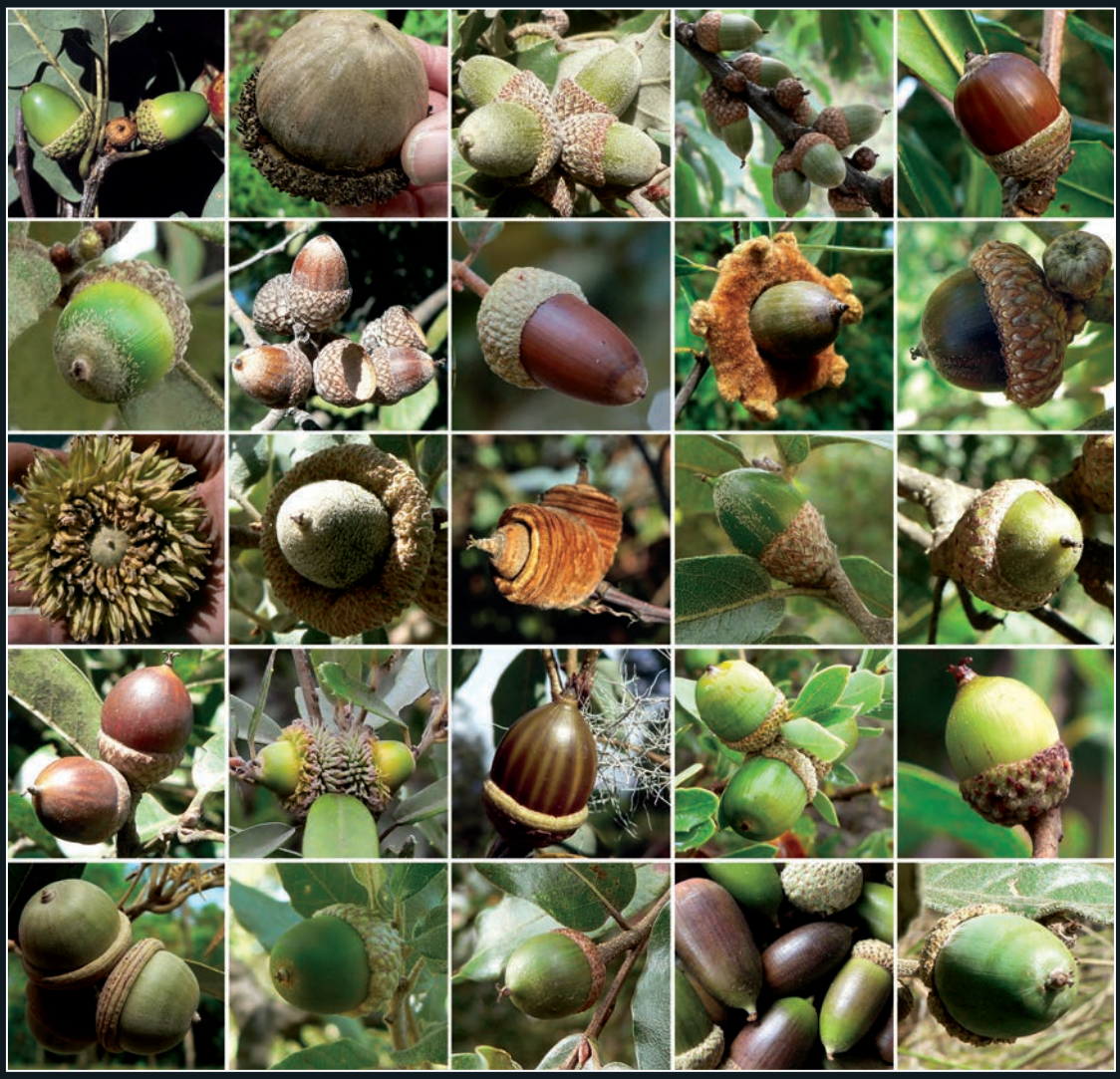

International Oaks

The Journal of the International Oak Society

25th Anniversary Issue

Issue No. 28/ 2017 / ISSN 1941-2061

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International Oak Society Officers and Board of Directors 2015-2018

For contributions to *International Oaks*

contact
Béatrice Chassé
pouyouleix.arboretum@gmail.com or editor@internationaloaksociety.org
Les Pouyouleix
24800 St.-Jory-de-Chalais
France
Author guidelines for submissions can be found at
http://www.internationaloaksociety.org/content/author-guidelines-journal-ios

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FOREWORD

Happy 25th!

I remember it well. It was the 1980s. Personal e-mail usage was not yet a part of everyday life. Pocket cell phones were science fiction and social networks were not even a remote fantasy. Overseas telephone calls via the trans-Atlantic cable were expensive, unreliable, and often difficult to hear when one could get through at all and someone at the other end of the world actually had a telephone to use. That telephone had a rotary dial, a long, coiled cord, and a handset heavy enough to be useful as a mortal weapon. We had paper, postage stamps, and the ball-point pen, and we made the most of them.

Several people from the US, Belgium, France, Germany, the Netherlands, Romania, Turkey, and the United Kingdom, had created an informal network for seed exchange (specifically, acorn exchange). We needed to expand our group to increase our opportunities to obtain germplasm of this greatest of tree genera. In 1992, one of us, Steve Roesch, our driving force, suggested that naming our little group of oak nuts might attract additional participation and confer some credibility. And thus the International Oak Society was born with Steve Roesch, Founder; Susan Cooper, Co-Founder; Guy Sternberg, Co-Organizer; and Nigel Wright, who, suggesting it would be helpful to begin a periodical publication, became our first Editor. Six members contributed to the first issue, compiled as a photocopied, hand-stapled, 16-page document that was sent out to those already on board.

At that point, I suggested that a conference meeting and a discussion of possible incorporation as a legal non-profit corporation seemed to be the logical next step. We spent the next year working with the education staff of The Morton Arboretum to spread the word, recruit speakers, and sell trade booths to raise funds. I made some of those trans-Atlantic cable phone calls (with my trusty rotary-dial phone) to places like Romania and Turkey to persuade international speakers to participate. They were promised that we would generate enough revenue from trade booth sales to cover their plane fare, and that was a promise we were very lucky to be able to keep. We wrote letters and more letters (mostly in longhand and on a manual typewriter) to everyone in every country whom we thought might be interested. I remember spending many hours on the phone recruiting participation from across the US during a time in our history when long-distance calls were billed by the minute and private conversations sometimes compromised by party

lines serving several households.

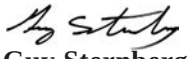
It came together in October 1994, just two years after we began as an organization with our name and our first publications, and it was successful beyond our dreams. The Morton Arboretum's Thornhill Conference Room that held about 175 people was filled, and many more stood outside the door to listen to this gathering of oak experts from around the world present their information. They also had come for the now-famous seed exchange, which already was a massive event even at that first gathering. Some of those people were excited enough about this that they decided to stay for a post-conference meeting that resulted in the formalization of the International Oak Society that you know today.

We elected a steering committee (Allen Coombes, Nigel Wright, Amy Larson, Peter van der Linden, and myself) for the purposes of our incorporation and we also planned for additional conferences at three-year intervals. Annual conferences would have been beyond our capacity to organize and beyond the capability of most people to attend, but holding one every three years would allow everyone to plan and save well in advance for them and to gather en masse during the conference years for these grand triennial reunions.

After our third conference (North Carolina, 2000) our membership was spread through 31 countries. Our Journal, THIS Journal, named *International Oaks* in 1998 (Issue No. 8), grew over time into what you hold in your hands today. In 1997 we created a newsletter, *Oak News & Notes*, and, in 2014, an electronic newsletter, *The Cupule*. In 2002, a web site was created; in 2007 it was redesigned and augmented in functionalities, and again, in 2012, with upgrades that have made it one of the best online resources of any plant society. The IOS also became the International Cultivar Registration Authority in 1998. Today, in addition to the triennial conferences, ever broader and more rewarding, annual Oak Open Day events and tours on different continents provide opportunities for members and non-members to meet and share their love of oaks.

Friends from around the globe help each other and host each other in a constantly increasing network. Since then, my oak motivations have led me to visit more than 20 countries, some several times, virtually all with tremendous help and guidance from other IOS members. The oak collection at our arboretum, Starhill Forest, has become the most comprehensive accredited one in North America, again with such help. Many others in many countries have benefitted similarly, and oaks worldwide have attained the prominence that they deserve.

Where do we go from here? Let your imagination run wild, as we did more than 25 years ago, with the knowledge that you will continue to see new surprises that no one can predict at the present time. But always remember how it started, as a dream shared by a few people who had never before met face to face, and for the most part had never even shared a phone call. We didn't realize that it couldn't be done, so we just did it.



Guy Sternberg

PREFACE

What Now?

This year is the 25th anniversary of the International Oak Society, and Guy Sternberg recollects the history of the Society in the Foreword to this volume. Furthermore, in 2012, the then four past Presidents of the IOS each wrote a paper published in *International Oaks*, No. 23 about their love affair with the IOS, about its members, and of the achievements of the Society over its first 20 years. Thus, I do not want to repeat what Guy writes – and what he, Ron, Eike and Allen wrote – about the Society but rather reflect on its present and future.

Although the IOS grew fast in its early days, when I look at the statistics it rapidly reached a peak that has not yet been surpassed. We have never had more than 500 members, we were 435 when I joined the Board in 2009; we were 422 at the close of 2016. We lost 60 members in 2016 (not an unusual loss after a conference year) and 145 since 2013. Fortunately, new members generally compensate these losses. While each of us should work at recruiting new members, it seems clear that we will always be small. Being small has advantages, of course. Guy Sternberg noted in 2012: "Many of my very best friendships, worldwide, have come from this group. Many of the special places I have seen, with the help of other individual members or via our tours, are places I never would have found (or even known about) without the IOS." Indeed, we have now members in 32 countries, including one new member from Lebanon.

Nevertheless, small implies that our means will always be limited. We rely largely on volunteers and donors to organize our triennial conferences and their gigantic seed exchanges. Without these benevolent volunteers and donors, we would no longer be able to hold our conferences.

As Allen Coombes pointed out in *International Oaks*, Issue No. 23, 2012, our members have been very successful at introducing new oak species to cultivation. That is how the Society began: individual private collectors exchanging acorns. Today, several private individuals hold remarkable oak collections, including many plants grown from wild-collected seed as well as newly introduced species. The diversity in these private collections plays an important role in providing key information about the distribution and cultivation of oak species to those institutions concerned about their status and future. However, increasingly restrictive international legislation will in the future make

it nearly impossible for individuals to collect acorns in the wild in most countries rich in oak species. Future seed exchanges might not be what they have been, although we firmly intend to maintain that tradition.

Note that conference attendance is also essential to the Society's success and I remind you that our 2018 Conference will take place at UC Davis in Northern California. Tentative dates are October 22 to 24 for the Conference itself, but there will be a Pre-Conference Tour and a Post-Conference Tour. Make every attempt to attend and book your calendars now!

What is certainly within the means of the Society is to carry out its mission. This includes to: 1) publish *International Oaks*, the Journal you are holding in your hands, which we want to be among the best in its category: a medium between scientific institutions, the horticultural world, and amateurs (in the noblest sense) deeply interested in the genus *Quercus* and a publication that also reflects the life of the Society and its activities; 2) be the International Registrar for Oak Cultivars and to maintain the Oak Name Checklist at www.oaknames.org, a reference for all oak taxa, not only cultivar names, a database initially created by the late Piers Trehane; 3) organize Oak Open Days and tours; 4) publish *Oak News & Notes*, our newsletter, and *The Cupule*, our quarterly e-newsletter; and 5) maintain the www.internationaloaksociety.org website: all activities that provide the glue that keeps the Society and its members together and make us a community.

Whilst I hope that we will continue to find sponsorship to hold our triennial conferences, I nevertheless view these three as key activities of the Society, which, importantly, can easily be financed by membership dues. We constantly aim at improving the Journal and the Oak Name Checklist. Issue No. 27 of *International Oaks*, the Proceedings of the 2015 Conference, was considered by many to be our best issue ever. We have improved our other media as well and we want to improve them further.

This is not to say that administrative activities are not important. These form the operational basis without which we would not be able to carry out the above-mentioned activities. And here too, our website is key since we now manage membership through it.

I close this foreword with an appeal that past Presidents have made before. The Society relies almost exclusively on volunteers. Seven Board Members, including four Officers, run the Society. They are all members of one or more committee. Ten other members are involved in committee activities, chiefly the Taxonomy, Editorial and Oak Cultivars Committees. In 2018, we will hold new Board elections. Whatever your skills are, be it in finance and administration, oak taxonomy, or editorship and publishing, consider applying to the Board. You do not even need to wait until next year to join a committee of your choice and see for yourself how rewarding it can be to contribute to the life of your Society.

Charles Snyers d'Attenhoven
President

INTRODUCTION

A Ripe Young Age

Reading through the different contributions to this issue of *International Oaks*, I asked myself in what way, if any, do they reflect these past 25 years? What do they tell us about the "oak world" today? Perhaps even, what might they signify for tomorrow?

Not in the least, as Valencia shows us with *Quercus meavei*, that species remain to be discovered. The list of new taxa described over the last 25 years is not short – to name but a few: *Q.* ×*alentejana* (2015), *Q. barrancana* (2014), *Q. gaditana* (2014), *Q. delgadoana* (2011), *Q. pacifica* (1994), and *Q. macvaughii* (1992). Closely related to this, studies based on history, behavior, morphology and genetics, here by Avishai, Koenig et al., and Murphey and Potter, continue to try and make sense of this funny little thing called life as represented by this genus of remarkable plasticity and complex evolutionary history.

For plant enthusiasts, as for others, the past 25 years have been marked by massive conservation concerns that have largely taken the form of complex institutions and programs actively occupied with increasing public and decision-maker awareness about the importance of this issue. Oaks and their habitats are a primary focus of these efforts and Lobdell gives in these pages an example: a joint venture between the US Forest Service and the American Public Gardens Association for the ex-situ conservation of a critically endangered species, *Q. oglethorpensis*, through collaborative cultivation. Collaboration – in cultivation but also by exchanging information – is of course the first step towards a brighter future, in this, as in many undertakings.

From a historic oak collection in Australia (Buttigieg and Velázquez), through several collections in the United Kingdom, some still growing and some that have disappeared (Carnaghan, Chassé), to new and not-so-new collections in Argentina (Cameron), one can not help but recognize the undeniable reservoir of information about oaks that these (and other) collections represent, while acknowledging the fundamental role that the IOS plays in providing, on the one hand, the avenues through which information can be shared, and, on the other, the stimulus that helps feed our passion for these trees.

Enjoy the passion such as springs from the pages in this issue that will take you back in time through a bit of IOS history (Sternberg) on a stroll through the incredible forests of Panama (Cameron), share with you the beauty of Martha's Vineyard and of the mountains

of Taiwan (Chassé), help you discover the interesting flora of New Mexico (Russell), or recent cultivar selections (Jablonski and Russell). As all of these articles show, on their own or in groups, there are private individuals who devote resources and time to learning about oaks all over the world – again, a non-negligible force considering the state of concern about these, and other, plants all over the planet.

Now and again, I have heard concern expressed about the future of botanic societies since, generally, and the IOS is no exception, their membership is not largely constituted by that demographic category which has in recent years tended to supplant the significance of all others. This concern has always left me a bit perplexed given that since time immemorial membership in these societies has always been recruited from older generations – and I can not see how this is a handicap. Au contraire. Human beings are like trees in really only one aspect: they both take considerable time to mature.

The International Oak Society, now at the ripe young age of 25, has grown, if not terribly so in number of members, as our President points out in the Preface to this volume, certainly in scope and ambition.

Writing in 2014 (*International Oaks*, No. 25) Allen Coombes remarked that in the twenty years then past since the first IOS Conference in 1994, the number of oak collections and the number of new species growing in them had increased significantly, both due largely to increased collecting efforts in the oak-rich areas of the world. "Today the names of many obscure, and even then unnamed, oaks are tripping off the tongue in not so idle conversations."

Indeed.

In these times of ecological despair, I should like to end with a sincere homage to plant collectors and propagators past and present as well as to the botanic societies, such as ours, that have been instrumental in disseminating the fruits of their efforts. Identifying fragile zones and endangered species is surely a useful exercise – but is it not necessary, if we want to save those species, to have knowledge about their cultivation? In Europe very nearly the only arboreta that are growing many endangered oak taxa, or, less dramatically, the more recent introductions, are the private ones along with a very few specialized nurserymen. The activities of these individuals are an essential resource for the success of conservation efforts and for building awareness about the beauty in the diversity of our planet and the positive role that each of us can assume.

Béatrice Chassé
Editor

Chevithorne Barton
A Tribute to Michael Heathcoat Amory
(October 2, 1941- February 24, 2016

Introduction

In February 2016, Michael Heathcoat Amory, creator of the renowned oak collection at Chevithorne Barton, friend to many of us, and indefatigable supporter of the International Oak Society, passed away.

In the Preface to *The Oaks of Chevithorne Barton*, published in 2009, Michael wrote, "When I started to collect, I did so because oaks had such variety, and encompass so many outstanding species, and also because oaks through the ages have been of vital importance to man in so many different ways. I thought then it would be an interesting, if challenging, genus to collect and a quarter of a century later I have not changed my mind." Not only did he not change his mind, but for 32 years his interest and passion for oaks in general, and in his trees in particular, grew stronger, pushing him ever further in the quest for new taxa, and to expand the garden to find the best spots for planting his oaks.

In tribute to Michael, these pages carry the personal memories of some who had the pleasure of working with him, developing and sharing his passion, as well as a few of the very special oaks of Chevithorne Barton that are in turn part of what he has left in heritage to his fellow quercophiles.

Photo 1/ *Quercus schottkyana*

Christine Battle

I first met Michael in 2003 at the 5th International Oak Society Conference in Winchester, England. I'd been invited (it was more like a three-line whip) by Allen Coombes, who thought that with my nascent enthusiasm for oaks, I would benefit from meeting some proper collectors. My friend James MacEwen orchestrated the actual introduction and

as I shook hands with this immensely tall, lean man, he bent down and – speaking in his characteristically low voice – asked me how many oaks I had in my collection. "Forty-two." I replied proudly. "Very good, very good." he said.

Of course I soon learned that forty-two oaks wasn't really very good at all, but by then Michael had drawn me into his own oak collecting world, infecting me along the way with his passion for seeking out the rarest, choicest, most exciting species of *Quercus*. However Michael wasn't just about long lists of rare oaks, he also loved getting out amongst his trees to plant, prune (often severely) and nurture them.

Photo 2/ Michael Heathcoat Amory and Christine Battle at Chevithorne Barton in 2011.

Although I was a mere dabbler in collecting terms, Michael was always incredibly generous to me, not only giving me numerous prime seedlings to add to my own collection, but also providing the opportunity to meet oak aficionados from far and wide. He and Arabella were the most generous hosts; oak weekends at Chevithorne were cherished invitations, where Michael would gather like-minded enthusiasts for a couple of days spent talking and walking the Chevithorne oaks. He made sure that all were made to feel involved, and the less knowledgeable (like me) had the privilege to talk with, listen to and learn from the real experts.

Weekends often started with a visit to the greenhouse or polytunnel. Seedlings and young plants were pored over, those that were thriving admired and complimented, and those doing less well (or sometimes not at all) examined, and causes/cures discussed at length. A stroll amongst the trees would follow and woe betide the visitor who strayed too far from the oaks; I occasionally found myself exclaiming with pleasure at some gorgeous non-oak specimen, only to turn around and find I'd been talking to myself, the rest of the party disappeared from view en route towards another oak. Days spent among the oaks were followed by evenings around the fire, with reference books scattered about, specimen leaves (often rather crumpled from an afternoon spent in a jacket pocket) compared and argued over, and overall a feeling of comradeship between a disparate group of individuals who nonetheless were bound together by one unifying factor – Michael and his beloved oaks.

Photo 3/ *Quercus acuta*

Photos 4/ In the greenhouse (a) *Quercus marilandica* var. *ashei*; (b) *Q. glabrescens*; (c) *Q. hypargyrea.*

Béatrice Chassé

I remember the first time I was invited to Chevithorne for one of Michael's oak weekends (May 2010) during which one was always sure to meet interesting people to share interesting tree stories with. My first tour of the collection at Chevithorne with Michael in 2010 was, I believe, a bit of a test. Luckily for me, the first oaks that we encountered were ones that I knew, *Q. schottkyana*, *Q. acuta*, *Q. salicina* (one of my favorites) and a few others, though I think I got a few good points for remarking that the *Q. rysophylla* looked a bit odd with those very long petioles and also for recognizing *Q. miquihuanensis* that had only just been introduced to cultivation in the UK by Nick Macer.

During one of our conversations at dinner, Michael asked me if I intended to obtain a National Collection label for the Arboretum des Pouyouleix. When I replied yes, he said "Hmm. Good, but the competition is hard in France, isn't it?" The answer to that question is of course yes, with such excellent collections as those of Henri de Brem, Michel Duhart, and Shaun Haddock – but after a moment's hesitation I looked at him wryly and, with a shrug, replied, blasé, "No." He was very amused by this, winked and replied, "Ah…well then, I'll be your competition!"

Admittedly, while a little bit of competition motivates us all, without question Michael

Photo 5/ From left to right: James MacEwen, Béatrice Chassé, Thomas Packenham, David Campbell, David Lancelles, and Michael Heathcoat Amory at Chevithorne Barton in 2010.

was truly an ally and a major force behind all of my oak adventures in different parts of the world. Michael took the time, before attending the 7th International Oak Society Conference in Bordeaux in 2012, to come and visit the Arboretum des Pouyouleix with his lovely wife, Arabella, his brother, sister-in-law, and James MacEwen. He was of course particularly interested to see those species that he did not have!

During my most recent visit, in October 2016, it was wonderful to see how the trees had grown and to marvel at the new treasures, including a small *Q. albocincta* and *Q. gentryi* from my Mexico 2010 expedition. These two taxa did not survive our February 2012 cold spell and, as I looked at them, it wasn't difficult for me to imagine Michael softly grinning behind me.

Allen Coombes

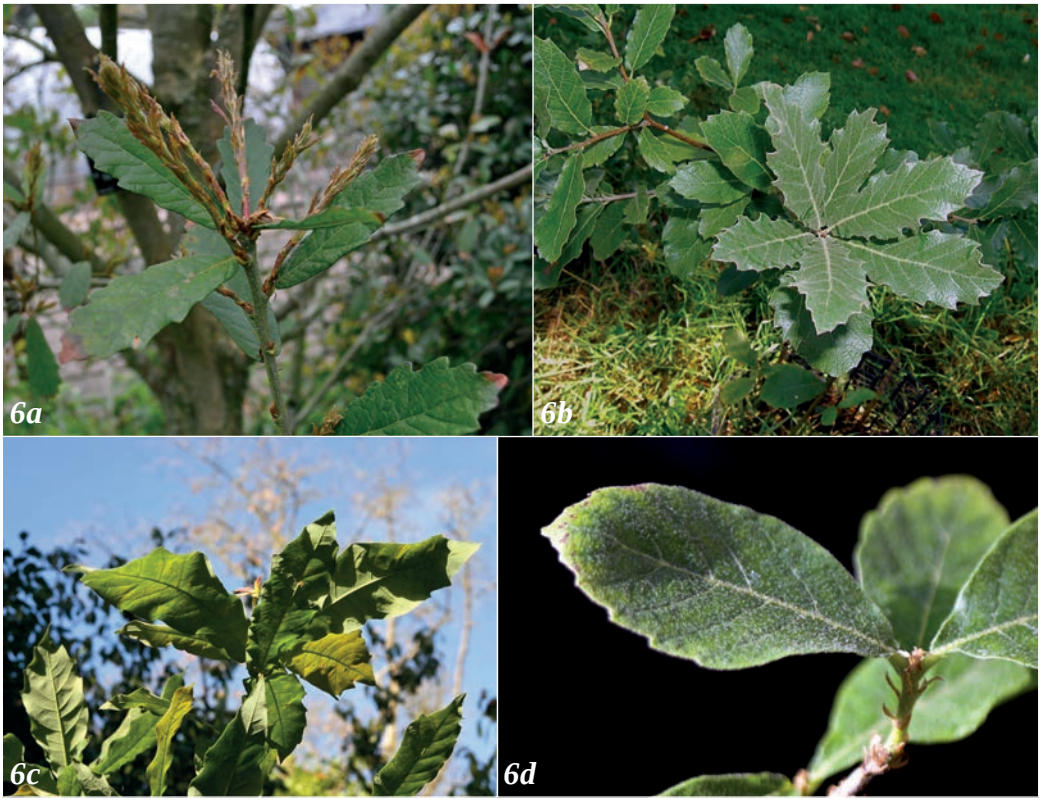
How often do we hear of a remarkable garden or collection only to discover that its inception and development is due to a single person? In my own experience I have found such a situation to be very common and the oak collection at Chevithorne is a good example, demonstrating that the most important factor in developing a good collection, is passion, a force that never leaves us and drives us to achieve. Michael Heathcoat Amory had this passion and devoted the latter part of his life to his collection.

I first met Michael in 1996, having been introduced to him by Piers Trehane. This was one year after my first visit to Mexico and just before my second, and less than two years after my induction into the serious study of oaks at the first International Oak Society Conference at the Morton Arboretum in 1994. Of course, there was already a garden at Chevithorne with many trees planted around the house and a woodland area with many

rhododendrons. There were even some oaks, including some Mexicans, set against a background, in some areas, of large *Quercus robur*, but Michael was keen to expand his collection and asked me to help. At this time there were few collections devoted primarily to oaks and relatively few gardens had much out of the ordinary. A lot has changed in only 20 years.

From the beginning I was involved in the collection on several levels, obtaining new material, identifying what was already there, and documenting existing plants. We set up a record system with accession books and a database and started to label existing trees. Very often a little detective work was needed and I remember one of the first challenges was a small, bushy oak with an obviously wrong label, situated not far from the house. The information associated with this indicated that it came from Susan Cooper, who often made available plants of some unusual oaks, and was collected in Texas. I identified this plant as *Q. intricata*, a shrubby species from Texas and northern Mexico, then and now very rare in cultivation and a valuable addition to the collection. Today it still grows, slowly but steadily, showing that plants from very dry areas can survive in the relative lushness of Devon. Another tree already in the collection proved to be *Q. acherdophylla*, a species I had found in Mexico the previous year.

It was thanks to Michael and others that I was able to travel the world looking for oaks, particularly in countries with very high numbers of species such as Mexico and China. I made good contacts in many countries and was always made welcome. Particular successes from Mexico must include *Q. sartorii* and *Q. delgadoana*, both of which grew very quickly. It soon became obvious at Chevithorne and other collections



Photos 6/ (a) *Quercus glabrescens*; (b) *Q. castanea*; (c) *Q. germana*; (d) *Q. liebmannii*.

that the Mexican Red Oaks were going to perform much better in cultivation than the White Oaks, which are more common in hotter and drier areas in Mexico and need a lot of heat to ripen the wood. For the less hardy species Michael constructed a greenhouse kept above freezing in winter where, amongst others, a small tree of *Q. insignis* grows. This species, well known now for its huge acorns has failed almost everywhere outside in the UK.

As the interest in oaks grew, others were making plants available as well and this was the start of another detective story. From Tom Hudson came an oak that Keith Rushforth had collected at 3,000 m in Tibet. I remember when I first saw this plant that it was like nothing I had seen before. Of course there are many species of oak in China (second only to Mexico) and I was fairly confident I could track it down in the online flora. However, no matter how hard I tried, I could not fit the tree at Chevithorne to any of the species listed. Never one to give up easily I found the Chinese Virtual Herbarium. This a little known and valuable resource with photographs of specimens from many Chinese herbaria. It was not so easy to use in those days as it was necessary to guess at what the Chinese characters meant before a search could be carried out. Eventually I managed to get a list of all the oaks in Chinese herbaria and was able to go through them one by one, obviously discounting the ones I knew. It was towards the end of the list that an image appeared on my screen and recognition was instant. The dried specimen in front of me was exactly the same as the tree at Chevithorne. It was the type specimen of what they called *Q. tungmaiensis*, however, this species was regarded as a synonym of *Q. lanata* in the Flora of China and someone had written at the bottom of the sheet "*Quercus leucotrichophora*". Obviously there had been some confusion here and I could see that both of these names were wrong. Today, *Q. tungmaiensis* is accepted as a good species, but still appears in

Photo 7/ *Quercus tungmaiensis*

Photo 8/ *Quercus crassifolia*

Photo 9/ Allen Coombes and Michael Heathcoat Amory with *Quercus candicans* at Chevithorne Barton.

the Chinese Virtual Herbarium as *Q. leucotrichophora*.

Since my first visit to Chevithorne in 1996 I have stayed there at least once every year. These oak weekends involved several other oak enthusiasts, such as Piers Trehane, James MacEwen, Christine Battle, Thomas Methuen Campbell, Tony Kirkham, and usually others. We were always made very welcome and comfortable by Michael and his wife Arabella. The first day always started off the same, with a visit to the greenhouse. Here, Michael would proudly show off his latest acquisitions and germinations, usually with a discussions over the name of a plant which was sometimes only about two inches tall. This would be followed by a tour of the garden to see how the trees had grown. And how they did grow. The collection expanded rapidly and Michael ventured into other parts of the garden, such as the Walnut Orchard and the Rifle Range. In these areas, the south-facing slopes and usually good rainfall gave perfect conditions for most of the species he was planting.

Stops at many of the trees resulted in long discussions over how they should be pruned or whether the correct name was on the label. A particular occasion that those that were present will not forget for a long time was when we were looking at a tree of *Q. crassifolia*. Although growing very well it had two trunks from the base of very similar size. There was a lot of discussion over whether to remove one of them. Luckily, Tony Kirkham was there and when a decision had been made Tony swiftly felled the smaller stem. It was obviously the right choice as the tree is today, probably twice the size and the old stump can barely be seen.

Although Michael was very passionate about his collection, he rarely showed a lot

of emotion. A slight grin showed he was delighted, maybe with a new species for the collection, a tree doing particularly well, or perhaps having just removed an offending limb. He also did not seem to be affected by the few disasters Chevithorne has suffered. He just seemed to take it in his stride when the two magnificent *Q. candicans* succumbed to late frost or when the largest *Q. delgadoana*, always spectacular for the bronze flush of its young leaves, was irrevocably smashed by a falling tree.

For me it has been a pleasure and a privilege to be involved with the development of the collection at Chevithorne for so long. Whenever I visit I will have fond memories of the times I spent with him looking at his trees and maybe, at times, I will hear a whisper in my ear "Do you think I should take that branch off?"

James MacEwen

Photo 10/ From left to right: James MacEwen, Béatrice Chassé, and Michael Heathcoat Amory at Chevithorne Barton in 2011.

The most important element of making the collection at Chevithorne so special was of course Michael Heathcoat Amory's determination that it be as comprehensive as possible. If Michael was going to have a collection, it was going to be the best one in the world. I remember that it was always very hard to get Michael to accept that a seedling was dead, especially if it were the only one of that species in the collection! Over the years of our collaboration, that began seriously in 1992, the oak collection has grown and changed with the balance between new introductions and inevitable losses. The arrival of new acorns and plants was a pleasure to share with him, a moment that we both looked forward to every year.

The National Oak Collection at Chevithorne exists because of Michael Heathcoat Amory's commitment but also because of the extraordinary support, goodwill and advice that came from so many people. There are many individuals whose encouragement has helped make this collection what it is today, individuals who, in turn, were encouraged by Michael's interest, passion, and…competitive spirit. Allen Coombes was a catalyst as were Christine Battle, Min Deng, Tom Hudson, Tony Kirkham and Thomas Methuen Campbell. Michael and I were always grateful for their generosity in sharing acorns, plants, and knowledge, as we were grateful for Piers Trehane's contribution that did so much to sort out the nomenclature of oak names and to stimulate the adoption of quality labels at Chevithorne. The development of the excellent website (oaksofchevithornebarton.com), for which we are indebted to Will Blackwell, achieved another important goal that we had set, namely, the accessibility of the collection data.

The collection has a number of species that are quite rare in cultivation – *Quercus albocincta, Q. gentryi*, *Q. liboensis* to name but a few – and perhaps not all would survive a really hard winter, such as we have not had for some number of years. Our policy was

Photos 11/ (a) *Quercus baronii*; (b) *Q. utilis*; (c) *Q. lamellosa*; (d) *Q. pentacycla*.

to try and have three specimens of different provenance and only if all attempts failed, to accept that the species would not be suitable for this part of Devon. Sometimes we were surprised at what survived: for example, a *Q. palmeri* that Michael planted (much to my dismay!) in a soggy, frost pocket has survived whilst another one, in a prime, sunny, sheltered position has not.

