional *Quercus* Collection webpage:
http://www.publicgardens.org/web/2008/08/multiinstitutional_quercu_oak.aspx

Celebrating the Tradition of Managing Trees in the Forest of Dean

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On June 18th 2008, an event at the Cyril Hart Arboretum in the Forest of Dean marked the 200th anniversary of the passing of the Dean Forest (Timber) Act 1808. Having spent a lifetime involved in forestry, it was satisfying to be able to mark this long history of managing trees in the Forest of Dean.

But the story starts with mismanagement. Centuries ago, in 1633, John Broughton was appointed as the first Deputy Surveyor for Dean Forest. The prompt for his appointment was concern about the state of the Forest. His first task was to survey the trees in the Dean, and he established that many trees and much timber had been destroyed, with the notable exception of Lea Bailey.

A few years later, this situation was exacerbated when the whole forest was effectively sold to John Wintour in 1640 and subjected to exploitation of the resources, particularly iron ore and timber for charcoal.

Concern was raised, and in 1668 the Dean Forest (Reafforestation) Act was passed with the intention of enclosing and planting 11,000 acres. The Act established commissioners to oversee this enclosure. Since that time, responsibility

Rob Guest, Deputy Surveyor, addresses participants at the event.

for ensuring healthy tree growth has been shared by the Inclosure Commissioners, the Verderers, and the Deputy Surveyor and his staff. The Queen's Remembrancer, who was also present at the event in June 2008, and his predecessors have been involved in forestry in the Dean for some 350 years in appointing the Inclosure Commissioners.

It is clear that through the 1700's increasing the timber resource was not an easy task, at a time when demand for timber for the navy was increasing. By the time of Nelson's visit to the area in 1802, it was recorded that only 676 of the 11000 acres had been enclosed.

Nelson's visit was a landmark. He talked to concerned locals and prepared a strong report for parliament in 1803 urging the planting of more trees in the Dean for the benefit of the nation. This led to the important legislation in 1808 which was to have such a big impact on the Dean.

The first thing the Act did was to reinforce the legality of enclosures already made – specifically Stapledge, Speech House, Birch Wood and Buck Holt. It also introduced penalties for breaking down fences and enclosures. And it laid the foundation for a planting boom.

Inclosing and planting began in Autumn 1808. Over the next ten years, some 100 miles of new fences were formed including 25 miles of stone walls and 70 miles of earthen banks with gorse hedges. These banks were 5' high and 4'6" wide at the base with an outside ditch. They were completed with 3 rows of gorse, one on top, the others at the bases.

Before 1811, trees were established quite densely at 2722 to the acre – but because of the time delay in producing sufficient seedlings, the establishment was mainly with acorns with every 10th being a 5 yr old oak seedling and every 100th being a sweet chestnut seedling. On sites less favourable for oak, other species including elm, sycamore, Norway spruce, European larch and Scots pine were planted

After 1811, year old oak seedlings were favoured over acorns. These were supplemented with large oaks (up to 30 feet high) transplanted from Acorn Patch. By 1820, a fifth of the planting was with European larch and Scots pine as conifer nurse crops to draw the oak up.

This was all not without difficulty. There were sheep, cattle, rooks, and oak leaf roller moth to name a few of the problems….

From autumn 1813 and through much of 1814 there was a plague of mice. It is estimated 200,000 seedlings and acorns were destroyed during that time. Several plans to control the mice failed. Eventually a Mr Simmons from Edge Hills (a miner) recounted how mice fell into his mine and he developed a pit – 2' square and deep with a slightly wider base into which the mice fell and couldn't get out. These were dug 20 yards apart across the Forest, and Simmons and his mates were paid a bounty on mice tails - the Deputy Surveyor at the time paid out on over 100,000 tails. Various animals came to exploit the mice – e.g. polecats, and the first record of little owl in the Forest was noted.

Ten years on in 1818, the 10324 acres (to bring the total enclosures to 11,000 acres) had been established – an impressive achievement which would be a challenge even today. It is interesting to speculate who to credit most for this achievement – there are a number of possibilities: Glenbervie (the Surveyor General), Price (brought in as special advisor when Glenbervie was suspended), Machen (the Deputy Surveyor at the time), the Drivers (the planting contractors),

Senior Master Whitaker (the Queen's Remembrancer) and Rob Guest, the Deputy Surveyor, with the unveiled boundary stone.

Billington (their local supervisor) or Sleed (their agent). In discussing this with Dr Hart we have together concluded that it is likely all played a significant part – although it is interesting that in the records of the time they rarely acknowledge each others' contribution.

A feature noted at that time that still prevails today was the real lack of any very old trees in the Dean. With the exception of the Newland Oak outside the Forest, the only others noted were Jack of the Yat and the Crad Oak - both located near the Big Hill. Today, the Crad Oak still exists, and a number of trees planted after the restoration of the monarchy in 1660 are also now considered to be veterans.

Contrary to common perception, the enclosures were made with very little opposition. Controversy only surfaced a decade or so later - the commoners felt aggrieved by 1831 when they considered the trees had become established and the enclosures had not been thrown open. In June 1831, Warren James and about 2000 others threw open most enclosures by destroying nearly a third of the fences. The Deputy Surveyor called in the Royal Monmouthshire Militia (with their caps!) and the Third Dragoons to quell the riot.

This all helped to precipitate the 1831 Commission which looked at a range of issues and traditions including encroachment and freemining – but that's another story…….

By 1841 the process of throwing open and enclosing new areas on a rolling basis had begun, and this continued through to about 1872. The last significant loads of timber for the navy left in 1855 with small amounts till 1874. After that, the oak was mainly used for mining timber with particular demands during the two war efforts in the 20th century, but there were still significant areas of oak left unexploited.

This has left us with a legacy. The Dean is now considered to be Britain's premier oak forest - and this is down to the foresight of the legislators who pushed through that Act of Parliament in 1808.

I would like to acknowledge my gratitude to Dr Cyril Hart OBE - it is through his scholarship that we have such a good understanding of the history of the Forest and the nature of its management and I much appreciate having been able to discuss these issues with him.

Survivors—the Founding Member Trees of the Live Oak Society

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In South Louisiana, the landscape lies flat as cut sugarcane. Here, the sprawling shape of a live oak tree can dominate the view for miles. By the sight of a familiar oak you can tell where you're going, where you'd been, and how much farther you have to go before you reach your destination. Live oaks are heritage, heirlooms, and history all rolled into one. On the old land maps, oaks marked where one property line ended and another began. They were a point on the horizon to aim the blade of a plow or the nose of a tractor. They mark where back roads cross and provide a shady spot where neighbors can park their pickups, pass a plastic thermos cup of chicory coffee, and discuss the weather. Duels were fought and honor won or lost under their bowed limbs. People picnic under them, get married under them, dance the two-step under them, and finally when the music ends, are laid to rest alongside their massive roots.

In April 1934, Dr. Edwin Lewis Stephens, the first president of the Southwestern Louisiana Institute (now University of Louisiana at Lafayette), published an article in the *Louisiana Conservation Review* titled, "I Saw in Louisiana a Live Oak Growing." The piece drew its name from a poem by Walt Whitman, and like Whitman's poem, Stephens praised the singular beauty of this distinctly Southern species of oak (*Quercus virginiana*). His appreciation for live oaks grew over many years of being raised and living in Louisiana and from frequent motor trips he took with his wife along the back roads and byways through Cajun country. Influenced by his background as a science teacher, he observed, measured, photographed, and collected data on the oaks, taking special interest in the oldest and largest of the species. And from his orientation as a scholar and poet, he recognized the deeper truth of this Southern icon—that more than any other aspect of the landscape, the live oak symbolically reflects the most memorable and distinctive characteristics of the cultures and people that settled this rich alluvial area: strength of character, forbearance, longevity, and a hearty nature.

Eventually, Stephens was inspired to propose the creation of an organization that might preserve and protect the most senior members of this oak species, those "…whose age is not less than a hundred years..." He was not at a loss for examples near his home in Lafayette. As he noted in his *Conservation Review* article, "I, at present, number among my personal acquaintance forty-three such live oaks in Louisiana eligible for charter membership." These forty-three oaks comprised his original inductees into what is known today as the Live Oak Society. Seventy-four years later, the Society counts more than 5800 member oaks on its registry in 14 states (and now includes junior league trees with a girth of at least eight feet).

Early in my efforts as a photographer/artist, an older and wiser photographer friend advised me that if I wished to make more powerful and personal images, I should find something I loved and photograph it—over and over again. When I looked around my native Louisiana, I found myself drawn to the old oaks, and still do today. For more than two decades, I've focused my camera's lens on these elder trees of Louisiana's landscape over and over again, searching to reveal their unique character and spirit. A sampling of my black-and-white images of live oaks was published by Bullfinch/Little Brown Books in 1998 in the book titled, *Heartwood, Meditations on Southern Oaks*.

The 100 oaks project.

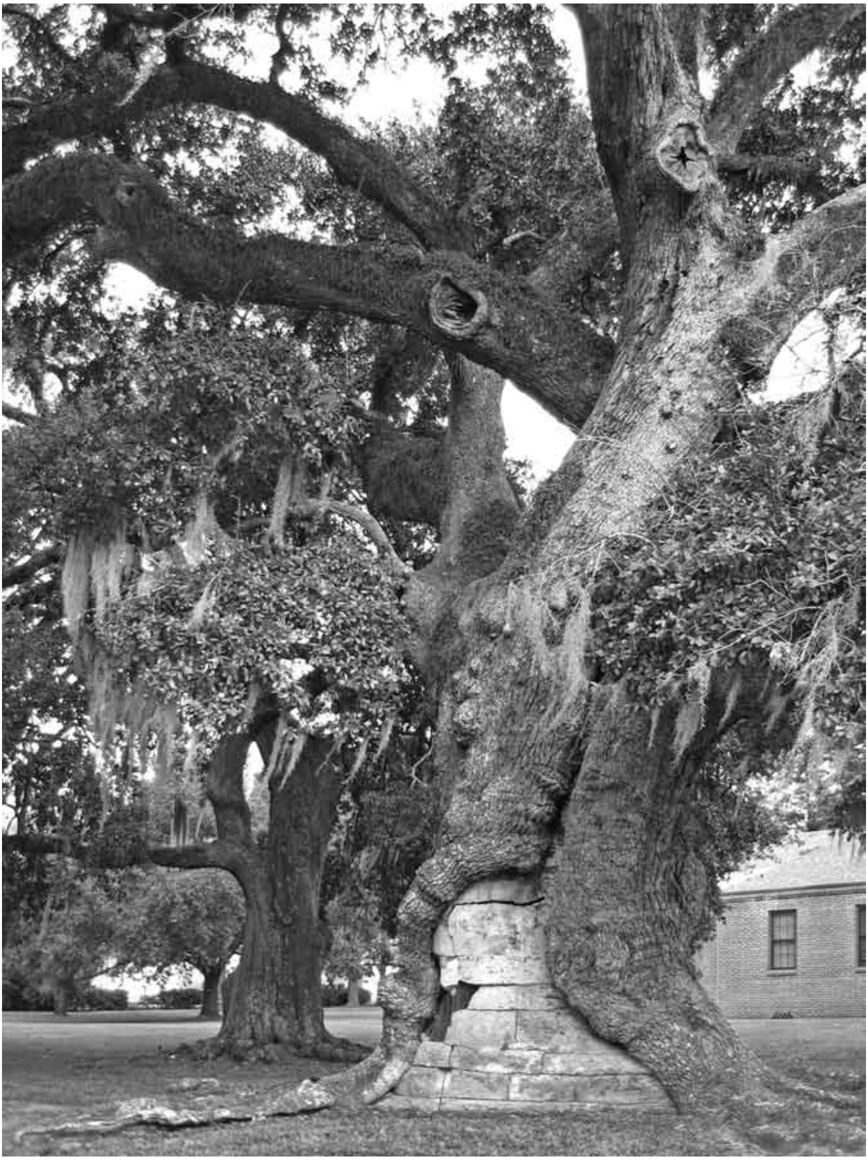
After the devastating one-two blow of Hurricanes Katrina and Rita in late 2005, I realized that even the most permanent aspects of my native Louisiana could be lost overnight. Even centuries-old trees were not invincible. And though I had photographed several historic oaks, I had never seen many of the Society's oldest member trees, including most of Dr. Stephen's original inductees. So I turned my focus to documenting the "survivors"—the Society's 100 largest and oldest oaks, beginning with Dr. Lewis's forty-three charter member trees.

Using his 74-year old article as a guide, I began retracing his drives across South Louisiana, along bayous with names like Teche, Lafourche, Maringouin, Grosse Tete, and Terrebonne, and the along banks of the Mississippi River and Lake Pontchartrain—French and native American names that evoke romantic images of moss-draped trees, Cajun fisherman in flatboats, sultry heat, and white-columned plantation homes. Dr. Stephens listed the 43 charter oaks in order of their size—large to less large—noting the circumference, name (usually that of a sponsor), and general location.

