International Oaks

The Journal of the International Oak Society

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that time forgot, oak-rod baskets,
pros and cons of grafting…

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p. 205, Photo 3: Charles Snyers d'Attenhoven

FOREWORD

You Reap What You Sow (But Not Always)

Twenty years ago this year we held our first conference at The Morton Arboretum. This marked not only the birth of the International Oak Society but also my entry into the world of oaks. I probably knew quite a few species by then including some unusual ones but here I was thrust amongst the oak giants as someone more curious than anything, interested and wanting to be involved. Looking back to those times it is easy to see how many things have changed. Compared to today there were relatively few oaks in cultivation and few people collected them. With more thorough collecting in the oak-rich countries such as Mexico and China, as well as in Europe and the USA, the number of species in gardens has increased tremendously, as well as the number of oak collections. In 1994 we were learning about oaks that were unheard of by most of us, today the names of many obscure, and even then unnamed, oaks are tripping of the tongue in not so idle conversations.

The growth of knowledge of oaks has been accompanied by a concomitant growth in our publications, both in quality and content. A journal of much more professional appearance now contains articles of a diversity only rivalled by our eponymous genus. *International Oaks*' sister publication, *Oak New & Notes*, has also made great strides and provides an ideal place for shorter, but no less interesting, articles and news items. The piece by Michael Avishai "Mating in Single Oaks" (*Oak News & Notes*, Vol. 18, No. 1, 2014) particularly caught my attention.

Like most of us, I try to ensure oaks are raised from wild-collected seed. We all know, however, that this is often not possible. Collectors can only bring back a limited amount of seed, usually not enough to satisfy the number of hungry mouths waiting for them and the temptation to collect acorns from an unusual species in a garden is usually too great to resist. While our triennial conferences and many of the Oak Open Days provide good opportunities to collect from wild populations, there are always visits to gardens, and you usually find so many more species there. I confess, I have done this myself, and have watched many others avidly picking acorns from cultivated plants in the hope that they

will get “the real thing”. I wonder how many consider the possibility of hybridization, or follow up the results of their harvest? Certainly I have not found many collection holders that can provide information on whether their tree will come true from seed or what it is likely to hybridize with.

There seems to be little information available on this. We might assume that if a group of several plants of a species are planted together they may come true from seed, we might also assume that a single plant of a species will always be pollinated by another species but I do not believe there is evidence to support this. Following my 1994 induction into the world of oaks I started to do a little work on this myself at Hillier Gardens. Although, even then, there was a considerable oak collection, acorns were often not frequent on exotic species. Whether this was due to the climate or to lack of pollinators I cannot say for sure, but I suspect the former. I can say that those I did manage to raise from seed, from plants in the garden, did produce interesting results.

A single tree of *Quercus macrocarpa* Michx. did occasionally produce acorns. The seedlings raised from this tree were all hybrids with *Q. robur* L. which is common in the area. Does this tell us that this species is not self-compatible? I think all it tells us is that it did not pollinate itself on this occasion. It would be very useful to be able to raise a valuable and rare species from seed, so much easier than grafting or cuttings. Several times Hillier Nurseries tried to raise *Q. rysophylla* Weath. from cuttings but this was very slow with a very poor success rate. One year, the famous tree of this at Hillier Gardens produced a few acorns, which gave two plants, both obviously hybrids with another red oak, even though there were two trees at the same location. This species seems to be notorious for producing hybrids and I have come across many of them in different places. Is this unusual, or normal, or is it just because everybody wants it so seed from cultivated plants is often collected?

The Chinese oaks that I grew from garden seed gave different results. Both *Q. longispica* (Hand.-Mazz.) A. Camus and *Q. monimotricha* (Hand.-Mazz.) Hand.-Mazz. grew at Hillier Gardens, at the time as single plants, and both produced seed regularly. To my surprise, both of these came true from seed, not just once but several times, proving that not only are they self-compatible, but also that seed is an effective way of propagating them. However, the situation may not be that simple. Roy Lancaster (who collected both of these species in China) had a plant of *Q. monimotricha* in his garden, which, although it flowered regularly, never produced any acorns. Is it possible that some plants of a species are self-compatible and others not? Since those early days, several more of the Chinese golden oaks have come into cultivation. Will it also be possible to propagate these in the same way? Maybe not, as another plant at Hillier Gardens that I collected in Yunnan as *Q. rehderiana* Hand.-Mazz. may be a natural hybrid with *Q. senescens* Hand.-Mazz.

Michael Avishai’s note highlighted a problem that affects us all. Which oaks, if any, can we propagate with confidence from garden seed? Can any be guaranteed to come true and do any always hybridize, if so with what? While the answers to these questions and to the question of compatibility in oaks may not be available at the moment, we can make some progress. I know most collection holders are not always keen to raise seed of their own plants, but doing this could provide useful information, particularly if from single plants.

Allen Coombes

FROM THE EDITOR

Sugar and Spice

For longer than I have been interested in oaks, I have been interested in cooking—all things really, but especially desserts. It is truly the alchemy of culinary art: can you even count the number of transformations you can subject a bit of egg, flour, butter, milk, and sugar to in order to create the most extraordinarily different things?

Reading Marcie Mayer's article, "Creating Sustainable Income From the Ancient Oak Forest On Kea Island, Greece" (pp. 13-22) brought me, on a bit of a side-track, to a book entitled *Sherbet and Spice: The Complete Story of Turkish Sweets and Desserts* (Mary Isin, 2013, London, New York: I.B. Tauris & Co. Ltd.) and to the delightful story of *kudret helvasi* (oak manna).

"The other type of manna found in Turkey is oak manna, produced by aphids that breed in oak forests, particularly in the eastern provinces. The manna is known by various local names…*men* from the Arabic *man*, and the Turkish words *kudret helvasi* and *yagci pelidi*. Persian *ges* (can)…be used as a generic term for oak manna produced in western Iran, northern Iraq and eastern Turkey. It was also called *man-es-simma* (manna from the skies) in Persian and Arabic pharmacopoeas…"

This idea of manna from the skies—despite evidence to the contrary—has been perpetuated by the mysterious (unpredictable) appearance of the sugary substance from one year to the next and also by the almost invisible aphids responsible for it. The sugar and spice and everything nice that myths are made of! According to Isin, "There is sometimes little or no oak manna for several years running followed by a glut year probably depending on unknown factors relating to the life cycle of the insect and to weather conditions."

The aphids nourish themselves on the elaborated sugar and carbohydrates that run through the phloem just beneath the bark but retain mostly only the nitrogen that is present. The rest of the sugary sap passes through them dripping on to the tree (eventually drying into a powdery white substance). Manna was collected in liquid form and then dried and sold as crystallized lumps. Alternatively, once dry the leaves and branches

could be shaken to brush off the white powder (this was considered the finest variety). The leaves and branches could also be collected and rinsed in cauldrons of water. The sugary solution thus obtained was then strained to produce a delicious and dark syrup. In these various forms, oak manna would then be purified by confectioners and mixed with egg white, almonds or other nuts to make nougat and other sweets. Local people in manna-producing areas ate it for breakfast after boiling and straining, diluted it with water to make a sherbet drink, or mixed it with flower and nuts to make cakes.

There is some difference of opinion as to which oak species is the candymaker of the genus, but the one most frequently named is *Quercus infectoria* Oliv. I have found several references also for *Q. brantii* Oliv., *Q. persica* Jaub. & Spach, and one reference to manna oak being a common name for *Q. cerris* L. And, as Marcie Mayer writes, this sugary substance also appears on the leaves of *Q. ithaburensis* subsp. *macrolepis* (Kotschy) Hedge & Yalt. One must conclude that there are a great number of oaks in the world that accommodate with their sugary sap the even greater number of aphids in the world although only one or two oaks have contributed significantly to confectionery history.

In Madame Camus' *Les Chênes* (Tome II, p. 260) there is an entry for "(×)? *Q. mannifera* Lindley." The "(×)?" representing her suspicion that this taxon, described as a species, was probably a hybrid. In addition to her description, she provides Mr. Lindley's original description in Latin, followed by a few lines in French (translated here) that made me smile: "The upper surface of the leaves of this oak exudes manna during the hot months of the year according to Mr. Lindley." And while this is indeed a part of what he writes, Mr. Lindley actually describes in great detail the entomological origin of manna along with his description of the species (*Edwards Botanical Register*, 1840, No. 26, pp. 242-43). Part of the story is thus often a very different story—indeed the very things that myths are made of.

How sweet to be able to end this oak story with yet another name story: today, *Q.* ×*mannifera* Lindl. is an accepted name for the hybrid between *Q. infectoria* subsp. *veneris* (A. Kern.) Meikle and *Q. petraea* subsp. *iberica* (Steven ex M. Bieb.) Krassiln.

Enjoy *International Oaks*… with a nice piece of candy!

Béatrice Chassé

Thoughts in Purple and Blue

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Any article written on trees, and indeed on nature in general, is of necessity a snapshot, and no sooner is the ink dry than the scene has changed. Thus, I hazard an update to two articles I have written in the past for the IOS Journal, *International Oaks*.

Members with long memories may recall that in the Spring 2008 Issue I wrote about the widespread but rarely seen purple hairstreak butterfly, whose entire life cycle is completed on some Eurasian oak species.[1] Incidentally, we "plant people" are often annoyed when the botanists change the Latin name of a familiar plant, but be assured it happens in other fields as well. Linnaeus himself assigned the delightfully oaky Latin name of *Quercusia quercus* L. to this little insect, but there seems to be a move afoot to place it in a new genus as *Neozephyrus quercus* (a name for which I have yet to find an authority).

I wrote at the time that the butterfly was rarely seen at ground level, but since then I have found there is one attractant they are unable to resist—the sap exuded from the abscission layer when the short-lived petals of *Magnolia delavayi* Franch. have fallen. The photograph above shows them literally climbing over one another to reach the feast. Their native ranges do not overlap, showing once again that one does not need to "plant native" in order to attract wildlife.

More recently, in Issue No. 23, the article "Oaks in a difficult climate—Arboretum de la Bergerette" was published, in which I attempted to discuss the relative merits of

oaks in a dry climate with warm summers.[2] Participants in the Post Tour of the 7th IOS Conference (Bordeaux, 2012) will already have seen the consequences of my tempting fate when I wrote, regarding *Quercus delgadoana* S. Valencia, Nixon & L.M. Kelly (previously included in *Q. eugeniifolia* Liebm.), Allen Coombes collection CMBS 219, "untouched by cold or drought since its planting in October 1996." In February 2012 the coldest weather for 25 years arrived (-13.2 °C/8.2 °F absolute minimum, but with almost two weeks below freezing point), and although it took some time to fully ascertain the damage, this was virtually the only species that was completely killed—even some meager basal sprouts failed to reestablish. This and the "death" (though today happily resprouting) of a fair sized *Q. franchetii* Skan (shown here) posed some interesting questions regarding hardiness, because both these species had survived lower temperatures as smaller plants further north, notably in Béatrice Chassé's and Gérard Lionet's Arboretum des Pouyouleix where -18 °C/-0.4 °F was recorded, and with Jean-Louis Hélardot a young *Q. delgadoana* also survived -18 °C/-0.4 °F. When the cold weather arrived I had consoled myself with the thought that according to received wisdom the preceding two years of drought would have hardened the wood of my plants to such an extent that they would be more than usually resistant to cold. However, ignoring for a moment that provenance may have been a factor, it would seem that the reverse was true and that the trees had instead been stressed to such an extent by drought that they more readily succumbed. Furthermore, it suggests that the common assumption that established trees are hardier than the young stages may also not be true in every case.

Of other species cut almost to the ground but regenerating were two different provenances of *Q. conspersa* Benth. and a sizeable tree of *Q. acutifolia* Née. Of two specimens of the latter's hybrid with *Q. mexicana* Bonpl., both from an identical provenance, one was cut back but the other, only slightly higher up the hillside, survived. Of three specimens of *Q. leucotrichophora* A. Camus, the smallest was killed completely, and of two 5-meter/16-foot plants, one was cut to the ground and the other, despite having the same provenance as the plant killed, survived with only twig damage (thus, did size or situation explain this dichotomy?). However, the strangest behavior of all was exhibited by the somewhat tender Mexican *Q. sapotifolia* Liebm. originally planted in 1999. For years it had never shown its head above its surrounding rabbit guard and fleece, so that I had assumed it was dead. In 2012, perversely, it commenced to sprout vigorously. It would seem we still have much to learn about hardiness.

Photographers. Title page: Charles Snyers d'Attenhoven (Arboretum de la Bergerette). Photos 1, 2: Shaun Haddock.

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Creating Sustainable Income From the Ancient Oak Forest on Kea Island, Greece

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ABSTRACT

Quercus ithaburensis subsp. *macrolepis* (Kotschy) Hedge & Yalt. is a semi-deciduous native of the Mediterranean region that produces acorns 4-6 cm/1.5-2.3 long, weighing 10-40 g/.35-1.4 oz each and with very large caps that have long, protruding scales. *Q. ithaburensis* subsp. *macrolepis* has been known by many aliases, the most common being *Q. aegilops* L. or *Q. aegilops* subsp. *macrolepis* (Kotschy) A. Camus as well as Valonia oak. The island of Kea is located in the drought prone Southern Cyclades where annual rainfall rarely exceeds 300 mm/12 in. Today, rugged Valonia oak cover 2,000 hectares/5,000 acres of central and eastern Kea, representing nearly 8% of the entire oak population in Greece. Although the forest is protected under the Natura 2000 protocol, trees continue to be sacrificed for firewood. Historically, the exportation of acorn caps for the leather tanning industry was a major sector of the local agricultural economy for at least four hundred years. The Hamada Acorn Initiative for Kea works to develop and promote responsibly sourced, oak-based income for farm families by facilitating the exportation of acorn caps to traditional leather tanneries and by developing and promoting acorn-based products.

Keywords: *Quercus ithaburensis* subsp. *macrolepis, Q. aegilops*, Valonia oak, hamada, tanning industry

History of hamada harvest on Kea

The annual exportation of tannin rich, giant, spiky acorn caps to leather tanneries in Europe and within Greece contributed significantly to the island's agriculturally based economy for as many as six centuries from the mid 1200s to 1965.[1] In 1687, Bernard Randolph in his survey of Greek islands writes, "The chief product of the Island, is Corn, Wine, and Velonia."[2] Acorn-cap collecting on Kea is mentioned in 1718 by the traveler Tournefort who admired Valonia oak as Greece's most attractive oak.[3] Entire families gathered the acorn caps from late August until the first rains in November. Extensive stone storage houses remain at the ports of Kambi and Korissia where more than 1,000 tons were gathered and exported annually (specific data for Kea is not archived; the amount quoted here is based on 6% of national exports in 1934).[4] Acorn caps were graded into three categories, the earliest harvest fetching the highest price per kilo. "Hamada" refers to grade AAA caps that were beaten out of the trees still ripe and left to dry thoroughly resulting in a cleaner and lighter leather and fabric dye. Acorn caps became less valuable as the harvest days grew damper and the acorn caps darkened with precipitation.

1/ Kea Island (Greece).

During the second half of the 18th century and the beginning of the 19th century the best quality acorn caps were nearly the same price as wheat (acorn caps are of course not edible but the comparison is to give an idea of their value).[5] 14,000 tons of acorns caps were exported from Greece in 1934 according to Thodoros Veltitsas.[6] Only raw (or dry) caps were used by the leather tanning industry until the 1920s. Later, liquid extracts made in Mytylini and known under the trade name Tanoval replaced the use of raw caps. Until 1935 Mytylini alone processed 8,000 tons of liquid extract and dry acorn caps per year. Records show that from 1938 on, one Athens factory processed 4,000 tons of tanning extract per year and in Turkey three times more extracts were produced during the same period.[7] Chemical alternatives for leather tanning that appeared in the late 1960s brought a sudden end to this vital source of income for Kean farm families. In 2011, local senior residents report regarding the local oak trees with anger and resentment immediately following the abrupt halt in income from the forest fifty years earlier (personal communication from Natasha Blatsiou who is currently editing a Greek documentary about the revitalization of the acorn-cap harvest on Kea). Oak trees were subsequently disregarded and cut down in large numbers for fuel. Only a fraction of the largest and oldest oak stands survived. No evidence of the oak as a motif in ceramics or other decorative arts can be found despite the ancient origins of the forest on Kea.

In 2005, Stephanos Lepouros, then mayor of Kea, organized a two-day conference on the Kean oak forest to encourage interest and understanding of this rare Greek island phenomenon. Participants learned the names in the Kean dialect for the different sizes and shapes of acorn caps: *dimiti (Διμιτυ)* for the heavier and harder ones and *malliari*

2/ Acorns ready to be harvested.

(Μαλλιαρη) for the fluffier, lighter caps. *Dimiti*, generally regarded as superior, are sold by weight. Amongst other presentations Dr. Yiannakopoulou contributed an interesting paper on the export history of the products of the Kean oak forest.[8]

Eating acorns—past and present

In 1862, German botanist Theodor Von Heldreich mentions acorns being eaten, often raw, throughout Greece.[9] In 1920, *National Geographic* featured an article entitled "Acorn, A Possibly Overlooked Source of Food" which builds a strong case for eating the fruit of oaks.[10] Acorn as an abundant food source for humans has been of particular interest to me ever since I learned that many Native American tribes in Northern California processed and ate acorns until the middle of the 20th century.[11] "There seems to be no reason why acorn meal should not be a food of unsurpassed excellence for cows, stock hogs, all work animals, and probably for beef cattle." writes Russel in his 1929 survey of possible uses for tree crops.[12] He also made this rather interesting observation:

"Some factory may be giving us artistic boxes of acorn cakes under an attractive name. We need be surprised by nothing, now that the food factory has come. One man is now selling each week, one and one half million sandwiches made of peanut butter and crackers. A few generations ago the peanut was unknown. Then for a few decades it served as the pocket food of the socially unsophisticated while enjoying the circus or the horse race. Finally, some enterprising enthusiast took the peanut to the factory. Millions now eat the one-time lowly nut in its various dignified forms. Peanut butter and the salted

3/ The ground has been netted to receive the acorns.

peanut, have an established place at the American table. Will the acorn be next?"[13]

Conducting my own experiments with acorns—this widely misunderstood nut—has led to the charting of optimum steps for medium-scale acorn processing; implementing what I've learned and using as little fossil fuel as possible. I have been fortunate enough to live among *Quercus* for much of my life and the giant acorns from Valonia oak on Kea are by far the most satisfying acorns I've had the opportunity to work with. Greek botanist Kavadas in his *Plant Dictionary* states that Valonia oak is the sweetest of the Greek acorns.[14]

In May 2011 I launched an awareness campaign to promote understanding acorns as an additional, and often superior, food source for much of the planet. In May 2012 I spoke at the TEDxThessaloniki—The Courage to Create gathering about utilizing previously disregarded resources available, especially during an economic crisis.[15]

2013 is the first year local farmers had the opportunity to profit from acorn nuts in addition to the acorn caps. The largest nuts tend to be sweeter and some Valonia oak acorns on Kea need very little leaching before being processed into gluten-free flour. Acorn flour can be used in any bread recipe, replacing up to 30% of wheat or corn flour and in gluten-free recipes up to 100%. Acorn flour is used to make tortillas, pancakes, pasta, *dotorimuk* (Korean acorn jelly), vegetarian burgers, cakes and cookies. The Gluten-Free Food Department at the Technical University of Thessaloniki has conducted extensive analyses on acorn nutrients (based on samples I provided) the results of which will be published in 2014. Initial findings, reviewed in June 2013, point to an extremely rich source for anti-oxidants, potassium, magnesium, protein and high levels of phenols, all of which make acorn a very promising source of protein and starch for any diet. Acorn

nuts from Valonia oak have 7-13% fat content, so high-quality oil extraction is a viable possibility. Acorn-oil based bath and body products are currently being researched and developed. Possibilities for interesting and marketable products produced from acorn flour and acorn oil are seemingly infinite.

Hamada Acorn Initiative

In 2011 the first exportation of acorn caps, 12.5 tons, left Kea for a German leather tannery. The Kean Farmers Association assisted farmers in determining opportunities to sell acorn caps and oversaw their payment. George Voutsina, President of the Kea Farmers Association, is an active supporter of the oak initiative with a particular interest in supplementing animal feed with shelled acorn. In 2013 orders tripled and Kean acorn caps were shipped to Germany, Amfissia and India. Aside from the traditional leather tanning industry, acorn caps are now available for decorative purposes in mass quantities.

Creating income for farmers on Kea through reigniting the acorn-cap economy in a manner that respects and conserves the ancient oak forest also creates the opportunity to spread practical information about acorns as a daily food ingredient. The Hamada Acorn Center will open on Kea in Spring 2014 providing our current grant proposal in the framework of the Leader+EU initiative for sustainable rural development is approved. In addition to organizing the annual hamada acorn and acorn-cap harvest and developing new oak-based products, the Acorn Center will serve baked goods made with acorn flour, host regular seminars and school trips and continue sharing acorn knowledge. An Acorn Cookbook will be published by the Hamada Acorn Center as our acorn recipe archives grow.

Several innovative measures have helped encourage and promote the Hamada Acorn Initiative. Crowd funding provides seed money and has helped to purchase an industrial acorn huller, an acorn-cap mill and a solar-powered dehydrator. Through meetings, seminars, school activities and speeches in Greece and abroad we have distributed over ten thousand acorn cookies! The 2013 Acorn Festival in late October was the second annual celebration of the oak harvest organized by the Hamada Acorn Initiative. Festival highlights included an exhibition on the steps of processing acorn flour*, examples of leather tanned with Kean hamada provided by Kostantinos Merinopoulos & Son O.A. (Amfissa)—a traditional leather tannery, and now the only representative of this industry that used to be central to the Amfissa economy—decorative oak craft workshop for adults and children, a demo of the acorn huller for creating animal feed and “the golden acorn” treasure hunt as well as other activities for children. The Acorn Festival is unique in bringing local farmers, students and Kea Island holiday homeowners together in a multifaceted and informative day of oak and acorn celebration.

Harvest 2013

Kea’s oldest generation, who have clear recollections of the hamada harvests of their youth, have shared traditional oak harvesting practices with us. After the ground under the trees is netted, green acorns that are firmly attached to the acorn caps are hit, beaten, shaken and swatted off the branches. Harvesting begins in late September

* The Festival was on October 27 and just two weeks later on November 11, a local resident began selling his own homemade acorn flour on Facebook!

4/ Sorting caps and acorns.

and lasts through to the first weeks of November when the acorns and acorn caps fall, ripe and dry to the ground. Upon reaching the ground, the largest and sweetest acorns are almost immediately eaten and/or stored away by both wild and domesticated creatures (rodents, birds, beetles, donkeys, goats, sheep and pigs). Trees that have been identified as yielding optimum acorns should be carefully monitored to determine optimum harvest time. Heavy spring rains usually result in higher acorn set.[16] Valonia oak has a unique mechanism for adapting to extreme drought by shedding larger leaves and replacing them with smaller, lighter, hairier leaves for optimum photosynthesis abilities and water retention.[17]

Trees are ready to harvest when the acorn can be gently released from the acorn cap without tearing the acorn shell. Acorns display a range of colors, from pure green to green with increasing patches and bands of brown as they ripen. Green and light tan-colored acorns must be left to ripen in a warm, dry place. Wooden decks are ideal to absorb moisture but acorns will permanently dye any surface they come in contact with if they get wet. Acorns should be covered at night when there is high humidity and they should not be exposed to more than a few days of direct sunlight to prevent the oils from becoming rancid. Acorns are ready to store when the moisture level in the nuts reaches 10%. Acorns must be stored in a sealed, dry area, preferably in wooden boxes. When plastic crates are the only storage available, an unfinished piece of timber is buried in the center of each crate to absorb moisture. Crates can be filled with acorns to a depth of 20-25 cm/8-10 in and should be stacked in a manner that allows air to flow through the crates. Acorns can also be stored in clean water for months, preferably in stainless steel containers with enough cold water to

keep the nuts covered. All acorn nuts must be leached and dehydrated, including those stored in water, before they can go to the flourmill.

Medium-size trees 4-6 meters/13-20 feet in height with canopies of 5 meters/16 feet in diameter can yield 15-35 k/33-77 lb of ripe acorns and an equal amount of acorn caps. It is not unusual to gather 200-300 kilos/441-661 pounds of acorns and caps from 10-meter-/33-foot-tall trees. Allowing for loss of hull weight and acorns discarded due to infestation, flour production represents 60% of total weight at collection. Acorns on Kea are frequently infested by moths, beetles, mites, and most notably by *Balaninus glandium* (*Curculionidae*) and *Tortrix viridana* (*Tortricidae*). The pronymph of these insects eats the leaves while creating a web around the damaged leaves.[18]

5/ Hamada Acorn Initiative volunteers.

Highly motivated farm workers can collect 90-120 kilos/198-265 pounds of acorns and/or acorn caps in six hours. Volunteers collect an average of 40 kilos/88 pounds each in five working hours. Nine volunteers hosted over a six-week gathering period from September to November 2013 collected two tons of acorns and one ton of acorn caps. Comparing four-, five-, seven- and nine-person volunteer teams for acorn and acorn-cap harvesting, I have found that maximum efficiency is achieved with teams of no more than five people per medium-size tree: two or three to climb into the branches of the tree and the remaining workers to help sort acorns and caps into bags after they have fallen. Trees should be beaten lightly from inside towards the outside to avoid damaging the next cycle of acorn production. It is important to turn the acorn caps as they dry to avoid over heating and subsequent mold. Caps dried on rocky ground rather than on tilled soil are always considered superior. Kean caps, dried on flat rooftops, have always been considered by the leather tanneries in Greece as being the finest available hamada.

Obstacles and challenges

One in six oak trees never produces mature acorns but it is not understood why. Some Valonia oak trees consistently drop the young flowers and acorns and are almost always barren. X. Diapoulis, who studied this phenomenon, concluded that one or more of the following could be responsible: a species of *Loranthus* (semi-parasitic plants), incomplete development of the flower, or insufficient nutrients.[19] Kavadas hypothesizes that an autosterilization mechanism resulting from incompatible autofertilization in the tree may play a role.[20] The first small acorns are rejected early in the summer as the result of warm southern winds in June of each year.[21]

Another problem is that sometimes the scales of the caps become dark with surface

6/ Acorn chips being leached in fresh water.
7-9/ Marcie Meyer straining leached acorn chips that will be sent to the dehydrator.

dust, due to the presence of a resinous, gum-like fluid, called oak manna, a sugary substance produced by aphids, also known as *manna quersina* or *eichen Manna*.[22] It does not affect the tannins in the caps but can cause black spots during the tanning process.

Conclusion

Acorns and acorn caps can once again play an important role in the agricultural sector on Kea. The Hamada Acorn Initiative shares practical knowledge about cultivating, harvesting, processing, and cooking with oak nuts. Across the planet, our ability to transport food over long distances will drastically diminish during the 21st century. Nearly all *Quercus* produce edible acorns and they are widely distributed throughout the Northern Hemisphere. Spreading acorn knowledge, which was once so commonly held, is the first and foremost goal of the Hamada Acorn Initiative. In this way, we hope to

give new value to all *Quercus* and encourage people in their admiration and preservation of oaks everywhere. On Kea we have seen an entirely new attitude arise in only two years, one that takes into consideration the welfare of the trees. The oak forest and new farming possibilities are now regularly discussed on Kea and there is a general awareness that residents can once again look to the trees for sustenance and support. It is our hope that the Hamada Acorn Initiative serves as an example for others to create small- and medium-size facilities for processing acorns everywhere oaks are found.

Hamada Acorn Initiative Timeline

August 2011: 1st Kickstarter Project raises $10,777. *http://www.kickstarter.com/projects/acorns/eating-acorns*
October 2011: 1st Acorn Cap hamada harvest since 1965.
October 2011: 1.5 tons of acorns collected and stored for processing into gluten-free baking flour.
November 2011: Industrial acorn huller imported from Southern Turkey.
March 2012: 12.5 tons hamada exported to Germany by Kean Farmers Association* at 0.47 €/k.
May 2012: Hamada Acorn Initiative featured at TEDxThessaloniki.
July 2012: 2nd Kickstarter Project raises $18,004.
http://www.kickstarter.com/projects/acorns/mighty-acorn-mighty-oak
October 2012: NO acorn harvest—all trees barren.
October 2013: 4 tons of acorns collected, bought and stored for processing into gluten-free baking flour and cold-pressed acorn oil.
November 2013: 1st time acorns purchased on Kea at 0.25 €/k.
November 2013: A 43,000 € ESPA grant awarded for acorn cookie processing tools and machinery.
November 2013: Hamada mill purchased by Marcie Mayer for the Kean Farmers Association to obtain the Merinopoulos contract.
December 2013: 3rd Kickstarter Project launched to raise funds to open the Hamada Acorn Center on Kea.
http://www.kickstarter.com/projects/acorns/the-acorn-center
December 2013: 40 ft container of hamada (approximately 11 tons) exported to India at the price of 0.50 €/k.
February 2014: Merinopoulos contract, 2 tons of hamada in powder form at 0.78 €/k.
March 2014: 25 tons of hamada exported to Germany at 0.50 €/k.

*All hamada exports from the island of Kea are overseen by the Kean Farmers Association.

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Photographers. Title page: Marcie Mayer (the magnificent acorn of the Valonia oak). Photos 2, 5: Marcie Mayer. Photos 3, 4, 6-9: Kostis Maroulis.

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For more information about processing acorns and acorn recipes please visit: www.iloveacorns.com

Searching for the Hardy Southern Live Oak

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ABSTRACT

It's no secret that individual plants within a species can show variation in both morphological and physiological characteristics, winter hardiness being one of the latter. When adding accessions, we want to capture as much variation as possible within a species, so we often collect from multiple populations within a species' range. This is standard practice for species in our core, or high-priority, collections that are already well adapted to our local arboretum conditions. However, for species that are not typically winter hardy in our climate, we must seek specific provenances that may hold hardier populations. One of those marginally hardy species that has evaded our grasp so far is the southern live oak (*Quercus virginiana* Mill.). In their combined 260 years of acquiring and testing species from all over the temperate world, the Arnold and Morris Arboreta have made only a handful of attempts to grow *Q. virginiana*. In fact, the Arnold Arboretum never even tried to cultivate the species. We feel there is potential to grow this species in our collections, or at least make the attempt. For one, our average annual minimum temperatures have risen because of climate change and urban heat island effects. This article recounts our short trip from October 20 to 24, 2012 to collect germplasm from the species' most northerly natural populations in Virginia.

Keywords: *Quercus virginiana* Mill., hardiness, Arnold Arboretum, Morris Arboretum

1/ Botanical illustration drawn by Charles Faxon (taken from *The Silva of North America* by Charles Sprague Sargent).

Introduction

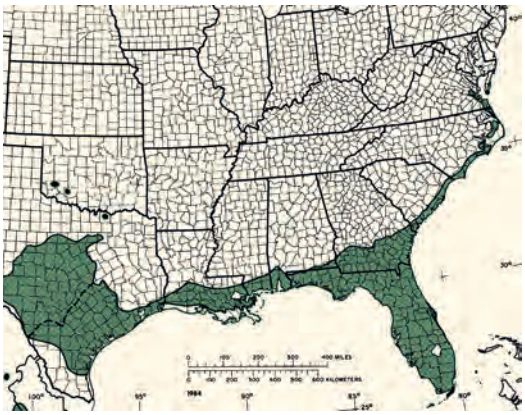
It's no secret that individual plants within a species can vary in appearance—just peruse the range of Japanese maples (*Acer palmatum* Thunb.) for sale at your local nursery. All belong to a single species, yet show diversity in traits like growth habit, foliage color, and leaf shape. It's also old news that individuals can vary according to provenance (geographic source); winter hardiness is frequently noted as one of those variable physiological traits. Although he was not the first to note this phenomenon, botanist and plant explorer Joseph Hooker provided an early description in 1853. In an introductory essay preceding his notes on the flora of New Zealand, he described differences in the hardiness of Himalayan plants, "depending upon the altitude at which they were gathered." Specifically, "some of the seedling Pines whose parents grew at 12,000 feet appear hardy, whilst those of the same species from 10,000 are tender. The common scarlet *Rhododendron* of Nepal and the North-west Himalaya is tender, but seedlings of the same species from Sikkim, whose parents grew at a greater elevation, have proved perfectly hardy." A few years ago, we wrote about C.S. Sargent's interest in acquiring cedar of Lebanon (*Cedrus libani* A. Rich.) germplasm that would prove to be hardy in Boston (Aiello and Dosmann, 2007). He succeeded by obtaining seeds from Turkey, and those plants and others from that region have fared notably well in Philadelphia and Boston as well as in colder climes, while accessions from other provenances have failed.

The cedar of Lebanon story points out the ongoing importance of plant exploration, a vital component of the missions of our respective arboreta. When adding accessions, we want to capture as much variation as possible within a species, so we often collect from multiple populations within a species' range. This is standard practice for species in our core, or high-priority, collections that are already well adapted to our local arboretum conditions. However, for species like *C. libani* that are not typically winter hardy in our climate, we must seek specific provenances that may hold hardier populations.

One of those marginally hardy species that has evaded our grasp so far is the southern live oak (*Quercus virginiana* Mill.) whose massive, gnarled form—often draped in Spanish moss (*Tillandsia usneoides* (L.) L.)—conjures up images of the antebellum South. This oak often exceeds 50 feet/15.2 meters in height, but it is the spread that typically draws our attention. Almost always wider than tall, the colossal sweeping branches of old trees are a marvel. The common name "live oak" refers to the typically evergreen leaves, stiff and shiny on the top, gray and tomentose on the bottom. However, during particularly cold spells the species may shed some of its leaves and is regarded as brevideciduous. Tolerant of drought, soil salinity and salt spray, southern live oak is often categorized as a "tough plant" aside from winter hardiness issues.

The quest begins

In their combined 260 years of acquiring and testing species from all over the temperate world, the Arnold and Morris Arboreta have made only a handful of attempts to grow *Q. virginiana*. In fact, the Arnold Arboretum never even tried to cultivate the species. To its credit, the Morris Arboretum did make the attempt, with *Q. virginiana* acorns received in the mid-1950s as part of the ambitious Michaux Quercetum project. Acorns from several collections germinated and were planted in the oak nursery, but none of these survived to be grown on because, "mortality during the first winter [in the



2/ The native range of *Quercus virginiana* (taken from *Silvics of North America,* USDA Handbook 654).

nursery] was extremely high, and no trees survived the second winter" (Santamour, 1960). With this history at both Arboreta, we remained determined that it would be worth the effort to document and collect from trees that, like the special provenance of *C. libani* in Turkey, might be hardy for us in our respective regions.