Michael treasured the gifts of rare species, for example, two trees of *Q. lamellosa*, growing well (though the early growth can be caught by spring frosts), *Q. baronii*, a small-leaved oak that seems to be a survivor, *Q. tungmaiensis* with a distinctive leaf unlike any other oak, and *Q. utilis*, a very special oak whose roots seem particularly attractive to rabbits. Michael would be pleased to know that recently Chevithorne was given a specimen of *Q. poilanei*, a very rare oak from Asia that I'm sure he would have cherished.

Only just a few years ago, I convinced Michael that it would be wise that the rarer species growing on the edge of what can be grown in Devon should be propagated – especially when we only had one plant, as is the case, for example with *Q. marlipoensis* and *Q. hinckleyi*. This project is being brought to fruition by Tom Hudson (Tregrehan House) who is trying to propagate cuttings from them – indeed, with already some notable successes. The plants thus raised will be planted at Tregrehan, where there is a milder climate than at Chevithorne.

Michael was particularly fond of Chevithorne's important collection of Mexican oaks, one of the most successful group to be introduced into cultivation in Europe. This is largely due to Allen Coombes' endeavors and to the efforts of the intrepid Béatrice Chassé. Michael was intent both on continuing to develop the cultivation of Mexican oaks and on expanding collaboration with those arboreta sharing the same objective.

Photo 12/ *Quercus crispipilis*

Photo 13/ Guy Sternberg and Michael Heathcoat Amory at the 5th International Oak Society Conference (2003) in Winchester (UK).

But, in fact, Michael had a passion for oaks from all over the world, and quite recently, had begun to develop an interest in their cousins, the lithocarps.

All of us who enjoyed Michael's passion for oaks and his very generous hospitality owe a great debt to his wife Arabella who was the perfect hostess and survived through all of the interminable conversations from the assorted oakaholics whom she courteously entertained. Today, the collection at Chevithorne Barton is in the process of being secured by a trust to safeguard it and to ensure its continued development. Edward and Alice Heathcoat Amory are committed to maintaining and fostering the collection, and have their own exciting ideas about expanding the garden.

Michael was a very special friend whom I will truly miss.

Photo 14/ *Quercus ×runcinata*

Photographers. Title page: Charles Snyers d'Attenhoven (Chevithorne Barton, the Walnut Orchard looking down towards the Rifle Range. From the right-hand corner going downhill: *Quercus georgiana*, *Q. affinis*, *Q. frainetto* 'Trump Ball', *Q. lancifolia*; from the left-hand corner going downhill: *Q. imbricaria* and *Q. dentata* 'Carl Ferris Miller'). Photos 1-5, 10: Charles Snyers d'Attenhoven. Photos 6, 7, 11, 12, 14: James MacEwen. Photo 8: Béatrice Chassé. Photo 9: Maricela Rodríguez-Acosta. Photo 13: Mike Tyner.

Quercus meavei Valencia-A., Sabás & Soto: a Recently Described Oak From Eastern Mexico

Susana Valencia-A.
Herbario de la Facultad de Ciencias, Universidad Nacional Autónoma de México
Ciudad Universitaria, C.P. 04510, Coyoacán, Ciudad de México, México
querc2002@yahoo.com.mx

***Quercus meavei* in FCME, Universidad Nacional Autónoma de México.**

In August 2016 my colleagues and I published a new species of Red Oak (*Quercus* section *Lobatae*) (Valencia-A. et al. 2016). I first found it in Hidalgo state in the municipality of San Bartolo Tutotepec, while exploring that state for oaks. In San Bartolo Tutotepec the new species grows along the banks of rivers, and, in high-humidity forests, can reach 30 m in height. Sabás and Soto later showed me a specimen of the same species collected in San Luis Potosí. We compared these specimens with other species from the *Acutifoliae* complex and decided that it was an undescribed species. So it was described and published as *Quercus meavei*. It is named after Dr. Jorge Arturo Meave del Castillo, of the Department of Ecology and Natural Resources, Faculty of Sciences, Universidad Nacional Autónoma de México (UNAM).

Photo 1/ Leaves of *Quercus meavei* in San Bartolo Tutotepec, Hidalgo, Mexico.

Description

Quercus meavei is an evergreen and very tall tree, reaching up to 30 m in height. Twigs fulvo-tomentose, buds long-ovoid with golden-pilose superior scales. The leaves are 13 × 4.5 cm or more frequently larger, up to 18 cm long, lanceolate, oblong-lanceolate, or rarely elliptic, with 14-19 secondary veins on each side of the midvein, parallel, ascending, straight, continuing until the aristae, and impressed adaxially; the blade margin has 11-16 aristate teeth on each side. The fruits ripen from September to November; they are biennial, with hemispheric cupules from 18-23 mm diam. which have adpressed and flat scales; the acorns are ovoid, glabrate and their size is 12-16 × 11-16 mm.

At the moment, *Q. meavei* is only known from Mexico in the Sierra Madre Oriental, in both cloud and oak forests, in the states of Hidalgo, Puebla, San Luis Potosí and Veracruz in temperate areas with high humidity at altitudes between 1,630 and 2,250 m.

The new species can be confused with *Q. xalapensis* Bonpl., *Q. skinneri* Benth. and *Q. uxoris* McVaugh because of their similar leaf shape and size, the blade margin which is aristate-dentate, and the biennial fruits. See Table 1 for a comparison of the main characters.

Photo 2/ Herbarium specimens of A. *Quercus uxoris*, B. *Q. skinneri*, and C. *Q. xalapensis*.

	Q. meavei	*Q. xalapensis*	*Q. uxoris*	*Q. skinneri*
Twigs	fulvo-tomentose	glabrous	fulvo-tomentose	glabrous
Buds	golden-pilose towards the apex	glabrate and amber	golden-pilose towards the apex	glabrate and amber
Shape of the cupule	hemispheric or slightly patelliform	hemispheric	subhemispheric to patelliform	patelliform
Cupule diameter	18-23 mm	20 mm	15.5-23 mm	22-50 mm
Scales of the cupule	flat	flat	flat	keeled
Shape of the acorn	ovoid to broadly ovoid, glabrous or glabrate	Ovoid, depressed to subhemispheric glabrous	broadly ovoid to ovoid tomentose	broadly ovoid to depresaly ovoid, tomentose
Acorn diameter	12-16 mm	16 mm	12-21 mm	18-40 mm
Pericarp	thin	thin	thin	strongly thickened
Secondary veins	(12)14-17 impressed adaxially	8-12 flat adaxially	10-14 flat adaxially	(7) 9-14 flat adaxially
Teeth on each side of the midvein	11-16	7-12	10-14	9-14
Distribution	Hgo., SLP.,Ver., Pue.	Pue., Ver., Nicaragua	Col., Gro., Jal., Oax.	Chis., Oax., Ver., Guatemala.
Elevation (m)	1,630-2,250	320-1,400	1,400-2,500	700-1,200

Table 1/ Comparison of main characters of *Quercus meavei, Q. xalapensis, Q. uxoris and Q. skinneri.*

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Photographers. Title page: courtesy of FCME, UNAM. Photos 1, 2: Antonio Hernández.

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Evolutionary Drivers, Proximate Mechanisms, and Spatial Synchrony of Acorn Production in Oaks

Walter D. Koenig[1,2], Mario B. Pesendorfer[1,2], and Johannes M. H. Knops[3]

1. Lab of Ornithology, Cornell University, 159 Sapsucker Woods Road, Ithaca, NY 14850 USA
wdk4@cornell.edu

2. Hastings Reservation, University of California, Berkeley, 38601 E. Carmel Valley Road, Carmel Valley, CA 93924 USA

3. School of Biological Sciences, University of Nebraska, 348 Manter Hall, Lincoln, NE 68588 USA

ABSTRACT

Masting behavior – the highly variable and synchronized production of seeds by a population of plants – is common among oaks and has dramatic effects on resource dynamics and community structure. Based on the California Acorn Survey, our long-term study of acorn production by California oaks, we summarize the major hypotheses driving this phenomenon along with some of the questions remaining to be answered about masting at both the functional (ultimate) and mechanistic (proximate) levels of analysis. We also discuss one of the key issues regarding the definition of masting, namely what constitutes a population. This latter issue has recently been addressed by quantifying spatial synchrony, the spatial and temporal scale at which acorn production is synchronous. The drivers of spatial synchrony differ dramatically depending on the spatial scale of interest; at the relatively small spatial scale of individual trees a few km apart, the primary drivers for one species we have studied in detail, *Quercus lobata* Née (valley oak) are local environmental factors such as soil nutrients and water availability, whereas at the large spatial scale of several hundred km the drivers of both differences in overall productivity and spatial synchrony are primarily more general environmental factors, specifically weather.

Keywords: California Acorn Survey, economy of scale, masting, Moran effect, pollination efficiency, predator satiation, resource matching

Introduction

Masting or mast-fruiting, the highly variable and synchronized production of seeds by a population of plants, has been recognized for over 250 years (Ellis 1743: "Under these trees, the hogs generally get pork in a maste-year"; cited in the Oxford English Dictionary). It is only much more recently, however, that workers have investigated this enigmatic phenomenon critically and begun to understand both its ecological drivers and evolutionary implications.

One of the earlier evolutionary considerations of mast-fruiting can be found in Stearns (1976), who briefly outlined several hypotheses for mast-fruiting as part of his discussion of life-history adaptations to different kinds of environments. The start of the modern scientific investigation of masting behavior, however, can reasonably be attributed to Silvertown (1980), who was the first to conduct a meta-analysis with the goal of testing the most long-standing and durable evolutionary hypothesis for this phenomenon, the idea that masting behavior increases the survival of seeds by reducing the probability of seed predation (the "predator satiation" hypothesis). Following Silvertown's review, subsequent papers generally focused on the implications of masting behavior for seed dispersal and seedling survival. This changed with the landmark paper by Norton and Kelly (1988), which analyzed variable seed production by the rimu (*Dacrydium cupressinum* Sol. ex G. Forst.), a New Zealand coniferous tree. Norton and Kelly's key contribution was to identify alternative hypotheses for masting behavior and to point out that most involved an "economy of scale" such that occasional larger episodes of reproduction are more efficient than more regular, smaller ones.

Hypotheses involving some economy of scale include not only predator satiation but the possibility that a higher proportion of flowers may be successfully fertilized in mast years (the "pollination efficiency" hypothesis) and the hypothesis that masting occurs following events that portend environmental conditions favorable to seedling establishment (the "environmental prediction" hypothesis). The key feature of all economy of scale hypotheses is that they require more from the plants than simply responding to current conditions; in other words, they are an adaptive response to some ecological factor and thus a product of selection. As such, they require an evolved mechanism on the part of the plant to produce the highly variable patterns of reproduction characteristic of this phenomenon.

The senior author's interest in masting behavior stems from a long-term study, still ongoing, of the acorn woodpecker (*Melanerpes formicivorus* Swainson), a species common in California whose extraordinary social behavior is matched only by its unique habit of individually storing acorns, often by the thousands, in special trees modified by the birds called storage trees or granaries (Photo 1). As part of this study, we noted that almost everything about these birds, from their family-living behavior to their reproductive success, seemed to be dependent on the size of the acorn crop, which varied dramatically from year to year. Oddly, however, there was relatively little information on the factors that drove such variability, and thus we initiated what we now call the California Acorn Survey in autumn of 1980.

The original goal of the California Acorn Survey was to use brief (15 s by each of two observers for a total of 30 s) visual counts of acorns (Koenig et al. 1994a) on marked trees to quantify annual variation in seed production by the various species of oaks at our study site and use the data to gain a greater understanding of the ecological variables

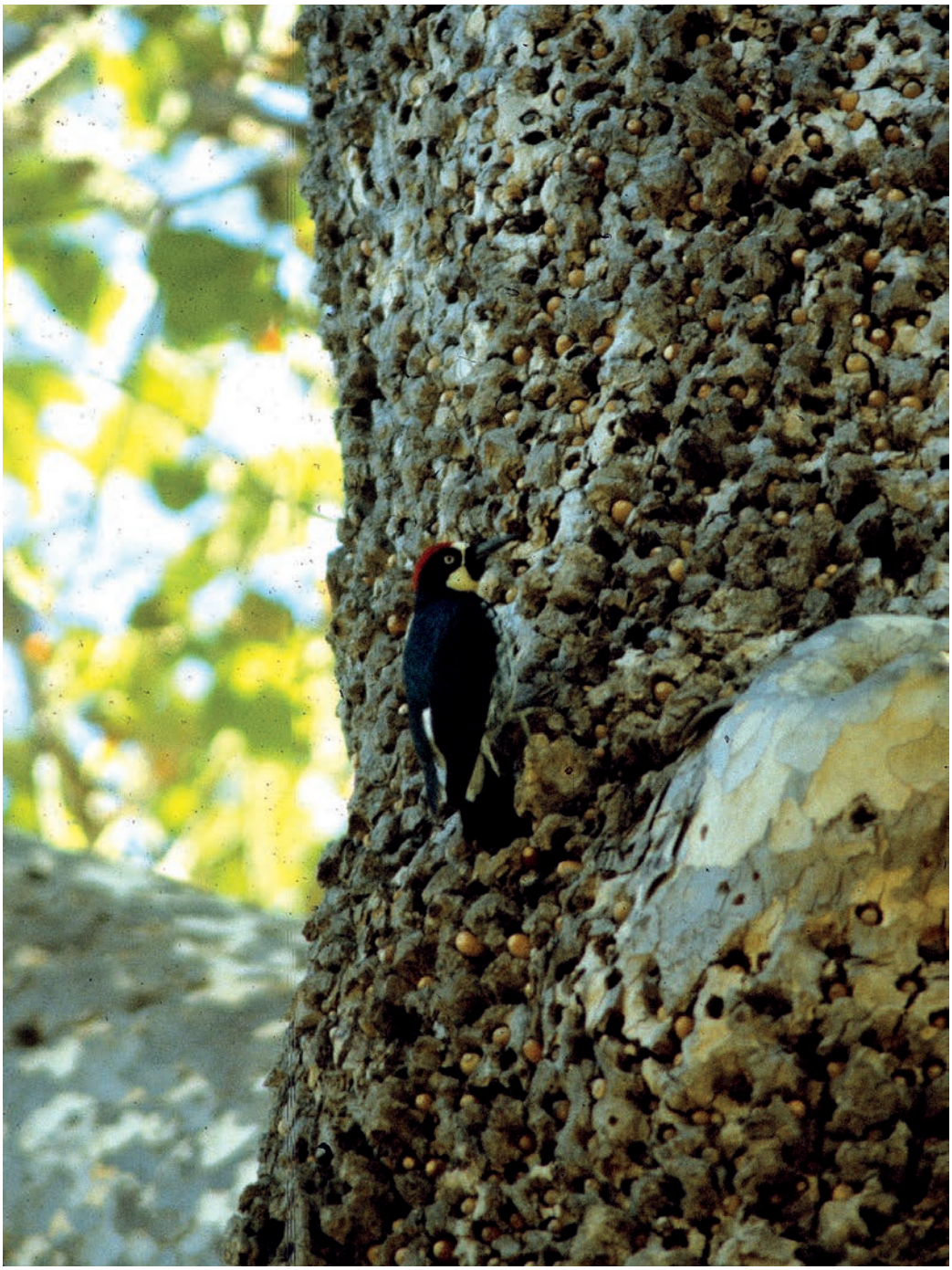

Photo 1/ An acorn woodpecker defending acorns stored in its family's granary, in this case *Platanus racemosa* (California sycamore).

selecting for the unusual social behavior of the birds we were studying. Within a few years, however, the survey took on a life of its own, eventually expanding to encompass mast surveys at 20 sites across the entire state of California and the additional goal of understanding the drivers of variable acorn production at multiple levels of analysis.

Photo 2/ Using binoculars to visually count acorns on the California Acorn Survey.

Here we summarize some recent findings and discuss a few of the problems that remain to be solved before we gain a complete understanding of masting behavior in oaks and other forest trees.

Ultimate drivers

Despite the intuitiveness of the predator satiation hypothesis, there are at least two reasons why it is unlikely to provide the only, and in some cases possibly even the main, selective advantage to masting in oaks. The first is that the main vertebrate predator of acorns, birds in the family Corvidae (jays and magpies) are typically also their main dispersers (Pesendorfer et al. 2016b). As a consequence, the selective advantage of reducing jay populations by means of poor acorn years is counteracted by the selective disadvantage of decimating the primary agents of seed dispersal during good acorn years.

In its most extreme form, predator satiation predicts that all masting species in a community will be selected to produce seed crops that are both highly variable and highly synchronized, thus severely reducing or even eliminating seed predators. In contrast, maintaining healthy seed dispersal agents such as jays is likely to select for asynchronous seed production interspecifically, and possibly even intraspecifically, depending on whether the birds are attracted to groups of trees masting synchronously or individual trees producing large seed crops, and the interactions between different species of seed predators/dispersers (Pesendorfer et al. 2016).

Interestingly, seed production by oak communities often appears to conform more closely to this latter, asynchronized, pattern. This is a consequence of the second reason why predator satiation is unlikely to be the only evolutionary factor selecting for masting: the frequent co-occurrence of species in different sections that typically require a different number of years (one vs. two) to mature acorns (Mohler 1990), and as a result do not mast synchronously (Koenig et al. 1994b). Thus, regardless of how synchronous acorn production by individual species may be, acorn availability on the community level is

generally moderated at any site where oaks of different sections coexist, such as is typically the case in North America and anywhere that oaks in both the White and Red sections are sympatric. On a community level, masting by oaks is not particularly striking.

If masting in oaks is not selected for exclusively by predator satiation, what other factors are important? Counteracting selection for seed dispersal is clearly one important evolutionary factor. For these wind-pollinated, self-incompatible species, another important alternative is that trees are able to achieve more efficient pollination by investing their resources in occasional years of large flower and seed production rather than spreading their resources out across all or most years. This "pollination efficiency" or "pollen coupling" hypothesis assumes that pollen is limited in at least some years, a possibility that has only recently been confirmed in wind-pollinated species (Koenig and Ashley 2003; Koenig et al. 2012; Pearse et al. 2015). Evidence for the importance of the pollination efficiency hypothesis has, however, been accumulating for some time both empirically (Kelly et al. 2001; Knapp et al. 2001; Sork et al. 2002; Moreira et al. 2014) and theoretically (Satake and Iwasa 2000, 2002a, b).

Although evidence that more than one factor plays a role in selecting for masting behavior in oaks exists, quantifying the relative importance of each is difficult and there has as yet been no study that has unambiguously been able to disentangle them. Perhaps the best attempt so far is the conceptual model developed by Kelly et al. (2001), which attempts to quantify the importance of pollination efficiency. Their results suggest that masting can be evolutionarily favored by either one factor or a combination of factors, and that the relative importance of different factors may vary both between and within species depending on variables such as altitude, fragmentation, and plant density. Clearly more work needs to be done to understand the importance of different adaptive hypotheses for masting behavior in oaks and how they are influenced by environmental and ecological factors.

Proximate drivers

Although many gaps regarding the functional (evolutionary) basis of masting remain, we know even less when it comes to the proximate drivers of variable seed production (Crone and Rapp 2014; Pearse et al. 2016). This is most obvious when considering the large literature on the relationships between weather and seed production, both in oaks and other masting species, particularly conifers. Clearly weather correlates with subsequent seed production in many species. But why? How, exactly, do trees "see" different kinds of weather conditions and use them to decide how much to invest in seed production in a particular year?

Photo 3/ *Quercus lobata* (valley oak) on Liebre Mountain in northern Los Angeles County, California.

In many White Oaks (section *Quercus*), for example, warm, dry conditions during the spring generally correlate with large acorn crops the subsequent autumn (Sharp and Sprague 1967; Sork et al. 1993; Koenig et al. 1994b). In our study site in central coastal California, the strongest correlation between weather and the annual acorn crop in valley oaks (*Quercus lobata* Née), is with mean maximum temperature in April (Photos 3 and 4). Since flowering in this population occurs primarily in March and April, these results suggest that weather affects pollen flow and/or fertilization of flowers in this population. But how?

The answer to this question has important implications for issues such as how and if climate change will affect masting behavior. One relatively straightforward possibility is the "pollen wash-out" hypothesis, that cool, wet conditions during flowering directly inhibit pollen flow by washing pollen out of the air (Pérez-Ramos et al. 2010). Another, more complicated possibility is the "phenological synchrony" hypothesis that synchrony of flowering driven by microclimatic variability drives annual differences in pollen availability and pollination success (Koenig et al. 2015)(Figure 1). Despite patterns related to life history and phylogeny, however, the weather factors that correlate with seed production are often different for different species, and thus there are almost certainly other mechanisms potentially linking weather and seed production in masting species (Koenig et al. 2016).

To the extent that seed production is affected by weather through the latter's effects on pollination success, pollination is potentially important to masting at both the ultimate evolutionary level, via pollen coupling, and proximate mechanistic levels of analysis. It is nonetheless important to try and distinguish these levels and make it clear which one is being considered in any particular analysis.

The pollen wash-out and phenological synchrony hypotheses are predicated on the assumption that weather is a mechanistic driver of masting behavior (Pearse et al. 2014). An alternative, however, is that weather is simply a cue sensed by the trees and perhaps amplified in some way so as to result in variable seed production (Kelly et al. 2013). To the extent that this is true, it is possible that masting will not be influenced by climate change, whereas if weather affects acorn production because of its close mechanistic relationship to acorn production, it is likely that climate change will directly affect masting (Koenig et al. 2015). This is another area that is clearly in need of additional study.

How weather affects acorn production is only one aspect of the issues related to the proximate drivers of masting behavior in oaks. The second major issue is the role of resources. Acorns of most oak species are relatively large and cannot be conjured out of nothing, and thus resources are clearly necessary in order to produce them. Exactly what resources are critical, where they come from, and whether they are limiting or not are all questions that remain to be fully understood.

As pointed out recently by Pearse et al. (2016), there are at least four different ways that resources may play a role in seed production. The first of these, resource matching, is the idea that masting behavior is a response to varying levels of resources that happen to be available from one year to the next. This idea, which dates back to the early part of the 20th century (Büsgen and Münch 1929), is the one hypothesis that does *not* require that masting behavior be the result of an economy of scale nor the product of selection. Studies investigating this hypothesis have generally found that variability in resources that are likely to be involved in masting is much smaller than variability in seed production,

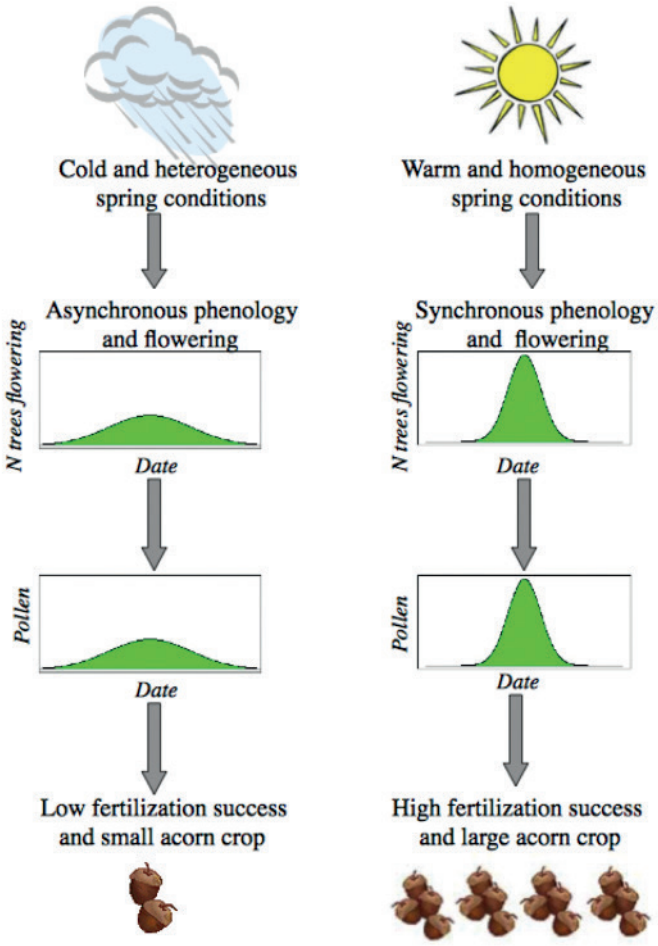

Figure 1/ The phenological synchrony hypothesis, from Koenig et al. (2013). The hypothesis proposes a mechanism for how differences in weather conditions during the spring may interact with synchrony among trees in their flowering phenology to determine the overall size of the subsequent acorn crop.

countering a key prediction of this hypothesis (Koenig and Knops 2000). Also contrary to this hypothesis is the negative temporal autocorrelation in seed production reported in many species; that is, a good mast year is generally followed by a relatively poor one, and vice versa (Sork et al. 1993; Koenig et al. 1994b). In contrast, a positive correlation between growth and reproduction within individuals among years provides support for the resource-tracking hypothesis; this pattern has rarely been observed in masting species, however (Kelly and Sork 2002).

A second way that resources might be important in seed production is if resources are "switched" between reproduction and some other function – most obviously growth – within years. Such a pattern is potentially consistent with resources being relatively consistent from one year to the next, since the greater variability in seed production is hypothesized to be due to differences in the proportion of resources devoted to

Photo 4/ *Quercus douglasii* (blue oak) acorns. A large acorn crop such as this may require use of resources stored up by trees over several years.

reproduction, not differences in resource availability per se. A strong negative correlation between growth and reproduction is consistent with this hypothesis. Such a relationship does occur in many oaks, but is not general and is potentially due to opposite correlations of weather with growth and reproduction rather than to a direct trade-off between these two life-history variables (Knops et al. 2007).

The third potential role of resources is via storage. Resource storage has played a prominent role in thinking about masting behavior ever since publication of the elegant model of Isagi et al. (1997) hypothesizing that mast years entail the expenditure of a large amount of resources that may require several years for the trees to accumulate. Expanding this model has become something of a cottage industry and has resulted in numerous insights as to the potential roles of pollen coupling and weather in masting behavior (Satake and Iwasa 2000, 2002a, b; Abe et al. 2016; Monks et al. 2016; Pesendorfer et al. 2016a).

Unfortunately, there are considerable logistic difficulties in testing these models empirically, and analyses investigating the role of resource storage in masting behavior have thus far yielded conflicting results (Crone and Rapp 2014; Pearse et al. 2016). Among the problems are that we as yet do not know what resources may be critical and the fact that oaks are modular in structure and thus resource storage may occur on a smaller scale than that of the entire tree (Sánchez-Humanes et al. 2011).

The fourth way that resources may play a role in seed production is by what Pearse et al. (2016) refer to as "veto" mechanisms. Basically, the idea is that weather conditions make it impossible for trees to produce as many acorns as they could in any particular year, and that the resources that are "saved" are then either used for other functions (growth, for example), or possibly stored and made available for seed production the next year. Variable seed production then results not because of switching or storage per se (although either or both are potentially involved), but rather because of different levels of effort that the "veto" mechanism allows the tree to expend on reproduction in any one year.

What combination of these models applies to oaks? This problem has yet to be answered. Not only is it likely that different species are dependent on different mechanisms for their patterns of acorn production, but it is also probable that switching, resource storage, and veto mechanisms all play some role in variable acorn production. Determining the relative importance of each is a problem that will require considerable effort, since it is likely to require proximate analyses of potentially key resources both within and among trees across multiple years.

The good news is that there is considerable variability in masting behavior among oaks, and thus that appropriate comparisons will potentially provide considerable insights as to the mechanisms driving observed differences. There is also a relatively similar acorn-producing, but largely insect-pollinated sister groups, the tanoaks (*Notholithocarpus*) and lithocarps (*Lithocarpus*), whose contrast with wind-pollinated *Quercus* species may be uniquely useful for determining the importance of wind pollination to masting behavior. Based on the California Acorn Survey, for example, the (mean) coefficient of variation (CV; a standard measure of masting behavior equal to the standard deviation divided by the mean expressed as a percentage) for three populations of *Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S. H. Oh, the California tanoak, is 29.5%, whereas for seven populations of *Q. kelloggii* Newb. (California black oak), a species found in roughly the same habitat that also requires two years to mature acorns, the mean CV is 77.0%, a significant difference (Wilcoxon sign-rank test, $P = 0.02$). This supports the hypothesis that wind pollination plays a key role in producing the highly variable, synchronized reproduction characteristic of oaks. Since wind pollination is likely to be important as a veto mechanism rather than playing any role in resource switching or storage, this difference by itself supports the hypothesis that veto mechanisms are key to the relatively highly variable seed production behavior observed in many oak species.

Even more challenging, but potentially more illuminating, may be experimental studies manipulating resources and seed production, such as have been performed on mast-fruiting wildflowers (Crone et al. 2009) and grasses (D. Kelly, unpublished data), but not as yet on oaks. Such manipulations are difficult due to the large size of tree oaks. Many oak species grow in both tree and shrub forms, however, and resource manipulations on the latter offer a potentially important means of inferring what is going on in larger, less tractable forms of this genus.

Spatial synchrony

As mentioned at the start, masting behavior is defined as variable and synchronized reproduction by a population of trees. But how large is that population? One of the more dramatic discoveries of recent studies, both of oaks and of several other taxa, is the remarkably large geographic scale of synchrony in masting behavior. In the case of *Q. lobata*, for example, significant synchrony in acorn production is detectable across their entire geographic range encompassing a distance of over 700 km and millions of individual trees (Koenig and Knops 2013)(Figure 2). What drives such impressive synchrony?

The primary candidates in this case are in some sense the usual suspects: weather – a phenomenon known as the "Moran effect" after the Australian mathematician who first recognized the potential importance of this relationship – and pollen coupling, the dependence of oaks on pollen from other individuals to fertilize their flowers. Spatial

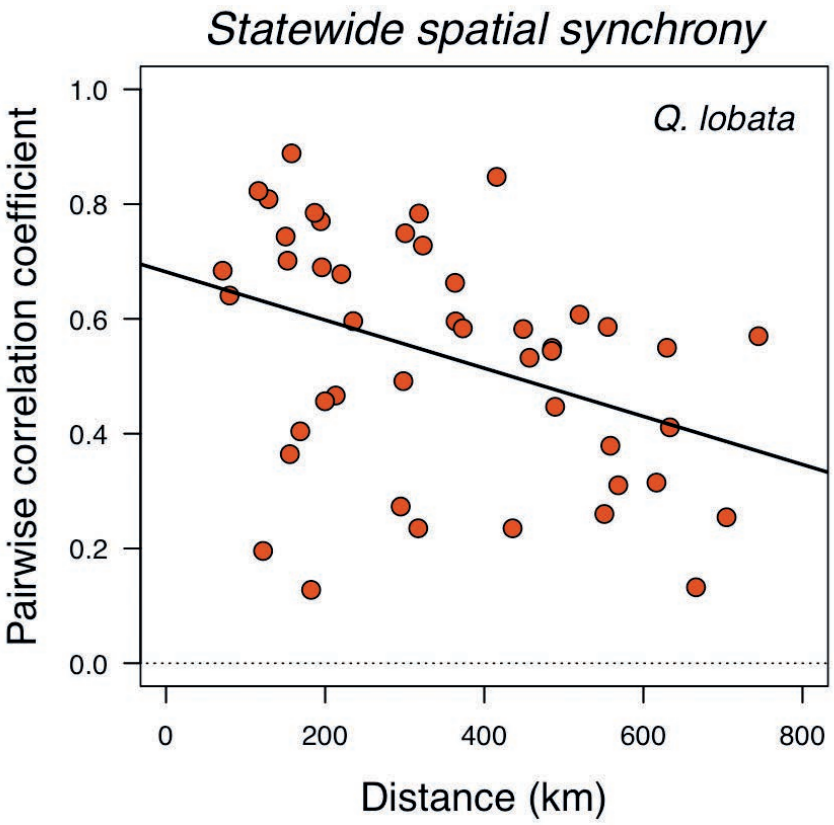

Figure 2/ Spatial synchrony in *Quercus lobata* (valley oak) acorn production. Each point plots, for each pair of sites on the California Acorn Survey, the distance between sites (on the x-axis) versus the correlation between mean acorn production by trees at the two sites (on the y-axis).

synchrony of weather, both temperature and rainfall, is sufficiently high to potentially be driving the observed synchrony in acorn production (Koenig 2002) and is consistent with many aspects of that latter (Koenig and Knops 2013). Models of masting behavior based on resource storage, however, suggest that pollen coupling can similarly produce large-scale spatial synchrony in seed production (Satake and Iwasa 2002a). Little explored is the possibility that genetic similarity among individuals and sites may be a key driver of spatial synchrony, which typically declines with distance in a manner consistent with genetic differentiation.