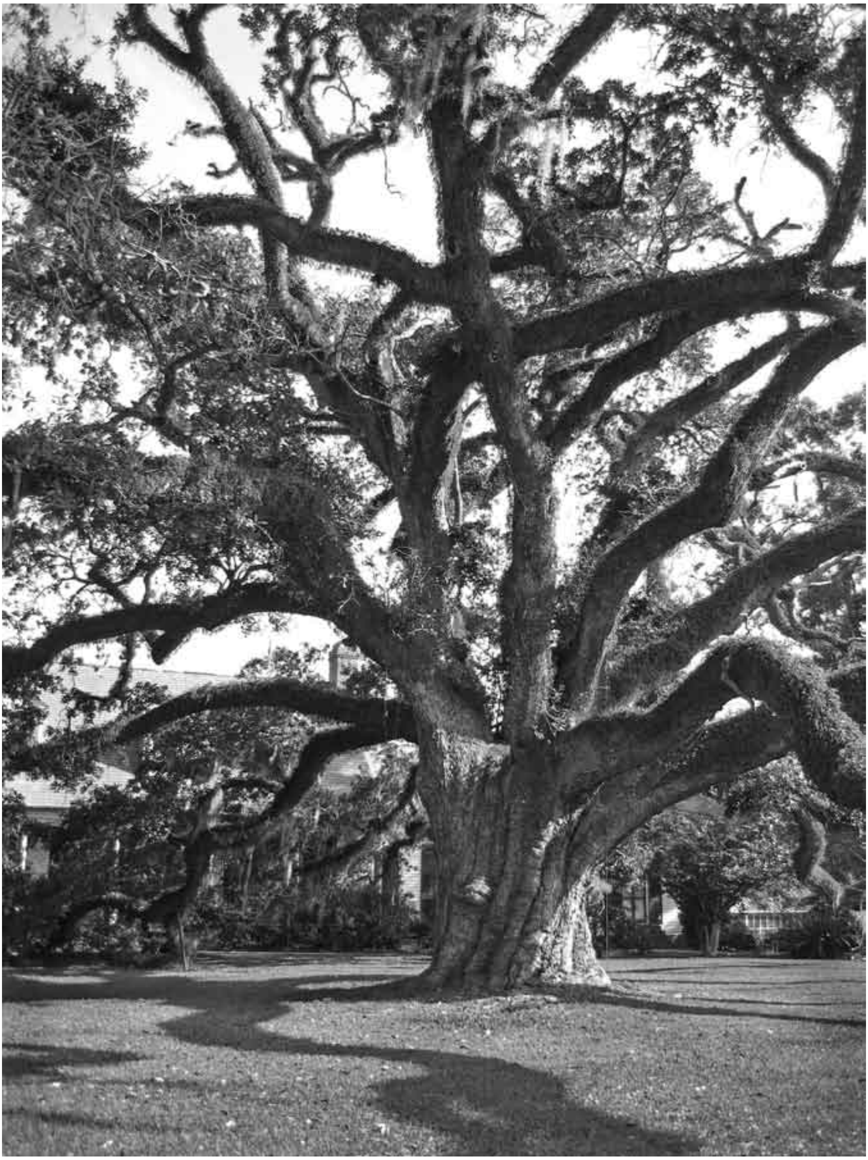
I quickly realized on my journeys that I was naïve about the degree of change that can occur in a landscape over 74 years. Plantations have faded away, changed names, been parceled off and subdivided. Properties have changed owners, and entire families have died or moved away, and even trees of the size and magnificence of the Mays Oak were lost with the passing years. In some cases oaks have been registered more than once, and by different owners adding to the confusion between Dr. Stephens article and the current landscape. Some oaks were known to a few locals and were not particularly difficult to find. Others required extensive research through libraries, Web sites, and books, and the help of many local librarians, chambers of commerce, sheriff's deputies, and Louisiana Garden Club members across the state.

The top three oaks were the Locke Breaux Oak (a beautiful giant named after a descendent of the English philosopher, John Locke) located near Hahnville, in St. Charles Parish; the Arnaud Robert Oak, near Breaux Bridge in St. Martin Parish; and the George Washington Oak, located in Audubon Park, in New Orleans. They have all died since 1934. The Locke Breaux Oak reportedly died from air and water pollution from nearby chemical plants, and the other two from natural causes.

Fourth on the list was the Luling Oak, now also known as the Lagarde Oak (current girth, 30 feet, five inches). This elder oak towers above traffic passing along Old Spanish Trail (US Highway 90) in Luling. Fifth was the Martha Washington Oak, the mate of the George Washington Oak, which still stands in the rhino and wildebeest habitat at Audubon Zoo, sharing her habitat with the zoo's gray rhinos, Yvonne, Macite, and Saba. Martha's current girth is 28 feet, seven inches. The Mays Oak, sixth on the list, is located on the right bank of Bayou Grosse Tete, near Live Oak Plantation.



Beaux Bridge Oak photo © William Guion



Gebert Oak photo © William Guion

The number seven had several sevens associated with it. Stephens called it the Seven Sisters Oak, but it is now known as the Seven Brothers or Lastrappes Oak. Located two miles west of Washington in St. Landry Parish, this magnificent oak is comprised of seven main trunks growing in two clusters that merge into a single base. One cluster is 32 feet, two inches in girth, the other twenty-eight feet eleven inches. The current name originated with a previous owner of the property who reportedly had seven sons. As the legend goes, Mr. Lastrappes sent his sons into the woods to each gather a live oak sapling that he planned to plant in a row in front of their home. The sons piled the saplings together in the yard, but then the next day the call to arms of the Civil War caused the sons to leave home and enlist. The trees were never transplanted into a row, and they eventually grew together. However, based on the size of these oaks, it's more likely that they were planted as much as 150 to 200 years prior to the Civil War.

The remainder of the list of inductees is as follows:

#8 – Jamison or Jackson Oak. I assumed this tree would be easy to locate. Dr Stephens described its location on the Preston Pugh Plantation in Lafourche Parish, near Thibodaux, my hometown. But after extensive research, I learned the property had changed hands several times since the 1930s and today is completely overgrown with small trees and brambles. There's no evidence of the oak or even a plantation home at the site. I assume it's deceased.

#9 – The Kaplan Oak. Though reportedly still alive, I was unable to photograph this oak because it is located on a small island in Vermillion Bay near the mouth of the Vermillion River and is accessible only by boat.

#10 – The double live oak at Parks on Bayou Teche. I was unable to locate this tree, but found a stump of what was once a double-trunked oak of approximately the correct size and so suspect it is deceased.

#11 – The Maryland Oak. Located near New Roads, on False River, this historic oak was the inspiration for James Ryder Randall's song, *Maryland, My Maryland*. He supposedly penned its lyrics under this oak's limbs. It's confirmed alive, even though I've not yet found it.

#12 – The Potier Oak in Parks. I believe I've located this tree based on its measurements, though it's still unconfirmed.

#13 – Audubon Park Oak #3, Etienne de Bore Oak. This oak was later named the Etienne de Bore' Oak after the plantation owner whose land became Audubon Park and is noted in local history as the first man in Louisiana to successfully granulate sugarcane into sugar. The tree is now nicknamed "the Tree of Life" by locals. (34 feet, four inches).

#14 – Breaux Bridge Oak. Located in the southeast corner of the town square, this oak is being considered by the city council for removal. The city is facing a lawsuit for a large limb that fell onto a parked car during a storm. (26 feet 7 inches)

#15 – Bayou Grosse Tete Oak. Located on the north side of Interstate-10 along Bayou Grosse Tete. (30 feet, 3 inches)

#16 – Stonaker Oak. Growing north of the intersection of Airport Road and Highway 820 outside of New Roads. (28 feet, 2 inches)

#17 – Kenner Ferry Oak. Originally on the west bank of the Mississippi River in Jefferson Parish. Unable to locate. Suspect deceased.

#18 – Jefferson Island Oak. Located in an open field to the right (north) side of the gate to Jefferson Island. (28 feet, 5 inches)

#19 – Cleveland Oak. Located on Avery Island, home of Tabasco Pepper Sauce, and named after President Grover Cleveland who supposedly visited there in 1931. Another Cleveland Oak is located about seven miles away on Jefferson Island. (24 feet, 8 inches)

#20 – McDonough Oak. City Park, New Orleans. (26 feet, 1 inch)

#21 – Avery Island Oak #2. Unable to identify accurately, but there are many oaks on the McIlhenny property large enough to be this unnamed oak.

#22 – Gosserand Oak. Located on the west bank of False River, in New Roads (possibly later renamed to the Langlois Oak. (27 feet, nine inches)

#23 – Avery Island Oak #3. Suspect this may be the oak with a plaque stating "Planted by E.A. McIlhenny in the year of McIlhenny's home.

#24 – New Iberia Oak. On grounds of Mt. Carmel girl's school. Was recently stuck by lightning, but still living. Photographed but unable to access private grounds to measure.

#25 – Parks Oak #3. Unable to identify accurately.

#26 – Campbell Oak. Supposedly located in the Catholic cemetery in Lafayette. Not found at this location. Suspect deceased.

#27 – Charenton Oak. Supposedly located at Charenton Beach. Unable to locate.

#28 – Rochard Oak. Located on east bank of Bayou Teche in back yard of old Pere' Rochard home. Identified two oaks in the yard that could be the named tree.

#29 – Grenier Oak. Still on west bank of Bayou Lafourche, four miles above Thibodaux. (27 feet, five inches)

#30 – Rosedale Oak. Listed as located on the east bank of Bayou Grosse Tete. I believe I located the tree, but as yet unconfirmed.

#31 – Audubon Park Oak #4 – Suspect this is a tree near the front gate of Audubon Park off of St. Charles Ave. in New Orleans, but unable to confirm.

#32 – Monarch Oak of Paradise Woods. One of Dr. Stephens' favorite trees. He called the 74-acre grove "incomparable" in its beauty, and frequently took guests there. It has been developed and two large mansions built on the property. Several trees were lost. The Monarch Oak is confirmed deceased. Its stump is lying in the yard of current residents.

#33 – Cathedral Oak. Current 2nd Vice President tree of the Live Oak Society. Located next to St. John's Catholic Cathedral in downtown Lafayette. (27 feet in girth)

#34 - Singleton Oak. Listed as located on Twin Oaks Place, northeast of Carencro. Unable to locate.

#35 – G.A Martin Oak. Supposedly located near Lafayette. Unable to locate.

#36 – Audubon Park Oak #5. Still living.

#37 – Broussard Oak. Supposedly located near train depot in Broussard. Unable to locate.

Grenier Oak photo © William Guion

Gross tete oak photo © William Guion

#38 – Thomas D. Boyd Oak. Deceased. It was on the north side of park in front of new state capital building but was blown down in Hurricane Gustav, September 2008.

#39 – Uncle George Oak. Supposedly located near Mobile, Mississippi. Unable to locate, suspect deceased in fire.

#40 – Protestant Cemetery Oak. Supposedly located in Lafayette. Found cemetery, but unable to locate tree. Suspect deceased.

#41 – Shady Grove Oak. Supposedly located in Iberville Parish. Unable to locate.

#42 – St. Denis Oak. Located in American Graveyard in Natchitoches. As yet unable to locate.

#43 – Gebert Oak. Located on Main Street in New Iberia, near downtown. This beautiful historic oak was recently poisoned in a neighborhood dispute and has lost much of its usual foliage.

After 74 years, the majority of the South's historic oaks are still not legally protected from human damage or removal, though a growing number of cities and counties have begun to pass ordinances for their protection. In the City of Covington, Louisiana (a neighbor of the community Lewisburg where the current Live Oak Society President tree is located), the removal of any live oak larger than 12 inches in diameter is restricted. In Waveland, Mississippi, another Gulf coast city hard hit by Hurricane Katrina, citizens passed a similar ordinance protecting their historic live oaks and magnolia trees.

An innovative ordinance passed in 1996 in East Baton Rouge Parish, Louisiana, created the Tree Registry of Ancient, Historic and Unique Trees. This forward-thinking regulation is part of the Parish's master plan for development. It could serve as a legal example for protecting trees across the Gulf South. The ordinance ensures protection not just to live oaks, but to all trees "which, by virtue of their size, age, historic significance, or other uniqueness, can be recognized as being the most noteworthy representatives of their kind." Live Oak Society member trees were automatically included. According to the Program Statement of this ordinance, the purpose of this program is to "create a direct link between the recognized trees and the human or cultural community… to use this linkage as a means of encouraging the protection of these important trees… by using ancient, historic and unique trees as examples, we can stimulate a greater understanding of trees and their importance to the community and perhaps encourage an informed public to plant trees for future generations to enjoy."

For more information about how to apply for a city ordinance in your city or county to protect any species of tree, the Louisiana State University School of Landscape Architecture has created a model "Guide to Writing a City Tree Ordinance" for Louisiana, available online at *www.greenlaws.lsu.edu/modeltree.htm*. It's likely to prove helpful for other states as well.

See The Live Oak Society web site at: *http://www.louisianagardenclubs.org/live_oak_society/about.html*

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Rosedale Oak photo © William Guion

Stonaker oak photo © William Guion

Molecular Studies in Selected Oak Species: What Have We Learned About Oak Evolution?

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INTRODUCTION

The genus *Quercus* is the largest in the family Fagaceae and consists of approximately 500 species of trees and shrubs. Two subgenera, *Cyclobalanus* and *Quercus,* have been recognized based on morphological characters, with *Cyclobalanus* native to Asia and *Quercus* distributed in tropical and subtropical regions of the Northern Hemisphere. Subgenus *Quercus* has been further subdivided into sections *Quercus* (white oaks), *Lobatae* (red and black oaks), and *Protobalanus* (intermediate oaks) with the two latter sections endemic to the Americas, and section *Quercus* found in both the Old- and the New World (Nixon, 1993).

Taxonomic problems in oaks still persist due to their extensive foliar polymorphism, convergence, and occurrence of hybridization and introgression. Despite these challenges, good progress has been made in the morphological characterization of oak species through the publication of local and regional floras (e.g. Flora of California, Flora of North America, and Flora of China). Morphological and molecular studies of representative species in the sections of subgenus *Quercus* have also been conducted and have provided insight into the phylogenetic relationships at the intersectional level (Nixon, 1985, 1993; Manos et al., 1999); however, these two character sources (i.e. morphological and molecular) have not yielded enough information to understand the phylogenetic relationships of oaks at the species level. Detailed phylogenetic analyses, at the intraspecific level and based on morphological characters, have not been conducted due to the limited number of vegetative and reproductive characters available (Manos, 1999; Vazquez 2001). Consequently, researchers of oak systematics have turned to DNA sequences as possible sources of additional characters; nonetheless, searches in genbank as well as in the literature show that only a limited number of genes in oaks have been sequenced.

The intent of this paper is to present the advances in the research of molecular variation in oaks, as well as to assess the amount of nucleotide variation in nuclear and organelle genes from oak species.

METHODS

Two general types of methods were used: 1) analysis of oak sequences available in genbank (a public database: http://www.ncbi.nlm.nih.gov/, and 2) analysis of data obtained in the laboratory.

Table 1. Variation of chloroplast genes in oak species

Gene name	Region analyzed	Nucleotide Sequence divergence
rbcL	Coding region	0 – 0.0122
matK	Coding region	0.0007-0.0135
rps16	intron	0 to 0.0273
trnL	intron	0 to 0.0279
trnL-trnF	intergenic spacer	0 to 0.0586

Table 2. Variation of nuclear genes/regions in oak species

Gene name	Region analyzed	Nucleotide Sequence divergence
Cinnamyl alcohol dehydrogenase.	Coding region	0.0328
Legumin	Intron	0 to 0.0540
Legumin	Exon	0 to 0.0455
Glyceraldehyde 3-phosphate dehydrogenase (GA3-P).	Intron and exon	0 to 0.0183
Internal transcribed spacers (ITS) of the nuclear ribosomal DNA.	Internal transcribed spacers and 5.8S	Large paralogue- 0.0530 Medium paralogue-0.0230 Small paralogue-0.0130

For the first method, representative oak sequences available in genbank were downloaded and aligned using the default parameters in Clustal W (Thompson et al. 1994). When necessary, sequence alignment editing was carried out with the program Seaview (Galtier et al., 1996). Estimation of distances was performed with the program Phylip (Felsenstein, 1989) using the Kimura 2-parameter for DNA sequences.

