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International Oaks

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Spring 2008

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Oak watercolors on vellum by Wendy Brockman
(Back Cover - *Quercus prinoides*)
Quercus alba, Q. bicolor, Q. coccinea
Quercus imbricaria, Q. macrocarpa, Q. montana
Quercus palustris, Q. rubra, Q. velutina

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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:
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Cover Photos:

Front: *Quercus petraea* at Verzy Faux Foret, France
photo © Guy Sternberg

Back: Oak watercolor on vellum by Wendy Brockman
(*Quercus prinoides*)

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International Oak Society Awards 2006

Eike Jablonski, Luxembourg

Every three years the International Oak Society holds an International Oak Conference. Since the year 1997, awards have been given at each Conference to members who uniquely contribute to the Society or to the promotion of oaks. Recipients of these awards were selected by the board after being nominated by the membership. In 2006, five members were chosen to receive an International Oak Society award.

There are two categories of awards:

1. **Lifetime Service Award**: this award is given to members who over a lifetime have contributed outstanding support to the Oak Society, or to the global study of oaks. A gift of Life Membership accompanies this award.
2. **Special Service Award:** this award is given to members who contributed particular services to the Oak Society or the promotion of oaks.

2006 Lifetime Service Award

The 2006 *Lifetime Service Award* belongs to two well known members from Turkey: **Nihat Gökiyğit** and **Hayrettin Karaca**, longtime members of the IOS. Both shared a tremendous accomplishment when they founded TEMA, the Turkish foundation combating soil erosion and forest destruction. With some 250,000 members worldwide, TEMA plays an important role in Turkish environmental protection. The planting of trees, including millions of oak seedlings, in eroded Anatolian landscapes is one of the many efforts TEMA undertakes daily. This ambitious project was started in 1998; within 25 years 10 billion acorns shall be planted in eroded soils! Nihat gave a short presentation of this project at the 5th International Oak Conference in 2000 in Asheville, North Carolina (Gökiyğit, 2000). Furthermore, both Nihat and Hayrettin are supporting scientists in their efforts to learn more about Turkish flora and fauna. Nihat founded the Nezehat Gökyigit Botanical Garden in busy Istanbul, with an emphasis to plant as many native Turkish plants as possible. Hayrettin founded the Karaca Arboretum in Yalova, on the other side of the Bosporus, and assembled there a huge number of native and exotic plants from around the world. Interesting oaks are growing in both collections, of course.

2006 Special Service Award

The first *Special Service Award* was presented to **Christian Spinelli**, who with his wife Carin, founded the Finca Tori, a centre for education and forestation in Costa Rica. Both are busy educating the local population, and especially school kids, in environmental protection and forestation projects. Working with local groups, Christian manages to plant thousands of trees in deforested areas, including many native oaks which have been raised from seed in the affiliated nursery. Carin writes and draws stories for children. Even though their homeland is Costa Rica, they are establishing similar environmental projects in many other South American countries such as Chile and Argentina.

The second *Special Service Award* was given to **Richard Jensen**, professor of biology at Saint Mary's College, Notre Dame, Indiana, U.S.A. Dick has served as our society's membership chair for many years, and is responsible for the membership directory. He created and currently maintains the society's web page. Both of these services, done completely voluntarily, are essential to the Oak Society and its members.

The third *Special Service Award* was presented to **Dan "The Oakman" Keiser**, from Minnesota, U.S.A. Dan is a certified arborist and a well known member of the Oak Society. When local authorities wanted to build a road through a sacred oak woodland, consisting of several old *Quercus macrocarpa*, Dan organized gatherings and brought hundreds of people together to protest against the project. These oaks were sacred trees to the Mendota Midewakanton Dakota, a Native American community. Unfortunately, the trees have been felled, but Dan saved scion wood and managed to establish grafts from the original trees. The Mendota Midewakanton Dakota Community made him an honorary member and gave him the name *Utuhu Tanka*, which means "Old Oak in the Forest."

The 2006 award winners illustrate the diverse interests and projects of Oak Society members and all they do for the sake of oak trees. Good luck and success for future endeavors to all the IOS members!

Eike Jablonski

The Case for Oaks in Residential Land Development

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The impact on the natural world of people living in community has been well described and adjustments have been made to mitigate many deleterious environmental effects, especially those brought on by economic growth and increasing population. The primary manifestation in our times is found at the perimeter of communities, where commercial and residential activity spreads to land that was previously used for agricultural purposes.

Although not in an undisturbed state, farm and ranch land close to the edge of town retains many more natural features than are left after commercial and residential development. If the land were naturally wooded, conversion to agricultural use typically results in greater loss of trees than would have resulted from development, if that use had occurred instead. Even so, it has been estimated that ninety-percent or more of native forest is lost when land is used either for agriculture or developed for commercial and residential purposes.

Several business strategies are followed by the residential real estate development industry. Most are essentially opportunistic and short-term, that is, based upon exploiting a discrete and limited economic opportunity, in contrast to an ongoing businesses operated from one or more established locations, such as manufacturing, banking, hospitality, communications, transportation, etc. The vulnerability of residential real estate development to business cycles is especially acute. In fact, because it is heavily reliant on debt, from time to time, homebuilding bears a disproportionate burden placed on it by interest rate policy of the Federal Reserve Board of Governors in slowing an overly robust U.S. economy. Similarly, the Federal Reserve may seek to stimulate the U.S. economy through the effect of lower interest rates on homebuilding. Consequently, the homebuilding industry has historically been comprised of small businesses, often undercapitalized, thinly staffed, focused on short-term goals, and paying little attention to secondary elements of the new home product, such as landscaping -- in particular, planting of attractive and long-lived trees.

Developers of residential subdivisions and homebuilders have long understood and met the homebuyer expectation of trees planted in their yards. For many years, the Federal Housing Administration has required the planting of trees on lots in neighborhoods that are qualified for its mortgage subsidy. In general, however, homebuyers, developers and builders lack information about trees and conditions conducive to their health. Furthermore, there is a preference for fast growing trees for planting in yards of new homes. These factors, along with budgetary constraints in new homebuilding, often result in tree selections and planting practices that fail to achieve the best aesthetic and restoration outcome in new home subdivisions and commercial developments.

Because most home buyers appreciate the aesthetic contribution of trees, if not also their economic benefits, builders and developers may differentiate their product, provide customers added value, and achieve greater investment security by preserving native trees and by planting high quality trees for homebuyers and in neighborhood common areas according to an comprehensive, artful and well-explained plan. The subdivision development business strategy of the David Bagwell Company is guided by these considerations.

The David Bagwell Company is a developer of residential subdivisions active in the Northeast Tarrant County new home market of Dallas and Fort Worth. This area falls within the Eastern Cross Timbers, which experienced substantial conversion to agricultural use prior to encroachment by the growth of Fort Worth and Dallas. Native woods remain in floodplains and waterways, while significant stands of undisturbed forest are rare.

The predominant trees of the Eastern Cross Timbers are Post Oak (*Quercus stellata*), including the Margaret's Post Oak (*Quercus margaretta*), and Blackjack Oak (*Quercus marilandica*). Other oaks of the Eastern Cross Timbers found in riparian zones are Bur Oak (*Quercus macrocarpa*) and Shumard Oak (*Quercus shumardii*). American Elm, Cedar Elm, Chittamwood, Pecan, Eastern Cottonwood, Eastern Red Cedar, and Black Hickory are also native trees of the Eastern Cross Timbers.

Preservation of Trees - Site Selection

Notwithstanding that trees are a renewable resource, several generations will pass before an acorn becomes a tree of the size and character potential to many species. No amount of tree planting can overcome the loss of stalwart forest trees when wooded land is cleared of trees for streets, utilities, floodway reclamation, and building sites. In evaluating sites for new developments, the David Bagwell Company passes over wooded sites, unless early in the feasibility analysis it can be determined that land use and zoning laws can be reconciled both to market demand and to a site plan that will preserve native trees.

Avoiding development in naturally wooded areas serves three business objectives. First, if controlling factors permit a partially wooded site to be developed and the native trees preserved, a more aesthetically pleasing and, thus, more valuable and financially secure neighborhood investment results. Second, by avoiding homebuilding among sensitive trees -- post oak and blackjack oak are very intolerant of development activities -- the company ensures against homebuyer reluctance toward the conclusion of lot and house sales when prospective buyers observe moribund trees in yards of homes built earlier. Third, the developer is able to demonstrate to elected officials the community wide value in natural area preservation, which was obtained by zoning and platting tradeoffs. The good will that accrues to the developer is likely to affect future development entitlement applications in the same community, as well as nearby communities.

Tree Planting - Restoration, Replacement, and Experimentation

In the planning process for each development, landscape architects are employed to prepare a tree planting plan that encompasses lots, open space areas, entryways, boulevards and residential streets. The business objectives of the plan are both short term and long term. Immediately upon completion of excavation, utility installation and street paving, tree planting begins where homebuilding will not conflict. As each home is completed, trees are planted generally according to the plan. Particular attention is given to maintaining the species called for, but locations of trees may vary somewhat from plan. This work serves the short term objective of the company to differentiate its product -- an attractively planted homesite in a neighborhood heavily planted with trees -- and to demonstrate the added value that homebuyers receive in the company's neighborhoods.

In the long term, tree planting serves the company's business objectives of tree planting by demonstrating the benefits to the community of neighborhood tree planting. The good will is useful to the developer in the same way as tree preservation described above. It also serves the developer's brand building and identification efforts.

Trees Employed in Neighborhood Planting

Oaks are the primary species of trees planted by the David Bagwell Company. The sandy loam, slightly acidic soils of the Eastern Cross Timbers support a wider variety of oaks than the alkaline soils that comprise most of the Fort Worth - Dallas area. Many oak trees used extensively through the company's developments are unseen elsewhere in North Texas, e.g. Scarlet Oak (*Quercus coccinea*), Bluff Oak (*Quercus austrina*), Stone Mountain Oak (*Quercus georgiana*), Swamp Chestnut Oak (*Quercus michauxii*), Compton Oak (*Quercus lyrata* x *Q. virginiana*), English Oak (*Quercus robur*), and Swamp White Oak (*Quercus bicolor*). Other oaks that the company uses are rarely seen elsewhere in North Texas, e.g. Eastern White Oak (*Quercus alba*), Overcup Oak (*Quercus lyrata*), and Nuttall's Oak (*Quercus nuttallii*, syn. *Q. texana*) . Some oaks used are uncommon in North Texas, e.g. Water Oak (*Quercus nigra*). The company has planted two demonstration areas with seldom seen oak hybrids, e.g. Saul's Oak, Schuettes Oak, etc., and rarely seen species like Willow Oak (*Quercus phellos*), Darlington Oak (*Quercus hemispherica*, Laurel Oak (*Quercus laurifolia*), Shingle Oak (*Quercus imbricaria*), and Cherrybark Oak (*Quercus pagoda*). Native and common non-native varieties of oaks are also used, e.g. Bur Oak (*Quercus macrocarpa*), Shumard Oak (*Quercus shumardii*), Texas Oak (*Quercus buckleyi*), and Chinkapin Oak (*Quercus muhlenbergii*), The company prohibits Southern Live Oak (*Quercus virginiana*) and Escarpment Oak (*Quercus fusiformis*), as these trees tend to have a broad canopy relatively low to the ground that provides too much shade for smaller yards typical of the company's lots.

Nuttall Oak, Swamp White Oak, Bluff Oak, and Overcup Oak are the most commonly planted oaks. The former is considered a more reliable fall coloring tree than its kin, the native Shumard Oak and is otherwise indistinguishable by homebuyers from Shumard Oak, with which many North Texans are vaguely familiar. Swamp white oak and Overcup Oak are considered good substitutes for the native post oak, and Swamp White Oak is preferred to bur oak because its autumn color is more attractive and because it produces less litter. The company also plants large numbers of American Elm and Urbanite Ash (*Fraxinus pennsylvanica* 'Urbanite').

Nurseries of landscape trees are maintained from which trees are planted throughout the neighborhoods. A full time landscape crew is employed by the company to maintain trees in the nurseries, to plant trees, to receive newly purchased trees into the nurseries, and to water, prune, and fertilize trees. The landscape crew also grows trees from seed, particularly hard to find non-native trees, e.g. Loquatleaf Oak (*Quercus rhysophylla*), native trees that are hard to find, e.g.

Quercus stellata and *Quercus marlilandica*, and trees with especially attractive attributes, e.g. late fall color and leaf shape.

Virtually all trees planted by the developer are field dug and purchased from wholesale nurseries in Texas, Oklahoma, Alabama, Florida, and Georgia. They range in size from 2" caliper to 6" caliper.

Landed costs of landscape trees are around $135.00 per caliper inch. Handling, storage, planting, related equipment, and direct overhead come to about $300.00 per tree. (No cost allocation is included for land on which trees are stored until planting.) All together, the cost of a typical 3-1/2" caliper, 14'-16' Nuttall Oak purchased as part of a truckload of other trees from a southern nursery and planted within 12 months in the yard of a new homebuyer amounts to about $735.00. A smaller oak tree (e.g., a 2" caliper, 8'-10' Nuttall Oak) would cost the developer about two thirds of that. Four landscape trees per homeowner's yard cost the developer between about $2,100.00 and $3,100.00 or roughly two percent of the retail price of the lot on which each size of tree would be planted. The company believes its per lot revenue more than covers the cost of such planted trees.

The company's business strategy is dependent upon prospective homebuyers perceiving a significant difference between developments with extensive tree planting and those without. The challenges of this effort are not insignificant. Most relate to resources. Foremost are knowledge of where to find top quality landscape trees that will thrive in the North Texas area, in particular the Eastern Cross Timbers -- trees that are well-grown, well-dug, and properly loaded and shipped. Northern Red Oak (*Quercus rubra*) and Chestnut Oak (*Quercus montana*), for example, have not proven viable in the area. Originally, the company provided trees to builders' landscapers to plant in yards of new homes, but most landscape installers that serve the homebuilding industry lack the knowledge, management systems and equipment to properly handle and plant the trees the company provides, so the company now installs trees it provides. The costs of equipment, labor and tree inventory is also substantial. Knowledgeable staff is also difficult to recruit and retain.

Local government can encourage tree preservation and extensive tree planting, by providing liberal property entitlements, i.e. value enhancing zoning and platting approvals, and accommodation, e.g. allowing fire hydrant use for supplemental tree watering. Not only does tree preservation and extensive tree planting offer all stakeholders an enriched environment, but it also creates a reference point for future developments to emulate and improve upon.

It also increases local tax rolls in the short and long term. When local government enables tree planting, there is a marginal increase in taxable value and thus tax receipts and also an undergirding of long term taxable value of homes and neighborhoods. This is achieved without local government having to make a financial investment in this outcome through tax abatement, as businesses often seek to help underwrite the cost of a new business ventures that are claimed will eventually return the investment and pay employment and local tax dividends thereon. If, for example, lots without tree enhancement in an area sell for $80,000.00, then, without overextending government services, local government could enable a developer to pay for all the above-described trees in a development simply by entitling property with additional density of 0.075 unit per acre over and above its ordinance density cap of, say, 2.0 units per acre. Applied to a 100 acre residential development, this would result in just 7.5 households above the hypothetical density cap but 830 high quality, well-planted oak trees contributing more each year to the financial well-being of the community and to sustaining a picturesque neighborhood environment for those living there. Tree preservation and extensive planting offer all stakeholders an enriched environment.

Editor's Note: Figures 1 and 2 are examples of David Bagwell Company's landscape plans utilizing placement of trees and woodlands within two residential developments.

DAVID BAGWELL COMPANY
TIMELESS NEIGHBORHOODS
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Figure 1

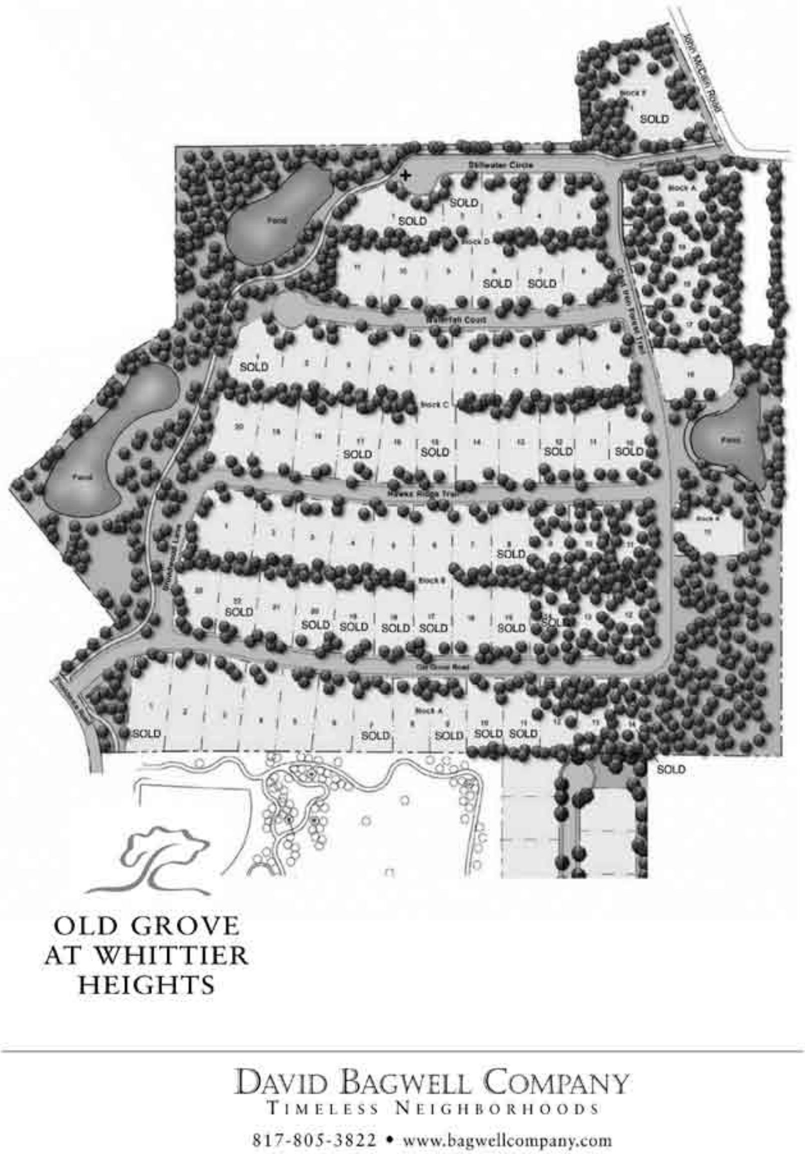
OLD GROVE
AT WHITTIER
HEIGHTS
DAVID BAGWELL COMPANY
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Figure 2

Wendy Brockman shows her paintings of oak leaves.