Recent work by our group on *Q. lobata* (valley oak) suggests that the drivers of spatial synchrony differ considerably depending on the spatial scale of interest. At the relatively small spatial scale of individual trees within a few kilometers of each other, the main factors that appear to drive differences in mean productivity, overall variability, and spatial synchrony are soil nutrients and water availability. At the much larger spatial scale of California, however, where valley oaks were sampled over an area of nearly 2,000 km^2, the major factor driving mean productivity of the sites and spatial synchrony among sites appears to be weather (the Moran effect). In neither case do genetic differences among individuals or populations appear to play a significant role. Once again, however, additional study and analyses will be required before we gain a complete and satisfying answer to the question of what drives spatial synchrony in the masting behavior of oaks.

Conclusion

Variable and synchronized seed production – masting – is common among oaks, has broad ecological consequences, and has been recognized by humans for centuries. Nonetheless, we are only starting to understand both the evolutionary factors selecting for and the mechanisms driving masting behavior. Oaks – with their relatively large and easily quantified seeds – have and are likely to continue to play a key role in our future, hopefully deeper, understanding of this striking natural phenomenon.

Acknowledgments

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Photographers. Title page: Walter Koenig (*Quercus lobata* acorns). Photos 1-4: Walter Koenig.

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Quercus oglethorpensis Duncan: Ex-Situ Conservation Through Collaborative Cultivation

Matthew Lobdell
The Morton Arboretum
Lisle, IL 60532-1293, USA
mlobdell@mortonarb.org

ABSTRACT

Quercus oglethorpensis Duncan (Oglethorpe oak) is an endangered species native to the Southeastern United States. The sparse distribution covers a linear distance of ca. 950 km, including several disjunct populations potentially harboring unique genetic diversity or adaptive variation. Traditional techniques such as seed banking are insufficient for ex-situ conservation of *Q. oglethorpensis* due to the recalcitrant nature of the seeds. However, the species has been demonstrated as suitable for cultivation in a wide range of the United States and Europe, and can be conserved ex situ in the living collections of arboreta and botanical gardens.

In 2015, through a joint venture between the US Forest Service and American Public Gardens Association, seed and/or samples of scion wood were collected from populations of the species in Mississippi, Alabama, and South Carolina. Following propagation at The Morton Arboretum (Lisle, Illinois), they were distributed to five additional arboreta and botanical gardens throughout the Midwestern and Southeastern United States. Through cultivation in collections of these arboreta and botanical gardens, genetically diverse and representative germplasm of *Q. oglethorpensis* will be preserved and potentially utilized in future reintroduction efforts.

Keywords: *Quercus oglethorpensis*, Oglethorpe oak, ex-situ conservation, endangered species, plant collections

Introduction and history

When considering the oaks of Eastern North America, *Quercus oglethorpensis* W.H. Duncan (Oglethorpe oak) is perhaps best thought of as both the most easily recognizable, and the most poorly understood.

In the wild, the species occurs as a medium- to large-sized canopy tree generally reaching 18-24 m (60-80 ft) in height. The bark can resemble *Quercus alba* L. (white oak) or *Q. stellata* Wangenh. (post oak) (Coder 2003). The most distinctive characteristic of the tree is likely its leaves. They exhibit little to no lobing[1] and possess a pubescence making them smooth and velvety to the touch. No other oak with these characteristics occurs in the Eastern United States, save for perhaps forms of the variable *Q. sinuata* Walter (bastard oak), which when fruiting can generally be distinguished based on the shallow acorn caps of that species. Despite this morphological distinctiveness, Oglethorpe oak would remain undescribed and unknown to science until 1940. As discussed by Coombes and Coates (1996), trees belonging to this species were found in Oglethorpe County, Georgia, where they were mistaken for a southern disjunction of *Q. imbricaria* Michx. (shingle oak). Closer inspection revealed a lack of awns or bristles to the leaves and an annual acorn maturation period, clarifying these trees as a distinct species and member of the White Oak Group (*Quercu*s section *Quercus*). This new species was named after Oglethorpe County, and thus indirectly in honor of General James Oglethorpe, the founder of the state of Georgia (Coombes and Coates 1996).

For the next few decades, Oglethorpe oak was understood as a rare endemic of the southern Piedmont, restricted to northeastern Georgia and adjacent localities in South Carolina. Subsequent floristic work (Marx and Thomas 1975; Haehnle and Jones 1985) revealed a disjunct population in Caldwell Parish, Louisiana, as well as additional populations in Georgia and South Carolina. Once the Caldwell Parish site was documented, an effort to locate the species on similar soil types in Mississippi was initiated, with three populations discovered in Bienville National Forest (Wiseman 1987). In 1998, a population of the species was discovered in Sumter County, Alabama, with additional Alabama populations located in Marengo and Wilcox counties in 2013 (Keener et al. 2016).

A species of conservation concern

Despite the fact that distribution of Oglethorpe oak has been found to be broader than initially realized, it still exhibits a fragmented distribution where it is locally uncommon. Though somewhat susceptible to chestnut blight, the largest threat facing the species has largely been land clearing, particularly that which occurred prior to its description (Coombes and Coates 1996). It is listed as Endangered B1+2ce on the IUCN (International Union for Conservation of Nature) Red List, defined as a species which is severely fragmented or known to exist at no more than five locations, with continuing decline inferred, observed or projected in area, extent and/or quality of habitat, and number of mature individuals (Nixon et al. 1998). It is not federally ranked as endangered, though is considered threatened in the state of Georgia.

Populations located in Sumter National Forest (South Carolina), Oconee National Forest (Georgia), and Bienville National Forest (Mississippi) are conserved and managed

1. Vigorous second-growth shoots can have lobed leaves.

in situ by the US Forest Service. However, several other populations, including those in Alabama, are located on private land where they are not managed for conservation purposes. Ex-situ, or off-site conservation is thus desirable for long-term management of this species. As with many species of oaks, conservation through seed banking is not currently feasible for Oglethorpe oak due to the recalcitrant nature of the acorns. Conservation through living collections of botanical gardens and arboreta is likely to provide more success, particularly due to the demonstrated ability of the species to be successfully cultivated in several regions of the United States and in Europe.

History of cultivation

Interest in horticultural cultivation of Oglethorpe oak has been minimal though present for the last 35-40 years. In the United States, Oglethorpe oak has never been common in the nursery trade, typically only available from specialty providers such as Woodlanders, Inc. (Aiken, South Carolina) and Heritage Seedlings (Salem, Oregon). At the time of writing, the earliest record of cultivation in the United States appears to date to 1980. That year, several United States arboreta and botanic gardens began growing the species following distribution of seed collected in Greenwood County, South Carolina, by the Clemson University Forestry Department. A few plants resulting from this seed lot were successfully grown at The Morton Arboretum (Lisle, Illinois), with one surviving in outdoor conditions until its removal in 2014. Though the plant was chlorotic, it had achieved a height of approximately 6-7m with an equal or greater spread and a thick trunk of significant girth. The Morton Arboretum is located in USDA Hardiness Zone 5b, with a mean annual extreme minimum temperature of -26 to -23 °C. Survival of Oglethorpe oak in these conditions demonstrates cold-tolerance for the species beyond what would be expected given its distribution in the Southeastern US. Other significant oak collections in the United States holding Oglethorpe oak include Bartlett Tree Research Laboratories and Arboretum (North Carolina), Starhill Forest Arboretum (Illinois), The Scott Arboretum of Swarthmore College (Pennsylvania), and Donald E. Davis Arboretum of Auburn University (Alabama), though all accessions of documented wild origin present in these arboreta appear to trace their lineage to South Carolina or Georgia.

Photo 1/ Canopy of *Quercus oglethorpensis* (Bienville National Forest, Mississippi).

Oglethorpe oak has also been grown in Europe. Ironically, cultivation there may actually predate cultivation in North America, with an introduction occurring at Hillier Nurseries in 1978 (Hillier and Lancaster 2014). Several additional introductions have occurred since this time, predominantly from acorns distributed through the 1994, 2000, and 2003 International Oak Society seed exchanges. Material from such has been further distributed by Birchfleet Nurseries (Petersfield, United Kingdom), Mallet Court Nursery (Taunton, United Kingdom), and PAVIA (Deerlijk, Belgium) and is currently

in the collections of several European private arboreta and gardens. It is collected by multiple institutions with French National Collection status including Arboretum de la Bergerette (French National Collection for American Oaks), Arboretum des Pouyouleix (French National Collection for the genus *Quercus*), and Arboretum de Chocha (French National Collection for Mexican Oaks), all three of which are located in Southwest France. The species is also held by Giardino Reinhardt (Central Italy), David Gooder (Central England), Trompenburg Gardens (Rotterdam, The Netherlands), and by Jean-Louis Hélardot (Southwest France). There are also several accessions at the Sir Harold Hillier Gardens (UK National Plant Collection for *Quercus*). When of documented wild origin, the provenance of plants growing in European collections are generally from McCormick County, South Carolina, though one accession at Arboretum des Pouyouleix (APO 1038) is from nearby Edgefield County, and one accession at Sir Harold Hillier Gardens (1989.0348) traces its lineage to Georgia.

Photo 2/ *Quercus oglethorpensis* at Starhill Forest Arboretum (Illinois).

Performance of Oglethorpe oak in the United Kingdom has been somewhat poor, likely due to insufficient summer heat for hardening of growth (Coombes and Coates 1996). Collection holders surveyed in 2016 generally described a slow-growing plant. Growing conditions for the species may be somewhat better in southern France. Though a few plants at Arboretum de la Bergerette exhibit anthracnose, possibly due to poor soil conditions or proximity to a *Quercus pubescens* Willd. (downy oak) woodland, other Oglethorpe oaks on this site appear healthy, and no health problems were reported for accessions at Arboretum des Pouyouleix. Cultivation in Italy may also be suitable, with vigorous growth of a young Oglethorpe oak reported from Giardino Reinhardt.

Though cultivation has been attempted on both the American and European continents, all material in cultivation worldwide appears to trace its lineage to Georgia or South Carolina populations, with those in Louisiana, Mississippi, and Alabama apparently unrepresented. Plants from these latter populations could potentially harbor unique genetic diversity or adaptive variation that unfortunately would be largely lost if they were to become extirpated without a "back up" in cultivation.

Summary of fieldwork

As a first stage in alleviating this issue, The Morton Arboretum began a collaborative project with the Donald E. Davis Arboretum of Auburn University (Auburn, Alabama) and the Moore Farms Botanical Garden (Lake City, South Carolina) to collect seed or scion wood from Oglethorpe oak populations for the purpose of ex-situ conservation. This effort began in 2015 as a pilot project of the Tree Gene Conservation Program sponsored by the American Public Gardens Association and US Forest Service. To set a scope attainable during the project timeframe, specific populations in Mississippi, Alabama and South Carolina were targeted. These were visited between late July and early August for verification, health assessment, and observation of seed production, and again in mid- to late October for seed collection when applicable.

The first site visited was Bienville National Forest, located in Central Mississippi. Oglethorpe oaks were successfully located here with some assistance from the US Forest Service. All individuals located appeared to be in good health with no significant threats noticed save for competition from associated species, namely fast growing native trees such as *Liquidambar styraciflua* L. (American sweetgum) and *Nyssa sylvatica* Marshall (black gum) which easily outgrow and overshadow Oglethorpe oak seedlings as they begin to establish. The Forest Service attempts to alleviate this issue through a "release" program, in which staff will cut back all vegetation around a young Oglethorpe oak sapling until it is of a size where it can more easily compete. Fruit production was not observed on any individuals, so a return visit that fall for seed collection was deemed unnecessary. However, US Forest Service staff sent scion wood to The Morton Arboretum so propagation by grafting could be attempted.

The first documented occurrence of Oglethorpe oak in Alabama, located by Al Schotz in Sumter County along the bottomlands of the Alamuchee Creek, was also visited. Sadly, all Oglethorpe oaks here seem to have been removed as a result of logging activity in the area. Attempts by Al Schotz to relocate the original specimens or outlying members of the population have failed, as did attempts by Wayne K. Webb in 2012 and 2013. This is unfortunately a case where attempts to collect and distribute seed from this species may have been too late. On a more positive note, the Alabama population of Oglethorpe

oak spanning Marengo and Wilcox counties is much more robust, consisting of at least 60 individuals. Many were also observed producing suitable quantities of fruit, and were revisited in the fall for seed collection. However, despite prolific seed production, recruitment was virtually nonexistent in this population with only a sparse few seedlings and saplings observed.

Towards the end of the trip, populations in South Carolina were visited. Across the Sumter National Forest, the species appeared to be in good health and was locally more common than observed in Mississippi or Alabama. Several documented locations were visited throughout the forest, but only one was observed with sufficient fruit production to justify a second visit in the fall. Finally, an attempt was made to locate a reported population in York County, South Carolina, likely representing the most northern distribution of the species. No evidence of the species was located after several hours of searching, and there are no observation records confirming its existence since 1980. As with the aforementioned site in Alabama, Oglethorpe oak is likely extirpated from this site.

Propagation and distribution

Though poor fruit production in Bienville and Sumter National Forests prevented extensive sampling in those locations, 281 acorns were collected as part of this effort, largely representing Alabama populations. In January 2016, US Forest Service Staff from the Bienville National Forest collected cut stems from four individuals in Scott County, sufficient for a total of 35 scions to be grafted.

All propagation efforts occurred at The Morton Arboretum. For germination, acorns were placed in flats consisting of 50% germination mix and 50% potting mix. Seed was

Photo 3/ Seedlings of *Quercus oglethorpensis* at The Morton Arboretum.

warm stratified for two months (November 2015 to January 2016), then cold stratified for four months (January 2016 to May 2016). Germination percentage was as low as 29% (two of seven seeds) for acorns collected from the ground in McCormick County, to as high as 100% for acorns collected from one individual in Alabama. A total of 218 out of 281 seeds germinated, with a mean germination percentage of 78% when considering all seed collections.

In March 2016, scions were grafted via the side-veneer method onto Oglethorpe oak understock received from Heritage Seedlings. Grafts were waxed and callused in a tube for approximately five weeks. Upon removal from the tube and subsequent transplanting one month later, 28 of 35 attempted grafts (80%) appeared to have taken.

Seedlings and scions from this project will be grown in the collections of The Morton Arboretum (Lisle, Illinois), Chicago Botanic Garden (Glencoe, Illinois), Starhill Forest Arboretum (Petersburg, Illinois), Donald E. Davis Arboretum (Auburn, Alabama), Moore Farms Botanical Garden (Lake City, South Carolina), and Holden Arboretum (Willoughby, Ohio). Plants were distributed to these various institutions in January 2017.

Accession[1]	Provenance[2]	# Sown	# Emerging	% Germination
644-2015	Marengo, AL	36	30	83%
645-2015	Marengo, AL	36	23	64%
646-2015	Marengo, AL	13	13	100%
647-2015	Marengo, AL	36	35	97%
648-2015	Marengo, AL	36	33	92%
649-2015	Marengo, AL	36	25	69%
650-2015	Marengo, AL	3	3	33%
651-2015	Marengo, AL	36	31	86%
652-2015	Wilcox, AL	36	23	64%
717-2015	McCormick, SC	7	2	29%
Total		281	218	78%

Table 1/ Germination rates of acorns collected during the project. 1. Provenance at county level; 2. Accession numbers are of The Morton Arboretum.

Accession[1]	Provenance[2]	# Attemps	# Takes	% Success
1-2016	Scott, MS	5	4	80%
2-2016	Scott, MS	7	7	100%
3-2016	Scott, MS	14	10	71%
4-2016	Scott, MS	9	7	78%
Total		35	28	80%

Table 2/ Success percentages of side veneer grafts taken during the project. 1. Provenance at county level; 2. Accession numbers are of The Morton Arboretum.

Conclusions and future work

Despite low fruit production of many populations in 2015, this project has been largely successful in terms of acquiring propagules of Oglethorpe oak for ex-situ conservation purposes. The populations from Alabama and in Bienville National Forest will likely be adequately represented in cultivation barring production failure. Additional seed

collection from the latter population may be desirable in case of short- or long-term incompatibility of grafted plants produced during this project. Collection of seed or scion wood from the population in Caldwell Parish, Louisiana would also be desirable in the future as germplasm from this population does not appear to be represented in cultivation at all.

Of further interest is the long-term performance of the Oglethorpe oak in a horticultural setting. By cultivating and evaluating the species in the collections of botanical gardens and arboreta, a better understanding of its ideal growing conditions will be gained, and the success rate for it in cultivation will likely increase. The potential also exists for such cultivated plants to be utilized for reintroduction efforts where appropriate. Furthermore, interpretive and other educational activities occurring at botanical gardens and arboreta could increase awareness of the species, ultimately supporting further conservation efforts and helping to secure its long-term viability as a mysterious but distinct member of the Eastern North American forest.

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Photographers. Title page: Matthew Lobdell (Leaves of *Quercus oglethorpensis* in Bienville National Foret, Mississippi). Photos 1, 3,: Matthew Lobdell. Photo 2: Charles Snyers d'Attenhoven.

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Nineteenth Century Wild-Sourced *Quercus canariensis* Willd. Confirmed at Anlaby

Charlie Buttigieg[1] and Francisco M. Vázquez Pardo[2]

1. Redwood Horticultural Management
P.O. Box 226, Hawthorn Victoria, 3122, Australia
redwoodhort@gmail.com

2. Grupo de Investigación HABITAT, La Orden-CICYTEX
Km.372, N-V, Guadajira (Badajoz), Spain
frvazquez50@hotmail.com

ABSTRACT

Quercus canariensis Willd., (Mirbeck oak, Algerian oak, Canary Island oak) has a very complex and convoluted introduction story in Australia. Many taxonomists and tree authorities in Australia agree that many cultivated specimens of this taxon are in fact hybrids. A specimen of *Q. canariensis* from a non-hybrid source is rare in Australia. It is therefore quite significant to have discovered and verified a small population of wild-sourced *Q. canariensis* growing at one of South Australia's most influential and significant pastoral properties, Anlaby. What is more astounding is that some specimens, dating from the mid-nineteenth century, share similar leaf and flower morphology with the relic populations of *Q. canariensis* growing near the ancient port city of Cádiz in southwestern Spain. These specimens are culturally and historically linked to Anlaby's mid-nineteenth century importation of merino sheep from Spain and this in turn adds another dimension to the story of the introduction of the species into Australia.

Keywords: Mirbeck oak, Canary Island oak, Algerian oak, oaks in Australia, relic oak populations in Spain

Introduction

During the Anlaby Heritage Tree Project (2012-2014) the first author thoroughly examined the tree plantings at this iconic South Australian pastoral property. He was acting on behalf of the National Trust of South Australia for their Significant Tree Register. As the project advanced the first author became increasingly aware of the need to verify the identities of the oak species and hybrids growing throughout the property. During October 2014 specimens were collected of semi-mature spring foliage, and where possible, male and female flowers of the various species and hybrids, and these were sent to the second author for examination. The results of his examination confirmed most of the initial identifications of the first author. The most eagerly awaited were those concerning the *Q. canariensis* Willd., specimens that grow throughout the property. These are now confirmed to be the largest collection of wild-sourced *Q. canariensis* in one location in Australia dating from the mid-nineteenth century.

There are a total of 24 specimens registered at Anlaby as trees of heritage significance by the National Trust of South Australia. Some are planted as single specimens. A large number of them, now amounting to 19 living specimens, were planted as the main body of the Oak Carriageway. It is these particular 19 trees that share morphological similarities with the relic populations of *Q. canariensis* Willd. growing near the ancient port city of Cádiz in southwestern Spain.

The problematic name of Quercus canariensis

The species epithet of *Q. canariensis* is misleading presumably because it is not indigenous to the Canary Islands. Carl Ludwig Willdenow (1765-1812) published the name (*Enum. Pl*. 2:975. 1809) based on specimens sent to him by Pierre-Marie Auguste Broussonet (1761-1807) who unfortunately got his collection information mixed up with samples he had collected in Morocco. Afterwards, in 1846 Michel Charles Durieu de Maisonneuve (1796-1878) described what he thought to be a new species of oak from North Africa, *Q. mirbeckii* Durieu (in Duchartre, *Rev. Bot*., 2: 426-427, no. 21, 1846) that was later made synonymous with *Q. canariensis* Willd.[1] The slightly different leaf morphology and structure of these two taxa, as can be seen in the type specimens, represent the two most significant patterns of intraspecific variation of this species that is commonly refered to as Mirbeck oak, Canary Island oak, or Algerian oak.

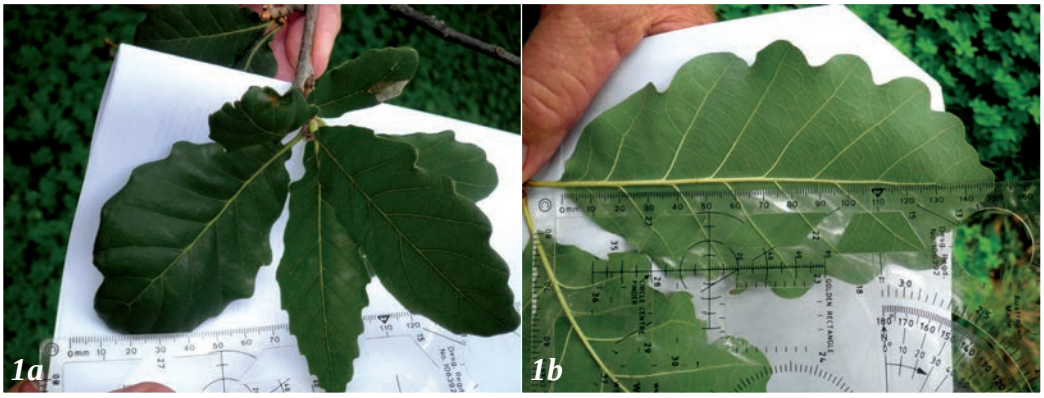
The holotype of *Q. canariensis* Willd. (Willdenow Folder: B-W 17608 – 10) (http://herbarium.bgbm.org/object/BW17608010), conserved at the Freie Universität in Berlin, has leaves with lamina that are lanceolate in shape, with more than ten pairs of secondary veins and an acute apex. The holotype of *Q. mirbeckii* Durieu, collected in Algeria, and conserved at the Herbier Université de Montpellier (MPU010443) (http://www.herbiermpu.org/zoomify/zoomify.php?fichier=MPU010443), has leaves with ovate-oblong lamina, with up to twelve pairs of secondary veins and normally a rounded apex.

These two types of leaf morphology are represented in the *Q. canariensis* populations in the Southern Iberian Peninsula and North Africa. However, the leaves of the lanceolate-

1. Schwarz (1936-1938) writes a propos this issue : "If this taxon is really at home on the Canary Islands or not, does not bother the species epithet… On Tenerife it was not collected again since Broussonet's time, also not as cultivated tree; because this taxon is cultivated only since a very short time, I doubt that *Q. canariensis* was only planted and not indigenous there; my opinion is instead that the sparse population was completely destroyed during the "forest destruction period" on that Island because its wood is extremely durable and hard and one of the best timbers in that area."

shape and acute-apex morphology are more prevalent in the Iberian Peninsula while the ovate-oblong shape and rounded-apex morphology more prevalent in North Africa.

The specimens growing at Anlaby correspond to the morphology with leaves that are wide, with rounded apex, and fewer than 11 pairs of secondary veins. This morphological type of *Q. canariensis* appears in relictual populations in southern Spain on the outskirts of Cádiz and at some locations near the Strait of Gibraltar, always in locations with a strong oceanic influence.



Photos 1a-b/ ***Quercus canariensis*** **leaves showing the morphology of this species found in relictual populations in southern Spain (wide leaves with rounded apex and fewer than 11 pairs of secondary veins).**

The ecology of Q. canariensis *populations in the southern Iberian Peninsula*

The *Q. canariensis* forests in the southern Iberian Peninsula are located in areas with rainfall greater than 800 mm per year. Some of these forests are in areas with a strong oceanic influence where the rainfall does not exceed more than 600 mm per year. However, the moisture from these oceanic environments compensates for the reduced precipitation. Soil pH varies from slightly alkaline to slightly acidic, but is predominantly neutral. The soil is light, predominantly silty to slightly sandy in texture, as well as deep and fertile, and rich in organic material.

The natural habitats of *Q. canariensis* are between 400 and 1,000 metres above sea level. These habitats tend to be shared by other singular species such as *Rhododendron ponticum* L., *Abies pinsapo* Boiss., or *A. maroccana* Trab., all relicts of times past characterized by more humid environmental conditions. These species occupy deep valleys or areas of strong oceanic influence. These refugia enable them to survive seasonality, the thermal gradient of the Mediterranean climate and its high temperatures.

Distribution

Mirbeck oak forests are located in the western regions of the Mediterranean basin, especially in Spain, Portugal, Morocco, Algeria and Tunisia. However, *Q. canariensis*, has been used as an ornamental species since the beginning of the nineteenth century in much of Europe, its colonies and later in North America. It is a species common in

Photos 2/ *Quercus canariensis* forest in southern Spain.

parks and gardens in Central Europe, where it co-exists with *Q. robur* L., *Q. petraea* (Matt.) Liebl., or *Q. cerris* L. The high growth rate at the juvenile stages, the resistance to intense frost in winter, adaptation to both high precipitation throughout the year and mild temperatures from spring to autumn, explain its diverse and extensive use in the temperate and subtropical regions around the world. Its use was not limited to the Northern Hemisphere, reaching the Southern Hemisphere in South America, and – as shown in the present article – in South Australia.

The planting of the Oak Carriageway

Present-day Anlaby is the oldest merino stud in existence on mainland Australia and was originally founded by Frederick Hansborough Dutton (1812-1890) (for a detailed account of the history of Anlaby, see Buttigieg 2014a). From 1856-1869 more than five different importations of specially selected merino rams were brought from Spain and Saxony. These special selections were made by H. Schwartz & Company, a wool classer and merchant dealing in Australian colonial wool and sheep. It is during this period that Frederick most likely visited Europe to oversee the sheep purchases and organize their shipping from Spain and the rest of Europe. This may have brought him in contact with the flora of the Iberian Peninsula and the oaks native to the region. The early colonial emigrants to Australia were encouraged to take acorns with them to their new homeland. For example, the suitability and proven performance of *Q. cerris* in Australia is well noted by 1842. *The Garden Magazine Register* (Anonymous 1842) quotes a letter in "Article V. Queries and Answers" from a Mr. James Backhouse of York, dated October 23, 1841, which states that *Q. cerris* thrives in Australia. Mr. Backhouse explains that P.M. Cunningham in his *Hints for Australian Emigrants* (Cunningham 1841) encouraged emigrants to Australia to take acorns on the presumption that they would thrive well like the introduced *Q. cerris*.

Photo 3/ Part of the Oak Carriageway (autumn 2014) showing *Quercus robur* changing color (on the right) and *Q. canariensis* (on the left).

Frederick Dutton never resided at Anlaby and visited Europe many times before eventually taking up residence in England where he lived until his death in 1890. Anlaby grew and prospered under Alexander Buchanan's (1810-1865) tenure as Anlaby's second Station Manager. The first carriageway at Anlaby was planted with *Eucalyptus camaldulensis* Dehnh. (river red gum) ca.1848-1850 under his direction. There are currently 78 specimens of this native tree planted in two parallel rows separated by 4.5 m. Oriented on a northeast to southeast axis, this 267-m-long carriageway was eventually abandoned because the rapid growth of these trees growing in such close proximity quickly made it impossible for carriages to move safely through.

When Alexander Buchanan died in May 1865 Frederick appointed Henry Thomas Morris (1823-1911) to be his third Station Manager and Australian Representative. During Henry's tenure the gardens were noted for the array of botanical and horticultural collections thanks to his planting of many exotic and native trees throughout the garden and the land surrounding the main residence and garden. It was also during this period that a second attempt (ca.1865-1870) to plant a carriageway leading from the outer perimeter of the property towards the homestead was undertaken – this time using oaks.

Photo 4/ The *Quercus canariensis* × *robur* in the Oak Carriageway.

Colonists in the nineteenth century considered Australia's landscape as untamed and savage with harsh environmental conditions and extreme weather. The planting of the Oak Carriageway leading to the main residence from the "untamed wilderness" was an attempt to add a European sense of order and civilization. Originally, 44 oak trees were planted: 11 *Q. robur* on the south end, 29 *Q. canariensis* in the middle, and 4

Photo 5/ *Quercus canariensis* NTSA Reg. # 789. One of the five solitary specimens located near the Plantation Dam.

Q. canariensis × *robur*[2] on the north end. Unfortunately, 10 of the *Q. canariensis* died following planting. Currently, there are 19 specimens of *Q. canariensis* in excellent health with the original 11 *Q. robur* L. and 4 *Q. canariensis* × *robur.* The 255.8-metre-long Carriageway is planted with two rows of oaks on a north-south axis leading towards the main residence. Interestingly, with time this Carriageway was also abandoned due to flooding caused by periodic heavy rains.

It is these nineteenth-century specimens of Mirbeck oaks that were most likely sourced from the southwestern region of Spain where the early Spanish merino bloodlines were purchased. Whether they were shipped to Anlaby as acorns, seedlings or both is a point of conjecture. Acorns were part of the basic fodder available for livestock in England in the early nineteenth century (Trow-Smith 2005). The use of acorns from various evergreen and deciduous oak species was an ancient practice in Mediterranean Europe. No documentary evidence from the Dutton archival documents has yet surfaced to resolve these issues. Perhaps it was a case of Frederick Dutton or his agents acting on his behalf observing Spanish animal husbandry practices and procuring acorns and/or seedlings to grow the trees back at Anlaby for acorn production to be used as animal fodder.

The Oak Carriageway is located southeast of the main homestead behind the main garden in a 10-hectare area known as “The Plantation” where planting had begun in the mid-nineteenth century with a selection of exotic trees and shrubs from around the Mediterranean. This planting was done around what was then a small lake known as the “Plantation Dam” which supplied the garden watering system. Each generation of

2. Originally the name *Quercus* ×*carrissoana* A. Camus was given to the hybrid *Q. canariensis* × *robur*. For some authors today, this name is given to the hybrid between *Q. canariensis* and *Q. robur* subsp. *estremadurensis* (O. Schwarz) A. Camus.

the Dutton family added its own planting overlay in this area so that today the original nineteenth century planting is overlaid with extensive planting of selected native trees and shrubs from around Australia that was undertaken during the 1920s.

The Oak Carriageway is currently registered by the National Trust of South Australia under its Significant Tree Register. It is registered as a heritage planting style of "State Significance" (NTSA Reg. # 728).

The three solitary specimens of Q. canariensis

There are three living solitary specimens of *Q. canariensis* within The Plantation that are registered by the National Trust of South Australia. (A fourth solitary specimen was not registered due to its poor condition). They are in close proximity to the Oak Carriageway and were also planted ca.1865-1870. They almost appear to be "left-overs" or "extra trees" which were not required or did not fit the measured planting pattern of the main body of the Oak Carriageway composed of this species. Their measurements and biomass are similar to the specimens in the Oak Carriageway. These three registered solitary specimens, plus a few others, along with the remaining Mirbeck oaks within the Oak Carriageway, are the earliest plantings of this species at Anlaby. They were probably all from the same wild source of acorns/ seedlings that were collected and grown prior to ca.1865.

	NTSA Reg. 741[b]	NTSA Reg. 750[c]	NTSA Reg. 789[d]	Fourth specimen[e]
GIRTH	3.5[a]	3.9	3.6	3
HEIGHT	20.5	15.7	17	17.2
CANOPY E-W	22	20.5	25.5	24
CANOPY N-S	25	22	26	19
COLLECTOR	C. Buttigieg	C. Buttigieg	C. Buttigieg	C. Buttigieg
NUMBER	CB6912	CB6914	CB6911	Oct. 27, 2014
DATE	Oct. 27, 2014	Oct. 27, 2014	Oct. 27, 2014	Oct. 27, 2014

Table 1/ a) measurements in m.; b) the solitary specimen located in The Plantation, girth measured at 1.3 m; c) the solitary specimen located in The Plantation directly south of the Garden Folly on the banks of the shallow over-flow from the Plantation Dam, girth measured at 1.3 m; d) the solitary specimen located in The Plantation growing west of the Plantation Dam wall, girth measured at 500 mm; e) the fourth solitary specimen in The Plantation was not registered due to its poor condition. The fifth *Q. canariensis* solitary specimen, at the south end of the Oak Carriageway, was measured during the Anlaby Heritage Tree Project. Samples were collected in October 2014 for examination by the second author.