Southern live oak is native to the Southeastern United States, with a range that extends from central Texas (plus a few populations of the closely related *Q. fusiformis* Small in Southwest Oklahoma) all along the Gulf Coast and Florida peninsula, turning northward to follow the coasts of Georgia, South Carolina, North Carolina, and Southern Virginia. Flint (1997) noted that while the species' useful range as a landscape plant is USDA Zone 8b (average annual minimum temperature 15 to 20 °F/-9.4 to -6.7 °C), it can tolerate colder extremes like Zone 7b (average annual minimum temperature 5 to 10 °F/-15 to -12.2 °C) but is unlikely to reach its full size (or be functional, from a horticultural perspective) because of ice and snow damage. Recent research from the lab of Jeannine Cavender-Bares at the University of Minnesota has yielded interesting information on its ecology. Her lab found that *Q. virginiana*, like many other temperate species, varies in leaf and stem hardiness as a function of latitude: the more northern populations possess greater hardiness (Cavender-Bares, 2007; Cavender-Bares et al., 2011; Koehler et al., 2012). In these studies, the lowest temperature that plants were exposed to (and survived) was 14 °F/-10 °C, which is still warmer than the average annual minimum temperatures found in Philadelphia (0 to 5 °F/-17.8 to -15 °C) or Boston (-5 to 0 °F/-20.6 to -17.8 °C).

We feel there is potential to grow this species in our collections, or at least make the attempt. For one, our average annual minimum temperatures have risen because of climate change and urban heat island effects. These changes are reflected in the current version of the USDA plant hardiness zone map (http://planthardiness.ars.usda.gov/PHZMWeb/) that places the Morris and Arnold Arboreta in Zones 7a and 6b respectively. Although this hardly places us in the banana belt, it warrants an attempt to grow *Q. virginiana*. Also, the northernmost population sampled by Cavender-Bares was from Goose Creek State Park, North Carolina, where notably cold temperatures have occurred (down to 9 °F/-12.8 °C in 1904). Surely if these populations survived that weather event, they likely possess greater hardiness than was indicated in experimental testing. Lastly, our review of various checklists, atlases, and other resources revealed that natural populations could be found around Norfolk and Virginia Beach, Virginia, (particularly First Landing State Park), as well as a few points northward—over 90 miles/145 kilometers north of the Goose Creek sampling sites.

We wanted to collect germplasm from the most northerly natural populations in Virginia. Because some of these populations are near (or even within) urban areas, it is especially important to collect acorns and grow the seedlings elsewhere in case these populations become threatened by development in the future. During our planning, we also learned of notable trees that were either remnant natural populations or planted specimens that

had survived frigid winters. These included old specimen trees growing in Hampton and Williamsburg (where it reached -7 °F/-21.7 °C in 1985), and Richmond (-12 °F/-24.4 °C in 1940). Even if these trees were planted (and therefore did not represent a wild source), their potential hardiness makes them valuable. And for a few of them, their extreme age suggests they were derived from now extirpated local populations.

3/ Tony Aiello measures the diameter of one of three mature southern live oak specimens growing in Bryan Park.

To Richmond

Our short trip from October 20 to 24, 2012 to explore the Eastern Shore of Virginia started in Richmond and finished in Virginia Beach. Our first collection site was the campus of the University of Richmond. Using directions provided by Professor of Biology John Hayden, we were able to easily find the various specimens, many of which had been planted in the last few decades. Although we had seen the occasional *Q. virginiana* before, this site gave us our first chance to really observe the species in depth. Our first two collections were from trees growing near Westhampton Lake. The first tree, rounded and spreading in form, was about 15-feet/4.6-meters tall and twice as wide; we estimated that it had been growing in that location for 10 to 15 years. And it was loaded with acorns, most with bright yellowish-green nuts and tawny-brown caps.

However, a few had started to turn the typical mature color, a rich burgundy brown. The branches were dense, with short internodes, and thickly set with oblong to oval, leathery leaves. Considering their form and (brevi)evergreenness, we thought they would make great screens. As was our protocol for the entire trip, we gathered germplasm in the form of acorns, made herbarium vouchers from cut twigs (complete with the acorns), and of course jotted down copious collection details that pertained to the trees as well as to the local conditions and environment. The second collection was from a nearby tree, smaller and younger than the first, but similar to another six growing nearby. Before leaving the University, we located and collected from two trees, older than the first, which were growing near a dining hall.

Our next destination—after an amazing lunch at Buz and Ned's BBQ—was Bryan Park, a historic Richmond landscape founded in 1910. We expected to find small, rounded trees similar to those we had found at the University earlier in the morning. However, what we in fact found were three very large individuals, just down the hill from the Gatekeeper's House on the park's northeast side. Heights ranged from 30 to 40 feet/9.1 to 12.2 meters; each was rounded, usually twice as wide as tall, and with gnarled, twisting stems and branches. Only two of the trees (with dbh values of 35 and 39 inches/89 and 99 centimeters, respectively) bore acorns. Although we do not have any records to confirm this, based on their size we assume that the trees date back to the founding of Bryan Park and approach the 100-year mark. If so, they certainly would have survived the frigid winter of 1940.

To Williamsburg

We departed Richmond in the early morning of October 22, and by 9:00 a.m. arrived at our next destination: the College of William and Mary in Williamsburg. Beth Chambers, curator of William and Mary's Herbarium, was a great help to our efforts. Prior to our arrival, she scouted the numerous southern live oaks on campus, and even collected a few acorns in case there were none to be had by the time we arrived. She also accompanied us during collecting, providing assistance as well as anecdotes about the trees and buildings of this historic campus and neighboring colonial village. There were numerous southern live oaks planted on the campus, and their history dates to even before the founding of the University in 1693. The Corner Live Oak, a famous tree on campus, had served as a prominent boundary marker until its removal in 1943. Its age was estimated to be about 300 years at that time. Prior to its removal, acorns were collected and the progeny were planted around campus, including a prominent line along Landrum Drive (Mathes, 1992).

4/ *Quercus ×comptoniae* with a 100-ft/30.5-m crown spread growing in Williamsburg.

The southern live oak legacy

is also preserved in an 1836 watercolor of the Wren Building, a prominent campus edifice named after the famous architect Sir Christopher Wren, who may have designed it. When we arrived at the Wren Building, we were greeted by a towering *Q. virginiana* on the southeast corner. Although it had few accessible acorns, just to the east were several other large trees, the tallest nearly 40 feet/12.2 meters in height. We collected seeds and vouchers from three of these specimens, two of which appear in a photograph from about 1875 (http://www.history.org/foundation/journal/Winter11/old_williamsburg/#3). We speculated that the trees planted throughout the campus were likely of regional origin, perhaps having originated from populations occurring naturally to the southeast of Williamsburg.

A number of trees also grew off campus, in the Colonial Williamsburg section of town. We made two additional collections from these town trees, and also made the interesting discovery of the Compton oak, *Q.* ×*comptoniae* Sarg., a hybrid between *Q. virginiana* and *Q. lyrata* Walter (overcup oak). We ascertained its identity from Terry Thon, a basket maker for Colonial Williamsburg, who has been routinely collecting acorns from it for years. This tree was an impressive specimen with a dbh of 60 inches/152.4 centimeters) and a spread of 100 feet/30.5 meters, and we were anxious to make a collection too.

5/ Michael Dosmann at the base of the Algernourne Oak at Fort Monroe.

The oaks of Fort Monroe

During the trip's planning stage, Michael Dosmann spoke to Christopher Beagan of the National Park Service's (NPS) Olmsted Center for Landscape Preservation. Christopher described the amazing oaks of Fort Monroe and insisted that we visit this population and

others near Hampton. He put us in touch with one of his NPS colleagues, Eola Dance, who is the Chief of Visitor Services and Resources Management at the Fort. We were thankful for the lead!

Perched at the ocean's edge, the Fort has a rich history that dates to the early seventeenth century. It had been occupied by the military until its recent decommissioning in 2011, and it is now a National Monument. The massive six-sided stone structure is the largest of its kind in North America: 63 acres/25 hectares of land surrounded by walls and an impressive moat. Construction of the current Fort took 15 years to complete and the final phase (finished in 1843) was overseen by Robert E. Lee. In an ironic twist, such was its fortitude that it was never lost to the Confederacy.

We arrived in the late afternoon of the 22nd to meet Eola, who enthusiastically showed us around the facility and explained some of its fascinating history. We also returned on the morning of the 24th to visit with her, as well as Joshua Gillespie and Robert Kelly of the Fort Monroe Authority. Inside the buttressed edifice we found a composite of former army barracks, period officer quarters, office and training facilities, storage buildings, a chapel, and a museum, as well as nearly 350 southern live oak specimens scattered throughout. Perhaps the most impressive is a large grove that grows along the south and west edge of the interior parade ground. Some trees stood as lone sentries, while others grew in small groups, sometimes arching over the sidewalks and defying gravity. Most were no taller than 35 to 40 feet/10.7 to 12.2 meters, and all had dramatic, ethereal forms, the result of decades and even centuries of difficult environmental conditions including drought, intense heat, and salt spray (even inside the Fort's walls). No doubt, the grandest of these was the Algernourne Oak, a leviathan estimated to be over 450 years old. This tree has a basal diameter of 90 inches/228.6 centimeters, with two massive leaders diverging about 3 feet/0.9 meters above the ground. True to the species' form, the tree's height is around 60 feet/18.3 meters, but its spread is nearly 100 feet/30.5 meters.

The acorns on all the oaks at Fort Monroe were few and far between, so we collected only herbarium vouchers from this representative population. We assumed that these trees produced few acorns because of the exposed, hot and dry location and the droughty summer. That same exposed and hot nature of the Fort is probably the reason these trees still exist. People needed shade, and because few other trees were capable of growing in such an environment, this remnant natural population was left in place and even allowed to regenerate (perhaps with a bit of assistance from the local inhabitants). Standing in the parade ground, we imagined ourselves dressed in full uniform, performing drills and marching for hours under the hot sun and dry, salty breeze—those trees would be considered sacred! The trees were in remarkably good condition considering their age, size, and the heavy impact of human activities on the site. Many of them showed the marks of time but they were mostly healthy and growing well, a testament to the resilience of southern live oaks.

First Landing

We dedicated the 23rd to surveying the flora of First Landing State Park, which lies on Cape Henry between Norfolk and Virginia Beach. Its current name, changed from Seashore State Park in 1997, acknowledges this site as the location where the Virginia Company first landed in 1607 prior to settling Jamestown. The park covers about 3,000 acres/1,214 hectares and comprises eight upland plant community types that range from

6/ Southern live oaks and sea grasses growing along the dunes of First Landing State Park.

dune crests to mesic forests (Clampitt, 1991). Our initial foray was into the mesic forests where several of our non-oak collecting targets were to be found: devilwood (*Osmanthus americanus* (L.) Gray*) and swamp bay (*Persea palustris* (Raf.) Sarg.). Like southern live oak, these two species of shrubs or small trees are near or at their northernmost ranges in Virginia. And, for reasons similar to our quest for hardy southern live oak germplasm, we were anxious to locate and collect from these species.

Finding them was quite easy thanks to our earlier planning conversations with Erik Molleen of the Virginia Department of Conservation and Recreation; the fact that there was an Osmanthus Trail in the park was also helpful. *O. americanus* specimens were numerous and scattered throughout the understory. They became easy to identify from a distance because their glossy green leaves are arranged oppositely, as with other members of the olive family (*Oleaceae*). At the Arnold Arboretum, this species has proven to be quite a challenge to cultivate because of cold hardiness issues. One clone, a cultivated lineage from Spring Grove Cemetery in Cincinnati, Ohio, has been reliably hardy in Boston. Likewise a plant at the Morris Arboretum has survived but not thrived since they received it from a local nursery in 1962. Wild-provenance material has long been a target because of the species' botanical and ornamental appeal. Its broadleaved evergreen foliage provides winter interest, and the small, creamy-white flowers in spring are a delight to the nose; their mellic scent beckons from great distances! We were able to collect fruits—bright green drupes at this stage—from many trees in the woodland.

Persea palustris also dotted the understory, and, like devilwood, has large, elliptic, evergreen leaves. However, the leaves are coarser in texture and borne alternately in

* Now sometimes separated as *Cartrema americana* (L.) G.L. Nesom.

this member of the laurel family (*Lauraceae*), and the fruits (also drupes) were an eye-catching purplish blue at this stage. With only a bit of imagination, it is easy to see the kinship to *P. americana* Mill. the avocado. However, with drupes less than ½ inch/1.4 centimeters long, they wouldn't yield much guacamole.

7/ *Quercus incana* grows with *Q. virginiana* on the sandy shoreline of First Landing State Park.

Many other plant species caught our eyes. Sand hickory (*Carya pallida* (Ashe) Engl. & Graebn.) grew in and along the higher ridges. This species was also on our target list, but there were very few fruits to be found; those we did stumble upon were on the ground and of poor quality. While scouring the ground, it was a treat to see Indian pipe (*Monotropa uniflora* L.), the nodding white flowers and stems appearing like dancing apparitions among the pinecones. Looking up, we noticed many leaves of sourwood (*Oxydendrum arboreum* (L.) DC.) at their peak for autumn color, the brilliant reds and oranges echoed in the near-spent needles of bald cypress (*Taxodium distichum* (L.) Rich.). These bald cypress trees were impressive, conjuring up images of great swamps, and yet we were only a few hundred meters from sand dunes and the ocean (a reminder of how quickly landscapes change). Because the water level was down considerably, their buttressed trunks and knees were exposed to reveal an amazing network of lignified stalagmites. Throughout the woodland landscape, Spanish moss draped across the limbs and branches like overloaded Christmas tree tinsel. As with southern live oak and devilwood, Southeast Virginia marks the northern edge of the native range for this rootless member of the pineapple family (*Bromeliaceae*).

After a brief lunch, we explored the shoreline of First Landing, a strip considerably different than what we saw in the morning. The morning site was lush and diverse, but this sandy strand was quite the opposite. Oaks—primarily southern live oak but also some bluejack oak (*Q. incana* W. Bartram)—dominated this landscape to create a band of dense vegetation that was pruned by the salt-laden winds into interesting forms and habits. As we had seen with the cultivated plants, the live oak trees were wider than tall (but rarely over 20 feet/6.1 meters in height) and frequently had multiple stems and a low-branching form. One of the larger trees we found had three stems measuring 12.5, 17, and 21 inches/31.8, 43.2, and 53.3 centimeters in diameter at 12 inches/30.5 centimeters above the ground. Despite the stressful environment, trees were healthy and there was noticeable regeneration of young seedlings in the understory, which is always a good sign. Rather than focus on individual trees at this site, we maximized the amount of genetic variation in the collection by gathering acorns from 12 trees. Some trees were so fecund and at perfect ripeness that we could easily shake the branch and scores of acorns would drop from their caps.

8/ Will they prove to be hardy in Philadelphia and Boston?

Next steps

Although the fieldwork is complete, the data in the databases, and the herbarium specimens mounted, much work remains ahead of us. Each of our institutions has had great success in germinating the seeds from the various collections made on the trip—12 separate *Q. virginiana* collections, plus one each of the *Persea*, and *Q.* ×*comptoniae*. The oaks germinated immediately and as of the time of this writing are experiencing their first winter outside the comforts of our warm propagation greenhouses. At the Morris Arboretum the seedlings are in a poly-house that is heated to approximately 34°F/1°C. At the Arnold Arboretum the seedlings are overwintering in several places: about half of each accession's seedlings was planted into the seedling nursery, exposed to the elements, while the others are overwintering in containers in the cold storage unit, which is maintained at a temperature of 33 to 36 °F/0.6 to 2 °C. The live oak seedlings show great variability in their vigor and growth rates, but little variation in leaf morphology—among the dozens of seedlings we have observed only one or two possible hybrids. Not surprisingly, the Compton oaks have shown great variation in leaf shape, as would be expected from open-pollinated seedlings from a naturally occurring hybrid.

We plan to try several different methods to successfully coax the oaks into cultivation. For starters, we captured a wide swath of variation during our trip—one never knows just which germinating seedlings from which populations will be the ones to survive. Because young plants are less cold hardy than older ones, we plan to hold some seedlings in containers for a few more years before planting them into nurseries. And, because

each of our Arboreta has microclimates that are warmer than our nursery areas, we also plan to plant some young plants directly into those microclimates, skipping the nursery altogether. We do not expect to see the results of this project for many years, but hope that in the future we will be fortunate enough to have graceful live oaks enhancing both of our Arboreta.

Photogaphers. Title page: Anthony S. Aiello (*Quercus virgniana* acorn). Photos 3, 5, 8: Michael S. Dosmann. Photos 4, 6, 7: Anthony S. Aiello.

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The Hybrid Oak That Time Forgot: *Quercus ×coutinhoi* Samp. Discovered in Australia

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ABSTRACT

Located in a small farm paddock grazed by merino sheep for over one hundred years is a small group of selected European trees. They were planted around 1900 under the direction of the Head Gardener Thomas Leslie on behalf of the owner of one of South Australia's most influential and significant pastoral properties, Anlaby. This article deals with one of the two hybrids found to date on this property, *Quercus ×coutinhoi* Samp. The presence of hybrids in Australia has a long history with introductions from both wild and cultivated sources from around the world and from Australian collections. Their prevalence in Australia has complicated the process of identification. Discovering a hybrid that has never been reported in cultivation in Australia extends our botanical knowledge and attracts our historical attention, while we stop to simply admire its presence. Such is the case for *Q. ×coutinhoi* discovered in April 2013. Its identification opened a new pathway of historical research on the cultivated oaks of Anlaby in South Australia's Barossa Valley.

Keywords: Anlaby, oak hybrids in Australia

Introduction

In October 2012 while I was concluding a research project on some stone pines (*Pinus pinea* L.) in Adelaide, South Australia, friends invited me to visit an old pastoral property in South Australia's Barossa Valley owned by friends of theirs. They were very keen for me to see the trees on the property and gauge my opinion. After an introduction to the owners and a walk around the main garden and some of the "outer" areas we sat down for lunch. I was then asked for my opinion about the trees I saw during the walk. My response was very direct and simple: "This property has native and exotic trees worthy of nomination to the Significant Tree Register of the National Trust of South Australia." This statement was the beginning of a yearlong journey of discovery, research and registration that became known as The Anlaby Heritage Tree Project. The number of specimens, the species diversity, the history of the property and the stories which the heritage trees remaining on the property have revealed have astounded all those who were involved in the project. One of the great finds of this research project was the discovery of Australia's first identified specimen of a mature *Quercus ×coutinhoi* Samp.

Anlaby history (1839-1914)

Present day Anlaby is the oldest merino stud in existence on mainland Australia. Located 101.38 km/63 mi north of Adelaide, it currently comprises 202.34 hectares/500 acres, just a small fraction of its historical dimensions of 64,749.70 hectares/160,000 acres (40.23 km /25 mi long by 16.09 km/10 mi wide or 647.30 km^2/250 mi^2).

1/ Grazing merino sheep at Anlaby.

The genesis of this merino stud is due to Frederick Hansborough Dutton (1812-1890), the third son of Frederick Hugh Hampden Dutton, British Vice-Consul and Agent for Packets at Cuxhaven, Germany. Frederick Hansborough arrived in Sydney in March 1830 with his older brother, William Hampden Dutton (1805-1849) and in 1832 they went into partnership in sheep at Yass, New South Wales, and later in the Monaro District. In 1838 Frederick and William arrived in Adelaide. After different business ventures with cattle and sheep, Frederick took up a sheep run known by its native name of Pudna. He renamed it Anlaby after the Yorkshire home of his sister Charlotte's husband, Richard Cankrein.

Frederick's first overseer was his younger brother, Francis Stacker Dutton (1818-1877), who had arrived in January 1840 to assist their older brother, William in his pastoral and business ventures in the Colony of Port Phillip. Frederick and Francis thrived in South Australia and Anlaby grew from its original 49-hectare/120-acre run to 28, 327 hectares/70,000 acres of freehold. The sheep flock of 20,000 grew to some 60,000.

The Anlaby merino bloodline dates back to 1838 when Frederick bought 5,000 mixed sheep from New South Wales to stock his Koonunga Run and then transferred them to Anlaby in 1841. From 1852 onwards he imported purebred Rambouillet and Saxon rams of Spanish bloodlines from Spain. This original connection with Spain through sheep was to have important consequences for the gardens and plantings at Anlaby, as we will see later.

Frederick never resided at Anlaby and later retired to England making only periodic visits to Australia. He died in 1890 unmarried with no children of his own. He bequeathed Anlaby to his nephew, Henry Dutton, the only surviving son of his older brother William Hampden Dutton.

Henry Dutton (1848-1914) was born in Victoria and educated at St. Peter's College. He was working at the Bank of South Australia when news of his inheritance reached him. He took up residence at Anlaby in 1890 and in the twenty-four years he owned the property he greatly extended this pastoral empire while his business empire also grew considerably. Henry's principal recreation apart from extending and improving the gardens of Anlaby was yachting. At the turn of the 20th century he was the owner of the Adele a 350-ton, 42-meter/140-foot long steam yacht designed for extended cruising by Alfred H. Brown, the noted naval architect of London and built by Messrs. Hawthorn & Co., Ltd., the well-known engineers and ship builders of Leith. Henry cruised around Australia and the world in this yacht. His big game hunting expeditions to southern Africa resulted in many head trophies in the homestead. But, more importantly for this story certainly, his Head Gardener, Thomas Leslie, accompanied him on many overseas expeditions to collect plant specimens and seeds.

He visited Spain to view and purchase the merino stud sheep that he was importing for the Anlaby merino breeding program, continuing what his uncle, Frederick Hansborough Dutton, had started in 1852. Part of the historic rose collection at Anlaby was an extensive collection of Spanish-bred rose cultivars and species like *Rosa sempervirens* L. from Spain and south Portugal where *Q.* ×*coutinhoi* and its parents are also found. There are some old specimens of this evergreen rambling rose species still growing on the property. There is a dry grown specimen of *Buxus balearica* Lam. or Balearic box growing in the plantation area behind the main garden. ("Dry grown" refers, in Australia, to trees/shrubs planted and watered for the first summer or two and then left to their own devices to survive.) It is growing on the edge of the outer canopy of an Algerian Oak (*Q. canariensis* Willd.). Both of these species are native to southern Spain.

2/ The Anlaby *Q.* ×*coutinhoi,* with Dave Moyle for scale.

Henry Dutton improved and extended the main residence, built houses for farm managers and workers, developed and extended the tree collection. Thomas Leslie was employed as Head Gardener to maintain and develop the gardens and landscape of Anlaby in the European colonial style so typical of Australian gardens of the time, planting large European and exotic trees in the outer lands surrounding the main residence and garden. This type of planting enhanced the "English parkland" appeal of the vast tracts of outer farmland. Many exotic trees were used for this purpose, such as oaks, poplars and elms. Henry built extensive trellises, pergolas and several shade houses and conservatories. He was widely respected, honored and became known far and wide as the Squire of Anlaby. Henry opened his garden one day a week to the public so that they could picnic on the lawns and appreciate its beauty and seasonal appeal. He died on August 25, 1914 and bequeathed Anlaby to his only son, Henry Hampden Dutton.

The oak that time forgot

In November 2012, during my first research visit to Anlaby I had noticed a mysterious oak towards the end of the outer farm paddock. At the time, my assistant and I were measuring and collecting data on the hybrid *Q. canariensis* Willd × *Q. robur* L. As it had been a long day in the searing South Australian heat and we were tired, dehydrated and hot, I decided to end the day, agreeing with my assistant that this other mysterious oak would have to wait for another visit.

It was in late April 2013 during a week at Anlaby to document a selection of heritage trees for the National Trust of South Australia's Significant Tree Register that I finally returned to this mysterious oak. A close look at the acorns and leaf morphology told me that I was looking at another hybrid. The leaves had the auricular basal lobes of *Q. robur* L. but the angles of the marginal lobes were very unusual and the acorns were long and narrow unlike what I had seen before for *Q. robur.*

I submitted specimens of foliage and acorns to botanist, Dr. Roger Spencer on Monday, April 29, 2013, at the National Herbarium of Victoria, Royal Botanic Gardens, South Yarra, Melbourne. On Monday, May 6, 2013 Dr. Spencer sent an e-mail indicating that the leaf characteristics, auricular leaf bases, long peduncles and long, narrow acorns and acorn cap pointed to a hybrid of *Q. robur* and, perhaps, *Q. lusitanica* Lam. But we were both dubious of this parentage because *Q. lusitanica* is a low shrub or prostrate plant rarely reaching 1-2 m/3.3-6.6 ft in height. He advised me to seek a second opinion from an oak expert in the United Kingdom.

On Monday, May 6, 2013 I sent an e-mail to the International Oak Society in search of a second opinion for the identification of this hybrid. On Tuesday, May 7, 2013 Béatrice Chassé answered me suggesting I contact Mr. Allen Coombes, the Curator of Scientific Collections of the Botanic Garden and Herbarium of the Benemérita Universidad Autónoma de Puebla, (Puebla, Mexico). I sent an e-mail that night. At 3.03 a.m., Wednesday, May 8, 2013, I received an e-mail from Mr. Coombes with a clear botanical identification and confirmation that this specimen from Anlaby was indeed a *Q. robur* hybrid as Dr. Spencer thought but that the other parent was *Q. faginea* Lam. not *Q. lusitanica.* Mr. Coombes confirmed that he had identified the same hybrid, *Q. ×coutinhoi*, at Bob Berry's Hackfalls Arboretum in New Zealand. Described in 1910, its

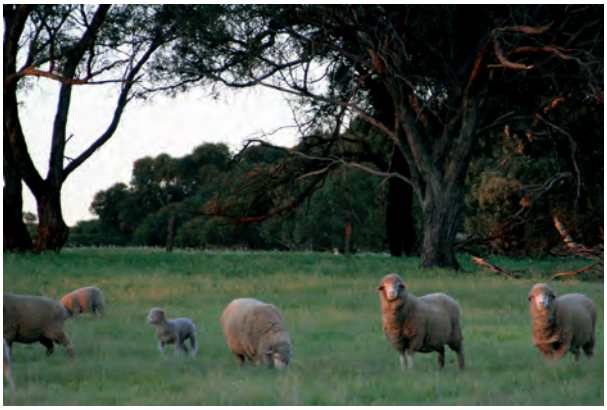
3/ Foliage, adaxial surface.

4/ Foliage, abaxial surface.

distribution range is in Portugal and Spain and it is a naturally occurring hybrid where its parents are sympatric.* He recommended depositing specimens in a reputable herbarium. Thanks to Dr. Spencer these specimens, the first in Australia from a mature specimen, are now part of the National Herbarium of Victoria.

The Anlaby Q. ×coutinhoi

Circumference (of trunk at 1.3 m/4.3 ft above ground level): 3.2 m/10.5 ft
Canopy spread: east-west: 21.2 m/70 ft / north-south: 19.5 m/64 ft
Height: 14.1 m/46.3
Date Measured: April 23, 2013
Measured by: Charlie Buttigieg (Heritage Tree Researcher) and Dave Moyle (Assistant)
Estimated Age: 113 years
(Or date planted if known): circa 1900
Planted by: a gardener under the instruction of Thomas Leslie, the Head Gardener to Henry Dutton
NTSA Registration Number: 761



5/ Grazing merino sheep at Anlaby.

Discussion

The Anlaby *Q.* ×*coutinhoi* is the first formally identified specimen of this oak hybrid officially recorded in Australia by the National Herbarium of Victoria. Its identity has been confirmed by Mr. Allen Coombes and herbarium specimens are now a part of the National Herbarium of Victoria. The maturity and size of this specimen, planted around 1900, is unique.

It is an outstanding specimen as much for its age, size, and uniformity of canopy, as for its health and vigor. These attributes are even more astounding when one observes the hot, dry, and wind-swept conditions this specimen is growing under. There is no artificial irrigation or protection from the onslaught of the elements and natural cycle of floods and droughts—so characteristic of rural Australian landscapes. Its uniform canopy structure and spread has withstood the battering of over one hundred years of weather extremes. Its size is far greater than what it grows to in its natural habitat.

Q. robur was widely planted in Southeastern Australia in the 19th century. However, *Q. faginea* was and still is a relatively rare oak species in this country. Few old specimens from the 19th century exist. The likelihood of the Dutton family or their Head Gardener accessing such hybridized material from within Australia is low. Such hybrids were not known or understood at the time. This hybrid was first described in 1910 and Henry Dutton died in 1914. As mentioned previously, Henry Dutton, like his uncles before him, had strong links with Spain and, with his Head Gardener, collected many plants and trees

* J.M. Aparicio and P.M. Uribe-Echebarría, Presencia del roble pedunculado (*Quercus robur* L.) en la provincia de Castellón, *Toll Negre. Revista de actualidad cientifica*, 2005. 5: 5-11.

6/ Bark texture on main trunk.

native to that region of the Mediterranean. Therefore, it seems likely that Thomas Leslie collected acorns from a *Q. faginea* population that had been pollinated by *Q. robur.* And one hundred years later one of these acorns has produced a magnificent *Q. ×coutinhoi.*

The use of oaks is indicative of a historic planting style. Oaks were commonly planted in the 19th and early 20th centuries for functional and aesthetic reasons. They were used

as excellent feature trees, to line avenues, for wind hedges, as stock protection barriers and in commemorative plantings. This specimen was planted to help create an English parkland in the agricultural land immediately surrounding the main residence and garden at Anlaby. As it grew it also provided shade and protection for the merino sheep flocks that grazed the pastures. Wooden posts and railings, installed when the tree was planted to protect it from grazing sheep stock, are still present near the main trunk.

Conclusion

The mature specimen of *Q.* ×*coutinhoi* discovered at Anlaby in South Australia's Barossa Valley is the source of the herbarium specimen by which all future specimens of this oak hybrid will be compared for identification purposes in Australia. This is probably not the only specimen of this hybrid in Australia. I believe many more specimens, both mature and newly planted, are yet to be identified and documented. The introduction of oaks in Australia during the 19th century is a very convoluted story. What many consider to be species are in fact interspecific hybrids. There are so many hidden oaks growing in secluded or out-of-reach places that time has forgotten. One day someone may take the time to walk to these specimens and question their presence—it is then that these forgotten oaks will reveal their true identity and story. In August 2013 the National Trust of South Australia reviewed my nomination report on this specimen of *Q.* ×*coutinhoi* for inclusion in the Register of Significant Trees. It was accepted as a Tree of National Significance. This is the highest level of registration on the National Trust Register of Significant Trees. In 2014 this specimen will be among the many trees on the South Australian Significant Tree Register to be entered onto the National Trust of Australia National Register of Significant Trees when it is launched.

Photographers. Title page: Charlie Buttigieg (*Q.* ×*coutinhoi* acorns). Photo 1, 5: John David Morphett. Photos 2-4, 6: Charlie Buttigieg.

Specimen photographed on April 23, 2013. Assistant shown in the comparative photograph is Dave Moyle. These photographs were part of the formal Nomination Report to the Significant Tree Register Steering Committee, National Trust of South Australia.

Further reading

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Sudden Oak Death, *Phytophthora ramorum*: a Persistent Threat to Oaks and Other Tree Species

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ABSTRACT

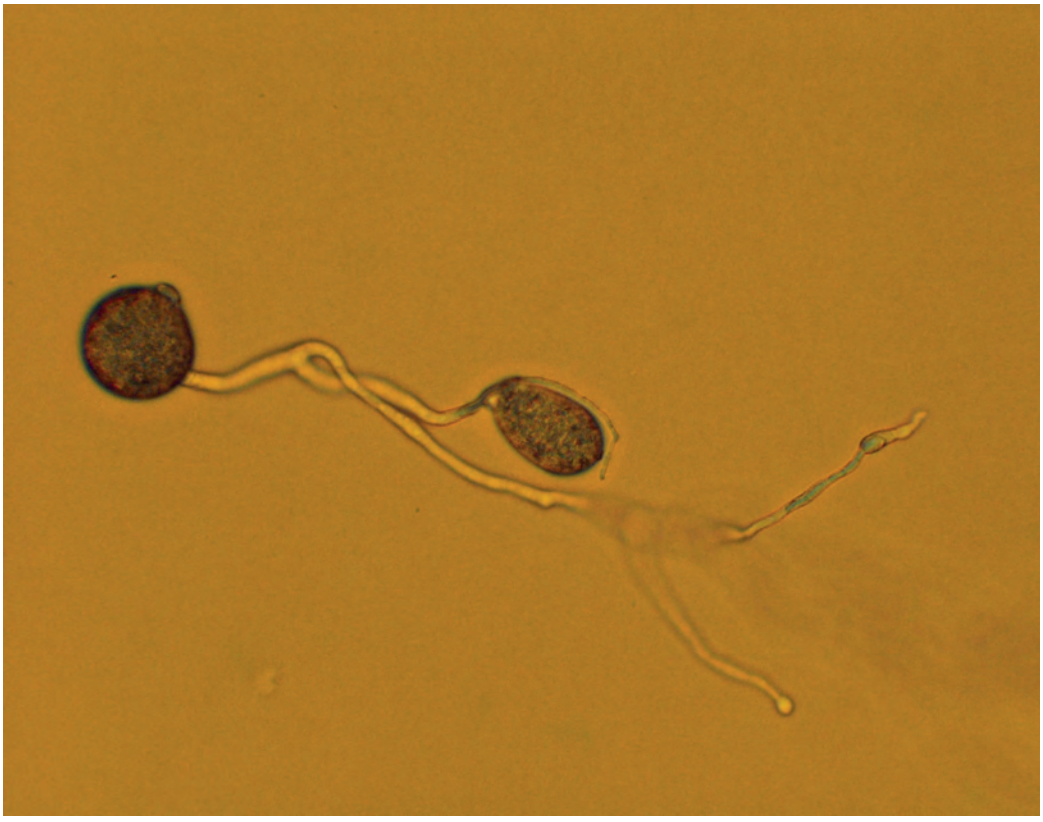
This paper reviews the status and management of sudden oak death and sudden larch death in the urban and wildland forests of California, Oregon, and the United Kingdom. The causal pathogen, *Phytophthora ramorum* (Werres, De Cock & Man in't Veld), was discovered in all three locations over a decade ago. Despite professional, dedicated attempts, efforts to contain and eliminate infestations have been unsuccessful. These less than satisfactory management intervention outcomes underscore the importance of prevention, for once forest pathogens become established, response is costly and difficult, and eradication is unlikely. New approaches are needed to protect forests from invasive pathogens.

Keywords: ***Notholithocarpus densiflorus, Quercus agrifolia, Larix kaempferi,*** **invasive forest pathogens, forestry management**

Introduction

Over the past 20 years, *Phytophthora ramorum* (Werres, De Cock & Man in't Veld), the pathogen known to cause sudden oak death, has killed well over 5 million trees along the coast of California and Oregon as well as millions of Japanese larch trees throughout much of the United Kingdom (UK) and areas of the Republic of Ireland. Despite eradication attempts and quarantines, four pathogen strains continue to move undetected overseas and across continents on nursery plant shipments (Goss et al., 2009; Grunwald et al., 2012). Meanwhile, in coastal California and Oregon, communities struggle to remove hazardous snags and reduce fuel loads as they lose tanoak (*Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S.H. Oh) and coast live oak (*Quercus agrifolia* Née) (Frankel, 2008). Additionally, in the UK, commercial Japanese larch (*Larix kaempferi* (Lamb.) Carrière) plantations are being clear-cut by the millions to comply with quarantine regulations and to slow pathogen spread (Brasier and Webber, 2010).

Sudden oak death is emblematic of the threat invasive species pose not only to oaks, but to the health of forest ecosystems. Here we present a review of the status and management of sudden oak death in the urban and wildland forests of California and Oregon and sudden larch death in the UK. In all three locations, determined, skillful efforts to eradicate or slow pathogen spread have not been fully realized; consequently, forests and the susceptible trees within them remain threatened. The less than satisfactory



1/ Chlamydospore of *Phytophthora ramorum* germinating on agar medium and forming a sporangium.

outcomes of management interventions underscore the importance of prevention, for once forest pathogens become established, response is costly and difficult, and eradication is unlikely.