Autumn Oaks

Wendy Brockman
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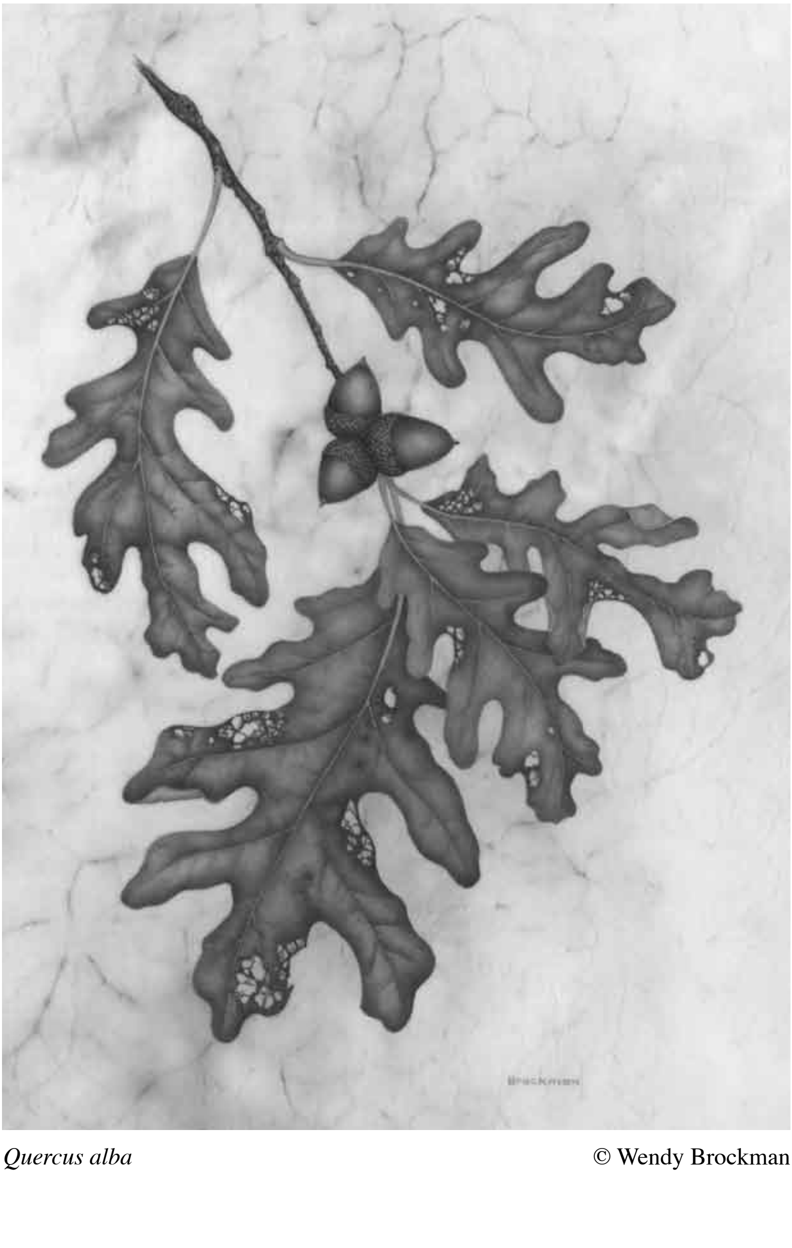
Oak trees have inspired artists for hundreds of years and continue to be the subject of much contemporary artwork. Providing an ongoing variety of color and form, oaks are beautiful throughout the year and especially dramatic in autumn. In 2006 I painted Autumn Oaks, a series of ten watercolor paintings of oaks in fall color. Each piece represents a different species and expresses its individual personality and seasonal characteristics. All of the pieces in the Autumn Oaks series, except Dwarf Chinquapin oak, were painted from studies of trees growing at the University of Minnesota Landscape Arboretum in Chaska, Minnesota. Guy Sternberg generously provided a clipping of Dwarf Chinquapin from his oak collection at Starhill Forest Arboretum. The Autumn Oaks collection was exhibited at the Royal Horticultural Society show in London in February of 2007. Since then, several pieces have been accessioned by various botanical art collections.

As a botanical and natural history artist, my work is an ongoing process of exploring and documenting elements in our environment. Primarily self-taught, I credit my development as an observer and as an artist to a rural childhood spent close to nature. Combining concepts of creative expression and observation, my work is realistic and emphasizes both artistic and factual details. My goal is to encourage viewers to pause and appreciate the truth and beauty found in art and nature. The success of this work depends upon my ability to communicate on an aesthetic as well as an informative level. Consequently, I have developed a painting style rooted in the realistic accuracy of traditional botanical and natural history paintings. Autumn Oaks reflects the clarity and elegance inherent in this genre.

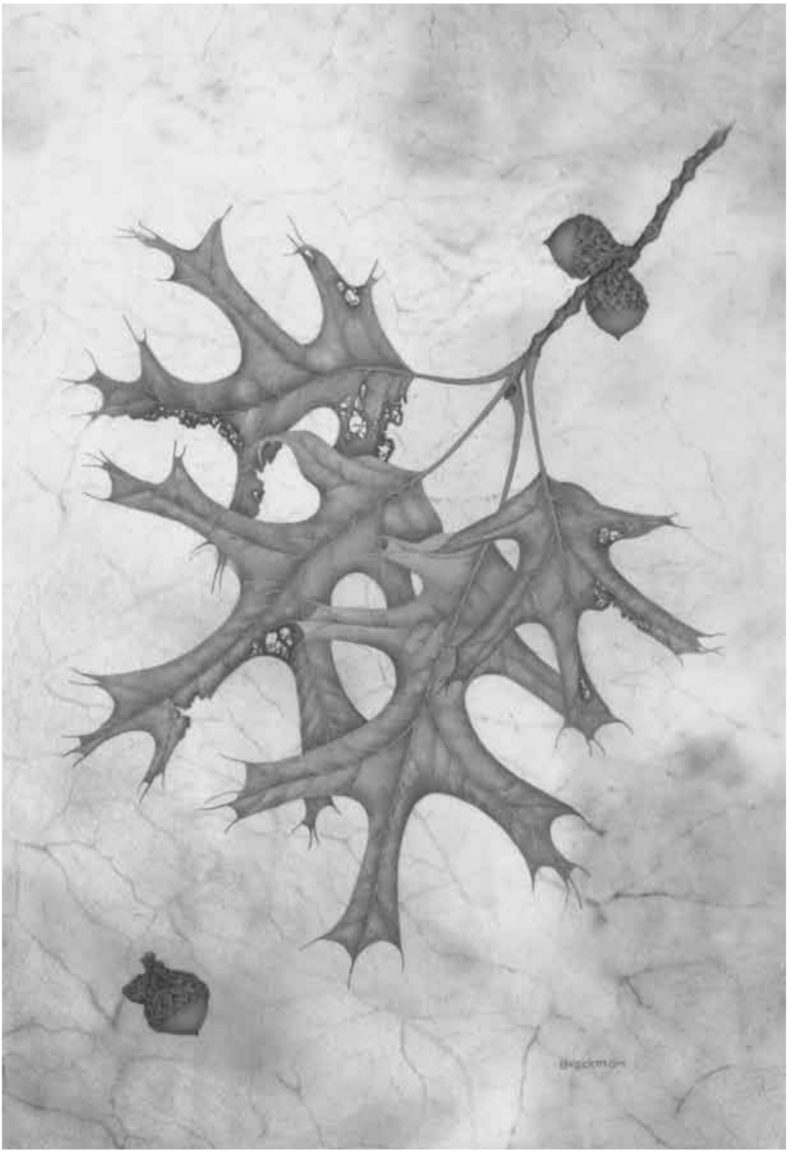
Working from my Minnesota studio, I paint from carefully observed drawings and specimens to capture the features and nuances of my subjects. I work almost exclusively in traditional watercolor on calfskin vellum. Vellum, sometimes known as parchment, is a treated animal skin highly prized for its superb painting surface and archival qualities. Available in a variety of subtle shades of cream, honey and brown, every skin is different, with colors ranging from light even tones, to dramatic shades of sepia with unusual markings. Because of its organic properties, vellum can be an unpredictable and challenging material to work with. It is a demanding surface possessing a translucent quality that makes ordinary watercolor glow with a unique luminosity. Both difficult and forgiving, vellum is a material that insures that with care, fine watercolor paintings will last for centuries.

Editors' Note: We urge everyone viewing Autumn Oaks to look closely and appreciate the diverse beauty of America's native oak species. In addition to original paintings, the images are also available as reproductions and on note cards. For more information please contact Wendy Brockman at *www.wendybrockman.com*. Wendy's full color illustrations can be seen on the back cover of this journal and the inside front cover.



Quercus alba © Wendy Brockman

Quercus bicolor © Wendy Brockman



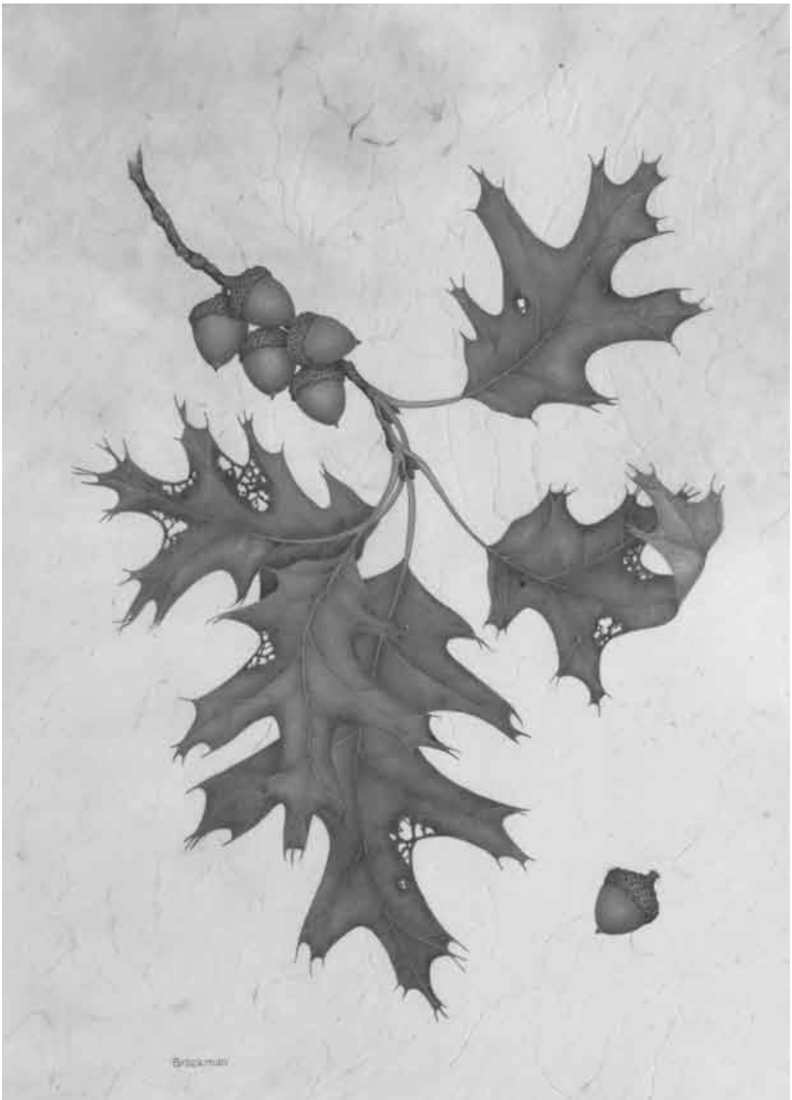
Quercus coccinea © Wendy Brockman

Quercus imbricaria © Wendy Brockman

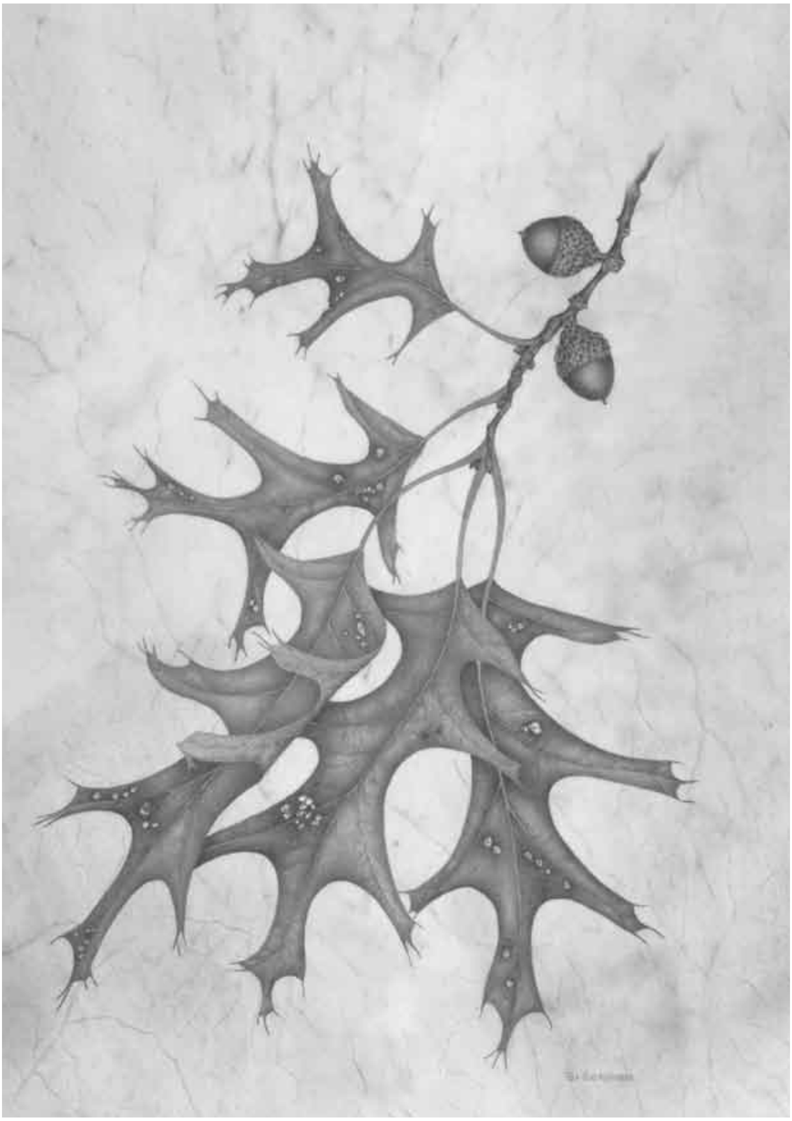
Quercus macrocarpa © Wendy Brockman

Quercus montana © Wendy Brockman

Quercus palustris © Wendy Brockman



Quercus rubra © Wendy Brockman



Quercus velutina © Wendy Brockman

The Monument of Nature, Veshensky Great Oak, Russia

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[2]Senior Resarch Associate, Southern Scientific Center, Russian Academy of Sciences, Rostov-on-Don, Russia

Rostov administrative region is situated at the steppe zone of Russia, at the south of this country, and in fact it is an area of intensive agriculture. As a result, the territory of natural ecosystems has been progressively reduced, and existing territories of wild nature are under intensive anthropogenic pressure. In the northern districts of the Rostov region the percentage of surviving natural communities are somewhat higher.

There is an oak tree (*Quercus robur* L.) of immense size which grows at the state territory of the M.A. Sholokhov Museum-Reserve. This is the area where the famous Russian writer and Nobel Prize Winner, Mikhail Sholokhov worked and created his novel “Tikhy Don” (“The Quiet Don”). The Museum-Reserve, including the zone of protected natural landscapes, covers the area of 38,236 hectares. It occupies territories of two administrative districts – Sholokhovsky and Bokovsky.

The climate here is moderately dry, with 440 mm of precipitation per year. The average monthly temperature of air in July is +21-+22^0 C; in January it reaches -8-9^0 C. The frost free period is 165 days or less. The flora and fauna are diverse, due to the rich diversity of landscapes because they have received protection. Besides having zones of multi-species grass and feather-grass steppe, there are communities of sandy steppe, floodland forests along river valleys, watershed and ravine forests, specific types of alder, birch and aspen forests at sands, planted forest cultures of Scotch pine (*Pinus sylvestris*), and water meadows and chalk denudations. The afforestation of Sholokhovsky district, at which the main part of the Museum-Reserve is situated, reaches 12% (while the average one on Rostov region is only 3.4 %). Totally, more than 1500 taxa of plants, 318 species of mushrooms and more than 2300 species of animals occur at this territory. There are 57 species of plants and animals considered to be threatened and rare, and listed in the Red Data Book of Russia.