The second method for the analysis of nuclear genes began with the collection of plant material in several localities throughout Mexico. Consequent lab work included isolation of total genomic DNA, design of primers for the amplification of nuclear genes, isolation of genes using polymerase chain reaction (PCR), cloning of PCR products, DNA sequencing, DNA editing, and DNA analysis. The genes/regions studied in the laboratory include the internal transcribed spacer of the nuclear ribosomal genes (ITS), introns of the nuclear genes *leafy*, *agamous*, *pistillata*, *slg*, and the intron of the chloroplast gene *rps16*. Phylogenetic analyses were conducted with Winclada 2.0 (Nixon, 1999); only informative characters where analyzed and gaps were coded following the simple indel coding method of Simmons and Ochoterena (2000).

RESULTS

Mitochondrial genes. Only four oak mitochondrial genes were found in genbank: orfx, ribosomal protein small 3 (rps3), maturase (matR), and NADH dehydrogenase subunits 4 & 7, and their introns 3 & 2, respectively. Only the last two genes had at least two sequences to allow some comparisons. DNA sequence alignment of the mitochondrial gene matR in *Quercus engleriana* and *Q. multinervis* showed that the coding sequence of this gene is 1743 base pairs (bp) long and shows no nucleotide differences in these species. The third intron of the mitochondrial gene NADH dehydrogenase subunit 4 in *Q. glauca* is 541 bp long and revealed only 2 nucleotide substitutions; one of the four sequences analyzed showed an 8-bp gap. The second intron of the mitochondrial gene NADH dehydrogenase subunit 7 in *Q. glauca* is 702 bp long and displayed only two nucleotide substitutions.

*Chloroplast genes***.** Sequences of the following oak chloroplast genes were found in genbank: ndhF intergenic region, ycf6-psbM intergenic spacer, NADH dehydrogenase subunit F, ATP synthase beta subunit, atpB-*rbcL* spacer region, trnD-trnT intergenic spacer, *matK*, *rbcL*, tRNA-Leu (trnL)-tRNA-Phe (trnF), and rps16. Of these genes, only the genes *rbcL*, *matK*, the intron and intergenic spacer of trnL-trnF, and rps16 intron, had more than two sequences to allow any comparisons and generalizations.

rbcL. Analysis of 32 *rbcL* protein sequences corresponding to 27 oak species available in genbank indicate that this protein is 482 amino acids long, and it showed differences at only 3 amino acid sites. The sequence analysis of 31 *rbcL* nucleotide sequences corresponding to 30 species, revealed sequence divergences ranging from zero to 0.0122. No inversions were detected in the sequences analyzed, and 2 indels ranging in size from 1 to 3 bp were detected in a sequence from *Quercus virginiana*.

matK. Analysis of 59 chloroplast maturase (*matK*) protein sequences from 29 oak species showed that this protein is 431 amino acids long and 1293 nucleotides long. At the protein level, these sequences show substitutions at 11 amino acid sites, one insertion that is 6 amino acids long, and genetic distances ranging from zero to 0.026. A comparison of *matK* nucleotide sequences from 12 oak species showed nucleotide substitution at 30 sites and distances ranging from 0.007 to 0.0135. This apparently higher level of protein sequence divergence compared to nucleotide divergence may be due to the larger number of protein sequences analyzed. Nevertheless, the levels of nucleotide sequence divergence are still low compared to nuclear genes.

trnQ-trnS, rps16 & trnL-trnF. A comparison of eight aligned *trnQ-trnS* oak sequences available in genbank also revealed low amounts of sequence variation with only one nucleotide substitution and a few deletions. Vazquez (2001) sequenced the *rps16* intron, and the intron and intergenic spacer of the *trnL-trnF* gene from several Mexican red oak species. Analysis of the sequences generated by Vazquez (2001) and those available in genbank revealed that the sequence divergence of the rps16 intron ranges from zero to 0.0270. Similarly, analysis of the *trnL-F* sequences showed that the nucleotide sequence divergence for the intron ranges from zero to 0.0279, while the sequence divergence of the intergenic spacer varies from zero to 0.0586.

Oak nuclear genes and regions

As in the case of chloroplast genes, only a limited number of nuclear genes have been studied in oaks. The sequences of nuclear genes available in genbank included in this study are *cinnamyl alcohol dehydrogenase*, *legumin*, *glyceraldehyde 3-phosphate dehydrogenase* (GA3-P), and the internal transcribed spacers (ITS) of the ribosomal genes. Ninety-five additional sequences of ITS generated by the author of this paper were added to the analysis, as well as several sequences from the transposon En/Spm. *Cinnamyl alcohol dehydrogenase*. The gene cinnamyl alcohol dehydrogenase in *Quercus* is 326 amino acids long and their corresponding DNA sequences are 978 nucleotides long. Alignment of two protein sequences from *Q. ilex* and *Q. suber* showed amino acid differences at 12 sites with most of these changes being conserved and semiconserved. Analysis of the corresponding nucleotide sequences shows differences at 38 nucleotide sites including two 3-bp insertions, and a nucleotide sequence divergence of 0.0328.

Legumin. Examination of 13 *legumin* oak sequences from genbank indicates that this nuclear gene consist of an intron 105 bp long and an exon 366 bp long. Aligned sequences showed 30 nucleotide substitutions with 9 of them located in the intron and the remaining 21 in the coding region of the exon. Two of the examined sequences differ from the rest by the presence of a 5-bp insertion. The nucleotide divergences in the *legumin* intron range from zero to 0.0540, and in the *legumin* exon they vary from zero to 0.0455.

Glyceraldehyde 3-phosphate dehydrogenase (GA3-P). The oak sequences available in genbank consist of 3 noncoding regions and two exons. Comparisons with rosid GA3-P sequences suggest that these oak coding sequences correspond to exons 8 and 9. The beginning of the oak GA3-P sequences available in genbank consists of a noncoding region that is 80 bp long. A noncoding region 408 bp long is located between exons 8 and 9; downstream of exon 9 there is a third noncoding region 163 bp long. Alignment of oak GA3-P sequences revealed that most of the 45-nucleotide substitutions observed occur in the longest noncoding region located between exons 8 and 9. Furthermore, some of these sequences have a 3-bp insertion and a 11-bp insertion. The average nucleotide divergence of this region ranges from zero to 0.0183.

Internal transcribed spacers (ITS) of the nuclear ribosomal DNA. Fifty-three ITS sequences were downloaded from genbank, and 50 additional sequences were generated by the author. It is worth mentioning that although over 100 oak ITS sequences are available in genbank, only complete sequences of different species were selected for this analysis. In contrast to the genes discussed above, the oak ITS region has been previously studied by several authors. A phylogenetic study of the ITS region by Manos et al. (1999) supported the previously recognized monophyletic sections *Quercus* (white oaks *sensu stricto*) and *Lobatae* (red oaks). Manos et al. (1999) also showed that the Eurasian white oaks form a monophyletic group different from *Quercus sensu stricto*.

In a subsequent study, Vazquez (2001) focused on the red oaks and sampled 30 species mainly native to Mexico. In contrast to Manos et al. (1999), the results of Vazquez (2001) showed that there are at least 3 different ITS paralogues of sizes 613 bp (large paralogue), 600 bp (medium paralogue), and 497 bp (small paralogue). Furthermore, sequence divergence of the ITS region ranged from 0.013 in the small paralogue to 0.053 in the large paralogue; the average divergence of the medium-size paralogue was 0.023. Interestingly, intraspecific sequence divergences ranged from zero to 0.29. These results suggest that the ITS region in the Mexican red oak taxa examined has not undergone full concerted evolution. The use of the ITS region, therefore, is unlikely to yield information about the phylogenetic relationships of Mexican red oak taxa.

Other nuclear regions under study. In the search for genomic regions that could provide phylogenetic information for reconstructing oak phylogenies, Vazquez (unpublished) has focused on the study of the introns from the nuclear genes pistillata, cauliflower, and leafy, as well as the DNA sequence variation of the En-Spm transposons. Vazquez's preliminary results (unpublished) show that there are two to four copies of the *pistillata* intron, depending on the species, with sizes of 800-900 bp long. The second intron of *leafy* seems to consist of at least two copies of sizes 700 and 800 bp. The intron of *agamous* is about 2000 bp long and of all the nuclear regions examined, appears to be the only one that is a single copy gene.

Transposons, also called jumping genes, are very important in genome structure and function (Bennetzen, 2000). Given that transposons have never been studied in oaks, Vazquez (unpublished) has isolated and sequenced En/Spm transposons from selected *Quercus* (oak) species using a PCR-based approach. The results show that the oak En/Spm transposons sequences show conserved regions, as well as highly variable regions. A preliminary phylogenetic analysis of these oak En/Spm sequences suggests that more than one copy of this transposon may be present in the oak genome.

DISCUSSION AND CONCLUSIONS

Analysis of the oak mitochondria genes available in genbank showed low nucleotide variation rates. This result is in agreement with other angiosperms studies, which have concluded that the variation rates of mitochondrial sequences are "roughly 4 times slower than in land plant chloroplast DNA (cpDNA)" (Palmer & Herbon, 1988).

Analysis of the oak chloroplast genes in this study indicates that the trnL-F intergenic spacer has a higher divergence level than the chloroplast introns examined. This result agrees with studies in other angiosperm taxa, which have shown that chloroplast intergenic spacers are more variable than chloroplast introns (Shaw et al. 2007).

Regarding the amount of nucleotide divergence in *matK*, previous studies have shown that this gene is more variable than *rbcL* (Hilu & Liang 1997); however, the amount of sequence divergence of these genes in oaks may suggest that is similar. Nevertheless, one has to keep in mind that the number of sequences analyzed for *matK* was smaller than those of *rbcL*, which may skew the results obtained in this analysis.

In general, chloroplast coding and noncoding sequences have been useful in the reconstruction of phylogenies at the genus and family levels in a variety of plant taxa (see Mummenhoff et al., 2001; Olmstead & Palmer, 1992; Hall et al., 2002); however, the use of chloroplast genes in oaks is unlikely to provide valuable information for phylogeny reconstruction at the interspecific level. The documented high levels of gene flow and reticulate histories in oak species make chloroplast data inappropriate for the reconstruction of phylogenetic relationships. Chloroplast genes are inherited maternally and if used in the phylogeny reconstruction of oaks, they would only provide partial information on the evolutionary history of the taxa sampled (Whittemore and Schaal, 1991). Despite the limitations for phylogenetic studies, chloroplast genes are suitable for the estimation of genetic diversity, as well as for phylogeographic studies, as has been shown in numerous studies (Ferris et al., 1993; Lumaret et al., 2002; Petit et al., 1993, 2002; Romero-Severson et al., 2003; Magni et al., 2005, among others).

The nuclear genes/regions examined showed sequence divergences ranging from 0.0183 in the *glyceraldehyde 3 phosphate dehydrogenase* gene, to 0.0540 in the *legumin* intron. Of the sequences compared, the coding region of the *Cinnamyl alcohol dehydrogenase* gene showed moderate sequence divergence with a value of 0.0328. Although the large copy of the ITS region also showed a relatively high level of nucleotide divergence with a value of 0.0530, the use of this molecule for phylogeny reconstruction of Mexican red oak taxa is not recommended due to the presence of paralogues.

Of the nuclear gene sequences examined, the most promising for providing phylogenetic information are the exon and intron of the legumin gene. However, before these genes are used, it must be verified that they are present as single copy genes in the oak genome. If present in low-copy numbers, then the orthologous sequences must be identified before carrying out any type of analysis.

In summary, mitochondrial genes are not suitable for reconstructing the phylogeny of oak species due to their low rate of evolution and the frequency of structural arrangements, that have been documented in other angiosperms (Wolfe et al., 1987). Although chloroplast genes evolve at a faster rate than mitochondrial genes, their use in phylogeny reconstruction is not advisable as gene flow is very common in oak species, and it would only reveal the maternal parentage in oaks.

Regarding nuclear genes, there is a limited number of genes available with potential to recover the evolutionary history of oaks, such as the *legumin* and the *cinnamyl alcohol dehydrogenase* genes. Even though the ITS region has been used in the analysis of North American, European, and Asian oak species, its use should be avoided in Mexican taxa due to the presence of paralogues. Despite the large number of gene entries in the public gene databases, the number of genes useful for phylogeny reconstruction in oaks remains very small. Uncovering the evolutionary history of oaks at the interspecific level will require the active collaboration of oak researchers to find additional and multiple single copy or low-copy genes with enough information to reconstruct the phylogenetic relationships of this challenging but yet interesting group of plants.

LITERATURE CITED

Bennetzen, J. L. 2000. Transposable element contributions to plant gene and genome evolution. Plant Molecular Biology 42 (1): 251-269.

Felsenstein, J. 1989. PHYLIP - Phylogeny Inference Package (Version 3.2). Cladistics 5: 164-166.

Ferris C, R. P. Oliver, A. J. Davy, G. M. Hewitt. 1993. Native oak chloroplasts reveal an ancient divide across Europe. Molecular Ecology 2:337-344.

Galtier, N., Gouy, M. & Gautier, C. (1996) SEAVIEW and PHYLO_WIN: two graphic tools for sequence alignment and molecular phylogeny. Comput. Appl. Biosci., 12:543-548.

Hall, J. C., K. J. Sytsma and H. H. Iltis. 2002. Phylogeny of Capparaceae and Brassicaceae based on chloroplast sequence data. American Journal of Botany, 89:1826-1842.

Hilu, K. W. and H. Liang. The *matK* gene: sequence variation and application in plant systematics. Am. J. Bot. 84(6):830-839.

Mummenhoff K., H. Brüggemann. and J. L. Bowman. 2001. Chloroplast DNA phylogeny and biogeography of Lepidium (Brassicaceae). American Journal of Botany 88:2051-2063.

Lumaret et al. 2002. Phylogeographical variation of chloroplast DNA in holm oak (*Quercus ilex* L.). Molecular Ecology 11: 2327-2336.

Magni et al. 2005. Chloroplast DNA variation of *Quercus rubra* L. in North America and comparison with other Fagaceae. Molecular Ecology 14: 513-524.