Conclusion

The *Q. canariensis* of Anlaby are living links not only to the cultural and historical story of Anlaby, but also to its agricultural and pastoral history since this provided the probable context for the accession of wild-sourced *Q. canariensis* from the Iberian Peninsula. The recent identification and verification of these specimens and their link to the relic populations from southwestern Spain confirms the Anlaby pioneers' link to that region of Spain. The Mediterranean region is a geographic area that early colonial pioneers knew to be similar to the Anlaby environment and therefore that the animal husbandry practices, food plants, ornamental shrubs and trees from this region would be more adaptable to South Australia than those of England. What has survived from the

Photo 6/ *Quercus canariensis* NTSA Reg. # 741. One of the five solitary specimens located at the west end of the Plantation Dam next to the feed-in water channels. On the right, a large specimen of *Buxus balearica*, also planted in the 19th century and thus of similar age to the oak.

extensive collections of trees, shrubs and plants from the Iberian Peninsula at Anlaby represents many generations of the Dutton family's passion for collecting taxa from around the world and is intrinsically linked to the nineteenth century importation of Spanish and other European merino sheep. The Mirbeck oaks of Anlaby are some of the nineteenth century treasures only recently discovered alive on one of South Australia's most significant pastoral properties.

Photographers. Title page: Charlie Buttigieg (*Quercus canariensis*). Photos 1, 3-6: Charlie Buttigieg. Photos 2, 7: Carlos Vila-Viçosa.

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Photos 7/ *Quercus canariensis* forest in southern Spain.

Genetic Distinctions Among Oaks in the University of California, Davis Arboretum: Contributions to Oak Phylogeny

Terence M. Murphy[1] and Daniel Potter[2]

1. Department of Plant Biology
University of California, Davis, CA 95616, USA
corresponding author: *tmmurphy@ucdavis.edu*

2. Department of Plant Sciences
University of California, Davis, CA 95616, USA

ABSTRACT

DNA samples of oaks from the collection at the University of California, Davis Arboretum have been isolated, and partial sequences determined for genes of ribulosebisphosphate carboxylase large subunit and for internal transcribed sequences of ribosomal RNA genes. A comparison of these sequences contributes to an elucidation of the phylogeny of this important plant genus. The agreement between the patterns with *rbcL* and ITS sequences strengthens considerably the conclusion that these molecular data can reveal the actual pattern of evolutionary relationships among the *Quercus* species.

Keywords: phylogenetic analysis, gene sequencing, ribulosebisphosphate carboxylase (*rbcL*), internal transcribed sequence (ITS), transfer RNA (*trnL/trnF*)

Introduction

Owing to the interest of the late Professor John Tucker and his students, the Arboretum at the Davis campus of the University of California has a particularly large and diverse collection of oak trees. The phylogeny of the oaks has been a subject of interest and some uncertainty for many years. Within the last fifteen years, a few groups (Samuel et al. 1998; Manos et al. 1999; Oh and Manos 2008) have applied the techniques of molecular phylogenetics to comparisons of oak genes, adding information to the understanding of oak evolution. The present paper extends this information by comparing the sequences of *rbcL*, a chloroplast gene that encodes the large subunit of the photosynthetic enzyme ribulosebisphosphate carboxylase, ITS, the internal transcribed sequences together with 5.8S ribosomal DNA, and the intergenic region between *trnL* and *trnF* genes among oak accessions in the UC Davis Arboretum.

Materials and Methods

Samples

Samples of leaves were taken from the University Arboretum at the Davis campus of the University of California. The search facility of the web site of the Arboretum (http://arboretum.ucdavis.edu/collections_search.aspx) lists 163 accessions, including 74 species and subspecies and 22 hybrids. The plants sampled for this report are listed in Table 1. DNA extracts were made from all samples, although not all extracts gave satisfactory DNA sequences.

Generally, young leaves were sampled in the spring and early summer of 2012 and the spring of 2013. Leaves were collected and frozen at -80 °C until DNA extraction.

Leaf samples of 0.05 to 0.1 g were frozen to brittleness in liquid N_2 and then ground in a 1.5-ml plastic centrifuge tube with a plastic pestle turned by a hand drill. CTAB extraction buffer, 300 µl, was added, and the grinding repeated until the slurry was reasonably uniform. (CTAB extraction buffer contains 2% cetyltrimethyammonium bromide, 1.4 M NaCl, 0.1 M trishydroxyaminomethane (Tris)-Cl, and 20 mM ethylenedinitrilotetraacetic acid adjusted to pH 8.) The slurry was extracted with 300 µl of chloroform and centrifuged, and the upper, aqueous phase (approximately 250 µl) was mixed with an equal amount of isopropanol. The mixture was centrifuged, and the pellet was washed with 70% ethanol and dissolved in 50-100 µl of water. Most samples were further purified by adsorption and elution from glass (e.g. Promega Wizard[R], see below).

		Arboretum Accession	Extract	*rbcL* GenBank Acc Accession	ITS GenBank Accession
Quercus ×acutidens		A67.0978	32	KF683136	
Quercus agrifolia	coast live oak	A64.0713	31	KF683137	
Quercus arizonica	Arizona white oak	A92.0013	34		KM200955
Quercus berberidifolia	California scrub oak	A64.1271	1	KF683138	KM200956
Quercus canariensis	Algerian oak; Mirbeck oak	A64.1303	36	KF683140	KM200957
Quercus candicans		A90.0489	2	KF683139	KM200958
Quercus castaneifolia	Persian oak	A94.0497	37	KF683141	KM200959
Quercus chrysolepis	canyon live oak	A65.0013	38	KF683142	KM200961

		Arboretum Accession	Extract	*rbcL* GenBank Acc Accession	ITS GenBank Accession
Quercus crassipes		A68.0361	3	KF683143	KM200960
Quercus ×deamii		A69.0642	28	KF683144	KM200962
Quercus diversifolia		A68.0353	20		
Quercus douglasii	blue oak	A64.0406	4	KF683145	
Quercus durata	leather oak	A58.0104	5		
Quercus engelmannii		A65.0011	26	KF683146	
Quercus faginea	Portuguese oak	A71.0155	39	KF683147	
Quercus gambelii	Gambel oak	A63.0004	40	KF683148	
Quercus gravesii		A86.0445	7	KF683150	KM200965
Quercus greggii		A68.0359	8	KF683151	
Quercus grisea	gray oak	A63.0002	9	KF683152	KM200966
Quercus hartwegii		A68.0350	10	KF683153	
Quercus ×hispanica		A98.0112	13	KF683154	KM200967
Quercus iberica		A64.1216	21	KF683156	
Quercus infectoria	subsp. veneris	A64.1284	17	KF683157	KM200968
Quercus lobata	valley oak	A33.9041	41		KM200963
Quercus ×macdonaldii		A74.0008	23		
Quercus margaretta		A64.0004	33	KF683158	
Quercus mexicana		A68.0349	11	KF683159	KM200970
Quercus mohriana	Mohr oak	A64.0006	12	KF683160	KM200971
Quercus muehlenbergii	yellow chestnut oak; chinkapin oak	A63.0009	16	KF683161	KM200972
Quercus oblongifolia	Mexican blue oak	A64.0075	18	KF683162	KM200973
Quercus palmeri		A64.1173	27		
Quercus pilicaulis		A91.0741	24		
Quercus prinoides	dwarf chinkapin oak	A66.0172	19	KF683163	KM200974
Quercus pungens		A63.0007	15	KF683164	KM200975
Quercus rugosa		A65.0838	42	KF683165	
Quercus serrata	Syn.: *Q. glandulifera*	A64.1306	6	KF683149	KM200964
Quercus sinuata		A64.0062	30	KF683166	
Quercus sp., Iran		A96.0684	22	KF683155	KM200969
Quercus turbinella		A67.1042	29		
Quercus vaseyana	sandpaper oak Syn.: *Quercus pungens* var. *vaseyana*	A63.0008	14	KF683167	KM200976
Quercus wislizeni	interior live oak	A36.0031	25	KF683168	KM200977

Table 1/ Oak species sampled for DNA. For Arboretum Accession information, refer to the web page: http://arboretum.ucdavis.edu/collections_search.aspx. GenBank accessions prefixed with "KF" and "KM" were determined as part of this study.

Polymerase Chain Reactions

Polymerase chain reactions (PCRs) amplified segments of DNA in the sample extracts. Primers were designed to select three segments, a portion of the chloroplast gene for the large subunit of ribulosebisphosphate carboxylase/oxygenase (*rbcL*), the internal

transcribed spacers adjacent to, together with, the 5.8S ribosomal gene (ITS), and a 250-base section near the chloroplast *trnF* and *trnL* genes (Table 2).

Rubisco		
Forward	rbcLF1	AGTTCCCCCTGAAGAAGCAG
Forward	rbcLF2	TGTTTACTTCCATTGTGGGTAATG
Forward	rbcLF4	ATGTCACCACAAACAGAGACTAA
Reverse	rbcLR1	TTCATTACCCTCACGAGCAAG
Reverse	rbcLR3a	TTCGGTTTAATAGTACAGCCCAAT
ITS		
Forward	ITS3	GCTACGTTCTTCATCGATGC
Forward	ITS4	TCCTCCGCTTATTGATATGC
Reverse	ITS5	GGAAGTAAAAGTCGTAACAAGG
Reverse	ITS21	TATTCAAAACGACTCTCGGCA
trnF-trnL		
Forward	trnLF1	AGCTGTTCTAACAAATGGAGTTG
Reverse	trnLR1	GGACTCTATCTTTGTTCTCGTCC
Reverse	trnLR4	TCGACGGATTTTCCTCTTCCTATAAATTTC

Table 2/ Primers used in PCR reactions.

Each reaction mixture of 20 µl contained 12.1 µl of water, 4 µl of Green GoTaq buffer (Promega Corporation, Madison, WI, USA), 1.6 µl of dNTPs (2.5 mM of each dNTP), 0.125 µl of Taq DNA polymerase (GoTaq, 5 u/µl, Promega), 0.6 µl of each primer solution (20 µM) and 1 µl of template DNA. Initial PCR conditions were 96 °C for 2 min; 35 cycles of 94 °C for 30 s, 59 °C for 30 s, and 72°C for 1 min; 72 °C for 5 min; 4 °C hold. Mixtures were separated on 1.5% agarose gels. Bands were cut from the gel and extracted and purified by adsorption and elution from glass filters (Promega Wizard^{R} SV Gel and PCR Cleanup System). Re-amplification of DNA purified from bands used a similar PCR protocol, except the template DNA was diluted (generally 1/10 to 1/100) and only 25 cycles were used for amplification.

Sequence Determination and Analysis

The sequence of each template DNA, using both forward and reverse primers, was determined by the College of Biological Sciences ^{UC}DNA Sequencing Facility (http://dnaseq.ucdavis.edu/). Sequences were aligned and differences identified using Vector NTI Suite 9.

Phylogenetic relationships among *Quercus* species were inferred using nucleotide sequences from internal transcribed spacer 1, the 5.8S ribosomal RNA gene, and internal transcribed spacer 2 (the combination abbreviated ITS herein) for 23 species generated for this study plus 44 sequences published by Manos et al. (1999) and two from Jackson et al. (1999), which we downloaded from GenBank (Table 3). ITS sequences were aligned in ClustalX (Thompson et al. 1997). Bayesian inference was implemented in MrBayes version 3.2.1 (Ronquist and Huelsenbeck 2003) using the GTR+I+G model and parameters selected based on the Akaike information criterion (AIC) with the program jModelTest 2.1.4 (Guindon and Gascuel 2003, Darriba et al. 2012). Two parallel analyses of four Monte Carlo Markov chains each were run for 4 million generations, sampling every 1,000 generations. The first 25% of trees were discarded as burn-in, and the 50%

majority-rule consensus tree for the 6,002 trees retained from the two analyses was used to infer phylogenetic relationships and clade support.

Species	**GenBank Accession**
Sequences from Manos et al. 1999:	
Colombobalanus excelsa	AF098412
Trigonobalanus verticillata	AF098413
Quercus acutissima	AF098428
Quercus agrifolia	AF098415
Quercus alba	AF098419
Quercus calliprinos	AF098429
Quercus cedrosensis A	AF098449
Quercus cedrosensis B	AF098450
Quercus cedrosensis C	AF098451
Quercus cerris	AF098430
Quercus chrysolepis A	AF098438
Quercus chrysolepis B	AF098439
Quercus chrysolepis C	AF098440
Quercus chrysolepis D	AF098441
Quercus chrysolepis E	AF098442
Quercus chrysolepis F	AF098443
Quercus chrysolepis G	AF098444
Quercus chrysolepis H	AF098445
Quercus coccifera	AF098431
Quercus engelmannii	AF098420
Quercus geminata	AF098426
Quercus ilex	AF098432
Quercus kelloggii	AF098416
Quercus laeta	AF098421
Quercus lobata	AF098422
Quercus myrsinifolia	AF098414
Quercus palmeri A	AF098446
Quercus palmeri B	AF098447
Quercus palmeri C	AF098448
Quercus palustris	AF098417
Quercus phillyreoides	AF098433
Quercus robur	AF098424
Quercus rubra	AF098418
Quercus rugosa	AF098425
Quercus suber	AF098434
Quercus tomentella A	AF098435
Quercus tomentella D	AF098436
Quercus tomentella E	AF098437

Species	GenBank Accession
Quercus turbinella	AF098425
Quercus vacciniifolia A	AF098452
Quercus vacciniifolia B	AF098453
Quercus vacciniifolia C	AF098454
Quercus vacciniifolia D	AF098455
Quercus virginiana	AF098427
Sequences from Jackson et al. 1999:	
Quercus fusiformis	AF174634
Quercus stellata	AF174636

Table 3/ ITS sequence information from GenBank used in the construction of the tree in Fig. 5.

Results and Discussion

For many of the oak species it was difficult to prepare DNA solutions that did not inhibit the PCR reactions. Leaves collected in the spring provided better templates than ones collected in the summer. Glass purification helped reduce the degree of inhibition. Most samples could be purified using glass spin tubes (Promega Wizard^{R}), but some samples were gelatinous and could only be purified using glass beads, which allow thick solutions of polysaccharides to be washed off. For a few of the species (*Q. durata* Jeps., *Q. lobata* Née, *Q. palmeri* Engelm., *Q. turbinella* Greene), it was not possible to obtain PCR products and sequences from the extracted and purified DNA preparations.

rbcL

The primers chosen to determine the sequence of the gene for the large subunit of Rubisco (*rbcL*) gave sequences of 1328 base pairs, representing a large fraction of the gene. Figure 1 shows a diagram of the gene (with length determined from the gene for *Q. suber* L., GenBank Accession AB125027.1) and indicates the extent of the sequence amplified by the present primers and the positions of 30 sites that varied among the species that were tested in the present study. Table 1 lists the 33 species from which we were able to determine clear Rubisco sequences. Figure 2 indicates the number of base differences between each pair of species. For one sample, that from a *Quercus* from Iran that was not identified to species, there was a 59-base-pair insertion that was not found in any other sample. For the purposes of comparison in Figure 2, that insertion was counted as one difference.

The data presented in Figure 2 provide a comparison of the *rbcL* sequences of 33 accessions in the UC Davis Arboretum. GenBank also contains the *rbcL* sequences of an additional 16 species found in the Arboretum. References to the GenBank *rbcL* sequences of these additional 16 are given in Table 4. Thus *rbcL* sequences are available for 49 of the 74 species and subspecies in the Arboretum. It is unfortunate that four members of the 20 species found in California (Nixon 2002) refused to give templates for amplification of the *rbcL* gene.

Before the submission of these sequences to GenBank, a search of the GenBank database, using “Quercus AND rbcL” and “Quercus AND carboxylase/oxygenase” produced 103 records involving 47 species and varieties, all different from the ones tested here. Thus the new data reported here have increased by 70% the number of species for

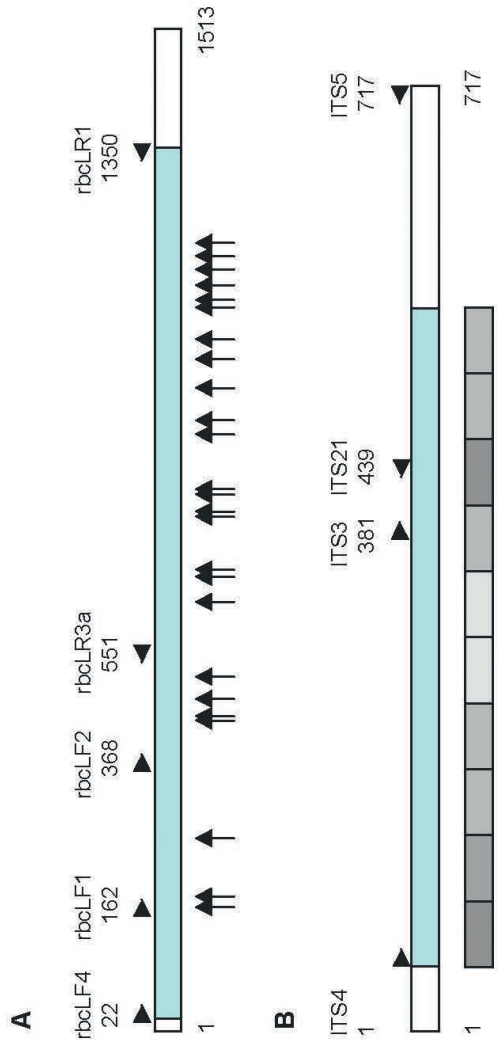

Figure 1/ Diagrams of (A) the *rbcL* gene and (B) the ITS sequence, showing the positions of the primers used in amplification and sequence analysis. Shaded regions show the sequences used for the numerical comparisons (Figs. 2-4). In A, arrows point to the positions of base variants identified among the species tested in this work. In B, there were over 80 positions that varied among the species tested. Shading in the lower bar shows the approximate distribution of those variants.

which information is available on the *Quercus rbcL* gene.

Figure 3 shows a comparison of the sequences used in Figure 2 plus nine more of the longer sequences in the GenBank files, chosen to match as many as possible of the species compared by Manos et al. (1999). What is remarkable is the lack of coincidence between the relationships of the *rbcL* genes and the relationships of the *Quercus* species determined on the basis of the classical and molecular data used by Manos et al. (1999) and later by Oh and Manos (2008). The number of differences among *rbcL* sequences ranged from 0 to 15, with an average of 5.8. There were relatively large base differences between three species grouped in *Lobatae* (*Q. agrifolia* Née vs *Q. palustris* Münchh., 9

	acu	chr	eng	ira	cas	his	can36	gla	fag	ibi	inf	wis	can2	gra	cra	mex	ber	dea	dou	obl	gam	gri	vas	har	gre	moh	mue	pun	rug	pri	agr	sin	mar
acu	-	3	1	10	9	10	10	9	8	8	8	9	9	9	10	10	9	9	8	8	8	8	9	9	9	9	9	9	9	10	12	13	13
chr	3	-	2	11	10	11	11	10	9	9	9	8	10	10	11	11	10	10	9	9	9	9	10	10	10	10	10	10	10	11	13	14	14
eng	1	2	-	9	8	9	9	8	7	7	7	8	8	8	9	9	8	8	7	7	7	7	8	8	8	8	8	8	8	9	11	12	12
ira	10	11	9	-	1	2	6	5	4	4	4	7	7	7	8	8	9	9	8	8	8	8	9	9	9	9	9	9	9	10	12	13	13
cas	9	10	8	1	-	1	5	4	3	3	3	6	6	6	7	7	8	8	7	7	7	7	8	8	8	8	8	8	8	9	11	12	12
his	10	11	9	2	1	-	4	5	4	4	4	5	7	7	8	8	9	9	8	8	8	8	9	9	9	9	9	9	9	10	10	11	11
can36	10	11	9	6	5	4	-	1	2	2	2	3	5	5	6	6	7	7	6	6	6	6	7	7	7	7	7	7	7	8	8	9	9
gla	9	10	8	5	4	5	1	-	1	1	1	4	4	4	5	5	6	6	5	5	5	5	6	6	6	6	6	6	6	7	9	10	10
fag	8	9	7	4	3	4	2	1	-	0	0	3	3	3	4	4	5	5	4	4	4	4	5	5	5	5	5	5	5	6	8	9	9
ibi	8	9	7	4	3	4	2	1	0	-	0	3	3	3	4	4	5	5	4	4	4	4	5	5	5	5	5	5	5	6	8	9	9
inf	8	9	7	4	3	4	2	1	0	0	-	3	3	3	4	4	5	5	4	4	4	4	5	5	5	5	5	5	5	6	8	9	9
wis	9	8	8	7	6	5	3	4	3	3	3	-	4	4	5	5	6	6	5	5	5	5	6	6	6	6	6	6	6	7	7	8	8
can2	9	10	8	7	6	7	5	4	3	3	3	4	-	0	1	1	6	6	5	5	5	5	4	4	4	4	4	4	4	7	9	10	10
gra	9	10	8	7	6	7	5	4	3	3	3	4	0	-	1	1	6	6	5	5	5	5	4	4	4	4	4	4	4	7	9	10	10
cra	10	11	9	8	7	8	6	5	4	4	4	5	1	1	-	2	7	7	6	6	6	6	5	5	5	5	5	5	5	8	10	11	11
mex	10	11	9	8	7	8	6	5	4	4	4	5	1	1	2	-	7	7	6	6	6	6	5	5	5	5	5	5	5	8	10	11	11
ber	9	10	8	9	8	9	7	6	5	5	5	6	6	6	7	7	-	2	1	1	1	1	2	2	2	2	2	2	2	3	5	6	6
dea	9	10	8	9	8	9	7	6	5	5	5	6	6	6	7	7	2	-	1	1	1	1	2	2	2	2	2	2	2	3	5	6	6
dou	8	9	7	8	7	8	6	5	4	4	4	5	5	5	6	6	1	1	-	0	0	0	1	1	1	1	1	1	1	2	4	5	5
obl	8	9	7	8	7	8	6	5	4	4	4	5	5	5	6	6	1	1	0	-	0	0	1	1	1	1	1	1	1	2	4	5	5
gam	8	9	7	8	7	8	6	5	4	4	4	5	5	5	6	6	1	1	0	0	-	0	1	1	1	1	1	1	1	2	4	5	5
gri	8	9	7	8	7	8	6	5	4	4	4	5	5	5	6	6	1	1	0	0	0	-	1	1	1	1	1	1	1	2	4	5	5
vas	9	10	8	9	8	9	7	6	5	5	5	6	4	4	5	5	2	2	1	1	1	1	-	0	0	0	0	0	0	3	5	6	6
har	9	10	8	9	8	9	7	6	5	5	5	6	4	4	5	5	2	2	1	1	1	1	0	-	0	0	0	0	0	3	5	6	6
gre	9	10	8	9	8	9	7	6	5	5	5	6	4	4	5	5	2	2	1	1	1	1	0	0	-	0	0	0	0	3	5	6	6
moh	9	10	8	9	8	9	7	6	5	5	5	6	4	4	5	5	2	2	1	1	1	1	0	0	0	-	0	0	0	3	5	6	6
mue	9	10	8	9	8	9	7	6	5	5	5	6	4	4	5	5	2	2	1	1	1	1	0	0	0	0	-	0	0	3	5	6	6
pun	9	10	8	9	8	9	7	6	5	5	5	6	4	4	5	5	2	2	1	1	1	1	0	0	0	0	0	-	0	3	5	6	6
rug	9	10	8	9	8	9	7	6	5	5	5	6	4	4	5	5	2	2	1	1	1	1	0	0	0	0	0	0	-	3	5	6	6
pri	10	11	9	10	9	10	8	7	6	6	6	7	7	7	8	8	3	3	2	2	2	2	3	3	3	3	3	3	3	-	4	5	5
agr	12	13	11	12	11	10	8	9	8	8	8	7	9	9	10	10	5	5	4	4	4	4	5	5	5	5	5	5	5	4	-	1	3
sin	13	14	12	13	12	11	9	10	9	9	9	8	10	10	11	11	6	6	5	5	5	5	6	6	6	6	6	6	6	5	1	-	4
mar	13	14	12	13	12	11	9	10	9	9	9	8	10	10	11	11	6	6	5	5	5	5	6	6	6	6	6	6	6	5	3	4	-

Figure 2/ Numbers of base sequence differences between the *rbcL* genes of *Quercus* species determined in this work. Abbreviations: acu, *Q. ×acutidens*; agr, *Q. agrifolia*; ber, *Q. berberidifolia*; can36, *Q. canariensis*; can2, *Q. candicans*; cas, *Q. castaneifolia*; chr, *Q. chrysolepis*; cra, *Q. crassipes*; dea, *Q. ×deamii*; dou, *Q. douglasii*; eng, *Q. engelmannii*; fag, *Q. faginea*; gam, *Q. gambelii*; gla *Q. glandulifera* (*Q. serrata*); gra, *Q. gravesii*; gre, *Q. greggii*; gri, *Q. grisea*; har, *Q. hartwegii*; his, *Q. ×hispanica*; ibi, *Q. iberica*; inf, *Q. infectoria* subsp. *veneris*; mar, *Q. margaretta*; mex, *Q. mexicana*; moh, *Q. mohriana*; mue, *Q. muehlenbergii*; obl, *Q. oblongifolia*; pri, *Q. prinoides*; pun, *Q. pungens*; rug, *Q. rugosa*; sin, *Q. sinuata*; ira, Q. *sp*., Iran; vas, *Q. vaseyana*; wis, *Q. wislizeni*. Boxes point out groups with ≤2 base pair differences.

differences; *Q. agrifolia* vs *Q. rubra* L., 7). There were also relatively large differences between species grouped in section *Quercus* (*Q. engelmannii* Greene vs *Q. virginiana* Mill., 13; *Q. robur* L. vs. *Q. virginiana*, 9). In contrast, sequences from two species grouped in different sections, *Q. engelmannii* and *Q. chrysolepis* Liebm. differed by only one base; similarly, *Q. agrifolia* and *Q. virginiana* differed by only 5 bases; sequences from *Q. berberidifolia* Liebm. and *Q. douglasii* Hook. & Arn., again in different sections (Nixon 2002), did not differ. On the other hand, following the standard taxonomy, the sequences from two species in section *Ilex*, *Q. ilex* L. and *Q. coccifera* L. did not differ at all, and the sequences from three species in section *Cerris*, *Q. cerris* L., *Q. acutissima* Carruth., and *Q. phillyreoides* A. Gray, differed by only 3-5 bases. Phylogenetic analyses of the *rbcL* sequences generated here (results not shown) provided considerably less resolution than the ITS data (see below) and although there was support for some of the same groupings as in the ITS analysis (e.g., section *Cerris*), the placements of several taxa were inconsistent with our ITS results and with other phylogenetic studies (Manos et al. 1999; Pearse and Hipp 2009) as well as current infrageneric taxonomy.

	Arboretum accession	**GenBank accession**
Quercus acutissima	A64.0385	AB060578.1
Quercus alba	A64.1174	EU676968.1
Quercus cerris	A64.1304	AB125017.1
Quercus coccifera	A64.1324	AB125018.1
Quercus garryana	A71.0132	HQ184325.1
Quercus ilex	A64.1315	AB125020.1
Quercus ithaburensis	A64.1285	FN675729.1
Quercus macrocarpa	A64.0368	HQ590229.1
Quercus myrsinifolia	A64.0375	AB060572.1
Quercus oleoides	A68.0354	JQ592116.1
Quercus petraea	A93.0319	AB125024.1
Quercus robur	A64.1208	AB125025.1
Quercus suber	A41.0195	AB125027.1
Quercus trojana	A64.0008	FN675725.1
Quercus variabilis	A69.0181	AB060574.1
Quercus virginiana	A64.0012	AF119175.1

Table 4/ Accession numbers for rbcL sequences of UCD Arboretum oak species that were not assayed in this project but were given in GenBank. Where multiple GenBank accessions were available, the number for the accession with longest sequence is listed.

ITS

The primers for the ITS sequence defined a section of up to 717 base pairs. Within that section, a segment of 500 base pairs, from base 51 to base 550, was used for comparisons (Fig. 1). Long stretches of poly(G)::poly(C) made sequencing difficult, and even multiple sequencing trials using different primers resulted in some consistently ambiguous sites, although those could represent true heterozygosity. Table 1 lists the 23 species from which we were able to determine ITS sequences. Figure 4 shows the number of clear base differences (+ the number of differences involving ambiguities) between each pair of sequences. In three cases (*Q. arizonica* Sarg., *Q.* ×*deamii* Trel., and *Q. wislizeni* A.

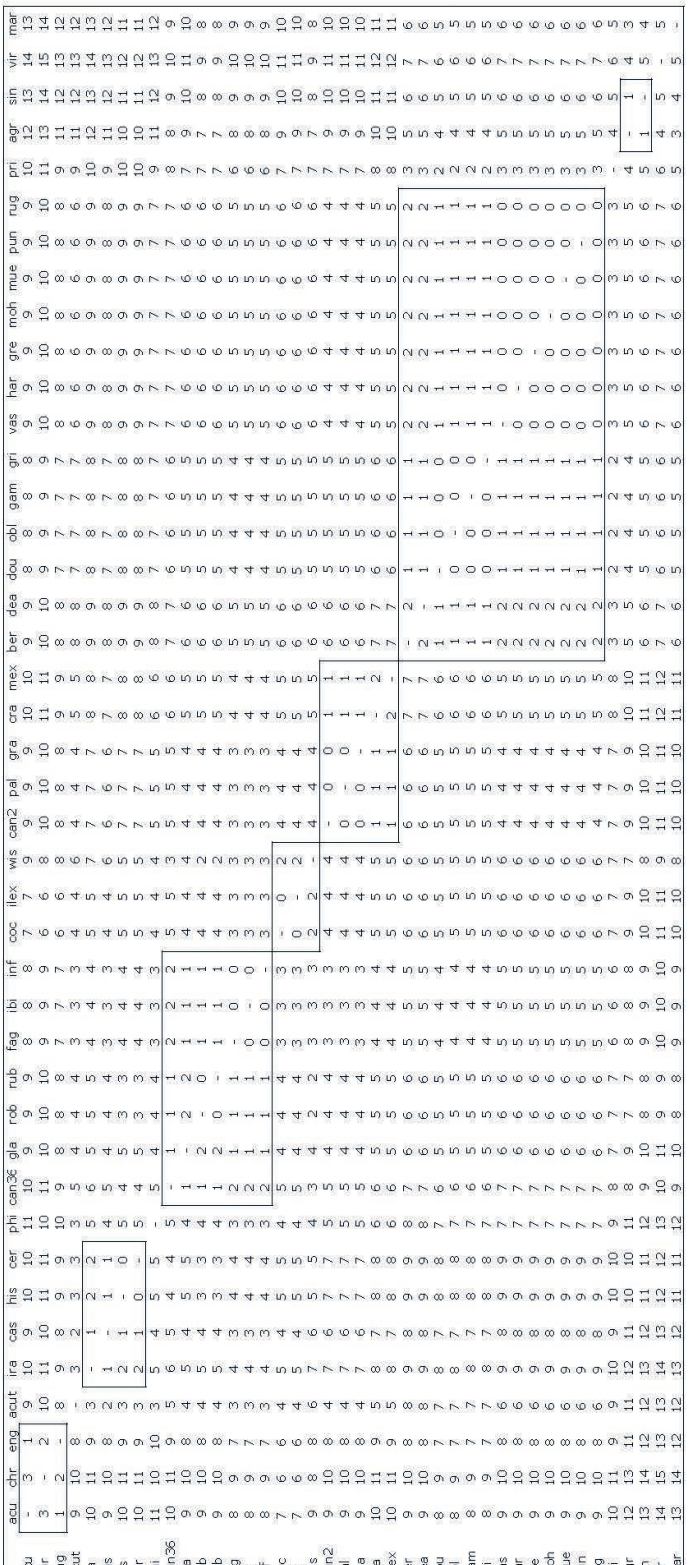

Figure 3/ Numbers of sequence differences between the *rbcL* genes of *Quercus* species, including the species noted in Fig. 2 plus the following species: acut, *Q. acutissima*; cer, *Q. cerris*; phi, *Q. phillyraeoides*; rob, *Q. robur*; rub, *Q. rubra*; coc, *Q. coccifera*; ile, *Q. ilex*; pal, *Q. palustris*; vir, *Q. virginiana*. Boxes point out groups with ≤2 base pair differences.