Background

The pattern of mortality and symptoms of sudden oak death were first described in the mid-1990s (Rizzo et al., 2002), with *P. ramorum* identified as the causal agent several years later (Werres et al., 2001). A microscopic, fungus-like organism (Kingdom Stramenopila; phylum Oomycota) (Photo 1), the biology, genetics, and history of *P. ramorum* have been reviewed by Rizzo and Garbelotto (2003), Sansford et al. (2009), Kliejunas (2010), and Grunwald et al. (2008, 2012). The pathogen is currently known to infect over 135 plant species, with symptoms including leaf spots and/or twig dieback (USDA APHIS 2012) on all foliar or ramorum blight hosts and bleeding cankers and/or mortality on all sudden oak death or sudden larch death hosts, including coast live oak, California black oak (*Q. kelloggii* Newberry), Shreve oak (*Q. parvula* Greene var. *shrevei* (C.H. Mull.) Nixon), canyon live oak (*Q. chrysolepis* Liebm.), tanoak, and Japanese larch. With ramorum blight affecting common horticultural plants such as rhododendrons and camellias, the pathogen is able to inadvertently travel long distances via the movement of nursery stock (Ivors et al., 2006).

Once established in a susceptible forest, pathogen spread can occur through wind-driven rain, infested soil splash, watercourse currents, or by harvest and transport of infected plant material (Davidson et al., 2005). Cyclical in nature, the pathogen thrives in wet conditions, allowing inoculum build up and spread in years with ample moisture. Once a sudden oak death-susceptible tree is infected, its vascular system becomes obstructed, frequently leading to the death of the tree within a few years, when dry conditions lead to high evaporative demands (Brown and Brasier, 2007; Parke et al., 2007). However, not all infected trees die. Some oaks are able to form cankers that wall off and isolate the infection (Swiecki and Bernhardt, 2010).

An internationally recognized threat to forest ecosystems and the ornamental plant trade, *P. ramorum* quarantines have been initiated in Canada (2001), South Korea (2001), the US (2002), the UK (2002), Australia (2002), the EU (2002), the Czech Republic (2003), Taiwan (2006), New Zealand (2006), China (2008), and more than 65 other countries (COMTF, 2013; Sansford et al., 2009).

In the US, *P. ramorum* was detected at over 540 wholesale and retail nurseries between 2001 to 2013, with an average of 28 detections per year since 2007 (USDA APHIS, 2013). Detections for *P. ramorum* in the UK have averaged 50 sites per year from 2004 to 2013 in retail nurseries, garden centers, and plant passport nurseries. The average for the past seven years has been 37 sites per year (Jane Barbrook, personal communication, November 26, 2013).

Continental and global movement

Genetic analysis demonstrates that *P. ramorum* has moved across at least one ocean, become established, and infected native vegetation at least five times in North America and Europe (Grünwald et al., 2012; Van Poucke et al., 2012), with four clonal lineages having been identified in one or more locations. Each lineage (EU1, EU2, NA1, and

NA2) is named after the continent where it was first detected, followed by the number representing its order of discovery on that continent (Grünwald et al., 2009; Van Poucke et al., 2012).

The NA1 lineage was introduced to North America from an unknown location via imported nursery stock shipped to a nursery near Santa Cruz, CA sometime prior to the 1990s (Mascheretti et al., 2008, 2009; Grünwald et al., 2012). In 2004, millions of camellias potentially infected with the NA1 lineage were inadvertently shipped from a Los Angeles County, CA nursery to more than 1,200 nurseries in 39 states. The pathogen was ultimately recovered from 171 nurseries in 21 states (USDA APHIS 2013), and eventually detected in soil and water adjacent to infested nurseries in Alabama, Florida, Georgia, Mississippi, North Carolina, Washington, (Oak et al., 2013), Texas (COMTF 2013), and New York (Snover-Clift et al., 2013).

The NA2 lineage has been recovered from nurseries in Washington, California, and British Columbia, Canada as well as from waterways adjacent to infested nurseries in Washington and California. In spring 2009, runoff from a Pierce County, Washington retail nursery was the source of inoculum for salal (*Gaultheria shallon* Pursh) plants along a drainage ditch that became infected with the NA2 strain. The plants were destroyed and the pathogen has since only been recovered from the water in the drainage ditch (Chastagner et al., 2013).

The EU1 lineage was first detected in nurseries and established gardens in Germany and the Netherlands on *Rhododendron* and *Viburnum* in the 1990s (Werres et al., 2001). It was then discovered in the UK on *Viburnum* in 2002 (Lane et al., 2002) and on trees (*Q. falcata* Michx.) in 2003 in Sussex, southern Britain (Brasier et al., 2004) as well as in the Netherlands (*Q. rubra* L.). It continued to spread throughout the UK, sporulating on *R. ponticum* L. and threatening natural heathlands (Walters et al., 2009). Then, in 2009, Japanese larch emerged in the UK as a new host that both facilitated pathogen spread and died from infection (Brasier and Webber, 2010). The EU1 lineage has also been recovered from nurseries and adjacent waterways in California and Washington (COMTF, 2013).

The EU2 strain was first introduced to Northern Ireland and western Scotland in 2007 from Japanese larch, *Q. robur* L., *Vaccinium myrtillus*, L., and *R. ponticum*. Genetic analysis indicates it is a recent introduction, despite quarantine measures to prevent pathogen spread (Van Poucke et al., 2012).

Pathogen status in California

Sudden oak death continues to be the primary cause of tree mortality along 600 kilometers/373 miles of the California coast from Monterey County north to Humboldt County (Figure 1, Photo 2). Infestations occur in densely populated residential areas in several San Francisco Bay Area counties and in managed and unmanaged woodlands. The infestation is patchy and, due to an affinity for moisture, limited to areas within 80 kilometers/50 miles of the Pacific Ocean. Aerial surveys identified over 294,000 trees killed in 2013 alone, a number similar to mortality levels in 2012 (COMTF, 2013). In California, most of the mortality occurs in coastal evergreen forests with *Q. agrifolia*, California bay laurel (*Umbellularia californica* (Hook. & Arn.) Nutt.), California black oak, Pacific madrone (*Arbutus menziesii* Pursh), and other species and in coast redwood (*Sequoia sempervirens* (Lamb. ex D. Don) Endl.) forests with tanoak in the understory (Rizzo et al., 2002).

2/ Tanoaks killed by sudden oak death near Big Sur, Monterey Co., 2012.

Tanoak is the most susceptible species in California and Oregon. Some local populations in the Big Sur area (Monterey County, CA) have lost most of their mature tanoak trees because of sudden oak death (Cobb et al., 2012). Measurements in forest research plots in Marin County from 2000-2008 found approximately 78% (cumulatively) of all tanoak to be symptomatic, with a 51% mortality rate, while the cumulative infected rate for coast live oak was 50% with 32% mortality (McPherson et al., 2005; 2010). Swiecki and Bernhardt (2013) recorded cumulative mortality of coast live oak at 32% and tanoak mortality at 54% in Marin, Sonoma, and Napa County plots measured from 2000 to 2012. In all studies, the mortality rate for both species increased with tree size (McPherson et al., 2010; Cobb et al., 2012; 2013). Shreve oak, California black oak, canyon live oak, and Pacific madrone can also be killed by *P. ramorum* (Swiecki et al., 2013); however, as these species are not as common in infested areas, data on mortality rates is limited.

Despite widespread infestation throughout California's 14 infested counties, less than 10% of the native range of tanoak has been infected (Meentemeyer et al., 2012); however, mortality is expected to continue as the pathogen spreads north into the cool, moist environments of Northern California and coastal Oregon (Meentemeyer et al., 2011).

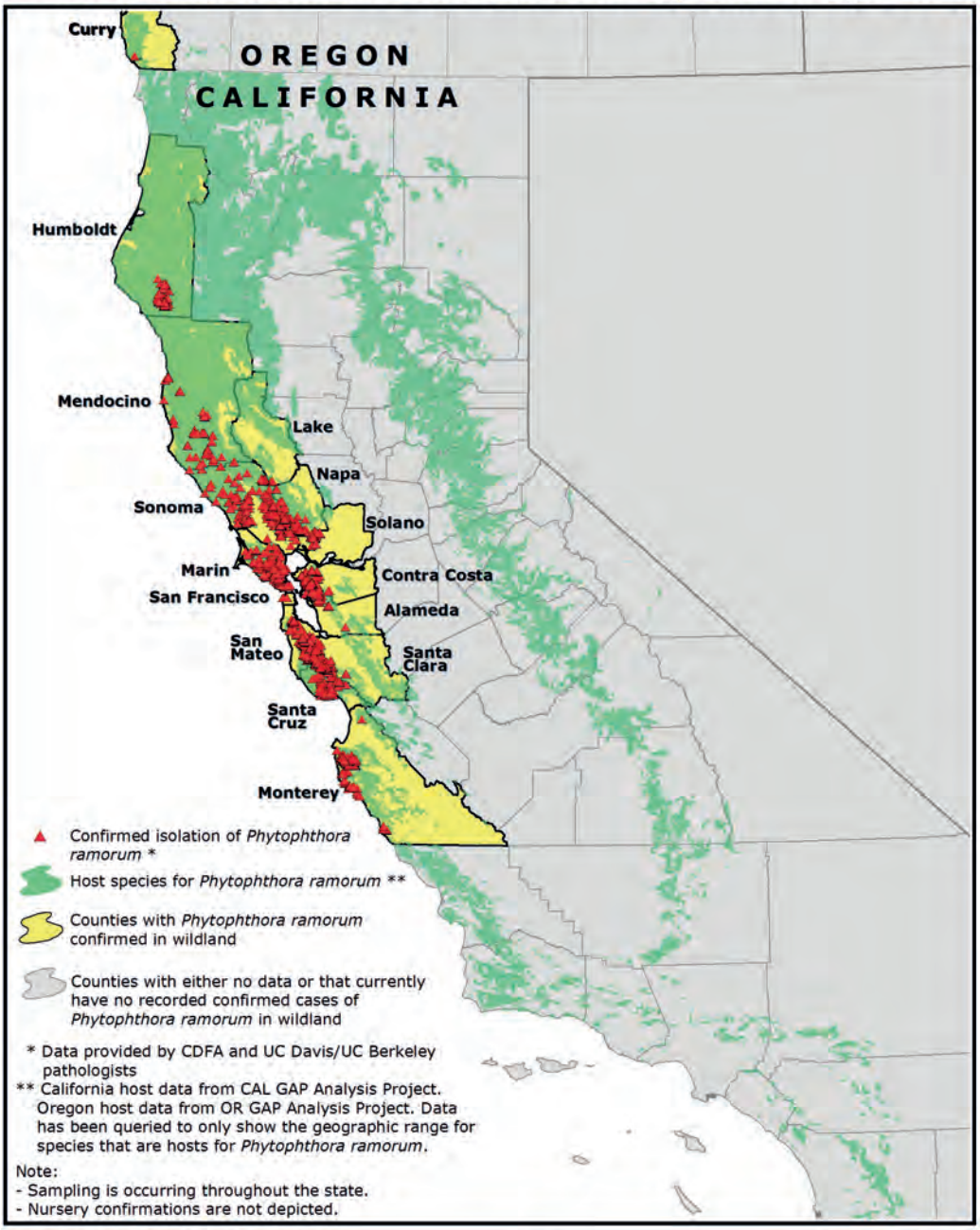


Figure 1/ Distribution of *Phytophthora ramorum* in California as of September 30, 2013. (Maggi Kelly, UC Berkeley, Geospatial Innovation Facility.)

Management in California

Widely dispersed in California by the time of its discovery in 2000 (Rizzo et al., 2002), sudden oak death management in the state has been focused on maintaining a safe environment, minimizing pathogen impacts in infested communities, and preventing long-distance movement of the pathogen (Frankel, 2008). Management is primarily locally driven, with landowners (individually or collaboratively) taking action in an effort to protect resources (Alexander and Lee, 2010). The non-profit California Oak Mortality Task Force (www.suddenoakdeath.org) works to coordinate sudden oak death-related activities as well as to provide educational outreach to impacted communities and industries, lawmakers, land managers, regulators, Native American tribes, and the media. As the state does not fund or require eradication, most management activity targets protecting individual high-value and/or high-risk trees, reducing roadside hazards from dead and failing trees, and abating fuels for fire prevention.

In 2011, an isolated outbreak 80 km/50 mi north of the nearest known California infestation was identified in Redwood Valley (Humboldt County, CA) and has been under eradication ever since. The infestation extended across more than 20 properties and included a mix of residential landholdings as well as large, private timberlands. Over 150 hectares/371 acres were treated with herbicide or by removal of infected trees and adjacent asymptomatic trees to create a 100 m/328 ft buffer. The multi-agency collaborative effort, led by University of California Cooperative Extension (UCCE), Humboldt and Del Norte Counties, relied on early detection and rapid response as the cornerstone of the eradication effort (Valachovic et al., 2013). However, despite treatment, wet springs led to pathogen spread into steep, rocky, densely vegetated terrain surrounding infested properties, which ultimately overwhelmed treatment efforts. As a result, the program is currently transitioning from eradication to a slow-the-spread or containment program. The pathogen continues to spread northward, threatening Redwood National and State Park as well as Yurok, Hoopa, and Karuk tribal lands.

Management in Oregon

In July 2001, *P. ramorum* was discovered in Curry County, Oregon. Since then it has spread across public and private lands in forests dominated by tanoak, with Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and other tree species (Goheen et al., 2002; Hansen et al., 2008). A multi-agency team set out to eradicate the pathogen, with the state mandating that all infected trees as well as those within a 100 m/328 ft buffer be cut, piled, and burned on commercial timber lands, residential lots, parks, and federally managed forests. Although there was no direct cost to landowners, no compensation was made for loss of timber or other assets (Kanaskie et al., 2013).

Eradication sites were identified using fixed-wing airplanes and helicopters or by water baiting with native rhododendron and tanoak leaves (Sutton et al., 2009). These surveys were conducted by the Oregon Department of Forestry (ODF), Oregon State University, and Oregon Department of Agriculture in cooperation with the USDA Forest Service, and were followed by ground checks to confirm pathogen presence and identify newly infected trees for treatment (Kanaskie et al., 2013).

Over $10 million was expended from 2001 to 2012 to eradicate the pathogen in Oregon (Kanaskie et al., 2013) through a combination of federal and state funds. However,

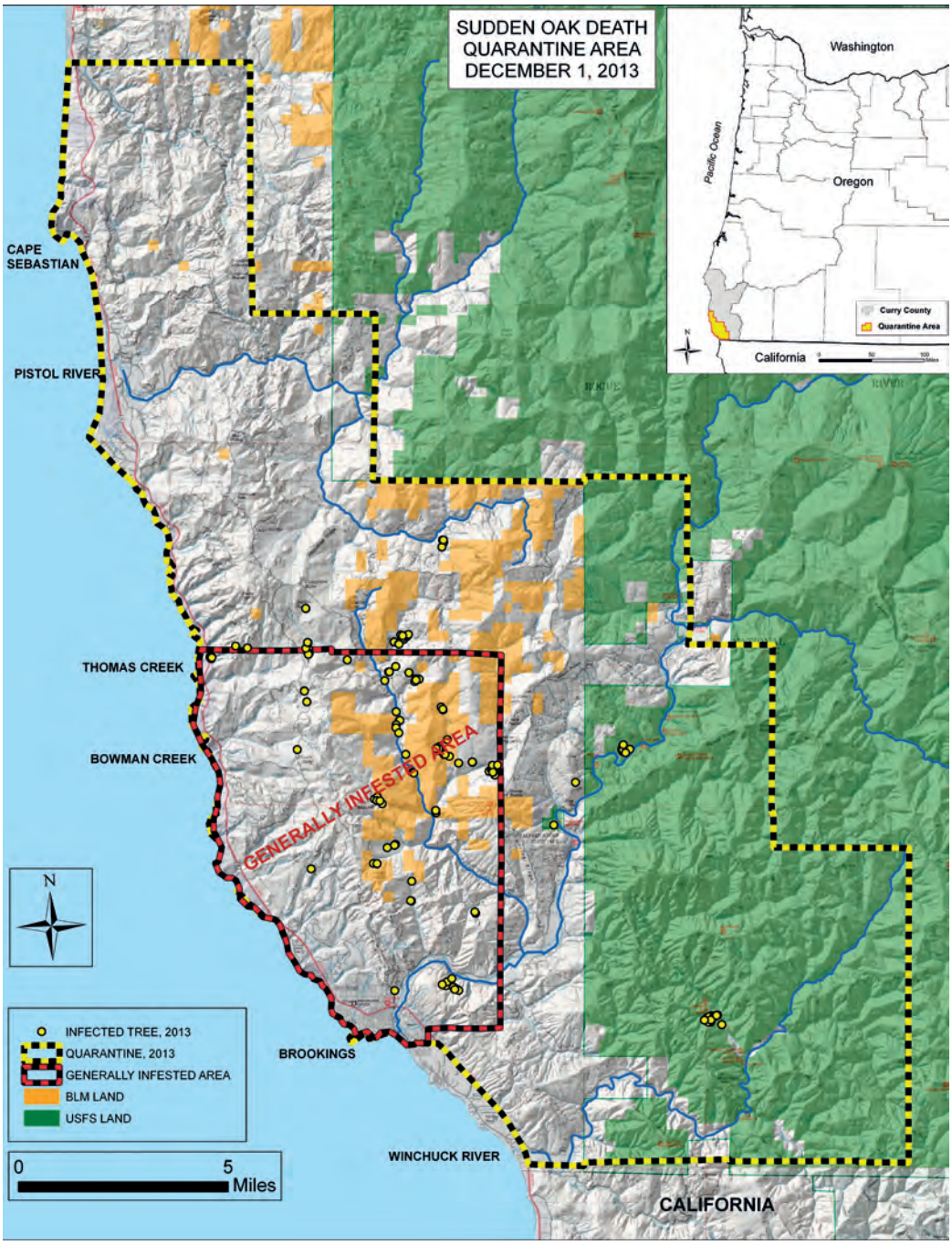


Figure 2/ Location of sites infested with *Phytophthora ramorum* in southwest Oregon that were discovered in 2013 (as of December 1). Sites enlarged for visibility. (Kanaskie, Oregon Department of Forestry.)

3/ Sudden oak death tanoak mortality near Brookings, Oregon inside the "Generally Infested Area" on private lands that are no longer under state-mandated eradication.

expansion and intensification of disease in late 2012 overwhelmed the funds and manpower required for treatment, making eradication unachievable. During the 10-year eradication effort, the pathogen spread from the initial infestation southward, 1.9 km/1.2 mi, and northward and eastward, 28 km/17.4 mi and 7.6 km/4.7 mi, respectively. The area under quarantine had expanded from 22 km^2/8.5 mi^2 in 2001 to over 680 km^2/263 mi^2 in 2013 (Figure 2). Eradication treatments eliminated the pathogen from 39% of the treated areas (Goheen et al., 2013), yet *P. ramorum* continued to slowly spread (predominantly northward, in the direction of storm tracks). Oregon revised its quarantine rule in March 2013, establishing a 125 km^2/48 mi^2 "Generally Infested Area" (GIA) where eradication is no longer required. Federal agencies continue to treat infestations on federal lands, but have redirected funds on private lands to focus on the leading edges of the infestation in an effort to slow disease spread and eradicate new, high-risk infestations. In the GIA, concern continues to grow over increased tree mortality posing hazardous conditions to people, dwellings, and roadways if standing dead trees and fuels are not removed (Photo 3).

Despite continued pathogen spread and disease intensification, Oregon's program has had numerous benefits. In the 12 years since the first detection, *P. ramorum* is still confined to a relatively small area of Curry County, OR, particularly when compared to similar areas in California that have only been managed for disease containment and

slow-the-spread programs over the same period of time. This containment has protected wildlife and millions of tanoaks as well as shielded the Oregon nursery, forestry, and special products industries from quarantine restrictions.

Management in the United Kingdom

In 2002, a *P. ramorum* quarantine was initiated in England and Wales, limiting imports of host plants from California and Oregon as a precautionary measure whilst more evidence was gathered on pathogen risk (Sansford et al., 2010). At about the same time, the first UK *P. ramorum* find occurred on *Viburnum* at a garden center in Sussex, Britain (Lane et al., 2002). The pathogen continued to be intercepted in nurseries and historic gardens. From 2004 to 2013, approximately 446 retail and nursery confirmations were reported in England and Wales (Jane Barbrook, personal communication, November 26, 2013).

In spring 2009, a five year *Phytophthora* Disease Management Programme was launched by the UK Food Environment Research Agency (Fera) and the UK Forestry Commission (Walters et al., 2009). The program expanded research, education, and disease control through clearance of host plants in high-risk areas, with the goal of reducing inoculum to epidemiologically insignificant levels through the elimination of sporulating hosts (primarily *R. ponticum*). Then, in the summer of 2009 in Southwest England, Japanese larch was found to be a host of *P. ramorum*, supporting prolific pathogen sporulation as well as experiencing extensive dieback and mortality upon infection (Brasier and Webber, 2010). In 2010, *P. ramorum* was again isolated from larch plantations in Southern Wales, Northern Ireland, and the Republic of Ireland, and in 2011, it was found in Western Scotland (Schlenzig and Cooke, 2013). These infestations were the first widespread instances of lethal damage caused by *P. ramorum* to a commercially important conifer species anywhere in the world. In response to the larch detection, statutory Plant Health Notices were issued to woodland owners, requiring infected trees to be felled. Some financial assistance was offered through grants (UK Forestry Commission, 2012).

The impacts of the pathogen in the UK include the felling of millions of Japanese larch in commercial timber plantations, removing highly-valued rhododendron plants in historic gardens to maintain phytosanitary conditions, and costly impacts to the nursery industry for regulatory compliance (Sandsford et al., 2009). *P. ramorum* has also been found infecting bilberry, or European blueberry (*V. myrtillus* L.) (FERA 2012), in valuable, native lowland and upland heathlands.

Aerial surveys in spring 2013 detected a major disease expansion in the Dumfries and Galloway area of Scotland, where an estimated 4,000-6,000 hectares/9,884-14,826 acres of larch were infected (Forestry Commission - Scotland, 2013b.). This spread is believed to be a result of exceptionally wet and windy conditions in 2012 combined with the virulent genetic characteristics of the EU2 lineage. As a result, *P. ramorum* eradication on larch in Scotland was declared unachievable, causing the Scotland Forestry Commission to shift to a containment and slow-the-spread program. A proposed “red zone” (or generally infested area) in Southwest Scotland has been identified, delineating the area where the only statutory controls are movement of infested timber and bark. Statutory Plant Health Notices continue to be issued throughout the rest of Scotland, requiring felling or killing of infected stands of larch and all surrounding larch within 250 meters/820 feet (Forestry Commission - Scotland, 2013a).

Management hopes for the future

As the hope for eradication in each region struggling with *P. ramorum* dwindles, it is clear that this pathogen is one with which we must learn to live. Containing outbreaks to those regions currently infested is a primary goal if we are to protect natural resources, wildlands, and all the tangible and intangible benefits they provide. Tools to help minimize impacts from *P. ramorum* are relatively limited at this point. Educational outreach currently provides information to all affected parties on how to implement best management practices, thereby minimizing risk of artificial movement of the pathogen. Research into "super host" California bay laurel trees that may harbour disease even in the driest of years may also prove to be important in understanding and minimizing disease persistence in California (Eyre et al., 2013). Still even further off is the potential for disease management through deployment of naturally resistant tanoak stock as Hayden and others (2013) have identified tanoak traits and seedling families with increased survivorship and provided a framework to further identify seed parents for restoration.

Conclusions

While California, Oregon, and the UK have conditions unique to each region, such as climate, host species distribution, and pathogen lineage variation, the eradication actions in each area fell short of desired objectives. All three projects were conducted with state-of-the-art detection and treatment methods by capable, dedicated teams, yet, each program has only managed to slow disease spread while the pathogen continues to kill trees and expand into new areas. The experience gained from these eradication attempts has yielded many improvements in invasive species management: improved use of GIS databases and detection techniques as well as better preparation, coordination, and cooperation among forest managers, affected industry representatives, and regulatory agency personnel. But it has also demonstrated that complete eradication is likely not achievable as the pathogen is not identifiable early enough, leading to incomplete disease delimitation.

Unfortunately, throughout the 20th century similar scenarios have unfolded in Europe and North America with introductions of white pine blister rust (*Cronartium ribicola* A. Dietr.) (Liebhold et al., 2012), chestnut blight (*Cryphonectria parasitica* (Murrill) Barr) (Freinkel, 2007), Dutch elm disease (*Ophiostoma ulmi* (Buisman) Nannf., *Ophiostoma novo-ulmi* Brasier) (Brasier, 1991), and other destructive forest pathogens. On average, two significant invasive forest pests are introduced into the US annually (Aukema et al., 2010). In Europe, invasive forest pathogens have increased exponentially in the last four decades, with approximately 60 pathogens introduced from the 1800s to the present (Santini et al., 2013). If society wants to protect trees, plants, natural resources, and industries from invasive species, additional ornamental nursery and forest research is needed to develop new approaches and technologies to prevent their introduction. Planning and action to protect against the next unknown pathogen is key to sustaining forests.

Photographers. Title page: Tom Coleman (dying tanoaks). Photo 1: Paul Tooley, USDA Agricultural Research Service. Photo 3: Tom Coleman, USDA Forest Service, Forest Health Protection. Photo 5: Ellen Goheen, USDA Forest Service.

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For more information about Sudden Oak Death, please visit the California Oak Mortality Task Force website at hhtp://www.suddenoakdeath.org

Diversity Within Oaks

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ABSTRACT

In this paper an overview of the range of variations that occur in the genus *Quercus* (oaks) of the family *Fagaceae* is given. Oaks are one of the most important groups of flowering plants and dominate large regions of the Northern Hemisphere. We considered oaks from all regions of the world, while focusing on Himalayan oaks. These have not been studied as much by Western workers or by Indian botanists and foresters. With more than 600 species, *Quercus* is possibly the greatest natural ecosystem-forming genus of the world. Oaks are known for their great variety of growth forms, leaf shape and size, and for their nutrient-rich acorns. Many other trees might exceed the commercial value of oaks, but with regard to biodiversity, they have few parallels in the living world. Outside tropical rainforests, oaks are the greatest biodiversity-centric plants on the planet.

Keywords: acorns, biodiversity, Himalayan oaks, *Quercus,* leaf morphology, oak ecology

Introduction

1/ *Quercus floribunda* in Pakistan.

Oaks (*Quercus*), a genus of the family *Fagaceae*, contains the largest and the most important hardwoods distributed in the Northern Temperate Zone, Subtropical and Tropical Asia and in the Andes of South America. Oaks occupy a wide range of sites as members of several vegetation types (Munz and Keck, 1959) and they are intimately linked with a large number of other organisms ranging from fungi to ferns, birds to bears and wasps to ants. According to Keator and Bazell (1998), the oak has been a symbol of permanence, strength and courage. Due to their high degree of specialization, oaks are regarded as the most advanced member of the *Fagaceae* (Kaul, 1986), and occupy latitudes from the Southern Hemisphere close to the equator up to the 65th parallel. This genus is anemophilous (wind pollinated), and likely to have evolved in a seasonal climate that favored anemophily in the early part of the growing season, when there is a paucity of insect pollinators. Oaks are considered to be early- to mid-successional trees (Abrams, 1992). But the Himalayan oaks are generally regarded as late-successional trees (Singh and Singh, 1987; Bargali et al., 2005). Generally oaks are outcompeted by more shade-tolerant species under intact oak canopies. However, some species, such as the Himalayan *Q. floribunda* Lindl. are tolerant of deep shade in the regeneration phase (Singh and Singh, 1992). Many oaks are well adapted to xeric conditions (Abrams, 1990), a characteristic that has helped oaks occupy large areas not available to more mesic species. Oaks possess many morphological characteristic that help them endure severe drought conditions (Zobel et al., 1995). They are among the deepest-rooted trees and therefore are able to extract water from great depths. In the Himalayas, *Q. leucotrichophora* A. Camus is known for its massive root system.

Quercus is the largest genus of the *Fagaceae* with an estimated 300 (Lawrence, 1951) to 600 species (Soepadmo, 1972) from all over the world. In the Himalayan region oaks are mostly gregarious, medium- to large-sized evergreen trees distributed between 800 and 3,800 m/2,625 and 12,467 ft above sea level. Negi and Naithani (1995) reported more than 35 species from this region. The exact number of oak species is an unresolved and dynamic debate. The considerable variation in morphology among species (Negi and Naithani, 1995), parallelism in leaf form (Tucker, 1974) and the ability of many oak species to hybridize (Burns and Honkala, 1990; Parker, 1939) are some of the issues that fuel this debate.

This article summarizes the diversity the genus *Quercus* exhibits in growth forms, leaves, acorns, and ecosystems. While so doing we have considered all of the major oak regions of the world, trying where possible to include what is known about Himalayan oaks for two reasons:

1. Oaks show ecological dominance over a large area in Himalayan ranges, (easily

encompassing about 20 million hectares/49 million acres).

2. The Himalayan oaks are crucial for the biodiversity associated with them and for the services their ecosystems generate.

What are oaks?

Characteristic features of true oaks are: 1. pendulous male catkins that release their pollen to the wind; 2. inconspicuous female flowers with three stigmas; 3. the male and female flowers are separated from one another both in time and space; 4. they bear an acorn that sits in a distinctive scale-covered cup. Although different authors of oak classification systems have divided the genus in various ways, they roughly recognize the same major groups. These are: White Oaks (*Quercus*), Black Oaks (*Erythrobalanus*), Golden Oaks (*Protobalanus*), and Ring-Cupped Oaks (*Cyclobalanopsis*). A comparative account of these groups is given in Table 1. Among oaks, *Q. glauca* Thunb., *Q. lamellosa* Sm. and *Q. semiserrata* A. Camus come under *Cyclobalanopsis*, while *Q. semecarpifolia* Sm., *Q. lanata* Sm., and *Q. serrata* Murray come under *Quercus*. White Oaks are abundant in Temperate and Mediterranean regions and absent from the Tropics. Black Oaks occur in North and Central America, Golden Oaks in California and Mexico and Ring-Cupped Oaks are mostly tropical and subtropical. All four groups have many features in common, and very few of these features can single out any one particular group. For example, whether acorns ripen in one or two years is a feature shared by at least two different groups. The only trait that seems confined to one group alone is the unique ring-like arrangement of the cup scales in the *Cyclobalanopsis* group (that also has very distinctive leaves). In many cases, there are exceptions to the general characters described for distinguishing

2/ *Quercus brantii* Lindl. in Iran.

between the four groups. For example not all White Oaks ripen their acorns in a year; the Turkey oak (*Q. cerris* L.) that has many White-Oak features, matures its acorns in two years. The only relatively consistent difference between White Oaks and Black Oaks is the presence or absence of bristles on the leaf lobes and tips, and even that has exceptions. Free exchange of genes among different species account for the sharing of characters.

Parameters	***Quercus***	***Erythrobalanus***	***Protobalanus***	***Cyclobalanopsis***
Common name	The White Oaks	The Black or Red Oaks	The Golden Oaks	The Ring-Cupped Oaks
No. of species	100	200	6	40
Distribution	Abundant in Europe and the Mediterranean region, prolific in Temperate mountainous Asia, rich and varied across North and Central America from the Pacific Coast to the Atlantic Seaboard, absent from Tropical Southeast Asia	Restricted entirely to North and Central America, diverse in the mountains of Mexico	Restricted to Western North America occurring chiefly in California, the Southwestern United States and Northern Mexico	Tropical, centered in Southeast Asia and adjacent island such as Borneo and New Guinea, also extended into India, China and Japan
Bark	Pale whitish, shallowly flaky	Dark grey to near black, deeply fissured	Pale grey	Pale grey, flaky
Leaves	Usually have rounded or blunt lobes for the deciduous species, tapered tips for the evergreen ones	Often have bristle-tipped lobes for the deciduous species and spine-tipped teeth along the leaf margins for the evergreen kinds	Evergreen leaves, spiny- toothed leaf margins or sharply tipped	Leaves are characterized by the drip tips, allowing water to roll off the leaf surface instead of accumulating
No. of stamens	7-9	6	8-10	6
Stigmas	Short, broad, horizontal	Long, curved styles that gradually taper into spoon- shaped stigmas	Short, broad	Head-shaped, attached to slender styles
Acorn maturation time	One year	Usually two years, but in mild climates one year	Two years	One or two years
Acorn shell/cap	Inner shell smooth and hairless	Inner shell lined with woolly hairs	Inner shell with woolly hairs	Inner shell lined with woolly hairs

Table 1/ A comparative account of the four major groups of the genus *Quercus* (adapted from Keator and Bazell, 1998).

There are many trees and shrubs that carry the word oak as a part of their common name but that are not related to true oaks. For example, silk oak (*Grevillea robusta* A. Cunn ex R. Br.), a member of the family *Proteaceae*, she oak (*Casuarina* spp.) belonging to the family *Casuarinaceae* and poison oak (*Toxicodendron diversilobum* (Torr. & A. Gray) Greene), a member of the family *Anacardiaceae*. However, some so-called oaks outside the genus *Quercus* are related to them. Tanbark oaks (*Notholithocarpus*) and stone oaks (*Lithocarpus*) are among such trees. Lithocarps resemble oaks in many characters such as appearing to bear acorns that sit in distinctive bract-covered cups. The two genera appear to be very closely related, even though they consistently differ in their arrangement of flowers and mode of pollination (Table 2). *Lithocarpus* acorn cups can resemble the acorn cups of the oak subgenus *Cyclobalanopsis* as well as the scaly cups of the White Oaks. The evergreen chestnut *Castanopsis* also looks exactly like a tropical oak, except for its fruits. This chestnut produces spiny burrs enclosing the shiny nuts. Individual seeds looks just like glossy acorns, but they are flat-faced on one side (Keator and Bazell, 1998).

Oaks	Lithocarps
1. Pendulous male catkins that are wind pollinated.	1. Stiff, upright, male catkins that attract insects.
2. Male and female flowers are separated both in time and space.	2. Female flowers are at the base of the male catkins
3. Belong to subfamily *Quercoideae* of family *Fagaceae*.	3. Belong to subfamily *Castanoideae* of family *Fagaceae*.

Table 2/ Differences between oaks and lithocarps.

Oak ecosystems

Oak forest

Oak species form pure as well as mixed forests in different parts of the world. They form a part of the rainforests of Malaysia, the dense mixed hardwood forests of China, Japan, and the Eastern United States and low to mid-montane hemi-sclerophyllous broadleaf forests of the Indian Himalayas. In China oaks occupy various habitats and can be found from Tropical and Subtropical to Temperate Zones and from sea level to very high mountain altitudes. They generally form four forest types: evergreen oak forest, evergreen sclerophyllous oak forest, semi-evergreen oak forest and deciduous oak forest. *Q. gilliana* Rehder & Wilson, *Q. longispica* (Hand.-Mazz.) A. Camus, *Q. pannosa* Hand.-Mazz., *Q. monimotricha (*Hand.-Mazz.) Hand.-Mazz. are some oaks which form pure evergreen sclerophyllous oak forests or occur mixed with pines. This is a dominant forest type in the Hengduan mountain areas of northwest Yunnan and the western part of southwest Sichuan, and is a very important forest type of high-mountain ecosystems. *Q. baronii* Skan, *Q. acrodonta* Seemen and *Q. phillyreoides* A. Gray form evergreen oak forests in subtropical areas of China. They can grow from sea level to 2,800 m/9,186 ft above sea level, but are best represented at 200 m/656 ft above sea level. Some deciduous oaks like *Q. acutissima* Carruth., *Q. chenii* Nakai, *Q. variabilis* Blume form pure oak forests in temperate areas of China. *Q. schottkyana* Rehder & Wilson is endemic to

3/ *Quercus pannosa*

central Yunnan, where it forms pure or mixed Schottky oak forest.