Manos, P., J. J. Doyle, K.C. Nixon. 1999. Phylogeny, biogeography, and processes of molecular differentiation in *Quercus* subgenus *Quercus* (Fagaceae). Mol. Phyl. Evol. 12: 333-349.

Nixon, K. C. 1985. A biosystematic study of *Quercus* series *Virentes* (the live oaks) with phylogenetic analysis of Fagales, Fagaceae and *Quercus*. Dissertation thesis. University of Texas. Austin, Texas. 392 p.

Nixon, K.C. 1993. Infrageneric classification of *Quercus* (Fagaceae) and typification of sectional names. Annals Sci. For. 50 Suppl 1: 25s-34s

---------------. 1999. Winclada (beta) ver. Published by the author. Ithaca, NY.

Olmstead, R.G., and J. D. Palmer. 1992. A Chloroplast DNA Phylogeny of the Solanaceae: Subfamilial Relationships and Character Evolution. Ann. Missouri Bot. Gard. 79: 346-360.

Palmer, J. D. & L. A. Herbon. 1988. Plant mitochondrial DNA evolved rapidly in structure, but slowly in sequence. J. Mol. Evol. 28: 87-97.

Petit R. J., A. Kremer and D. B. Wagner. 1993. Geographic structure of chloroplast DNA polymorphisms in European oaks. Theoretical and Applied Genetics. 87:122-128.

Romero-Severson J, P. Aldrich, Y. Feng, W. Sun, and C. Michler. 2003. Chloroplast DNA variation of northern red oak *(Quercus rubra L.)* in Indiana. New Forests 26: 43-19.

Shaw, J., E. B. Lickey, E. E. Schilling, and R. L. Small. 2007. Comparison of whole chloroplast genome sequences to choose noncoding regions for phylogenetic studies in angiosperms: the tortoise and the hare III. Am. J. Bot. 94(3):275-288.

Simmons, M. P. and H. Ochoterena. 2000. Gaps as characters in sequence-based phylogenetic analyses. Syst. Biol 49:369-381.

Thompson, J. D., D. G. Higgins, and T. J. Gibson. 1994. CLUSTAL W: improving the sensitivity of sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. Nucleic Acids Res. 22:4673-4680.

Vázquez, M.L. 2001 Molecular and morphological studies on Mexican red oaks (*Quercus* sect. *Lobatae*). Ph D. Dissertation. Cornell University, New York, 290 pp.

Whittemore, A. T. and B. A. Schaal. 1991. Interspecific gene flow in sympatric oaks. Proc. Natl. Acad. Sci. 88: 2540-2544.

Wolfe, K.H., W.H. Li, and P.M. Sharp. 1987. Rates of nucleotide substitution vary greatly among mitochondrial, chloroplast, and nuclear DNAs. Proc. Natl. Acad. Sci. 84: 9054-9058.

A Review of the Taxonomic Status of *Quercus ellipsoidalis* and *Quercus coccinea* in the Eastern United States

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Photos of acorns were taken by Doug and Dave Shepard for the COCC & Ell paper.

The current taxonomic status of *Q. ellipsoidalis* Hill, Hill's oak or northern pin oak, and *Q. coccinea* Muenchh., scarlet oak, in the midwestern states of Indiana, Michigan, Illinois, Wisconsin, Iowa, and Minnesota has been controversial among field botanists and systematists for over one hundred years (**Fig 1**). Field and herbarium study have revealed unresolved discrepancies in attempting to define clear morphological distinctions between these two taxa. Currently there is no uniform agreement among biologists as to the range or the actual taxonomy of both species in the upper midwestern United States. Many of the taxonomic problems concerning both species have centered historically in Illinois and have been discussed most recently by Hipp (2006).

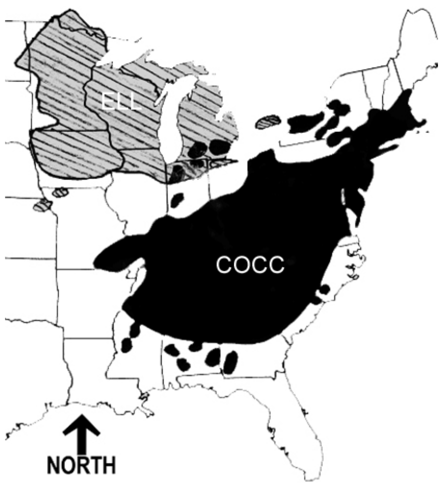

Figure 1. Range map of *Quercus coccinea* (COCC) and *Quercus ellipsoidalis* (ELL).

Quercus coccinea was first described and named by the German botanist Muenchhausen in 1770 from a New England population of the taxon. The species was first recognized in the Illinois flora by Vasey (1870) and later, in 1872, H. H. Babcock cited the taxon for the flora of the Chicago area (Jones and Fuller 1955). In 1876, *Q. coccinea* was listed in the flora of the Wabash River Valley in southern Illinois by Schneck (Jones and Fuller 1955). *Quercus ellipsoidalis* was discovered growing near the Little Calumet River of southern Chicago in southeastern Cook County Illinois by E.J. Hill.

The description of the morphologically similar *Q. ellipsoidalis* by E. J. Hill (1899) and subsequent publications by Trelease (1919) and Wadmond (1933) prompted botanists to question the validity of populations of *Q. coccinea* in northern Illinois, Iowa, Minnesota, and Wisconsin. *Quercus coccinea* was deleted from the Chicago flora and subsequently northern Illinois by Buhl (1934) leaving only records for southern Illinois. *Quercus coccinea* was, however, recognized as occurring in nearby Michigan and northwest Indiana (Deam 1953). Later, Overlease (1977) presented a detailed morphological study on variation in the red oak group (Lobatae) in the states of Wisconsin, Illinois, Indiana and Michigan, concluding that *Q. ellipsoidalis* was a northern small fruited expression of *Q. coccinea* showing a similar pattern of clinal variation displayed by *Quercus rubra* and *Quercus velutina*. Voss (1985) concurred with the findings of Overlease (1977) by omitting *Q. ellipsoidalis*, and extending the range of *Q. coccinea* throughout the state of Michigan. Swink and Wilhelm (1994) concurred with Voss and Overlease by eliminating *Q. ellipsoidalis* from the flora of the Chicago region but still recognized alternative interpretations by other botanists.

In a numerical taxonomic study on the *Lobatae* group, (Jensen 1977b) found no support for Overlease's conclusions and suggested that *Q. coccinea* and *Q. ellipsoidalis* are two phenetically distinct taxa. Jensen further countered Overlease's clinal concept in a study on geographic spatial autocorrelation in *Q. ellipsoidalis* in the states of Illinois, Wisconsin, Michigan and Indiana (Jensen 1986). In his analyses Jensen concluded that trees growing near the type locality of *Q. ellipsoidalis* (*i. e.*, southeastern Cook County) and northward most reflected the morphological characters diagnostic of the taxon. His results also indicated that the type locality populations were more related to those of Wisconsin and northern Michigan than the populations of nearby northwest Indiana where he presumed the ranges of *Q. coccinea* and *Q. ellipsoidalis* overlap and introgression between the two taxa is likely. Jensen (1997) in the *Flora of North America* has *Q. coccinea* ranging through most of Illinois and southern Wisconsin and maintains the original distribution of *Q. ellipsoidalis*. Shepard (1993) found northern Illinois populations of *Q, ellipsoidalis* to be morphologically similar to southern Illinois populations of *Q. coccinea* and not a product of hybridization with *Q. velutina* or *Q. palustris*.

Quercus coccinea ranges from southern Maine south through the Appalachians to Georgia, Mississippi, and into the Ozarks of northern Arkansas, southern Missouri, and extending into southern Illinois. Disjuncts occur in upstate New York and in several states along the southern Atlantic coastal plain. One isolated population recently discovered in the Tinley Creek Forest Preserve of northern Illinois grows with southern forests associates in a flatwoods community.

Quercus ellipsoidalis was described by E. J. Hill (1899) from populations observed in the south Chicago region of Cook County Illinois. The species is predominately Midwestern and is presumed to range from extreme northwest Ohio through northern Indiana, Michigan, Illinois, Wisconsin, Iowa, and Minnesota. Disjunct populations occur in southern Ontario near Lake Erie, northern Missouri, and extreme northeast Kansas. The current distinction between *Q. ellipsoidalis* (abbreviated as ELL) and *Q. coccinea* (abbreviated as COCC) is outlined in **Table 1**. Additional differences botanists have used in distinguishing ELL are its shiny, striated acorns and yellowish cotyledons versus dull, unstriated acorns with white cotyledons for COCC.

This paper is a synopsis of key points encompassing twenty five years of unpublished data collected on these two taxa. It includes statistical, herbarium, ecological, annual variation (plasticity), and general field observations of populations of both taxa throughout most of their range. Studies were performed to find out whether the range of morphological variability seen in populations of COCC encompasses the range of variability seen in populations of ELL. It was to be determined whether observable morphological differences were genetic or due to climatic variation. The relationship between the ELL/COCC complex and

Table 1. Current Characters distinguishing COCC and ELL based on the Flora of North America (Jensen, 1997) and Palmer (1942). Asterisk* indicates key characters from Jensen (1997).

Quercus coccinea	*Quercus ellipsoidalis*
Dead branches absent	Dead branches present
Nut oblong, subglobose	Nut mostly ellipsoidal to oval
*One or more concentric rings of pits at apex	*Occasionally with one or more rings of pits at apex
Buds 4-7 mm conic to ovoid pubescent above middle	Buds 3-5mm nearly glabrous/ pubescent above middle
Cupule 16-30mm, bract scales broad at base	Cupule 11-19mm, bract scales narrow
*Scales with a broad glossy base, scale (bract) margins often strongly concave	* Scales pubescent with straight or slightly concave margins

Illinois populations of *Quercus velutina,* black oak (VEL) and *Quercus palustris,* pin oak (PAL) was also analyzed.

The initial research for this paper began in 1990 with an extensive herbarium study of populations of COCC and ELL across the eastern United States. Six major herbaria were utilized in the study, with over 200 specimens examined. Soil surveys from each site were obtained along with associated climatic information. Forest associations were studied in the field along with supplementary research articles on each site. Portions of this research and statistical analysis of Illinois populations of ELL, COCC, VEL, and PAL were presented at the Transactions of Illinois Academy of Science meetings in 1991 and 1993. Data for the statistical analysis is derived from a yet unpublished manuscript.

Statistical Methods: Morphology comparisons utilizing multivariate statistical designs employing scatter plots can be useful tools in comparing and sorting out closely related species groups. Morphological variation seen can be associated with climate and local site conditions and thus be useful in determining clines or allopatric speciation.

Discriminate Functions Analyses (SYSTAT 1997, SPSS Inc., Chicago, IL.) were performed on quantitative and qualitative morphological data of leaves, buds, twigs, and acorns of COCC and ELL. A total of 174 trees were used in the study, segregated into twenty populations. Two different statistical assays were performed: one attempting to separate ELL, COCC, VEL, and PAL; and the other separating individual COCC and ELL populations. The first test involved a comparative analysis with VEL, PAL, COCC, and ELL using twelve morphological characters involving leaves, buds, and acorns (**Fig 2.**). Eighteen populations representing 154 trees of the *Q. ellipsoidalis*/*Q. coccinea* complex were studied, encompassing a

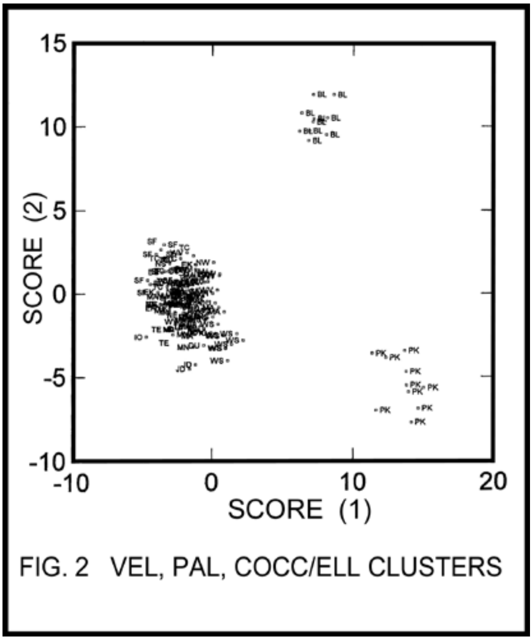

Fig 2. Discriminate Functions Analysis. Discriminate Functions One and Two Comparing COCC, ELL populations, PAL, and VEL. Twelve morphological variables.

distance of 1375 kilometers east to west from Massachusetts to Minnesota and an 830-kilometer distance north to south from Minnesota to southern Illinois/West Virginia (**Fig. 3**). Twelve populations of ELL from the states of Michigan, Indiana, Illinois, Wisconsin, Iowa, and Minnesota, and seven populations of COCC from the states of Illinois, Indiana, West Virginia, Pennsylvania, and Massachusetts were analyzed. Likewise, one population of ten trees representing VEL from central Illinois and one population of ten trees representing PAL from southern Illinois were studied.

The second DFA analysis involved thirty-four morphological characters attempting to segregate populations of ELL and COCC. Eighteen characters dealt directly with bud and nut/cupule characters, fourteen related to leaf and twig morphology, and two analyzed growth form and dead branching patterns.

Specimens that could be located in the natural areas of the study sites were assigned a number and deposited in a plastic bag. Leaves from each specimen were then pressed and dried. Acorns, both viable and non viable, were refrigerated until analyzed. Leaves, buds, and acorns were collected from late summer and early fall through late winter from the various sites during the years 1990 to 2008. Sampling from each location generated an average subsample of five mature buds, five mature acorns (nuts with cupules), and five mature leaves from each tree. Leaves and mature buds exposed to full sun were collected by various methods. Nuts with cupules were collected directly from mature trees and from twigs lying on the ground from recently broken upper crown exposed branches with the aid of binoculars to avoid misidentification. Photographs of individual trees and associated leaves, buds, and acorns were made for reference. Forest associations, soil types, and climate were noted and recorded taken at each site. Terminal buds, twigs, nuts, and cupules were measured using either a binocular scope or hand lens using 7X and 30X magnification. Viable acorns from the sampled trees were collected and planted in pots with potting soil, germinated, moved, and studied.