DC.), sequencing with different primers gave results with small differences; both results are shown.

The data in Fig. 4, comparing ITS sequences determined here, largely support the relationships indicated by the *rbcL* results. Boxes along the diagonal of Fig. 4 were chosen to include, as closely as possible, the species in boxes in Fig. 2, and indeed the numbers in these boxes are relatively low (averaging 6.9, compared to the total collection, which average 14.1). There are also some low numbers that were not indicated in the *rbcL* comparisons. The boxes off the diagonal in Fig. 4, averaging 5.8, indicate a possible relationship between two groups: *Q. canariensis* Willd., *Q. serrata* Murray, *Q. infectoria* subsp. *veneri*s, and *Q. ×deamii* with *Q. vaseyana* Buckley., *Q. mohriana* Buckley ex Rydb.., *Q. pungens* Liebm., *Q. lobata* Née, and *Q. prinoides* Willd. Base-sequence similarities in the ITS region within sections *Ilex* and *Cerris* were also noted by Manos et al. (1999). Samuel et al. (1998) also found ITS identity between *Q. ilex* and *Q. coccifera*.

Phylogenetic analyses (Fig. 5) of ITS sequences determined in this work (Table 1) and by others (Table 3) provided support for monophyly of groups corresponding largely to sections *Cerris*, *Lobatae*, *Protobalanus*, and *Quercus*, as was found in previous phylogenetic studies based on ITS sequences (Manos et al. 1999) and AFLP data (Pearse and Hipp 2009). Our results also agree with those past studies with respect to pattern of relationship among the four groups. Sequences from two accessions of *Q. cedrosensis* C.H. Mull. from Manos et al. (1999) were not resolved within section *Protobalanus* (where the species is classified based on morphology). This result is not surprising, since Manos et al. (1999) also reported anomalous placements of these sequences. Two species classified in Section *Quercus*, *Q. canariensis* and *Q. serrata*, were not resolved within the clade with the other members of that section. Those species were not included in the ITS analysis by Manos et al. (1999), but they were resolved within the section *Quercus* clade in the analysis of AFLP data by Pearse and Hipp (2009). We can think of two potential explanations for this discrepancy. First, it is possible that our ITS sequences for these two species are paralogous to those for the other species and include the difference in taxon sampling. Second, we did not have ITS sequences for several of the section *Quercus* species sampled by Pearse and Hipp (2009), and this difference in taxon sampling could explain the difference in phylogenetic resolution between the two studies.

trnL/trnF

The primers chosen to determine the sequence of an intergenic region between *trnL* and *trnF* produced an amplicon of approximately 350 base pairs. Seventeen of the extracts were amplified and sequenced. However, not all amplicons gave clear sequences over the full region; in addition, only four sites showed polymorphisms, providing a maximum sequence difference of three bases between extracts. As a result, the other extracts were not tested. One interesting finding was that the *Quercus* from Iran, noted above as having an insertion in the *rbcL* gene, also had an insertion in the *trnL-trnF* region. This *trnL-trnF* insertion (although not the *rbcL* insertion) was also found in *Q. castaneifolia* C.A. Mey (Persian oak). A third species, *Q. faginea* Lam., had an insertion at the same point of the *trnL-trnF* sequence, but its insertion had a different base sequence.

	chr	ira	cas	his	can36	gla-1	gla-2	inf-1	inf-2	dea-1	dea-2	wis-1	wis-2	ari-1	ari-2	can2	gra	cra	mex	ber	obl	gri	vas	moh	pun	lob	pri	mue
chr	-	22+5	21+2	18+3	14+5	13+3	15+3	17+3	17+3	15+7	18+6	23+2	20+2	24+2	24+2	21+6	22+2	19+10	22+5	20+4	17+6	18+3	14+7	16+2	18+3	16+2	15+6	15+3
ira	22+5	-	4+3	7+3	18+6	18+3	18+3	23+4	23+4	20+7	24+5	29+1	25+2	32+1	31+1	27+6	30+0	26+8	28+4	26+4	25+6	26+3	19+10	23+2	22+3	23+2	22+6	22+2
cas	21+2	4+3	-	6+1	17+4	18+1	18+1	23+2	23+2	20+5	23+4	28+0	25+0	31+0	30+0	27+4	29+0	26+7	27+3	27+4	23+5	26+1	19+8	23+0	22+1	23+0	21+5	21+0
his	18+3	7+3	6+1	-	12+5	15+2	15+2	18+3	18+3	15+6	16+5	21+1	20+1	24+1	23+1	20+5	24+1	18+3	22+4	22+5	21+6	23+2	14+9	18+1	17+2	18+1	16+6	14+2
can36	14+5	18+6	17+4	12+5	-	2+5	4+5	8+6	8+6	5+8	11+8	18+4	12+4	18+4	17+4	16+7	16+4	12+12	16+7	9+6	10+8	11+5	4+12	7+4	8+5	5+4	4+8	8+4
gla-1	13+3	18+3	18+1	15+2	2+5	-	3+0	8+3	8+3	5+6	11+5	18+1	12+1	19+1	18+1	16+5	17+0	13+9	17+4	9+5	8+5	9+2	4+9	7+1	8+2	5+1	4+6	8+2
gla-2	15+3	18+3	18+1	15+2	4+5	3+0	-	11+3	11+3	8+6	14+5	21+1	15+1	22+1	21+1	19+5	20+0	16+9	18+4	12+5	9+6	11+2	7+9	10+1	9+2	8+1	6+6	8+2
inf-1	17+3	23+4	23+2	18+3	8+6	8+3	11+3	-	0+0	4+7	9+6	16+2	11+2	17+2	16+2	14+5	16+1	12+9	15+4	11+6	13+6	14+3	3+9	7+2	4+3	8+2	7+7	11+2
inf-2	17+3	23+4	23+2	18+3	8+6	8+3	11+3	0+0	-	4+7	9+6	16+2	11+2	17+2	16+2	14+5	16+1	12+9	15+4	11+6	13+6	14+3	3+9	7+2	4+3	8+2	7+7	11+2
dea-1	15+7	20+7	20+5	15+6	5+8	5+6	8+6	4+7	4+7	-	6+1	12+5	6+5	17+2	15+3	18+7	15+4	11+12	13+7	10+8	10+8	11+5	0+10	2+5	4+6	7+4	6+7	10+5
dea-2	18+6	24+5	23+4	16+5	11+8	11+5	14+5	9+6	9+6	6+1	-	6+4	12+4	10+3	9+3	6+9	11+4	6+11	3+7	16+6	16+7	17+4	6+9	8+4	10+5	13+3	12+6	12+4
wis-1	23+2	29+1	28+0	21+1	18+4	18+1	21+1	16+2	16+2	12+5	6+4	-	6+0	9+0	7+1	4+5	14+0	5+9	7+4	22+3	22+4	23+1	12+9	16+0	17+1	18+0	19+4	18+1
wis-2	20+2	25+2	25+0	20+1	12+4	12+1	15+1	11+2	11+2	6+5	12+4	6+0	-	15+0	13+1	10+4	18+0	10+9	12+4	16+4	16+4	17+1	6+9	10+0	11+1	12+0	12+5	16+1
ari-1	24+2	32+1	31+0	24+1	18+4	19+1	22+1	17+2	17+2	17+2	10+3	9+0	15+0	-	1+1	5+5	12+0	6+8	6+4	23+2	23+4	24+1	16+7	19+0	19+1	19+0	19+5	19+0
ari-2	24+2	31+1	30+0	23+1	17+4	18+1	21+1	16+2	16+2	15+3	9+3	7+1	13+1	1+1	-	3+6	10+1	3+10	4+5	21+3	22+4	23+1	15+7	18+0	18+1	18+0	18+5	18+0
can2	21+6	27+6	27+4	20+5	16+7	16+5	19+5	14+5	14+5	18+7	6+9	4+5	10+4	5+5	3+6	-	9+5	2+14	3+9	19+6	18+6	18+5	12+11	16+4	15+5	15+4	16+8	16+3
gra	22+2	30+0	29+0	24+1	16+4	17+0	20+0	16+1	16+1	15+4	11+4	14+0	18+0	12+0	10+1	9+5	-	6+9	8+4	22+2	23+4	24+1	15+8	17+0	19+1	18+0	19+4	20+0
cra	19+10	26+8	26+7	18+3	12+12	13+9	16+9	12+9	12+9	11+12	6+11	5+9	10+9	6+8	3+10	2+14	6+9	-	4+8	17+11	17+12	18+9	11+14	14+8	14+9	13+8	14+12	14+8
mex	22+5	28+4	27+3	22+4	16+7	17+4	18+4	15+4	15+4	13+7	3+7	7+4	12+4	6+4	4+5	3+9	8+4	4+8	-	20+6	21+7	22+4	13+9	17+3	16+5	17+3	18+7	18+3
ber	20+4	26+4	27+4	22+5	9+6	9+5	12+5	11+6	11+6	10+8	16+6	22+3	16+4	23+2	21+3	19+6	22+2	17+11	20+6	-	11+7	12+4	8+11	13+3	10+5	7+3	6+6	9+5
obl	17+6	25+6	23+5	21+6	10+8	8+5	9+6	13+6	13+6	10+8	16+7	22+4	16+4	23+4	22+4	18+6	23+4	17+12	21+7	11+7	-	0+4	8+12	11+4	10+6	7+4	6+9	8+6
gri	18+3	26+3	26+1	23+2	11+5	9+2	11+2	14+3	14+3	11+5	17+4	23+1	17+1	24+1	23+1	18+5	24+1	18+9	22+4	12+4	0+4	-	9+9	12+1	12+2	8+1	7+7	10+2
vas	14+7	19+10	19+8	14+9	4+12	4+9	7+9	3+9	3+9	0+10	6+9	12+9	6+9	16+7	15+7	12+11	15+8	11+14	13+9	8+11	8+12	9+9	-	0+9	2+10	5+8	4+11	8+9
moh	16+2	23+2	23+0	18+1	7+4	7+1	10+1	7+2	7+2	2+5	8+4	16+0	10+0	19+0	18+0	16+4	17+0	14+8	17+3	13+3	11+4	12+1	0+9	-	7+1	10+0	8+5	13+1
pun	18+3	22+3	22+1	17+2	8+5	8+2	9+2	4+3	4+3	4+6	10+5	17+1	11+1	19+1	18+1	15+5	19+1	14+9	16+5	10+5	10+6	12+2	2+10	7+1	-	7+1	5+5	8+1
lob	16+2	23+2	23+0	18+1	5+4	5+1	8+1	8+2	8+2	7+4	13+3	18+0	12+0	19+0	18+0	15+4	18+0	13+8	17+3	7+3	7+4	8+1	5+8	10+0	7+1	-	2+5	5+1
pri	15+6	22+6	21+5	16+6	4+8	4+6	6+6	7+7	7+7	6+7	12+6	19+4	12+5	19+5	18+5	16+8	19+4	14+12	18+7	6+6	6+9	7+7	4+11	8+5	5+5	2+5	-	4+6
mue	15+3	22+2	21+0	14+2	8+4	8+2	8+2	11+2	11+2	10+5	12+4	18+1	16+1	19+0	18+0	16+3	20+0	14+8	18+3	9+5	8+6	10+2	8+9	13+1	8+1	5+1	4+6	-

Figure 4/ Number of sequence differences between the ITS genes of *Quercus* species determined in this work. The two numbers in each box indicate clear differences + ambiguities, where ambiguities may have occurred because of heterozygosity or because of the difficulty in determining sequences past poly(G) or poly(C) regions through mis-priming in the sequencing reactions. Abbreviations are as given in Figure 2 with the following additions: ari, *Q. arizonica*; lob, *Q. lobata*.

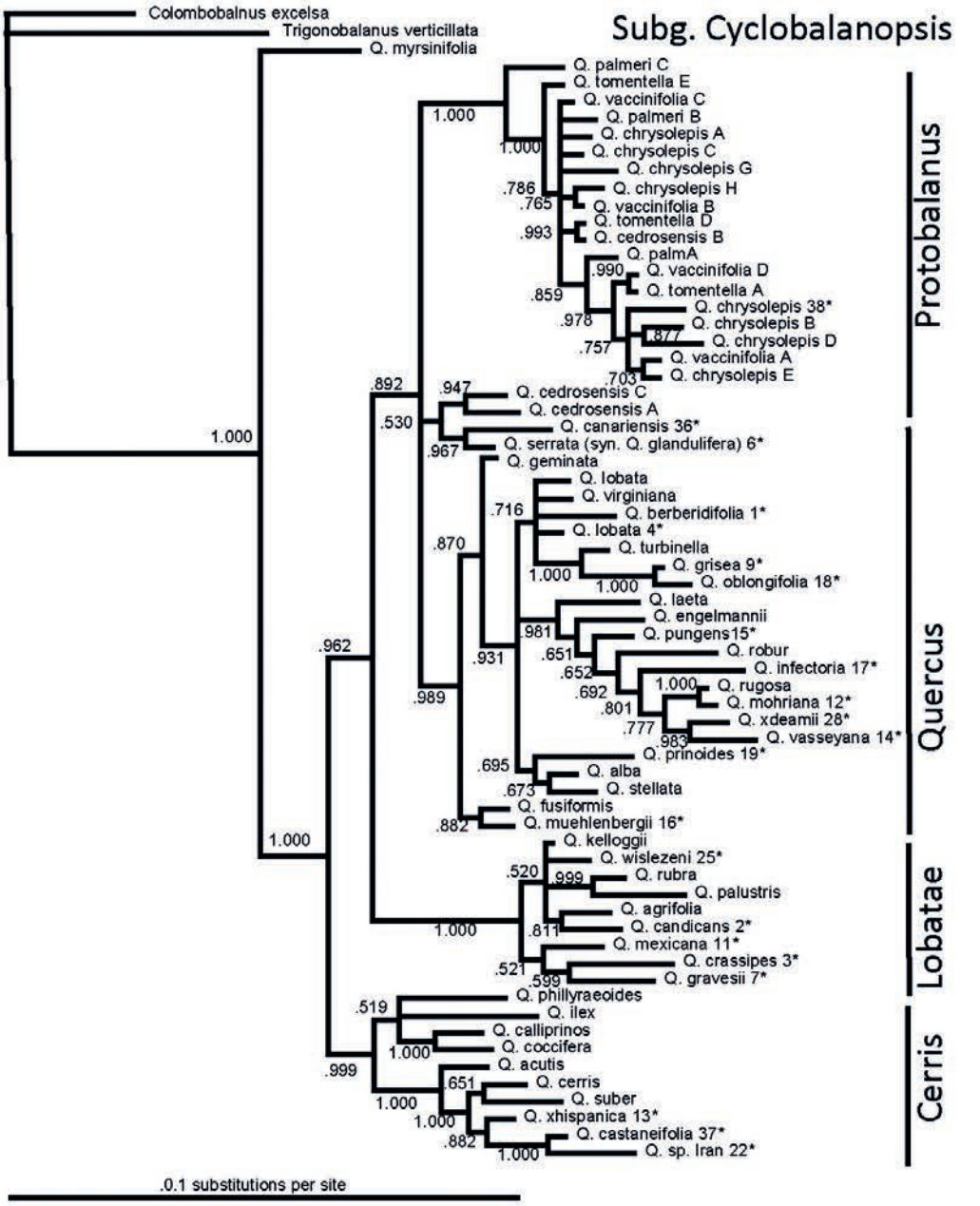

Figure 5/ Phylogenetic relationships among *Quercus* species based on Bayesian Inference analysis of ITS sequences determined in this work plus those listed in Table 3. The tree shown is a phylogram of the 50% majority-rule consensus tree from 6,002 trees retained after running two parallel analyses of four Monte Carlo Markov chains each for 4 million generations, sampling every 1,000 generations and discarding the first 25% of trees as burn-in. Sequences generated for this study are marked with asterisks. The number on each branch represents the proportion of trees in which that branch was supported, which is interpreted as the Bayesian clade credibility value. Specimens denoted by a number plus "ITS" were determined in this work. See Table 1 for species identification.

Conclusion

Molecular data such as presented here have contributed to phylogenetic studies, but there are cases where taxonomists question or reject the information (see Nixon 2002 concerning Manos et al. 2001). It is important to point out that in a gene such as *rbcL*, selection is strongly conservative. Also, base changes that produce amino acid substitutions in the expressed protein may have selective effects. Furthermore, the amino acid substitutions produced by two such base changes could interact positively or negatively. The conservative nature of this gene and its limitations for phylogenetic discrimination may be inferred by the shared sequences of groups of species, one of seven species and one of thirteen (Fig. 3). It may be that the sequences of the *rbcL* gene will be found to be particularly sensitive to environmental (external or internal) influences.

Phylogenetic analyses of the more variable non-coding ITS sequences provide support for major groupings and overall relationships within the genus *Quercus*, as was found in a previous study (Manos et al. 1999). While there are potential concerns about the use of ITS in phylogeny reconstruction (e.g., Nixon 2002), especially in a group such as *Quercus* in which hybridization is frequent, the fact that the major groups and patterns of relationship recovered by ITS sequences were also found using AFLP markers (Pearse and Hipp 2009) adds support to the view that these patterns are accurate reflections of phylogenetic relationship. Moreover, the agreement between the patterns with *rbcL* and ITS sequences strengthens considerably the conclusion, earlier advanced by Samuel et al. (1998), that these molecular data can reveal the actual pattern of evolutionary relationships among the *Quercus* species.

Photographers. Title page: Béatrice Chassé (*Quercus engelmannii*).

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Quercus look Kotschy: a Distinct Mt. Hermon Species

Dr. Michael Avishai
The Jerusalem Botanical Garden
Jerusalem, Israel, 91904
michavish@gmail.com

ABSTRACT

Quercus look Kotschy is an endemic, little-known species from Mount Hermon, Mount Lebanon and the Anti-Lebanon Mountains where it is an important element of the open deciduous mountain forest at 1,500-1,900 m. First collected by Theodor Kotschy in 1855 this taxon has a rather complicated taxonomic history – here reviewed – but current data suggests that Kotschy was correct and that *Q. look* is a valid taxon distinct from other species. A brief survey of *Q. look* in cultivation is also presented.

Keywords: oaks in Israel, relictual Mediterranean oak populations

Photo 1/ Kotschy's original drawing of *Quercus look*.

Introduction

Since 1967 the slopes of Mount Hermon have again been made accessible to botanists and nature lovers. With its unique environmental conditions (elevation and climate) it has become a focus of botanical research and the number of species found on this mountain increases with time. Much effort has been deployed to preserve large areas that in the past have suffered from overgrazing and clean cutting and are now protected as nature reserves. The high number of species found on Mt. Hermon is the result of its history and geographic location that sets it on the boundary between two of the world's floristic and vegetation belts. The distinctiveness of these mountains is illustrated by the presence of four oak species at similar elevation belts: *Q. calliprinos* Webb.[1], *Q. boissieri* Reut.[2], *Q. look* Kotschy and *Q. cerris* L.

A discussion of the systematic status of *Q. look* is needed, with a view, amongst others, to rectifying certain errors in the scientific literature such as the distinction of plant communities in the Judean mountains that include *Q. look* (Ighbareyeh et al. 2014).

A review of the research

Theodor Kotschy initially collected *Q. look* during his first journey to Syria and Lebanon on the 25th of June in 1855. These collections were published in his magnificent monograph (Kotschy 1862) dedicated to 40 oaks of Europe and the Near East, among them 18 new to science. Among his very extensive collections of dry plant samples, No. 172 collected on the western slopes of Mt. Hermon near Rachaya, was used to formulate the description of *Q. look* found on plate 31 of his monumental work. The specific epithet is in fact the local name for this species used by the inhabitants of Rachaya. Duplicates of this number are now preserved in different Herbaria (Geneva, Kew, Paris and Vienna) where I was able to check them.

Kotschy's Middle Eastern collections contributed much to the cognizance of oaks and indicated many species suitable for forestry and for European gardens. In order to finance his travels, Kotschy organized (as was customary in 19th century high-society when interest in botany was more in fashion than today) a group of "subscribers" who would each receive numbered herbarium samples. In order to respond to the expectations of the members for novel and unique collections, many newly named and numbered "species" were distributed "in schedis", but few were published in his treatise and even fewer have survived the test of time to be recognized today as valid biological species by later researchers.

Alphonse de Candolle in 1864 was the first to accept *Q. look* as a valid species in his global monograph of the genus, the first of its kind. He included in his distribution samples that were collected for Kotschy by M. de Pfaeffinger[3] on the Horan (near Damascus) that had in the past been regarded as *Q. ithaburensis* Decne. My opinion is that these samples are in fact *Q. look*.

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1. The more widely accepted name for this plant is *Q. coccifera* susbp. *calliprinos* (Webb) Holmboe.

2. Although considered by many to be a synonym of *Q. infectoria* subsp. *veneris*, (A. Kern) Meikle this author does not agree with this synonymy 1) based on observations of a cultivated specimen at the Vienna University Botanical Garden, grown from an acorn collected by Kotschy and 2) because these two taxa differ in drought resistance, *Q. infectoria* subsp. *veneris* being much less so than *Q. boissieri*.

3. M. de Pfaeffinger was the Austrian Consul in Damascus during the second half of the 19th century. He was a friend of Kotschy's and often collected plants for him.

E. Boissier (1879) also accepted *Q. look* as a valid species and though he included in his description of the species de Pfaeffinger's materials (distributed by Kotschy as No. 53) he noted that this material was too juvenile. In the past I mistakenly determined this sample as *Q. ithaburensis* but recent new examination has re-established the sheet as typical for *Q. look* collected near Damascus. T. Wenzig (1887), following in the footsteps of Boissier and based on Kotschy's herbarium samples (Ky. 172, Ky. rev. 53, and Ky. 98), recognized the species, referring to it as part of his grouping with *Q. libani*, *Q. regia* Lindl.[4] and *Q. vesca* Kotschy[5]. Later, Post (1896) and Post and Dinsmore (1933), in different editions of the *Flora of Syria, Palestine and Sinai*, accepted a number of Kotschy's species from Lebanon and Mount Hermon. They both included *Q. look* among the five species (*Q. cerris, Q. ehrenbergii* Kotschy[6] *Q. aegilops* subsp. *ithaburensis* Decne.,[7] *Q. libani* G. Olivier, and *Q. look*) from Mt. Hermon.

From the study of the collections in the herbaria of Edinburgh, Geneva, London, Paris and Vienna, our tours on Mt. Hermon, and the study of the wild-collected plants cultivated at the Jerusalem Botanical Garden, I have concluded that of these five species only *Q. cerris* and *Q. look* occur at elevations above 1,300 m. *Quercus ehrenbergii*, a form of *Q. macrolepis* Kotschy,[8] does not occur on Mt. Hermon or on Mt. Lebanon. Leaf texture, indumentum, cupule and scale features correspond to what is mentioned in the *Flora of Turkey* under Kotschy's specimen No. 393 (Hedge and Yaltirik 1982).

Photos 2/(a) *Quercus look* leaves (Jerusalem Botanical Gardens); (b) *Q. libani* leaves (Arboretum des Pouyouleix).

4. Today considered a synonym of *Q. libani.*
5. Today consdiered a synonym of *Q. libani*.
6. Today considered a synonym of *Q. ithaburensis* subsp. *macrolepis.*
7. Today considered a synonym of *Q. ithaburensis*.
8. Considered by some as a synonym of *Q. ithaburensis* subsp. *macrolepis* (Kotschy) Hedge & Yalt.

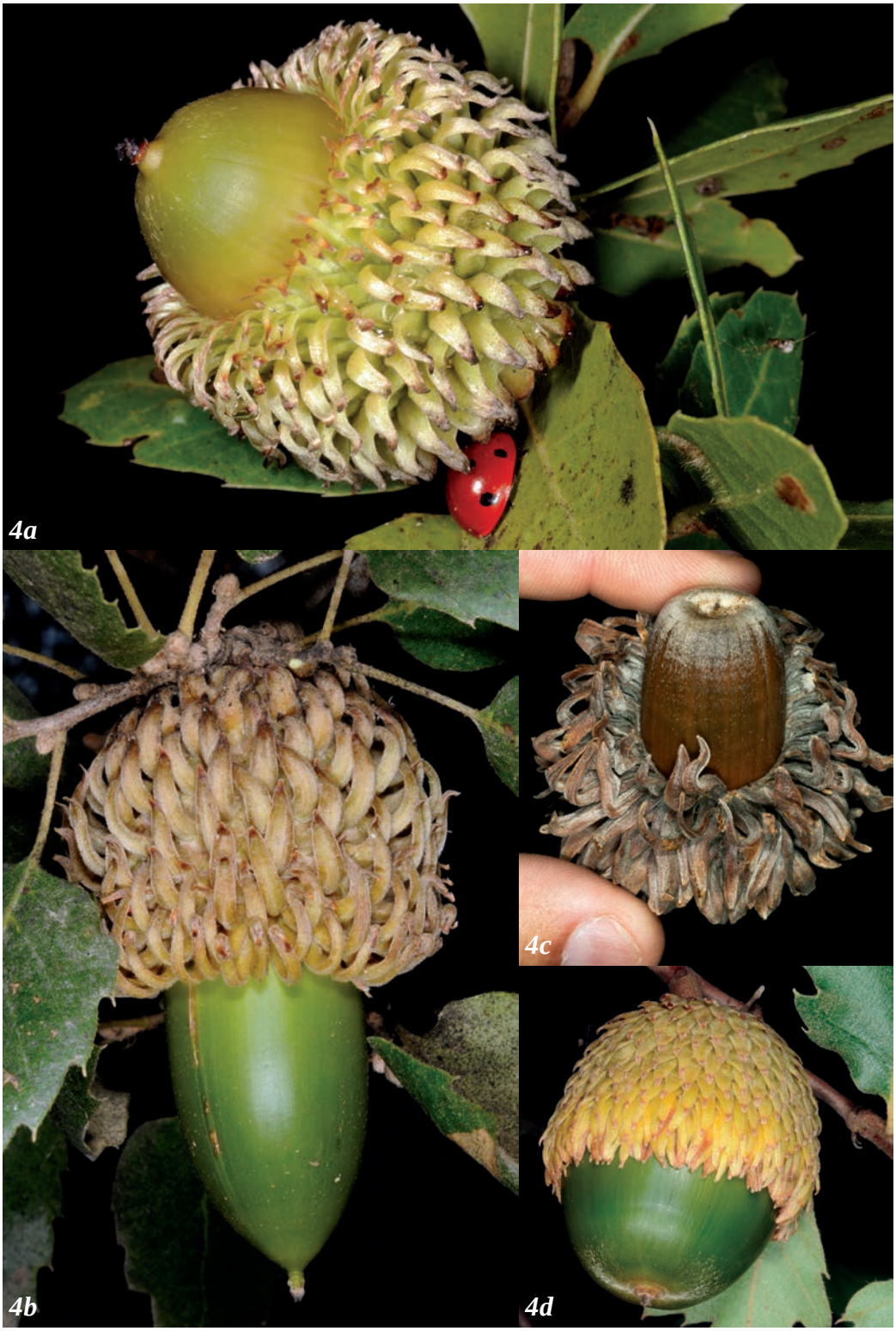
In the first modern monograph of oaks, Aimée Camus (1936-1938) chose some specific forms from Kotschy's collections including *Q. ehrenbergii* (Ky. 393) from southern Turkey and Kurdistan. The sample of the plant that served Kotschy for *Q. look*, she published as *Q. aegilops* subsp. *look* (Kotschy) A. Camus.[9] Otto Schwarz (1936) who studied the genus contemporaneously with Mme Camus, included in his *Atlas* Kotschy's *Q. look* leaves in the assemblage of leaf forms of the species that he published as *Q. libani* Olivier. However a review of the material in Schwarz's *Atlas* shows that the characteristic leaf forms of *Q. libani* in Syria and Turkey, are different from those of *Q. look* from Mt. Hermon, and therefore that the determination of these forms as *Q. libani* was a mistake.

In the beginning of the 1960s Michael Zohary (1961) regarded the oaks of Mt. Hermon as a continuation of more northern species or as doubtful hybrids with one of the more common species in Israel. Later, in *The Geobotanical Foundations of the Middle East* (Zohary 1973) he follows Schwarz and includes the species from Mt. Hermon as part of the general distribution of *Q. libani*. However he noted that "In southern Lebanon and on Mt. Hermon it (*Q. libani*) is replaced by *Q. look* which is sometimes leading the montane forest remnants there." It must be noted that Mt. Hermon is not included in the first volume of *Flora Palaestina* (Zohary 1966). Paul Mouterde (1966), the author of the *Nouvelle Flore du Liban et de la Syrie*, recognized the specificity of the Kotschy collections but mistakenly defined the oaks of Mt. Hermon as a subspecies of the Persian oak, *Q. brantii* Lindl., that is not found in Western Syria or Lebanon (see also, Browicz 1982). This mistake is repeated in the *Illustrated Flora of Lebanon* (Tohmé and Tohmé 2007).

Avishai (1971) recognized *Q. look* Kotschy as a valid taxon, but this opinion was not accepted at the time. Zohary (1976) and Shmida and Livneh (1979; 1981) mention *Q. cerris* and *Q. libani* but not *Q. look*. Shmida and Livneh mention the plants from Mt. Hermon as *Q. libani* subsp. *libani* although no subspecies are known for *Q. libani* and therefore the use of this autonym is incorrect. Avishai (1982) described *Q. look*, the Mt. Hermon oak, however the description was short and based on insufficient material. Yu. L. Menitsky (2005), among the outstanding modern oak researchers, regarded the plants from Mt. Hermon as a "montane hybrid" between *Q. ithaburensis* and *Q. libani*, although

Photos 3/ *Quercus boissieri* (Golan Heights).

9. Today consdiered a synonym of *Q. look*.



Photos 4/(a) *Quercus calliprinos* (Mt. Hermon); (b) *Q. ithaburensis* (Jerusalem Botanical Gardens); (c) *Q. macrolepis* (Jerusalem Botanical Gardens); (d) *Q. look* (Jerusalem Botanical Gardens).

Photos 5/ *Quercus cerris* (Mt. Hermon).

neither species are present today on Mt. Hermon. Feinbrun-Dothan and Danin (1991) described the plants from Mt. Hermon with features of, and illustrated as, *Q. libani.*

Quercus look in the genus

The genus *Quercus* comprises 450 to 500 species of plants essentially limited to the Northern Hemisphere. The collection established in 1965 and maintained since then at the Jerusalem Botanical Garden, reflects well the great diversity and the evolution of the genus from tropical evergreen plants with annual or biennial ripening acorns and lanceolate leaves to deciduous plants with divided or pinnate-partite leaves. Evidence for the antiquity of these evolutionary processes can be found in a fossil species similar to *Q. cerris* dated to the Middle Miocene (Song et al. 2000). The genus is definitely known from the Middle Eocene period (Hubert 2014) in all parts of the Northern Hemisphere including Greenland (Grimmsson et al. 2015).

New molecular research about oaks shows that they originated during the Eocene during which time they occupied the northern half of the globe. The disappearance of the land bridges that existed at the time, between Alaska and Siberia and between Alaska, Iceland and Europe, simultaneous with the mountain building processes in Eurasia along with the growing impact of the cooling and desiccation in the Tertiary and Quaternary resulted in the genus evolving with two primary centers of diversity: 1. in Southeast Asia (Taiwan, Southwest China, Vietnam and Myanmar); and, 2. in North America and western and southern Mexico. From these, developed secondary centers: from the Southeast Asian center, a secondary center in Southwest Asia and the Mediterranean basin, and from the North American and Mexican center evolved the secondary centers in the Southeastern US and California. In each of these the species as we know them today developed. The oak

Photo 6/ *Quercus look* on Mt. Hermon at 1,650 m.

collection at the Jerusalem Botanic Garden contains many species that evolved in the Mediterranean and Californian secondary centers. Material from the Garden as well as from wild collections on Mt. Hermon has contributed to recent molecular studies.

From the store of ancient forms on Mt. Hermon today one finds *Q. calliprinos* (the Kermes oak) at elevations up to 1,300 m. With its evergreen foliage and biennial acorn maturation, this species does not tolerate the winter temperatures of higher altitudes. The outstanding drought resistance of *Q. calliprinos* has made it a characteristic plant of the Mediterranean maquis.