Oaks, lithocarps and evergreen chestnuts form a part of the rainforests of Malaysia. Deciduous oaks such as *Q. coccinea* Münchh., *Q. marilandica* (L.) Münchh., *Q. alba* L., *Q. rubra* L., etc., form temperate hardwood forests in the Appalachian Mountains of the Southeastern United States. Due to shifts in rainfall pattern and heavy logging, only patches of oak forest are left in North America. Some shrubby oaks such as *Q. garryana* var. *breweri* (Engelm.) Jepson, *Q. vacciniifolia* Kellogg, and *Q. sadleriana* R. Br. ter grow in the Siskiyou Mountains between California and Oregon.

In the Indian Central Himalayas, generally one or two species of oak dominate oak forests; hence dominant types are easily recognizable (Bargali et al., 2013). These are *Q. leucotrichophora* forest which covers extensive areas in lower elevations (1,000-2,100 m/3,281-6,890 ft), *Q. lanata* forest which forms pure stands in some pockets at 1,800-2,200m/5,906 and 7,218 ft, *Q. floribunda* forest distributed in limited areas between 1,800 and 2,400 m/5,906 and 7,874 ft, and *Q. semecarpifolia* forest between 2,400 and 3,200 m/7,874 and 10,499 ft, often forming timberlines. *Rhododendron arboreum* Sm., *Lyonia ovalifolia* (Wall.) Drude, and *Ilex dipyrena* Wall. are the commonly associated species.

Oak woodland

Oak-woodland canopies are generally formed by *Quercus* spp. with an understory of exotic annual grasses and forbs, and occasionally native perennial grasses (Holmes, 1990; Allen et al., 1991). In California oak woodlands cover about 4.1 million hectares/10 million acres (10% area of the state) (Pacific Meridian Resources, 1994). These areas have the richest species abundance, with over 300 vertebrate species, 5,000 invertebrate

species and about 2,000 plant species (Barret, 1980; Garrison, 1996). Oak woodlands also provide water and preserve its quality, outdoor recreation and aesthetics. In California, the five major oak species occurring in oak woodlands include three deciduous White Oak species (*Q. douglasii* Hook. & Arn., *Q. lobata* Née, *Q. engelmannii* Greene), and two evergreen oaks (*Q. agrifolia* Née, *Q. wislizeni* A. DC.). Landscape factors affecting oak-woodland distribution include long-term climatic factors, and, more recently, human-caused events. Recently some oak woodlands have decreased due to human-induced factors such as urban expansion (Doak, 1989), firewood harvesting (Standiford et al., 1996), range improvement (Bolsinger, 1988), and conversion to intensive agriculture (Mayer et al., 1985).

Oak savannah

An oak savannah is an area covered by grasses and dotted with widely spaced oak trees. The foothills that ring California's great Central Valley represent one of the best oak savannahs. In this region one part of the year is hot and dry and the other part is cool and wet. The oak species present in savannah vary according to slope and latitude. On steep hills, deciduous blue oaks (*Q. douglasii*) dominate or associate with interior oak (*Q. wislizeni*). The valley oak (*Q. lobata*) generally dominates on the hill base. California's savannahs are a habitat for herds of browsing mammals such as elk and deer, which are hunted by mountain lions and other predators.

Man-made oak scrub of the Himalayas

In an oak scrub, the oaks and associated species are reduced to low, stunted trees. In the Himalayan region, all the oak forests are subjected to heavy grazing and to heavy lopping. The older trees usually succumb but the smaller tend to become coppice scrub. All oak species as well as most of the associated species are easily exploited, but some unpalatable or poor fuelwood species like *Rhododendron arboreum* and *Lyonia ovalifolia*

4/ *Quercus floribunda* in Iran.

are generally left. *Q. floribunda* tends to be lopped to the main stem and stands in columnar form till it is killed, so most of the scrub is of *Q. leucotrichophora* and locally *Q. semecarpifolia*. With oaks are bushes of *Berberis* spp., *Crataegus* spp., *Prinsepia* spp. etc. (all thorny) and sometimes *Spiraea*, *Indigofera*, *Wikstroemia*, etc. Short grasses cover the soil with some ferns like *Pteridium aquilinum* (L.) Kuhn in the deeper pockets, where it is not completely exposed by trampling.

Diversity within the genus

In growth form and leaf longevity

Differences in growth form, (tree or shrub) and leaf longevity (evergreen or deciduous) (Table 3) are very significant in the adaptation of individual species to their environments. These differences are responses to environmental stress including climatic, edaphic and/or biotic factors such as fire and lopping. Groups of adaptive characters result in the evolutionary selection of the genotypes most adapted to these stresses.

Growth form	Examples
Deciduous tree	*Q. kelloggii, Q. garryana*
Deciduous shrub	*Q. ilicifolia, Q. garryana* var. *breweri*
Evergreen tree	*Q. agrifolia, Q. chrysolepis, Q.leucotrichophora, Q. floribunda, Q. semecarpifolia, Q. lanata*
Evergreen shrub	*Q. vacciniifolia, Q. sadleriana*
Stoloniferous shrub	*Q. monimotricha*

Table 3/ Different growth forms.

Oaks have various habits. They can be evergreen, semi-evergreen or deciduous trees, shrubs and stoloniferous shrubs (Table 3). In general, shrubby growth forms are associated with conditions of high environmental stress. Common forms of stress, which may promote dominance of shrub species, are arid conditions, high fire frequency, cold temperatures with a short growing season, low nutrient availability and heavy grazing. Mountain tops relentlessly swept by drying winds or covered by heavy snows, places that receive little rainfall and experience boiling hot summers also favor shrubs. Oak shrubs also thrive in the understory of dense forests. In such condition, shading and vigorous competition for water result in shrub growth forms. *Q. monimotricha* is a stoloniferous shrub only 0.2 to 1 m/0.66 to 3.2 ft tall, mostly in open areas or on mountain tops, usually occupying a large area.

In the Himalayas where there are nutrient soils and adequate moisture, the tree growth form is favored, producing trees with umbrella-like, wide crowns and extensive root systems. All the Himalayan oaks are evergreen with leaf lifespan of about one year. Among the Himalayan oaks, *Q. floribunda* is the tallest and largest forming up to 40-m-/131-ft-tall trees despite a very dense wood (Table 4). *Q. leucotrichophora* forms a large canopy, and its main stem may fork generally at 3-6 m/9.8-19.7 ft from the ground. We recorded that about 40% of these trees have bifurcated stems compared to 13.5% of *Q. floribunda* trees. *Q. floribunda* and *Q. semecarpifolia* have generally clean boles. On hill bases along watercourses, even *Q. leucotrichophora* may have clean boles. All Himalayan oaks have extremely dense wood, so much so that they do not produce good timber. However, many European and American oaks are well known for their timber.

Species	Height (m)	Girth (m)
Q. leucotrichophora	30	4
Q. floribunda	40	6
Q. semecarpifolia	36	4,5
Q. lanata	25	3,3
Q. glauca	18	1,7
Q. lamellosa	35	12
Q. serrata	8	-

Table 4/ Comparative heights of Himalayan oaks (developed from Troup, 1921, and from personal observation).

Q. baloot Griff., which generally occurs in arid regions like Afghanistan is the only Himalayan oak that can approach a shrubby habit.* Some other oak species of other regions are small or large trees (7 to 30 m/23 to 98 ft) in undisturbed forest, but they become shrubs, even stoloniferous shrubs, under excessive human activity when they are frequently cut for their wood and foliage. For example, Garry oak, *Q. garryana* Douglas ex Hook. var. *garryana* is a tree, while Brewer's oak, *Q. garryana* var. *breweri* is a shrub, although they are alike in their leaf design, bark color and patterns, and acorns. The Rocky Mountain Gambel's oak (*Q. gambelii* Nutt.) is also capable of changing form. On well-watered sites it sends up a few stout trunks and a dense rounded canopy; on a rock stream slope or where it is subjected to frequent browsing, it quickly forms groves of miniature trees with slender trunks. When it takes root on steep rock shelves, it changes once again forming sprawling woody mats only a few feet high.

5/ *Quercus lanata* in Bhutan.

These growth forms, shrub and tree, differ in their ecological responses. For example, patterns of biomass allocation differ considerably between shrub or tree growth forms. Shrubs lack a central trunk and have much smaller structural requirements for woody tissue than do trees and therefore aboveground biomass allocation is greater to the leaves. Root:shoot ratios are also greater in shrubs than in trees.

Evergreen and deciduous leaves have different characteristics that influence their physiological behavior. Selective pressures for evergreen or deciduous leaves are a response to the seasonality of the environment. In some environments

* Editor's note: Eike Jablonski reports that when left undisturbed it will grow as a small, single-stemmed tree.

because of seasonal drought or cold, photosynthesis cannot take place at specific times. In such environments, the metabolic cost of maintaining leaves during the stress period is greater than the cost of producing new leaves in the following season. In such conditions, natural selection promotes deciduous leaves. Where stress periods are variable in length and intensity, favorable conditions for photosynthetic production can occur at any time during the year and therefore evergreen leaves are better adapted. The metabolic cost of producing evergreen leaves is lower than that for deciduous leaves. Evergreen leaves are also better adapted to nutrient-poor environments because long leaf-life allows for greater net photosynthesis per unit of leaf nutrient and thus a more efficient use of these nutrients. In addition, evergreen leaves are able to store nutrients during the winter for future growth, and further since they drop old leaves slowly there is a better return of nutrients to the soil through decomposition.

Deciduousness is an effective way to deal with excessive winter cold, when frigid air dehydrates leaves and water is frozen solid in soil. Thus, deciduous oaks are widespread in colder temperate climates such as those found in Eastern and Midwestern North America, in Central and Northern China, throughout Japan, and in Central and Northern Europe. Deciduousness also helps in climates with long, hot, dry summers, such as those in the foothills of California and mountains of Texas and Arizona. Evergreen oaks are generally distributed in tropical, subtropical and Mediterranean climates. In places with summer drought, some oaks simply make tough leaves that resist water loss and keep them throughout the year. The proof of the effectiveness of both strategies is seen in Texas, Arizona and California, where deciduous and evergreen oaks grow side by side, or at least within a short distance. Most Himalayan oaks are evergreen, even those growing in subalpine belts. The monsoon period provides conditions almost as favorable as the

6/ ***Quercus leucotrichophora***

tropical rain forest region does, and winters are relatively mild for the altitudes because of the tropical location and the controlling effects of the unusually massive mountain ranges. In such conditions, species that maximize their growth period have a competitive advantage.

In leaves

The color, shape, size, vein pattern, margins and leaf hairs vary from species to species, and within a species the leaf size varies in accordance with environmental conditions, age of the tree, and position of the leaf on the tree. For example, Thadani (1997) reported that in *Q. floribunda* the shade leaves were larger in size than leaves that were exposed to direct sunlight even on the same tree. The shape of the leaf blade varies from a extremely narrow to a broad oval with a pointed tip to a wide ellipse (Figure 1). The leaf margin may be flat or concave and revolute. It can be smooth and entire, serrate or dentate, shallowly to deeply lobed (Figure 1). Among the Central Himalayan oaks, *Q. floribunda* and *Q. semecarpifolia* have spinose leaves and *Q. leucotrichophora* leaves have dentate margins in the upper half and entire in the lower half (Bargali and Bargali, 2000; Singh et al., 2005). However, even within a species leaf margin varies, depending upon the position of the leaves in the tree. For example, in *Q. floribunda* leaves in the upper crown have completely entire margins, while those borne close to the ground have spinose margins. The latter is considered an adaptation to mammal herbivory. The veins are arranged in a pinnate, featherlike pattern, which branches from a substantial and obvious central midrib. These veins themselves branch into complex patterns that vary from one oak group to another.

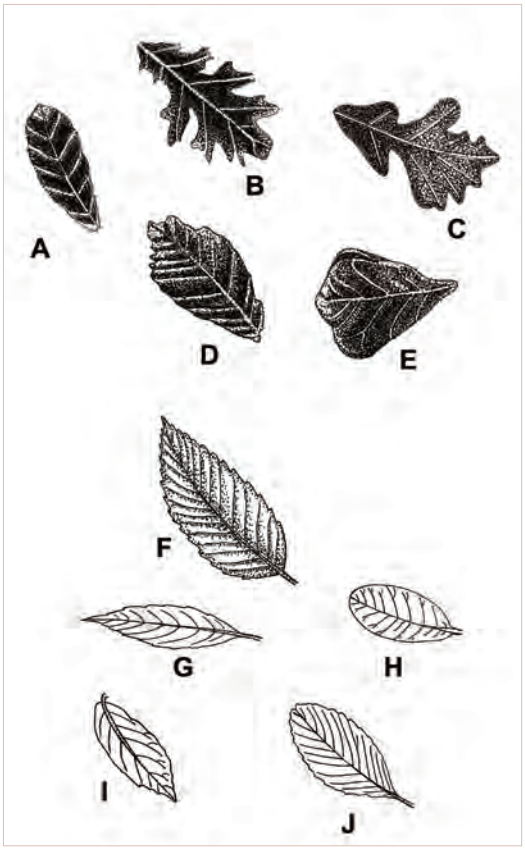

Figure 1/ Diversity in oak leaves. Non-Himalayan oaks: A. *Quercus crassifoli*a; B. *Q. gambelii*; C. *Q. stellata*; D. *Q. rugosa*; E. *Q. marilandica* (source: Keator and Bazell, 1998). Oaks from the Indian Himalayas: *F. Q leucotrichophora*; G. *Q. glauca*; H. *Q semecarpifolia*; I. *Q. floribunda*; J. *Q. lanata* (source: Troup, 1921).

Oaks employ various strategies to change leaf size and shape. For example, surface area is reduced when leaf margins are revolute. In some oaks large surfaces are broken up into many parts or they are lobed. Lobing is a feature that has evolved in many unrelated oak species from similar habitats and provides maximum leaf area to utilize sunlight. Indentation between lobes also allows bits of light to pass through and be absorbed by a lobe on the leaf just below, like a jigsaw puzzle. These lobed leaves also lose large amounts of water to evaporation, which cool the leaf surface in fierce summer temperatures.

Most oak leaves are green, but in some oaks in addition to chlorophyll, accessory pigments are present which are responsible for colored leaves. The exact kind and amount of these pigments are specific to each kind of oak. These accessory pigments absorb light

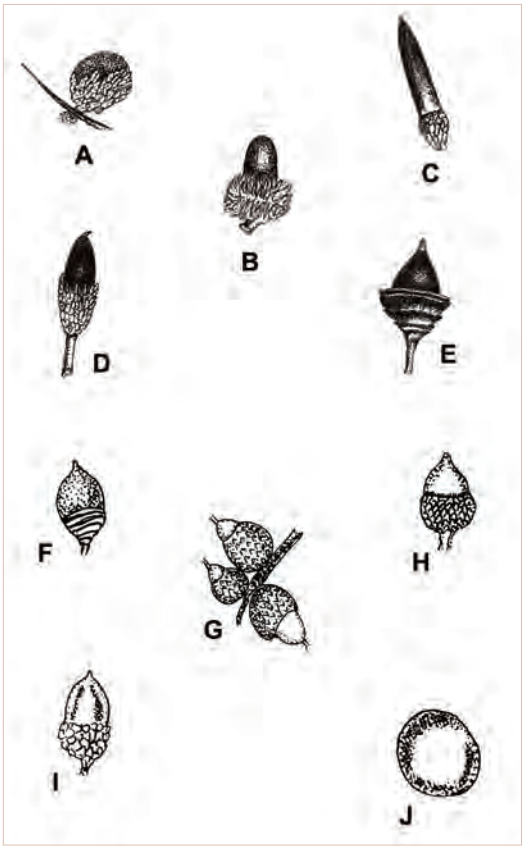

Figure 2/ Diversity in oak acorns. Non-Himalayan oaks: A. *Quercus lyrata*; B. *Q. cerris*; C. *Q. agrifolia* var. *oxyadenia*; D. *Q. suber* (source: Keator and Bazell, 1998). Oaks from the Indian Himalayas: E. *Q. kerangasensis* Soepadmo; F. *Q glauca*; G. *Q. lanata*, H. *Q. floribunda*; I. *Q. leucotrichophora*; J. *Q. semecarpifolia* (source: Troup, 1921).

from the orange, yellow, green, and blue-green parts of the spectrum at wavelengths chlorophyll does not absorb. The leaves of California black oak (*Q. kelloggii* Newb.) contain a lot of carotenoids (yellow or orange pigments) which result in yellow, gold or yellow-brown leaves in the autumn. The leaves of the scarlet oak (*Q. coccinea*) are rich in xanthophylls (reddish or brownish pigments) resulting in scarlet-red leaves.

Himalayan oaks also vary in leaf color and size. Leaves of *Q. floribunda* are green on both dorsal and ventral surfaces. The other species have different colors on their ventral surface: silvery white in *Q. leucotrichophora*, yellowish brown in *Q. lanata* and brown in *Q. semecarpifolia*. The latter two may have xanthophylls and also carotenes. Himalayan oak leaves also change color with age. For example, leaves of *Q. leucotrichophora* are reddish brown when young, and turn green when mature. In contrast, the young leaves of *Q. floribunda* do not contain any of the abovementioned pigments when young. Oak leaves from drought-prone habitats may take on a blue color like California blue oak (*Q. douglasii*) Engelmann oak (*Q. engelmannii*) and Mexican blue oak (*Q. oblongifolia* Torr.). The distinctive blue-green color that these leaves exhibit comes from the extra thick wax coating that protects them by reflecting the highly energetic wavelengths of the blue end of the spectrum that would otherwise heat up and dry out the leaf. The California black oak (*Q. kelloggii*) produces new leaves that wear a velvety frosting of pink hairs. These hairs are soon shed as leaves mature and begin to manufacture more chlorophyll. The pink hair deludes potential browsers into believing that these leaves may be bitter and distasteful. The Himalayan banj oak (*Q. leucotrichophora*) has a thick wax layer when young to check transpirational loss because stomatal control is not yet developed.

Leaf hairs may be simple and straight, wavy, interlaced, cobwebbed, multirayed starbursts, or have enlarged, rounded, glandular tips. Different hairs offer different kinds of protection: white hairs reflect hot sun to cool the leaf surfaces, and densely matted hairs retard water loss from the leaf surface. On the other hand, sticky hairs protect leaves from tiny chewing insects. Some hair patterns are unique to oaks, while some are also present in other genera.

The Central Himalayan oaks are sclerophyllous with specific leaf mass (SLM) exceeding 130 g/m^2, and their size class varies from microphyll to mesophyll.

In acorns

In botanical terms, the acorn consists of two components: a nut and a cupule. The nut is derived from the ovary of the female flower and the cupule is derived from a series of scales or bracts present at the base of the female flower. Oak acorns are a characteristic feature for species identification because size, shape, color pattern, and nature of cup vary from species to species (Figure 2). Acorns can be small (*Q. phellos* L.) or large (*Q. gemelliflora* Blume), pencil thin (*Q. agrifolia* var. *oxyadenia* (Torr.) J.T. Howell) or plump (*Q. kingiana* Craig), solid tan or bronze (*Q. suber* L.) or striped with dark lines (*Q. lamellosa*). Acorns can be more broad than long (*Q. phellos*) or taper elegantly from base to tip (*Q. lobata*). Acorn-cup design differs mainly in the shape and arrangement of the scales (bracts) and is an important criterion in distinguishing between subgenera, sections and series (Keator and Bazell, 1998). Acorn cups can have thin shingle-like pointed scales or thick, warty scales. These scales can be brown or tan or powdered with gold and may sometimes be spiny or fused into concentric rings.

Oaks differ in the time needed from pollination to seed ripening (Table 5) and in their pattern of seed production. Some oaks demonstrate the periodic and synchronous production of large seed crops, a phenomenon known as mast seeding or masting (Janzen, 1971). Mast seeding is hypothesized to satiate seed predators, as more seeds are produced than can be consumed (Janzen, 1971; Koenig et al., 1994). Among the Himalayan oaks (Photo 5), *Q. floribunda* and *Q. semecarpifolia* are known for seed masting, producing extraordinarily large crops in some years. Negi et al., (1996) have reported 2.6 t/ha acorn production in a *Q. floribunda* forest of Nainital. Acorn production by oak trees is highly variable from tree to tree, year to year and species to species (Koenig et al., 1994). Annual crop size correlates strongly with conditions during spring pollination and fertilization.

Species	Time taken (months)
Q. leucotrichophora	19-21
Q. floribunda	14-18
Q. semecarpifolia	13-15
Q. lanata	8
Q. glauca	7

Table 5/ Number of months from pollination to seed maturation in some Himalayan oaks (developed from Troup, 1921).

Photographers. Title page: Béatrice Chassé (*Quercus monimotricha* (Hand.-Mazz.) Hand.-Mazz.) Photos 1, 5: Shaun Haddock. Photos 2, 4: Daud Rafiqpoor. Photo 3: Charles Snyers d'Attenhoven. Photo 6: Béatrice Chassé.

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The Mirbeck Oak in Iberia: Source of an Inspiration

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ABSTRACT

Although the Mirbeck oak, *Quercus canariensis* Willd., is, or perhaps was, native to Portugal, widespread deforestation has decimated its numbers in the country. It is easier to see in some places in Spain but on both sides of the border this beautiful tree is barely known and rarely used for landscaping. As is typical within this genus, its taxonomy is complicated. The purpose of its marcescence and the mysteries of masting are also open to debate. There is disagreement amongst experts concerning some conservation strategies. But the tree's need for protection especially in the face of climate change is not in doubt and an ambitious measure to ensure its future in Portugal is described. Comments and criticism are welcome.

Keywords: *Quercus canariensis* Willd., *Q.* ×*marianica* C. Vicioso, *Q.* ×*fagineomirbeckii* Villar, *carvalho-de-Monchique*, *quejigo andaluz*, conservation, climate change

1/ Serra de Monchique, view from the northeast behind *Erica multiflora* L. and ever-present *Eucalyptus*.

Introduction

An observant wanderer in the woods on the north side of the Serra de Monchique range, two gentle bumps (Photo 1) that are just big enough (902 m/2,960 ft and 774 m/2,540 ft) to wring more rain from usually dry skies than anywhere else in southern Portugal, may, if lucky, spot a particularly attractive tree. Its acorns identify it as one of some 500 species of oak (Govaerts and Frodin, 1998) yet its large leaves (Photo 2) are less stiff and without the prickles that characterize Iberia's usual Mediterranean oaks, the cork (*Q. suber* L.), holm oak (*Q. ilex* L.), *Q. rotundifolia* Lam. and kermes oak (*Q. coccifera* L.).

2/ *Quercus canariensis* foliage (Ceixe Valley).

Luck is required to see this tree partly because, the Mirbeck or Algerian oak, *Q. canariensis* Willd. is usually small and frequently concealed by exotics such as *Eucalyptus globulus* Labill., Portugal's predominant tree, as well as by various prolific acacias. But the main reason is because the *carvalho-de-Monchique*, as it is known in Portugal, has become very scarce. Indeed, the Portuguese specimens found are remarkable survivors on a continent whose forests have endured climatic upheavals and great changes since early man entered Europe from Africa hundreds of thousands of years ago.

A changing landscape

For much of that time Europe was in the depths of our planet's most recent glacial period. What northern land wasn't under ice would have been tundra and taiga with no broadleaved trees. Conditions were not only colder but also drier and any dense woodland was probably confined to parts of the south where southern Iberia served as an important refugium. Early bands of hunter-gatherers used fire either for hunting or, perhaps more significantly, to create hunting habitats (as some speculate their predecessors did to increase the surface of African savannas to the detriment of forest cover).

Rising temperatures between 15,000 and 9,000 years ago heralded the onset of the Holocene interglacial period and a retreat of ice sheets that had become so massive they dented parts of the Earth's crust and locked up as much as 126 m/413 ft of sea level (Fairbanks, 1989). With warmer and wetter conditions a new mantle of forest spread northward rapidly—300 to 500 m/984 to 1,640 ft per year across most of the continent in the case of *Quercus* (Brewer et al., 2002). In Iberia, perhaps only the arid southeast was not wooded. The flora that developed, especially in Southern Europe, became very diverse and this was particularly true of oaks. Alexis Ducousso writes in *International Oaks*, No. 24, that there are only two oak species in Northern Europe, five in mid latitudes and 29 species with 44 taxa, or perhaps more as we shall see, in the South (Ducousso, 2012).

Postglacial afforestation attained its maximum extent in Europe around 8,000 BCE (Colchester, 1998) but had already begun to decline dramatically in Mesopotamia following the development of agriculture in the Fertile Crescent about 10,000 years ago

3/ *Quercus canariensis* in Cornwall Park, New Zealand. Photographer Brad Cadwallader's father gives the scale.

4/ *Q. rotundifolia* in Alentejo "savanna".

when more and more forest was converted to cropland. Neolithic farming with the accompanying felling of trees, reached Portugal about 3,000 BCE.

Our knowledge of the processes of deforestation is patchy. Best estimates indicate that over 70% remained in both Portugal and Spain in 1,000 CE (Kaplan et al., 2009). The worst, that little coastal forest survived in Portugal 4,000 years ago and by the early Middle Ages, 500-1,000 CE, the last vestiges of ancient forest in the country had disappeared (Canaveira et al., 1999). Today almost 40% of Portugal is forested (World Bank, 2013), one of the highest percentages in Europe, and, as with more prosperous countries worldwide, this level continues to rise. But the woodland is largely monotypic, exotic plantation. Not only is there no old growth in Portugal today but the felling of Mirbecks continued until recently. Few surviving trees are more than 30-40 years old and the author is aware of only two Mirbecks, one moribund, the other magnificent, that may well be over a century old. Even Australia and New Zealand have more ancient and more outstanding specimens that can exceed 30 m/98 ft in height and width (Photo 3).

Extrinsic mitigating factors

Forest losses would have occurred earlier and been more extensive without the Spanish *dehesas* or Portuguese *montados*. For hundreds of years large areas under these traditional stewardship methods involving cattle, limited agriculture and mainly non-timber harvesting of forest products did much to preserve biodiversity. Such management also produced a landscape reminiscent of Africa's savannahs in which oaks rather than acacias predominate and grazing rather than sporadic rainfall or fire was instrumental in shaping the landscape (Photo 4).

Among the oaks, the cork survived in large numbers thanks to its remarkable bark that is still being transformed into a growing array of products even as cost and cork taint have driven its replacement by plastic and screwtop stoppers onto many wine bottles. *Q. rotundifolia* also possesses a redeeming feature that is valued to this day: the acorns are appreciably less bitter than most and thus favored by pigs whose hams command handsome prices from carnivores worldwide.

Mirbeck oak with its smaller range and lower tolerance of drought and cold as compared to its two cousins has no such saving graces. Although some in Spain were coppiced for

charcoal most were more valuable dead than alive and much of their fine timber went into the Portuguese and Spanish fleets when these countries were major naval powers. Until recent decades, surviving trees were felled at will. In Spain it was sometimes deliberately replaced by more lucrative cork oaks.

Survival advantages

That any Mirbecks still survive under these circumstances can appear miraculous. From the start the Mirbeck displays great determination to overcome natural and human challenges. The author is accustomed to waiting a year for palm seeds to germinate. Yet within days of planting a few hundred Mirbeck acorns dozens have sprouted. Impressive as this *Lebenslust* may be though, it pales beside that of certain other oaks whose even more impatient seeds can germinate while still on the tree. Young specimens may not tolerate temperatures much below -5 °C/23 °F and in the absence of ground water Mirbecks languish where annual rainfall is inferior to 600 mm/23.6 in. But within these limits the taxon rapidly outpaces cork and holm oaks. Moreover, on the same property (with annual rainfall of less than 500 mm/19.6 in) the Mirbeck's survival rate is the highest of the three species when all receive some irrigation.

5/ Mirbeck leaves collected from trees only a few meters apart in the Ceixe Valley.

Oaks as a whole display tremendous resilience in the face of natural and anthropomorphic challenges not only by hybridizing amongst themselves with alacrity to adapt to changing conditions but then rapidly reverting to original type by crossing with parental species even with pollen from distant trees (Valbuena and Hampe, pers. comm.). Oaks have shown the same ability in North America (Dodd and Afzal-Rafii, 2003). How many genera can boast such a range of phenotype and behavior, from scrubby groundcover to towering tree and from cool temperate woodland to equatorial montane forest? It is a testament to the tenacity and the adaptability of this exceptional genus that for millions of years it was and remains an important component in all of these environments.

Taxonomy

Predictably with plants as plastic as these (note the significant range of leaf size in Photo 5) trying to identify the genera's promiscuous members can test even taxonomists. Nomenclature can be as volatile as the trees' pollen; the Spanish Royal Botanic Garden lists 14 heterotypic synonyms for *Quercus canariensis* (Real Jardín Botánico, 2013), Kew no less than 31 (Kew, 2013) and new oak species continue to be added while still others are renamed. Surviving Mirbecks in Portugal have become so hybridized, mainly with *Q.*

broteroi Cout.,* that pure *Q. canariensis* may no longer exist here, having been replaced, in the view of most Portuguese botanists, by the hybrid *Q.* ×*marianica* C. Vicioso** (Oliveira, 2006) which may ultimately be given species rank (Vila-Viçosa, 2012).

At a distance *Q. canariensis* and *Q.* ×*marianica* are indistinguishable. Even on closer inspection differences can be slight, especially considering the leaf variations on individual trees and the author's suspicion that, as with *Q. ilex* and *Q. rotundifolia*, a taxonomist's no-man's land lies within a subtle spectrum blending one species into the other. Examining trichomes requires a magnifying glass but more easily observed characters include longer *Q. canariensis* petioles (15-25 mm/0.59-0.98 in) while *Q.* ×*marianica* petioles do not exceed 15 mm/0.59 in; and more lateral veins (13-15) while *Q.* ×*marianica* has 12 at most (Vila-Viçosa, 2012).

Marcescence

Most trees are either evergreen or deciduous. *Q. canariensis*, like a few other oaks, belongs to a marcescent minority whose foliage, in cooler areas at least, dries in the autumn or winter but remains attached to the tree, in defiance of winter according to Seneca Indian legend, until being shed when new growth emerges (Photo 6). And certainly in North America where ice storms are relatively common there is hubris in this habit. Leafy branches covered with ice or snow are much more vulnerable to breakage.

6/ What is the purpose of marcescence?

The benefits of marcescence are obvious for plants adapted to more extreme conditions. The "skirts" of *Washingtonia* palms might confer some protection against desert heat and desiccation. Several striking tropical high-elevation rosetted species such as *Argyroxiphium* in Hawaii, *Lobelia* in Africa and, even more spectacular than these, *Puya* in the Andes, retain their long-dead and even detached foliage for the same purpose and against severe radiating night cooling.

The argument posited for temperate species—protection from browsing deer in winter because dead, less digestible foliage protects more nutritious buds behind—is more nuanced. European beech and hornbeam definitely benefit from dead-leaf protection but *Q. robur* does not (Svendsen, 2001). And *Q. subpyrenaica* Villar*** sheds accessible lower foliage but retains it in more sun-exposed crowns (Abadía et al., 2006). There are similar examples in North America. So marcescence may reflect selection for increased photosynthetic potential over the lifetime of each leaf on a tree (Hipp, 2005).

Marcescence is considered a transitional feature between temperate and Mediterranean ecotones (Rivas-Martínez, 2007). But, as Abadía et al. submit, it cannot occur without

* Considered by some authors to be a synonym of *Q. faginea* subsp. *broteroi* (Cout.) A. Camus.

** Considered by some authors to be a synonym of *Q.* ×*fagineomirbeckii* Villar. The name *Q.* ×*marianica* comes from the Sierra Mariánica or, more usually, the Sierra Morena, an east-west range that stretches across the north of Southern Spain's Andalucía.

*** Considered by some authors to be a synonym of *Q. pubescens* subsp. *subpyrenaica* Villar (Rivas Mart. & C. Saenz.).

cold and in the Algarve the phenomenon appears infrequent. (The author's decade-old trees, most of which benefit from temperature inversion, have never retained desiccated leaves.) Moreover, it can be argued that in Mediterranean zones it makes more sense to synchronize marcescence to coincide with arid summer to shade the ground and reduce transpiration instead of with wet winter (which for many plants is the main, even the only growing season). In fact the Mirbeck's timing recalls what one would expect in the Neotropical *invierno* (hot, wet "winter") and *verano* (hot, dry "summer" when the sun is less direct and so produces little convectional rain). And so it is with Central American oaks that drop their leaves in the dry (northern winter) season (Rodríguez, pers. comm.).

Masting

While details of oaks' seemingly whimsical boom-or-bust acorn production remain uncertain, the strategy known as masting is clever and clear enough—keep granivore populations low and then overwhelm them with a bumper crop they cannot possibly devour completely. Thus many more acorns survive to start a new generation and the significant resources saved during low or no harvest years can go into permanent growth. Masting is most effective because oaks are wind-pollinated. Overwhelming predators is one thing; overwhelming pollinators quite another. So insect-dependent species of the beautiful *Miconia* genus in Trinidad, for example, synchronize flowering regularly throughout the year to accommodate their habitat's finite pollinating resources.

There has been more masting research in the United States than in Spain (Carbonero, pers. comm.). But oak interest and knowledge has increased in many countries and the annual fluctuations are now better understood (Pearse and Koenig, 2012). It is a Spanish investigator who recommends planting acorns from these fruiting peaks because they will have greater genetic diversity (Gil, 2009). Still, questions remain. Mirbecks are masting in Monchique this autumn (2013) while just 20 km/12 mi away in the Ceixe basin they are barren. Yet Ceixe cork oaks are laden. Why, when both trees' acorns are eaten by the same predators, boar, rodents and pigeons? Will we ever be able to predict good crops with certainty?

Mirbecks in Iberia

Today, while the *carvalho-de-Monchique* is scarce in Portugal with perhaps only a dozen very altered small pockets containing a few hundred trees in damper parts of the Algarve and the southwest corner of the Alentejo region to its north, in Spain the *quejigo andaluz* or *roble moruno* (Andalusian or Moorish oak, as *Q. canariensis* is also known) is much more prevalent, albeit again in only some places. Unlike in Portugal, they are found over a wide area from fairly close to the Algarve border in Andalucía's Aracena hills to the Sierra de Ojén near Western Europe's southernmost point. (From here one can see Morocco's serrated Rif Mountains where the forests not yet converted to *Cannabis* plantations provide part of the African habitat of *Q. canariensis*.) Unusually, there are also a few isolated populations almost 1,000 km/621 mi away in Catalonia but most of these are the variable hybrid *Q. canariensis* × *Q. humilis* Mill.* (Goicoechea, pers. comm.).