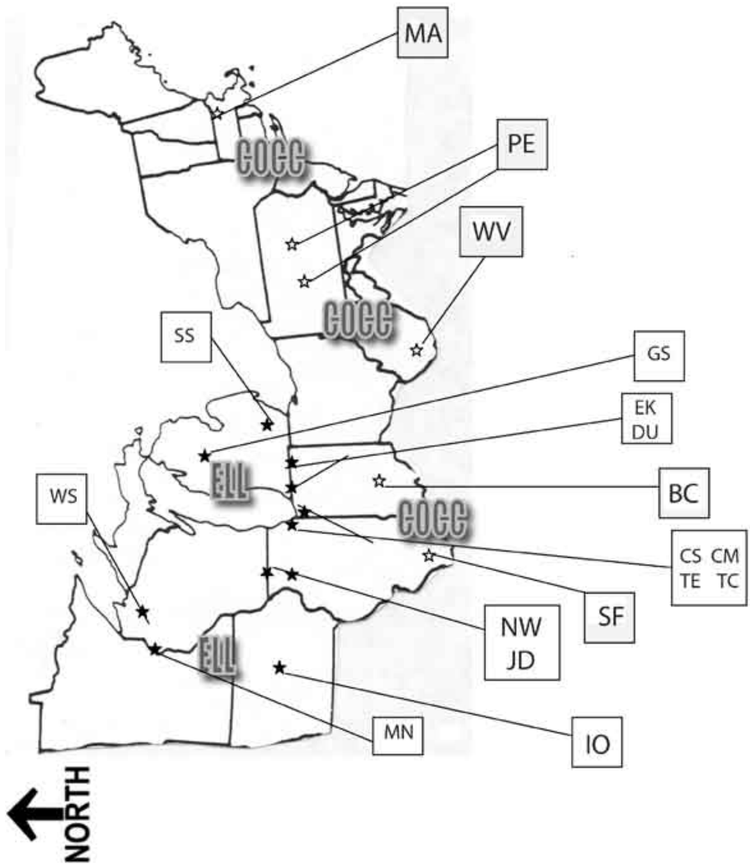

Figure 3. Study sites of *Quercus ellipsoidalis* and *Quercus coccinea*. Number of trees analyzed in parenthesis.

Quercus coccinea: MA (16) = Massachusetts, PE(6)=Pennsylvania, WV(11)=West Virginia, EK(11)=Elkhart, Indiana, BC(6)=Brown County, Indiana, TC(10)=Tinley Creek Woods/ Chicago, SF(10)=Southern Illinois.

Quercus ellipsoidalis: SS(6)=Waterloo, Michigan, GS(9)=Northern Michigan, CS(7)=Chicago Sand Ridges, CM(5)=Chicago Moraine, TE(3)= inley Creek/ Chicago, DU(3)=Indiana Dunes, NW(5)=Northwest Illinois, JD(5)=Jo Daviess Co., IO(11)=Hardin County, WS(10)=Wisconsin, MN(12)=Minnesota

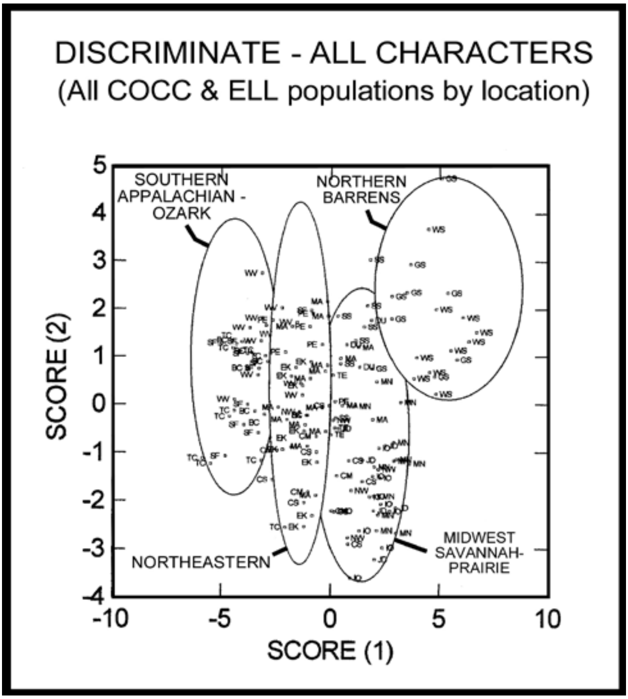

Fig 4. Discriminate Functions Analysis. Discriminate Functions One and Two Comparing COCC/ELL Populations. Ecotypical complexes illustrated.

Statistical Results of DFA (Fig 2)

Figure 2 shows the results of the first study comparing the populations of ELL, COCC, PAL, and VEL in attempt to clarify morphological differences. Canonical coefficients within groups and canonical loadings for Discriminate Functions One and Two indicated that bud length, bud pubescence, scale length, scale shape, cup pubescence, rings present or absent, nut width, aristae (bristle tip) number, leaf length, amount of cupule covering nut, and percent scar width divided by nut width, separated VEL and PAL into distinct entities. ELL and COCC grouped into an amorphous mass with overlapping COCC and ELL populations but showed a wide separation from VEL and PAL. Two extremes show southern Illinois COCC trees (SF) at one end and the northern Michigan and Wisconsin trees (WS) at the other with all other populations in the middle.

Statistical Results of DFA (Fig. 4)

Fig 4 shows the results of the second study comparing just the populations of ELL and COCC using all thirty-four morphological characters. Canonical coefficients within groups and canonical loadings for Discriminate Functions One and Two indicated width of the widest leaf lobe, percent of the widest leaf lobe in relationship to leaf length, leaf width, leaf length, percent leaf width to leaf length, sinus length, cup width, nut length, and total nut size (length plus width). Four clustering patterns are discernable showing rather loose regional affinities in a left to right pattern. Southern populations group on the far left followed by northern Appalachian, Midwestern, and finally northern Wisconsin and Michigan on the far right. The southern COCC populations were illustrated by WV, BC, SF, and TC. The second clustering showed a mix of COCC and ELL with MA, PA, EK dominating, but with individual trees of WV, CS, CM, NW, and SF. It is notable that individual trees of Massachusetts and Pennsylvania populations grouped more closely to ELL populations of Minnesota and northwest Illinois than the southern trees of COCC in the DFA plot. The third clustering was dominated by ELL with MN, IO, JD, NW,CS, CM, SS, and DU dominant but with trees of MA and GS. The fourth cluster represented the northern population of ELL and was represented by GS and WS.

Discussion

Diagnostic morphological characters attributed to ELL were common in populations of COCC from the Northern Appalachians (**Photos 2, 3, 4, 5,and 8**). DFA plots and field observations show COCC and ELL as highly polymorphic and variable taxa that appear to be closely related and conspecific. Characters attributed to both COCC and ELL were found in all populations studied. The key diagnostic characters -- presence or absence of rings, ellipsoid versus globular nuts, and scale shape of involucre (cupule) bracts (Table 1) -- used in segregating these two taxa were not statistically significant. Field work revealed by this study shows that both COCC and ELL produce globular and ellipsoidal nuts, many without the presence of rings or pits about the stylar end, and may have acute bracts with slightly concave margins.

Northern Appalachian COCC possess ELL morphological characters.

Hill's oak has been classically defined by the shape of its ellipsoid acorn, yet in this study COCC was found to produce ellipsoid acorns in PE , MA, and WV. These smaller ellipsoid nuts were most prevalent at the MA study site of Mt. Lincoln at 1000 ft (310 m) near Pelham, Massachusetts and at the Clearfield County, Pennsylvania site. Those collected in this study were viable and germinated to produce seedlings. Populations of COCC at these sites exhibited ELL characters such as dead branches, smaller buds, and striated nuts with slightly yellowish cotyledons.

E.J. Palmer noted this variability among COCC in New England and termed it "ellipsoidalis forms" on an annotated herbarium specimen from Arnold Arboretum collected in 1945 from Essex County Massachusetts. ELL was reported from Long Island, New York by Grier (1924) but later dismissed because it was presumed out of its range. Hill's oak populations in Iowa, Wisconsin, Northwest Illinois, and Minnesota produce acorns with diagnostic characters for COCC (**photos 3, 4, 5, 7, and 11**).

Trees producing nuts with concentric arcs, pits and ring patterns were observed in all populations of ELL. Representative specimens with these characters used in this study were collected from southeastern Cook County (**photos 7 and 11**), northwestern Wisconsin, Minnesota, and Jo Daviess County and deposited at the Field Museum. **Photo three** (3) shows acorns collected from Central Iowa, Northern Wisconsin and Northern Michigan with broad-based cupule bracts not discernible from a MA specimen. Leaf morphology was similar in COCC and ELL (**Photos 14 and 15**). It was also observed that leaf morphology was unique to

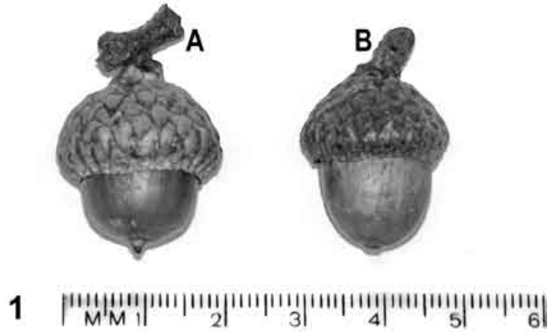

Photo 1. Annual Cupule plasticity of ELL from Southern Cook County, Ill. Acorn A coll. 1991 glossy broad scales; Acorn B coll. 1992 narrow puberulent scales.

Photo 2. Acorn A COCC Pelham Mass. Ellipsoidalis form; Acorn B ELL glossy-scale form.

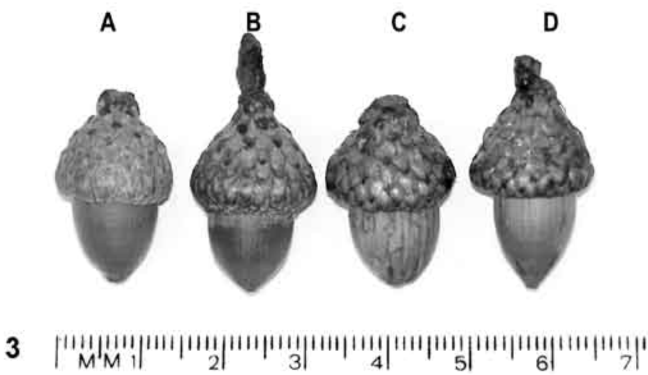

Photo 3. Ellipsoidalis forms. Acorn A ELL Minn; Acorn B ELL N. Wisc.; Acorn C COCC Mass.; Acorn D COCC Mass.

ELL and COCC but distinct from PAL and VEL. Northwestern Illinois and central Minnesota specimens deposited at Western Illinois University and the Field Museum showed striking leaf morphology to southern Illinois trees.

Variability and Plasticity (Photos 1 and 9)

It has been known that the genus *Quercus* shows a great deal of plasticity and variability in its morphological characters. In the Chicago area both *Quercus alba* and *Quercus macrocarpa* will produce atypical ellipsoid acorns in any given year. After several years of observations, it was noted that leaf, bud, and acorn morphology can fluctuate considerably in size, pubescence, and form among the COCC/ELL complex. Statistically significant changes in bud, leaf and acorn morphology were noted on several trees collected in Cook, Will, Dupage, and Pope Counties in Illinois and recorded (Shepard, 1993). Trees in Cook County can fluctuate annually in the intensity of ring patterns, bud size, and cupule. Many trees produced acorns, and buds with "ellipsoidalis" characters (puberulent cupules) one year and then "coccinea" characters the next year (tuberculated and glossy cupules). Recent higher annual rainfall in northern Illinois has apparently induced many trees in southern Cook County to produce typical COCC characters.

E. J. Hill's syntype and "authentic type" material deposited at the University of Illinois and St. Louis Botanical Garden possess diagnostic characters of COCC (Photos 12 and 13)

Definitive separation of ELL from COCC becomes obscure with further examination of E. J. Hill's herbarium collections of ELL. It is clear that E.J. Hill and William Trelease did not attempt to study the range of northeastern populations of COCC and neither used the concentric rings or pits or strongly concave bracts as diagnostic for any species of *Quercus*. While Hill did not specify a holotype, he did leave a large collection of what he felt were typical examples of specimens labeled "authentic type" material housed at the University of Illinois (UI). The lectotype specimen for ELL was made from these collections by Jensen (1979).

It should be noted that three of Hill's "authentic type" specimens; *Hill 62, 1902* UI, *Hill 150 1895* UI, *Hill 175 1895* UI collected at the type locality (CS) possess nuts with concentric rings and pitting at the stylar end and buds falling within the size range of COCC. Hill's syntype specimen (collected off the lectotype tree) *Hill 176, 1895* **(***97, 1896* UI**)** is a nearly identical replicate of a COCC specimen collected by Agnes Chase from Beltsville, Maryland (photo 13). Likewise, another "authentic type" specimen from Gardner's Park, Chicago **(***Hill 129, 1896* UI*)* exhibits leaf forms, buds, and acorns falling in COCC range of variability to a COCC specimen from Anderson County South Carolina **(** *Davis 899360* MO**).** The acorns from this South Carolina specimen possess the same ring pattern as specimen *Trelease 16073* UI collected by William Trelease in southern Cook County (Glenwood), Illinois.

Ecological differences can define species

Along these same lines, oak species can be segregated on ecological habitat differences, forest associations and related habitat requirements. Outside of the obvious morphological discrepancies presented in this document, segregating ELL/COCC populations based on habitat likewise has not been observed where both are purported to grow. No specific soil or site preference differences exist

Photo 4. COCC acorn form. Acorn A Minn. Glossy strongly concave bracts.

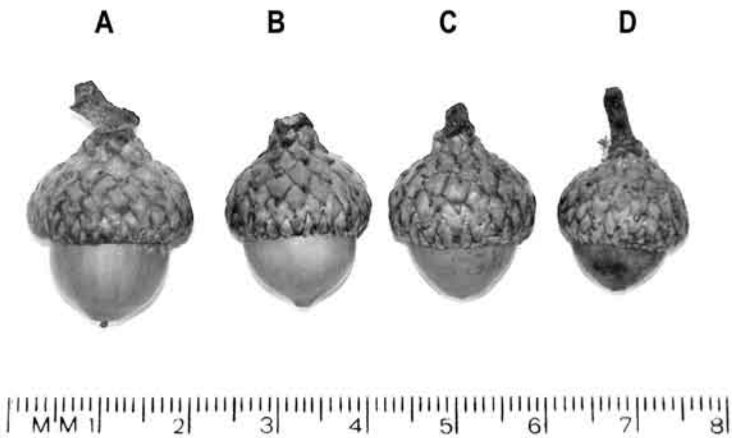

Photo 5. Globular acorns with glossy bract scales. Acorn A ELL Central Iowa; Acorn B COCC Mass; Acorn C ELL N. Wisc; Acorn D ELL N. Michigan.