At present there are four local botanical monuments of nature, which rather completely reflect the landscape and biological diversity of the left side area of the Don River. And the oak-patriarch is one of these monuments. It obtained official status through registration and protection since 1977. The tree grows at the second terrace of the Don River in the central part of Sholokhovsky district, 4 km north of Stanitsa (Cossack village), Veshenskaya, at the watershed of streams Gorokhovsky and Chernovsky. The general relief is plane, cut by a valley of a shallow stream. The soils are sandy or sandy-loam and soil-forming bedrocks are loess loams and clay. This is a territory of the Kolundaevsky forestry of the Veshensky Forest State Enterprise.

The tree is 25.2 m high, with trunk diameter 2.5 m in at breast height (7.6 m girth), and a crown diameter of 28 m. At a height of 1.9 m the tree is forked into two trunks (1.4, and 1.6 m consequently). Total volume of timber is 42 cubic m.

Schoolgirls near the great Veshinsky oak.

Such large specimens of oaks can be seen nowhere else at Rostov region. That is why this unique natural phenomenon deserves special protection not only at the regional, but also at the federal level. This tree is very attractive and has been developing normally. Earlier it was considered that the tree is more than 400 years old (Turchin, Sholokhov, 1997). But according to the newest data, fulfilled by researchers of Voronezh State Forest-Technical Academy, its age is not more than 250 years old (Malikov, Chernyshov, 2004). In recent years the condition of this tree has worsened, apparently due to anthropogenic pressure and drying up of the Gorokhovsky stream. Close by to the oak-patriarch two old oaks of smaller size reaching 21.5 m high and 98 cm in diameter. Near at hand there are other good oaks, not so large but also interesting. They might represent the next generation of the old mother oak, and the tree currently continues to produce acorns.

The oak grows at the south-east border of its natural distribution. It may be concluded that it is of an ancient forest. It occurs in a specific type of forest which grows as a belt along a stream, with a rather rich set of trees and shrubs. The tree grows not in a pure oak stand or oak wood (in Russia such oak wood is called "dubrava"), but at the edge of broadleaved forest, formed by several tree species. It may be considered to be at the edge of floodland alder forest, but the borders of forest types are not clearly obvious.

About 60% of reserved territory around the old oak (1.3 hectares) is occupied by alder forest, connected with wet places along the stream, where *Alnus glutinosa* dominates. There are also *Fraxinus excelsior*, more less commonly *Populus tremula*, *Acer campestre*, *Pyrus communis*, and *Quercus robur*. This shrubby layer is formed by *Padus avium*, *Acer tataricum, Prunus spinosa, Crataegus curvise-*

Veshensky great oak.

pala, and *Euonymus verrucosus*. The grassy layer is well developed and meadow vegetation covers 20% of the territory around the tree, and at the edge of forest and shrubby thicket. There are also sands with planted trees of *Pinus sylvestris* and the natural vegetation of sandy steppe.

The acorns are collected by the local Veshensky Forest Enterprise, but mostly in small amounts, for purposes of ecological education of schoolchildren and to be planted at a special small plot. The tree is often visited by many people, not only by local Cossacks, but also coming from far away, participants of conferences and common tourists.

We hope that the Veshensky Great Oak is of interest for the Members of the International Oak Society and for the International Dendrology Society and deserves consideration to be included in the European database. It would be useful to confirm or clarify its age using the radio-carbon method of identification.

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Rooting Stem Cuttings of Several Species within the genus *Quercus* L.

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Introduction

Several species in the genus *Quercus* L. have been vegetatively propagated by means of rooted stem cuttings including *Q. alba* L. and *Q. palustris* Muenchh. (Zaczek et al. 1997), *Q. nigra* L. (Hare 1977), *Q. pagoda* Raf. (Farmer 1965), *Q. phillyreoides* A. Gray (McGuigan et al. 1996), *Q. robur* L. (Larsen 1946), *Q. rubra* L. (Zaczek et al. 2006, Dreps 2007), *Q. suber* L. (Kommisarov 1960) and *Q. turbinella* Greene (Davis 1970). Rooting trials for a number of additional oak species were conducted at North Carolina State University from 2004 to 2007.

These trials were the natural progression of a forest research project initiated at NC State in 2002 to develop protocol for large-scale production of rooted stem cuttings of *Quercus rubra* [northern red oak (NRO)] intended for deployment as reforestation planting stock.

Oak rooted stem cuttings and Forestry in eastern North America

Regenerating natural hardwood timber stands in upland regions of eastern North America, with NRO (and other native oak species) as a significant component, has proved challenging to foresters. Two major limitations to such regeneration efforts are the lack of advanced oak regeneration in pre-harvested or pre-disturbed stands and the slow growth and high mortality rates of existing advanced oak regeneration, after canopy removal, as a result of intense herbaceous and woody competition. In some cases, this regeneration dilemma has been addressed by employing artificial regeneration techniques, such as plantation systems and enrichment plantings.

Planting stock utilized in these systems is commonly obtained from bare-root nurseries growing seedlings from unimproved, bulk collected acorns. Efforts to genetically improve oak planting stock exist, but have been limited largely due to the costs associated with relatively long periods of juvenility, episodic acorn crops, abundant acorn predators, and long term progeny trials (Robison et al. 2004). However, recent advances in the vegetative propagation of oak by means of rooting stem cuttings may offer a viable alternative to conventional oak improvement practices, improving growth rates, consistency, and quality of artificial planting stock.

Additionally, the ability to vegetatively propagate oak species such as NRO (Gocke and Robison 2007), southern red oak (*Q. falcata* Michx.) and water oak (*Q. nigra*) (Duncan and Matthews 1969) from stump sprouts originating at the base of recently felled trees gives tree breeders a direct means of basing tree selection on phenotypic expression. Vegetative propagules could also save considerable time and money associated with NRO breeding strategies utilizing acorns.

As a result of its ecological and economic importance in eastern North America several techniques have been developed to vegetatively propagate NRO from stem cuttings including rooting juvenile and mature semi-hardwood cuttings under conditions of high humidity (Teclaw and Isebrands 1987, Zaczek et al. 1993, Zaczek 1994) and rooting shoots originating from mature buds grafted onto juvenile root stocks (Zaczek and Steiner 1997, Zaczek et al. 2006). Of these techniques, rooting juvenile semi-hardwood cuttings has provided some of the most consistent results (Picture 1). For a detailed discussion on efforts to vegetatively propagate stem cuttings of NRO see Dreps 2007, Drew and Dirr 1989, Fishel et al. 2003, Gocke and Robison 2007, Teclaw and Isebrands 1987, and Zazcek et al. 2006.

Attempts to root juvenile and mature semi-hardwood cuttings of other oak species have also been successful under conditions of high humidity**.** On occasion some of theses mature cuttings produce flowers and fruiting structures (Figure 3). Other mature traits exhibited by these mature rooted cuttings may include slower growth rates and greater branching. Field trials need to be established to determine the affect of the physiological age of oak stem cuttings on subsequent rooted cutting field growth.

Oak rooted cuttings and Horticulture

Interest in the vegetative propagation of various oak species via rooted stem cuttings has also been encouraged by the horticultural industry. Here interest in rooted stem cuttings of oak has been stimulated by a desire to capture individual genotypes with unique traits (growth habit, leaf characteristics, drought tolerance, etc…) and market them as named oak cultivars. Until recently oak cultivars were mostly limited to grafted plants. Currently several oak cultivars on their own root systems have been introduced into the horticultural market. These recent introductions include several selection from Tree Introductions, Inc. [Highbeam™ overcup oak (*Q. lyrata* Walter), Hightower™ willow oak (*Q. phellos* L.), Highpoint™ nuttall oak (*Q. texana* Buckl.), Highrise™ live oak (*Q. virginiana* Mill.), Panache™ shumard oak (*Q. shumardii* Buckl.)], a single introduction from Southern Selections, LLC (Wynstar™ willow oak), and a selection from Shadowlawn Nursery [Cathedral Oak™ live oak]. The majority of these introduced cultivars were selected for their compact, narrow form and adaptability to urban environments as street and landscape trees.

Factors affecting adventitious root formation on oak stem cuttings

Several factors affect the ability of oak stem cuttings to form adventitious roots. These factors include maturation or aging patterns common in many woody plants, genetics and stock plant management. The rooting ability of NRO stem cuttings reflects ontogenetic aging patterns common in many woody plants (Robinson and Wareing 1969, Hartmann et al. 1997, Fishel et al. 2003), in which, rooting ability along with other morphological and physiological characteristics, follow distinct patterns closely related to the developmental age at which new shoots are produced (Hartmann et al. 1997). High rooting ability, considered mostly a juvenile trait, therefore, decreases as ontogenetic maturation and the adult phase of development capable of sexual reproduction, is gradually and eventually attained in shoots growing at increasing distances from the base of the tree (Hartmann et al. 1997, Fishel et al. 2003).

Maturation is generally accepted as the major obstacle to rooting stem cuttings from trees. Therefore, though large trees can produce a large number of stem cuttings many fail to root (Naujoks et al.1995). Whereas, stem cuttings collected from seedlings are few in number but root in high percentages. An example of an exception to this rule is the results of a study conducted by McGuigan et al. 1996 to evaluate the rooting ability of stem cuttings collected from two *Q. phillyreoides* trees, 40- and 8-years-old. Softwood cuttings were collected when the leaves were fully expanded on the initial flush of the growing season from the mid- to upper crown of the two trees. Optimal rooting occurred when individual stem cuttings were treated with 0.8% indole-3-butyric acid (IBA) in talc. In this treatment cuttings collected from the 40-year-old tree rooted in higher percentages then the 8-year-old tree (97% and 56%, respectively). Genetic differences between the two trees utilized in this study may have influenced the resulting disparity in rooting. Variation in rooting among individual genotypes of several woody plant species has been widely reported.

For many tree species maturation can be slowed by pruning near the base of the tree to encourage juvenile shoot production from sprouts (Hartmann et al. 1997, Zaczek and Steiner 1997). Juvenility has been maintained in this way for NRO by pruning seedlings into stock plant hedges (Drew and Dirr 1989). These stock plant hedges can be grown in containers or in the field and re-pruned multiple times to provide a continuous supply of stem cuttings for future rooting efforts.

Stem cutting collection time, rooting environment, and stem cutting preparation also impact the success of oak rooted cutting propagation. Teclaw and Isebrands (1987) reported optimal rooting for stem cuttings collected from early season, semi-hardwood NRO shoots collected during flush lag (Lag), the stage of development within a flush defined as the interval between the completion of one growth flush and the onset of the next flush of growth (Hanson et al. 1986).

Northern red oak, like other oak species, exhibits semi-determinate shoot growth characterized by recurrent, cyclic, or episodic flushes of growth during the growing season (Dickson 1994). Environmental conditions and the age of the tree impact the number of flushes produced within a given year (Dickson 1994). For example, young NRO seedlings are capable of producing a greater number of progressive flushes in one growing season than older, more mature NRO trees (Dickson 1994) (Figure 1).

NRO stem cuttings are most successfully rooted in conditions of high humidity, either under intermittent mist (Teclaw and Isebrands 1987 - stem cuttings from juvenile seedlings) or in a fog chamber (Zaczek et al. 2006 - stem cuttings from seedlings and mature trees). High levels of shade prior to rooting have further increased rooting percentages for NRO, especially among more mature cuttings, (Zaczek 1994) and *Q. phillyreoides* (McGuigan et al. 1996). New shoots collected from pruned containerized stock plants grown in partial shade (50%) rooted at higher percentages than those grown in full sun (84% and 68%, respectively) (unpublished data from NC State NRO rooting efforts).

Though exogenously applied rooting hormones are not required for adventitious root formation on juvenile NRO stem cuttings (Teclaw and Isebrands 1987) and juvenile stem cuttings of *Q. pagoda* (unpublished data from NC State oak rooting efforts), concentrations of IBA ranging between 0.5 % (5,000 ppm) and 1.5% (15,000 ppm) applied to the base of stem cuttings have led to high rooting percentages (Teclaw and Isebrands 1987, Zaczek et al. 2006). Increasing concentration of exogenously applied IBA has also been reported to result in a greater number of primary roots (Teclaw and Isebrands 1987).

Post-rooting care and subsequent growth

Once propagated, newly rooted oak stem cuttings should be acclimated to a less humid environment than the rooting chamber. This is completed in gradual steps over approximately two weeks. Following acclimation, if additional shoot growth is desired the cuttings are subjected to an extended photoperiod and warm temperatures to encourage a new flush of growth (forcing). Flushing after rooting improves overwintering survival for some oak species (McGuigan et al. 1996, Dirr and Heuser 2006). In one study conducted at NC State, NRO rooted cuttings that were forced demonstrated higher rates of overwintering survival than those not forced (91 % and 59 %, respectively), regardless of whether or not the cuttings flushed (Dreps 2007). The current author has observed that some oak species flush more readily following rooting than other oak species.

Rooting protocol for juvenile northern red oak stem cuttings

The following section is a description of the methods developed at NC State for rooting juvenile stem cuttings of NRO and follows one particular study. The collected stem cuttings originated as single flushes of growth from recently pruned containerized seedling stock plants.

Stock Plant Establishment

One-year-old, bare-root NRO seedlings (1-0) from the Clements State Tree Nursery (West Columbia, WV) were transplanted in April 2002 into 30 liter Treepot ™ (Stuewe and Sons, Inc., Corvallis, OR) containers, filled with a medium mixture of 1 peat: 1 perlite: 1 field soil [Congaree series silt loam (USDA Soil Conservation Service 1970)]: 3 composted pine bark, by volume. These containerized seedling stock plants were grown outside at the North Carolina State University Horticulture Field Laboratory in Raleigh, NC and were spaced 0.3 m apart for one growing season without pruning.

In February 2003 these seedling stock plants (now entering their third growing season) were pruned to 2 cm above the base of 1) the first flush (B1); 2) the second flush (B2); or 3) the third flush (B3) of growth (Figure 1). The stock plants were organized into a split plot design with one half of the stock plants placed under partial shade (50%). Light level (sun vs. shade) was established as the whole plot factor and prune location, as the subplot factor. There were 15 stock plants per treatment (3 prune locations x 2 light levels) for a total of 90 stock plants.

The seedling stock plants were watered every one to two days for 5 minutes during the two growing seasons (2002 and 2003) with individual spray stakes (Antelco Shrubbler ™ 360^0, Antelco Corporation, Longwood, FL). Irrigation frequency and duration during the growing season was controlled by a Hunter Smart Valve Controller (Hunter Industries, San Marcos, CA).

The stock plants were fertilized two months after the bare-root seedlings were transplanted into containers, with 50 grams of Coor's 14-14-14 slow release fertilizer plus minors (Coor Farm Supply, Smithfield, NC)] applied as a top dressing. The shade cloth was supported by a wooden box frame and enclosed the entire area surrounding the shaded stock plants.

In May 2003 semi-hardwood stem cuttings were collected with by-pass pruners from the first flush of re-growth formed within 5 cm of each prune location on sun and shade grown seedling stock plants. Twenty-five stem cuttings were collected from each group of stock plants (3 prune locations x 2 light levels). There were six treatments, five blocks, and five cuttings per treatment per block for a total of 150 experimental stem cuttings plus borders. For purposes of uniformity, only terminal stem pieces 16 cm or longer were collected for rooting. However, NRO stem cuttings ranging from 6 cm to 45 cm have been successfully rooted (unpublished data from NC State NRO rooting efforts). Following collection the stem cuttings were partially submerged in water and placed in shade until processing later the same day.

Rooting Facility and Procedures

The cuttings were processed by removing the leaves and petioles from the bottom half of each 16 cm terminal cutting. The remaining leaves were trimmed 1/2 of their original size to facilitate sticking and reduce leaf transpiration rates. The base of each cutting was then recut (approximately 1 cm of stem was removed) and dipped 2 cm deep into a liquid solution of 1% IBA in an aqueous 50% EtOH (95%) solution for 5 seconds. After allowing the bases to dry for one minute, the cuttings were stuck 4 cm deep into 164 ml Ray Leach "RL" tubes (Ray Leach SC-10 Super Cell Cone-tainers™, Stuewe and Sons, Inc. Corvallis, OR) filled with a moist media mixture of 3 peat: 3 perlite: 1 vermiculite, by volume. The containers were placed into every other hole of RL-98 trays (Stuewe and Sons, Inc., Corvallis, OR) at a linear spacing of 8.6 cm and a diagonal spacing of 4.3 cm.

The trays were then placed in a rooting chamber constructed around a propagation table inside a polyethylene-covered, Quonset-styled greenhouse with shade cloth. The rooting chamber consisted of a rectangular PVC frame (2.5 m tall x 1 m wide x 5 m long) covered on all four sides with sheets of Frost Blanket ™, a white UV stabilized non-woven fabric, (The Master Gardener Company, Spartanburg, SC) to contain humidity. A shade cloth (50%) was placed on top of the PVC frame to reduce light stress during rooting. Combined, the shaded greenhouse and shaded rooting chamber provided 15% ambient light (as compared to mid-day, outdoor ambient light) within the rooting chamber (measured with a Sunfleck Ceptometer™ , Decagon Inc., Pullman, WA).