For all the excesses of Spain's untrammeled tourist strips along the Mediterranean

* Considered by some authors to be a synonym of *Q. pubescens* Willd.

coast, much beauty and wilderness can still be found sometimes only a few kilometers inland. Indeed, in Cádiz Province several gallery forests or *canutos*, privileged stream-fed gullies that capture vital mist or drizzle from Levantine winds even in summer, harbor ancient trees and continental Europe's only good surviving examples of Macaronesian Laurisilva forest. Many Mirbecks in the Sierra de Ojén and especially in the Parque Natural de Los Alcornocales, a magnificent wilderness which stretches from horizon to horizon, are similarly centuries old (Photo 7).

7/ A veteran *Quercus canariensis* of the Parque Natural de Los Alcornocales.

A Canary Island Q. canariensis*?*

The geographic herbarium notes jotted down by Carl Ludwig Willdenow who named the tree *Q. canariensis* in 1809 (Teneriffa and Kanarische Inseln Herb. Willd. no. 17608, leg. Broussonet!) (Eike Jablonski, pers. comm.) are remarkably imprecise. Tenerife covers some 2,000 km²/775 mi² of widely varying habitat. But in defense of one of phytogeography's founders, the identification is based on material previously gathered by Pierre Marie Auguste Broussonet who collected in Morocco as well as in the Canary Islands. It now seems likely that the Moroccan and Canary samples were shuffled

(Pascual and Lorenzo, 2000) at some point in Broussonet's life that at times was eventful and dangerous.

But the *Quercus* in Canarias questions do not end here. Alexander von Humboldt listed an oak "similar to *Quercus* ×*turneri* Willd. of the mountains of Tibet" during a brief stopover on Tenerife in 1799 devoted largely to an ascent of its 3,718 m/12,198 ft Teide Volcano (Pascual and Lorenzo, 2000). Today *Q.* ×*turneri* is considered a hybrid between two largely European oaks, *Q. ilex* and *Q. robur* L. But, geography aside, *Q.* ×*turneri* does bear a resemblance to *Q. canariensis*.

Adding to the intrigue, for over six millennia and up until 6,000 years ago summer rains transformed the Sahara into a savanna and palynologists have identified *Quercus* pollen deposits which date from as recently as ca 2,000 years ago in a Tenerife lakebed (de Nascimento et al., 2009). Findings show that these deposits declined while microfossil charcoal remains simultaneously increased, coinciding with archæological evidence of the first Guanche human settlement on the island. Sadly, it appears that with extensive burning these people managed to exterminate all the trees in spite of the island's often rugged and inaccessible terrain. Still, one wonders why during this extended monsoon period North Africa's oaks did not, apparently, spread south as they did, to almost equatorial latitudes, in the Americas.

Climate change and a Quaternary quandary

Temperate and subtropical gardeners know that many plants tolerate far colder temperatures than their habitats suggest but their growth will slow. There are fine cork and holm oak specimens in parts of England, for example, and a medium-sized Mirbeck grows in Kew. Acclimation to rapidly rising temperatures is expected to present a greater obstacle.

Although oaks have overcome manifold challenges for millions of years experts now fear for the future of Europe's mid-latitude species. The Mediterranean Basin is expected to be more strongly affected by ongoing climate change than most other regions on Earth (IPCC, 2013). The magnitude of these projections warrants great concern for the particularly rich biodiversity found in this region (Petit et al., 2005). This is especially alarming because the predicted loss of the southern marginal populations in or close to glacial refugia would extinguish invaluable genetic resources which possess just the characteristics that would be essential to face the hotter and more arid conditions forecast (Ducousso, 2012).

Specific consequences have already been identified. The combined stress of rising temperature and falling water availability will mean lower acorn production in cork oaks (Pérez-Ramos et al., 2010). The thirstier Mirbeck is likely to be affected still more although there are promising intimations from Spain's Agriculture Ministry that the species is more xeric than previously thought (Benito-Matías, pers. comm.). Rising temperature and reduced water raises a third threat: fire. Only cork oaks are resistant (if their bark has not been harvested). Such conditions could end southern Iberia's peak summer tourism season as visitors stay away (Stern, 2006).

Optimists or global warming skeptics cite the Quaternary quandary in which fossil records over the last 2.5 million years show far fewer species went extinct in some areas than current models suggest. But several doubts must be raised. Those records are fragmentary and may misrepresent actual losses. Further, while only one tree is known to

have become extinct in North America, Northern Europe suffered dramatic losses in which over two thirds of its tree genera disappeared (Svenning and Skov, 2004). Greenland and Antarctic ice core samples have revealed temperature rises actually more abrupt than predicted due to anthropogenic climate change (MacDougall, 2006). But no species in the past has had to confront the challenges of precipitous weather changes compounded by landscape fragmentation, air pollution and biotic invasions (Hampe, pers. comm.).

Conservation concerns

The Mirbecks or Marianicas surviving in Portugal total only a few hundred mainly young individuals confined to perhaps a dozen vestigial populations in an area about 100 km/62 mi from east to west with roughly the same distance from the nearest Spanish trees. These small populations are vulnerable to fire or illegal destruction (which occurs regularly with the much more valued cork oak). Such low numbers and isolated populations also raise concern about inbreeding depression and genetic drift in which gene variants or alleles disappear from generation to generation and are not replenished because of isolation, rendering a population more homogeneous and thus more susceptible to environmental change. These survivors have become so hybridized that true *Q. canariensis* may no longer exist here, having been replaced by *Q. ×marianica*, as mentioned previously. As noted earlier almost no trees in the country are older than 30-40 years. Although numbers are modest, specimens appear healthy and self-sustaining. Moreover, reduced numbers do not necessarily mean a reduced genetic base or limited diversity. Nevertheless, *in extremis,* one must recognize the danger of minimum population numbers below which a species is no longer viable in the wild (Schaffer, 1981).

In spite of these concerns, no public or private nursery is propagating the tree in Portugal, unlike in Spain, and importing material from about 400-500 km/249-310 mi away (or further if African acorns were available) can be controversial. Exogenous introductions can generate outbreeding depression in which very maladapted alleles added to a small population could depress fitness enough to lead to extinction. Still, the long time oaks need before being capable of reproduction means that any unsuitable introduced genotypes are likely to succumb in the new environment or can be removed before they reproduce (Moran, pers. comm.).

On the other hand, reintroduction of exogenous material eventually to furnish wider genetic resources or replenish lost ones can enhance a reduced population (Godefroid et al., 2011). Doing so with material from further south that may possess greater resistance to the higher temperatures and or lower rainfall anticipated might even be imperative for its survival (Ducousso, 2012).

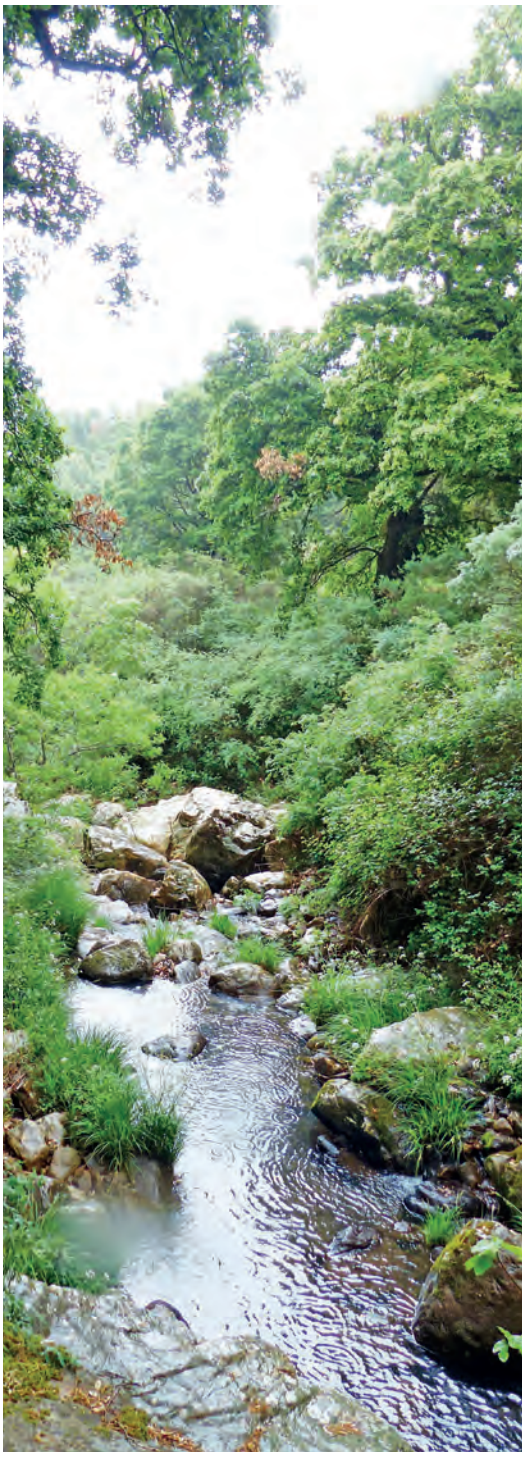
How does one implement genetic rescue of rare plant populations that may have limited genetic variation? Which populations can suitably be mixed with other populations? Poor selection raises the potential for maladaptation and outbreeding depression. Or will unsuitable intruders simply die out long before any pollen is produced? In a world in which invasive species may, as the biologist Edward Wilson asserted, be the second greatest threat to biological diversity after habitat loss, concerns about intraspecific, let alone intrahybrid, differences can appear superfluous. Still, trying out a range of genotypes in a distant area without Mirbecks rather than in existing possibly vulnerable populations would appear prudent.

An ambitious project

The Algarve is best known for the tourists it attracts—almost 10 million yearly. Because the masses mainly seek sun and sand much of the interior is peaceful and relatively unpopulated even in high summer. This is especially true of the Ceixe Valley that meanders some 35 km/22 mi from Monchique's highlands through abandoned farms and regimented eucalyptus plantations down to the Atlantic Ocean (Photo 8). From a conservation perspective the area is outstanding. It is fed by one of the few rivers in the region that flows constantly, even after months of summer drought. It contains more surviving Mirbecks than anywhere else in Portugal and could protect other rare Portuguese oaks such as *Q. faginea* subsp. *alpestris* (Boiss.) Maire that still survive in the Valley.

Other rare taxa that would benefit from protection include *Q. robur* subsp. *estremadurensis* (O. Schwarz) A. Camus, *Q.* ×*andegavensis* Hy nothosubsp. *henriquesii* (Franco & Vasc.) Rivas Mart. & Sáenz*, *Q.* ×*andegavensis* Hy nothosubsp. *subandegavensis* (A. Camus) Vila-Viçosa, F.M. Vázquez, Meireles & Pinto-Gomes nom. ined., *Q.* ×*coutinhoi* Samp., *Q.* ×*coutinhoi* Samp. nothosubsp. *beturica* F.M. Vázquez, A. Coombes, M. Rodríguez-Coombes, S. Ramos & E. Doncel** and *Q.* ×*neomairei* A. Camus (Vila-Viçosa, 2012).

A ravine at its higher eastern end shelters what is probably the country's largest community of practically extinct *Rhododendron ponticum* var. *baeticum* (Boiss. & Reut.) Hand.-Mazz. The threatened endemic spurge *Euphorbia monchiquensis* Franco & P. Silva*** is almost certainly present at lower elevations and the western end joins the Costa Vicentina



8/ The Passadallana Valley in Los Alcornocales.

* Considered by some authors to be a synonym of *Q.* ×*andegavensis* Hy.
** Considered by some authors to be a synonym of *Q.* ×*coutinhoi* Samp.
*** Considered by some authors to be a synonym of *Euphorbia paniculata* subsp. *monchiquensis* (Franco & P. Silva) Vicens, Molero & C. Blanché.

Natural Park along one of Europe's most beautiful oceanic coasts. From insects and fish to birds, such as the Bonelli eagle, and mammals, such as the European lynx, the world's most threatened cat, southern Portugal has no shortage of creatures at risk and the Ceixe Valley's varied terrain could provide a refuge for many of them.

It is this special place with vestiges of a remote past, as close to an Arcadia in the

9/ The Pico de El Aljibe in the Parque Natural de Los Alcornocales.

Algarve as one can hope to find today, that has inspired a dream: to create a national reserve like the magnificent forest of Los Alcornocales in neighboring Andalucía. Such a reserve for threatened flora and fauna would mean that in a century or two, if future changes are not too extreme, Portugal and its visitors may be able to sense what the Earth was like before we arrived.

The challenges

At a recent Spanish workshop, Oak Forests Coping with Environmental Change, one speaker spoke for many in declaring: "Great concern exists that ongoing rapid climate change is likely to overstrain the capacity of oaks and other forest tree species to track suitable climate spaces, potentially leading to widespread extinctions through the coming decades." (Hampe, 2013).

Such concern is not massively evident in Portugal. To date there has been little effort to preserve a significant component of its natural heritage and probably its largest native tree. Although *Eucalyptus* covers a higher proportion of Portugal than of any nation on Earth, legislation was issued in July allowing further plantations on 80% of forested land. This is likely to increase fire risk, will lower water tables and restrict wildlife still

further. It is no surprise, then, that Portugal's 2012 Environmental Performance Ranking for forests is 119 out of 132 countries (Yale, 2012; FAO, 2010).

With the rise of environmental issues on government and citizen agendas worldwide, perhaps the Portuguese authorities will eventually take substantive steps to promote this exceptional component of the nation's natural heritage. Perhaps the country's biggest environmental NGO, providentially called *Quercus*, will do much more to raise awareness of the tree's profile and uncertain prospects. To date the signs are not promising. But support may be forthcoming from European Union programs. And businesses, which are already contributing to other conservation efforts, may be persuaded to extend their stewardship to this magnificent tree.

So the dream of creating one of the country's largest natural sanctuaries is challenging at best. At worst, attempting such a venture in the face of general indifference by replacing existing eucalyptus plantations which officials actually want more of in a country with scant environmental activism during deep recession and high unemployment is quixotic. Yet this may be Portugal's last and best chance to preserve an important part of its heritage, restore a unique valley and leave a precious legacy for future generations. It was in even more adverse economic times that a visionary Franklin Roosevelt employed hundreds of thousands of the Great Depression's unemployed to plant billions of trees. And in a cruel irony of Portugal's current financial anguish, only multimillionaires are prospering. Could a rare benefactor be found among them? A few individuals with reasonable funding and unreasonable determination and commitment could make such a difference. Those concerned about the future should remember these words attributed to Margaret Mead: "Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has."

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Photographers. Title page: Antonio Lambe (*Quercus canariensis* in the Parque Natural de los Alcornocales). Photos 1-2, 5-9: Antonio Lambe. Photo 3: Brad Cadwallader.

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Oak-Rod Baskets in Brown County, Indiana: Historic Photographs of a Craft Tradition

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ABSTRACT

The Hovis and Bohall families of Brown County, Indiana, made distinctive white-oak (*Quercus alba* L.) baskets for their neighbors to gather corn and carry everyday items. However, by the 1930s, the interest of urban tourists transformed these sturdy containers into desirable souvenirs. Using historic photographs, this brief essay explores the shifts in the uses and meanings of these handmade objects: when this type of basket became obsolete as agricultural implement, it became a symbol for the County and its residents who many outsiders viewed as simple and quaint. While tourism encouraged the tradition to continue for a time, by the 1980s the making of oak-rod baskets had disappeared in Brown County.

Keywords: *Quercus alba* L.

Introduction

Henry Hovis and his family brought the distinctive tradition of making oak-rod baskets to Brown County, Indiana from Pennsylvania sometime in the 1850s. Similar to other white-oak basket styles, these woven containers are made from rived splits; however, in this distinctive tradition, the oak stock is rendered round by pulling thin lengths through iron dies. These round rods look similar to the willow used in some basket traditions, but have the advantage of being stronger and more durable. In addition, oak rods can be produced from longer stock than the willow withes, which makes weaving faster and more uniform.* While white oak remains one of the most common materials used in making baskets in the Eastern United States, the labor-intensive tradition of making oak-rod baskets is very uncommon.

For much of the 19th and early 20th centuries, the Hovis and Bohall families in Brown County made these white-oak baskets (Photo 1) for their neighbors to gather, carry and store everyday items. However, by the 1930s, urban tourists started coming to the Brown County Art Colony to see its natural beauty and to meet its rural people. Within this new context oak-rod baskets changed from commonplace containers into desirable souvenirs.** As these baskets became obsolete as agricultural implements, they developed into symbols for the County and its residents, whom outsiders often viewed as simple and quaint. While tourism prolonged the tradition of making these baskets, by the 1980s the weaving of oak-rod baskets had disappeared completely in Brown County. The historical transition of this tradition is absent from written histories, however, by using historic photographs, one can study the shifts in the uses and meanings of these handmade objects.

1/ ***Joe Bohall, basket weaver,*** **circa 1920.**

Looking at old photographs from Brown County, one can observe some of the early everyday uses of these woven containers. Large bushel baskets were used to store corn, smaller ones were carried to the woods to gather hickory nuts, while others used these sturdy baskets to carry food to local church dinners and family gatherings. Images from the 1930s and later show the transformation of these baskets from an everyday object into a kind of ready-made antique and art object. In the early 20th century, many began to view the residents of Brown County as an isolated remnant of Indiana's pioneer settlers. As anti-modern sentiments increased in the state, oak-rod baskets became an icon of a vanishing way of life. Photojournalist Frank Hohenberger promoted this nostalgic view of Brown

* For a detailed description of this creative process see Joyce (1989). A comprehensive survey of basketmakers is found in Law, et al. (1991).

** For more about the Brown County Art Colony see Letsinger-Miller (1994).

County in his weekly *Indianapolis Star* column, "Down in the Hills of Brown". His images of rural practices (Photo 2) such as weaving and broom making, fueled interest in local handicrafts—especially oak-rod baskets.* Below I explore a sampling of images from over a century of white-oak baskets in Brown County that I contend tell the story of this traditional craft and its shifting significance in a rural community.

2/ *John Bohall pulling basket reeds,* 1927.

1900s

This early image of the Ping Family (Photo 3) picking up hickory nuts predates the beginning of the Art Colony and the rise of tourism in the County. The photograph shows that oak-rod baskets were in common, daily use in the county at the turn of the century. While members of both the Bohall and Hovis families did not list their occupations as basketmakers until the 1880 census, material evidence and oral histories reveal that these families made baskets for generations.

1910s

Studying historic photographs can show the variety of everyday uses of these baskets. Most of the images of these baskets show them as agricultural tools or tourist crafts, but in Photo 4 there is a basket under the table at *Mr. Mabe's birthday party* near the small community of Stone Head. Apparently, locals used the baskets to carry food to the dinner, showing that these baskets were also a domestic object (Hartley, 1994).

3/ *Gathering nuts,* circa 1900.

1920s

Early in the 20th century, urban outsiders began to view these baskets as a symbol of the passing agricultural way of life in the state; a way of life that they thought Brown County epitomized. In Photo 5, Brown County resident Vene Schrock is dressed as the

* For more about Hohenberger and his photography see Bustin (1982) and Byrd (1993).

4/ ***Mr. Mabe's birthday party,*** **circa 1905.**

5/ ***Vene Schrock dressed as Abe Martin,*** **circa 1920.**

once-popular syndicated cartoon character from Brown County, Abe Martin. Schrock is surrounded by several out-of-date things: a rope bed, spinning wheels, and a yoke for oxen.* A small rod basket hangs conspicuously in the upper right-hand corner of the image. The basket was just one of several objects deployed as material proof that Brown County was a stronghold of the past and an otherworldly place peopled by curious country folk.

6/ ***Restaurant and shop in Nashville, Brown County,*** **1935.**

1930s

Joshua Bond's Rustic Inn Restaurant (Photo 6) in the County Seat of Nashville served as the local "information bureau" for the auto-tourist who came to Brown County in the 1930s. In front of the establishment are child-sized "old hickory" chairs as well as rod baskets that are for sale to tourists. This was perhaps the first wave of local craft marketing that took place in the County, an economic development strategy that would be revived repeatedly throughout the following decades. Photo 6 was taken by Theodor Jung, a New Deal photographer with the Farm Security Administration, who traveled throughout the County photographing the farms of the rural poor, in advance of resettlement efforts.

* Created by Frank McKinney Hubbard, Abe Martin came to personify the rural perceptions of Brown County, even though he was a cartoon. Many locals found Hubbard's depiction of Brown County and his characters offensive. For more about Abe Martin see Kelly (1952).

1940s

7/ ***Display of woven baskets at Bill Schnepp's,*** **1949.**

With the promotion of Brown County as a tourist destination tourism became its primary industry. While handicrafts remained popular among visitors, locals grew tired of making crafts for tourists, who expected to pay old-time prices for old-time crafts (Hohenberger, 1952). More and more crafts were imported from Southern States to meet the growing tourist demand. Displayed alongside Brown County baskets (Photo 7) were handmade baskets from Cannon County, Tennessee, that tourist shops imported by the truckload (Kay, 2013).

1950s

8/ ***The Old Country Store,*** **1950.**

By the 1950s, Nashville had emerged as Indiana's premier tourist destination. A. J. Rogers did much to promote the town through his Nashville House Restaurant and the Old Country Store (Photo 8). Initially sold as tourist wares, the rod baskets soon became display items and fixtures for holding less expensive souvenirs in the store. Along with antiques and other crafts, these white-oak baskets became artifacts that reflected the County's subsistent history (Kay, 2010).

1970s

For many years, the baskets seemed to vanish from the imagination of the County with imported crafts replacing the oak baskets. However, folklorists became interested in this traditional art and sought out the last members of the Hovis and Bohall families still making baskets (Photo 9). Gary Stanton and Warren Roberts interviewed several retired makers, including Bruce Hovis, the last of the oak-rod basketmakers. Often focusing on the creative process, images from these fieldwork collections provide an amazing photographic legacy of this basket tradition, which ended sometime in the 1980s.

2014

Today, these baskets have become highly collectable and are displayed in area museums and historical societies, such as the Monroe County History Center (Photo

9/ ***Bruce Hovis making a basket,*** **1975.**

10/ ***Basket at Monroe County History Center,*** **2012**

10). Few remain who remember any of the oak-rod basketmakers but these objects are once again deployed as symbols of the region's pioneer past. Commonly stripped of their contextual meanings and uses, these baskets and their complex history can be better understood by studying their representation in photographs over time. In addition, the study of these white-oak baskets provides important insights into the changing perceptions of a community over time.

Photographers. Title photo: Anonymous, courtesy of Brown County Historical Society (*Man pulling rods*, circa 1920). Photos 1, 2, 7, 8: Frank Hohenberger, courtesy of the Lilly Library, Indiana University, Bloomington Indiana. Photos 3, 4: Otto Ping, courtesy of the Indiana Historical Society. Photo 5: Anonymous, courtesy of Brown County Historical Society. Photo 6: Theodor Jung, courtesy of the Library of Congress. Photo 9: Gary Stanton, courtesy of Traditional Arts Indiana. Photo 10: Jon Kay.

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The Anlaby Commemorative Oaks: an Extraordinary Case of Multiple Ground-Layered Branches in *Quercus canariensis* Willd.

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ABSTRACT

Located beside a dry creek bed and originally fenced off in a farm paddock grazed by merino sheep for over one hundred years are three Algerian oaks (*Quercus canariensis* Willd.). These three Algerian oaks were planted in the winter of 1918 under the direction of Thomas Leslie, the former Head Gardener on behalf of the owners of Anlaby, one of South Australia's most influential and significant pastoral properties. The Anlaby Commemorative Oaks were planted as a memorial to three farmworkers who went to fight in World War One and lost their lives. This story is certainly very significant in the context of Australia's many sacrifices during the First World War but in November 2012 when I first examined these specimens another story, a botanical one, was apparent. A complex combination of human, environmental, biomechanical and biochemical factors or sequence of events has resulted in a behavior never seen before in this species of oak: numerous ground-layered branches that have grown their own root systems, yet are still attached to the mother tree via the original "umbilical" branches.

Keywords: Algerian oak, Australia in World War One

1/ The Anlaby Memorial Oaks.

Introduction

In November 2012 when I began my research on the heritage trees of Anlaby in South Australia's Barossa Valley I came across three Algerian oaks (*Quercus canariensis* Willd.) that aroused my curiosity. What lay before my eyes was a phenomenon which I thought was not possible in oak trees: ground-layered branches with their own developed roots, yet still attached to their mother tree by the original "umbilical" portion of the branches. I could not believe what was in front of me. Climbing amongst the low tangle of branches and gently brushing aside the collected leaf litter I embarked on what was to become a year long journey of discovery, examination and research. What is this phenomenon? How did it develop? What factors contributed to this peculiar oak behavior? Could this happen again? How could this happen in such a dry, low-rainfall area? These are some of the questions that I pondered as I stood there in awe of the magnitude of the ground-layered branches that I had discovered on the Anlaby Commemorative Oaks. What seemed obvious was that only a complex and fairly unlikely combination of factors—both natural and social—could have produced this unique behavior. These commemorative oaks have stood in silence since their planting in 1918 as the guardians of the three fallen soldiers. It was an honor to be allowed into their silence. It is an honor to be able to tell their story.

The social history

During the First World War three young men from the pastoral property Anlaby in South Australia's Barossa Valley went to war. They were enlisted through the Kapunda Enlistment Office that served the Barossa Region.

The first of these young men to die, George Albert Lieschke, was a farmhand whose parents, Frederick and Elizabeth, resided at Anlaby. He enlisted on August 31, 1914 as a

private in the 10th Battalion (D Company Australian Infantry Forces) and embarked from Adelaide, South Australia, on board Transport A11 Ascanius on October 20, 1914. He died of meningitis on May 3, 1915 and was buried at the East Mudros Military Cemetery on Lemnos Island (Greece). The deep sadness and grief that was felt by the death of George Albert Lieschke touched many in the local Kapunda district, as was expressed in the local paper *The Kapunda Herald*:[1]

"The late Private Albert George Lieschke, whose parents reside at Anlaby, went with the early volunteers… At the time he volunteered he held a good position on Anlaby Estate as one of the farmhands on the station. Mr. C. de N. Lucas, the manager of Anlaby, in making reference to the sad event, said he felt a personal sense of grief at the young man's death… The whole district felt the loss, and the deepest sympathy had been extended to his parents, who were widely respected."

J.M. Robertson, the second young man, was the son of an Anlaby manager. He was a bombardier with the 11th Brigade of the Australian Field Artillery, and died on July 5, 1917. His remains repose at Trois Arbres Cemetery in Steenwerck (France).

David Clark was born in Crieff, Perthshire, Scotland. He migrated to South Australia and worked as a gardener at Anlaby. He was a private in the 43rd Battalion of the Australian Infantry Forces. David Clark was the last to die of the three young men from Anlaby on May 3, 1918, at the age of 27. About 307 men enlisted from the Kapunda district during World War One. Sixty-five men, almost one in five, did not survive and were interred close to where they died, except for six of them who were never found. They are commemorated only with their names inscribed on major memorials in Gallipoli (Turkey), France and Belgium. David Clark was one of those whose memory is commemorated in perpetuity at St. Sever Cemetery Extension in Rouen (France).

After the death of David Clark, the owners of Anlaby, Henry Hampden Dutton and Emily Dutton, decided to plant three Algerian oaks* as a commemorative planting. It is most likely that they were planted in the winter of 1918 under the guidance of Thomas Leslie, the retired Head Gardener. A brass plaque, approximately 200 mm x 400 mm/8 x 16 in, was inscribed with the three soldiers' details and memorial dedication. It was attached to a wooden stake and placed under the oak trees. The oaks were fenced off with a wire rabbit-proof fence with a small pedestrian gate on wooden posts to provide access. It is most likely that these Algerian oaks were grown from acorns gathered from the numerous specimens on the property most of which date from the mid-nineteenth century. Henry and Emily Dutton's gesture to have a commemorative memorial planted for the fallen soldiers from Anlaby was indicative of the national enthusiasm that swept across the country. Commemorative plantings of gardens and trees for fallen soldiers took place all over Australia. *The Kapunda Herald* recorded this enthusiasm:[2]

"The Committee of Dutton Park, Kapunda, have decided to plant a soldiers' memorial garden at the park close to the front entrance, and are making an appeal to meet the cost of the material for erecting a fence around the plot selected… Mr. and Mrs. Dutton, of Anlaby, have promised to assist the committee in every way."

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* The Dutton family's travels to Spain during the nineteenth century for their merino breeding program exposed them to this oak species (highly suited to harsh conditions and drought) and its potential use on their South Australian family property. These early specimens were certainly proven performers by 1918. The Federation Drought (1895-1903) left its mark on the Dutton family's selection of suitable exotic trees. Indeed the Algerian oaks have proven to be outstanding drought-tolerant trees for Australian conditions.

2-3/ A tangle of ground-layered branches (Specimen 1).

An unlikely sequence of events

Botanically, many trees have the potential to ground layer low-lying branches given the necessary environmental, biomechanical, biochemical, or other factors. Finding an explanation to the magnitude of the ground layering of these three Algerian oaks meant discovering what combination of factors could have contributed to this, and what event, if any would have triggered this behavior. It is important to keep in mind that the geographic area in South Australia where Anlaby is located has an annual rainfall of 450-470 mm/18-19 in. It is technically an area of dry sclerophyll conditions as evidenced by the indigenous trees and plants that have thick drought-proof foliage, bark and root system. Some of the critical factors contributing to the Anlaby phenomenon include the following:

Lack of human intervention

When these three Algerian oaks were planted during the winter of 1918 they were left to grow naturally and thus developed sizeable branches from ground level. The cultivation of exotic trees in Australia has a long history of pruning high to allow pedestrian and/or vehicle passage. It is a common sight around Australia to see trees used in ornamental horticulture with lifted canopies. These three oaks escaped this formal arboricultural pruning from a young age. It is certain that these trees were watered regularly during the summers from 1918 to 1920 because during that period, a severe drought affected much of Australia: Queensland, New South Wales, South Australia, the Northern Territory (Darwin-Daly Waters area and Central Australia), Western Australia (Fortescue area), Victoria and Tasmania. If these trees had not been watered they would most certainly have died. The severity of this drought may also explain why these oak specimens were allowed to develop a canopy from ground level. Such canopy silhouettes would have helped retain moisture under the trees for longer periods of time, prevented leaf and bark scorch from the blaring sun, and cooled the ground under the canopies during the drought period. They were simply allowed to grow as nature and their individual genetics predisposed them to grow. Whether there was a purpose behind leaving these three oaks to grow naturally or whether it was simply by chance that they were left to grow as they pleased is a matter for conjecture. What is important is that the possibility for ground layering depends on this low canopy structure. This, I believe, is one of the initial critical factors that was in place before the trigger event occurred.

Accumulated organic material

In late October 2013 when I had nearly finished researching the Anlaby Oaks, I still had found no evidence to substantiate the long-standing oral tradition that these oaks had been planted as a WW1 memorial. In November of that same year, Mrs. Joan Elino Schutz was visiting the garden on a tour conducted by Andrew Morphett, one of Anlaby's current owners, when it was revealed that she was the wife of a former Anlaby employee and had the evidence I was looking for. According to her, by the time she was living on the property in 1953, a thick layer of leaf litter and organic debris had accumulated under the tree canopies, due in part to the rabbit-proof fence that had been put up to protect the trees. Rabbit-proof fencing was necessary to protect the young trees from the horrific rabbit plagues of the beginning of the twentieth century. From 1904 to 1905 the twenty Anlaby "rabbiters" employed full-time killed 111,851 rabbits. By 1929, control programs during summer were killing about 2,000 rabbits per day.[3] Ironically, the necessity of protecting the trees from rabbits also prevented the wind from dispersing the autumn

leaves. This thick layer of organic material that had accumulated since 1918 was central to maintaining a substrate moisture level for a prolonged period of time in addition to providing a rich substrate to stimulate root development by covering and burying any branches which were lying on the ground. This leafy covering can still be seen today under the tree canopies.

4/ Ground-layered branches sprouting trees (Specimen 2).

The trigger event: water

In my quest to understand this phenomenon, I discovered a newspaper article in, *The Kapunda Herald* about a freak summer rainstorm in 1936 that delivered over 50 mm/2 in of rain in about an hour.[4] "Very heavy rain fell on Kapunda and district on Thursday afternoon of last week… At Anlaby, 212 points fell in about an hour. The concrete weir across the Waterloo Creek, near the Anlaby Woolshed, gave way, and the creek came down in heavy flood, inundating the low-lying country between the Anlaby homestead and the River Light… The weir which gave way diverts the water from the Waterloo Creek into the large dam which supplies the Anlaby gardens…" The three Algerian oaks are located exactly on the lower end of the Waterloo Creek in the Woolshed Paddock. The weir referred to was constructed in 1905 as part of the Northern Reservoir System. It diverted water into the Upper Catchment Reservoir. The January summer storm delivered such a volume of water in such a short period of time that it fractured the concrete weir wall. The force of water moving down the Waterloo Creek would have either destroyed the rabbit-proof fence or pushed through it. The Algerian Oaks were eighteen years old by this time. Their lower main limbs and ground-lying branches were covered with soil, silt, grass material, leaves and other organic debris. Their thick green canopies would

have shaded this organic and mineral soil build-up thus maintaining a high moisture level under the trees for a long time. The article recorded summer temperatures of between 32.6 °C/91 °F and 36.3 °C/97 °F. After this 1936 rain event the humidity was probably very high and later showers during that summer would have kept the moisture level under the trees quite high and stable. Regular rainfall patterns were recorded after the Federation

5/ Specimen 2.

Drought (1895-1903) and from the1920s until 1936. From 1937-1947 however Eastern Australia experienced another prolonged drought with little respite.

Scarification

The force of the 1936 rain event not only provided a high level of moisture to the lowest branches while increasing the amount of soil and organic debris they were buried under but also physically scarified (wounded) the buried branches. This type of wounding stimulates auxins (hormones) around the area of the wound. Epicormic buds under the bark and undifferentiated cells may have been stimulated to become root primordia thus producing upright foliar shoots. The high number of ground-layered branches and the multiple points of root stimulation indicate how extensively this water force scarified the branches when it forced its way under the trees carrying coarse debris and other materials.

Time

The 1936 rain event, the buried young low-lying branches, the forceful and random physical scarification, the prolonged and high moisture and humidity levels are the ingredients of the Anlaby phenomenon. But the length of time the layered branches were in contact with the moist substrate is a critical factor. It is hard to estimate how long it

6-7/ Specimen 3.

took for these low-lying branches to develop roots but clearly after the 1936 rain event the protected, humid and warm microclimate at ground level and under the accumulated organic substrate was maintained for a prolonged period of time. This may have been due to water in the Waterloo Creek, periodic summer showers, rains after the 1936 event, an unusually humid summer or a complex combination of these scenarios. When one visits Anlaby during the height of summer (January-February) one would seriously struggle to comprehend the probability of a wet humid summer. But this is exactly what happened in 1936. The regular rainfall patterns from 1920 until the end of 1936 came at a critical time between two periods of drought (1895-1903 and 1937-1947). A freak January storm (as happened in 1936) dumping a flooding rainfall but with no post-storm rainfall at all (as is usually the case in summer) would have meant that the wet and humid conditions that were created would not have lasted very long. This unusually wet summer season prolonged the time of contact the low-lying branches had with the moist substrate essential for the rooting of the ground-layered branches.