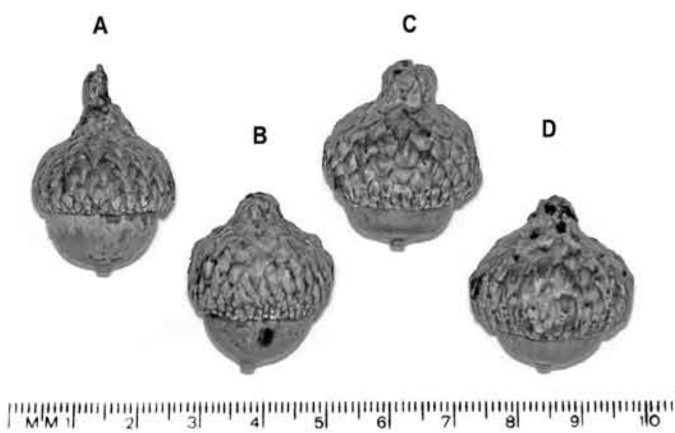

Photo 6. Southern COCC forms. Acorn A West Virginia; Acorn B Missouri Ozarks Acorn C Tinley Creek N. Ill.; Acorn D South Carolina.

between trees with COCC characters and trees with ELL characters in the Chicago region. On the other hand, sympatric species PAL and VEL, which can be found growing on the same acidic sand loams in southern Cook County as do COCC/ELL, segregate out morphologically and ecologically. Typically, PAL is most tolerant of wet sites, growing to the exclusion of VEL, COCC, and ELL on flood-prone Gilford Sand Loam. VEL grows commonly on dry sandy ridges on well drained Oakville Sand Loam while COCC/ELL grow in between moisture gradients on somewhat poorly drained Watseka Sand Loam. COCC/ELL appear to reproduce out of the same gene pool with a multiplicity of acorn forms, leaf forms and bark variation induced by local climatic conditions. This character is found throughout all populations of COCC/ELL.

DNA correlations with morphological results

There is no question that genetic differences exist between populations of oak taxa. This is true with the COCC/ELL dilemma. The question is how much is enough and what warrants a species designation. DNA studies have not shown to be conclusive on speciation of oak taxa and even other woody taxa. The DNA results recorded by Hipp and Weber (2008) revealed a strong genetic separation between populations of VEL and ELL and COCC alluding support of the hypothesis that COCC and ELL be regarded as segregate species. Several aspects of that study, which was published in ts entirety in *Systematic Botany* (Hipp and Weber, 2008), need to be examined.

First, ELL populations used were restricted to only Illinois, Wisconsin, and Indiana. Comparisons were also made in a circumscribed range of COCC that included only three states in southerly locations; Ohio, Illinois and Missouri. The study did not include northern Appalachia or other eastern populations including the type locality of COCC. A conclusion is made based on a limited a populational study that assessed a comparison between two extreme points of distribution where there is no apparent gene flow as there is between populations of VEL. ELL populations showed no gene flow with COCC populations because the variety or race of COCC used in the study is not sympatric with it. Except for the disjunct Tinley Creek population, southern COCC does not exist in the upper Midwest. The study used one genetic populational type as a representative for the whole species ignoring all the rest. From the view point of this paper essentially, two COCC populations were analyzed with expected genetic differences.

Another aspect of the study assumes that two species exist in the Chicago area. The results from the study were not clear as to whether DNA or morphology was used in ultimately determining ELL from COCC. Specimen labeled TAG-027 collected in northwest Indiana grouped genetically with ELL but morphologically possessed the diagnostic characters of COCC in its nut and bract cupules. The study grouped this tree as COCC, not ELL, despite the contradictory results. One explanation was that backcrossing with ELL populations could have resulted in the genotype but with selection for the phenotype of COCC. The question still remains as to what ELL are being referred to. What would southern Illinois tees be called without rings and elliptical nuts?

A third question regarding the paper involves VEL and its relationship with ELL and COCC. Continuous gene flow is seen in the southern and northern populatons of VEL . Gene flow is expected with populations from VEL where

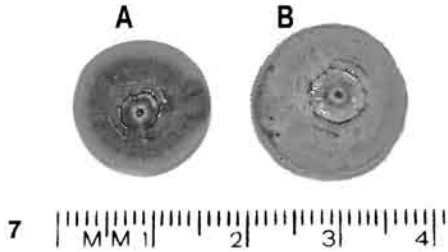

Photo 7. Concentric rings. Acorn A ELL Cook County, Illinois; Acorn B West Virginia

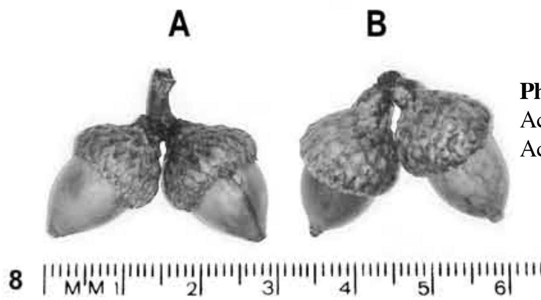

Photo 8. Ellipsoidalis forms. Acorn set A ELL N. Wisc.; Acorn set B COCC Mass.

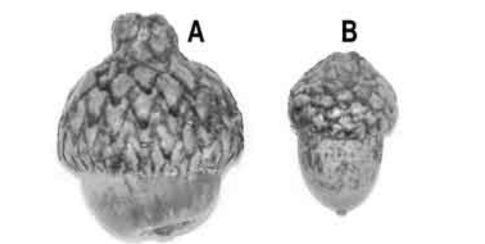

Photo 9. Annual variation S. Illinois COCC on same tree. Acorn A 1994; Acorn B 1995.

Photo 10 Concentric Rings. COCC Tinley Creek N. Illinois.

Photo 11. Concentric Rings. ELL Will Co. N. Illinois.

populations are continuous north to south and there is sympatry. The analysis is based upon an inordinate number of trees sampled from each population. While VEL showed no genetic break in clustering patterns between northern and southern populations as did COCC and ELL, only three trees out of a total of forty four represented southern populations. All the remaining trees studied were from the upper Midwest. VEL is also less polymorphic and probably more stable genetically than COCC, but caution should be used when there is such a dichotomy.

Finally, DNA inconsistencies have been noted in other studies done in the Chicago area. A recent study by Ashley (2006) involving *Quercus alba* L. white oak, *Quercus bicolor* L. swamp white oak, and *Quercus macrocarpa* L. bur oak, showed two Chicago-area populations of *Quercus alba* as genetically distinct even though morphologically similar. Ashley also noted that there was as much difference between the members of the same species as there was between members of different species. Another study by Gutman and Weigt (1988) involving electrophoretic allozyme analysis of the red oak group showed COCC and ELL to be more closely related to each other than to VEL or PAL as proposed by Jensen (1977). A small sample size warranted them to be tentative on their results.

DNA can and will continue to be a useful tool in helping taxonomists solve speciation. It is not the ultimate solution to plant taxonomy, however. This study recognizes genetic and morphological differences in COCC/ELL populations. The DNA study by Hipp and Weber substantiates this. However, speciation needs to be correlated with many other factors. Another aspect to the ELL/COCC controversy is the recognition of ecotypes or varieties.

Regional Ecotypes

The morphological variability of ELL and COCC is interpreted from this study to be attributed in part to local site conditions, current climatological influences, and dramatic climate shifts during the Pleistocene epoch. Statistical and ecological data suggest a COCC complex forming a clinal continuum with regional ecotypes ranging from the southern Appalachian/Ozarks through the northern Appalachians to the western upper Great Lakes and extending into Iowa and beyond. The statistical DFA of all characters reveals four major groupings: a southern Appalachian/Ozark scarlet complex; a northeastern complex; a prairie/savannah complex; and a northern sand barrens complex. Discussion on the four types follows.

Southern Scarlet Oak (Photos 6, 7, 10, 12, 13, 14)

The origin of ELL revolves around the nominate species COCC. It reaches its apex of development and greatest size in the southern Appalachians where it has attained heights of 50+ meters and circumferences of over 7m at breast height (Godfrey, 1988). It has been recorded as living over 400 years by some accounts (Harlow, 1984). It is here that the best examples of the species can be observed. Optimal growth is attained on deep, acidic, silt loams supplemented by annual rainfall patterns of over 50 inches (127cm) and high relative humidity. This form of COCC is restricted to the unglaciated regions of the lower Midwest and southern Appalachian/Ozark Mountains. The study populations included SF, WV, BC, and a disjunct TC. They are typified with an open growth form with or without dead branches, possessing large dull brown globular nuts with white cotyledons. The nuts reveal consistent ring patterns, with bowl shaped or turbinate cupules with

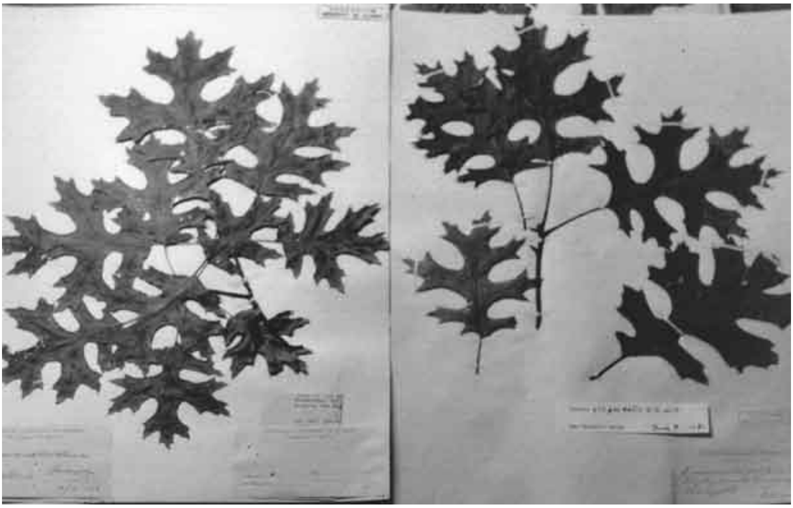

Photo 12. E.J. Hill's type material. Left photo South Carolina; Right Photo ELL "Authentic type" Chicago Illinois.

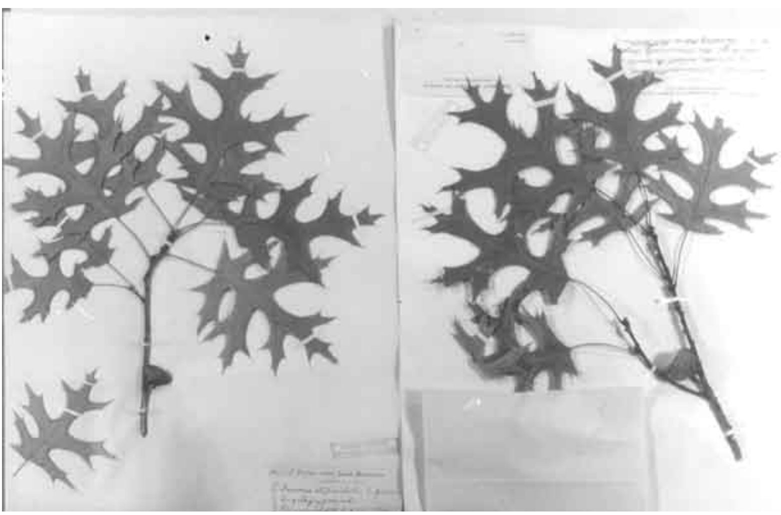

Photo 13. Syntype of ELL. Left photo Syntype of ELL Chicago, Illinois; Right Photo COCC Maryland

broad-based bracts frequently over 6mm. The buds range can range to 9mm (larger than many VEL) with elongated leaves over 200mm with 5-9 lobes. The Tinley Creek population is a population of over one hundred acorn-producing trees and represents a rare disjunct that grows with other southern taxa in a flatwoods near the lower end of Lake Michigan. Migrations of southern oaks along routes with silt loam deposits of the Mississippi River Valley from the unglaciated South in post glacial times has been suggested as its origin (Shepard, 2005).

Eastern Appalachian Scarlet Oak/ Origin of Hill's Oak (Photos 1, 3, 5, and 8)

Northern Appalachian populations of COCC presumably arose from post-glacial migration from the South and are represented by the study sites in Pennsylvania and Massachusetts. These forms of COCC are particularly common on the sand barrens of New Jersey, Massachusetts and Long Island of the Atlantic coastal plain. The populations of the northern Appalachians grow in high rainfall with cold winters. They represent northern variants of those to the south with slightly smaller, frequently tapered, cylindric, ellipsoidal nuts often lacking rings or pits. At elevations over 1000 feet in Massachusetts trees produce striated acorns with yellowish cotyledons and narrow, acute 4-5mm bracts. This is believed to

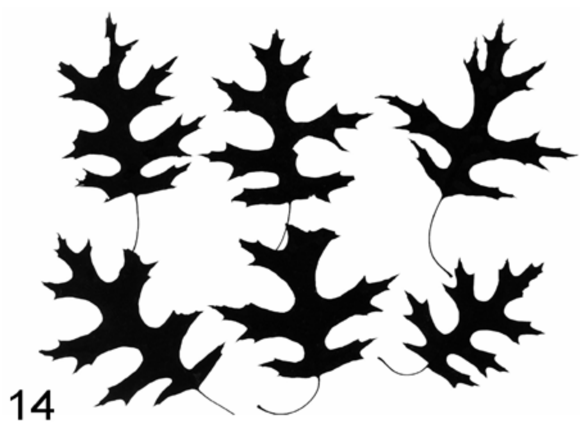

Photo 14. Leaf Morphology. Pope Co. Southern Illinois

Photo 15. Leaf Morphology. Whiteside Co. N.W. Illinois

be a response induced by cooler and dryer growing conditions and such trees have been grouped as "ellipsoidalis forms." All statistical studies showed a close relationship between the northern Appalachian populations of COCC and ELL. The DFA results indicate that Pennsylvania (PE) and Massachusetts (MA) populations are most closely related morphologically to those of ELL, suggesting ELL's origin. It is hypothesized here that populations of ELL of the western Great Lakes arose from a northwesterly migration of COCC originating from the northern Allegheny-Appalachian Mountains and Atlantic Coastal Plain following extensive sand deposits of the post-glacial stages of ancient glacial lakes from Lake Ontario and Erie in the East and continuing west and northward into Lakes Huron, Michigan, and Superior. Subsequent populations of ELL established themselves along the sand plains of northern Ohio, Michigan, northern Indiana, northern Illinois, Wisconsin, Minnesota, and Iowa. Populations of ELL reach their greatest abundance in the northern sections of Michigan, Wisconsin, and Minnesota. The absence of ELL/ COCC from central Illinois, northern Missouri (except for Harrison county), southern Iowa, central Indiana, and most of western Ohio suggests this. In northern Illinois, populations become increasingly scarce moving south from the Wisconsin/ Illinois border, indicating that major migrations originated from the north/northeast. Many coastal plain disjuncts in the genera *Carex*, *Eleocharis*, *Styrax,* and *Panicum* followed this presumed east/west path and occur in northwest Indiana, southern Michigan, northwest Wisconsin, and northeastern Illinois. This was documented by Peattie (1924), Curtis (1959), Swink and Wilhelm (1994), and Reznicek (1994). It is worth noting that woody taxa *Comptonia peregrina, Vaccinium angustifolium,* and *Amelanchier arborea* occurring at the Montague Massachusetts sandplain also occurred at the sites in northwest Wisconsin and northern Michigan. *Betula populifolia,* another disjunct, common in Montague and Pelham Massachusetts, grew as far west as northeastern Illinois on ancient beach sand a few kilometers east of the Tinley Creek Preserves (TE and TC) (Bartel, 1979) .