Talstar™ Flowable insecticide (FMC Agricultural Products Group, Philadelphia, PA) at a rate of 3.25 mL/L and Gnatrol™ biological larvicide (Valent USA Corp., Walnut Creek, CA) at a rate of 6.25 mL/L were used on the cuttings during rooting to control for insects. Zero-tol™ broad spectrum algaecide/fungicide (Biosafe Systems, Glastonbury, CT) at a rate of 3.25 mL/L was also applied to the cuttings and rooting chamber. The sheets of Frost Blanket™ covering the sides of the rooting chamber were replaced every 30 days to manage algae build up. Stem cutting leaf litter was removed regularly to maintain a clean rooting environment.

Overhead NaanDan™ "Water and Sprinkling" nozzles (Kibbutz Naan, Naan, Israel), with a flow rate of 41.6 liters/hour, provided mist initially every 12 minutes for 15 seconds in the rooting chamber. Irrigation frequency and duration during both years were controlled by a Davis Engineering Solar 6A Misting Controller (Davis Engineering, Winnetka, CA). The frequency of mist was tapered gradually after 50 days of rooting. Seventy-five days after sticking the rooted cuttings were acclimated to a non-misting environment and at 90 days were relocated to a propagation bench in the same greenhouse as the rooting chamber. The rooted cuttings were hand watered once daily for the remainder of the 2003 growing season.

Conditions in the greenhouse were conducive to new growth by extending the photoperiod to 18 hours per day with the aid of supplementary lighting (1.2 m, 40W GE Spectra Rays Full Spectrum Fluorescent Tubes, General Electric Company) hung 1 m above the cutting tops and a constant temperature of 26^0 C. This forcing step is not absolutely necessary but a period of extended growth can significantly improve overwintering survival for newly rooted NRO stem cuttings (Dreps 2007). After a three month period of extended growth, the day-length and temperature inside the greenhouse was slowly adjusted to those present outside. Once the cuttings were dormant (mid-January 2004) they were moved to an overwintering house covered with white polyethylene plastic until bud break the following growing season.

In early May 2004 the surviving rooted cuttings were transplanted into 6.23 L Treepot2™ containers (Stuewe and Sons, Corvallis, Oregon). Composted pine bark mulch was used during transplanting. The same day each transplanted rooted cuttings was top dressed with 1/8 cup of Nutricote Total (13-13-13) slow release fertilizer (Chisso-Asahi Fertilizer Co., Tokyo, Japan).

The newly transplanted rooted cuttings were then placed in a Quonset-style shade house (50%) and irrigated by hand every two to three days until shoot height and stem diameter were measured at the end of the growing season in November 2004 (Picture 3). The average rooted cutting stem height at the end of approximately 18 months of growth was 75 cm tall and 11.2mm in diameter.

Analysis of variance (ANOVA) for rooting percentage was conducted using the mixed model procedure in SAS (SAS Institute, Cary, NC) and included both fixed (treatment) and random (block) factors and their interactions. When ANOVA results indicated treatment differences of $p \leq 0.05$, a pairwise comparison was utilized to separate the means at $p \leq 0.05$. Rooting results for this NRO study are summarized in Tables 1.

Rooting trials for additional oak species 2004-2007

Rooting trials for a number of additional oak species were conducted at NC State University from 2004 to 2007. These trials were the natural progression of the NRO rooted cutting efforts at NC State conducted from 2002 to 2007. The same basic protocol described in the above section on NRO rooted cutting propagation was used for these trials. For some of the oak species evaluated during this period, stem cuttings were collected from pruned seedling stock plants.

Others were collected from the most juvenile material obtainable on non-pruned seedling specimens. Because the most physiologically juvenile portion of a tree is centered around the base of the trunk, shoots originating within the general vicinity of this area also provided potential juvenile rooting material including coppice sprouts, stump sprouts and epicormic sprouts. When this material was not available stem cuttings were collected from the lower third of the canopy of a tree.

All NRO stem cuttings collected were from first flush material in a semi-hardwood stage of development or LAG. In some cases it was difficult to obtain a sizeable number of stem cuttings for certain species. However successful rooting of even a single stem cutting demonstrates the potential for rooted cutting propagation of these species. The results of this work are presented in Table 2.

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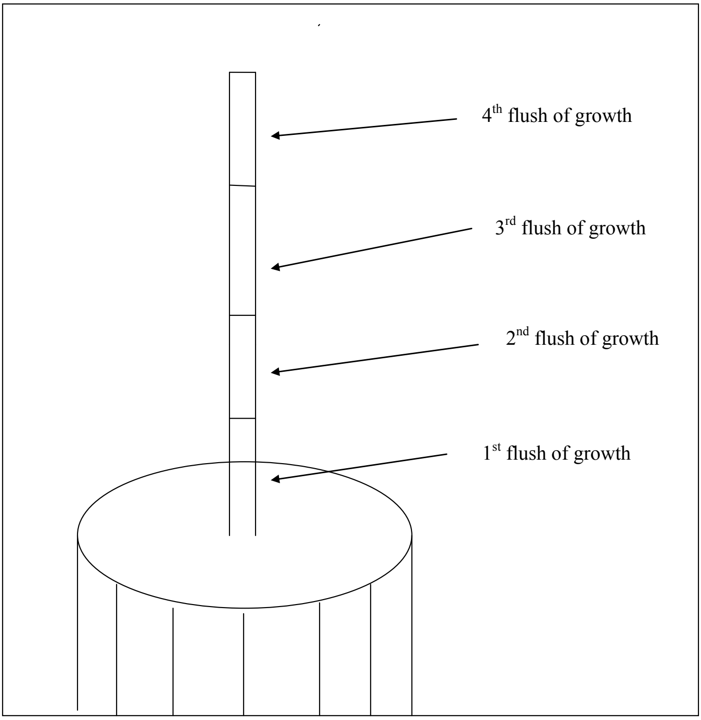

Figure 1. A representation of an oak seedling stock plant, prior to pruning, with four flushes of growth.

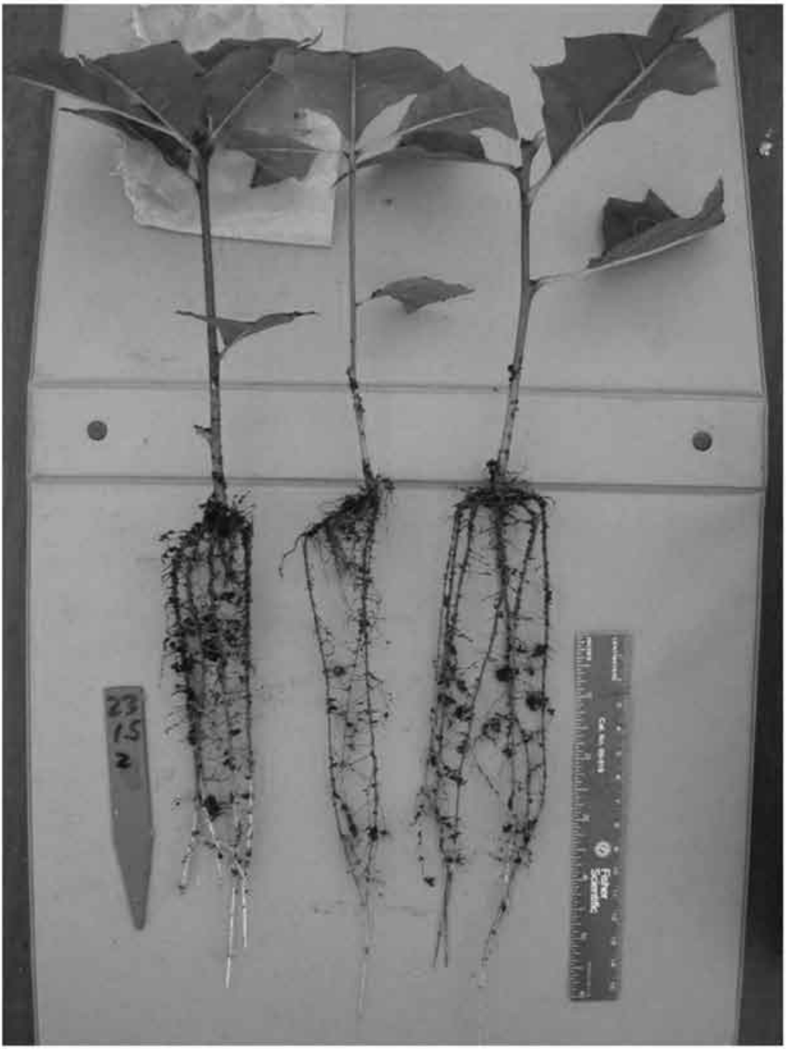

Figure 2. *Quercus rubra* L. (northern red oak; rooted juvenile stera cuttings after 12 weeks under intermittent mist in a rooting chamber.

Figure 3. A rooted stem cutting of *Quercus wutaishanica* Mayr. (Liaodong oak) in flower.

Figure 4. *Quercus rubra* L. (northern red oak) rooted juvenile stem cuttings after 12 weeks under intermittent mist in a rooting chamber.

Table 1. The effect of prune locations (B1, B2, and B3) and light level [sun versus shade (50%) grown stock plants] on rooting ability of northern red oak stem cuttings

Prune Treatment	Rooting Percentage		
	Sun	Shade	Total
B1	64	84	74 a
B2	56	72	64 b
B3	36	56	46 c
Total	52 b*	70.7 a	N/A
Anova Results (5 cuttings/5 blocks/6 treatments)	Sources of Variation • Prune location (p-value) = 0.0366 • Light level (p-value) = 0.0354 • Prune location*light level (p-value) = 0.9744 (Proc Mixed - SAS)		

* Prune location and light level rooting means with the same letter did not differ significantly (ANOVA Mixed model, pairwise comparisons, p<0.05).

Table 2. Rooting results for stem cuttings of twenty-nine oak species (*Quercus* L.)

Oak Species	Common Name	Stem Cutting Origin*	Rooting Hormone (IBA)**	Rooted / Collected = Rooting %
Quercus acuta Thunb.	Japanese evergreen oak	NP – J	2%	3/3 = 100%
Q. alba L.	eastern white oak	P – J	Control	6/20 = 30%
			0.5%	11/20 = 55%
			1.0%	10/20 = 50%
Q. canbyi Trel.	Canby's oak	NP – J	1.0%	1/2 = 50%
Q. castaneifolia C.A. Mey.	chestnut-leaved oak	NP - J	1.5%	3/4 = 75%
Q. chapmanii Sarg.	Chapman oak	NP – J	1.5%	8/15 = 53%
Q. chenii Nakai	a relative of sawtooth oak	P – J	1.0%	15/19 = 79%
Q. crassifolia H. & B.	Mexican leather leaf oak	M – C	2.0%	1/3 = 33%
Q. durandii Buckl.	Bigelow oak	NP – J	2.0%	6/8 = 75%
Q. falcata Michx.	southern red oak	NP – J	1.5%	11/12 = 92%
		M – E	1.5%	2/2 = 100%
Q. fruticosa Brot.	gall oak	NP - J	1.0%	2/8 = 25%
			1.5%	7/8 = 87.5%
Q. georgiana Curtis	Georgia oak	P – J	1.5%	14/14 = 100%
			2.0%	11/13 = 85%
Q. germana Schiltdl. & Cham.	Mexican royal oak	NP – J	1.0%	2/4 = 50%
Q. glauca Thunb.	Japanese blue oak	NP – J	1.5%	14/15 = 93%
Q. graciliformis C.H. Mull.	Chisos oak	M – C	1.5%	3/6 = 50%
Q. lusitanica Lam.	Portuguese oak	NP – J	2.0%	2/4 = 50%
Q. macranthera Fisch. & B. Mey.	Caucasian oak	NP – J	2.0%	1/2 = 50%
Q. michauxii Nutt.	swamp chestnut oak	P – J	1.5%	5/10 = 50%
Q. macrocarpa Michx.	bur oak	P - J	1.5%	27/39 = 69%
Q. montana Willd.	chestnut oak	P – J	1.0%	30/30 = 100%
Q. nigra L.	water oak	P – J	1.0%	9/9 = 100%
			1.5%	9/9 = 100%
Q. oglethorpensis Duncan	Oglethorpe oak	NP – J	1.5%	7/16 = 44%
Q. pagoda Raf.	cherrybark oak	P – J	0%	84/84 = 100%
			0.5%	82/84 = 98%
			1.0%	77/84 = 92%
Q. palustris Munchh.	pin oak	P – J	1.5%	9/10 = 90%
			2.0%	10/10 = 100%
Q. phillyreoides A. Gray	ubame oak	M – C	1.5%	13/15 = 87%
Q. robur 'Cupressoides' L.	English oak	M – C	2.0%	1/6 = 17%
Q. rugosa Nee.	netleaf oak	NP – J	1.0%	6/6 = 100%
Q. sinuata Walter	bastard oak	NP – J	2.0%	1/4 = 25%
Q. texana Buckl.	Nuttall's oak	NP – J	2.0%	5/5 = 100%
Q. virginiana Mill.	southern live oak	M – C	1.5%	2/2 = 100%

*N P-J = stem cuttings were collected from the lower third of the canopy or epicormic sprouts of a non-pruned juvenile tree. A juvenile tree is one that has not yet acquired the ability to produce flowering and fruiting structures (seedling to young tree).

P–J = stem cuttings were collected from pruned juvenile trees

M = stem cuttings were collected from epicormic sprouts (E) near the base of the tree or the lower third of the canopy (C) of a mature tree

**The various rooting hormone (IBA) concentrations were applied to the base of the cutting in a 45% EtOH (95%) solution.

The Purple Hairstreak – An Oak-Dependant Butterfly

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What could be oakier than an oak? When it comes to Latin binomials, a little Eurasian butterfly must take the prize – *Quercusia quercus*, the Purple Hairstreak. Indeed, to distinguish it from the Iberian and North African race, *Quercusia quercus* ssp. *iberica*, the typical form is known as *Quercusia quercus* ssp. *quercus*. Now I don't reckon you can get any oakier than that!

Like the German name of Eichenfalter, this Latin name is well-deserved, for the egg is laid on oak, the caterpillar feeds on oak, and the butterfly spends most of its life in oak treetops. Only the pupa or chrysalis stage occurs elsewhere, either on or under the soil (but still beneath oaks!). However, because of the habits and life cycle of this insect, many of you who live within its European (to 60 degrees north latitude), North African, and Western Asian range may be hosts to it without ever having noticed. There is only one brood a year, the major part of the life cycle of which is spent as tiny eggs laid in July or August, hatching only eight months later when the oak flower buds break in the following March or April. In addition, the resulting caterpillars immediately bore into the buds to feed and grow there invisibly for their first stage, in later stages relying on cryptic colouration to disguise them by day, feeding only at night, before they pupate in June to emerge finally as adult butterflies in July. These adults can survive through into September, but mostly inhabit the tops of oak trees, feeding on aphid honeydew and rarely flying except in sunny weather. They descend occasionally to feed on flowers – I was lucky enough to see one for the first time last July feeding on a tall Buddleia near a mixed-age stand of indigenous oaks in my valley in southwest France; but thus, equally, I had managed *not* to see them for nearly twenty years (which is what prompts this article). Butterfly aficionados often resort to tapping the branches of oaks, when occasionally scores fly up together in a shimmering cloud of purple and silver, or to using binoculars to watch them overhead. They are numerically the most common of the five species of Hairstreak found in the UK (more species are found in mainland Europe), and have been described as appearing from below like "a handful of silver coins that has been tossed into the sunlight" around the treetops.

The adult butterfly is not large, belonging as it does to the worldwide family of the Blues, the Lycaenidae, measuring not more than 3.5 cm (1 3/8 inches) across the wings. It is well described by the English common name: the "Hairstreak" refers to the markings underneath the wings of most of this group, taking in this species the form of a thin white line, inset from but roughly parallel to the outer wing margins, on a background of dove grey. A couple of orange spots, one with a black centre, on the rear tip of each hind wing complete the picture of the underside. But it is the colour of the upper side, an iridescent purple-blue more reminiscent of large lazily-flapping tropical butterflies than of a European species, which gives the males their special character -- a colour described in one book as "deep purplish fuscous irrorate submetallic indigo blue." So now you know.

An important practical point about such iridescent colours is that their appearance depends entirely upon the angle of the light, hence photographs often do not do them justice. The female has the same purple colouration, but in a reduced area within the forewing only, the rest of the upper wings being almost black, as are the wing borders of the male.

I suppose some might find the prospect of caterpillars burrowing into the buds of their precious oaks somewhat alarming, but please don't reach for the pesticides. The Hairstreaks never reach a sufficient density to cause harm to the trees, and any unsightliness is confined to the treetops. So instead, next summer, look up, for you too might see those 'silver coins' dancing in the sunlight.

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Oak-hunting in Japan: Report on the IOS Japan Tour, October 2007

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With an average age of over 65, ten IOS members from eight countries took part in the 2007 tour to Japan from October 5th to 19th, completed at a cost below budget! The tour was instigated and administered by Anke Mattern from Germany. At a meeting in Tokyo Professor Hideaki Ohba of the University of Tokyo (who revised the *Quercus* section, among others, of the Flora of Japan), had agreed with her to personally show us all 15 native species of oak found in Japan. He arranged the complex logistics necessary for such a wide-ranging but perfectly targeted tour, and his unrivalled contacts ensured that at each venue we were warmly welcomed immediately on arrival and expertly guided thereafter.

As a glance at the map will show, Japan consists of a long group of islands stretching from the cold temperate climate of Hokkaido in the northeast to a series of sub-tropical islands leading towards Taiwan in the southwest. Our travels took us from the northwest of Honshu, the main island, through ten degrees of latitude south to the small island of Amami Oshima in order to see every oak species. Japan's oceanic situation gives it a moist climate, areas receiving 'only' 1000mm (equating to nearly 40 inches) of annual rainfall are referred to as 'dry', whilst some places soak under 3000mm or more. However, its position on the east side of a continent in a cold sea current makes winter temperatures much colder than the same latitude in Europe/Africa or west coast USA, and more comparable to the US east coast. Man's influence has ensured that very little primary forest still exists, but latterly the use of petroleum fuels instead of wood and charcoal has allowed greater regeneration of secondary forest despite the widespread planting of *Cryptomeria japonica*. Equally, little natural wetland exists due to the cultivation of rice.