Statistics

These specimens are in excellent health and exhibit the typical silhouette of the species. It is common in Australia for Algerian oaks to grow to exceptional size. The three trees were planted close together and their interwoven canopies touch. The numerous ground-layered branches, which all three specimens possess, are still attached to each mother tree by the umbilical branches. From the point of attachment to the mother tree to the point where the roots have developed the umbilical branches are notably thin. From the point where the roots have grown they are exceptionally thick. Some branches continue to snake along the ground and take root at more points along the branch length. These umbilical branches are the most important physiological characteristic of this ground-layering behavior.

The largest specimen, identified as Specimen 1, has a main trunk with giant main limbs from close to the ground upward. This is rare to see in Australia where most oaks

are pruned to allow pedestrian and/or vehicle access under their canopies. The largest specimen has over 12 ground-layered branches located on the south side of the canopy towards the Waterloo Creek. Specimen 2 has three notable ground-layered branches with numerous smaller foliage shoots. The largest of the three, is a sizeable tree in its own right, yet still attached by an umbilical branch to the mother tree. This particular ground-layered branch is 1.4 m/4.5 ft in girth at 1.3 m/4.2 ft above ground and its lofty height extends the overall canopy silhouette of the three trees. Specimen 3 has one notable ground-layered branch. The integrity of this branching system with its multiple ground-layers and umbilical branches must be protected, maintained and intelligently managed for the future.

Specimen 1

Circumference: 5.6 m/18 ft (800 mm/31.4 in above the ground between numerous main limbs).
Canopy Spread: East-West: 24 m/79 ft; North-South: 30 m/98 ft
Height: 20.5 m/67 ft
Date measured: November 21, 2012
Measured by: Charlie Buttigieg (Heritage Tree Researcher) & John David Morphett (Assistant).
Year planted: 1918
Planted by: the family members of the deceased soldiers from Anlaby or by Anlaby gardeners under the direction of the retired Head Gardener, Thomas Leslie, on behalf of the owners of Anlaby, Henry Hampden Dutton and Emily Dutton.

Conclusion

There is no doubt that a complex combination of factors triggered by an exceptional natural event at the right moment in time is responsible for this unique behavior of *Q. canariensis*. It is astounding that it occurred in a geographic area that is a dry, harsh and unforgiving landscape. Which just goes to show that any environment, given the timely combination of exceptional factors and conditions, can produce unexpected behavior. The probability of this happening somewhere else in another time and place is low, but clearly it is possible. These historically and culturally significant Algerian oaks were planted to be guardians of the dead. Their primary function was to commemorate three farmworkers from Anlaby who died during the First World War: another thread in the national story of Australia's involvement in this War. But the botanical and scientific significance of these three Algerian oaks is a thread in the international story of understanding how and why oaks behave the way they do. There is no doubt that these three oaks will stimulate much discussion and debate in the future. Their future now needs to be protected and managed intelligently.

On December 3, 2013 the National Trust of South Australia reviewed my nomination report on these Anlaby Commemorative Oaks for inclusion onto the South Australian Register of Significant Trees. The nomination report was accompanied by a letter from Béatrice Chassé, the President of the International Oak Society—whom I had contacted to try and find out if anyone in that Society knew of the existence of other *Q. canariensis* exhibiting ground-layered branches. After questioning many IOS members, the answer

was no. The three trees have since been accepted as Trees of National Significance and registered under the NTSA Registration Number 785. This is currently the highest level of registration on the South Australian Register of Significant Trees. A note was added to this registration that these oaks be moved to Trees of International Significance when such a level is introduced under the new National Trust of Australia National Register of Significant Trees in 2014.

Photographers. Title page: Dragan Raboca (Anlaby Homestead with *Schinus molle* var. *areira* (L.) DC. in foreground). Photo 1: Andrew Morphett. Photos 2-7: Charlie Buttigieg.

The close-up photographs of the various ground-layered branches were taken on April 23, 2013 and were part of the formal Nomination Report to the Significant Tree Register Steering Committee, National Trust of South Australia.

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Oak Open Day
Sir Harold Hillier Gardens
United Kingdom
July 29, 2013

Hugh Angus
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Introduction

1/ Jermyn's House.

The venue for this meeting was the world-famous Sir Harold Hillier Gardens in Hampshire, UK, started by the late Sir Harold Hillier in 1953 and today managed as a charitable trust by Hampshire County Council. It was the site for the first of our Oak Open Days in 1995. Today it extends to some 72 hectares/180 acres and contains nearly 12,000 taxa represented by over 40,000 plants. One of the 13 National Plant Collections held by the Gardens is for the genus *Quercus* and has well over 350 taxa. Heaven for oak lovers such as ourselves! A great number of these oaks were introduced by Allen Coombes who was the Botanist at Hillier's for more than three decades and many of these accessions are from wild populations, adding greatly to their conservation value.

The day started in Jermyn's House over a cup of coffee allowing participants to chat and catch up with old friends before the day's business began. In total 41 people from six different countries attended the day. A warm welcome from IOS Tour Director Shaun Haddock was followed by greetings from Béatrice Chassé, IOS President, that included a message from Allen Coombes saying how much he would have liked to have been with us and that he hoped we would enjoy the day in the Gardens that he enjoyed for over 30 years. Just in case we had other ideas, he offered a number of suggestions on what we might want to have a look at and discuss. It was then down to Wolfgang Bopp, Director of Sir Harold Hillier Gardens, to welcome the group and lay out the plans for the day. A pack containing a list of all of the oaks in the collection, giving their location and other details, was given to every participant along with other information about the Gardens.

The morning's treasures

The group of 41 was split into two for the morning visit. The same route was to be followed by both but in opposite directions. Our leaders for this were David Jewell, Head of Collections, and Barry Clarke, Botanist. During this part of the day we concentrated on the oaks around Jermyn's House and the area known as Brentry Woodland, an area of "green sand" (formed in ancient marine environments, rich in organic detritus and low in sedimentary input) that allows for a greater diversity of plants to be grown. Many wonderful oaks were seen during the morning and this encouraged many discussions about names, how to identify species, performance in the UK, and many other interesting facts.

2/ *Quercus rysophylla*

3/ *Quercus sartorii* Liebm.

Q. rysophylla Weath. (loquat-leaf oak). This rare tree is a UK Champion and was collected by Sir Harold Hillier himself in Mexico in 1979. It is now over 18 m/59 ft tall, has survived temperatures down to -18 °C/0 °F, and is still growing vigorously.

Notholithocarpus densiflorus (Hook. & Arn.) Manos, Cannon & S.H. Oh (formerly *Lithocarpus*). A nice specimen near Brentry House. Discussions centered on how best to

propagate this species, with no definitive answers forthcoming.

Q. suber L. A beautiful specimen with lovely bark.

Q. mexicana Bonpl. This tree showed the lovely pachydermatous bark so characteristic of many Mexican oaks.

Q. serrata Murray (formerly *Q. glandulifera* Blume). Characterized by the bulbous spine on the edges of the leaf.

4/ *Quercus baloot*

Q. baloot Griff. This is a very rare plant in the UK and it is thought that most specimens have arisen from a collection made by Shaun Haddock, from Northwest Pakistan in 1995, at around 2,100 m/6,890 ft. It is a slow growing plant: the current specimen at Hillier's is about 2.8 m/9.2 ft tall.

Q. delgadoana S. Valencia, Nixon & L.M. Kelly (the new name for the Mexican plant that has been referred to as *Q. eugeniifolia* Liebm.).

Q. furfuracea Liebm. Certainly one of the rarest oaks in cultivation. This is an Allen Coombes collection from Mexico in 1996.

5/ *Quercus delgadoana*

Q. monimotricha (Hand.-Mazz.) Hand.-Mazz. This specimen really is one of the best you can see anywhere. It arose from a Roy Lancaster collection in 1986. It produces viable seed regularly and it was nice to see this specimen with many acorns. At best it makes a small multi-stemmed shrub.

And also: *Lithocarpus henryi* (Seemen) Rehder & E.H. Wilson; *Q. dentata* Thunb. 'Pinnatifida'; *Q. affinis* Scheidw.; *Q. oglethorpensis* W.H. Duncan; *Q. ithaburensis* subsp. *macrolepis* (Kotschy) Hedge & Yalt.; *Q. greggii* (A. DC.) Trel.; *Q. oxyodon* Miq.; *Q. kiukiangensis* (Y. T. Chang) Y. T. Chang, which was originally identified and distributed as *Q. argyrotricha* A. Camus; and *Q. tomentella* Engelm.

6-8/ *Quercus monimotricha*

The afternoon's treasures

Lunch was served back in Jermyn's House and this gave us all time to discuss what we had seen and again to catch up with old—and make new—friends. The afternoon self-guided tours were indicated on the map we received as OF (Oak Area A) slightly to the north of the Visitor Centre and CK (Oak Area B) in the southwestern part of the Gardens. Starting off from Jermyn's House took us across the fabulous Centenary Border. It is now two years since refurbishment of the border started and the hard work was very obvious as was the quality. It well demonstrated just what can be achieved in such a short time with good quality plants, planning and implementation. We admired the rare *Xanthoceras*

9/ The National Collection Glade.

sorbifolium Bunge, one of the few plants not removed during the project. Once we had arrived at the OF/CK areas we were then left to our own devices before assembling back at Jermyn's House for tea. This gave us the opportunity to meander at will admiring the many fine oaks in these areas. Some of my personal highlights of the afternoon were:

10-11/ *Quercus longispica*

Q. longispica (Hand.-Mazz.) A. Camus. From Western China, the plant at Hillier's is from a Roy Lancaster 1981 collection and is now around 7 m/23 ft tall. Distinguished by the notably long female inflorescences, this tree now flowers and fruits regularly.

Q. guyavifolia H. Lév. There is some debate over the spelling of the species epithet and its place amongst the Chinese "Golden Oaks" but nevertheless it is a most interesting plant. (The spelling used here is the original spelling.) The seed from which this plant was grown was collected from Western China in the 1990s.

12-13/ *Quercus guyavifolia*

Q. stellata Wangenh. (post oak). This attractive tree has a wide distribution down the USA East Coast but remains a rare tree in the UK.

Q. eduardi Trel. Another plant from Mexico where it grows amongst pines at an elevation of between 1,500 and 2,650 m/4,921 and 8,694 ft.

14/ *Quercus eduardi*

We then assembled back at Jermyn's House for a cup of tea, but more importantly for the fabulous chocolate cake all decked out with sugar oak leaves and acorns provided by Dorothy Holley. Can I have a second piece please? However this was not the end of the day and we had the chance to examine some samples that had been collected from the Gardens. This was a wonderful display and contained many interesting treasures including:

15/ *Quercus miquihuanensis*

Q. rehderiana Hand.-Mazz. Collected in Yunnan by John Rippon at 2,700 m/8,758 ft in 1990. It was good to compare this with the *Q. semecarpifolia* Sm. in A. Rees that we had seen before lunch. The leaves from above look very similar but there is no golden indumentum on *Q. rehderiana*. It has also been known under its synonym *Q. pseudosemecarpifolia* A. Camus.

Q. miquihuanensis Nixon & C.H. Mull. Collected by Nick Macer from Tamaulipas, Mexico in 2005. This is a rare plant with a very distinctive leaf that has a thick golden orange indumentum on the underside.

Q. dolicholepis A. Camus. This is another Chinese species from Yunnan and was collected by Cao Ming in 1998. In its native habitat it grows with rhododendrons, pines and other shrubs, growing generally no taller than 16 m/53 ft.

It was then time to depart and say our farewells. As always these days are great occasions, we see and learn about new plants, renew acquaintances with old and familiar friends as well as making new ones. It only leaves me to thank all those who helped in making this such a special day. Our thanks must therefore go to Shaun, Wolfgang, Barry, David, and the many others involved in making it such a success.

Participants

Dirk Benoit, Christof van Hulle, Charles Snyers d'Attenhoven (Belgium); Ondrej Fous, Dusan Placek (Czech Republic); Béatrice Chassé, Shaun Haddock (France); Francesco Gandini (Italy); Gert Fortgens, Wiecher Huisman (the Netherlands); Hugh Angus, Christine Battle, Amanda Cairns, Chris Carnaghan, Barry Clarke, Sandra Curtis Gilly Drummond, John Gammon, Michael George, David & Carol Gooder, James Harris, Michael Heathcoat Amory, John Hillier, Dorothy Holley, David Jewell, Lloyd & Sally Kenyon, Arabella Killander, John Kindler, Fergus Kinmonth, David Lancelles, John Lipscombe, Nick Macer, James MacEwen, Thomas Methuen-Campbell, John Parsons, Judy Scott, Caroline Todhunter, Harriet Tupper, Peter & Margaret Wells, Stephen Wood (United Kingdom)

Photographers. Photos 1-3, 5-11, 13-14, 16-19: Charles Snyers d'Attenhoven. Photos 4, 12, 15: Hugh Angus.

For more information on the Sir Harold Hillier Gardens visit http://www3.hants.gov.uk/hilliergardens

Q. senescens *Hand.-Mazz. ?*

I had suggested to Allen that it would be nice to deliver a small message from him as part of my welcome address for the Hillier Oak Open Day. He readily agreed, writing a text expressing fond memories of his career at the Gardens as well as pointing out a few oaks that were decisive in developing his passion for this genus. And, he gave us a mission!

"There is a tree I would like people to look at and discuss when you get to it. It is the *Q. senescens* on the road front in Lower Brentry.

I collected seed of both *Q. rehderiana* Hand.-Mazz. and *Q. senescens* Hand.-Mazz. in Yunnan from a mixed population. I still remember the plants in the nursery. The *Q. senescens* were very small and all died before planting. The *Q. rehderiana* were more vigorous and one of them (with very hairy undersides to the leaves) was eventually planted in Brentry Woodland. But, this species should have leaves more or less glabrous beneath so I sent a piece to Zhou Zhekun in Kunming who said it was *Q. senescens*. (Note: this is the label on the tree in lower Brentry today.) It was only a young plant and growing quickly and we had no *Q. senescens* plants to compare it with but I know this plant came from the batch of *Q. rehderiana* and was very different to the *Q. senescens* that came from my seed. In my opinion it is likely to be a hybrid between *Q. rehderiana* and *Q. senescens*. Please discuss!"

None of the participants had ever seen either species growing in the wild, so the first thing that had to be done was to get a good description of both and try and pick out the main characteristics that could distinguish the two.

Q. rehderiana: the acorns are on a very long peduncle (as much as 13 cm/5 in); mature leaves are mostly entirely glabrous with spiny teeth and are often arranged in rosettes and slightly upright.

Q. senescens: the acorns are on a very short peduncle (1-3 cm/.39-1.18 in); mature leaves have a thick grey (yellow at the end of the season) tomentum on the underside (Mme Camus notes on her original drawing that the tomentum is so thick that one can not see the veins) and mature leaves are generally without teeth.

No decisive conclusions were drawn this day at the Gardens. After a recent trip to China, Allen has since reported that the question remains open after discussion with Dr. Min Deng as well. According to her, it could be a hybrid but that a DNA analysis would be needed for a definitive answer.

Béatrice Chassé

16-19/ *Quercus senescens* Hand.-Mazz.?

Oak Open Day
Pavia Nusery, Belgium
September 22, 2013
The Art of Grafting

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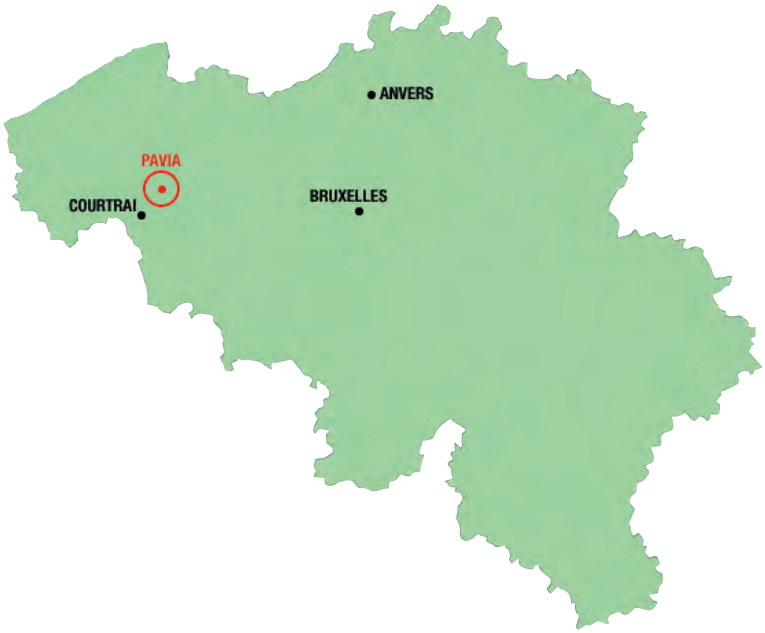

Introduction

September 22, 2013 was the day when nearly 30 "oakies" (members of the International Oak Society and non-members) came together in Southern Belgium to share the knowledge of and listen to nurseryman Dirk Benoit, owner of Pavia Nursery (Deerlijk). The subject of the day: oak propagation, either generatively with seeds or vegetatively through grafting.

Longtime IOS member Dirk, who served on the Board of Directors for two terms until 2012, together with Katrien, his wife, hosted the group that included individuals from Belgium and neighboring countries the Netherlands, Luxemburg, Germany and France, but also from Italy and, though a bit late and purely by chance, an IOS member from Australia.

1/ Dirk Benoit presenting Pavia Nursery.

Dirk started off with a presentation about his methods of oak propagation and about his nursery. Oaks are not the only prominent genus in cultivation—the name of the nursery, Pavia, suggests that there must be more. A cabinetmaker for many years, Dirk started the nursery business in 1990 on family property. His first love (besides Katrien, his wife) was *Aesculus*—and Dirk collected what he could find of this genus. Other genera followed: *Sorbus*, *Tilia* and *Crataegus* (these last two of which Dirk has the widest range of taxa of any European nursery), *Carpinus* and, of course, *Quercus*. Today, with more than 200 different oaks (species and cultivars) Pavia Nursery holds on its 7 hectares/17 acres what is probably the widest range of oaks in a nursery worldwide.

Some of the oak species and oak hybrids Dirk has introduced into European cultivation, are *Q.* ×*willdenowiana* (Dippel) Zabel (*Q. falcata* Michx. × *Q. velutina* Lam.) or the newly discovered Hispanic *Q. alentejana* nom. ined. and of course, many oak cultivars. New cultivars from the United States, or from Europe, usually show up first at Dirk's

place. He is himself a plant hunter and has introduced many novelties: several collecting trips to the United Sates, Mexico and different European countries have resulted in new plants. His own cultivars always do show very special characters, e.g., upright habit, laciniate leaves, unusual fruit or excellent fall color.

Dirk propagates oaks either with seed (most botanic species are propagated from acorns that come from all over the world, wild-collected in most cases or at least from known provenance); or by grafting (for the cultivars and hybrids, but botanic species as well).

Cuttings and in vitro propagation

It is possible to grow oaks successfully with cuttings. In Germany for example, large-scale propagation of "Plus-Oaks"* is done with long cuttings of about 50-60 cm/20-24 in selected from young plants. This technique requires special, expensive equipment that makes it uneconomic for nurserymen but feasible for institutional propagators such as university forest research units (Spethmann, 2000). If the number of cuttings exceeds more than 10,000, the costs of propagation come close to the costs of propagation via seedlings.

Propagation of evergreen oaks with ordinary small cuttings is usually successful, but with deciduous oaks it is trickier. Hawver & Bassuk (2001) have shown that a low content of endogenous cytokinin (a class of hormones which may inhibit adventitious rooting) could improve adventitious root formation. They also showed that the influence of "end-of-day" light, rich in the far red wavelengths, can improve rooting. With the necessary lights, this technique could be handled easily by nurserymen.

Another modern technique, in vitro propagation, is also too expensive for a nursery that is propagating small numbers of one taxon although Meier-Dinkel (1987, 1993) has shown that it is possible to get very good results with this technique. Thus, propagation of oaks either by cuttings or in vitro does not play an important role for commercial nurseries because it is not economically feasible.

Grafting

Why graft oaks? There are several reasons for choosing this method of propagation including unavailability of seed or the desire to reproduce a specific tree. Grafting will also allow you to increase the possibilities of cultivation for certain species by grafting them on rootstock with different characters (hardiness, alkaline tolerance, etc.). But, as with all living things there are some disadvantages as well.

Dirk has experimented with several grafting techniques and has adopted the hot-pipe system, where only the graft zone of the plant gets some heat (usually 20 °C/68 °F) which forces the two partners to grow together quite quickly and strongly. This is done mainly with plants that are difficult to propagate with traditional techniques (Benoit, 2009).

The major disadvantage of grafting is graft incompatibility: the rootstock and the scion do not grow firmly together and thus the plant fails to grow. Either the young graft will die directly, not producing callus at all, or it will die after a certain period. Interestingly this period can be quite long; grafted oaks can live for many years and suddenly fail. This

* Plus-Tree: A phenotype judged (but not proven by test) to be unusually superior in some quality or quantity, e.g. exceptional growth rate, desirable growth habit, high wood density, exceptional apparent resistance to disease and insect attack or to other adverse environmental factors (Nieuwenhuis, 2000).

problem is known as "delayed incompatibility." This is the main reason why collectors tend to plant oaks grown from seed. Nevertheless, as is discussed below, there are, despite the known disadvantages, reasons to plant clonally propagated oaks. Growing botanic species is very much in vogue with collectors but by far the vast majority of oaks are not planted by collectors but by cities for urban plantings and in these cases grafted trees are preferred for several good reasons. Their uniform shape, with good central leaders, is more suited to streets. In addition, if they are cultivars their disease and pest tolerance is probably better than that of botanic species.

It is not fully understood why some grafted partners fail to grow. As Santamour writes, the content of isoperoxidase in the plant is partly responsible for grafting results. He found that "general graft compatibilities were related to taxonomic classification, only in the sense that individuals with similar isoperoxidase patterns in either intersubgeneric or intrasubgeneric grafts are likely to be compatible." But even among individual trees of the same group, much variation in isoperoxidase patterns is found (Santamour, 1983). Interestingly, certain individuals of species in section *Quercus* have isoperoxidase patterns that are similar to some individuals of species in section *Lobatae*. As a result one may find old vital grafted partners of different sections such as the 120-year-old *Q. imbricaria* Michx. grafted on *Q. petraea* (Matt.) Liebl. rootstock (!) which is growing vigorously in the Forest Botanic Garden of Hannoversch Münden in Germany.

Grafting is of course simply necessary if you do not have seeds—and acorns of rare species are often impossible to get (even for members of the IOS!). Up until recently it was very difficult to obtain fresh acorns from the wild, especially when "the wild" was remote and unexplored. Up until the second half of the 20th century it was not easy to travel across the Atlantic, collect seeds and bring them back in good shape for germination. An acorn needs to keep at least 45% of its water content to be able to germinate, if not it will die. After only a week in a dry bag, the vitality of the embryo is lost. Still today, though acorn availability throughout the world has improved thanks to seed exchange schemes organized by botanic gardens, it has happened to more than one of us to receive nice, big unknown acorns in a dry paper bag showing no sign of life.

Historically, nurserymen have had two possibilities for propagating rare oaks (and other plants): either collecting seed in collections, which resulted in some cases in hybrid offspring, for those species that do not come true from seed; or grafting to ensure propagation of the true species. This is why there are so many grafted oak trees of botanic species in old collections in Europe. Two good examples of this in Germany are the 120-year-old *Q. imbricaria* (grafted on *Q. petraea* in the Hannoversch-Münden Forest Botanic Garden), and the *Q. robur* L. Fastigiata Group graft dating from 1795 and still growing vigorously in Kassel.

Only clonal propagation will preserve good hybrids that show the intermediate features of the parent plants. Dirk Benoit has some first class hybrids in his program, some of them coming from an American oak collector who has a good eye for these special plants. These include *Q.* ×*rudkinii* Britton (*Q. marilandica* Münchh. × *Q. phellos* L.); *Q.* ×*runcinata* (DC) Engelm. (*Q. imbricar*ia × *Q. rubra* L.); *Q.* ×*tridentata* Engelm. ex A. DC.; (*Q. imbricaria* × *Q. marilandica*); and *Q.* ×*willdenowiana* (*Q. falcata* × *Q. velutina).*

Today, thanks to the busy IOS, it is quite easy to get acorns from species that were literally unknown in cultivation 20 years ago. But since the beginnings of horticulture nurserymen have known how to propagate plants clonally with cuttings or by grafting.

Grafting was practiced by the Phoenicians, and later by the Greeks and the Romans. As discussed previously, cuttings and in vitro propagation are not economically feasible for nurserymen. But the skills and techniques to propagate oaks by grafting is accessible to them.

The rootstock quest

The rootstock is the key to successful grafting. This seems easy enough to say but in fact it is quite tricky and requirements differ from species to species! The nurseryman must have precise knowledge of the needs and ecology of both grafting partners. If you want to graft two unknown species, it is therefore trial and error. You may use one of the two "all-time goodies" rootstocks, *Q. robur* for White Oaks (section *Quercus*) and *Q. rubra* for Red Oaks (section *Lobatae*). But today, innovative nursery people do try other rootstocks as well. Dirk is one of the most innovative in this respect. He has improved an old grafting method, called cleft or wedge grafting, that takes much better. Side veneer grafting is another technique used by Dirk. Also, he usually grafts in September, whereas most nurseries prefer to graft much later in the year, from December to the beginning of March (Benoit, 2009).

Dirk is always looking for new rootstock material. This is critical especially when it comes to meeting cultivation requirements for certain soil types. Many oaks will only thrive in acid soil (pH 6.8 or lower if possible). This is the case for most of the Red Oaks, and many White Oaks too. This is the main challenge for propagating oaks that will do well in an urban situation: the soil is usually alkaline with a pH of well above 6.8 (often reaching 7.0 to 8.5) and often also very compact. This soil is poison for species like *Q. alba* L., *Q. coccinea* Münchh. or *Q. palustris* Münchh.—all of which are used at least in

2/ *Quercus* ×*schochiana* E.J. Palmer (*Q. palustris* × *Q. phellos*) grafted on *Q. palustris*.

3/ *Quercus tomentella* Engelm. grafted on *Q. robur.*

4/ *Quercus* ×*bebbiana* C.K. Schneid. (*Q. alba* × *Q. macrocarpa* Michx.) grafted on *Q. robur.*

European urban plantings quite frequently (often it is their various cultivars, such as the new fastigiate *Q. palustris* 'Pingreen' (Green Pillar™) or the older *Q. coccinea* 'Splendens' that are used). These oaks will not thrive in alkaline conditions. After only a couple of months or maybe a few years they will show chlorotic leaves and stunted growth. Using the right rootstock is critical if these widely used oak cultivars are to thrive in urban plantings. Dirk has introduced the use of *Q. shumardii* Buckley as an alternative rootstock for Red Oaks. It is one of the few Red Oaks that does well on alkaline soil. Until recently it was impossible to get acorns from that species—thus you will hardly see this pure species growing in collections, which is a pity because it has a lot of merit such as compact growth, stunning red autumn color, high drought and heat tolerance.

Together with *Q. shumardii* two other Texas natives have many of the same advantages: *Q. gravesii* Sudw. and *Q.*

5/ *Quercus* ×*schuettei* Trel. (*Q. bicolor* Willd. × *Q. macrocarpa*) grafted on *Q. robur* (*Q. macrocarpa* is also used).

buckleyi Nixon & Dorr. All three perform perfectly in Luxemburg, with no damage after winter temperatures below -20 °C/-4 °F, growing vigorously on a soil with a pH of 7.0! What would happen if these species were to be used as new rootstock? Our experience tells us that species grafted on them will perform much better in alkaline soils, (and this is, as stated above, the main restriction for planting oaks on a large scale in urban situations).

Dirk uses the swamp white oak, *Q. bicolor*, as rootstock for *Q.* ×*warei* T.L. Green & W.J. Hess 'Windcandle' (and other cultivars of this hybrid). This species shows no graft incompatibility while *Q. robur* does. Also, *Q. bicolor* grows vigorously in heavy, compact soils like clay, where *Q. robur* may fail. The recent bad press about cultivars of *Q.* ×*warei* is the result of the wrong rootstock having been used. When grafted on the right rootstock, this hybrid and its cultivars are exceptionally good and showy.

Sowing the seeds of future discussion

There was a lively discussion between participants throughout the day but also afterwards thanks to the internet, on suitable oaks for alkaline soils. Table 1 lists the species that the author knows grow well in alkaline soil without signs of iron-induced chlorosis. This may be dependent on provenance. Table 1 could well be enlarged by the experience of other IOS members and could result in a separate publication. (Please send a note to the author if you have interesting observations on oak performance in alkaline soil.)

SPECIES (SECTION)	**REMARKS**
Quercus bicolor (Quercus)	Depending on provenance; also tolerates heavy soil (clay); suitable as rootstock for *Q.* ×*warei* cultivars; showing less incompatibility problems than *Q. robur* for this oak.
Quercus shumardii (Lobatae)	New rootstock used for Red Oaks.
Quercus buckleyi (Lobatae)	New rootstock used for Red Oaks.
Quercus gravesii (Lobatae)	No observations yet if suitable for Red Oak rootstock.
Quercus pubescens (Quercus)	Disadvantage as rootstock: many suckers.
Quercus imbicaria (Lobatae)	Possible new rootstock, hardy, high pH tolerance, fast growing.
Quercus muehlenbergii (Quercus)	No observations yet if suitable for White Oak rootstock.
Quercus cerris (Quercus)	Often winter damage (stem), USDA zone 7 and below.

Table 1/ *Quercus* spp. growing on alkaline soil (pH > 6.8).

A stroll in the nursery

In the afternoon, after lunch in Dirk and Katrien's garden, time was taken to stroll around the nursery, seeing the various fields of mother plants and those ready for sale.

We saw many rare and special oaks, including Dirk's own fine introductions, such as *Q. buckleyi* Nixon & Dorr 'Carlsbad', *Q. laceyi* Small 'Bandera', *Q.* ×*mazei* publ. in prep. 'Three Sisters''or *Q. vulcanica* Boiss. & Heldr. ex Kotschy 'Kasnak'. Together with his friend Allan Taylor of Boulder, Colorado, Dirk traveled widely in the Southwest of the United States, in Texas, New Mexico, Colorado, Oklahoma and Utah. Together they selected some 40 native oaks, the majority of them belonging to the *Q.* ×*undulata* Torr. (syn.: *Q.* ×*pauciloba* Rydb.) widespread hybrid complex of that area with a lot of variation between individuals (sensu stricto this hybrid complex is restricted to *Q. gambelii* Nutt. × *Q. grisea* Liebm. forms; sensu lato *Q. gambelii* crosses with any other White Oak species with which it is (or has been) sympatric, e.g., *Q. turbinella* Greene, *Q. muehlenbergii* Engelm., *Q. mohriana* Buckley ex Rydb. or *Q. arizonica* Sarg.). Allan and Dirk selected stunning cultivars out of these, most of them exclusively available at Pavia Nursery. 'Blue Hole', 'Mesa de Maya', 'Picture Rock' or 'Spring Ranch' are only a few of these (see *International Oaks*, No. 24, 2013, pp. 161-173 for a presentation of these cultivars).

Whilst traveling in Utah, they also visited the Walter Cottam Hybrid Oak Grove at the University of Utah, where Dr. Walter P. Cottam planted his oak hybrids resulting from extensive breeding programs. Some of the interesting hybrids are in cultivation at Pavia, as he was allowed to take scion wood for grafting back home. These include the hybrids *Q. gambelii* × *Q. turbinella*, *Q. macrocarpa* × *Q. turbinella* and *Q. macrocarpa* × *Q. lobata* Née, all unusual but of great beauty and hardy for Central European climates. We saw most of these new introductions, and many others as well, but the list would be too long to praise them all here!

6/ An impeccable greenhouse.

We noticed the high quality of the plants Dirk is cultivating, not only the oaks but all of the plants were magnificent. Many of us took the opportunity to buy some of the trees he had to offer. And it was clear that oakies are not only fixed on oaks. Trees like *Aesculus glabra* Willd. 'October Red', *Carpinus orientalis* Mill. 'Pardika', *Sorbus insignis* (Hook. f.) Hedl., *Tilia henryana* Szyszyl. 'Arnold Select' or *Zelkova sicula* Di Pasquale, Garfi & Quézel 'Ciranna' also went into the cars.

7/ *Quercus grisea* 'Blue Hole' grafted on *Q. robur* (*Q. macrocarpa* is also used).

A farewell drink and snack concluded this remarkable meeting. Some of the members brought seed to exchange, such as *Acer sempervirens* L., *Q. ithaburnesis* subsp. *macrolepis* (Kotschy) Hedge & Yalt. from Crete and *Q.* ×*libanerris* Boom from Trompenburg. The members of the group knew each other well from other meetings, and again this Oak Open Day was not only a perfect day for sharing knowledge about oaks or their propagation, but also about personal thoughts, renewing contacts, and making new friends. Again, a wonderful opportunity for IOS members to spend a splendid day!

Conclusion

It must be said that the advantages of grafting far outweigh the disadvantages, taking into account all of the factors of oak propagation. Grafting is also the most economic way of clonally propagating oaks, and this is a crucial issue for the nursery business. To stay in business, a nursery can collect seed as much as possible but must also find economic ways to propagate, cultivate and sell what they produce. It is surely exceptional that a nurseryman like Dirk can keep up such an unbelievably rich assortment of different taxa! We all owe him special thanks for making it possible for us to get rare oaks and other plants so easily!

Acknowledgements

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Participants

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Photographers. Photos 1-7: Charles Snyers d'Attenhoven.

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Oak Open Days
Aiken Oak and Horticultural Tour, USA
November 1-3, 2013

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Introduction

On the evening of All Saints' Day, 2013, we gathered from different points of the world in Aiken, South Carolina, for a Barbeque Dinner that was to kick off the Aiken Oak and Horticultural Tour. In many ways, Aiken is the ideal venue for a *Quercus* event. One is even tempted to imagine that the name Aiken owes something to "oak" (it doesn't, the city was named after William Aiken, responsible for building the railroad that put the new town on the map, and the surname Aiken derives from a diminutive of Adam), but there are several reasons to link the town to our favorite genus. Aiken County may boast the largest number of native oak species of any county in the United States, though the jury is still out on that (Table 1), but in addition the City of Aiken holds one of the most comprehensive oak collections in the United States. While nature is responsible for the first claim, the second is due to the efforts of IOS member Bob McCartney, who has planted many oaks, rare and otherwise, in the city. But Aiken's horticultural bounty is not limited to oaks: on our tour we were treated to the highlights of its Citywide Arboretum, an area within a 6.4-km/4-mile radius of downtown that includes street plantings, gardens and natural woodland. During the two days of the event we were to go on four separate tours that covered the different areas of botanical interest and also indirectly gave as an overview of the town and its history. Rather than recount them in the order they occurred, I propose to use an account of Aiken's past as a narrative thread on which to hang the segments of this memorable event.