The two species that evolved with frost hardiness and that today grow on Mt. Hermon above 1,300 m are deciduous: *Q. look* and *Q. cerris*, forms of which are known from the Middle Miocene (Song et al. 2000). Witness to their antiquity is the number of species in section *Cerris* (and among them also the "true" *Q. libani* from Northwest Syria and Turkey) which occur today (albeit discontinuously) from China to North Africa. Species of the group (among them *Q. cerris* and *Q. look*) need a cold (but not too cold!) winter and more rainfall. In Southwest Asia, *Q. look* belongs to a smaller secondary grouping within the section. This comprises *Q. libani* in the traditional sense, which occurs from Kurdistan, Southern Turkey to Northwest Syria (but not in Lebanon) and *Q. trojana*, occurring from southwestern Turkey to the southern Balkans and southern Italy. Comparison of leaf shapes, ecophysiology and phylogenetic data support this assumption.

There exists on Mt. Hermon another species of oak with annually ripening acorns, *Q. boissieri*, that ripen in autumn before the onset of winter frosts. However this species represents a different, apparently earlier evolutionary line: section *Quercus*.

During the last Ice Age (the Pleistocene) there was a glacier on Mt. Hermon and Mt. Lebanon (Hughes et al. 2006). After

the retreat of the glacier, Mt. Hermon constituted the southern-most border of oaks in the Near East – as has been proven by fossil pollen analysis in more northern ranges (Bottema 1975; Butzer 1958; Langgut 2011).

Q. look represents a number of closely related oaks that once were common in all Eurasia from China and Northern India to Southwest Asia, and from the Balkan Peninsula to Spain, Portugal, and North Africa. The establishment of the desert biome in Central Asia (Akhemetiev and Beniamovski 2009; Akhemetiev et al. 2012) disrupted this continuity and replaced it in Southwest Asia where today we find a chain of mutually exclusive species including *Q. look*.

	Q. calliprinos	*Q. boissieri*	*Q. cerris*	*Q. libani*	*Q. look*	*Q. ithaburensis*
Fruiting period	18 months	6 months	18 months	18 months	18 months	18 months
Apical stipules	Deciduous	Deciduous	Persistent	Deciduous	Deciduous	Persistent
Seasons tomentum	Glabrous	Glabrous	Tomentose	Glabrous	Glabrous	Tomentose
Fruit ripening month	December	October	September	October	October	October
Scale Shape	Lanceolate	Ovate – adpressed	Filiferous-divergent	Rhomboid-adpressed	Rhomboid-adpressed	Broad-linear reflexed
Cup cover	Half	Low quarter	Half	Enclosed	Half	Half
Juvenile foliage	Wavy	Dentate	Wavy-partite	Wavy-partite	Wavy-partite	Wavy-partite
Acorn shape	Ovate	Oblong-ovate	Ovate-acuminate	Barrel-shaped	Barrel-shaped	Ovate-acuminate
Evergreen/ deciduous	Evergreen	Deciduous	Deciduous	Deciduous	Deciduous	Deciduous
Blade indumentum	Glabrous	Short-floculous	Stellate-tomentose	Glabrous	Glabrous	Hard stellate tomentose
Blade shape	Orbiculate-oblong	Obovate	Obovate	Narrow lanceolate-incised	Broad-lanceolate dentate	Obovate-lyrate
Blade texture	Sclerophyllous-hard	Soft	Hard	Soft	Soft	Hard
Secondary vein no.	4 - 5	6 - 8	6 - 8	11 - 13	6 - 8	7 - 9
Blade margin shape	Round	Crenate	Pinnate-partite	Serrate	Biserrate-Incised	Dentate
Mucro type (= pointed to aristate extension of the secondary vein beyond the blade margin)	Short-spiny	Pointed	Missing	Hard-aristate	Short -aristate	Hard-aristate

Table 1/ Distinctive features of 6 oak species found in Israel, on Mount Hermon, and on Mount Lebanon.

Analytical Key for the Identification of Oaks from Israel, Lebanon and Syria

1. Evergreen trees or shrubs; leaves hard, round to oblong, secondary veins of blade terminating in short, hardened or spiny mucro..... *Quercus calliprinos* Webb

- Deciduous trees; leaves soft, obovate to oblong, crenate or lanceolate, serrate to pinnatipartite; cupule scales ovate, tightly adpressed or scales filiform-narrow linear or rhomboid; acorn half - covered 2

2. Leaves obovate to oblong, crenate, flocculose or glabrous beneath..... *Quercus boissieri* Reuter
- Different plants.....3
3. Mature leaves narrow lanceolate, serrate; cupule scales all rhomboid, tightly adpressed. Acorn barrel shaped .....*Quercus libani* Olivier
- Mature leaves orbicular or broad lanceolate, stellate tomentose or glabrous..... 4
4. Leaves glabrous, broad lanceolate, dentate, young ones undulate, pinnatipartite; cupule scales all reflexed .....*Quercus look* Kotschy
- Leaves stellate tomentose, obovate, orbiculate, pinnate or pinnatipartite..... 5
5. Cupule scales all narrow filiform, diverging in all directions .....*Quercus cerris* L.
- Cupule scales broad linear, all uniformly reflexed ..... *Quercus ithaburensis* Decne.

Conclusion

Current data, including the study of materials in the National Herbarium at the Hebrew University of Jerusalem, observations in different herbaria and of the plants cultivated at the Jerusalem Botanical Garden, field collections, and the results of recent phylogenetic and molecular studies (Fitzek et al. 2016), suggests that Kotschy was correct and that *Q. look* is a valid taxon distinct from other species. It is an important element of the open deciduous mountain forest at 1,500-1,900 m on Mt. Hermon, Mt. Lebanon and the Anti-Lebanon Mountains.

Quercus look is endemic to the high slopes of Mount Hermon, Mount Lebanon and the Anti-Lebanon Mountains, and must be considered a relictual endemic from cooler and moister times in geological past. The specimens found on Mt. Hermon often present multiple stems from a single rootstock, and dwarf, shrubby growth forms, indicating that these trees have survived felling and damage from grazing by animals. Hopefully, in this presently protected area, these trees will be able to develop and thrive for the future.

Photo 7/ *Quercus look*

Quercus look Kotschy in cultivation

FRANCE

Arboretum de la Bergerette (St.-Sardos, Tarn-et-Garonne)

From two acorns of *Q. look* obtained from Michael Avishai in September 2004 one seedling was raised, and was planted out in March 2008 in an area of the Arboretum which had only recently been purchased and that unfortunately transpired to be a band of very poor soil. It was thus slow to make progress, and is at present only 2.6 m in height, although starting to make a little more headway now with annual growths of around 50 cm. The plant is fully exposed in an open grassy area on a north-facing slope, and is deciduous (albeit marcescent) even in mild winters. Since planting it has been subject to a minimum of -13 °C, and one year with only 380 mm rainfall (normal average is 600 mm per year) without supplementary watering.

Arboretum des Pouyouleix (St.-Jory-de-Chalais, Dordogne)

Q. look APO 562, APO 1048, APO 1911. The first specimen, 562, was grown from acorns received from Michael Avishai in 2004, collected from a tree in the Jerusalem Botanic Garden. The remaining 2 were grown from seed received in 2006 (1048) and 2009 (1911) collected by Michael Avishai from the type location on Mount Hermon in 2006. The seedlings were planted out in 2006, 2008, and 2013, measuring, 562: 24 cm, 1048: 11 cm; and 1911: 13 cm. Today, they measure 46 cm (multi-stem); 70 cm (single stem); and 75 cm (single stem), respectively. These plants are certainly not fast growers, but, except for the first one (562), are quite healthy with very nice foliage in season. The first two went unscathed during the very long cold spell of February 2012, when we had nighttime temperatures of -18 °C, and daytime temperatures never above -8 °C. The specimens 562 and 1048 are planted in the same area, where the soil is relatively deep and fertile, while the third one (1911) is planted on a northwesterly-facing slope in poorer soil, though with better drainage. Average annual rainfall is roughly 900 mm. Summer temperature highs are in the mid- to upper 30 °C, and winter lows at night are generally not lower than -4 °C, with diurnal temperatures generally above zero.

Arboretum de Jean-Louis Hélardot (Brive-la-Gaillarde, Corrèze)

Plant received from Béatrice Chassé in 2008, grown from seed collected by Michael Avishai in 2006 at the type location on Mount Hermon. It was planted in 2008 and measured 20 cm. In February 2017 it measured 3.5 m and is very healthy. It is planted on a south-facing slope, in non-calcareous, clay soil that is very heavy in winter and dry and compacted in summer; pH is neutral. The climate is generally continental with wet winters and dry, hot summers. This plant survived the weeklong cold spell of February 2012 during which nighttime temperatures were as low as -18 °C (and during the day not much higher) with no apparent damage.

GERMANY

Arboretum Kruchten (Kruchten, Rhineland-Palatinate)

Q. look 040924-01-1 and 040924-01-2. Trees raised from three acorns received on September 24, 2004 from Michael Avishai during a meeting in Paris. The acorns were collected at the type location on Mount Hermon. All three acorns germinated in 2005 and one seedling was given away. The two remaining plants were grown in a cold house during the first year and then outside in 3-litre pots for three years after which they were planted out in 2009. The site is at 335 m altitude, with annual rainfall of 650 mm. The soil is loam, dolomite, shallow skeleton rich marl with a pH of 6.8-7.0. The lowest temperatures since planting were in February 2012 (the coldest February in 30 years) with temperatures of -15 °C and -21 °C during 12 days. The plants suffered no frost damage at all. They have attained heights of 160 and 130 cm. They are remarkably uniform in growth: both single stemmed, multi-branched, and very healthy without any sign of disease or leaf scorch. The leaves are marcescent. No fructification yet. During the very hot and dry spring and summer of 2015 and 2016 with temperatures of 40 °C, there was no leaf damage or sign of water stress. All in all, one of the superior oaks of section *Cerris* on that location (not in terms of growth, but in terms of healthiness, draught resistance and overall appearance).

Photo 8/ Young leaves of *Quercus look* at Arboretum Kruchten.

ISRAEL

Jerusalem Botanical Garden

The Garden has two *Q. look* trees growing in close proximity to one another that were planted during the winter of 1981/1982. The trees were raised from seed collected by Michael Avishai in 1977 on Mount Hermon at 1,800 m. The seedlings were progressively

transplanted from small to larger containers until planting out. Today the trees average about 13 meters in height and fruit well. To date, no pests have been observed in nature or under cultivation. These accessions are part of an ongoing research project that deals with the taxonomy and geography of Near Eastern and other oaks. The site is on deep, heavy, alkaline Rendsina loam, on a moderately west-facing slope. During the first five years the trees were watered manually, since then weekly drip irrigation is used. While the local average rainfall in Jerusalem used to be about 560 mm, in recent years there has been less, with average annual precipitation being only about 400 mm. Absolute minimum temperature is about -11 °C.

UNITED KINGDOM

Chevithorne Barton (Tiverton, Devon)

Q. look 037.2013A. The plant was purchased from Waasland in 2003. It is growing vigorously although planted in a damp area. It has reached a height of 2.9 m, with a girth of 82 mm.

Gredington Park (Whitchurch, Shropshire)

Q. look 2007-394. Grafted plant acquired from John Gammon (Birchfleet Nurseries) in 2007, planted out in 2013. The soil is neutral clay, some of it heavy but generally draining well, partly down to a small glacier-gouged lake. Rainfall is about 750 mm a year and the mean annual temperature is around 10 °C. The tree is today about 2.5 m tall, and growing reasonably well with no signs of die back.

Sir Harold Hillier Gardens (Romsey, Hampshire)

Q. look 2003.0955. Plant raised from seed collected in 2003 by Ori Fragman-Sapir and Michael Avishai. The tree is planted in the area known as Lower Brentry where the soil is composed of “green sand” (formed in ancient marine environments, rich in organic detritus and low in sedimentary input). Measured in June 2015, the tree was 2.21 m tall.

UNITED STATES

Aiken Citywide Arboretum (South Carolina)

Photo 9/ *Quercus look* at the Aiken Citywide Arboretum (South Carolina).

Two plants of *Q. look* raised from seed received from Béatrice Chassé, in 2006, collected by Michael Avishai from the type location. One is still in a container, the other has been planted for several years. It was planted along with 8 other species of oak in full sun with ample space in 2011. Soil is sandy loam and well drained. All the trees are mulched with rubber mat mulch rings and kept free of weeds with occasional spraying around the mulch ring with glyphosate. The other species

Photo 10/ *Quercus look* at The Bartlett Tree Research Laboratories and Arboretum (North Carolina).

are *Q. pumila*, *Q.* ×*undulata*, *Q. similis*, *Q.* sp. (Mexico), *Q. pyrenaica*, *Q. garryana*, *Q.* ×*warei*, *Q.* ×*heterophylla*, several of which are today about 4 m tall. The *Q. look* is a multi-stemmed, healthy plant but the slowest grower of the group, having reached only about 76 mm.

The Bartlett Tree Research Laboratories and Arboretum (North Carolina)

Plant obtained at Woodlanders, Inc. (South Carolina) and planted in 2002. Information as to the origin of this plant is not available. The tree is reported to be about 3 m tall and in good health, growing in full sun, in sandy clay loam. It is mulched nearly every year, fertilized now and then, and watered when needed. The climate is characterized by hot, humid summers and mild winters.

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Photographers. Title page: Ori Fragman-Sapir (*Quercus look*, leaves and flowers). Photos 1, 2a, 3-7, 11: Ori Fragman-Sapir. Photo 2b: Jo Bömer. Photo 8: Eike Jablonski. Photo 9: Bob McCartney. Photo 10: Greg Paige.

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Photo 11/ *Quercus look* (left) with the characteristic columnar shape and *Q. boissieri* (*Q. infectoria* subsp. *veneris* (right) on Mount Hermon.

New Oak Cultivars 2017

Ryan Russell[1*] and Eike J. Jablonski[2]

1. Fulton, MO 65251, USA
**corresponding author: ryan.russell@como.gov*

2. LTA, Dept. Horticole, Arboretum
L-9001 Ettelbruck, Luxembourg
eike.jablonski@education.lu

ABSTRACT

The International Oak Society was appointed by the International Society for Horticultural Science (ISHS) as International Cultivar Registration Authority (ICRA) for the genus *Quercus* in 1998. Guidelines for oak cultivar registration can be found at oaknames.org, the International Oak Society's searchable taxonomic database that includes all names of botanic taxa and registered cultivar and Group names. This database is also accessible through the IOS home page at internationaloaksociety.org. Three new oak cultivars are described here, all from North America: *Quercus* ×*warei* T.L. Green & W.J. Hess **'Riverbank'**, *Quercus alba* L. **'Pathfinder',** and *Quercus* ×*schuettei* Trel. **'Silver Shadow'**.

Keywords: ICRA, *Quercus* cultivars

Photo 1/ *Quercus* ×*warei* 'Riverbank'

Introduction

The International Oak Society was appointed by the International Society for Horticultural Science (ISHS) as International Cultivar Registration Authority (ICRA) for the genus *Quercus* in 1998. The system of ICRAs aims to promote stability in the naming of cultivated plants by publishing lists of authenticated names in a number of important groups of plants which are commonly cultivated (Trehane 2005).

The registrars of the International Oak Society are responsible for registering, updating and locating new selections of oaks throughout the world. The majority of these come from North America and Europe. New cultivars are selected for a variety of reasons, including fall color, unique foliage, habit, form, or fruiting characteristics. These cultivars come to us in many ways. Some are notified to us by their originators through the registration link on the IOS website, others must be tracked down individually, and these can be cultivars for which patents or trademarks have been registered.

A selection which is represented by a single plant in a collection or nursery is not a cultivar; it is just a single specimen. A cultivar is a taxonomic unit made up of a number of plants with the same set of characters. Therefore, a single selected plant needs to be (vegetatively) propagated to obtain a certain number of identical plants. The number of new oak cultivars selected or raised by nurserymen or collectors, or originating in botanical collections has risen

rapidly over the last few years. The ICRA registers cultivar or Group names, describes the new cultivar and maintains records of the origin, characteristics, and history, without judgment of the value or distinctness of the cultivar. This is up to the breeder or finder of the cultivar.

Guidelines for oak cultivar registration can be found at oaknames.org, the International Oak Society's searchable taxonomic database that includes all names of botanic taxa and registered cultivar and Group names. This database is also accessible through the IOS home page at internationaloaksociety.org.

The cultivars described here are accompanied by herbarium specimens, that have been deposited as Standard Specimens in the Harold Hillier Herbarium (HILL) at the Sir Harold Hillier Gardens, the official herbarium of the International Oak Society. The holdings of that herbarium, as well as the living collections, can be consulted online using the search facility at www.hilliergardens.org.uk.

Three new oak cultivars are described here, all from North America: two from Illinois, and the third from Missouri.

Guy Sternberg (Petersburg, Illinois) is a past President of the IOS and Director of Starhill Forest Arboretum. He has introduced several other oak selections into the nursery trade.

Quercus ×*warei* T.L. Green & W.J. Hess **'Riverbank'** (section *Quercus*) New cultivar. Plant fastigiate in form, 18 m tall by 4.5 m wide after 45 years. Twigs tan in color with numerous prominent lenticels. Buds, 0.4 cm long, ovoid, imbricate, brown colored. Leaves: petiole 0.1-0.5 cm long, yellow. Leaf blade obovate, rounded shallow lobes, 5-7 per side, 4-9 cm wide by 8-15 cm long. Lustrous, medium green above, duller below, glabrous, yellow veining. Base acute to rounded, some showing slight auriculate characteristics. Acorns markedly like those of *Q. robu*r: long thin peduncles 6-9 cm, acorn shiny brown, 3-4 cm long, 1.5-2 cm wide, caps thin, tan to yellowish in color, covering 1/3 of acorn. Harold Hillier Herbarium (HILL) No. 8005.

Plant of cultivated origin. Planted as an outcrossed (spontaneous) seedling (thought to be *Q. robur* Fastigiata Group), thought to have originated at Carter Nursery, Ilinois, but no records have been found to confirm this. Selected for its mildew resistance, vigorous growth, and strong upright habit. This selection is also the pistilate parent of 'Windcandle', 'Chimney Fire', and 'Birthday Candle'. Scion wood has been distributed to Pavia Nursery, Deerlijk, Belgium and Forrest Keeling Nursery, Elsberry, Missouri, USA for propagation. The establishment in front of which the seedling was planted was originally a bank. Today, it is a hotel, the RiverBank Lodge and the cultivar name is derived from this.

Quercus alba L. **'Pathfinder'**[1] (section *Quercus*) New cultivar. Twigs, reddish/brown, slender to stout (0.03-0.5 cm), glabrous. Plump ovoid terminal bud, reddish purple, 0.4 cm long. Lateral buds globose to ovoid, 0.2 cm wide, reddish in color. Leaves: obovate, 12-18 cm long, 7-10 cm wide, 10-12 lobes with deeper than average sinus towards mid-rib of leaf blade, with slight forking at apex of each lobe; lustrous medium green, glabrous above, paler or dull green becoming glabrous below; base acute to somewhat rounded; petiole, 1-2 cm long. Acorns typical of species; subsessile on a stout peduncle 0.5 cm long; cups covering 1/4 of acorn, acorns chocolate-brown, shiny, oblong 1.5 cm wide to 3 cm long. Harold Hillier Herbarium (HILL) No. 8006.

Ortet tree found in Menard County, Illinois. This tree was not previously accepted

1. For a detailed account of trail trees in general, and 'Pathfinder' in particular, see Sternberg 2016.

Photo 2/ *Quercus alba* 'Pathfinder'

as a cultivar by the former ICRA registrar, as it lacks characteristics that distinguish it from typical *Q. alba*. However, after discussion with the Horticultural Taxonomy Group (HORTAX) we have been advised that it qualifies as a cultivar according to the International Code of Nomenclature for Cultivated Plants (ICNCP). The ortet tree of this selection was one of the last remaining Native American trail trees known in Illinois that presumably pointed to a low-water crossing of the Sangamon River, an important travel corridor for Native Americans and early settlers. The ortet tree, dated to the 1730s, succumbed to strong winds in 2008, but had been propagated by grafting a few years prior. Plant has been propagated by Pavia Nurseries, Deerlijk, Belgium and Forrest Keeling Nursery, Elsberry, Missouri, USA. Cultivar name honors the presumed role that the tree played in guiding travellers safely across the river.

Ryan Russell (Fulton, Missouri) has been an IOS Board Member since 2012, and is currently Co-Editor of Oak News & Notes, and Taxonomy Committee Chair. He is an ISA Certified Arborist and professional horticulturist.

Quercus ×*schuettei* Trel. **'Silver Shadow'** (section *Quercus*) New cultivar. Plant pyramidal in form, 8 m tall by 5 m wide. Twigs tan brown, stout (0.5 cm), glabrous with numerous lenticels. Plump ovoid terminal bud, 0.4 cm long by 0.5 cm wide, brown. Lateral buds globose to ovoid, 0.2 cm wide by 0.3 cm long, brown. Leaves: petiole yellow,1-2 cm long; obovate, 12-24 cm long, 5.5-14 cm wide at widest point, leaf shape showing affinity towards *Q. macrocarpa*; 11-13 lobes with deep sinus reaching the midrib towards middle of leaf blade; dark lustrous green, glabrous above, finely tomentose and whitish below; base acute to rounded. Acorns intermediate between parent species: peduncle,

Photo 3/ *Quercus* ×*schuettei* 'Silver Shadow'

5-7 cm long, stouter than *Q. bicolor*, cups 3 cm wide by 1 cm deep, covering 1/3-1/2 of acorn with little fringing; acorns rounded, 2.5 cm wide to 3 cm long, falling free from cup. Harold Hillier Herbarium (HILL) No. 8007.

Plant of cultivated origin (estimated at 20 years old) found growing in Columbia, Missouri at the University of Missouri campus. Selected for its clean, lustrous green foliage, flaky, peeling bark, uniform pyramidal growth, and large acorns. Plant has been propagated by originator and Pavia Nursery, Deerlijk, Belgium. Cultivar name describes the white undersides of the leaves that are visible when seen from below or as they are blown about by the wind.

Photographers. Title page: Guy Sternberg ('Pathfinder'). Photo 1: Charles Snyers d'Attenhoven. Photo 2: Guy Sternberg. Photo 3: Ryan Russell.

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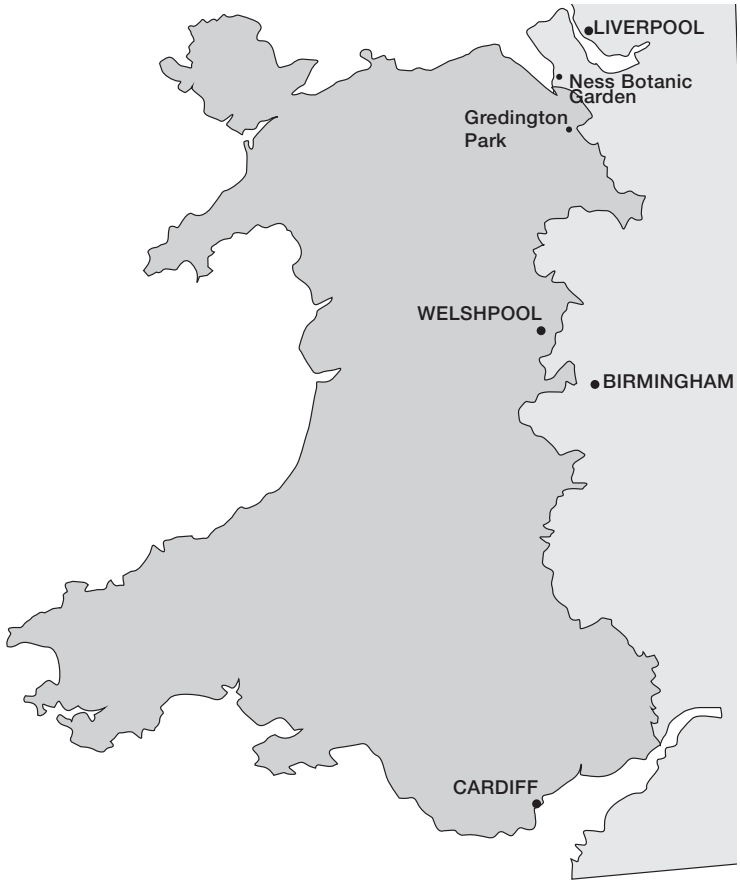
Oak Open Days Gredington Park and Ness Botanic Gardens, United Kingdom July 11-12, 2015

Christopher Carnaghan
Kings Langley, WD4 8EY, United Kingdom
cc@ilex.me.uk



Gredington Park,[1] 11 July

A small but select party of IOS members and friends gathered on a bright but showery day at Gredington Park in North Wales, the home of our hosts (and IOS members) Lloyd and Sally Kenyon, and were struck immediately by the beauty of the site. The house, its formal gardens and park are set in gently hilly country, lying at about 300 ft altitude. The park of some 80 acres was created during the early 19th century from natural oak woodland, as evidenced by a score of fine *Q. robur*, the native English oak, dating from around 1760, and other mature non-oak native species.

Less than 50 miles to the west, the mountains of Snowdonia National Park, rising to 3,600 ft, capture much of the rain driven in by the prevailing west and southwest winds. Precipitation there reaches a near-tropical 175 inches a year; while at Gredington a much more tolerable 30 in, plus a mean annual temperature of around 50 °F, provide a welcoming climate for growing most temperate trees. Abundant lichens on trunks and branches bear witness to the clean air and relatively damp climate.

Photo 1/ The house at Gredington Park.

The higher ground to the west enhances the landscape and takes the bulk of the rain but provides only partial shelter from the winds that test all of the trees, especially challenging the resilience of younger specimens. The soil is neutral clay, some of it heavy but generally draining well, partly down to a small glacier-gouged lake (known locally as a mere). Conditions are good for sheep and a large flock contentedly grazes the parkland.

The planting of oaks in the park began in the mid-1980s, starting with a handful of more common species like *Q. rubra* to complement the established *Q. robur.* They have grown well, gracing the slopes of the park close to the formal gardens, and stand witness to the affinity of most hardy oaks to the site. Lloyd's first major development of the arboretum was in 2003, largely thanks to a generous selection of acorns acquired at the International Oak Society conference in Winchester that same year. Since then he has planted more extensively and his collection now boasts about 275 taxa, with roughly 1/3 cultivars

1. For more information on the oak collection at Gredington Park, see Haddock 2015.

Photo 2/ Numerous very old and magnificent *Quercus robur* add majesty to the landscape.

and 2/3 botanic taxa (species, subspecies, and hybrids).

The saplings, many on more exposed slopes, are initially staked to help resist the wind, and they are enclosed by sturdy wire tubes to protect them from the sheep and rabbits. Lloyd manages his collection with DEMETER, the database application developed – with Lloyd's help – by Plant Heritage. DEMETER users can link photos, documents, and record descriptions of each plant. It can be used at a basic level just to record the plant's name, its source, date of acquisition and location in the garden and then more detail can be added as required.

Photo 3/ Part of the formal gardens.

Lloyd's impeccable labels are developed from the database and then printed on a Brother printer on plastic tape (18 mm wide) developed for use on oilrigs in the North Sea. The plastic labels are then affixed to 20-mm-wide aluminum strips. The labels include name and accession number, hybrid formula where necessary, as well as distribution information. As the park is freely grazed by sheep, each tree is surrounded by a metal cage, ideal for supporting the labels that are screwed on using a backing plate. Once the trees are large enough for the cages to be removed, a rubber string is passed through the screw holes and tied around the tree, allowing for several years of expansion with no damage to the tree.

The trees are generally healthy, with no incidence as yet of *Phytophthora ramorum*

(the agent responsible for Sudden Oak Death) or Acute Oak Decline[2], both now troubling British foresters. A few younger specimens – e.g., *Q. buckleyi* 'Carlsbad' – were suffering from dieback (maybe Chronic Oak Dieback?[3]), but this was rare. According to Lloyd, there is some defoliation by insects in the spring but it is of no consequence. The oak processionary moth, another recent and unwelcome immigrant to the UK, is fortunately absent.

A model nursery

If you were a baby oak tree and could choose what nursery you would like to grow up in, you would be well advised to choose Lloyd's. Impeccably cared for, bursting-with-energy seedlings and saplings wait their turn to enter the park. Lloyd raises many of his oaks from seed, much of it obtained via the IOS as well as from the expeditions he has helped to finance over the years as a long-standing member of a dedicated group of quercophiles (of which the late Michael Heathcoat Amory was a driving force). After germination the young oaks are potted on progressively, finally into air pots, the soil enriched with mycorrhizal fungi (in tablet form) but no bone meal or other fertilizer. If more proof were needed, here at Gredington it can again be shown that automated watering in the nursery is a boon for busy gardeners!

Photos 4a-b/ The polytunnel and nursery.

There are a bunch of oaks, rare in cultivation, in Lloyd's nursery – wonderful things like *Q. championii*, *Q. crispipilis*, *Q. daimingshanensis*, *Q. delgadoana*, *Q. inopina*, *Q. invaginata* – that are all in excellent health but Lloyd is hesitant about planting them outside, "When you have only one of something and you are almost certain that planting it outside is a death sentence, is there an alternative?" Lloyd has found an alternative for one of his *Q. insignis*: after testing it in North Wales with regrettable though understandable morbid results, he has donated one to Kew for their new temperate house which is to be inaugurated later this year.

2. Acute Oak Decline is a disease that appeared about 35 years ago affecting mainly native oaks in Britain. The responsible pathogens are not known exactly.
3. A complex disorder or syndrome implicating several damaging, interacting agents that cause serious decline in tree conditions.

Both Lloyd and Sally are long-standing and very active members of the IOS and so it may come as a surprise that, yes, they are also interested in other plants! In addition to the fine oak collection, Lloyd and Sally hold National Collections of *Viburnum, Geum, and Sarcococca*. The *Viburnum* collection, comprising about 230 taxa, some very rare, is housed in a beautiful old walled garden (well worth a visit even for oak lovers!). Gredington also hosts a fabulous kitchen garden of which Sally is the *maîtresse d'oeuvre*.

Photo 5/ *Quercus insignis* in the nursery.

The arboretum

Armed with Lloyd's detailed planting list, it was, as always, intriguing to compare growth rates and speculate on the reasons for the varied progress of specimens of the same age, some indeed planted on the same day. With so much space available Lloyd can plant plenty of specimens of the tried and tested species that can be relied upon to grow well to help provide shelter for the less hardy. These include, in addition to the many *Q. robur* (including over twenty cultivars) and *Q. cerris* (half a dozen cultivars plus a couple

Photos 6/ (a) In the *Viburnum* collection; (b) *V. lanata* 'Aureum'.

Photo 7/ *Viburnum erubescens*

of *Q.* ×*libanerris*), 17 *Q. imbricaria*, 11 *Q. shumardii*, 9 *Q. aliena*, and 9 *Q. coccinea* 'Splendens'.

Another good "mini-collection" is that of *Q. dentata*, the well-known daimyo oak, represented by seven examples of the species, one of the rarer *yunnanensis* subspecies, and two cultivars, 'Carl Ferris Miller' and 'Sir Harold Hillier'. It's well known that the young growth of this handsome Far-Eastern oak is susceptible to the late frosts that can strike well into spring in the UK, and consequently it is not widely grown; even those in botanic gardens are typically small and tending to the shrubby, and occasionally rather sad. So planting them is something of a leap of faith, which in Gredington – with less exposure to killing late frosts – has so far been well rewarded.