All the participants agreed to arrive a day early in Narita City near Tokyo to acclimatise to the time change. Our first introduction to one of the practical uses of oak came on our evening venture to give what was, for several participants, an introduction to Japanese food. Our chosen restaurant was opposite a shop selling beautifully finished but very expensive traditional drums constructed from oak in two methods: either from staves like a barrel or alternatively as a cylinder carved from solid wood, in both cases with a cowhide drumskin. Price peaked at an eye-watering 120,000 euros for a 180cm (6 foot) drum.

The next day, October 5th, saw us travelling into Tokyo to meet Professor Ohba before catching the Shinkansen, the Japanese high speed or 'bullet' train, to our most northerly venue at the city of Sendai. Inauspiciously, we lost one of our participants in the maze otherwise known as Tokyo Station, but everyone was eventually reunited in Sendai, to be greeted by Professor Mitsuo Suzuki, Director of the

Botanical Garden of Tohoku University, Sendai, and his team: Assistant Professor Motonari Ohyama; expert taxonomist Dr. Koji Yonekura; and Dr. Akihiro Yoshida. The garden is in the border region between the warm and cool temperate climatic zones and contains microclimates of each, but sadly there was time only for the briefest of walks before dusk to see evergreen *Quercus* species such as *Q. acuta*, *Q. glauca* and *Q. myrsinifolia* near their northern limit, mingling with deciduous species – *Q. serrata* is actually the most numerous tree of over 10cm diameter in the garden, with 5,155 of them counted, followed by *Pinus densiflora* and *Abies firma*. In the evening Professor Suzuki took us to a superb seafood and sobha (noodle) restaurant, where, under the guidance of the two Professors and replete with Sendai oysters, we happily undertook the first of many trials of Sake, the Japanese rice wine. Throughout our tour Professor Ohba ensured that we experienced to the full the wealth of Japanese cuisine.

After a stay in very comfortable student accommodation thanks to Professor Suzuki, the following day, October 6th, we set off in two minibuses driven by Professor Suzuki's team to Mount Zao, a winter ski destination where two lifts enabled us to make a final short climb on foot to over 1,700m (5,600 feet). A rich variety of non-oak tree species was reduced to stunted bushes, and autumn colour, three weeks later than usual in Japan in 2007, here provided a multi-coloured tapestry as we looked out on the clouds below. Descending to an intermediate level, we lunched amongst peaty hollows, boggy in places, where *Quercus crispula* and *Q. serrata* grew and fruited in dwarf form with *Pinus parviflora*, *Acer japonicum*, *Fagus crenata*, *Salix vulpina*, *Betula ermanii, Rhododendron degronianum* and even a *Daphniphyllum macropodum* (corresponding with var. *humile*) amongst a varied herbaceous cover, gentians still in flower. The sub-alpine form of *Q. crispula*, 'a shrub-like tree with bent trunk and branches', leaves 'sharply serrate', has been named var. *horikawae* by Professor Ohba in honour of Tomiya Horikawa (1920-1956), who studied oaks under difficult conditions during the Second World War, and as a consequence died tragically young.

Quercus dentata appears naturally but scattered and rare around the foot of Mt. Zao, and our next stop took us to a boundary plantation of this species aged around 50 years. *Q. dentata* becomes more plentiful on the northern island of Hokkaido, as does *Q. crispula*, although in the late 19th century much of the latter was cut and exported to Europe as 'Hakodate Oak', in some cases to be re-imported as finished Arts and Crafts furniture.

The final stop of the day took us to a streamside near Shiroishi Castle in Miyagi prefecture, where we saw *Q. serrata* in its variable guise, *Q. crispula*, *Q. acutissima* and *Q. aliena*. The latter was more frequent in Japan 10,000 years ago, its numbers having most probably declined due to man's past consumption of the large palatable acorns.

On October 7th we flew at midday from Sendai to Nagoya, enjoying en route a wonderful view of the stark black cone of Mt. Fuji backlit against a grey layer of cloud and haze. On arrival we were met by Professor Shozo Hiroki of Nagoya University, who took us through a secondary forest community immediately abutting the main campus of the University where *Quercus variabilis* and *Q. serrata* formed a cover with *Pinus densiflora*. These two oaks never cross, but *Q. varia-*

bilis, although easily distinguishable by its pale leaf underside, can hybridise with the closely related *Q. acutissima*, however, each has very different germination characteristics – *Q. variabilis* acorns sprout immediately on falling, whereas *Q. acutissima* awaits spring, allowing the latter to establish also in colder climates to maintain a wider range in Japan.

Professor Hiroki gave us a lecture and copies of his *Fagaceae*-related studies containing a breadth of information which space will not allow here, but, for instance, *Castanopsis sieboldii* has a double thickness of epidermal cells, *C. cuspidata* only one, giving the former a greater tolerance of drought and the latter of shade. Hybrids between the two vary chimaerally in epidermal thickness.

October 8th began with a visit to Sanage Shrine near Toyota City, Aichi Province, where we saw *Quercus glauca* and *Castanopsis cuspidata*.

Next, an unusual entrance through a graveyard to a wood offered one of the conundrums of the trip – *Quercus serrata* ssp. *mongolicoides*, newly described by Professor Ohba. The tree formerly known as *Q. mongolica* var. *grosseserrata* is now referred to as *Q. crispula*. The true *Q. mongolica* is now thought to occur only on the Asian mainland, not in Japan, but, to quote the Flora of Japan, 'the putative hybrid between *Q. crispula* and *Q. dentata* especially in Hokkaido, and this subspecies [*Q. serrata* ssp. *mongolicoides*] are mistakenly treated as *Q. mongolica*'. It then continues 'This subspecies is similar to *Q. crispula*, but differs from that in having longer leaves with coarsely and interruptedly crenate-dentate margins'. It occurs at much lower elevations than *Q. crispula*, and DNA analysis revealed the close relationship to *Q. serrata*. However, the acorns we saw here were larger and squarer in profile than either of those two species, and were already germinating strongly.

We could not resist a quick photo-stop at a rice field whose bordering banks were thickly ornamented with the red *Lycoris radiata* in full flower, on our way to the nearby type locality of *Q. serrata* var. *mongolicoides* where now we saw only *Q. serrata* in its normal incarnation with *Q. glauca* in attendance.

Our last visit of the day was to the grounds of an Edo period castle near Nagoya, where much *Q. acutissima* was planted about 60 years ago, and copious seed soon had the group in the traditional IOS stance – bottoms up filling collection bags.

The next day, October 9th, found us once again airborne, leaving the main island of Honshu for the first time on our way to Kochi on Shikoku, where we were greeted by Drs. Shiro Kobayashi and Kazumi Fujikawa from the Kochi Prefectural Makino Botanic Garden. The late Tomitaro Makino (1862-1957), perhaps the most famous Japanese botanist, by and for whom many Japanese plants were named, was based here, and the arboretum still contains his library along with an amazing 1,700 originals of his beautiful botanical illustrations.

We stopped on the way to the garden to walk through an area of evergreen secondary forest, and already several tropical elements intruded, including several species of *Symplocos*, notably *S. glauca* with long, arrow-shaped leaves. Now bamboo is no longer used for construction, it is becoming abundant and invading the forest. Here we saw again the ubiquitous *Quercus glauca*, and a heavily-fruited *Lithocarpus glabra*.

On reaching the Makino garden we lunched outside near a tree I think we all fell in love with – the beautiful orange- and white-barked evergreen *Prunus (Laurocerasus) zippeliana*. Although we were remarkably lucky with the weather on the tour, it rained on our afternoon parade, and we embarked under umbrellas to see firstly an eight year old plantation of non-Japanese oaks raised from seed from other botanic gardens, and thus, sadly, in many cases clearly of hybrid origin. The collection of native evergreen oaks, however, more than made up for this, and included the large-leaved stable hybrid *Quercus* x*takaoyamensis*, a cross between *Q. acuta* and *Q. sessilifolia*, leaning in character more towards the former.

October 10th, the sixth day of our tour, took us first to another Shinto shrine, Matsuo Shrine near Kitahara. High quality rice requires a diurnal temperature contrast, and thus is best grown further north than this latitude (33.5 degrees), instead the paddy fields by our parking spot were planted with ginger. Entering the shrines precincts another beautifully-mottled bark belonged this time to *Podocarpus* (now *Nageia*) *nagi*, but, once we had ascended the many steps, we saw for the first time *Quercus hondae*. The areas around Shinto shrines and Buddhist temples, with their great antiquity, provide perhaps the nearest approach in Japan to primary forest. Although possibly even here man may in the past have influenced which trees remained, time and time again we were to see the most dramatic trees in these situations. But do we put 'wild-collected' against the collection number? A hard call. And seed there was, although sparse and possibly immature, by dint of an ingenious tool constructed by Dr. Kobayashi to collect herbarium specimens – a hooked blade inserted in the end of a long rigid telescopic sea-fishing rod. Every home should have one, and many times subsequently we longed for the same implement, as so often the dense canopy of the evergreen forest was far out of reach, making photography impossible, and we began instead to identify trees by their bark.

Our second venue was a temple peopled with fierce sword-wielding stone spirits. In the grounds we had our first glimpse of 'wild' *Quercus gilva*, with its very distinctive pale bark flaking into loose plates, often marked with wavy parallel striations almost in the manner of bark beetle galleries. The matt leaves have pale distinctly-veined undersides. *Quercus salicina* put in an appearance, and the startlingly mottled brown and cream bark here belonged to *Litsea coreana*.

The final stop of the day was within sight of the sea, where a line of *Q. phillyreoides* planted by an embankment had been drawn up to 8m (25 feet) or so, forcing some of our number into spectacular seed-gathering antics suspended over the side of the embankment – evidently a good deal of mutual trust had developed by this stage! The group of four trees showed marked variation in leaf, from a narrow serrated inrolled form with a pale underside to a wider, darker leaf more green underneath.

Day 7, the 11th, took us first to Mt. Yokogura-yama, near Ochi town, up to nearly 800m (2,600 feet), where venerable *Quercus acuta* gave way on the dryer thinner soils of limestone ridges to *Quercus salicina*, with its distinctive bark banded horizontally in brown, green and grey – in older trees cream and almost black – and its delicate leaves with paler undersides. The markings may be caused by lichen colonisation, but were nevertheless characteristic of all trees we saw. Everyone had their own favourite experience of the tour, but this was certainly one of mine, as, after wandering through these wonderful oaks, we reached an intricately-carved wooden temple complex deep in the shade of a group of enormous cryptomerias, one measuring 9m (30 feet) in girth.

After lunch, our next stop was just as spectacular – Nisho Shrine, near Niyodogawa town, where, after a climb through a wood of *Q. gilva*, we emerged by the shrine, in front of which was the largest *Q. sessilifolia* that even Professor Ohba had ever seen! To my chagrin, I was a late-comer, having been mesmerised by the *Q. gilva*, and what little seed there was had already disappeared into other pockets.

Our return drive showed that *Q. glauca* was also happy to perch on these limestone crags, and a final unscheduled riverside stop on our return to admire more *Q. gilva*, whilst completely mystifying a passing Japanese policeman, completed a marvellous day. We sadly had to say goodbye to our Japanese hosts, one of whom had actually taken leave in order to accompany us for the two days.

On October 12th we had a morning appointment with Professor Tatsuya Okamoto of Kochi University, who took us by rail to brightly-painted Asakura Shrine, the only other location of *Quercus hondae* in Kochi. Seed of this tree was not expected to mature until December, but he had some dry acorns from the previous year to give us as mementos, before we journeyed to catch an afternoon flight, via Fukuoka, to Miyazaki on the island of Kyushu.

The following day, the 13th, we set off by bus with our guide, Mr. Masami Seito, northwards from the city firstly to the Takanabe wetland, one of the few remaining natural wetlands in Japan, where *Lithocarpus glabra* and *Quercus glauca* mingled with *Castanopsis, Albizia, Mallotus, Ficus, Rhus* and other genera in this interesting ecosystem. The roadside nearby yielded an attractive variant of *Q. acutissima* with narrow crimped-edged leaves, which would have made an ornamental cultivar had we had the means to propagate it.

We continued north to Cape Gongenzaki, 48 kms from Miyazaki, where we walked through an enchanted forest of *Castanopsis sieboldii*, trunks twisted by sea winds into extraordinary contortions for those normally placid trees, their roots also exposed and snaking across the path under our feet.

After lunch we set off westwards for Mt. Mukabaki, 12 kms west of Nobeoka City. En route we male members of the group were delighted to see a woman labouring manually in a field whilst her grandson watched and her husband played on his tractor. The mountain has two peaks, and adept Japanese mountain-sexers have in the past deemed that one is male, and the more north-easterly is female. I found it hard to tell, as mountains do not appear to work. Our eventual stop was amongst huge old-growth *Quercus gilva*, some to 35m (110 feet) or so (its Japanese name means Number One Oak!), growing amongst *Cryptomeria* and *Castanopsis*. Seed and photographs were gleaned in equal measure, although we were exhorted not to push too far into the undergrowth in case we frightened the poisonous snakes, a sin in a National Wildlife Refuge.

The final stop of another superb day took us to the Hukuse Shrine, where the 'biggest in the world' of the Japanese endemic *Quercus hondae* is situated. And big it certainly is, 300 years old, 40m (130 feet) in height, its buttressed trunk 5m 30cm in girth. But not an acorn in sight. It is perhaps symptomatic that the otherwise superbly illustrated book 'Woody Plants of Japan', generously donated to each of us by Prof. Obha, does not have a photograph of *Q. hondae* fruit!

October 14th again started early with a drive northwestwards to the Aya Gorge, where the spectacular Teruha pedestrian suspension bridge gave us a bird's-eye view of massed evergreens on this steep-sided gorge in the largest virgin forest in Japan. Continuing by bus up the valley, we came to more *Quercus gilva* and *Q. salicina*, our bark-identification skills again called into use on these 25 to 30m trees.

After lunch we made a brief stop at Lake Miike, one of several lakes in the enormous 30 to 40 km diameter 4,200 year old caldera complex of Mt. Kirishima, which consists also of 23 peaks, some actively volcanic. Then, down a quiet road nearby, we walked again below fine *Q. gilva* in prolific fruit. Several of us managed to bring leeches back to the bus, although to judge by the reaction screeches would be a more apt name.

A long climb in the bus took us to the Ebino plateau at 1,200m (3,700 feet) within the caldera, where *Quercus acuta* grew amongst *Pinus densiflora*, *Stuartia monadelpha* and *Abies*, and even our old friend *Q. crispula* reappeared in the cooler conditions.

On the 15th, airline network limitations demanded a drive across south Kyushu to Kagoshima, giving us another chance to see the complex of volcanoes around Mt. Kirishima, in order to catch a flight on a bonsai aircraft, a little Saab, to the island of Amami Oshima, one third of the way between Kyushu and Taiwan. En route we saw steep-sided Yakushima island of rhododendron fame.

Amami Oshima was for many a revelation – at just over 28 degrees north latitude, (the same as the Canary Islands and Orlando, Florida), a Caribbean-like island with Japanese writing and no commercialisation. Our first stop with our guide Takashi Suzuki, after a quick lunch, was to visit a large specimen of the rare endemic *Quercus miyagii*, which few westerners have ever seen. We proceeded with a certain amount of caution up a long flight of steps on a lightly wooded ridge, as Professor Ohba had just informed us that over the years three botanists had been killed on the island by poisonous snakes which here prefer the stratagem of attack to that of retreat. Undeterred, we were soon shuffling through the leaf litter below the boardwalk, looking unsuccessfully for acorns around the deeply buttressed striated trunk of this, the species with the largest acorns in Japan. The few leaves within reach showed their long drip-tips and paler undersides. Younger trees nearby showed a mottling of the bark between grey, yellow-green and brown. Returning down the path, the native fauna finally counter-attacked: several of the party were stung by bees, whose nest had been disturbed by our acorn-hunting.

A scenic seaside walk at sunset, Cycads guarding the rocky cliffs, completed the day.

On October 16th a reassuringly wide forest road, past wild *Prunus zippeliana*, *Schefflera*, tree ferns of extraordinary height and other markedly sub-tropical flora, led eventually to another superb *Q. miyagii*, since declared a national monument, 22m (72 feet) tall, 1 metre in diameter, and 150 years old. Once again we saw the characteristic buttressed base surmounted by knots and nodules.

Although worryingly sparse on Amami Oshima, Professor Ohba assures us that in other islands in the group, protected by an even denser population of the snakes, *Q. miyagii* becomes dominant, and is thus not endangered. Reassuringly, he is part of a committee which oversees development on Amami and assesses future impact upon the flora.

On our afternoon visit I was fascinated to see a climbing fern, the extraordinary *Lygodium japonicum*, growing freely by the roadside. Found as far north as mid-Honshu, it must therefore be tolerant of some frost. It was accompanied by a handsome Ash, *Fraxinus tashiroi*, with large fleshy leaves and grey buds, but the object of the stop was to see *Quercus glauca* var. *amamiana*, a variety endemic to the Ryukyu island string, the most evident difference being the petioles longer than the species.

A visit to a mangrove swamp was the last on the day's agendum, where tiny pop-eyed amphibious fish skittered around on the mud. Originally of one mangrove species only, interestingly, in recent years a second species has appeared.