1. *Q. alba* L.	9. *Q. laurifolia* Michx.	17. *Q. pagoda* Raf.
2. *Q. austrina* Small	10. *Q. lyrata* Walter	18. *Q. phellos* L.
3. *Q. coccinea* Münchh.	11. *Q. margaretta* (Ashe) Small	19. *Q. rubra* L.
4. *Q. falcata* Michx.	12. *Q. marilandica* Münchh.	20. *Q. shumardii* Buckley
5. *Q. geminata* Small	13. *Q. michauxii* Nutt.	21. *Q. stellata* Wangenh.
6. *Q. hemisphaerica* Bartram ex Willd.	14. *Q. montana* Willd.	22. *Q. velutina* Lam.
7. *Q. incana* Bartram	15. *Q. muehlenbergii* Engelm.	23. *Q. virginiana* Mill.
8. *Q. laevis* Walter	16. *Q. nigra* L.	

Table 1/ Aiken County's native oaks. *Quercus geminata and Q. virgniana* may be naturalized rather than native. Liberty Co. in Florida allegedly trumps Aiken Co. as regards oak species diversity, and at a state level South Carolina is outnumbered by Alabama and Texas.

All aboard

Aiken came into being as a station on the Charlotte to Hamburg railroad, built by the South Carolina Canal and Railroad Company between 1830 and 1833 and at its time the longest railroad in the world. Named in honor of William Aiken, President of the Railroad Company, the town began as a stopover required by the locomotives, which at that spot had to negotiate an inclined plane, originally with a steam-powered winch and later by means of a locomotive used as counterweight. Given the town's origins, it was appropriate that we should congregate on the Friday evening at the Visitors Centre and Train Museum located in the rebuilt Aiken Railroad Depot. Dinner was a tasty

barbeque and we were entertained by the talented musicians of Palmetto Blue, whose lively renditions of bluegrass classics had us all tapping our feet and even singing along. I was particularly impressed by a piece where the band imitated a steam train, with the fiddler making his instrument sound like the train's whistle and the banjo and guitar providing the background of valves and pistons. The song "Y'all Come" was the perfect Southern welcome to kick off the event. Next morning the rebuilt Railroad Depot served as our meeting point, and as we waited for our buses we had ample opportunity to admire specimens of *Quercus falcata* Michx. and *Q. hemisphaerica* Bartram ex Willd.—and to start filling our ziplock bags with their acorns.

1/ One mile/1.6 kilometers of oaks along Aiken's railway track.

The town of Aiken was chartered in 1835, after engineers Alfred Dexter and C.O. Pascalis laid out an attractive city plan featuring wide streets and parkways that in time would be filled with trees. Immediately the city attracted visitors, including wealthy Charlestonians who came in the summer to escape the heat and malaria of their hometown. After the Civil War, the city attracted wealthy visitors in the winter as well: in this case Northerners escaping from the cold and attracted by the favorable conditions for sports involving horse riding. These visitors from the North established Aiken's celebrated "Winter Colony" and amongst them was little Louise Eustis, a frail girl brought to the town by her aunt in the hope that her health would be restored by the mild climate and drier air. Louise would spend every winter in Aiken and when she married Thomas Hitchcock, a prominent Long Island sportsman, she brought him too. He discovered that the sandy

2/ A path through Hitchcock Woods. The sandy soil drains swiftly allowing riders to get back in their saddles soon after rain.

soil was ideal for training his horses, and together with his friend William C. Whitney they purchased large areas of the longleaf pine forest, which they devoted to the practice of equestrian sports, including fox hunting. Aiken is located on the Carolina Sandhills, a strip of ancient beach dunes that is evidence of a former coastline when the ocean level was higher. It is this sand that proved good training ground for Thomas Hitchcock's horses and the good drainage meant that riding could be resumed on dry ground very soon after rain. In 1939 Thomas and Louise's children established a foundation to protect a large area of the natural forest now named Hitchcock Woods. Comprising 850 ha/2,100 ac, it is one of the largest urban forests in the United States. A guided tour to these Woods was one of our four excursions in the Aiken Tour, and we spent the greater part of two hours walking a loop around diverse types of forest. When our guide showed us where we had been on the map of the reserve, we had barely dipped into a small corner of the vast expanse.

Hitchcock Woods

We were shown Hitchcock Woods by Woods Superintendent Bennett Tucker and Woods Technician Eric Grande. Botanist and ecologist Julie Moore of the U.S. Fish and Wildlife Service also accompanied us and it was interesting to learn of her work with endangered species. She is also an authority on the longleaf pine (*Pinus palustris* Mill.) ecosystem and on the Board of the Longleaf Alliance. We heard about the prescribed burn

program, whereby sections of the woods are subjected to controlled fires on a 2- to 7-year rotation, when weather conditions are right, and in such a way that the understory is burnt without harming the established pines. This mimics nature, i.e., the fires that would be caused by lightning, and restores the characteristic habitat conditions that are most suitable for native flora and fauna. In fact, if these fires did not occur, the longleaf pine/wiregrass (*Aristida beyrichiana* Trin. & Rupr.) ecosystem would be taken over by other plants, particularly oaks. In our walk through Hitchcock Woods we were able to see several *Quercus* species, including the predominant blackjack oak (*Q. marilandica* Münchh.) and turkey oak (*Q. laevis* Walter), and also bluejack oak (*Q. incana* W. Bartram), sand post oak (*Q. margaretta* (Ashe) Small), and scarlet oak (*Q. coccinea* Münchh.). In the case of scarlet oak, we found good examples of trees that showed how this species exhibits dimorphism on its bark: on older trees (40 + years) the base up to about 1 m/3.3 ft has dark bark with wart-like texture, while the trunk higher up features the smooth grayish-white ridges with darker bark in between known as "ski trails," all the way up to where the trunk and branches taper and have smooth grayish bark. This characteristic distinguishes *Q. coccinea* from *Q. rubra* L., which bears ski trails on the entire trunk down to ground level.

The walk through Hitchcock Woods was also a good opportunity to admire the elegant longleaf pine with its characteristic long needles extending to 45 cm/18 in. The species is pyrophytic (resistant to fire). New seedlings take on the form of a dark fountain of needles and can remain ankle-high for several years, in what is known as the grass stage. At this time it is resistant to grass fires, which only singe the ends of the needles. After about 5-12 years it makes a growth spurt, especially

3/ *Carya pallida* (Ashe) Engl. & Graebn. provides striking fall coloring in Hitchcock Woods.

if there is no tree canopy above it, and soon is tall enough to be unaffected by duff fires. If fires are suppressed, however, longleaf is no longer selected by natural wildfires, so it loses its dominance and the ecosystem is compromised. Furthermore, the understory builds up and when fires do occur they are destructive and burn the tall pines as well. Hence the importance of the prescribed burning program. The specific epithet *palustris* (of marshland) is misleading and derives from a misunderstanding when Philip Miller, who described and named the species, erroneously concluded it grew in swamps. It is likely that Miller was an "armchair botanist" and based his description on hearsay or misinformation from colleagues. In Hitchcock Woods we saw it growing together with scrub pine (*P. virginiana* Mill.) and loblolly pine (*P. taeda* L.). Fall color was the other attractive feature of the walk through the Woods, scarlet oak in particular was putting on a show, and turkey oak was beginning to turn. Other species, in particular *Carya pallida* (Ashe) Engl. & Graebn., offered spectacular washes of yellow.

Hopelands Gardens

Along with the Hitchcocks, other Northerners that made up Aiken's original Winter Colony included Hope Goodard, who would winter in Aiken with her parents in the late 1800s. She married Charles Oliver Iselin, a sportsman son of a wealthy New York family, who in 1897 bought a farm where the couple built their winter home. Hope Iselin, who was known as "the great lady of racing" for her lifetime interest in thoroughbred horses, also devoted time and energy to beautifying her Aiken residence. Following her death in 1970, Hopelands, as her home was called, was bequeathed to the City of Aiken and has become a haven of beauty and a garden noted for the diversity of its plants, including a remarkable collection of camellias, and its old trees, such as deodar cedars (*Cedrus deodara* (Roxb. ex Lamb.) G. Don) and live oaks (*Q. virginiana* Mill.). Next to Hopelands Gardens stands The Rye Patch, a sizeable estate that was also a winter home for wealthy Northerners, and was likewise bequeathed to the city and joined to Hopelands Gardens.

For our guided tour of Hopelands Gardens and The Rye Patch we were accompanied by keen plantsman Dean Jolly and Dr. Harry Shealy, retired Professor of Botany at USC Aiken. They complemented botanical information with many amusing anecdotes, such as the fact that the huge Winter Colony houses we saw were referred to by their owners as "cottages," simply because their mansions up North were so much bigger. Apparently, in order for an Aiken cottage to be considered as such, it had to consist of at least 22 rooms! A serpentine brick wall that lines one side of the Gardens was explained by Dean as a ruse to extract more money from Northerners with too much cash to spare: the local contractor could double the cost of the wall by making it follow a sine wave rather than a straight line. According to local lore, a Northerner was worth two bales of cotton—and was a lot easier to pick! One of the most peaceful spots in the Gardens is a fountain installed on the foundations of the original house, a creative solution to the space left when the building was demolished. In the middle stands an attractive bust of Hope Iselin, the work of sculptor Maria Kirby Smith. There was much amusement when Dean recounted how this artist was known for including in her statues a small insect. In one instance, her statue of a Governor of South Carolina was found to include a cockroach under the coat tails of the distinguished gentleman, and when the story reached the press, a construction worker was sent with a blowtorch to remove the bug. Several minutes were spent looking for a bug amongst the lifelike pearls around Hope Iselin's graceful bronze likeness, but none

was to be found. Perhaps the blowtorch had already visited!

Between The Rye Patch and Hopelands Gardens is a natural filtration system for rainwater run-off known as the Wetlands. Around this marshland we found pond cypress (*Taxodium distichum* (L.) Rich. var. *imbricarium* (Nutt.) Croom) and *Nyssa aquatica* L., which John Palmer taught us to identify by looking for three bundled traces or groupings of vascular tissue in the severed petiole. There were many botanical rarities that caught our attention, but on a personal note I was particularly taken with a specimen of *Ilex vomitoria* Sol. ex Aiton. This holly is native to Southeastern North America and was used by Native Americans to brew a tea called "black drink" that was imbibed in large quantities during rituals. The ceremonies involved vomiting and Europeans believed, incorrectly it seems, that it was the tea that caused the puking and thus chose the somewhat off-putting name. I was unaware that North Americans brewed tea from *Ilex*, as was common practice in southern South America, and continues to be, though fortunately our brew of yerba mate (*Ilex paraguariensis* A. St. Hil.) tends to stay in our stomachs.

For quercophiles, however, the highlight of Hopelands Gardens was undoubtedly the large number of majestic 100-year-old live oaks, their trunks covered in resurrection fern (*Pleopeltis polypodioides* (L.) E.G. Andrews & Windham). Live oak is not native to Aiken, as it grows nearer to the coast, but in Hopelands, where apparently they were planted by Hope Iselin herself, they have thrived and dominate parts of the park, particularly in the eponymous Oak Alley. The amount of acorns these trees had dropped was remarkable; in some spots they completely carpeted the ground. Mrs. Iselin is also believed to have planted the century-old Himalayan cedars we admired. One had recently lost a prominent limb in a storm, but the wood had been ingeniously recouped and made into attractive benches consisting of trunks split down the middle, so we were still able to count the many rings. On our way back downtown from the Gardens, we were treated to the typical Southern feature of a long tunnel-like allée of live oaks lining Boundary Avenue.

The Aiken Citywide Arboretum

In terms of its horticultural history, surely a milestone in Aiken's development was the arrival of Bob McCartney in the summer of 1980. In fact, many of the botanical treasures that grace Hopelands Gardens were donated by Woodlanders Inc., the nursery where Bob has been a partner since he first came to Aiken. Woodlanders also began donating trees to the city and Bob planted them in public spaces. The City of Aiken's Citywide Arboretum was launched in 1995 when a tree trail of labeled trees was established along Colleton Avenue and at two parks. A young student from the University of Georgia worked as an intern during the first summer to label the trees and to write the brochure that went with it. The student's name was Todd Lasseigne and he is currently director of the Tulsa Botanical Gardens and a member of the IOS, and was in fact a participant in the Aiken Oak and Horticultural Tour.

Today the Citywide Arboretum constitutes one of the most diverse collections of trees found in any municipal landscape. Aiken has been designated a Tree City USA for the last 28 years by the Arbor Day Foundation, an award requiring four core standards of urban tree management, including a community forestry program with an annual budget of at least $2 per capita. The jewel in Aiken's arboreal crown is the Arboretum Trail on Colleton Avenue, a double avenue or parkway running through a residential district and parallel to Richland Avenue, the town's main thoroughfare. The collection includes over

100 trees of diverse genera planted mainly in the open area between the two avenues of the parkway, and also in the gardens of the residences that line the parkway. Clear and well-maintained signs identify each tree in the collection, giving common name and scientific name, and the numbers required to access the Arboretum Trail's most remarkable feature: an interactive audio guide that can be accessed by calling a local number on your mobile phone. When you call in you hear an introduction to the Arboretum and you are invited to punch in the number of the tree you are observing, allowing you to hear interesting facts about the species of the tree in question. One even has the opportunity to leave recorded feedback. It is a remarkable resource: as I write this in Montevideo and review my photographs, I am able to zoom in on the signs, call the mobile tour and hear a description of the tree in my photo! Many of the trees in the Arboretum Trail had been planted prior to Bob's arrival, but Woodlanders donated many of the younger trees and Bob was instrumental in breathing new life into the collection and installing the mobile tour. Should you call the mobile tour number, it will be his mellifluous drawl you will hear introducing the Arboretum Trail. The City of Aiken has consistently supported Bob's efforts and recently honored him by proclaiming Sunday, July 14, 2013 as "Bob McCartney Day."

When we walked down Colleton Avenue we did not need to make great use of the mobile tour, as we had the privilege of having Bob as our personal guide. He even took us on a brief detour into a friend's garden that contained many treasures, including *Hydrangea quercifolia* W. Bartram, *Salvia microphylla* Kunth 'Hot Lips' and *Magnolia ashei* Weath. Personal highlights of the Arboretum Trail were the rounded lobes of a *Liquidambar styraciflua* f. *rotundiloba* Rehder, a vigorous and verdant young *Q. corrugata* Hook. grown from acorns collected at the 6th International Oak Society Conference in Puebla, Mexico, in 2009 (this caused me to envy Aiken's mild winter, as I have just lost mine to frost), a remarkably healthy *Araucaria angustifolia* (Bertol.) Kuntze originating from seed collected at Peter Laharrague's arboretum in Argentina, and a *Q. stellata* Wangenh. that straddled the parkway with a crown spread I estimated at 32 m/105 ft.

4/ *Quercus corrugata* thriving on Colleton Avenue.

Bob's interest in oaks dates back to his childhood on a Virginia plantation where he grew up in the company of many oaks, and it became more pronounced following his association with the IOS, which began at the 3rd International Oak Society Conference in Asheville, North Carolina, in 2000. This fascination with the genus led him to create two remarkable 1 mi/1.6 km plantings in Aiken: the first along the rail track and a newer one along Beaufort Street (pronunciation alert: it is Bew-rhymes-with-"dew"-fort, not to be confused with a town in North Carolina that is spelt the same yet is pronounced in the more traditional

manner, Bow-rhymes-with-"know"-fort). It was the tour of Aiken's oak collection that for quercophiles constituted the pièce de résistance of the two-day event, and we were not disappointed. Planted about 17.4 m/57 feet apart (19 of Bob's paces), many of them rare and originating from the acorn-hunting expeditions of fellow IOS members, these young oaks, about 90 in each of the 1 mi-/1.6 km-long plantings, bear witness to a man's vision and civic-mindedness and are a unique asset in Aiken's Citywide Arboretum. When we toured the first planting, again with Bob as guide, we began at the Aiken County Agricultural Services Center, whose grounds contain many notable plants also planted by our host: the rare *Fortunearia sinensis* Rehder & E.H. Wilson, a Chinese pistache (*Pistacia chinensis* Bunge) and a chalk maple (*Acer leucoderme* Small), both turning russet and vermillion, and three *Lithocarpus* (*L. edulis* (Makino) Nakai, *L. glaber* (Thunb.) Nakai and *L. chinensis* (Abel) A. Camus—this last is in fact a synonym for *Castanopsis sclerophylla* (Lindl. & Paxton) Schottky). By the Center's car park we saw several attractive oaks including *Q. salicina* Blume with its pale-grey-undersided leaves and a hybrid collected in the Sierra Madre Oriental by Yucca Do Nursery, believed to be *Q. canbyi* Trel. × *Q. rysophylla* Weath., and named 'La Espinosa' after the valley where it was found.

The mile of oaks along the rail track was begun shortly after the turn of the millennium and many of the oaks there have already exceeded 8 m/26 ft. They are evidently well cared for and their roots enjoy a wide covering of woodchip mulch. On younger trees we had seen a rubber disk made from recycled tires that has apparently yielded mixed results, but the 90 oaks along the rail track are in good condition, in spite some having suffered being run over by drunk drivers and other

5/ *Quercus stellata* in the Aiken Arboretum Trail on Colleton Avenue.

6/ *Quercus salicina* at the Aiken County Agricultural Services Center.

hazards of urban tree life. Some in fact were lost as a consequence of these calamities and have been replaced. This planting features many Mexican oaks, including *Q. affinis* Scheidw. grown from seed collected by Guy Sternberg and Allen Coombes in Central Mexico in 1995. The fact that we were viewing the oak in the presence of the acorn hunters themselves made the experience all the more significant. Other rare oaks along the rail track include *Q. sideroxyla* Bonpl. and *Q. germana* Schltdl. & Cham. and the Critically Endangered *Q. boyntonii* Beadle from Alabama and Eastern Texas. The Tour agenda stated that the guided tour of the 1 mi-/1.6-km long planting of oaks "promises to be an excellent opportunity for those who wish to collect acorns" and that promise was amply fulfilled.

The planting along Beaufort Street is a work in progress and some of the oaks there were planted as recently as 2012. This planting displays a wide geographical spectrum and makes evident Bob's perseverance in testing the cultivation potential of rarer *Quercus* species. Amongst the Asian oaks, worthy of mention is a hybrid of *Q. fabri* Hance and *Q. dentata* subsp. *yunnanensis* (Franch.) Menitsky, which has grown remarkably well, and a vigorous *Q. dolicholepis* A. Camus. European oaks are well represented here, including the slow-growing *Q. alnifolia* Poech (the golden oak of Cyprus, see *International Oaks*, No. 24, pp 27-34) and a *Q. libani* G. Olivier that sported a branch with variegated leaves (an opportunity for a new cultivar?). Bob is particularly proud of his specimen of the only endemic African oak, *Q. afares* Pomel, which is found only in the mountains of Algeria and Tunisia. It is the Mexican oaks, however, that steal the show on Beaufort Street, including *Q. acherdophylla* Trel., *Q. acutifolia* Née, *Q. laurina* Bonpl., *Q. crassipes* Bonpl., *Q. saltillensis* C.H. Mull., *Q. obtusata* Bonpl., and *Q. crassifolia* Bonpl., amongst

7/ *Quercus germana* in the railway-track planting that had one acorn. A complex exchange of courtesies took place before it was decided who would keep it!

others. Particularly striking was a *Q. candicans* Née, which though only knee high caught our attention displaying its large, glossy dark green leaves with attractive undersides covered with white hairs.

Bob had yarns to spin about how he obtained his oaks, many from his IOS friends, some from travels far afield and others closer to home. His most recent escapade was to Florida and Georgia with Dean, our guide in Hopelands Gardens, in search of *Q. minima* Small. The dwarf live oak proved elusive till on their way home, in Brantley County, GA, they passed through a large area that had been burned in a wildfire a few years before. They were delighted to find that although there were no trees left there was no end of *Q. minima* in the diverse flora—and full of acorns. What they had not anticipated was how hard on their waists it would be to harvest acorns from knee-high shrubs!

Naturally, not without acorns

I have recounted the highlights of the Aiken Oak and Horticultural Tour using the chronology of Aiken's past as a guide, but the weekend culminated with a view to the future. As often happens at IOS events that take place in autumn, participants were able to supplement the wide variety of Aiken acorns that was available during the tour by trading oaks-to-be with participants who had brought acorns from their home districts. The seed exchange took place late Sunday afternoon at Hopelands Gardens and involved enough bags of acorns to cover two long folding tables—including Bob's waist-wrecking *Q. minima*. And this time there was a grander finale to trump the acorn smorgasbord:

a giveaway of seedlings of oak species grown and donated by Woodlanders, including specimens representing Southeastern Europe, the Mediterranean, and Mexico.

At the welcome dinner the mandolin player of Palmetto Blue had sung: "Kin folks a-comin'/They're comin' by the dozen." We had indeed come by the dozen, well over two in fact, and it was encouraging to see IOS members and others enjoying an Oak Open Day in the United States. The excellent and efficient organization coordinated by Bob McCartney and the City of Aiken, which set up four different tours that could have run simultaneously, would have easily coped with a few dozen more participants. This two-day event punched as powerful a punch as a Pre- or Post-Tour associated with an IOS Conference—without the long bus rides, because all venues were within spitting distance of downtown Aiken—and it would have been nice to have seen it fully attended. It was an intense weekend of horticulture in general and oak study in particular, combining opportunities to view and discuss unusual and beautiful plants in company that blended bonhomie with knowledge and passion. As the band singer would have put it: "Y'all shoulda come." If you ever have the chance to visit Aiken, do not miss the opportunity, you shall not be disappointed.

These Oak Open Days are one of the core activities of our Society and, after the success of the Aiken event, one hopes that in the future an increasing number of members will participate in them. Thanks are due to the City of Aiken for hosting the event and providing transport and infrastructure, to the IOS Tour Committee, and to Bob McCartney for organizing and running the Tour and for sharing with us his vision of an "oaken Aiken." Surely in the future many will be forgiven for assuming that the town owes its name to its oaks.

Participants

Allen Coombes (Mexico); Brie Arthur, Don Creamer, Sara Creamer, Rebecca Dellinger-Johnston, Will Forster, Lucas Johnston, Ronald Lance, Todd Lasseigne, Dave Leonard, Bob McCartney, Julie Moore, John Palmer, David Parks, Ryan Russell, Tamara Russell, Philip Schetter , Guy Sternberg, Jeff Stevens, Michael Styers, Michele Styers (United States); Roderick Cameron (Uruguay).

Photographers. Photos 1-4, 6, 7: Roderick Cameron. Photo 5: Guy Sternberg.

For an additional account of the Aiken Oak and Horticultural Tour, see:
http://www.aikenstandard.com/article/20131104/AIK0101/131109808

In Search of Vietnam's Elusive Oaks Chassé-Colin-Snyers Vietnam 2013 (CCSV13)

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Introduction

Ha Noi, October 24, 2013, 6 a.m. After an 11-hour flight from Paris, Charles Snyers, Olivier Colin and I arrive in the thick morning air of this capital city located 25 m/85 ft above sea level, on almost exactly the 21st parallel, 1,300 km/808 mi from the country's most southern point and just over 300 km/186 mi from the most northerly. A comfortable though humid 26 °C/80 °F and a grey sky welcome us while a slight drizzle reminds us that we are in a country with average annual rainfall, in the north of about 1,600 mm/63 in, and in the south, of over 3,000 mm/118 in.

We are greeted by Mr. Chung, our guide for the first week and our driver, Mr. Nhan, and off we go to our first destination. *Roystonea regia* (Kunth.) O.F. Cook and *Livistona chinensis* (Jacq.) R. Br. ex Mart. line the airport roads and as we wind our way through the suburban traffic to the west of Ha Noi the street trees that we notice are *Terminalia catappa* L. and *T. mantaly* H. Perrier with their very large leaves, along with species of *Cassia*, *Ziziphus and Bauhinia*. No oaks.

It must be said though that the trees are not the most spectacular things along these roads. Ha Noi's human population is a little under seven million; the Honda small cylinder motorcycle population, three million. These motorcycles transport everything from five people at a time to live pigs stacked up by three, 5-meter-/16-foot-long bamboo canes that trail off the back, 3-meter-/10-foot-wide and as-high bundles of everything imaginable (the list would be endless). Their drivers (and passengers as well as pedestrians too) often wear white masks covering mouth and nose which offer protection, however slight, from leaded exhaust fumes and the thick dust of which the air seems not so much to contain as to be composed of. Driving in Vietnam is no joke and yet in our extensive travels there we saw only one accident and only nearly died once.

In preparation

What could we find and where? was obviously the first question that needed answering long before arriving in Ha Noi. For many reasons, this is not an easy question to answer. Precious little contemporary information exists on the Vietnamese flora in general and even less on the family *Fagaceae* (Averyanov et al., 2003; Dung, 1996; Hardÿ and Lamant, 2010; Thai et al., 2010; Thin and Harder, 1996). An illustrated flora of Vietnam, begun in 2000, has produced 11 volumes (unfortunately not including the *Fagaceae*) with the last one having been published in 2007. The Vietnamese National Library has 49 botanical references in its catalogue with 11 in Vietnamese and 2 in Greek. Of the remaining 36, 4 are Gaston Bonnier's *Flore complète de France, Suisse et Belgique*; 11 are Henri Lecomte's *Flore générale de l'Indochine*; 4 are L. Pierre's *Flore forestière de la Cochinchine*; 5 are floras of other parts of the world and the remainder deal with subjects as varied as rice cultivation and lichens as bioindicators.

Though out-of-date in more ways than one, the best references we have are undoubtedly Madame Camus' *Les Chênes*, and Henri Lecomte's *Flore générale de l'Indochine*. From these it was at least possible to compile a list of the oaks present in Vietnam in the first half of the 20th century when the (predominantly French) explorers went there. *Oaks of Asia* (Menitsky, 2005) also provided much useful information as did the *Guide illustré des Chênes* (Hardÿ and Lamant, 2010) and *Vietnam Forest Trees* (Dung, 1996)—the latter two especially in determining fruiting times. The Vietnam Plant Data Center (http://

www.botanyvn.com) provides a checklist, but not any detailed information on the individual species.

During the second half of the 20th century war, forest fires, slash and burn agriculture, encroachment into forest lands for industrial purposes and other forms of anthropic pressure, have reduced forestland in Vietnam from an estimated 43% of the total surface of the country in 1940 to 17% by the late 1970s (Bien, 2001). According to Be Viet Dang (1993), prior to 1954 most of the northern mountain regions were covered with forests. Today, in many parts of the region only 8 to 10% forest cover remains (roughly estimated at 13 million ha/32 million acres of lost forest). Interestingly, Eugène Poilane, one of the intrepid French explorers of Indochina, who sent a great number of *Fagaceae* (and other) specimens to the Muséum that Aimée Camus and Robert Hickel would work on, had already noticed in 1936 massive deforestation in the northwest of Tonkin* (Lecomte, 1943).

More recent expeditions, since Vietnam reopened its doors in 1987, have not specifically targeted the *Fagaceae*. All of these expeditions have discovered new taxa in a variety of genera and families, a tribute to Vietnam's great diversity and proof that a lot of work remains to be done to understand it all.

The itinerary

The first part of our route was to take us to Ba Vi National Park and to Tam Dao National Park (respectively west and north of Ha Noi) and then further northwest to the area around a village called Mu Cang Chai. Continuing our route north, the second part of the trip was to explore different areas near Sa Pa and further north near the Chinese border. Olivier Colin, who could

1/ *Quercus dinghuensis* C.C. Huang in Ba Vi National Park.

* During the French colonial period, northen Vietnam was called Tonkin, the center and a large part of the south were referred to as Annam, and the extreme south, Cochinchine.

only stay two weeks was to return to France at this point and Charles and I would then embark on the last part of our voyage going even further northeast to the Ha Giang Province, before eventually heading south back to Ha Noi.

Ba Vi National Park (October 24-25)

A warning to all of you who may be tempted in the near future to visit Vietnam: 40 km/25 mi an hour is the most you can hope to achieve on average—and often it is much, much less! Do not trust the various different route planners you can find on the Internet : it took us over three hours to drive the 50 km/31 m that separate Ba Vi from the airport.

The Ba Vi Mountains, of limestone origin, were often visited by explorers of the past. For example, Benjamin Balansa (1825-1891), who collected in Tonkin from 1885 to 1889, recorded over 5,000 collection numbers referred to in the *Flore g*énérale and most of them are from Ba Vi (Lecomte, 1943). Today a national park, it is an area enjoyed by Ha Noi residents for its cooler climate and beautiful landscapes.

2/ *Bauhinia* sp. in Ba Vi National Park.

After deciding not to have lunch, we quickly drop our bags, get changed and equipped with cameras, notebooks and GPS receptor to go and have a first look at Ba Vi, still some 10 km/6 mi away. We decided that we would go to the top first, passing along the way a spot called the French Summer Camp to which we would return. It was of course impossible not to stop along the roadside before reaching the parking lot and the start of two trails that led to the top! We couldn't resist having a closer look at this luxuriant vegetation. Beautiful begonias and many representatives of the family *Melastomataceae*, tree and other ferns, climbing pepper plants, various bamboos along with genera such as *Clerodendron*, *Alocasia*, *Mallotus*, *Gonostegia*, and *Aspidistra* were but a small part of what was to be seen. Mingled in with the indigenous species, we also noted *Tithonia diversifolia* (Hemsl.) A. Gray (Mexico), *Malvaviscus arboreus* Cav. (United States, Mexico, Central and South America) and *Tradescantia zebrina* Bosse (Mexico).

To start, we chose the trail—actually a staircase—that leads to the summit of one of Ba Vi's three peaks, Tan Vien (1,226 m/4,022 ft), from which it was fairly easy to go wandering off to the sides for more in-depth exploring. Along the path, some of the trees were labeled, with very large metal plaques graphically resembling Paris street signs (royal blue background and white lettering) not all of which could be trusted.

As Olivier and I got sidetracked, Charles patiently made his way to the top and to the first important oak find of the day: *Quercus xanthotricha* A. Camus, present in Vietnam but much further south in the Djiring province. The first oak of this trip was thus also an important lesson: the patiently compiled neat lists of who was to be found where could only serve as an indication. I had originally identified it as *Q. xanthoclada* Drake (discovered and described by Drake in Ba Vi) but Dr. Min Deng, who has been kind enough to look at so many of our samples, has identified it as *Q. xanthotricha*.

There are a great number of *Fagaceae* in this forest and clearly the *Lithocarpus*

and *Castanopsis* seriously outnumber the representatives of the genus *Quercus* both in diversity and in number of trees. This scenario was to be the rule of what we would find in the days to come. Many *Lithocarpus* and *Castanopsis* (both often with seed) and relatively few *Quercus* (most often without). *L. bacgiangensis* (Hickel & A. Camus) A. Camus, *L. cyrtocarpus* (Drake) A. Camus, *L. pseudoreinwardtii* A. Camus, *L. balansae* (Drake) A. Camus, *C. chinensis* (Spreng.) Hance, *C. lecomtei* Hickel & A. Camus, *C. tesselata* Hickel & A. Camus, *C. faberi* Hance, and *C. tonkinensis* Seemen are just a few that we found here.

3/ *Quercus xanthotricha* in Ba Vi National Park.

It is not always easy, in the absence of flowers or fruit, to distinguish between these three genera. Many of the specimens that were described as *Quercus* in *La Flore générale de l'Indochine* or in Drake del Castillo's *Contributions à l'étude de la flore du Tonkin* (Drake, 1890), are actually *Lithocarpus* and sometimes, *Castanopsis.* For example, *Q. baviensis* Drake, *Q. reinwardtii* Drake, *Q. tephrocarpa* Drake, and *Q. tunkinensis* Drake, are in fact *L. truncatus* (King ex Hook.f.) Rehder, *L. pseudoreinwardtii* A. Camus, *L. tephrocarpus* (Drake) A. Camus, and *C. fissa* (Champ. ex Benth.) Rehder & E.H. Wilson. The arrangement of the terminal buds is helpful and also many species of *Castanopsis* have a kind of metallic shiny look to the underside of the leaf not exhibited by species of the two other genera.

Several interesting species of *Aucuba* (resembling closely *A. himalaica* Hook.f. & Thomson or *A. chinensis* Benth.), *Tupistra hongheensis* G.W. Hu & H. Li (a species described in 2013), four species of *Aspidistra* including *A.* aff. *hainanensis* Chun & F.C. How), *Ophiopogon latifolius*, L. Rodr., different orchids (some belonging to the genera *Liparis* and *Flickingeria*), as well as many beautiful begonias kept Olivier's nose to the ground and our eyes opened wide as we discovered these things.

As the sun went down we reluctantly decide to end the day with a quick look around

4/ *Castanopsis calathiformis* (Skan) Rehder & E.H. Wilson, near Sa Pa.
5/ *Castanopsis lecomtei* Hickel & A. Camus, Ba Vi National Park.
6/ *Castanopsis chinensis*, Ba Vi National Park.
7/ *Lithocarpus echinotholus* (Hu) H.Y. Chun & Huang ex Y.C. Hsu & H.W. Jen, Phan Xi Pang.
8/ *Lithocarpus pachylepis* A. Camus, Phan Xi Pang.
9/ *Lithocarpus elegans* (Blume) Hatus. ex Soepadmo, near Sa Pa.

the area referred to as the French Summer Camp. This turned out to be a very good idea as we immediately fell upon very large acorns strewn over several square meters. It was very difficult to determine what tree these had come from because of the diminishing light in this thick vegetation but they did not seem to correspond to the description of any of the oaks I had thought we would find in Ba Vi though they did resemble the acorns of *Q. helferiana* A. DC. which we expected to find further north. It was literally nearly dark under the forest canopy and so we decided to call it a day and to come back to the French Summer Camp the following morning.

Worn out from having crossed half the planet, driving in Vietnam, and visiting Ba Vi, we were pleased to be headed for a shower, a nice dinner and a comfortable bed at our hotel, the Yen Bai Resort. But it was not to be: after only completing the first third of

10/ *Quercus braianensis* in Ba Vi National Park.

that program, our guide came to inform me that the police wanted us to leave this hotel. Thus we had to pack up our things and drive back to the National Park where there was another hotel willing to have us. In the end, although the rooms were not quite as good as the previous ones, the grounds were quite pleasant and the restaurant good—plus we were actually in the park which meant less driving for the following day.

The next morning back at the French Summer Camp (altitude between 500 and 700 m/1,640 and 2,296 ft) we find more of these very large acorns (and still have difficulty determining the species) as we make our way through this forest populated with, amongst others, *Amesiodendron chinense* (Merr.) Hu, *Chisocheton cumingianus* (A. DC.) Harms, *Magnolia lotungensis* Chun & C.H. Tsoon, *Diospyros pilosiuscula* G. Don., and the usual horde of *Lithocarpus* and *Castanopsis*. Finally we find a blue and white label for our mysterious oak: *Q. gemelliflora* Blume. But this did not seem correct: neither the leaves nor the acorns corresponded to the description of *Q. gemelliflora*. Not to mention the fact that this oak is only reported in Indonesia and Malaysia. Problems of identity notwithstanding, we were quite happy to begin the day with so many acorns in one place.