Quercus ×*hispanica*, that generally does well in the UK, and Gredington's many specimens are no exception, was first raised in around 1763 from seed of *Q. cerris* that had been pollinated by *Q. suber*. Although the name, published by Lamarck, was given to trees growing in the gardens of the Trianon at Versailles, the first cross would appear to have originated in England, raised by the Exeter nurseryman Lucombe – hence 'Lucombeana', and was widely distributed as a grafted plant. The seed of this cultivar produces offspring with varying degrees of corkiness in the bark and evergreen-ness depending on the predominant parental genes. Altogether Lloyd has six cultivars including 'Fulhamensis', an early clone, and more recent selections including 'Waasland Select' (a renaming of 'Waasland', to prevent confusion with other selections from the Arboretum Waasland in Belgium). Although still listed under *Q.* ×*hispanica*, the bark and acorns of 'Waasland Select' are more akin to *Q. ilex*, just to add to the confusion. To appreciate fully the complexity of the cross – and particularly if you enjoy detective stories! – it is worth reading with a clear head, on steam-driven pages (or now online thanks to the IDS) the pertinent section in Bean's, *Trees and Shrubs Hardy in the British Isles*. Then apply cold compress to head... *Quercus coccinea* 'Splendens', an Eastern American oak is doing, well, splendidly. *Quercus pubescens* 'Aydin', growing very nicely at Gredington, is a bluish-leaved form of the species, that was found by Eike Jablonski and Dirk Benoit during the 2002 IOS Tour of Turkey. The name honors Aydin Borazan who sadly passed away only three years after he had accompanied the Tour. *Quercus look*, a distinctive Asian oak, is grafted and, according to Lloyd, "not one of the remarkable oaks in the

collection, though it has grown to 8 ft, and has the potential of forming a good specimen once, or if, it gets going."[4]

In such a large and varied collection each of the visitors will have had particular favorites. The writer found much of interest, including a *Q. castaneifolia* 'Green Spire', noted by Lloyd as a trouble-free good grower making a nice shape and demanding no attention growing not far from a *Q. nigra*, planted on the same day in 2004 which is rather shrubby and has grown to about 15 feet. A lovely specimen of *Q.* ×*haynaldiana (Q. frainetto* × *robur*) 'Crisnetto', with its small dense bunches of leaves deserving to be modeled in stone or wood and a *Q. robur* 'Menhir' (provisionally accepted), stout, sturdy and almost fastigiate in form, much like its stone eponym.[5]

Photo 8/ *Quercus pyrenaica* 'Pendula'

Photo 9/ *Quercus castaneifolia* 'Green Spire'

Amongst the more recent introductions, Gredington has residents from Mexico, including the very elegant *Q. acherdophylla*, *Q. grahamii* (grown as *Q. acutifolia*) and the vigorous hybrid between *Q. grahamii* and *Q. mexicana*. *Quercus canbyi* is, as always, a good grower as are the bushier *Q. greggii* and *Q. miquihuanensis*.

Photo 10/ *Quercus* × *haynaldiana*

Numbers of trees were sporting the bright new foliage called "Lammas growth" (the free growth of newly made leaves put on, in good years, around the Celtic harvest festival of Lammas Day, celebrated on the first of August), notably a young *Q. affinis* with new leaves so richly red they might have passed for those of a photinia and a fine *Q. rysophylla*, planted in 2003 that has attained a height of 25 ft. It has done exceptionally well, after a bad hit from frost in the winter of 2010/11 it recovered strongly, now with no sign of having lost its top. With rather long petioles,

4. For a detailed account of this taxon see Avishai 2017, this volume, pp. 73-88.
5. A menhir is a massive standing stone, as erected by the native Celts in pre-Christian times.

Photo 11/ ***Quercus sartorii***

Lloyd suspects that it might be a hybrid, not unlike a similar fine specimen at Chevithorne Barton identified as a hybrid by Allen Coombes.

Ness Botanic Gardens, 12 July

The following day several members of the group visited the Ness Botanic Gardens – some 30 miles to the north, where we were welcomed and guided by Ness botanist Tim Baxter, who generously gave up a Sunday morning with his family to guide us. While not rich in oaks Ness is nonetheless deserving of attention because of its wide range of unusual and interesting woody plants, a large number grown from wild-collected seed.

The original garden was created in 1898 on the Wirral Peninsula, lying close to Liverpool between the estuaries of the Dee and the Mersey. The soils vary markedly from acid and sandy but well-drained to lime-rich clay. As at Gredington the moist southwesterly winds, although partly screened by the mountains of North Wales, deliver annual rainfall of about 30 in and blow briskly throughout much of the year.

The creator of the garden was Arthur Bulley. A wealthy cotton merchant, he was passionate about plants, especially those being introduced to European gardens from China, Tibet and Nepal by Western collectors, both amateur and professional. Initially obtaining seeds from diplomats and other travellers, he went on to lavish much of his fortune on his new garden, and – perhaps more importantly for posterity – on sponsoring professional plant collectors in the Far East, notably George Forrest and Frank Kingdon-Ward. Bulley also established Bees Seeds in order to distribute widely many species new to British gardeners. Bees grew apace to become a household name, eventually supplying one third of all the flower seeds sold in the UK.

Bulley's particular interest was in herbaceous plants, the rarer the better, and he also evidently liked shrubs (there is a splendid *Pieris formosa* 'Forrestii' grown from seed

originally collected by Forrest in China), but he seemed less interested in other woody plants; or perhaps his collectors brought back fewer trees and climbers that were new or rare in cultivation.

To protect his new plantings Bulley created deep shelter belts of more common trees and shrubs, including fine specimens of *Quercus ilex* and *Q. rubra* which have flourished mightily. While proximity to the Irish Sea already restricts the number and severity of frosts, the shelter belts – reinforced over time – afford further protection for more tender specimens.

After Bulley's death in 1942 his daughter presented the estate to the University of Liverpool. It was some time before the University could afford to remedy the necessary neglect of wartime, let alone expand the gardens or make them more accessible to visitors (Bulley had created many compartments, separated one from another with hawthorn hedges netted against rabbits). Under the leadership of Ken Hulme, appointed as Director in 1957, the ornamental gardens expanded from some two to eighteen hectares, housing new collections of camellias, rhododendrons, azaleas, cherries and heathers.

Regrettably there is no equivalent collection of oaks, although there are some good specimens, including *Q. variabilis* and several of the "usual suspect" US species (*Q. alba, Q. bicolor, Q. muehlenbergii*, and *Q. rubra*), all of these from their most northerly provenance in Ontario, Canada.[6]

There is also an interesting *Q. crispula* with an impeccable northern provenance – not northern England but Japan's northern island of Hokkaido, unusual as it is not necessary to stray north from Honshu to obtain wild seed. Perhaps it's

Photo 12/ *Betula pendula* × *papyrifera* (Ness Botanic Gardens).

6. For a detailed account of the oaks in Ontario, see Atkinson 2015.

just that little bit hardier.

Q. crispula is one of those oaks which has had more aliases than an international criminal (which makes me wonder in turn if oaks have been responsible for any as yet unsolved crimes ...). Blume's original *Q. crispula* (coined in 1851, the year he also confusingly coined *Q. grosseserrata*) was recombined by Menitsky to *Q. mongolica* subsp. *crispula* – the name under which it is grown at Ness – in 1973, whilst Rehder and Wilson had already given it a new name in 1916: *Q. mongolica* var. *grosseserrata*. IOS member Professor Hideaki Ohba, in the Flora of Japan (Iwatsuki et al. 2006) has, thankfully, returned us to the simplicity of Blume's original *Q. crispula*.

From 1972, largely thanks to the enthusiasm and expertise of resident botanist Dr. Hugh McAllister from the University of Liverpool, the gardens were enriched by a wide range of wild-collected trees and shrubs, including much material new to cultivation. *Betula*, *Alnus* and other genera that flourish in cool, moist conditions are well represented.

In particular, up to his retirement in 2010, Hugh selected and planted the extensive range of *Sorbus* that alone justifies a visit to Ness. Now a UK National Collection, there are over 500 taxa, notably including many of the intriguing apomictic microspecies that Hugh himself has documented in his definitive monograph (McAlister 2005).

Acknowledgements

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Participants

Marleen De Muyt, Patrick Vereecke (Belgium); Shaun Haddock (France), Wiecher Huisman (the Netherlands), Christopher Carnaghan, David Gooder, Helena Jamie, Robin Jamie, Des Needham, Gordon Simpson (UK).

Photographers. Photos 1, 3-7, 9-11: Charles Snyers d'Attenhoven (photos taken in 2014). Photos 2, 8, 12: Wiecher Huisman.

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For more information about Ness Botanic Gardens, visit www.nessgardens.org.uk
For more information on Demeter plant recording, visit http://www.nccpg.com
www.nccpg.com/National-Collections/Collection-Holder-Resources/Plant-Records-Software/Demeter-plant-recording-software.aspx

A Tale of Two Islands

Béatrice Chassé
Arboretum des Pouyouleix
24800 Saint-Jory-de-Chalais, France
pouyouleix.arboretum@gmail.com

Introduction

One could easily and convincingly argue that, although Martha's Vineyard and Taiwan are both islands, they do not have much in common. That being said, my visits, nearly back-to-back, to those two places in the autumn of 2015 have linked them forever in my mind. And in fact there is not only a botanical link (Polly Hill's search for the Taiwan endemic *Rhododendron nakaharae* for her arboretum on Martha's Vineyard) but a human one as well (the obsession I share with her for growing plants raised from wild-collected seed in our respective arboreta).

The oaks of Martha's Vineyard

This small island, six km from the southern coast of Cape Cod (Massachusetts), was named Martha's Vineyard by its discoverer, Bartholomew Gosnold, an early 17th century British merchant sailor, because of the abundance of wild vines and to honor his wife's grandmother and his deceased infant daughter, both named Martha (Boland 2011).

A fairly nasty storm that set in just after my arrival in Boston had grounded all of the tiny passenger planes that fly to the Vineyard, obliging me the following morning to take the ferry that leaves from Woods Hole (where eons ago I had an internship, at the Woods Hole Oceanographic Institution). No regrets: if you have never been to Martha's Vineyard, do go the first time by sea. I was welcomed by Tim Boland, Director of the Polly Hill Arboretum since 2004 and long-standing member of the IOS. I am sure it is safe to say he knows every nook and cranny of this island along with all of its plants. We spent

Photo 1/ A view from Menemsha looking northwest across the Vineyard Sound.

Photo 2/ *Quercus alba*

two and a half days hiking around Martha's Vineyard looking at the oaks and enjoying the marvelous scenery under clement skies washed bright blue by the storm.

There are six indigenous oaks present to varying degrees in seven different ecological communities.[1] *Quercus alba* and *Q. velutina* are found abundantly, in both the dry oak forest that occurs on well-drained soils of glacial outwash plains or moraines and in the oak savannahs. *Quercus velutina*, the tallest tree on the island, is also found in the maritime red cedar forest along with *Juniperus virginiana*, which gives its name to this community. *Quercus coccinea*, a rare tree on the island, is found in the dry oak forests as well as in the mesic forests characterized by richer soils, where *Q. alba* can also be found along with *Fagus grandifolia*, *Sassafras albidum*, and *Acer rubrum*. *Quercus stellata*, not abundant here, in one of its most northern

Photo 3/ *Quercus ilicifolia*

1. For a more detailed account of the ecology and history of Martha's Vineyard, see Boland 2011; Ogden III 1961; Swanson & Knapp 1999.

Photo 4/ *Quercus ×fernowi (Q. alba × stellata)*

Photo 5/ *Quercus ×stelloides (Q. prinoides × stellata)*

populations, is found in the sandy-soiled scrub-oak barrens and in oak savannahs. *Quercus ilicifolia*, king of the scrub-oak barrens, shares this stage with the less common *Q. prinoides*, both of which can also be found in the coastal heathlands; *Q. ilicifolia* is also present in the pine barrens that are dominated by *Pinus rigida*.

There are also five hybrids on the Vineyard, *Q. ×rehderi* (*Q. ilicifolia* × *velutina*), *Q. ×faxonii* (*Q. alba* × *prinoides*), *Q. ×fontana* (*Q. coccinea* × *velutina*), *Q. ×fernowii* (*Q. alba* × *stellata*), and *Q. ×stelloides* (*Q. prinoides* × *stellata*). Different individuals of these hybrids are very variable, representing different degrees of introgression. It is interesting to note that the parents of first two, *Q. ×rehderi* and *Q. ×faxonii* are not present together today in the same ecological communities.

The Polly Hill Arboretum today

The Polly Hill Arboretum (8 hectares) is home to the National *Stewartia* Collection as well as other collections including camellias, clematis, crabapples, and magnolias. Throughout the different parts of the Arboretum, innumerable magnificent specimens

of the indigenous *Q. velutina* and *Q. alba* can be found. The non-native oaks that have been planted are primarily from non-wild sources and include *Q. acutissima*, *Q. cerris*, *Q. dentata*, *Q. laurifolia*, *Q. lyrata*, *Q. macrocarpa*, *Q. mongolica*, *Q. montana*, *Q. oglethorpensis*, *Q. variabilis*, *Q. vaseyana*, and *Q. virginiana*.

Photo 6/ *Quercus velutina* at the Polly Hill Arboretum.

According to PHA's dynamic Director, Tim Boland, space constraints limit the development of the oak collection. Of the non-native oaks that have been planted, the best performers so far have been *Q. macrocarpa*, *Q. acutissima*, and *Q. variabilis*. Generally the trees are impacted by the strong winds that occur on the Vineyard, resulting often in trees with multiple leaders and diminished height. Nevertheless, Tim adds, "In an effort to build a conservation collection of oaks, the Arboretum has recently added wild-sourced *Q. acerifolia* and *Q. oglethorpensis* and has plans for yearly trips to collect in the wild in partnership with The Morton Arboretum as part of their Global Tree Conservation program."[2] In addition to these collection efforts, PHA began a research project eight years ago in its natural woodlands (16 hectares) and in partnership with Harvard forest researchers, aiming to assess the species, community, and ecosystem responses to a nearly 50% loss of oak woodlands from insect pests. They plan to publish a report on this study in two years, and the project is expected to continue over several years.

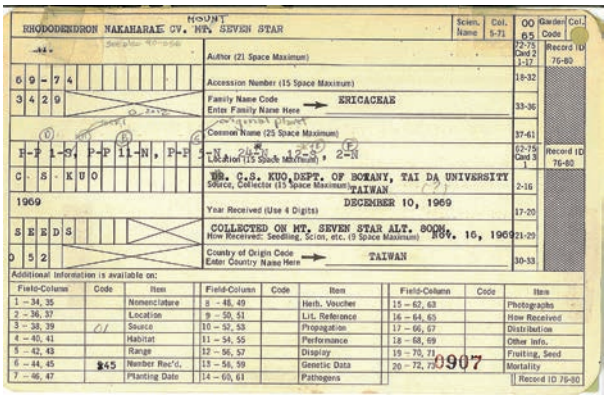
Tim Boland has had a decisive influence at the Arboretum, spearheading projects that have successfully generated the funds needed for the creation of a new greenhouse and nursery facilities, a maintenance building, and an Education Center and Botany Laboratory, of which I saw only the very beginnings of construction and hope to see some day in the future in full throttle.

Polly Hill

In 1926, Polly Hill's parents bought 40 acres of land on Martha's Vineyard in West Tisbury and by 1957, when her mother died, Polly had decided that it was time to have a serious Vineyard garden and that she should be the one to do it. "I was interested to find out how many different things I could grow on the Vineyard if I experimented and took

2. For a detailed account of The Morton Arboretum's *Q. oglethorpensis* conservation efforts, see Lobdell 2017, this volume, pp. 41-48.

Photo 7/ The Polly Hill Arboretum.


RHODODENDRON NAKAHARAE CV. MT. SEVEN STAR

Author (21 Space Maximum)

Accession Number (15 Space Maximum)

Family Name Code
Enter Family Name Here → ERICACEAE

Common Name (25 Space Maximum)

Location (15 Space Maximum)

DR. C.S. KUO, DEPT. OF BOTANY, TAI DA UNIVERSITY
Source, Collector (15 Space Maximum) TAIWAN

Year Received (Use 4 Digits) DECEMBER 10, 1969

How Received: Seedling, Scion, etc. (9 Space Maximum) COLLECTED ON MT. SEVEN STAR ALT. 8000. NOV. 16, 1969

Country of Origin Code
Enter Country Name Here → TAIWAN

Additional information is available on:

Field-Column	Code	Item	Field-Column	Code	Item	Field-Column	Code	Item
1 – 34, 35		Nomenclature	8 – 48, 49		Herb. Voucher	15 – 62, 63		Photographs
2 – 36, 37		Location	9 – 50, 51		Lit. Reference	16 – 64, 65		How Received
3 – 38, 39	C1	Source	10 – 52, 53		Propagation	17 – 66, 67		Distribution
4 – 40, 41		Habitat	11 – 54, 55		Performance	18 – 68, 69		Other Info.
5 – 42, 43		Range	12 – 56, 57		Display	19 – 70, 71		Fruiting, Seed
6 – 44, 45	845	Number Rec'd.	13 – 58, 59		Genetic Data	20 – 72, 73 0907		Mortality
7 – 46, 47		Planting Date	14 – 60, 61		Pathogens			Record ID 76-80

Photo 8/ One of Polly's original record cards.

Photo 9/ *Rhododendron nakaharae* 'Mount Seven Star' at the Polly Hill Arboretum.

some chances." (Graves 2003).

Which is exactly what she did: experiment enormously, taking many chances and, perhaps as importantly, documenting each plant with scientific methodology. Initially on typed cards, she recorded information including name and author, source, date received and in what form, and the location in the arboretum. This aspect of her work was to be the key element that convinced David Smith – a scientist who had developed a vaccine for spinal meningitis that made him a very wealthy man – to invest in and develop the Polly Hill Arboretum in 1996, when Polly Hill was 89 and knew already that none of her children was interested in taking on and continuing her arboretum. David Smith knew nothing about horticulture but after their first encounter in 1996, when he learned from Polly that she had records of all the plants she had ever grown, he began to be interested. His motivation to secure a future for her arboretum stemmed from what he recognized as a shared scientific spirit between them.

Polly's scientific motivation also led her to focus on propagating plants from wild-collected material. She had learned about *Rhododendron nakaharae* from Dr. Tsuneshige Rokujo from Japan, with whom she had been in touch for many years, exchanging plants, seeds, and information. This rhododendron is native to Taiwan, where it is very rare in the wild, but it could (and still can) be found extensively in Japan where it has been successfully propagated since World War II. Polly Hill is recorded as having said, "But I didn't want a

secondhand plant from Japan. I wanted the true wild plants from Taiwan." (Graves 2003). She eventually received seeds, only two of which germinated, and one of those plants died. From the remaining plant that Polly grew successfully she named a cultivar, 'Mount Seven Star', which can still be found in nurseries around the world.

Ilha formosa

As the crow flies there are roughly 17,000 km between Martha's Vineyard and Taiwan. With an extended stop in Ilinois for the 8th International Oak Society Conference in between the two, I arrived in Taiwan on Saturday, 24 October and was greeted by Dr. Fuh-Jiunn Pan and Dr. Li-Ping Ju, both members of the IOS. I had met them during the 2014 Oak Open Days at the Trompenburg Tuinen & Arboretum (Benoit 2015), at which time we discussed the possibility of a visit – originally intended for 2014 but postponed due to very bad weather in Taiwan that year.

In numerous books and websites, one can read that a Portuguese expedition, on its way to Japan in 1542 (in some sources, 1544) noting the incredibly beautiful scenery and luxuriant vegetation of Taiwan, called it *ilha formosa* (beautiful island). Try as I have, I have not been able to find the original source for this piece of information, only that a Portuguese expedition commanded by Diogo de Freitas arrived in Japan for the first time in 1542 or in 1543 (Newitt 2005).

Photo 10/ Ilha formosa, the beautiful island of Taiwan (between Chishang and Xiama).

Although today there is no oak named *Quercus formosana*[3] or *Q. taiwanensis*, there are many extraordinary oaks, as well as numerous members of the family Fagaceae, on this beautiful island, which I set off to explore with different individuals who all have in common their enthusiasm for, and knowledge about, the Fagaceae of Taiwan.

Geography and geology[4]

This 400-km-long/140-km-wide island with an area of 35,800 square km, is situated along the fringe of the continental shelf of Asia on the western border of the Pacific Ocean and near the boundary of the Holarctic and Paleotropical floristic kingdoms. It is part of an intermittently submerged chain of mountains that runs from the Kuriles in the north to the Indo-Malaysian Archipelagos in the south. The chain is situated along a zone of instability in the earth's crust, bordered by marked oceanic depths and crustal subduction zones to the east and shallow seas to the west. The highest mountains between the Himalayas and the Sierra Nevada are in Taiwan, as are the highest sea cliffs, in some places more than 600 m, dropping at dramatic right angles to the sea.

The most striking feature is the Central Mountain Range – with 48 peaks over 3,300 m – which runs from north to south for nearly the entire length of the island. This mountain range actually consists of several parallel ranges that, amongst other things, determine how and where one can get from one side of the island to the other. In addition to this Central Mountain Range, there is an Eastern or Coastal Mountain Range that runs from Hualien to Taitung, of much lower elevation and volcanic in origin, presenting numerous hot springs. The eastern side of the island is very rugged and rather less populated than the western side, which is relatively flat and fertile thanks to the numerous streams and small rivers that carry sediment from the mountains and create alluvial plains. Different attempts at "cross-island highways" have been made but due to routine flooding and typhoons these are difficult to maintain. Large sections are often closed to traffic. Being mountain roads, they are more often narrow than wide; it is incredible to see how road crews maneuver in the very limited space available for their machines and themselves. I think it is not excessive to say that the two things one most frequently encounters in Taiwan are road-repair works and…*Quercus glauca*.

Photo 11/ "Mountain plumbing", to distribute the flow of water and prevent it from cascading in concentrated areas.

As in other parts of Eastern Asia, the dominant winds are from the northwest and, while these have little effect on the tropical temperatures, both the northwestern and southeastern monsoons have a phenomenal effect on precipitation. Average annual rainfall in Taiwan is a number that is difficult to ascertain, varying greatly from one author to another: about 2,500 mm

3. What used to be called *Q. formosana* Skan is today *Lithocarpus formosanus* (Skan) Hayata.
4. This background information has been adapted from Li 1963.

according to some,[5] and more than 4,000 according to others (Li 1963). At any rate, averages, generally not very useful, are in this case absurd: in some areas precipitation can be as much as 10,000 mm a year, while in others not more than 1,000 mm (Li 1963). In addition, some typhoons have been known to bring as much as 2,000 mm in the space of 48 hours. Erosion is understandably a severely critical problem in Taiwan. Over and above repairing damage, a large part of the roadwork is devoted to what I would call "preventive mountain plumbing".

Photo 12/ From left to right, Mike Chen, Fu-Che Pan, Ai-Gung Dung, and Béatrice Chassé having lunch in Ma Sa Lu.

In the introduction to his monumental *Icones Plantarum Formosanarum nec non et Contributiones Ad Floram Formosanam,* Hayata (1911) puts the total number of species on the island at 2,660, representing 109 families and 836 genera. By the time the tenth and final volume was published in 1921, those numbers had increased to 3,658 species, 1,197 genera, and 170 families (Hayata 1921). In 1936, according to Masamune (1936) the number of plants known in Taiwan was 3,841, representing 190 families and 1,174 genera. Hsieh (2002) brings the total number of species to 4,077, divided between 233 families and 1,389 genera. Li (1963) estimated that 40% of the species on the island are endemic, and though that number has fallen today to slightly less than 30% (Hsieh 2002), readers be warned: endemic is a word that you will be tired of reading by the end of this story. Forty-five percent of the members of the family Fagaceae found in Taiwan are endemic to the island (Hsieh 2002).

From Taipei to Hualien

As we leave Taipei behind us on Freeway 5 to Provincial Highway 9, heading south while hugging the eastern coastline, I am thinking sadly that what has been referred to as the "Taiwanese miracle"[6] has perhaps been one only for the economy. Pushing beyond Taipei's jungle of freeway ramps, pedestrian skywalks, and concrete everything, the city outskirts are marked by mounds of earth with bulldozers on top and rice paddies crisscrossed by high-tension wire pylons. Here and there flocks of little egrets (*Egretta garzetta*) add a small but welcome touch of beauty across these flat plains, where all kinds of factories battle for space amidst agricultural fields that are perpetually inundated with industrial smoke and waste.

Mike Chen, my very amiable and fluent-in-English driver, introduces me to Taiwan's leading brand of cigarettes called – would you believe? – "Long Life"! Apparently Madame Chiang Kai-shek lived to be 106 years old, smoking two packs of these a day. Another Taiwanese miracle? Leaving Provincial Highway 9 for Provincial Highway 8 (or the Central Cross Island Highway), our first destination is Taroko National Park in Hualien County, some three hours from Taipei, where we are to meet with Fu-Che Pan and Ai-Gung

5. http://www.taiwan.climatemps.com

6. Ferocious economic development between 1960 and 1990 that corresponds to the well-known label, "Made in Taiwan".

Photos 13/(a) Acorns of *Quercus tarokoensis* in Taroko National Park and (b) leaves from trees found along Road 23 between Donghe and Fuli.

Dung, Dr. Fuh-Jiunn Pan's brother and sister-in-law (both members of the IOS). When I first met with Dr. Pan at the IOS Oak Open Day at Trompenburg, mentioned above, he told me that his brother was a keen oak afficionado. I now know that that was an extraordinary understatement: it would be only a very slight exaggeration to affirm that Fu-Che knows personally nearly every tree in Taiwan. Both he and his wife are passionate about oaks and I owe the success of this expedition, and my appreciation of Taiwan, to them more than anyone.

Taroko (which in the Truku language means "magnificent and beautiful") National Park covers about 90,000 ha and is one of Taiwan's major tourist attractions. Declared a national park in 1937 by the Japanese, the Chinese, who took control of Taiwan after the Second World War and the Japanese defeat, abolished its status as national park in 1945 – status that was reestablished in 1986 by the Taiwanese government. As the name suggests, our target species in Taroko National Park is *Q. tarokoensis*, a rare Taiwan endemic found on steep limestone slopes and ridges between 400 and 1,300 m with a very restricted distribution. We do not find many tourists enraptured by *Q. tarokoensis*, the main attraction of Taroko National Park being its remarkable sculpted marble facies, some of which are over 250 million years old. Through the ages, marine fossil deposits, rich in calcium carbonate, have been eroded away to reveal the magnificent marble substrate, particularly spectacular at Taroko Gorge, the signature gorge of the park, which has been sculpted over time by the Liwu River.

Photo 14/ *Quercus liaoi* in Taroko National Park.

Between 400 and 800 m we find several populations of *Q. tarokoensis*, mostly medium-sized (12-15 m) trees with very dainty acorns and even daintier acorn caps. This is a very exciting moment indeed: *Q. tarokoensis* is endemic to eastern Taiwan and unknown in cultivation. As we move to higher altitudes other oaks appear.

Slightly above 1,000 m, we find *Q. globosa*[7] along with two more island endemics, the first one also being unknown in cultivation*: Q. liaoi*, and *Q. stenophylloides*; at 2,300 m *Q. morii*, yet another Taiwan endemic; and at 2,500 m a few isolated trees of *Q. spinosa* subsp. *miyabei*. Needless to say, there is *Q. glauca*, everywhere. Amongst the other plants to be admired as we work our way up the mountains: *Hibiscus taiwanensis*, *Aralia bipinnata*, *Juglans mandshurica*, *Picea asperata*, *Trochodendron aralioides*, *Acer caudatifolium*, *Lithocarpus kawakamii*, *Cephalotaxus harringtonii* var. *wilsoniana*, and *Pinus taiwanensis*. As we head back down we are graced with spectacular views across the sea of clouds.

Photo 15/ *Hibiscus taiwanensis* in Taroko National Park.

Photo 16/ Spectacular views at the end of the afternoon in Taroko National Park.

From Hualien to Changbin

After spending the night in Hualien, a small city bordered on one side by the Pacific Ocean and on the other by the Coastal Mountain Range, we set off going south to meet up with Fu-Che and Ai-Gung, who had returned home the previous evening. The most important (in terms of population) aboriginal people in Taiwan are the Amis – and the eastern part of Taiwan is where most of them live, with Hualien being their "capital". These people are hunter-gatherers and fishermen, some of whom still use an extraordinary, rather unique technique for capturing creatures of the sea. The bottom of a three-level trap made of bamboo is placed in a

Photo 17/ Hualien

7. *Quercus globosa*, considered a synonym of *Q. glauca* for Western authorities, is still considered a separate taxon in the *Flora of China.*

Photos 18/ (a) Dragon fruit (*Hylocereus undatus*); (b) Java apples (*Syzigum samarangense*); (c) Custard apples (*Annona reticulata*).

hole in the seabed. With time, eels that swim through are retained at the bottom level, various crustaceans are trapped at the middle level, and fish are caught at the top level.

We meet our friends near the small city of Donghe, about 50 km south of the Tropic of Cancer, and head off into the Coastal Mountain Range along Provincial Highway 23 towards Chishang. More *Q. tarokoensis* greet us along this road, which we leave at Chishang for Provincial Highway 20 in the direction of the Siangyang National Forest, our destination of the day. We make a quick stop in Chishang to buy our box-lunch à la Taiwanese along with some fruit, including custard and java apples (neither of which are apples but both of which are quite delicious!) and the heavenly dragon fruit. After lunch, a few kilometers from Chishang we find a small population of *Q. variabilis* and again many trees of *Q. tarokoensis* on the western slopes off of Provincial Highway

Photo 19/ *Quercus stenophylloides*

Photo 20/ *Quercus longinux*

Photo 21/ *Lithocarpus konishii*

20. At higher altitudes, between 1,600 and 2,300 m we find what we had come for: *Q. tatakaensis*[8] and *Q. longinux*, both endemic to Taiwan, along with *Q. stenophylloides* and – two more Taiwanese endemics: *Pinus morrisonicola* and superbly majestic *Chamaecyparis formosensis* towering at the top.

After this exhilaratingly oak-filled day, we head towards Changbin to spend the night at a truly marvelous place, the Juhu Farmstay, which I recommend to anyone thinking of visiting Taiwan, whether you are looking for oaks or not! Superb accommodation, spectacular views, lovely owners, delicious food – three stars in my book to be sure. Last but not least, the owners are oak lovers and have planted on their property, along with many other beautiful plants, *Q. aliena*, *Q. gilva*, *Q. tarokoensis* and *Lithocarpus konishii*. The makings of a very pleasant stroll before breakfast.

Photo 22/ Breakfast at the Juhu Farmstay.

Continuing our journey southward we hug the coast on Provincial Highway 11, which merges into Provincial Highway 9 after Taitung City, to explore the country further inland between Dawu village and Shimen. The area proves as rich in oak discoveries as the places we had seen the day before. The first marvel of the day is *Q. hypophaea*, showing mature foliage, new growth, acorns, and catkins. Endemic to the southeast of Taiwan at relatively low altitudes, this is a lovely oak with distinctly bicolored leaves that are a bright, medium green on one side and a lovely white-silvery gray on the other.

8. See pages 127-131 for a discussion of *Q. tatakaensis* Tomiya and *Q. spinosa* subsp. *miyabei* (Hayata) A. Camus.

Photos 23a-c/ *Quercus hypophaea*

The new growth is rusty orange and the catkins are yellowish white. To the best of my knowledge this oak is not in cultivation in European or American collections. We did not have very far to go before finding *Q. longinux*, *Q. pachyloma*, and *Q. championii*, the latter two, I believe, not in cultivation (although *Q. championii* was reported in 1933 as being in cultivation at Caerhays Castle (Cornwall, UK) (Warburg and Warburg 1933).[9] There are other *Cyclobalanopsis* with more attractive leaves, but no other oak could beat *Q. pachyloma* in the most-spectacular-acorn contest. What is the selective advantage of that absolutely fabulous acorn cap?

Unlike my visit to Vietnam, where the oaks were rare and the *Castanopsis* and *Lithocarpus* everywhere, this Taiwanese oak extravaganza has somewhat relegated these other Fagaceae to the back of my mind. But there are quite a few of these about as well: *L. amygdalifolius, L. brevicaudatus, L. harlandii, L. shinsuiensis* (endemic to Taiwan), *C.*

9. For a detailed account of the Fagaceae at Caerhays Castle, see Chassé 2017, this volume pp. 151-166.

Photo 24/ The fabulous acorn of *Quercus pachyloma.*

carlesii, and *C. kawakamii*. As my attention is drawn to non-oak things, I notice, rather far from where we are but still quite visible on the horizon, several massive conifers. I learn that 1) these are *Keteleeria davidiana* var. *formosana*, 2) that to get to them is not easy, 3) that if I really wanted to, we could go tomorrow, and 4) that Fu-Che and his entire family go once a year to pay homage to this magnificent and endangered species.