Returning to the hotel, we stopped to photograph *Pinus lutchuense*, a rare endemic pine.

We were scheduled to fly direct from Amami to Tokyo's domestic airport, Haneda, on the evening of the 17th October, which left us the daytime to see more of the island's flora. Our first two stops were at spectacular colonies first of a species of Musa, with all stages of flower and fruit, and secondly of *Cycas revoluta*, in each case dense to the exclusion of almost all other plants. The Musa's bananas are not eaten, and its origin and identity is somewhat in doubt. The Japanese say it was introduced from China, the Chinese say it was introduced from Japan. At a later stop, also dense with *Cycas*, their large orange fruits were being harvested in quantity. A visit to a wildlife park showed us we had rivals in the acorn-collecting field – a group of small schoolchildren, immaculate in sunhats and T-shirts emblazoned with their school class, were also thrusting acorns into bags. Future IOS members, perhaps?

A seaside lunch saw two of our number venture into the sea, although sharp rocks underfoot limited their enjoyment somewhat.

Professor Ohba had business to attend to on October 18th, but he led us first across the Tokyo rail system to introduce our guide for the day, Mr. Taku Miyazaki, for our visit to Mt. Takao on the city outskirts. We chose to walk up the hill, eventually to catch a cable car down. We saw again *Quercus acuta*, its iron-grey bark characteristically mottled with pale grey and brown, *Q. glauca*, *Q. myrsinifolia*, *Q. salicina* and *Q. serrata*, some of them of enormous size, but sadly *Q. sessilifolia*, which our guide said is known to grow on the mountain, eluded us. Notable also were the very pale lenticelled bark and buttressed roots of tall *Idesia polycarpa*, unfortunately without their scarlet fruits.

Fierce demon statues, fortunately in cages, guarded a shrine and graveyard towards the top of the mountain, from where views of Tokyo appeared far below through the trees.

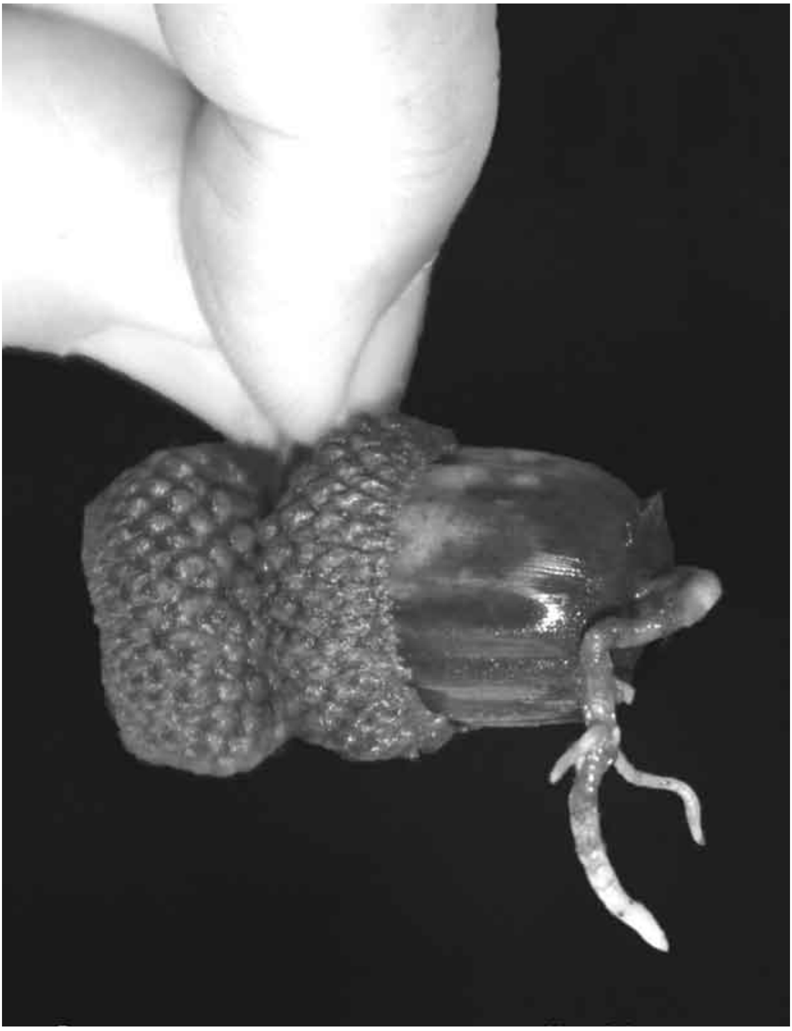
On the 19th, after a short welcoming talk by the present Director, Professor Jin Murata, Professor Ohba led us around the Koishikawa Botanical Gardens, the University of Tokyo. We saw both *Quercus phillyreoides* and *Q. myrsinifolia* drawn up to an unusual 16m (50 feet) or more, and an intruder, *Q. lanuginosa* from the

Himalayas, had reached a similar height. Looking remarkably like evergreen oaks from a distance were broad-crowned *Cinnamomum camphora* of approximately 300 years in age. Space precludes mention of the wealth of other plants which caught our eyes, but eventually we had to leave to travel to Narita. Professor Ohba joined us later for a farewell dinner, giving us the opportunity to thank him for all that he had done for us; for his calm forbearance; for sharing his enormous knowledge of the Japanese flora; and not least for his legendary politeness no matter how provoked by our lack of knowledge of Japanese customs and manners. Several participants had brought him gifts relating to their own countries – Antoine LeHardy even donated his recently-published encyclopaedic two-volume *Guide illustré des Chênes* – and jointly we gave him a silver cup chased with oak leaves and engraved as a memento. Lastly we were able to give him a Life Membership of the IOS, the latter two gifts sponsored in part by generous members of the society. He is keen to come to the 2009 Conference in Mexico to lecture on the oaks of Japan, where I hope he will get to know many more of our members. It was also our chance at last to thank Anke Mattern for her organisational and logistic skills and her boundless cheerfulness and enthusiasm.

The following day, for the majority, was the day of departure from Japan. And the most lasting memories? First, without doubt, the unfailing generosity and kindness of our hosts and guides throughout Japan, who were so delighted to share with us their deep knowledge and love of the flora. Thanks to the IOS Board we were provided with oak memorabilia which we distributed as some small recompense for their efforts, whilst Anke emptied her once-rich fund of thank-you speeches. Second, the overawing peace and serenity of the shrine and temple precincts, overarched protectively by the limbs of prodigious trees which so often were oaks.

Participants (in alphabetical order): Shaun Haddock, France; Michiko Hester, USA; Norman Kenny, Netherlands; Ina Kenny-De Leng, Netherlands; Antoine LeHardy, Belgium; Anke Mattern, Germany; Margaret Miles, England; Sten Ridderlof, Sweden; Allan Taylor, USA; Pauline Topham, Scotland.

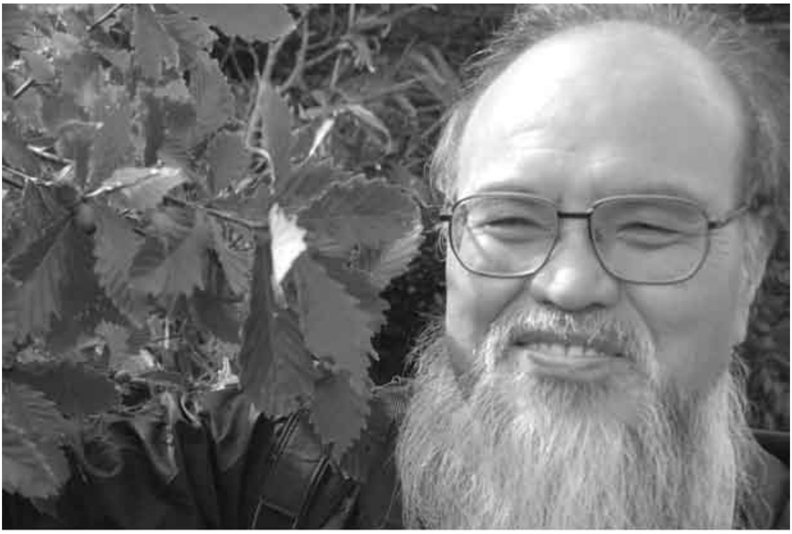
Quercus miyagii base, Amami Oshima photo © Shaun Haddock



Quercus serrata ssp. *mongolicoides* photo © Shaun Haddock

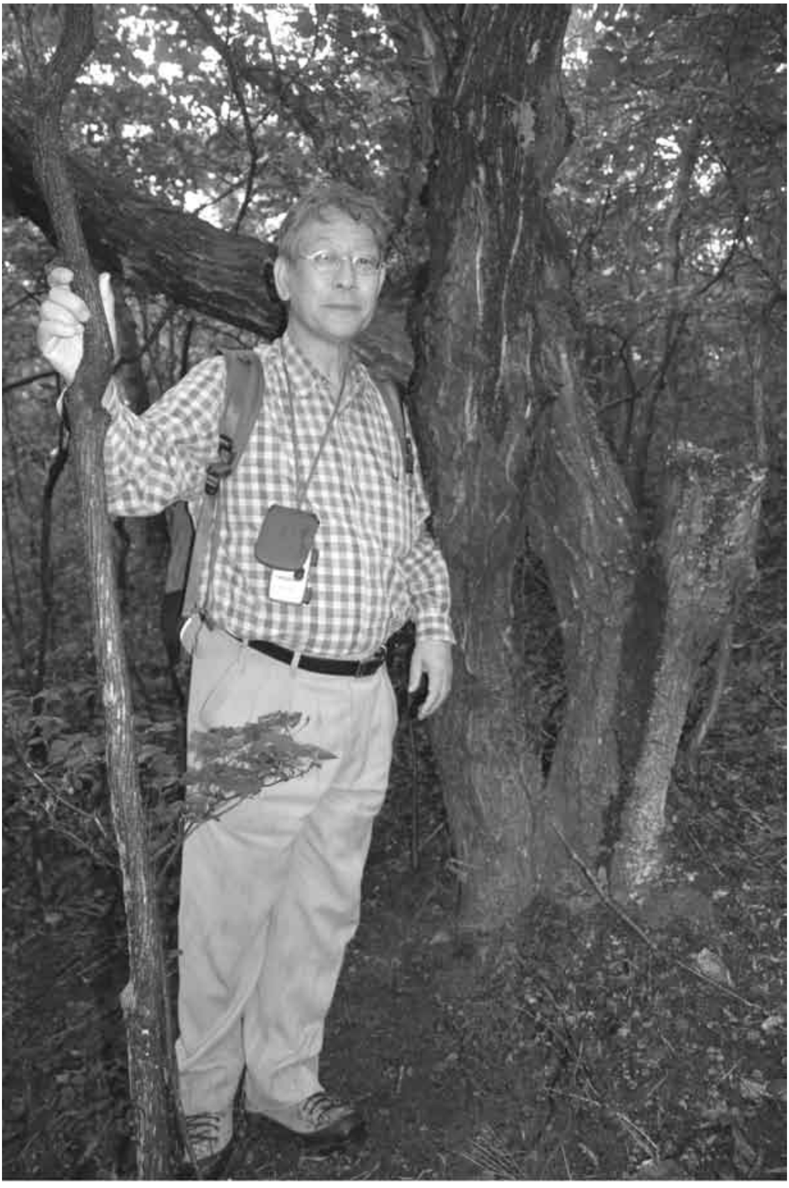
Entrance to the Makino Botanic Gardens, Kocki photo © Anke Mattern

Asst. Prof. Motonari Ohyama, Dr. Akihiro Yoshida, and Dr. Koji Yonekura at Sendai with IOS T-shirt gifts.



Professor Mitsuo Suzuki, Director of Sendai Botanic Garden, with *Quercus crispula*, Mt. Zao. photo © Anke Mattern

Quercus gilva photo © Shaun Haddock



Professor Hideaki Ohba in front of *Quercus serrata* ssp. *mongolicoides*
photo © Anke Mattern

The true face of *Quercus gilva* photo © Anke Mattern

Quercus glauca var. *amamiana*, Amami Oshima photo © Shaun Haddock

Quercus hondae Kitahara, Shikoku photo © Anke Mattern

Anke Mattern with the largest *Quecus hondae* in the world, Kyushu
photo © Shaun Haddock

Quercus serrata ssp. *mongolicoides* photo © Shaun Haddock

Quercus salicina photo © Anke Mattern

Quercus gilva near Kochi photo © Anki Mattern

Preliminary Report on the Relative Suitability of *Quercus* Taxa for Gypsy Moth Larval Development 2007

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Lisle, Illinois 60532 USA

The gypsy moth is a major defoliator of a wide variety of wood plant species. Oaks (*Quercus* spp.) are preferred, and within the *Quercus* some are more preferred than others.

The goal of this study was to evaluate various *Quercus* taxa for their relative suitibility for gypsy moth larval development with the hopes of identifying additional *Quercus* species that might be incorporated into existing oak breeding programs. Results from this study will hopefully contribute to the selection and development of oak species less preferred by the gypsy moth, and for use in forest plantings, the urban forest, and landscapes.

Materials and Methods

No-choice laboratory feeding bioassays were conducted on neonate gypsy moth larvae (May - July) during the 2007 growing season. Sixty-one (61) different *Quercus* taxa were evaluated. Common crabapple (*Malus* spp.) and bur oak (*Q. macrocarpa*), both favored hosts of gypsy moth larvae, served as standards. All candidate biotypes are growing at Starhill Forest Arboretum, near Springfield, IL.

Leaves for the laboratory bioassay tests were randomly collected from ground level from all four cardinal directions and held in cold storage in plastic bags at 5^{o}C for a maximum of 2 d. Leaves collected from each test tree were combined for the laboratory bioassays. Because of the small size or limited number of some of the trees, only one tree per biotype was available for testing.

Gypsy moth larvae used in the no-choice study were field-collected from plant material at Lisle, IL during an egg mass survey conducted in December, 2006. Eggs masses were held in a refrigerator until May, 2007. In mid May, 2007, the egg masses were placed in clear plastic petri dishes and held in an incubator under a photoperiod of 16:8 (L:D)h at 25^{o}C. Upon eclosion, approximately 10 gypsy moth (GM) larvae were placed into a 1 quart container along with foliage of a candidate biotype. The petioles of the foliage were placed into a water pick to insure freshness and turgidity. There was one (1) container (sub-replicates) for each tree for each biotype (total of 10 larvae per biotype). The containers were examined daily for larval mortality, evidence of feeding, pupation, and adult emergence. Foliage was replaced every 3 days or as needed. When all larvae had died or had pupated, study was completed.

Within 24 hours of pupation, fresh weights were taken to the nearest 0.01 gm. Pupae were then returned to the incubator until adult emergence occurred. Upon emergence, the adult moths were sexed and adult females and males reared on the same host were placed into plastic one (1) quart cartons and allowed to mate. Cartons were observed daily for adult mortality and oviposition. Adult females were provided with a cotton wick dipped in a sugar solution.

The measure of suitability for larval development for each biotype was defined by mean number of days of longevity, mean number of days to pupation, and mean dried fecal pellet weights.

Results

Of the 61 biotypes tested in this study, no gypsy moth larvae (610 larvae) lived more than seven (7) days. In most cases, larvae died with 5-7 days of being placed on the foliage. In contrast, larvae feeding on *Q. macrocarpa* completed development, pupated, and emerged as adults. Approximately 70% of the larvae feeding on *Q. macrocapra* completed development and emerged as adults.

Based on these very preliminary results, it appears that there are a number of *Quercus* biotypes that may be suitable for future breeding programs. Futher studies are needed to better identify these species in the field under normal gypsy moth pressure.

Assistance for this study was provided by Guy Sternberg, owner, Starhill Forest Arboretum; and Julia Ossler, Lynnaun Johnson, Alana Cook, Kie Layne, and Audrey Masawi, students from Illinois College interning at Starhill Forest during 2007.

Audrey Masawi, Julia Ossler, Alana Cook, Lynnaun Johnson, Kie Layne, and Guy Sternberg collecting feeding specimens from some dwarf oaks at Starhill Forest Arboretum. photo © Fredric Miller

The Pine-Oak Rusts: How Forest Tree Species Connect

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Abstract

The pine-oak rust fungi, which live out their lives as pathogens on pines and oaks, have multiple spore states and complex life cycles. Because they can be severe pathogens of pines, much of what we know about them depends on how damaging they are to management of pine forests for timber, recreation, and ecosystem values. Widely distributed in North America, they are often difficult to identify on their oak hosts, and thus the distributions and frequencies of many species are not well known, especially in urban and rural forest settings. Although they are usually minor pathogens on oaks, changing climates could alter that relationship.

Life is full of connections through which species' natural histories are expressed and enriched: shared habitats, social interactions, and gender relationships are a few among many. Some connections, however, are difficult to appreciate because they are unpleasant to us, especially if they impact us negatively: predator-prey or host-pathogen relationships, for example, can evoke fear or disgust. Our sympathies inherently lie with the animal victim or plant host, and we often dismiss or actively despise the predator or pathogen.

Yet, if we examine nature closely, we discover that ecosystems cannot prosper without disease and death. We define health for ourselves as never being sick and living a long, full life. But, for ecosystems, life-death, predator-prey, and host-pathogen relationships are essential to the health of the system. A forest without tree-killing insects or pathogens would soon be so crowded that it would become uninhabitable to most plants, animals, and other organisms, a strangled, overstocked desert.