In the afternoon we ascended the trail that leads to Vua Peak (1,296 m/4,251 ft) to find many oaks. *Q. neglecta* (Schottky) Koidz., *Q. dinghuensis* C.C Huang, *Q. petelotti* A. Camus, *Q. macrocalyx* Hickel & A. Camus, and another that could be either *Q. quangtriensis* Hickel & A. Camus or *Q. semiserrata* Roxb. It is difficult to say because we found no acorns and the only leaves that we could get both from the tree and from the ground were not in very good shape. We continued to find specimens of the purported *Q. gemelliflora*. This has since been identified by Min Deng as *Q. braianensis* A. Camus (reported in Vietnam but much further south). Many different magnolias dotted the way as we roamed around: *Magnolia fordiana* (Oliv.) Hu, *M. fordiana* var. *hainanensis (*Dandy)

11/ *Quercus neglecta* in Ba Vi National Park.

12/ *Quercus dinghuensis* in Ba Vi National Park.

13/ *Quercus petelotii* in Ba Vi National Park.

Noot., *M. dandyi* Gagnep., and others.

Q. neglecta is a beautifully elegant and very tall tree with very distinctive elongated, bamboo-like leaves (hence, *Q. bambusifolia* Hance as it used to be called) with secondary veins that are hardly visible (which is what the specific epithet refers to).

Q. dinghuensis is a very rare oak, not reported in Vietnam. The description of this oak in the Flora of China (based on specimens from the Dinghu Shan Mountains, Guangdong, China) gives a maximum height of 8 m/26 ft whereas our tree was easily 12 or 14 m/39 or 46 ft (maybe even taller, but it is difficult to estimate from the photograph). It is not described by Mme Camus in *Les Chênes* or in *La Flore générale* and no specimen exists in the Paris herbarium. How is it that Mr. Balansa, who collected over 5,000 specimens in Ba Vi, including many oaks, did not find this one? I think that the best working hypothesis is that he probably did and that it is somewhere in the herbarium but with another name. I visited the Paris herbarium in February to look first-hand at some of the Vietnamese oaks and more than one had been baptized with a different name than the one it currently has (for example, some specimens that are now labeled *Q. macrocalyx* were originally labeled *Q. semiserrata*). *Q. dinghuensis* is an important find in Vietnam and another good reason to go back to the wonderful Paris herbarium!

Q. petelotii, dedicated by Mme Camus to another of the great French explorers of this region, Alfred Pételot (5,396 collections in Vietnam), has young leaves and acorn caps covered with a dense, yellow tomentum. *Q. macrocalyx* is a stunning tree the young leaves, twigs, and buds of which are covered with a very dense, rusty orange or golden tomentum. The acorns are unmistakable: the distinctly bell-shaped, orange, velvety acorn caps are a sure signature.

With these lovely oaks to end the day we prepare our departure from Ba Vi National Park as we head back to the hotel. We intend to leave the following day for Tam Dao, a mere 60 km/37 mi from where we are and yet, after discussion with our guide and driver we realize that we will need from between three and four hours to get there, mainly because there are many rivers in Vietnam but the bridges are few and far between. We

thus decide, that our departure time will be 6 a.m. and that we will stop on the road for breakfast. Like the previous evening, the day ended over a wonderful dinner composed of a multitude of different meat and vegetable dishes laid out on the table to be shared by all. *Chayotte*, a kind of pale green very firm squash (*Sechium edule* (Jacq.) Sw.) that we would be served at nearly every meal (no vegetable garden that we saw was without them) was this evening cut up in large chunks and steamed to be eaten after dipping in a salt and sesame seed-peanut powder. It is of Mexican origin and is cultivated in many tropical countries where it sometimes becomes invasive. Another vegetable that was quite a regular on our table was *Brassica rapa* L. of which there are many varieties and a seemingly infinite number of ways to prepare the leaves, stems, and roots.

Tam Dao National Park (October 26)

Off we go a bit after sunrise in the direction of Son Tay a small town 35 km/22 mi to the west of Ha Noi and just south of the Red River but with no bridge to cross it. Son Tay was the theater in 1970 of a prisoner-of-war rescue mission involving the Green Berets, the US Navy and the US Air Force that failed because… there were no prisoners there. The Battle for Son Tay, December 17, 1883, an offensive of the French Tonkin Expeditionary Corps, is another page in its history. But for us on October 26, 2013 it was merely the town with no bridge to cross the Red River, from where we could have gone directly to Tam Dao on a fairly good road (2C-2B). We stopped to have breakfast there—the typical Vietnamese breakfast called *pho*. Being a black-coffee-and-cigarettes-for-breakfast-person myself, this was a challenge. Olivier, a true aficionado, and Charles, a practical man, were happy enough.

This soup is considered a national dish and you can find it in every corner of Vietnam, with countless variations. Its origins are obscure with the dish reported for the first time (by Westerners at any rate) shortly after the French occupation of Ha Noi in 1850. It is thought that the dish, as it exists today, is a hybrid between Vietnamese, French, and Chinese traditions. The main ingredient of the dish is the broth that is made the same way the French make a dish called *pot au feu* (and some link the origin of the word *pho* to the French *feu*). Stewing bones and tough pieces of meat to make a nutritious broth can be found in so many different rural culinary traditions that chances are the Vietnamese did not wait for the French to teach them how to do this. The soup is an eloquent symbol of Vietnam: a melting-pot patchwork of a great many cultural traditions.

Driving alongside the Red River (Song Hong) on route 32 we cross the Black River (Song Da), the most important tributary of the Red River, with which it joins in Viet Tri. Shortly after, from the town of Hung Hoa, we can finally cross the Red River and head on to Viet Tri, Vinh Yen and Tam Dao where we arrive at around 10 a.m.

We only had the rest of the day to spend in Tam Dao so decide once again to skip lunch, buying a few biscuits and some candy instead. The Tam Dao mountain range is one of the terminal spurs of the high elevation northwestern mountains that we will be visiting in the days to come. The town of Tam Dao was founded by the French in 1907. Our main reason for coming here was to find *Quercus platycalyx* Hickel & A. Camus and *Q. poilanei* Hickel & A. Camus (Thai, 2010). The latter is dedicated to Eugène Poilane, one of the most important of the French collectors in Indochina, as well as one of Mme Camus' most prolific collaborators. Born in 1888, he went to live in Vietnam in 1909 and spent nearly thirty years exploring the country. Of the estimated 90,000 collections

14/ *Macroselen bibracteolatus* (Hance) Danser

referred to in *La Flore générale*, 32,671 are attributed to Mr. Poilane (Lecomte, 1943).

The day brought many botanic marvels to our attention—including *Q. petelotii* and possibly *Q. poilanei*—as we began our walk through an impressive *Indosasa crassiflora* McClure forest. Where the bamboo dwindled, there were many *Lithocarpus* (including *L. corneus* (Lour.) Rehder and *L. balansae* (Drake) A. Camus) and *Castanopsis* spp., many in flower, along with many soft purplish-red young leaves of the beautiful and rare *Acer campbellii* subsp. *flabellatum* (Rehder) A.E. Murray. Here and there, the very pretty parasitic *Macrosolen bibracteolatus* (Hance) Danser danced its way through somebody else's branches. Numerous species of the family *Melastomataceae* were to be seen, most notably a spectacular lithophyte, *Medinilla petelotii* Merr. with its delicate flowers, as well as a *Styrax serrulatus* Roxb. (later identified for us by Jan De Langhe). Strewn throughout were many trees of *Polyspora* sp., a close cousin of camellias, with its beautiful white flowers and dark green foliage. Since 2012, three new species have been described in this genus from Vietnam. Magnificent tree ferns, always a spectacular sight, were also present.

The Belvedere Tam Dao Resort is nestled on a steep mountain slope and the views are spectacular. The very chic and fancy restaurant that cost us about ten times what we paid at Ba Vi, was unfortunately not half as good but afforded us the occasion to learn two things about Vietnam. One, if you order something that is on the menu but not available,

15/ View from the Belvedere Tam Dao Resort, looking out over the vegetable garden.

16/ From Tam Dao to Mu Cang Chai.

they just bring you something else that they think is a close approximation! Charles, who had ordered fried sweet potatoes as a starter, received French fries instead. And two, that French fries as a starter is quite common practice here.

Mu Cang Chai (October 27-28)

300 km/186 mi separate us from our next destination, Mu Cang Chai to the northwest. On fairly decent roads most of the way, it took us only eight and a half hours to get there. The countryside is alternately patched with rice fields, tea, and banana plantations (these latter sometimes planted all the way up to the top of vertiginous slopes).

Not only is driving a very serious matter in Vietnam, but trying to figure out on a map where you are and where you are going can also be a challenge: different maps don't always tell the same story! We stop for a break in a village called Thu Cuc, that I can find on no map that I have, not even in the Vietnamese road atlas, bought in Vietnam—but it can be found in Google maps. The village is nestled in an area of karstic landscape, not typical for the region. While Charles and I took a stroll through the village Olivier could not resist climbing up one of these steep and densely carpeted knobs. After too long—but luckily for him just a second before we were thinking about leaving without him—he appeared, breathless from the effort and what he had found: different species of *Begonia, Asplenium macrophyllum* Sw., *Dracaena cambodiana* Pierre ex Gagnep., *Schefflera* sp., and *Plectranthus* sp.

The mountains near Mu Cang Chai, largely unexplored, seemed potentially interesting because they are part of the tail end of the Hoang Lien Mountains, the culminating peak of which is the Phan Xi Pang further north. There are no hotels in Mu Cang Chai and we were requested to fill out documents for the local police explaining our presence.

17/ The southern part of the Hoang Lien Son Mountains, near Mu Cang Chai.

We were lucky in that our guide was acquainted with some of the villagers (and one of the policeman) and so was able to arrange a very comfortable and pleasant "home-stay" (the Vietnamese equivalent of bed and breakfast).

From the village of Mu Cang Chai a trail (inaccessible to cars) of about 15 km/9.3 mi leads to a tiny hamlet called Mo De from where (on at least one map) there appeared to be footpaths into the mountains leading to peaks at 2,663 m/8,736 ft and 2,913 m/9,557 ft (but again these are not indicated on every map). We agreed to split our party in two for the next day: while I would go with our guide on motorbike to Mo De, Charles and Olivier would backtrack a few miles to a pass that we had crossed on the way (Khau Pha Pass at 1,560 m/5,118 ft).

We were very lucky weather-wise during our stay in Vietnam. Although we had only a few days with bright blue skies, we also had only a few days of light rain lasting only a few hours—except in Mu Cang Chai where it rained the entire time. This made the motorbike experience a very slippery and muddy one. In addition, the only pedestrian access to the mountains behind Mo De was a very steep path that was probably not a very good one even without the rain. In addition to the ever-present *Castanopsis* spp., here

18/ In the mountains behind Mo De.

I find dense populations of *Cunninghamia lanceolata* (Lamb.) Hook. along with a two-needle pine, perhaps *Pinus merkusii* Junghuhn & de Vriese. Nearing 1,900 m/6,234 ft, on an increasingly steep and slippery trail, it seemed to me that if any significantly higher

peaks existed they would have been visible but this was not the case.

From the Khau Pha Pass Charles and Olivier were able to explore a forest that is heavily exploited by the local population for firewood, for pig and cattle grazing as well as for recreational activities. A very wide trail that cuts across the forest has promoted the growth of many shrubs and small trees on either side while affording a certain degree of accessibility. In addition to an oak which is either *Q. glauca* Thunb. or *Q. glauca* var. *annulata* Min Deng & Z.K. Zhou, they noted several very large specimens of *Acer campbellii* Hook.f. & Thomson ex Hiern, three species of *Schefflera* (including *S. macrophylla* (Dunn) R. Vig.), *Actinidia latifolia* (Gardner & Champ.) Merr., *Actinodaphne pilosa* (Lour.) Merr., *Clethra fabri* Hance, *Embelia parviflora* Wall. ex A.DC., *Eurya acuminata* DC., *Holboellia chapaensis* Gagnep., *Clerodendron glandulosum* Coleb., and also unidentified species of *Illicium, Rhodoleia, Chimonocalamus*, *Callicarpa* and *Zanthoxylum*. *Exbucklandia populnea* (R. Br. ex Griff.) R.W. Br., that I had also seen in the mountains behind Mo De, was present here. On the way back to Mu Cang Chai they also found *Gaultheria fragrantissima* Wall. and a beautiful orchid, *Cymbidium iridioides* D. Don.

In addition to being a very warm and friendly person, our hostess in Mu Cang Chai was an incredible cook and every meal—breakfast or dinner—was memorable. Many of the things we ate were from her vegetable garden, herb patch and rice field. Wonderfully exotic things, novel spices and interesting combinations. We were treated to fried grasshoppers—considered a real treat because it is only at this time of year that grasshoppers abound in the rice fields. Our driver was especially fond of them. The most honest description I can give is that it is like eating potato chips with antennae. Very bland and crunchy.

Sa Pa and surrounding areas (October 29-November 2)

We leave Mu Cang Chai in the rain at 8.00 a.m. on route 32 that will take us all the way to Sa Pa, estimating that it will take us about five hours to drive the 158 km/98 mi. This road travels along a valley on the western side of the Hoang Lien Mountains crossing different rivers along the way. Every bridge in Vietnam, no matter how small, has, on both sides, a proud sign with an incredible number of vital statistics: start- and end-date of construction, name of the river it crosses and of the architect who built it, length, height, width, what it cost, etc. Along this valley, the landscape changes from hydraulic dam to rice fields to hydraulic dam to intact forest to hydraulic dam. We arrive in Than Uyen at 10.00 a.m. and continue our way to Sa Pa where we arrive a bit before 1.00 p.m.

We had planned to explore Sa Pa and nearby areas from October 30 until November 6, but only two things were sure: that we would spend the first two days on Phan Xi Pang and that we would hook up with Mr. Uoc Le Huu. Many recent expeditions to Vietnam have shown that if you want to look for plants, especially in the province of Lao Cai, Uoc is your man. Self-taught plantsman, born actor, consummate jester and thoughtful organizer, Uoc was a very valuable asset to us. Significantly, Uoc, like many Vietnamese whom we spoke to, did not really have a clear idea of what an oak was, and often mistook species of *Castanopsis* and *Lithocarpus* for oak. Nevertheless, we are grateful to him for his determination and extraordinary eyesight ("Eagle Eye" as he has been named by one of his Western friends).

19-20/ *Q. glauca* var. *annulata* on Phan Xi Pang.

At 3,143 m/10,312 ft Phan Xi Pang is the highest mountain in Indochina. It is part of the Hoang Lien Son Mountains that are the southern extension of the Himalayas and it is also the tourist attraction of the Hoang Lien Son National Park (before 2006, Hoang Lien Son Nature Reserve), just a few kilometers from Sa Pa. During the French colonial period, Sa Pa was the favored spot for secondary residences of well-to-do French bureaucrats as well as for the Vietnamese who had managed to find a profitable place for themselves within the colonial system. After the demise of the French, and throughout the incessant violent conflicts that marked the history of this country in the 20th century, Sa Pa practically disappeared from the map until about the 1990s, when, after the country reopened its doors, adventurous souls wandered once again to the northern reaches of Vietnam. In less than 15 years, this town has become a sort of Vietnamese Kathmandu: the town lives and breathes for tourists, whatever their style or budget. It is difficult to find good, authentic Vietnamese cooking in Sa Pa—indeed perhaps authentic Vietnamese anything—but a bottle of good (Italian, Chilean or Australian) wine can be found and the comfort that one of the decent hotels offers after a few nights camping is highly appreciated.

The point of departure for any trek on Phan Xi Pang is the Tram Ton Pass at 1,900 m/6,234 ft, the entrance to the National Park. This morning of October 30 greeted us with a hazy sun and just a slight drizzle that did not last for very long as we began the climb upwards through the lush vegetation overhead and all around us. Very quickly we see that the forest has been cut and burnt in many places to make room for vast cardamom plantations. Of course the Vietnamese are not the first to behave foolishly vis-à-vis their forest resources. This isn't to say that two (or many) wrongs make a right but the conclusion must be drawn that, in these matters at least, intelligence has been fairly equitably distributed on the planet.

Our camp was to be at 2,230 m/7,316 ft and so we had plenty of time before nightfall.

21/ Above the clouds on Phan Xi Pang.

As we near 2,000 m/6,562 ft, many *Lithocarpus pachylepis* A. Camus with their very large leaves (up to 35 cm/14 in long) are present with a great many nuts, also very large (with diameters of up to 6.5 cm/2.6 in), strewn over the ground. Also present, *L. echinophorus* (Hickel & A. Camus) A. Camus. In many different places we find *Quercus glauca* Thunb. and *Q. glauca* var. *annulata* M. Deng & Z.K. Zhou). Here also, *Castanopsis* and *Lithocarpus* species severely outnumber the *Quercus*.

The dazzling colors on display in the understory (sort of) make up for the lack of oaks and acorns: dark blue berries of *Dichroa febrifuga* Lour., pink seed pods of *Euonymus laxiflorus* Champ. ex Benth. opening to reveal bright orange seeds, *Lasianthus* sp. and *Ophiopogon* sp. showing off their electric blue seeds, rose-dappled fruit of *Lobelia montana* Reinw. ex Blume, soft pinkish-white blossoms of *Luculia pinceana* Hook., shiny red fruit of a *Smilax* sp., butter-yellow flowers of *Hypericum hookerianum* Wight & Arn. and *Rhododendron emarginatum* Hemsl. & E.H. Wilson and the pure white petals surrounding the orange and yellow stamens of *Polyspora longicarpa* (Hung T. Chang) C.X. Ye ex B.M. Barthol. & T.L. Ming… to name but just a few.

The next day we continue upwards, encountering here again many *Castanopsis* and *Lithocarpus* and just as few oaks. But there are other interesting things! Spectacular trees of *Rehderodendron indochinense* H.L. Li with their sausage-shaped, orange-spotted, enormous seeds literally piled in heaps in some places. *Schefflera hoi* (Dunn) R. Vig. and *S. fantsipanensis* Bui along with smaller trees of *Dendropanax dentiger* (Harms) Merr. also attract our attention along with the bushier *Viburnum cylindricum* Buch.-Ham ex D. Don, *Hydrangea heteromalla* D. Don and *Euonymus laxiflorus* Champ. ex Benth. Towards mid-afternoon we start our way back down and arrive in Sa Pa before nightfall.

On the morning of November 1 we visit an area of degraded forest 3 km/1.9 mi south

22/ The colors of Phan Xi Pang and Nhiu Co San: a) ***Aeschynanthus bracteatus*** **Wall. ex A. DC.; b)** ***Hypericum hookerianum*****; c)** ***Euonymus laxiflorus*****; d)** ***Ophiopogon*** **sp.; e)** ***Rhododendron emarginatum;*** **f)** ***Luculia pinceana*****.**

of Sa Pa at 1,500 m/4,921 ft. The path that leads into this forest is just across the road from Uoc's house, where we are invited for lunch. According to him this forest was completely cut down just a few years ago. We are welcomed by a magnificent *Lithocarpus elegans* (Blume) Hatus. ex Soepadmo and an equally nice *Castanopsis calathiformis* (Skan) Rehder & E.H. Wilson. The nomenclatural history of this taxon is revealing: in 1899, *Quercus calathiformis* Skan; in 1916, *Synaedrys calathiformis* (Skan) Koidz.; in 1921, *Pasania calathiformis* (Skan) Hickel & A. Camus, and in 1931, *L. calathiformis* (Skan) A. Camus. Continuing on our way, we are supremely rewarded with *Q. macrocalyx* in a slightly spread-out group of eight multi-stemmed trees 5-6 m/16-20 ft in height, two of which offer us a few of the beautiful acorns of this species. There are also a great number of other interesting plants: *Illigera* sp., *Schefflera schizophylla* (Hance) Frodin, *Magnolia* spp., *Alnus nepalensis* D. Don, *Aralia* sp., *Cornus* sp., *Camellia sinensis* (L.) Kuntze, *Melicope pteleifolia* (Champ. ex Benth.) T.G. Hartley. For the afternoon's hike we drive a dozen kilometers/seven and a half miles to the northwest of Sa Pa to Ban Khoang Mountain. Large areas covered with cardamom plantations make the climb fairly difficult but here too we find many (non-*Quercus*) interesting things: *Peliosanthes yunnanensis* F.T. Wang & Tang, *Acer laurinum* Hassk**.** (or is it *A. oblongum* Wall. ex DC.?), *Aesculus assamica* Griff., *Exbucklandia populnea***,** R.W. Brown, *Illigera* sp., *Eleutherococcus* sp., *Brassaiopsis* sp., *Microtropis* sp., *Asarum caudigerum* Hance and an unidentified *Viburnum*.

On November 2, our day's hike starts at the foot of the Thac Bac Waterfall

23-24/ *Quercus macrocalyx* near Sa Pa.

25/ Looking at Phan Xi Pang from Thac Bac Mountain.

(also known as the Silver Waterfall) 13 km/8 mi from Sa Pa and very near to the Tram Ton Pass though not quite as high (1,800 m/5,905 ft). The very steep climb to a little over 2,400 m/7,874 ft begins on several hundred meters of what appears to have been a treacherous rock slide. From 2,000 m/6,562 ft upwards, and thanks to the crystal blue sky, bright sun and perfect fluffy white clouds, the views are absolutely spectacular, with Phan Xi Pang looming on the horizon. There is a great variety of plant life with the usual crowd-minus-our-favorite-genus of *Fagaceae* plus a number of interesting things that we had not yet seen including *Buddleja macrostachya* Benth. with showy dark pink flower spikes, a species of *Aucuba* with very large leaves, a form of *Hydrangea stylosa* Hook.f. & Thomson with a dark purple underside to the leaf, *Osbeckia stellata* Buch.-Ham. ex Ker Gawl. in bloom, several *A. campbellii* and numerous very large specimens of *Rhodoleia* cf. *parvipetala* Tong. In several spots, beautiful white *Polyspora* sp. flowers cover the ground.

Nhiu Co San (November 3-5)

The next day (November 3) we leave Sa Pa heading northwest towards the Chinese border for a three-day camping trip to Nhiu Co San Mountain. A fairly good road, 4D, takes us west to the town of Quy Ho from where we turn north on an almost decent road, 155, in the direction of Muong Hum, and then slightly west again, on what can barely be called a road, to arrive in the town of Chu Phin (on some maps, Khu Chu Din) where we meet the porters that are to accompany us. After lunch we set off on foot, crossing a village also called, according to some maps, Nhiu Co San. As with Thac Bac, it seems obvious that many mountains in Vietnam have no name other than the name of the nearest village. Shortly thereafter, we walk on a part of what is left of an 80-km/50-mile stone path that was built in 1927 by the French (well really by thousands of the local citizens) so that they, the French, could cut across the mountains to go to Lao Cai on horseback. It is difficult to say for certain exactly where we are: in the Vietnam Road Atlas, there is a peak (with no name) at 2,661 m/8,730 ft situated pretty much where we think we are and while some references tend to corroborate this with 2,700 m/8,858 ft as Nhiu Co San's height, others give the height at only 2,231 m/7,320 ft. Still on other maps this peak, where we think we are, is indicated at 3,044 m/9,987 ft!

26/ The road to Nhiu Co San.

It is a pleasant hike to 1,600 m/5,249 ft where we plan to camp for the night. We stop along the way so that Uoc can show the local villagers we encounter my drawings of acorns in the hopes that they will be able to help us locate some oaks. We were

like the travellers in search of the mythical Kingdom of Thule: their questions, as ours, received very kind answers invariably involving referral to someone else who for sure knew where the object of desire was to be found and that this someone else could be found just a bit further down the road or just on the other side of the next mountain (Mund-Dopchie, 2009). Many species of maple live here and the number of seedlings that we saw would indicate that they are thriving. These included *Acer campbellii*, *A. erythranthum* Gagnep., *A. laurinum* and *A. pectinatum* Wall ex G. Nicholson. Perhaps the most spectacular tree we saw was an extraordinary *Huodendron* that we estimated at about 40 m tall/131 ft with a circumference that we measured of 3.3 m /10.8 ft. Of the four species in this genus of the family *Styracaceae*, the largest, *H. tibeticum* (J. Anthony) Rehder, is also the only one reported in this part of Vietnam but it is only supposed to reach 25 m/82 ft in height with a dbh of 25 cm/9.8 in (Flora of China). This was not the only "monster" that we found: a magnolia of over 35 m/115 ft tall with a 4.2 m/13.8 ft circumference was another spectacular sight. We found many, many trees of extraordinary size here—a good indication that we were in a relatively untouched piece of primary forest. We also found a very elegant *Stewartia*, possibly *S. pteropetiolata* W.C. Cheng (reported in southern and western Yunnan) or *S. tonkinensis* (Merr.) C.Y. Wu.

We arrive at our campsite just a bit before dusk and in less time than it takes to say it, the tents are pitched, the fire is blazing and dinner is on the way. And what a dinner it turns out to be! Six or seven different dishes, vegetable, meat and fish plus dessert are served up hot and delicious in very difficult conditions within which to exercise culinary talent. Our sincere thanks go to Sang, our excellent cook. Here, as in Mu Cang Chai, we had the pleasure of great food at every meal. The only thing

27/ A gigantic *Huodendron*, possibly *H. tibeticum*.

28/ Nhiu Co San campsite.

I could possibly complain about would be the absence of a good, ice-cold gin and tonic (with or without a twist of lime), for Charles it would be a good glass of wine, and for Olivier, a good mountain hotel, if only for the bed. The following day we set off for greater heights and encounter along the way different species of *Lithocarpus* including *L. echinotholus* (Hu) H.Y. Chun & Huang ex Y.C. Hsu & H.W. Jen and *L. pachylepis* that we had seen in many places

29/ The only way to get across!

as well as different *Castanopsis* with very distinctive nuts that we had not seen before. Although I have not mentioned them previously, here, as everywhere else we have been, a great number of delicate and colorful *Begonias* carpet the forest floor. The telltale bright red-orange seeds we find in several places announce the presence of different species of *Magnolia,* these too of very large dimensions. Different species of *Rhododendron, Hydrangea, Ilex, Schefflera, Pileostegia* and *Ericaceae* all contribute to making our days on Nhiu Co San interesting and productive (in an admittedly and sadly non-oak kind of way). In addition to another great meal that awaits us as we return to camp, Minh, Ro and Tinh, the porters who accompanied us, had collected fruit-bearing branches of *Cornus hongkongensis* Hemsl. to eat. We are grateful to them for this and for all of the assistance they provided us during this excursion.

As we make our way back to Sa Pa, Uoc takes us to a village where rumor has it that there are oaks. These turn out to be *Castanopsis*. On denuded slopes along the way

we notice here and there a kind of palm tentatively identified by Olivier as *Livistona speciosa* Kurz. We arrive back in Sa Pa in the early evening of November 5 and the following day is spent sorting samples and comparing notes, as well as preparing for the last leg of the trip and saying goodbye to Olivier who heads back to Ha Noi on the night train from Lao Cai.

Ha Giang (November 7-13)

The province of Ha Giang is still today largely unknown to tourists. Significantly, out of three different guide books, *National Geographic, Vietnam* (2011), *Bibliothèque du voyageur Gallimard, Vietnam* (2010) and *Michelin Le Guide vert Vietnam*, (2010) only in the latter is this region included. Early in the morning we leave Sa Pa behind us heading northeast on route 4D with about 200 km/124 mi to travel to our next destination, the small village of Lang Giang, in the Thong Nguyen area of the Ha Giang province. To get there we must cross the province of Lao Cai and our first stop is in this province's capital city, also called Lao Cai. It is nestled between the border with China and the Red River. The name Lao Cai comes from Chinese and means "the old street", apparently a term often used in Chinese to indicate border towns. To this day, commerce with China is the main activity of this city. Continuing on our way via the roads 70 and 153 we stop in Phu Lo so that Uoc can buy pineapples for a friend of his at a local market where we also buy *bao nhai* to snack on. This is very similar to Indian poppadoms but made from sesame-seed flour. We stop in Bac Ha for lunch and shortly after we cross the Lao Cai-Ha Giang border, continuing on our way to Coc Pai (Xin Man)* on a road which can barely be called that but that takes us through some of the most spectacular countryside we have seen thus far. Quite different in origin from the granite mountains in Northwestern Vietnam that are the southern extension of the Himalayas, the landscape here is formed by a combination of exposed ancient metamorphic basement rock, eroded marine sediments and uplifted limestone that form extensive karst topography with steep slopes and vertical bluffs. Tectonic activity in the late Triassic formed isolated granite mountain systems like Tay Con Linh (2,419 m/7,936 ft) but most of the region is of moderate relief (Averyanov et al., 2003).

30/ From Sa Pa to Lao Cai.

We stop along the way for anything mildly *Fagaceae* looking and are always rewarded with a nice species of *Castanopsis* or *Lithocarpus*. *Cunninghamia lanceolata*, several *Viburnum* and a *Carpinus* also attract our attention as does a two-needle pine that Uoc refers to as "horsetail pine" which is one of the common names for *Pinus massoniana* Lamb. A densely flowered *Camellia sinensis* (L.) Kuntze grove demands a photo stop. After which, in Coc Pai (Xin Man), a badly negotiated street-in-repair demands a flat-tire stop that also gives us the chance to visit the local covered market and stretch our

* Between 2012 (year of publication of the National Geographic map) and 2013 (date of publication of the Vietnam Road Atlas) the names of many cities have been changed. This can be confusing depending on what map you are looking at. Here I have given the old names in parentheses.

31/ From Bac Ha to Coc Pai.

legs, though we are anxious to arrive at our destination before nightfall, and it is already late afternoon. Not far from Vinh Quang (Hoang Su Phi) Uoc literally jumps out of the jeep declaring that there are oaks up on the adjacent hillside: a quick climb reveals this to be true, with several trees of *Quercus variabilis* Blume and, unfortunately, only a lot of dry acorns on the ground. Happy to end the day with an oak we finally arrive after a 200-km/124-mi, difficult, ten-hour drive in Pan Hou Ecolodge that we have elected as headquarters for our stay in this area (November 8-9).

Magnificent tree ferns, many *Castanopsis* in flower and *Melia azedarach* L. loaded with yellow-orange fruit, a real treat for many birds, greet us in the morning as we set off in the direction of Ho Thau to the west of where we are, passing through the villages of Nam Dich and Nam Son. Slightly after Nam Son we discover an oak whose identity has been the subject of much discussion since our return. *Q. gomeziana* A. Camus? *Q. chapensis* Hickel & A. Camus (considered to be a synonym of *Q. lineata* Blume by some authors)? *Q. tenuicupula* (Y.C. Hsu & H. Wei Jen) C.C. Huang (considered to be a synonym of *Q. sichourensis* (Y.C. Hsu) C.C Huang & Y.T. Chang by some authors)?

I might very well be wrong, but I think that the description of *Q. gomeziana* is the one that best fits our tree for many reasons: the mature leaves, with remarkably little variation between them, are the same color on both sides (there were no young leaves present), the slightly enlarged base of the petiole, the groove on its upper surface and maximum length of 1.5 cm/0.59 in, between 9 and 14 pairs of secondary veins (occasionally 15) that arch up before reaching the leaf margin, acorn with 4 or 5 styles and traces of a yellowish tomentum, acorn caps with 4-5 rings, and, finally, the brownish glabrous twigs with white lenticels. The only thing that does not correspond to the description is the number of teeth, theoretically 3-5 pairs whereas on the leaves that we examined there

32 a-f/ *Quercus gomeziana, Q. chapensis* or *Q. tenuicupula*?

were quite a few more. We found only a few acorns, but several trees of different age and size. Of the above-named species, *Q. chapensis* is reported in Vietnam (but not in this part of the country) and *Q. gomeziana* is listed in the Vietnam Plant Data Center, but without any precise indication of distribution. The subject is open to debate and opinions are welcome! The following day (November 9) we find more trees of this problematical *Cyclobalanopsis* between Nam Dich and Dam Peo, at roughly the same altitude of

33-34/ *Quercus asymmetrica*

35/ *Quercus austroglauca*

(600 m/1,969 ft). We also find clumps of *Pinus kesiya* Royle ex Gordon, *Tilia tuan* Szyszyl. and, on the way back to the hotel many trees of *Bombax ceiba* L. add a touch of cheery red to the end of this day.

On November 10 to 12 we travel from Pan Hou Village continuing further north on route 2 to the city of Ha Giang and from there on route 4C to Tam Son (Quan Ba) and Yen Minh from where we continue our route northward to Dong Van and Lung Cu, right on the Chinese border. These two days, very close to the end of our travels, were to provide some symmetry with our point of departure, for here too we do find a certain number of oaks. Two of these, found near the village of Ngan Chai (west of Yen Minh) in an area of primary evergreen mixed forest dominated by *Tsuga chinensis* (Franch.) Pritz. and *Pinus fenzeliana* Hand.-Mazz., have yet to be identified. Here also we find *Acer tonkinense* Lecomte. In certain places, especially on the way to Dong Van, there is the critically endangered *Aquilaria crassna* Pierre ex Lecomte and dense camellia patches.

Q. asymmetrica Hickel & A. Camus, found near the town of Sung La (between Yenh Minh and Dong Van), was a lone, very large tree growing on a rocky overhang that we would have needed climbing gear to get to. If it were not for a few broken branches lying on the ground, one of which had acorn caps still attached, we would have had to content ourselves with a few photographs from down below and probably would not have had enough material for a conclusive identification.

For several kilometers along the road that goes from Dong Van to Lung Cu (until recently forbidden to foreigners) there are many, many trees of *Q. aliena* Blume, covered in acorns. Most of these trees are multi-stemmed and not very tall (less than 10 m/33 ft).

The forest here has obviously been recently cut down and nearly all of these trees are resprouts. *Q. aliena* is not reported in Vietnam. Here also we find *Betula alnoides* Buch.-Ham. ex D. Don. At Lung Cu, from where one looks out over Chinese mountains, we find a lone tree of the very pretty *Q. austroglauca* Y.T. Chang, also not reported in Vietnam, as well as *Taxus wallichiana* Zucc., *Fraxinus* sp., *Carpinus* sp. and many more trees of *Q. aliena*. We travel from Dong Van to Meo Vac through spectacular landscape. From Meo Vac we continue south to Ba Be Lac with a short stop at the Co Lea pass (1,800 m/5,906 ft) that delivers up another oak: probably *Q. bella* Chun & Tsiang according to Dr. Deng, but she can not be entirely sure in the absence of acorns.

Conclusion

In the afternoon of November 14 we head back to the hustle and bustle of Ha Noi and I feel frustrated and disappointed that we were not able to find most of the oaks we had come for. Though we found less than half of what was on our list, of the 14 oaks (possibly 16) that we did find, four are not reported in Vietnam and three, not reported in northern Vietnam: *Q. aliena* (not reported in Vietnam), *Q. asymmetrica*, *Q. austroglauca* (not reported in Vietnam), *Q. braianensis* (not reported in northern Vietnam), *Q. dinghuensis* (not reported in Vietnam), *Q. glauca*, *Q. glauca* var. *annulata*, *Q. gomeziana* (reported in Vietnam but where?), *Q. macrocalyx*, *Q. neglecta*, *Q. petelotii*, *Q. variabilis* and *Q. xanthotricha* (not reported in northern Vietnam) – and possibly, *Q. poilanei*, *Q. bella* (not reported in Vietnam) and *Q. quangtriensis* or *Q. semiserrata* (not reported in northern Vietnam). Though we have not found many species or many acorns, we have contributed to knowledge of the distribution of these oaks. And this in turn convinces me, once again, that nothing is as important as trying to find them.

36/ *Quercus bella* (maybe).

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37/ From Sung La to Dong Van.

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