Plant communities of the western Great Lakes and upper Midwest have undergone dramatic climatic changes over several thousand years. A region including the states of Ohio, Illinois, Iowa, Wisconsin, Minnesota, northern Indiana, and portions of southern

Michigan comprised the Prairie Peninsula, an extension of the tall grass prairie, expanding 8,000 YBP during the hot and dry Hypsithermal Period (Transeau, 1935). Oak taxa migrating into these regions some 3-11,000 YBP incorporated themselves into these drier savannah / prairie communities. Climate in the Prairie Peninsula was and currently is not as suitable for development of complex forest communities as those further east or south (Braun, 1950). Forest species adapting to these shifting spells of extreme drought and extreme cold and wetness have had to survive by various changes genetically and through hybridization. Both COCC and ELL are

Photo 16. Bud Morphology. Pope Co. Southern Illinois

Photo 17. Bark Morphology. Lucas Co. Ohio

species that prefer open sites and are frequently pioneers in secondary succession, thus morphological responses to adverse climatic conditions seems likely. Scrubby oak populations of *Quercus alba* and *Quercus velutina,* growing alongside COCC, are associated with these savannahs.

Sand Plain Scarlet Oak

The region from Ohio through northeastern Illinois represents a vegetative ecotone from the complex mixed mesophytic forests of the east and south to the prairie/oak/savannahs of the west. Rainfall is annually under 100 cm (40in). It is typified by beech/maple on the moist sites and oak/hickory/savannah on the more upland drier areas. This area marks the eastern edge of the Prairie Peninsula. Populations across Lower Michigan, northern Indiana, and southeastern Cook County Illinois represented by SS, DU, CS, and CM represent transitional forms and have characteristics of both extremes of this continuum. Their members group morphologically between those of Appalachia and prairie groups. Scattered trees closely resembling those of the northern Appalachians can be found across northern Indiana and Lower Michigan. The Indiana counties of Elkhart (EK), Jasper, Cass, and White are a few of the counties representing these populations between the sand outwashes of the Kankakee and Wabash Rivers (Deam, 1953). Trees in this region have a more open growth form with fewer dead branches.

Prairie Scarlet Oak (Photos 1, 3, 4, 5, 7, 11, and 15)

The prairie/savannah region is represented by trees with generally poorer growth form, compacted branching patterns, smaller leaves, and shiny, striated nuts with yellow cotyledons. The populations of SS, CS, CM, DU, TE, NW, JD, IO and MN from southern Michigan, Illinois, Indiana, Iowa, and Minnesota are represented. Most of these populations lie on the west side of Lake Michigan, a region ecologically and vegetatively different than the Indiana/Michigan side (Swink and Wilhelm, 1994). Many eastern species drop out at this division, notably *Fagus grandifolia* and *Cornus florida*. The combinations of lower, unpredictable rainfall, high evapotranspiration rates, silty clay soil, and drought are environmental factors that can affect growth form and promote dead branching patterns and smaller buds (Cochrane and Iltis, 2000) (Nixon, et al. 1994). Hybridity between

COCC/ELL and VEL producing *Quercus* x*paleolithicola* is common on dry, sandy ridges near Lake Michigan. Alternately, locally moist conditions adjacent to Lake Michigan (CS, CM, DU, TE) offer more suitable sites and foster morphological characteristics of the complex in the form of larger buds, leaves, and nuts with concentric rings. Likewise, growing on better soil, trees of central Minnesota exhibit similar characteristics.

Northern Boreal Scarlet Oak (Photos 2, 3, 5, and 8)

Populations representing GS and WS represent northerly populations growing in the coldest climates in excessively dry sandy soil with the poorest nutrient capacity. These populations have the smallest acorns and buds, and thus position far statistically from the Appalachian groups. Individual trees at these sites frequently are stunted and scrubby and are sometimes called "grubs" (Curtis, 1959). Local site conditions play a role in separating northern populations of ELL. Moist loamy prairie soil of the Minnesota population (MN) supporting large trees contrasts with the stunted population in northwest Wisconsin (WS) growing almost directly across the Mississippi River in poor sandy soil. Nonetheless, Wisconsin trees showed COCC characters with cupules with acuminate bracts and broad bases, nuts with ring patterns, and COCC leaves.

Conclusion

The statistical, herbarium, and ecological observation from this study question the legitimacy of *Quercus ellipsoidalis* as a valid species. *Quercus ellipsoidalis* and *Quercus coccinea* are considered as infraspecific taxa with loosely based regional varieties comprising a complex. Four regional ecotypes of this *Quercus coccinea* complex are recognized, following the key below:

1a. Nuts frequently ellipsoid/subglobose with a pale yellow pigmented cotyledon, frequently shiny and striate, concentric rings often absent; Cupules mostly turbinate/conical; Buds mostly pubescent 25-75% of upper bud surface(rarely glabrous); Growth form compact, dense with dead branches, upper crown leaves frequently less than 125mm;
Midwestern in distribution.. **3**

1b. Nuts mostly globose with predominately white or occasionally pale yellow cotyledons, frequently dull and weakly striate. Cupules turbinate/ bowl shaped; Buds pubescent 25-75% of upper bud surface (rarely glabrous); Concentric rings often present; Growth form open, coarse with dead branches reduced; Upper crown leaves frequently over 125mm in length.
Mostly Appalachian and Ozarks in distribution **4**

2a. Buds 2-4 (6) mm, narrow, glabrous to sparsely pubescent, conical/turbinate cupules less than 19mm in width ,mostly glabrous, Tree often scrubby and stunted; growing on sand plains, boreal forest, edges of bogs in northern Michigan, northern Wisconsin, Minnesota, and southern Canada
....**Northern Scarlet Oak**

2b. Buds 3-6 (7.5) mm narrowly ovate, sparsely to moderately pubescent, Cupules mostly 13-28mm in width; Cupule bracts mostly 3-5mm frequently pubescent Tree to 30 meters; prairies, savannahs, hedgerows, oak woodlands, N.Illinois, NW. Indiana, Iowa, S. Mich., Minn, and Wisc.......... **Savannah Scarlet Oak**

3a. Buds 4-8mm narrowly ovate/bulbous, sparsely to densely pubescent. Cupules mostly 13 to 30mm, Cupule bracts 4-6mm mostly glabrous Nuts globular, cylindric and ellipsoid, concentric rings present or absent Northern Appalachian Mountains and associated sand plains, oak woodlands, pine barrens of New England, Penn, NJ, NY, Disjunct populations on sand savannahs; northern Indiana , extreme northeastern Illinois, northwest Ohio, lower Michigan...**Eastern Scarlet Oak**

3b. Buds 5-9mm broadly ovate/bulbous, sparsely to densely pubescent Cupules frequently 20-30+mm, mostly bowl shaped, Cupule bracts 5-8mm Nuts globular to cylindric mostly with prominent rings or pits. Dominant in Ozarks and southern Appalachian Mountains, also southern Illinois, southern Ohio, and southern Indiana; Disjunct in northern Illinois and southern Atlantic Coastal Plain... **Southern Scarlet Oak**

LITERATURE CITED

Braun, E. L. 1950. Deciduous Forests of Eastern North America. The Blakiston Co., Philadelphia, Pa. 596 pp.

Buhl, C. A. 1934. Supplement to an annotated flora of the Chicago Area by H. S. Pepoon. Bull. Chicago Acad. Sci. 5(2):5-12.

Craft K. J. and Ashley M. V. 2006. Population differentiation among three species of white oak in northeastern Illinois. Canadian Journal of Forest Resources 36: 206-215.

Curtis, J. T. 1959. The Vegetation of Wisconsin. University of Wisconsin Press, Madison, Wisconsin. 657 pp.

Deam, C. C. 1953. Trees of Indiana. The Bookwalter Co., Inc. Indianapolis, Indiana. 355 pp.

Godfrey, R. K. 1988. Trees, Shrubs, and Woody Vines of Northern Florida and adjacent Georgia and Alabama. University of Georgia Press. Athens, Georgia. 734 pp.

Grier, N. M. 1924. Unreported plants from Long Island. Torreya 24:71-76.

Gutman, S. I. and Weigt. L. A. 1989. Electrophoretic evidence of relationships among *Quercus* (oaks) of eastern North America. Canadian Journal of Botany 67: 339-351.

Harlow, W. M., E. S. Harrar, F. M. White. 1984. Textbook of Dendrology. 6th Ed. McGraw-Hill Book Company, New York, New York. 510 pp.

Hill, E. J. 1899. A new biennial fruited oak. Bot. Gaz. 27:204-208. Illinois Natural History Survey. 1976. Inventory of flora and fauna of Thornton

Hipp, A. L. and Weber, J. A., 2008. Taxonomy of Hill's Oak (*Quercus ellipsoidalis:* Fagaceae): Evidence from AFLP Data. Systematic Botany: 33(1) pp. 148-158.

Jensen, R. J. 1977a. A preliminary numerical analysis of the red oak complex in Michigan and Wisconsin. Taxon 26:399-407.
Jensen, R. J. 1977b. Numerical analysis of the scarlet oak complex (*Quercus* subgen. *Erythrobalanus*) in the eastern United States: Relationships above the species level. Syst. Bot. 2:122-133.
Jensen, R. J. 1979. Lectotypification of *Quercus ellipsoidalis* E. J. Hill. Taxon 29:154-155.
Jensen, R. J. 1997. *Quercus* Linnaeus sect. *Lobatae* Loudon. Pp. 447-468 in Flora of North America Editorial Committee, eds. *Flora of North America, North of Mexico,* Vol. 3 Oxford University Press, New York.
Jones, N., and G. D. Fuller. 1955. The Vascular Plants of Illinois. University of Illinois Press, Urbana, and the Illinois State Museum, Springfield, Museum Scientific Series (6). 55pp.
Little, E. L., Jr. 1971. Atlas of United States trees. Volume 1., Conifers and important hardwoods. United States Department of Agriculture, Forest Service, Miscellaneous Publication Number 1146. 200 pp.
Overlease, W. R. 1977. A study of the relationship between scarlet oak (*Quercus coccinea* Muenchh.) and Hill oak (*Quercus ellipsoidalis* E. J. Hill) in Michigan and nearby states. Proc. Penn. Acad. of Sci. 51:47-50. Palmer, E. J. 1942. The red oak complex in the United States. Amer. Midl. Naturalist 27:732- 740.
Peattie , D. C. 1922. The Atlantic Coastal Plain element in the flora of the Great Lakes. Rhodora 24: 57-88.
Reznicek, A. A. 1994. The disjunct coastal plain flora in the Great Lakes region. Biol. Conservation 68: 203-215.
Shepard, D. A. 1991. The occurrence of the scarlet oak, *Quercus coccinea* in northern Illinois. Trans. Ill. State Acad. Sci. 84 (Suppl. 35) (Abstract).
Shepard, D. A. 1993. The Legitimacy of *Quercus ellipsoidalis* based on a Populational study of *Quercus coccinea* in Illinois. Unpublished Thesis. Western Illinois University. 168pp.
Shepard, D. A. 2005. The land that time forgot; southern flatwood oaks and associates of the Tinley Creek Forest Preserve of Cook County, Illinois. International Oak Journal 16: 47-60.
Swink, F.and G. Wilhelm. 1994. Plants of the Chicago region, 2nd Edition. The Morton Arboretum, Lisle, Illinois. 922 pp.
Transeau, E. N. 1935. The prairie peninsula. Ecology 16:423-437.
Trelease, W. 1919. The Jack Oak (*Quercus ellipsoidalis*). Trans. Ill. State Aca. Sci. 12:108-
Vasey, G. 1870. Our native oaks. American Entomol. and Bot. 1:344-345.
Voss, E. G. 1985. Michigan Flora Part II, Dicots (Saururaceae-Cornaceae). Cranbrook Institute of Science and University of Michigan Herbarium 724 pp.
Wadmond, S. C. 1933. The *Quercus ellipsoidalis-Quercus coccinea* complex. Trans. Wisc. Acad. Sci Arts and Lett. 28:197-203.
Wilkenson, L. 1990. Systat: The System for Statistics. SYSTAT Inc., Evanston, Illinois. 677 pp.

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An Interesting Hybrid Oak Population in Southeastern Colorado and Adjacent Areas

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Farmers and ranchers in southeastern Colorado in Las Animas and Baca Counties have long been aware of unusually large oak trees growing in the bottomlands along creeks in the local "canyons," which are more properly gulches or draws in the context of the High Plains. Cottonwood (Creek) Canyon, located in western Baca County, is perhaps the best known of these.

On the drier, rocky hillsides above and away from the creeks are a different set of oaks entirely, short, twisty, and scrubby, certainly "scrub oaks" in the classical sense. These scrub oaks, which vary from short shrubs to trees up to 15 or more feet high, have been designated as *Quercus* x *undulata* (Tucker 1961-1971). These oaks are characterized generally by smallish, somewhat holly-like, sometimes prickly gray-green leaves which are very unlike the deeply-sinused, dark green leaves which most people associate with oaks. The acorns are also small, with shallow, rather smooth caps, often but not always on peduncles.