Many fungi are benign to plants, while others help decompose and recycle dead plant matter. Some are essential to plant growth; for example, mycorrhizal fungi facilitate nutrient uptake through plant-root symbioses. Many other fungi are parasitic. The pine-oak **rust**[1] fungi fall into the latter category (Figure 1, Table 1). They usually have multiple spore states (Table 2), and their life cycles are often complex (Hedgcock and Siggers, 1949). They are wholly parasitic, that is they require a living host throughout all stages of their lives (technically, they are called

[1] These fungi are called "rusts" because two of their most prominent spore stages (aeciospores and urediniospores) are yellow-orange, orange, or red-orange in color, and, when aggregated on a plant leaf, stem, or cone, appear rust-like from a distance. Examination of the underside of an oak leaf with a hand lens will reveal the individual spores; for viewing oak leaves in the field, a 2"-diameter, 3.5X double-lens magnifier provides a wide and flat field that allows rapid and convenient scanning of leaf surfaces. For information on how to obtain one, contact the author.

Table 1. Pine-Oak rust species, their principal oak and pine hosts, and their geographic distributions.

Rust genus, species, and special form (f. sp.)	Common name	Principal oak hosts	Principal pine hosts	Reported distribution
Cronartium quercuum f. sp. *banksianae*	Eastern gall rust (galls globose)	North of fusiform rust range: dwarf chinkapin, bur, chestnut, pin, northern pin, & northern red oak; within fusiform rust range: see species list below	Jack pine	NE U.S. into Ontario, Canada
C. quercuum f. sp. *echinatae*			Shortleaf pine	New Jersey to Texas
C. quercuum f. sp. *virginianae*			Virginia pine	New Jersey to Alabama
C. quercuum f. sp. *fusiforme*	Fusiform rust (galls spindle-shaped, tapering at each end)	Cherrybark, bluejack, laurel, water, & willow oak; also, black, blackjack, southern live, post, southern red, scarlet, shingle, Shumard, turkey, & white oak	Loblolly, slash, longleaf, pond, & pitch pine; (shortleaf pine is highly resistant)	SE U.S. (Maryland to Florida, Arkansas, & Texas)
C. strobilinum	Southeastern cone rust	Bluejack, burr, Chapman, chestnut, laurel, dwarf live, southern live, myrtle, post, running, turkey, water, white, & swamp white oak	Longleaf, slash, & South Florida slash pine	North Carolina to Florida & Louisiana
C. conigenum	Southwestern cone rust	Mexican blue, Dunn, Emory, gray, canyon live, netleaf, silverleaf, & Arizona white oak	Chihuahua, Apache, Cuban, ponderosa, & other pines	So. Arizona to Mexico & Central America
Cronartium sp.	Oak leaf rust	Coast live & California black oak	None known	California coast, rarely inland
Cronartium sp.	Tanoak leaf rust	Tanoak (*Lithocarpus* sp.)	None known	California coast

Table 2. Pine-Oak rust fungus spore states, where they are borne, and what they infect.

Spore states	Borne in (fungal organs)	Borne on (host)	Infect (host)
Spermatia & receptive hyphae [a]	Spermogonia	Pine branch, stem, or cone	(Non-infective) [b]
Aeciospores	Aecia	Pine branch, stem, or cone	Oak leaf
Urediniospores	Uredinia	Oak leaf	Oak leaf
Teliospores (aggregated in telial columns)	Telia (emerge from or around uredinia)	Oak leaf	(Non-infective) [c]
Basidiospores	Basidia	Telial column on oak leaf	Pine needle, shoot, or young cone

[a] *Hyphae* are thread-like filaments that grow around and within infected plant cells and absorb nutrients to support the growth of the rust fungus.
[b] *Spermatia* and *receptive hyphae* are contained in a *spermogonium* that is filled with nectar to attract insects, which carry the *spermatia* to compatible *spermogonia*, where the *spermatia* fertilize the *receptive hyphae*, leading to development of *aecia* and *aeciospores*.
[c] Each *teliospore* germinates in place in the *telial column* to produce a short, hypha-like *basidium* that bears four *basidiospores*, which are discharged when the *basidium* matures.

obligate parasites, or **biotrophs**). If the host dies, the rust fungus dies. Under such constraints, these fungi are adapted to not kill their hosts until they have reproduced (i.e., formed and released spores), after which the host may sooner or later succumb to infection and the disease it causes.

Although closely related to the fungi that form the mushrooms that abundantly fruit on the forest floor in fall and spring—and to the wood rot fungi that produce **conks**[2] upon the stems and branches of rotted trees and are usually associated with wounds—the rust fungi are aggressive pathogens, attacking trees that are healthy, fast-growing, and not necessarily compromised by insects, decay, climate, or adverse soil or site conditions.

[2] Generally firm, conspicuous, often large fruiting bodies of decay or stem-rot fungi in which spores are produced.

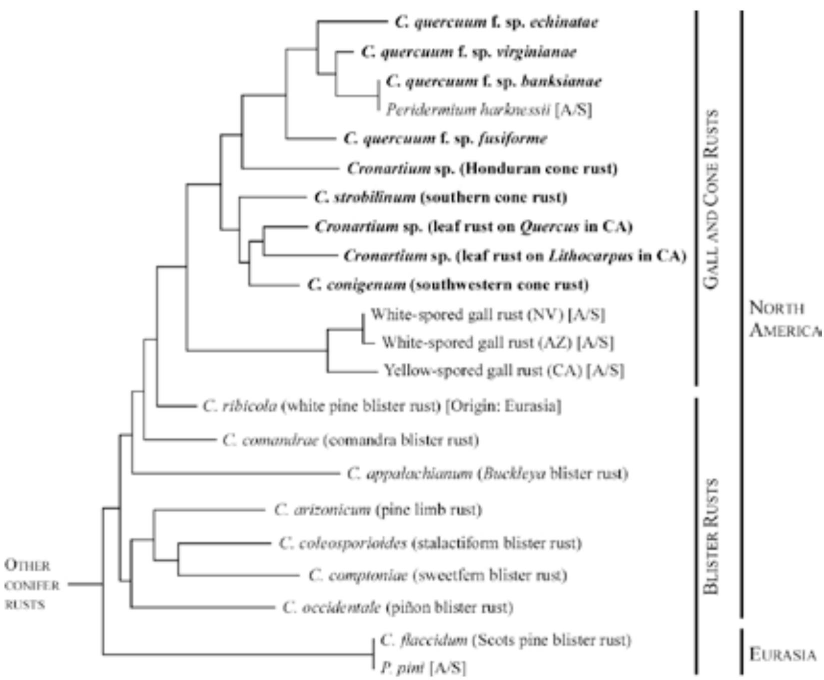

Figure 1. *Cronartium* phylogeny based upon nucleotide sequences of the internal transcribed spacer (ITS) region of the nuclear ribosomal DNA (tree modified from Vogler and Bruns, 1998). Among the North American gall and cone rusts, the species highlighted in bold are known to infect oak leaves and, except for the two *Cronartium* spp. from California, complete their life cycles by infecting pines. Gall rust species in non-bold text (*Peridermium harknessii*, and white-spored and yellow-spored gall rusts) infect from pine-to-pine only. The North American blister rusts in the lower half of the tree alternate between pines and woody and herbaceous species in several Angiosperm families. [A/S, autoecious/short-cycled pine-to-pine rust fungi.]

Figure 2. Underside of a *Quercus agrifolia* (Coast live oak) leaf from Marin Co., CA, showing scattered appearance of minute uredinia emitting orange urediniospores, and associated brown telial columns. Urediniospores infect other oak leaves, building up infection and increasing the potential distribution of the pathogen, while basidiospores (produced from the aggregated teliospores) infect pines. Although the fungal structures are best observed with a hand lens, the contrast between the green leaf and the bright, orange urediniospores would be clearly evident if the photograph were in color.

The pine-oak rust fungi provide a parasitic connection between the natural histories of pines and oaks. These fungi are members of the rust genus *Cronartium*, **heteroecious**[3] rusts and their derivatives that spend part of their lives infecting oak leaves (Figure 2) and part infecting pine stems (Figure 3), branches, or cones (Figure 4). The relative degree of parasitism the rust fungi exhibit on their alternate hosts when they occur together helps regulate and modify the local abundance and distribution of pines and oaks.

The severity of damage the pine-oak rust fungi cause is correlated with the type of tissue infected and colonized. Only leaves are infected on oaks, and if infection is especially extensive or damaging on any single oak leaf, that leaf may be shed, effectively eliminating the pathogen. Although pines are infected through needles or succulent shoots, the rust will eventually form a gall in perennial woody tissue, whether branch or stem, which can lead to deformity and death of the infected part. Multiple infections on branches and stems severely inhibit tree growth, often resulting in stunting and premature death of the entire tree.

When a cone is infected by either *Cronartium strobilinum* or *C. conigenum* (Table 2), the cone swells to at least twice the size of an uninfected cone (Figure 4), and, because the hyphae of the rust fungus entirely colonize the infected cone, no

[3] A **heteroecious** pathogen uses more than one host during its life cycle; within the Cronartium group of rust fungi there are also some that are **autoecious**, i.e., that require only one host during their life cycle (Figure 1).

seed are produced. Instead, aeciospores are produced in abundance on the infected cone surface in late spring, from which they are released and infect oak leaves. Although cone rust fungi destroy all infected cones, they do not directly impact the woody growth of the host tree.

Ranked by severity to the affected host, the gall rusts cause the greatest damage, deforming pine branches and stems and negatively impacting host growth, while the cone rusts, discounting destruction of the seed crop, cause insignificant damage to their hosts. Oak leaf infections generally cause negligible damage to oak, although infection-caused leaf-cast can be intermittently severe.

Where rust-susceptible pine species grow in forests that are heavily mixed with oaks, rust effects on pine growth and form can be severe, thereby maintaining a relatively high abundance of oaks, where otherwise uninfected pines might overtop the hardwoods and limit their ability to thrive. Conversely, non-host pines or other conifers that inhabit or invade an oak forest may eventually dominate the oaks because they are not susceptible to infection. Converting portions of an oak-dominated habitat to single-species cultivation of a rust-susceptible pine can be disastrous, since the planted pines may succumb to a pine-oak rust disease that they would otherwise escape if planted at a distance from oak habitat.

A phylogeny or family-tree of some of the major North American pine-rust fungi is shown in Figure 1 (based upon Vogler et al., 1996; Vogler and Bruns, 1998). Perhaps the best-known of these is *Cronartium ribicola*, cause of the white pine blister rust disease that was introduced from Asia via Europe around the turn of the 20th Century, and which alternates between members of the genus *Ribes* (gooseberries and currants) and the white, or five-needled pines. An invasive exotic, *C. ribicola* spread across North America in just a few decades, and severely affected commercial production of eastern white pine (*Pinus strobus*) in the northeastern U.S. and Canada, and western white pine (*P. monticola*) and sugar pine (*P. lambertiana*) in the northwestern and Pacific States and Provinces. Today it continues to spread into the habitats of the other white pines in the U.S.; at present, only Great Basin bristlecone pine (*P. longaeva*, the oldest living tree species on earth) is still free of blister rust infection in the wild.

The upper half of Figure 1 depicts the closely related group of gall and cone rust fungi. The pine-oak and oak-oak[4] rusts are illustrated in bold; their common names, their principal oak and pine hosts, and their known distributions are shown in Table 1. The other species not in bold (*Peridermium harknessii* and yellow- and white-spored gall rust, labeled "A/S") are autoecious pine-pine rust fungi that infect directly from pine-to-pine, without alternating to oak leaves, and thus, despite their likely derivation from pine-oak ancestors, have no current connections to oaks.

These examples of life-cycle and host complexities are common among the rust fungi, whereby a heteroecious, full-cycled species gives rise to autoecious, short-cycled derivatives that live on either one or the other of the hosts of the ancestor without having to cycle back to the former alternate host. One difference between the oak-to-oak and the pine-to-pine derivatives, however, is significant. The oak-to-oak derivatives that reside on live oaks may continue to cycle from oak leaf to oak leaf without infecting a pine (either because that pine host species is no

[4] By oak-oak rust fungi, I refer to those that have no known pine host. They produce spore states (**basidiospores**, Table 2) that ostensibly could infect a pine, but no pine host is known. They also produce spore states (**urediniospores**, Table 2) that serve to reinfect oak leaves.

longer in the vicinity, or has been eliminated), because live oaks retain some leaves throughout the year, and thus the spore stages (urediniospores, Table 2) that infect oak leaves can be present at any time of year. However, since these derivatives also continue to produce pine-infecting spores (basidiospores, Table 2) as well, they theoretically retain the ability to infect the former pine host or hosts, which could occur if those pine species were to be reintroduced by humans, or they were to migrate back under an altered climatic regime.

For the pine-to-pine species, however, this flexibility has been lost. The spore stages produced on pines (aeciospores, Table 2) that used to infect oak leaves have been genetically modified in such a way that they now infect pine stem tissue and not oak leaves, and thus their ability to infect anything but pine (usually through succulent, actively-expanding stem tissue) has been lost. In short, the pine-to-pine rusts appear to have evolved into a bottleneck that they can't get out of, while the oak-to-oak species retain a flexibility that potentially could allow them to regain their heteroecious life style, assuming a suitable pine host or hosts were to be introduced or migrate into the vicinity.

Figure 3. A subglobose to elongate, sporulating *Peridermium harknessii* (western gall rust) gall on lodgepole pine, Yellowstone N.P., WY. Aeciospores are enclosed in peridia (note light-colored, bulbous shapes between bark scales at the upper middle) that emerge in spring and early summer. Gall shown here is intermediate in shape between the globose galls of *Cronartium quercuum* f. sp. *banksianae* and the fusiform galls of *C. quercuum* f. sp. *fusiforme*. In *P. harknessii*, which is a pine-to-pine gall rust, the spores borne in the peridia will infect succulent shoots of nearby lodgepole pines, bypassing oaks. In *C. quercuum*, which is a pine-oak gall rust, spores emerging from the galls will infect oaks.

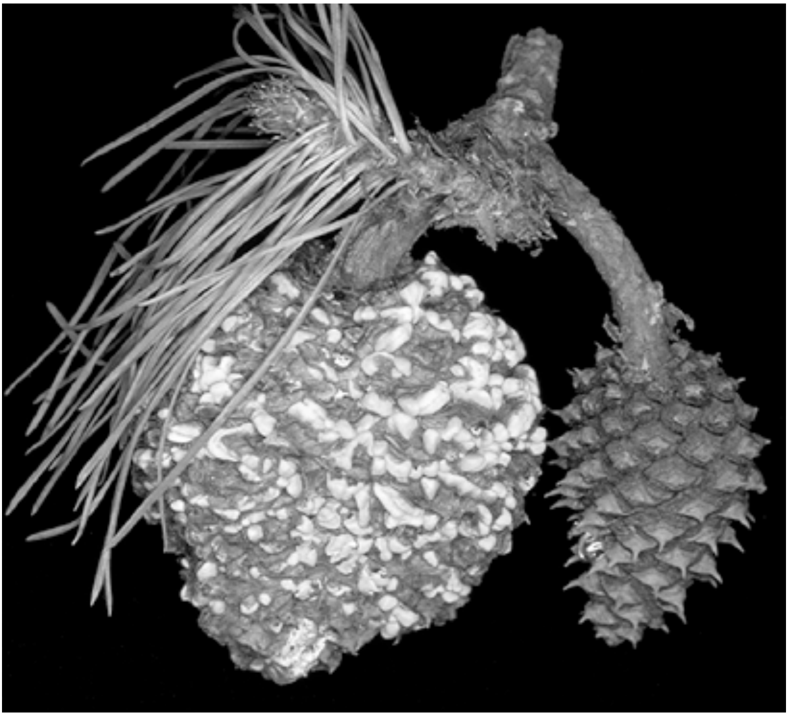

Figure 4. A cone of *Pinus leiophylla* (Chihuahua pine) infected by *Cronartium conigenum* (on left), Cochise Co., AZ. Infected cones become fully colonized by rust fungus mycelium (masses of hyphae), causing the cone to grow to at least double the size of a normal, uninfected cone (on right). *C. conigenum* spores are borne in peridia that erupt across the surface of the infected cone (note light-colored, bulbous peridia, which have not yet broken open to release aeciospores). When mature, aeciospores will infect nearby susceptible oaks, completing the cycle of infection.

Among the pine-oak rust fungi shown in Table 1, those that adversely affect the growth of pines for timber production are the most intensively studied. For example, fusiform rust (*Cronartium quercuum* f. sp. *fusiforme*) has had a major impact upon the economic viability of growing loblolly and slash pine for commercial uses in the southeast, and thus became a major threat to survival of the timber industry. Intensive, long-term, and successful research to develop fusiform-rust resistant loblolly and slash pines has permitted the forest industry to prosper in spite of the fusiform rust pathogen. Much research has also been done on the eastern gall rust, *C. quercuum* f. sp. *banksianae,* on southeastern cone rust, *C. strobilinum*, and on the pine-to-pine western gall rust, *Peridermium harknessii*, all of which affect timber production. The distributions of these four rust species on pine are well established, and the distributions of the three heteroecious species that also infect oaks are well known within the range of forests where commercial timber harvest occurs.

Less well known are the distributions of the pine-oak rusts outside of forests that are managed for timber production. And, even when these pathogens are thought to damage pines esthetically or are considered threats to pine sustainability in parks and suburban settings, little attention is given to the effects or distributions of the stages of these rusts that infect oaks. As noted earlier, without close examination, the spore stages on oak are cryptic and the damage to oak leaves is usually negligible. Thus, we don't really know how widespread these pine-oak rusts may be outside of forested lands where pines are abundant or cultivated commercially.

Information on distributions of the oak-infecting stages of the heteroecious pine-oak rusts would be useful. Aeciospores are known to spread hundreds of miles from infected pines if the winds are right, and urediniospores can spread infection from oak leaf to oak leaf for many miles, perhaps as far as aeciospores can be transported. Thus, the oak-infecting stages can establish long distances from rust-infected pines. Oak leaf rusts have been found on bur oak (*Quercus macrocarpa*) in South Dakota; they could have come from *C. quercuum* f. sp. *banksianae* infections on jack pine to the north, or from *C. quercuum* f. sp. *fusiforme* on loblolly or slash pine to the south. Other examples are the oak-leaf rusts on coast live oak and tanoak along the central California coast (Table 1); phylogenetically (Figure 1), they appear to be species distinct from the other pine-oak rust fungi, and yet no pine hosts have been found, suggesting they are long separated (both in distance and time) from the pine-infecting species from which they probably derived.

With climates predicted to change dramatically over the coming decades, it is possible that pine-oak rusts will establish elsewhere on live oaks far from infected pine stands. There they could become more common on oak leaves because of altered microclimates, and perhaps become more potent parasites on oaks. However, to make such predictions, we need more baseline data on which pine-oak rusts can be found infecting which oak species and where, especially outside the ranges of their pine hosts. Members of the International Oak Society could contribute substantially to providing observations on distributions and new hosts of these North American native "invasive exotics". Rust-infected oak leaves are readily pressed and dried, and, when properly treated and stored, can be used as sources of fungal DNA for sequencing, through which the species of pine-oak rust can be determined. From these observations and associated sequence data, scientists could begin to map the distributions of these fungi far from their alternate pine hosts. Contact the author if you would like further information on the pine-oak rust fungi, or would like to contribute to this mapping effort.

Acknowledgement

The author thanks Annette Delfino-Mix for her helpful comments on a draft of the manuscript.

Detlev R. Vogler is currently a Research Geneticist/Plant Pathologist at the Institute of Forest Genetics, USDA, Forest Service. His research focuses on mechanisms and inheritance of resistance to white pine blister rust in Pacific Coastal white pines, and to western gall rust in Monterey and ponderosa pines; since 2001, he has been studying how forest pathogens affect the diversity, sustainability, and evolution of fire-dominated coniferous forests in Parque Nacional Sierra de San Pedro Martir, Baja Norte, Mexico. With a Forest Service colleague, Brian Geils, he is preparing an extended manuscript on the natural history of the pine stem, branch, and cone rust fungi in North America.

Dr. Detlev Vogler collecting spore samples from an oak-pine rust in central Honduras (May 2002). photo © Guy Sternberg

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Vogler, D. R., and T. D. Bruns. 1998. Phylogenetic relationships among the pine stem rust fungi (*Cronartium* and *Peridermium* spp.). Mycologia 90: 244-257.

Suggested readings

Agrios, G. N. 2004. Plant Pathology. 5th Ed. Academic Press, San Diego, CA. 952 p.
Authoritative academic introduction to the *Cronartium* rusts as pathogens of pine, from the perspective of practicing forest pathologists and forest managers. Intended as a college-level introductory text in plant pathology, it provides a broad discussion for the general biologist on the science of phytopathology, and on the living organisms and abiotic agents that cause disease in plants. Includes a glossary of phytopathological terms.

Alexopoulos, C. J., C. W. Mims, and M. Blackwell. 1996. Introductory Mycology. 4th Edition. John Wiley & Sons, New York, NY. 869 p.
Authoritative academic introduction to the *Cronartium* rusts as fungi, within the context of the larger science of mycology; emphasis on taxonomy, phylogeny, life cycles and spore states, with secondary discussion of these organisms as pathogens. Intended as a college-level introductory text in mycology, it places the pine stem, branch, and cone rusts within the broader context of fungi and related microorganisms. Includes a glossary of mycological terms.

Sinclair, W. A., and H. H. Lyon. 2005. Diseases of Trees and Shrubs. 2nd Edition. Comstock Publishing Associates, Ithaca, NY. 660 p.
Information for plant pathologists, foresters, and landscapers who are responsible for the health of trees and forests and who need to know how to recognize and control their pathogens; beautifully illustrated with excellent color photographs. To quote from the dust jacket, "[This book] is a comprehensive pictorial survey of the disorders of forest and shade trees and woody ornamental plants in the United States and Canada. An authoritative reference, it is also a reliable and handy diagnostic tool that will simplify the identification of specific plant diseases by focusing on signs and symptoms that can be seen with the unaided eye or with a hand lens." Extensive glossary, reference list, and index.

Ziller, W. G. 1974. The Tree Rusts of Western Canada. Publication No. 1329. Environment Canada, Canadian Forestry Service, Ottawa, Canada. 272 p.
Although long out of print and restricted in geographic scope, this text is a classic in the conifer rust field, well-illustrated and comprehensive, with excellent life-cycle diagrams and glossary. May be available at your local University or College library, or, if you must have a copy, via one of the online used-book services.

A Gallery of the Common European Oaks

Quercus robur, Q. petraea, and their Hybrid _Q._ x_rosacea_

**Bernd Schulz, Daniel Dumont, Eike Jablonski,
Rob Guest, Guy Sternberg
Hugues Vaucher and Mike Tyner**

Drawings © Bernd Schulz

The Big Oak, *Q. robur,* Allouville - Belfosse, Dept. Seine Maritime, Normandy, France. photo © Daniel Dumont

The Machen Oak in the Forest of Dean (*Q. robur*) named after E. T. Machen who was Deputy Surveyor from 1808-1854.

photo © Rob Guest

The Victory Oak in the Forest of Dean (*Q. robur*). Planted 1808 following Nelson's report to parliament. Felled 2005 to repair the Victory.

photo © Rob Guest

Big Belly Oak, the oldest tree in Savernake Forest. Girth nearly 11 m.
(*Q.* x*rosacea*). photo © Rob Guest

Leonart Fuchs, New Kreüterbuch (*The New Herbal*), printed in Basel, 1534. Fuchs was a physician and the pioneer of modern Botany, born 1501 in Bavaria, died 1566 in Tübingen.

Drawing of *Q. robur* supplied by Eike Jablonski

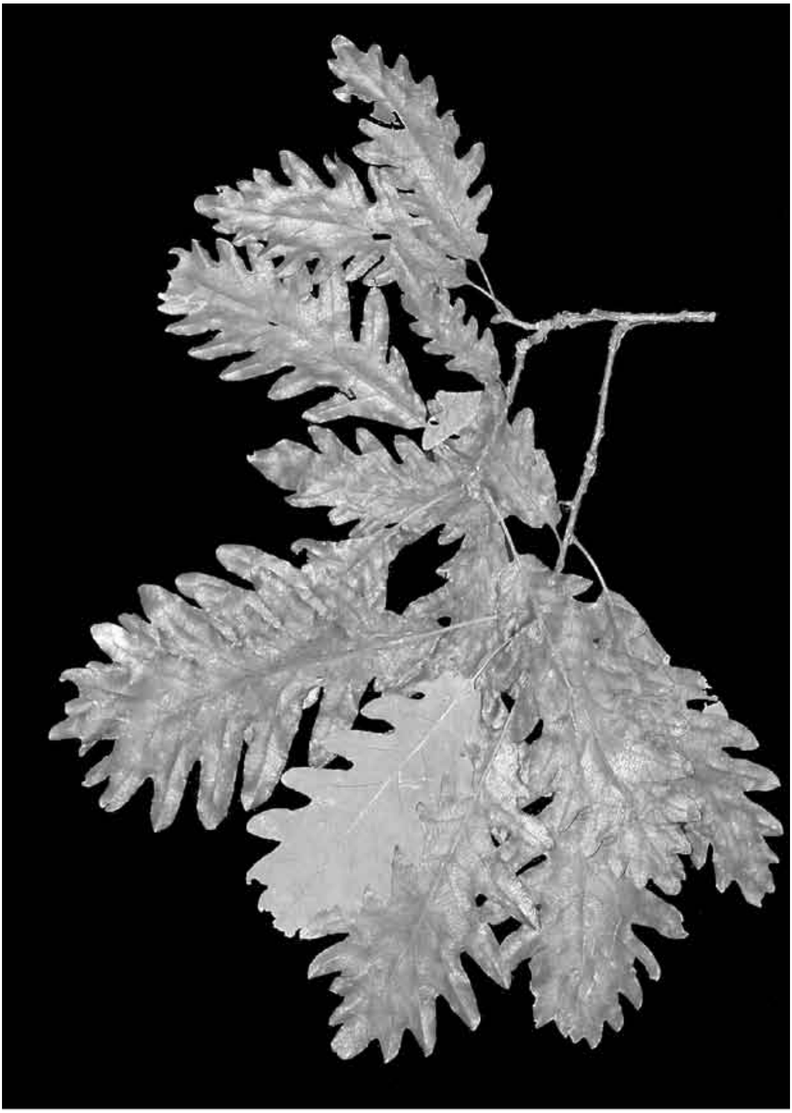
FemeEike, a 1500-year-old relic *Q. robur* in Germany that predates the introduction of oaks from other provenance by humans. photo © Eike Jablonski

A 600-year-old *Q. petraea* in the Spessart Forest of Germany at Rohrberg.
photo © Guy Sternberg

Bark texture on giant *Q. petraea* trees in the Spessart Forest of Germany at Rohrberg photo © Guy Sternberg

Mature *Q. petraea* at Sallburg Castle, Germany. photo © Guy Sternberg

Foliage and fruit of *Q. petraea*. photo © Guy Sternberg



Q. petraea var. *pinnatiloba*, a dissected form from Mus, Turkey.
photo © Guy Sternberg

A fastigiate tree propagated from the Schoen Eiche *Q. robur*, growing in Harreshausen, Germany. photo © Guy Sternberg

The original fastigiate oak – the Schoen Eiche (Beauty Oak) *Q. robur* of Germany (with Eike Jablonski). photo © Guy Sternberg

Edie Sternberg with a venerable *Q. robur* in the 800-year-old ancient forest (Urwald) at Sababurg, Germany. photo © Guy Sternberg

Q. robur root detail from the ancient forest (Urwald) of Sababurg, Germany.
photo © Guy Sternberg

Q. robur 'Filicifolia', an extremely dissected cultivar.
photo © Guy Sternberg

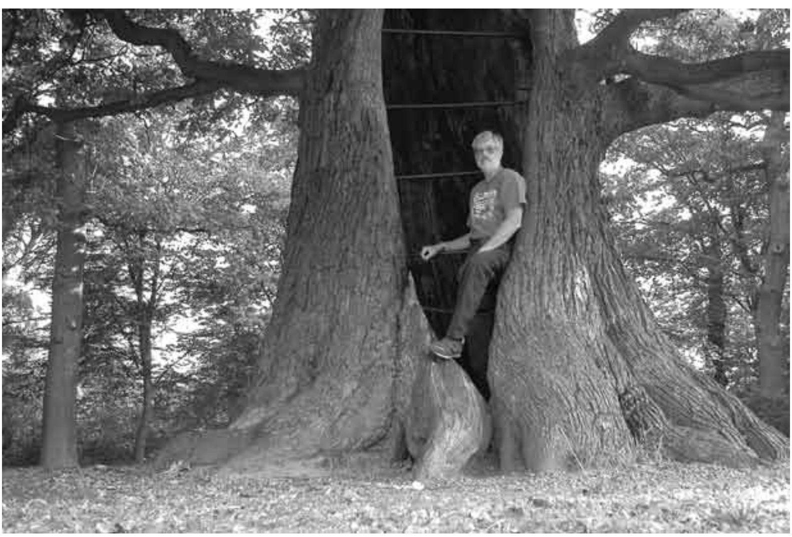
Guy Sternberg among ancient *Q. robur* trees at Windsor Gardens, England.
photo © Guy Sternberg

Antoine leHardy with one of the majestic *Q. robur* trees on his family's property in Belgium. photo © Guy Sternberg

The Pansanger Oak (*Q. robur*) planted by Queen Elizabeth I in the Forest of Dean. photo © Guy Sternberg

Foliage and fruits of *Q. robur.* photo © Guy Sternberg

Q. *robur* used as a landscape tree in Illinois. photo © Guy Sternberg



Guy Sternberg in a 300-year old *Q*. *robur* in Hamburg, Germany.
photo © Guy Sternberg

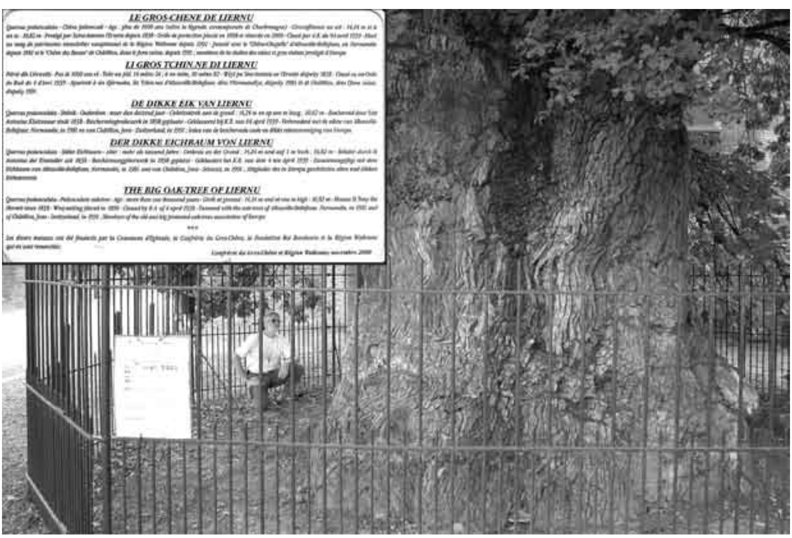
Q. *robur* planted as a commemorative tree in Missouri.

photo © Guy Sternberg

Guy Sternberg with an ancient "dodder" *Q. robur* in Windsor Great Park, England. photo © Guy Sternberg

The famous Billy Wilkins Oak, a legendary *Q. robur* in England.
photo © Guy Sternberg

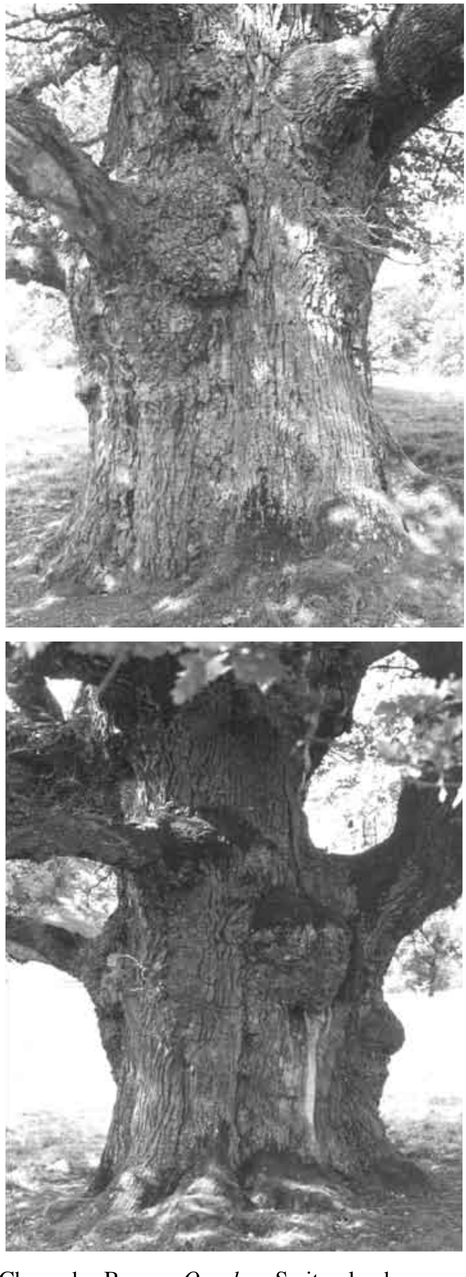
Q. *robur* 'Salicifolia', an unusual form with entire foliage and long petioles.
photo © Guy Sternberg



Guy Sternberg with the Gros Chene (Great Oak) of Liernu, Belgium, one of the elite club of world-class *Q*. *robur* trees. photo © Guy Sternberg

Q. Robur Verderer. photo © Mike Tyner

Chene des Bosses, *Q. robur,* Switzerland. photo ©Hugues Vaucher



Chene des Bosses, *Q. robur,* Switzerland.
photos ©Hugues Vaucher

INTERNATIONAL OAK SOCIETY

INTERNATIONAL OAK SOCIETY

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Triennial Conferences

2006 - Texas A&M University, Texas, USA
(Chair, David Richardson)

2003 - King Alfred College, Hampshire, England
(Chair, Allen Coombes)

2000 - The North Carolina Arboretum, North Carolina, USA
(Chair, Ron Lance)

1997 - The Huntington Botanical Garden, California USA
(Chair, Amy Larson)

1994 - The Morton Arboretum, Illinois, USA
(Chair, Guy Sternberg)

Oak Open Days and their Organizers

2005 - England- Barry Denyer-Green

2004 - France - Thierry Lamant

2002 - Turkey - TEMA and led by Adil Güner, Habib Güler, Aydin Borazon and Nihat Gokyigit

2001 - Spain - Francisco Vasquez

1999 - France - Thierry Lamant

1998 - Germany - Eike Jablonski

1995 - England - Allen Coombes and Dorothy Holley

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Quercus crispula, Mount Zao, Honshu Photo © Anke Mattern

IOS Tour Group with Sendai Botanic Garden team, Mount Zao, Honshu
Professor Suzuki, second from the left, front row. Photo © Anke Mattern

International Oaks

The Journal of the International Oak Society

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