The large trees are another matter: they DO have typical "oak leaves," with deep sinuses. The leaves are a rich green and can be quite large ranging from 8.5-15 cm length and 4.5-10 cm width with up to 5-7 lobes per leaf, and some have a blunt terminal lobe with an obovate to elliptical leaf blade in outline (Figure 1). The acorns are rather large, and virtually always have a smooth cap without fringes. Since the leaves in particular do not match those of any of the more familiar oaks of the area—*Q. gambelii* to the west and north, *Q. macrocarpa*, *Q. stellata* to the south and east, there has always been speculation as to just what they could be.

Figure 1. Foliage of an apparent *Q. macrocarpa* x *Q. gambelii* in Cottonwood Creek Canyon, Baca County located in SE Colorado.

Figure 2. Examples of the single-stem (left) and multi-stem (right) clumping oaks in Cottonwood Creek Canyon in Southeastern Colorado. Size and form of trees suggests hybridization between *Q. gambelii* and *Q. macrocarpa*.

The mystery was finally solved by Jack Maze, in his doctoral dissertation working under John Tucker at UC-Davis. Maze concluded, after studying similar populations in nearby Union County in northeastern New Mexico, that the trees represent a stable population of hybrids between *Q. gambelii* and *Q. macrocarpa* (Maze 1968). Indeed, the aspect of the mature tree is very much like *Q. macrocarpa*: moderately tall (10 or more meters), with the large limbs, open, spreading head, and many, though not all with a single-stemmed habit (Figure 2). The leaves, on the other hand, are more like the gambel parent, except for that blunt apical lobe suggestive of *Q. macrocarpa* ancestry. Where the hybrid tree consists of more than one stem, *Q. gambelii* parentage appears to be responsible.

There are several questions raised by the presence of these hybrids, chiefly, how and where did they originate? At the present time there are no individuals of either putative parent species in the immediate area of southeastern Colorado and northeastern New Mexico where the hybrids occur. There are many individuals of *Q. gambelii* farther west at higher altitudes, closer to the Front Range of the Rocky Mountains in Colorado and to the Sangre de Cristo Mountains in New Mexico, in both mountain and contiguous high plains environments. *Quercus gambelii* is typically a mountain plant, which grows as a tree or shrub either with a single trunk or as a clump which derives from basal and root suckers from a single original tree. Plains-dwelling trees do not differ from the mountain forms, and tend to be found along streams flowing east out of the mountains. Good examples can be viewed near Colorado City, along Greenhorn Creek, or a short distance farther south, along Apache Creek, both in Huerfano County, which is in the first tier of counties north of Las Animas and Baca Counties. (Most of the land near I-25 in Huerfano County is private, so inspection of trees should be done where access is not restricted.) Trees can also be found farther north along Plum Creek in Douglas County near Castle Rock. Good examples of *Q. gambelii* also occur in Colfax County, New

Figure 3. Left: (*Q. gambelii* in leaf), Roxborough State Park, Douglas County, southwest of Denver. Right: (*Q. gambelii* clump out of leaf), Glenwood Canyon, Garfield County, Colorado, near Glenwood Springs.

Mexico (just south of Las Animas County, Colorado), east of Raton, along Yankee Canyon all the way to the top and in places across Johnson Mesa, a high table land which rises to over 8,600 feet above sea level. Evidently pure individuals of *Q. gambelii* also occur in Toll Gate Canyon, south of Branson, Colorado and east of Folsom, New Mexico, both located at the eastern end of Johnson Mesa (Figure 3).

When one examines the Colorado vanguard trees, however, it is possible to discern in some of them the same traits characteristic of the clear hybrid populations farther to the southeast: primarily the larger leaf with the blunt tip and an obovate leaf outline. The present authors have discovered oaks which we consider to be the same hybrid as far north and west as Phantom Canyon, in Fremont County, and Castle Rock, in Douglas County (Figure 4). One specimen found in Cottonwood Creek Canyon and one much farther northwest along Plum Creek just south of Denver both produce acorn caps with a fringed top (Figure 5). It seems clear that there has been gene flow out of the southeastern part of the state, establishing in effect a mixed population of putatively pure *Q. gambelii* and hybrids of the latter with *Q. macrocarpa*.

To answer the how and where of the original hybridization, it is best to raise the issue also of when. It seems to us most likely that *Q. macrocarpa* x *Q. gambelii* hybridization occurred during or at the end of the Pleistocene or early in the Holocene, when the areas where hybrids now grow was cooler and wetter (Bement et al 2007). Indeed, at the end of the Pleistocene Epoch (14,000-12,000 years BP), the Great Plains south of the glacial front harbored a spruce forest as far south as Kansas, and the plains farther south were covered by deciduous forest (Trimble 1980). Remnants of this broadleaf forest still exist in mesic canyons in the Southern Plains and near the summit of the Quartz Mountains in Oklahoma and in some of the different mountain ranges in the Big Bend country of West Texas. Other remnant populations in Nebraska and South Dakota are noted below.

Figure 4. Apparent *Q. macrocarpa* x *Q. gambelii* specimen growing along Greenhorn Creek near Colorado City, Colorado at the base of the Front Range.

Gambel's oak would have extended much farther east and south at that time, and bur oak would have been present farther west at that time than at present. (The closest bur oak populations to the area in question at the present time are in western Oklahoma, east of the Texas Panhandle.) It seems likely that bur oaks would have been present at that time in the northern Texas Panhandle, in the Canadian River drainage, and so could have reached the territories in northeastern New Mexico where the hybrids are attested. As to the Colorado hybrid population, the Cimarron River Valley seems to be a likely avenue for the two oak species to have come into contact, if indeed both species were not dispersed generally throughout the area.

The same process certainly occurred in the Central Plains, since the same hybrid is found in the Black Hills of South Dakota (Maze 1968). In this case the hybrids co-occur with "pure" *Q. macrocarpa*, but *Q. gambelii* is totally missing. Its earlier presence is attested, however, by the presence on hybrids of an obligate parasite of *Q. gambelii*, the wasp *Cynips insulensis*.

As the climate of the early Holocene became warmer and drier during and after the Altithermal (Antevs 1955) some seven thousand years ago, the forests and lightly-wooded savannas of the Great Plains disappeared, and along with them one or both of the sympatric parent species of the *Q. macrocarpa* x *Q. gambelii* hybrids, leaving behind in the zones of hybridization a mixed-race progeny evidently better adapted to the newer conditions.

These conclusions are tentative, and will require additional research to either support or refute the hypothesis regarding the process of hybridization suggested here. DNA testing would certainly confirm that hybridization has occurred, and which species are involved, but paleo-climate information will be required to explain the mechanics. Information on the latter question known to the authors (e.g. Bell 1984; Dick-Peddie 1993) makes the hypothesis outlined above seem likely, but further suggestions and discussion would be very welcome.

Figure 5. Acorns from putative *Q. macrocarpa* x *Q. gambelii* displaying long awn-like scales at the top of the acorn cup. This characteristic is common in *Q. macrocarpa* but not in *Q. gambelii*. Left: Plum Creek specimen near Castle Rock in central Colorado. Right: Cottonwood Creek Canyon specimen in SE Colorado.

Another question requiring investigation about the *Q. macrocarpa* x *Q. gambelii* hybrids in the southeastern Colorado area is that there is so little apparent introgression between them and the local *Q.* x*undulata* hybrids; both populations are thoroughly intermixed where the two occur together. There appears to be some sort of barrier to free interbreeding (limited interbreeding is attested) between these two groups, but this barrier is for the moment unknown.

Still to be evaluated for evidence of hybridization are a couple of relict populations of bur oak in western Nebraska. These are Bur Oak Canyon in Hitchcock County in southwestern Nebraska, on the Kansas state line about 65 miles east of the Colorado state line, and the small Cunningham Creek population in Dawes County, in the Nebraska Pine Ridge south and west of Chadron, Nebraska. The Niobrara River Valley needs to be carefully examined also, particularly at its western end.

The authors have discovered one tree in Bur Oak Canyon which shows great affinity with putative *Q. macrocarpa* x *Q. gambelii* hybrids, although most of the trees in the canyon are much more like typical bur oaks (if a species as variable as *Q. macrocarpa* can be said to have "typical" members!). The suspected hybrid has leaves which are morphologically highly similar to those of Q. *gambelii*, and the acorn has a cup which is smooth, not fringed with long awn-like scales at the top of the cap, and which covers a third or less of the top of the acorn (Figure 6). Certainly these acorns are very different from the acorns on Q. macrocarpa-like trees only 20 feet away! Moreover, the acorns on this tree ripen much earlier in the season than the acorns on most of the trees in Bur Oak Canyon, again a trait characteristic of *Q. gambelii*. If *Synips insulensis* also occurs in the western Nebraska populations of *Q. macrocarpa*, there should be no further doubt that the populations are basically hybrid, regardless of appearances.

Figure 6. Specimen in Bur Oak Canyon located in SW Nebraska displaying *Q. gambelii* characteristics. Note the shallow cup on the mature acorns that doesn't have a fringe at the top of the acorn cup. Many other oaks in the canyon are *Q. macrocarpa*, and have a distinct fringe on the top of the cup. *Q. gambelii* doesn't have a fringed acorn cup.

References

Antevs, Ernst. 1955. Geologic-climatic dating in the West. American Antiquity 20:317-335.

Bell, Robert E., ed. 1984. Prehistory of Oklahoma. Orlando: Academic Press.

Bement, Leland C. et al. 2007. Paleo-environmental reconstruction and bio-stratigraphy, Oklahoma Panhandle, USA. Quaternary International 169-170:39-50.

Dick-Peddie, William A. 1993. New Mexico vegetation: past, present, and future. Albuquerque: University of New Mexico Press.

Maze, Jack. 1968. Past hybridization between *Quercus macrocarpa* and *Quercus gambelii*. Brittonia 20:321-333.

Trimble, Donald E. 1980. The geologic story of the Great Plains. Geological Survey Bulletin 1493. Washington: U.S. Government Printing Office.

Tucker, John M. (et al.) 1961-1971. Studies in the *Quercus undulata* complex I-V. American Journal of Botany 48:202-208; 329-339; 50:699-708; 57:71-84; 58:329-341.

Photos courtesy of the authors Allan Taylor and Tim Buchanan.

A Gallery of Oaks

This year our gallery features an oak from Asia. Please join
Gert Fortgens, Eike Jablonski, Bernd Schulz,
Philippe de Spoelberch, Guy Sternberg,
Michel Timacheff, and Keiko Tokanaga
for these views of the Emperor Oak, *Quercus dentata*,
and some of its hybrids and cultivars.

Leaves on *Quercus dentata* 'Sir Harold Hillier' at Arboretum Trompenburg
photo © Gert Fortgens

Ripe acorns ready for planting photo © Guy Sternberg

Q. dentata acorns maturing photo © Eike Jablonski

Q. dentata twigs and buds drawing © Bernd Schulz

Q. dentata acorns developing photo © Guy Sternberg

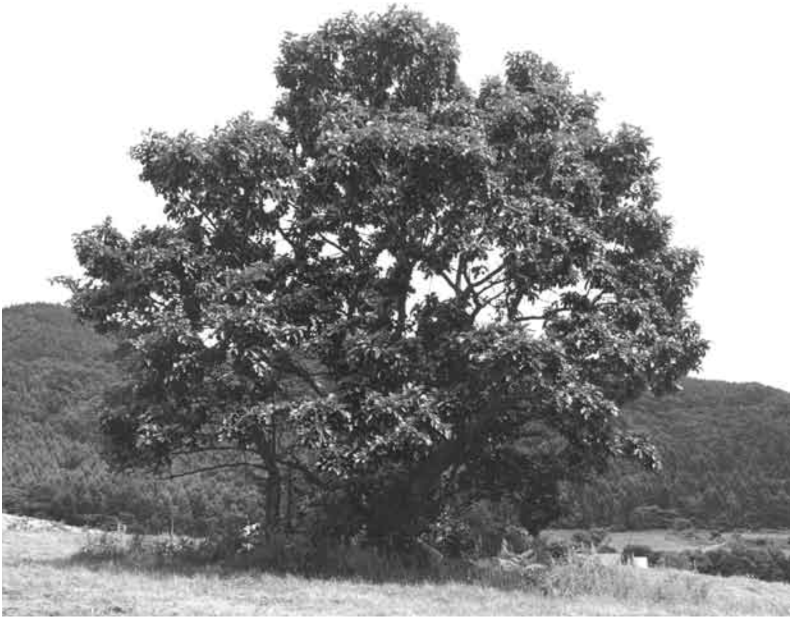
Fertile second growth flush photo © Guy Sternberg

Bark of a mature tree in the wild in Japan photo © Keiko Tokunaga

Bark on a medium-sized tree at the Hillier Arboretum photo © Michel Timacheff

Young seedlings in the forest in Korea photo © Philippe de Spoelberch

Staminate catkins expanding photo © Michel Timacheff



A mature tree in Japan photo © KeikoTokunaga

An old planted tree in the Los Angeles County Arboretum
photo © Michel Timacheff

Bark on a young tree at Starhill Forest Arboretum photo © Guy Sternberg

Foliage from a tree of Chinese origin at Starhill Forest Arboretum
photo © Guy Sternberg

Fertile second growth flush photo © Guy Sternberg

A young tree of Korean origin at Starhill Forest Arboretum

photo © Guy Sternberg

Leaf variation from three trees photo © Guy Sternberg

A large, erect tree at Gimborn Arboretum photo © MichelTimacheff

Quercus dentata 'Pinnatifida' at Starhill Forest Arboretum
photo © Guy Sternberg

Quercus dentata 'Pinnatifida' at Starhill Forest Arboretum

photo © Guy Sternberg

Quercus ×*vilmoriniana*, a rare hybrid pollinated by Q. petraea, at Starhill Forest Arboretum (grafted from the ortet at Arboretum des Barres in France)

photo © Guy Sternberg

‘Pondaim’, a cross with *Quercus pontica*, at Arboretum Trompenburg
photo © Gert Fortgens

Foliage of ‘Pondaim’, a cross with *Quercus pontica*, at Arboretum Trompenburg
photo © Gert Fortgens

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1999 - France - Thierry Lamant

1998 - Germany - Eike Jablonski

1995 - England - Allen Coombes and Dorothy Holley

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International Oaks

The Journal of the International Oak Society

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