Keteleeria davidiana *var.* formosana

Admittedly, I am not generally emphatic about conifers, but there are some that command my respect and admiration and this is certainly one of them. In the *Flora of China*, *K. davidiana* var. *formosana* has been retained as a valid taxon. The species – named to honor Armand David (1826-1900), French missionary and naturalist who collected the type specimen – is extremely variable. This has led different authors to describe new species, most of which, if not all, have been reduced to synonymy. According to the IUCN Red List, the Taiwanese population is clearly a disjunct element within the species and its status as Endangered does not affect the status of the species as a whole, considered Of Least Concern, though the population trend is unknown (Yang and Luscombe 2013). Apparently, the distinguishing feature of the Taiwanese variety is that the twigs are dark and that the leaf scars are obviously protruding. In Taiwan all of the populations (4 or 5) are in the northeast except for this population in the southeast, between Dawu and Fenggang. Before 1900, this tree was abundant on the island. Its current restricted distribution is the result of massive felling, the sad but seemingly inevitable destiny of this tree whose wood is extremely hard and dense and was thus (as the type still is in

Photo 25/ *Keteleeria davidiana* var. *formosana*

China) used intensively for construction and carpentry.

Along the trail that leads to the *Keteleeria*, that are at around 700 m altitude, there are very large *Q. hypophaea*, *Q. pachyloma*, *Q. longinux* (and also *Q. longinux* var. *kuoi*, which is no longer considered distinct from the type except by the Taiwanese), and *Q. globosa* (synonymous for most authors with *Q. glauca*), along with various other Fagaceae including *Castanopsis indica* and *Lithocarpus brevicaudatus*.

At the end of the day, we head south following Provincial Highway 1, which takes us to our lodgings in Kenting, nearly at the very tip of the island where we establish our headquarters for the next two nights.

Kenting National Park

Kenting is the oldest National Park in Taiwan, created in 1984, and covers just slightly over 180 km^2 of land and 150 km^2 of sea. There is a large diversity of habitats and a uniquely East Asian mix of "preserved nature" and frenetic commercial activity, mostly geared to attract and accommodate the several million tourists that visit the region each year (fortunately enough, not very many of them are interested in the "preserved nature" areas). The city of Kenting is, by day, a fairly standardly hectic small East Asian city but "Kenting by night" is a hallucinating experience that includes an army of nighttime vendors that line the streets with their goods and the air with their beckoning, in front of the uncountable number of shops (remaining open all night), each lit up like Christmas trees and all of which have their own blasting sound system playing different tunes, though all of the same boom-boom-boom variety – and all of this for the incessant flow of tourists. One is obliged to admit that there are people who actually enjoy this. Far from this maddening crowd, on the outskirts of town, Fu-Che and Ai-Gung, who come to visit the trees here

Photos 26/ (a) *Quercus championii* on the way to Nanren Lake; (b) *Q. championii* acorns and (c) new growth.

often enough, know a very good, quiet restaurant where we enjoyed delicious food in calm surroundings both nights of our stay here.

Our aim in coming is to visit the NanRenShan Ecological Protection Area in the northeastern part of the Park. Mount Nanren is the 2,009th highest mountain (395 m) in Taiwan; this doesn't really tell you anything about Mt. Nanren, but does indeed tell you something about Taiwanese topography. Mount Nanren is the heart of this protected area, which is Taiwan's only remaining low elevation forest. It is a very pleasant 10-km round-trip stroll from the Visitors Center to the Nanren Lake wetlands. The wetlands harbor many rare birds, butterflies, and plants, including populations of *Q. championii*, *Q. pachyloma*, and *Q. longinux*. *Quercus championii* is a lovely oak with spectacularly colored new growth and bright green mature leaves, which have a tendency to stand upright on the branches. The specific epithet is in honor of J. G. Champion, a British soldier and explorer known for having extensively explored Hong Kong, sending many specimens back to Kew (Bentham 1851).

From Kenting to Guanyuan

After saying heartfelt good-byes to Fu-Che and Ai-Gung, who return home after our day at Nanren, we head north with two new passengers, Dr. Ju and her assistant Louise Hsu. They had arrived by train from Taipei the previous evening to accompany me for the northward-bound portion of my visit. Much of our first day together is spent visiting two places to check out their suitability for hosting a future IOS conference: the National Sun Yat-Sen University in the city of Kaohsiung and the Huisun Forest Station, near Xinsheng Village. Both of these places would be suitable, but the latter would be more convenient logistically as the perfect end to the pre- and start of the post-conference tour, and also because it is set in the middle of a beautiful forest. The on-site facilities include spacious conference rooms as well as sufficient accommodation and catering services for large groups. For those who have never been to Asia and are hankering for an East-Asian oak experience, Taiwan is the perfect choice under a number of criteria: 1) for the number of (endemic and other) oaks that can be found fairly easily and 2) the short

Photo 27/ New growth of *Quercus gilva.*

distances that need to be travelled 3) on relatively good roads 4) to cover a lot of ground 5) in a reasonably short period of time. In addition, the enthusiasm I encountered from everyone I spoke with about the possibility of organizing an IOS event in Taiwan has set a more-than-positive note for the idea.

We do not have much time for trees during this day but we are welcomed at the Huisun Forest Station by several *Q. glauca*, which I have been snobbishly ignoring for the past few days, having seen so many of them. These trees are identified by Dr. Ju as *Q. globosa*, a valid taxon in *Taiwan Plant Names*.

We spend the night near Wuchen village at the Lien Hua-Chih Research Center of the Taiwan Forestry Research Institute and set off early the next morning to search primarily for *Q. gilva*, not yet encountered except as planted trees at the Juhu Farmstay. *Quercus gilva* is one of my favorite *Cyclobalanopsis*, with its distinctive leaf shape and the unmistakable fuzzy, yellow color of the new twigs and leaves. *Quercus gilva* is rare here, although we do find some, along with numerous *Q. pachyloma*, *Lithocarpus corneus*, *L. brevicaudatus*, *Cunninghamia konishii*, and towering *Taiwania cryptomerioides*.

Our lodgings for the night are at the High Altitude Experimental Station of the Taiwan Endemic Species Research Institute, not far from Guanyuan, on the western border of Taroko National Park. After lunch in Puli, we spend the rest of the afternoon botanizing along the beautiful mountain roads that will take us to the Station, climbing up to 3,300 m altitude.

As we cross the Zhuoshui, the longest river in Taiwan, which has its source on the nearby eastern peak of Mt. Hehuan, *Q. glauca* abounds from 1,000 m with a few small populations of *Q. variabilis* which we find also higher up at about 2,000 m). *Quercus morii* and *Q. stenophylloides* also begin to appear at this altitude. Above 2,600 m the conifers are more abundant, especially *Pinus morrisonicola* with its very smooth bark and *Abies kawakamii* with its deeply grooved bark (both endemic to Taiwan), as well as gigantic *Pseudotsuga sinensis*. Above 3,000 m there are no more trees, only *Yushania niitakayamensis* (a kind of bamboo). It is hard to believe, in this drizzling, freezing rain, that only the day before yesterday we were in sweltering Kenting.

Photo 28/ The Zhuoshui River, the longest river in Taiwan (186 km).

The next day, spent exploring the area between Lushan, Guanyuan, and Wuling, we find many *Q.*

stenophylloides and *Q. liaoi*, and numerous populations of *Q. spinosa* subsp. *miyabei*. Fu-Che and Ai-Gung join us – a wonderful surprise – at the hostel in Guanyuan where we spend the night.

From Li Shan to Taipingshan

This area of Taiwan is massively devoted to growing fruit. Apple, pear, peach, persimmon, and other fruit orchards cover the mountainsides and, at this time of year, each fruit has been wrapped up in whitish, silvery bags that from afar give the impression the trees are blossoming. The roadsides harbor many fruit stands, one of which we stop at before arriving at the Visitor Center of the Li Shan Scenic Area, where we have lunch. Li Shan also produces one of the finest oolong teas in the world. Fortunately the fruit orchards have not replaced all of the vegetation, and many interesting trees can be found here, including *Acer oliverianum* subsp. *formosanum*, *A. rubescens*, *Alnus formosana* (these last two endemic), *Carya cathayensis*, *Platycarya strobilacea*, *Pseudotsuga sinensis*, and many oaks: *Q. liaoi*, *Q. morii*, *Q. spinosa* subsp. *miyabei*, *Q. stenophylloides*, *Q. tatakaensis*, *Q. variabilis*, and, oh yes, lest we forget, *Q. glauca*.

We stop at Cijiawan Creek, which is in the Wuling area of Shei-Pa National Park, and harbors, as does Gaoshan Creek, the Critically Endangered Formosan landlocked salmon, *Oncorhynchus masou* subsp. *formosanus* (Kottelat 1996). The taxonomic status of this subspecies is questioned by those who support the idea that between landlocked salmon and the type the differences are in life history and behavior rather than genetic. We stay the night at the Hoya Resort in Wuling and say our good-byes to Fu-Che and Ai-Gung, who head back home to Taitung County while we continue our route northward.

Taipingshan National Forest Recreation Area

Our goal for the day is to reach Taipingshan National Forest Recreation Area, only about 30 km from where we are but the road, Provincial Highway 7, is narrow and steep and often shrouded in fog.

Taipingshan, along with Alishan and Bashianshan, were the three major logging sites in Taiwan for much of the 20th century (Taipingshan became a protected area in 1983). Perhaps one of the most visible traces of this history is the hectares and hectares of planted *Cryptomeria japonica*, first introduced by the Japanese and later massively used by Taiwanese foresters. Recently Taiwanese forestry policy has changed and new plantations of *Taiwania* and *Chamaecyparis* can be seen here and there. The original forest in Taipingshan was dominated by *Tsuga* and *Chamaecyparis* spp.

Photo 29/ *Macaca cyclopis* on the way to Taipingshan.

On our way, we find many *Q. gilva*, *Q. longinux*, *Q. morii*, and *Q. stenophylloides*. We cross the

Photo 30/ *Fagus hayatae* in Taipingshan National Forest.

Lanyang River, which, like many rivers in this part of Taiwan. is completely dry for up to eight months of the year, but becomes a torrential waterway during the rainy season. Though hard to believe for anyone who has even the slightest notion of ecology, the Taiwanese government allows farmers to farm these dry riverbeds. As we drive up the mountain to the National Park Headquarters, where we will be staying for the night at the Taipingshan Villa, we are in thick fog (until about 1,600 m) accompanied by many Taiwanese macaques (*Macaca cyclopis*).

Of course there are oaks, rhododendron, various conifers, maples, sorbus, tree ferns, myriad bryophytes, and many, many other interesting plants to be seen in the Taipingshan National Forest, where average annual temperatures are around 13 °C and the humidity is above 85% all year long. BUT the real reason for going to Taipingshan is *Fagus hayatae*, listed as Vulnerable in the IUCN Red List, though the assessment was done in 1998 and needs to be updated (Lu and Pan 1998). The 4-km Taiwan Beech Trail that we embark on the following morning is an easy hike for about the first 2.5 km, as it runs along an ancient logging railway on very flat ground. This part of the trail is composed of tree stumps cut very low to the ground and covered with round metal grates in the shape of a beech leaf – a very good idea to help hikers along on this soggy soil. After the 2.5-km mark, the trail is more difficult, being a succession of stairs that go sharply up and down a 100-m gradient before finally attaining the ridgeline that takes you to the *F. hayatae*. Though we are a bit late for the renowned autumn color, the views over the valley through the elegant beech branches are dramatic, even in the fog.

In the afternoon we are joined by Dr. Pan, as Dr. Ju and her assistant return to Taipei. Dr. Pan and I spend the remaining daylight hours climbing the Ancient Hemlock (*Tsuga chinensis*) Trail that starts in the forest behind the Taipingshan Villa. The trail is about

3 km, with an elevation gain of about 300 m, and ends in a lookout platform with views of Dabajianshan and other peaks in the Central Mountain Range. It is a very moving experience to walk among these giant trees and, though we did not find the *Q. spinosa* or *Q. morii* that are supposed to be here, I do not regret having made the effort.

From Taipingshan to Taipei

This is the last leg of my trek, and we have yet to find *Q. sessilifolia* and *Q. myrsinifolia*, the only two oaks on my list that we have not seen. We leave Taipingshan on the northwest-bound portion of Provincial Highway 7 and the first Fagaceae that we encounter are *Castanopsis carlesii* and *Lithocarpus kawakamii* – but mostly the vegetation consists of thickly planted *Cryptomeria japonica*. In some places, *Metasequoia glyptostroboides* was also planted. After the town of Mingchi, we spot some trees that could be *Q. myrsinifolia* or *Q. glauca*, but they are rather higher up than we are, and not accessible. Here also we find *L. brevicaudatus*, *Pinus morrisonicola*, and *Tetrapanax papyrifer*. After a quick lunch and dropping our bags at our hotel in Shangbaling, we embark on a circuitous route, crossing and changing small county and town roads so many times that I eventually give up trying to follow exactly where we are on my insufficiently-detailed map. I have ascertained that we have been travelling on County Road 60 and, of course, my GPS knows exactly where we are (24°40'10.1" N 121°17'04.0" E) when we find our first clump of *Q. sessilifolia* and, not very far from there, *Q. gilva* and, again, several clumps of *Q. sessilifolia*.

The following morning we leave Shangbaling, headed for Taipei, via Fuxing (the pronunciation of which I shall leave to your imagination). *Quercus gilva*, *Q. longinux*, and of course *Q. glauca*, are the last oaks I see as we enter the havoc of urban Taiwan, cossing the outer suburbs of Taipei that begin already in the city of Sanxia, where we have a delicious curbside lunch.

Photos 31 a-b/ *Quercus sessilifolia*

Around Taipei

The day after our return to Taipei (9 November), Dr. Pan takes me to Yangmingshan National Park, slightly north of Taipei, where there are small populations of *Q. gilva*, *Q. myrsinifolia*, and *Q. sessilifolia*. On November 10, I visit the Taiwan Forestry Research Institute's station in Wulai, guided by Mr. Chong who works at the Institute, where we see *Lithocarpus uraianus* (often still named by the Taiwanese *Limlia uraiana)*. On November 11, to my great surprise and pleasure, Fu-Che and Ai-Gung have driven up to accompany us to Wulai, where we find *Q. glauca* and *Q. longinux* as well as *L. uraianus*. For the first time since I have arrived, it is absolutely pouring rain and dangerous for us to continue on these very steep and slippery paths, so we decide to turn back and have a nice long lunch, drying off and warming up. On November 12, I am met in the morning by Mr. Chen, also from the Taiwan Forestry Research Institute, who takes me to the Fushan Botanic Garden, which maintains endemic plant collections represented by over 700 species of vascular plants. It is a very interesting, well-labeled garden, but after having seen so many of these plants in the wild my feeling is that it would have been more interesting to have visited here first to become familiar with the vegetation before I embarked on what has been a most rewarding tour of this *ilha formosa*.

Photo 32/ *Macaca cyclopis* in Fushan Botanic Garden.

To be or not to be *Quercus tatakaensis* Tomiya

A very confusing state of affairs exists in the literature regarding *Quercus spinosa* David ex Franch., *Q. spinosa* subsp. *miyabei* (Hayata) A. Camus, and *Q. tatakaensis* Tomiya. In the World Checklist of Selected Plant Families, Oaks of the World, and AsianFagaceae.com (Strijk 2017), *Q. spinosa* and *Q. spinosa* subsp. *miyabei* are valid names, whilst *Q. tatakaensis* is considered a synonym of the latter. In the Oak Name Checklist, *Q. tatakaensis* is considered a valid name (as are the other two) but there is a nomenclatural note that states "May belong to *Q. spinosa* subsp. *miyabei*."

In the *Flora of Taiwan* (Second Edition 1996), the treatment of the Fagaceae by Hui Lin Liao includes *Quercus spinosa* David ex Franch. (with *Q. spinosa* var. *miyabei* indicated as being a synonym); and *Q. tatakaensis* (with *Q. spinosa* var. *miyabei* f. *rugosa* (Masmune) Liao and *Q. spinosa* var. *miyabei* f. *tatakaensis* indicated as synonyms.)

However, the description of *Q. spinosa* given in this publication does not correspond to the protologue (see below) and Plate 57 that is intended to illustrate *Q. spinosa* is much more like *Q. spinosa* subsp. *miyabei*. Further, Plate 59, that supposedly illustrates *Q. tatakaensis*, also appears to me to be closer to *Q. spinosa* subsp. *miyabei*, and does not correspond to the accompanying description that in fact does correspond to the protologue of *Q. tatakaensis* (see below).

Finally, in the *Flora of China*, *Q. tatakaensis*, (mentioned under *Q. spinosa* as a synonym of *Q. spinosa* var. *miyabei*) is indicated as growing in populations in Taiwan with typical *Q. spinosa* and that its status needs further study.

The protologues[1]

Quercus spinosa *David ex Franch. (1884)*

Low-growing tree, evergreen, branches twisted, glabrous, bark becoming grey; branchlets of the year's growth are covered with a stellate pubescence; leaves coriaceous, shiny, obovate with rounded apex; base moderately cordate, leaf margin dentate-spinescent; the underside of the leaf with reddish stellate pubescence mainly near the veins, otherwise glabrous; 4-5 secondary veins, forked, abaxially strongly raised, making the leaves appear somewhat bullate; flowers…; fruit….

As far as can be determined in the absence of fruit, this oak is very near the variety glabra of Q. baloott [sic], from Afghanistan; the leaves are of the same dimensions and form, but thinner, green on both sides and not white-farinose underneath; the leaf margin is entirely dentate with finer, spiny teeth; the branches are more twisted and the bark is brown and not reddish-brown.

1. Translations from Latin and French by the author.

Quercus spinosa *var.* miyabei *Hayata (1918)*

Branchlets brownish purplish with few lenticels, stellate-tomentose towards the end, very densely leafy. Leaves coriaceous, elliptic or more rarely obovate-elliptic, 5.5 cm long and 3.5 cm wide, rounded apex, base moderately cordate, leaf margin entire or with few widely spaced teeth, midvein moderately raised adaxially, very prominent on the underside, 7 secondary veins on either side of the midvein, the central secondary veins form a 50° angle with the midvein, the lower ones, a 90° angle; upper surface glabrous; abaxially glabrous except towards the base of the midvein that is stellate tomentose, otherwise glabrous, petiole very short, 5 mm and more or less tomentose.

The species was first named as *Q. miyabei* by the late T. Kawakami but the name was not published as it was then considered to be identical with *Q. spinosa* David. In examining again the species and in comparing it closely with *Q. spinosa*, I have found that there are some differences between the two. The leaves of the present *Quercus* are usually elliptical or very slightly obovate-elliptical, while those of *Q. spinosa* are always obovate. Moreover, the leaves of the former are nearly plain on the upper surface, while those of the latter are very much impressed on the costas and lateral veins. For this reason, it would be better to regard the Formosan species as a variety of *Q. spinosa*.

Q. spinosa *subsp.* miyabei *(Hayata) A. Camus (1938)*

Small tree with branchlets purplish black, with few lenticels, stellate-tomentose (caduc) . towards the end. Leaves: elliptic, apex rounded or truncated, base moderately cordate; 3.5-5.5 cm long and 2.5-3 cm wide; adaxially glabrous; abaxially, near the base, stellate-hairy; leaf margin entire or with few widely spaced teeth; 4-5 pairs of secondary veins abaxially prominent, the central secondary veins form a 50° angle with the midvein; very short petiole, often 1-2 mm, more or less tomentose.

(Note: Mme Camus gives this taxon subspecies status as opposed to Mr. Hayata's variety. All modern sources use *Q. spinosa* subsp. *miyabei*, except for the *Flora of Taiwan* and the *Flora of China* that use Mr. Hayata's "variety".)

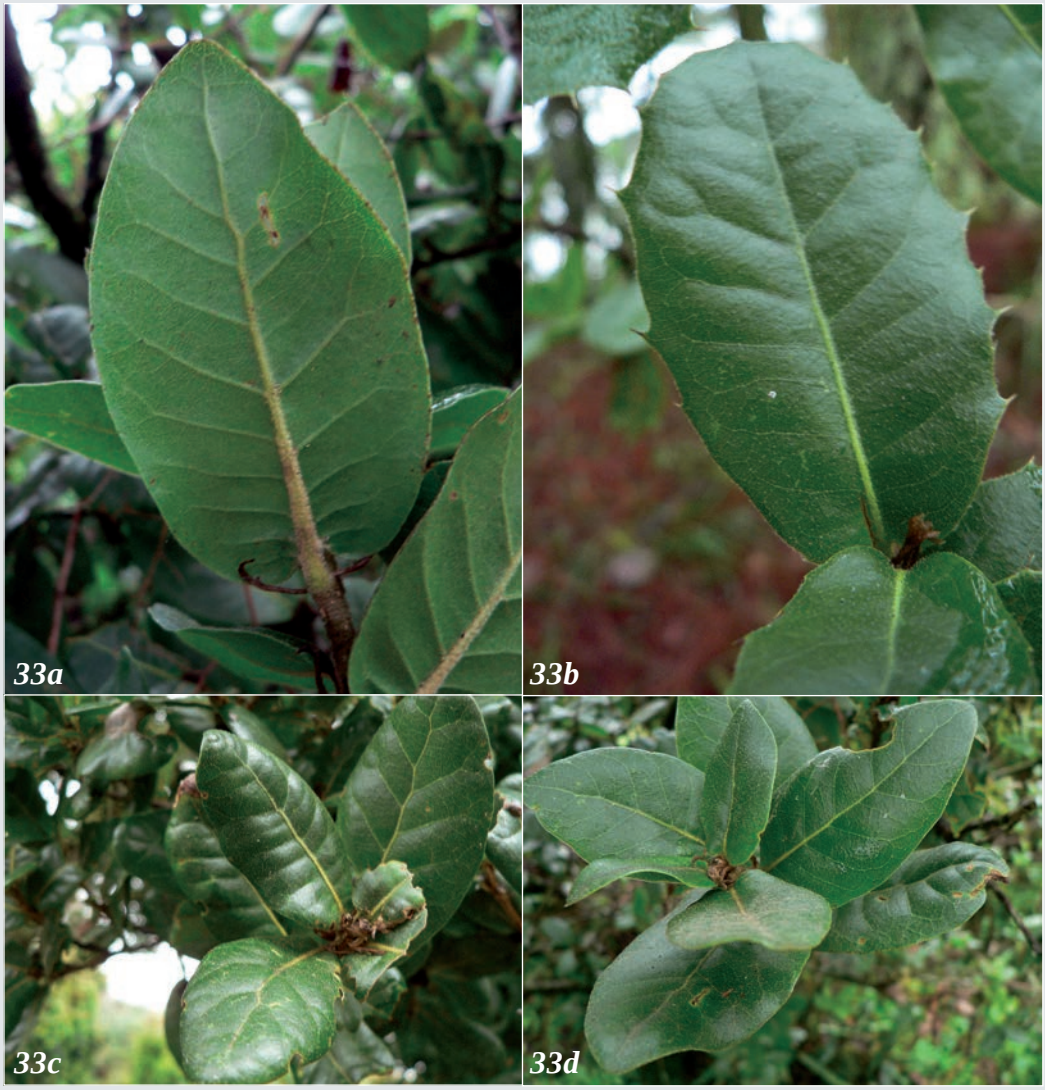
Quercus tatakaensis *Tomiya (1944)*

Branches grayish glabrous with small lenticels, branchlets with dark brown stellate pubescence. Leaves coriaceous, petiolate, ovate or elliptical more rarely oblong or lanceolate 7-16 cm long 4-6 cm wide, apex acuminate, base rounded or obtuse, margin aristate-serrulate more rarely entire, midvein adaxially depressed, abaxially prominent, on both sides of the midvein are 8-13 secondary veins often forked; leaf surface glabrous on both sides, sparsely stellate-hairy on the midvein.

Discussion

Although *Q. spinosa* is indicated as being in Taiwan in the Flora of China, le Hardÿ de Beaulieu and Lamant (2010), AsianFagaceae.com (Strijk 2017), the Oak Name Checklist, and the Flora of Taiwan, one is tempted to conclude from the last sentence in Mr. Hayata's protologue that only *Q. spinosa* var. *miyabei* is found in Taiwan and not *Q. spinosa*. Except for one plant growing in the Fushan Botanic Garden, labelled *Q. spinosa*, none of the plants that I saw in Taiwan correspond to the very spinescent form of *Q. spinosa*, which is growing at the Arboretum des Pouyouleix, and is the only form I have ever seen in photos of this species in China.

Significantly, in le Hardÿ de Beaulieu and Lamant (2010) the photographs that illustrate *Q. spinosa* on pages 694-695, all taken in Taiwan, correspond to the description of *Q. spinosa* subsp. *miyabei* – except for the last two on page 695 that appear to be *Q.*



Photos 33/(a-d) *Quercus spinosa* subsp. *miyabei*

Photos 34/ (a-d) *Q. tatakaensis*

spinosa subsp. *spinosa* and were taken in China. On the other hand, the photographs that illustrate *Q. spinosa* subsp. *miyabei* (pages 698-699), all taken in Taiwan, correspond to the description of *Q. tatakaensis* – except for the photograph in the lower left-hand corner of page 698 that corresponds to the description of *Q. spinosa* subsp. *spinosa* (or perhaps a juvenile form of *Q. spinosa* subsp. *miyabei*?) and was taken in Taiwan though there is no indication of location.

But what of *Q. tatakaensis*? This name was published in 1944 by Mr. Tomiya in the *Transactions of the Natural History Society of Taiwan* (34: 346). The plants that I saw in Taiwan that the Taiwanese identify as *Q. tatakaensis*, do not look anything like either of the two *spinosas* (and do correspond to the original description by Mr. Tomiya as well as to the description given in the *Flora of Taiwan*).

Conclusion

In addition to the discussion above, the photographs included here and the herbarium specimens available at http://www.hast.biodiv.tw/Specimens/SpecimenQueryE.aspx suggest that what has been described as *Q. tatakaensis* is rather different from the other taxa discussed here.

Between the first and the second edition of the *Flora of Taiwan*, *Quercus spinosa* var. *miyabei* was determined to be a synonym of *Q. spinosa* whereas the two forms of this variety – f. *tatakaensis* and f. *rugosa* – described in the first edition were determined to be synonyms of *Q. tatakaensis*.

It is quite plausible, even just based on Mr. Hayata's last sentence in the protologue of *Q. spinosa* var. *miyabei*, "…it would be better to regard the Formosan species as a variety of *Q. spinosa*.", that these two taxa are indeed the same thing. And, if this is true, what is unexplainable is why *Q. tatakaensis* is considered in the *Flora of China* as being synonymous with *Q. spinosa* var. *miyabei* – if only because this implies that it is also a synonym of *Q. spinosa*.

In a very recent study assessing the phylogenetic and taxonomic significance of leaf epidermal features in section *Ilex* oaks (Deng et al. 2017) the authors state, "The parallel evolutionary patterns of epidermal features in different lineages of *Quercus* s. I. apparently reflect a stochastic sorting of ancestral polymorphisms and the result of long-term adaptation rather than evolutionary relatedness. But large variations and combinations of unique traits of epidermal features in specific groups or species complexes are no doubt valuable for species identification." Based on main morphological characteristics, two main subgroups and seven morpho-complexes within them have been sorted out. Not only are *Q. spinosa* and *Q. tatakaensis* in different morpho-complexes, they are not even in the same subgroup: the former finds its place in the "capitate" subgroup (significantly, samples of *Q. spinosa* from both mainland China and Taiwan were used in this study) and the latter in the "branched uniseriate" subgroup.

All this being said, one can't help but wonder how it is possible that Mr. Hayata, who spent so much of his life botanizing in Taiwan, did not describe *Q. tatakaensis*.

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Photographers. Photos 1-34: Béatrice Chassé

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Oak Open Days Argentina April 22-24, 2016

Roderick Cameron
Américo Ilaria 6615
Montevideo, Uruguay
roderickcameron66@gmail.com

Introduction

The first IOS Oak Open Day event south of the Equator took place April 22-24, 2016, in Argentina. It was originally planned as a two-day event, visiting the two principal oak collections in the country, but a third day was added to include a visit to Argentina's first commercial truffle-oak plantation. A combined total of 53 people attended the event, with several participants partaking in one or two of the days: a core of 17 stayed the entire course and visited all three locations (the metaphor is apt, and indeed the event might have been called the Argentine Oak Rally, as participants covered about 450 km from starting point to end point, without counting travel to and from home!). The objective of this particular OOD was not so much to get IOS members together as to spread the oak gospel to the uninitiated, and while we had a full turnout of local members from Argentina and Uruguay (four, one unable to come but ably represented by an enthusiastic stand in), members were far outnumbered by guests.

Grigadale Arboretum: past and present

The event began at Grigadale Arboretum, located a little over 400 km south of Buenos Aires, and 25 km from the Atlantic Ocean, in the southeastern section of the fertile lowland plains that make up the pampas. The oak collection at Grigadale was begun by late IOS member Duncan Cameron, my father. When he retired in 1990 from his job as manager of the family farm, the property was divided among the cousins. The plot he drew from the hat was a section that did not include housing and so my parents took on the challenge of building a new house, garden, and park from scratch, starting in 1992 with a bare field that contained nothing but a depression that would be coaxed into a permanent lake. They were engrossed in this tree-planting project when my mother, Bridget, attended the Chelsea Flower Show and returned from the trip with two seedlings of oak cultivars as a gift for Duncan. He had already planted some *Quercus robur* (English oak) and *Q. rubra* (red oak) in the park, grown from acorns of trees in the original homestead, but he soon got enthused with obtaining rarer taxa, which he sourced at first from European nurseries. A key step was making contact with Peter Laharrague, who had written about oaks in a local horticultural magazine, and through him joining the International Oak Society. Thanks to the IOS seed exchanges and further contacts made through the Society the collection grew and by 2008 he had well over 100 oak taxa represented by established specimens.

My parents died unexpectedly in 2008, at which point I volunteered to take over the management of the collection. The first step was to join the IOS, which helped me acquire knowledge and contacts, and more importantly, receive advice. One of the first tasks was to identify the plants in the collection and build a database. As my father did not have the opportunity to prepare the transition of the collection from his hands to his heirs, I had to make do with what I could find. Fortunately he had placed labels on metal stakes in front of most of the trees, but many of these had to be revised. Duncan also jotted down some notes in a series of appointment diaries, starting in 1998, including the arrival of new material, and a helpful list he made on January 1 each year, noting all the oak taxa in the collection, including the ones still "in pots." Crossing the data from the diaries and other sources, we were able to construct a database of sorts, tracing the history of the accessions, about fifty percent of which did not survive. (The database is now published online: www.grigadale.com)

The park at Grigadale covers a total area of about 12 hectares, of which 2 are taken up by a shallow lake. It has a relatively benign climate for oaks, equivalent to USDA Hardiness Zone 9, with frequent frosts in winter, though the mercury rarely drops below -3 °C. Late frosts in spring, as late as November, can cause damage to newly sprouted leaves, but are not normally fatal for established trees. The fertile soil is slightly acidic (pH 6), and consists of loess and deep humus, which in combination with warm summers (up to mid-30s °C) results in rapid growth once oaks are established.

The original plantations

Activities began with a presentation in which I provided a brief introduction to the genus, under the title "An Invitation to Quercophilia." Emphasis was laid on the fact that, despite the great diversity of the genus, only five species are known and used in Argentina: three European species (*Q. robur*, *Q. suber*, and *Q. ilex*), and two species from North America: *Q. rubra* and *Q. palustris*. The latter is particularly popular in landscaping projects and is easily available in nurseries, where it is known as *roble de los pantanos*, or *oak of the swamps*, following the specific epithet. One of the objectives of these Oak Open Days was to put in motion a process that might end this "pentaculture" by introducing participants to the diversity of oaks and encouraging nurseries to broaden the palette of species on offer.

The first part of the morning was spent meandering along the path that runs through the quercetum, where established trees of close to 100 taxa are closely packed into little more than half a hectare, at a distance of 6 to 7 meters between trees. One of the first problems we had to address was the visualization of the collection. Not only were the trees difficult to appreciate

Photo 1/ *Quercus rugosa* along the path through the quercetum (Grigadale Arboretum).

Photo 2/ *Quercus agrifolia* planted in 1998 (Grigadale Arboretum).

Photo 3/ *Quercus phillyreoides* planted in the mid-1990s (Grigadale Arboretum).

or even locate, but maintenance was problematic. The solution that worked best was to establish a path that followed a labyrinthine course passing by every tree and returning to the starting point. This path is the width of the mower and is easily and quickly maintained, while the rest of the grass is allowed to grow and is only cut once in late summer. The tall grasses, waist high in spring and summer, create an attractive landscaping effect, and the only other maintenance the trees receive is occasional trimming around the younger seedlings to keep the area under the branches neat.

The first stop was at an impressive *Q. agrifolia*, grown from acorns obtained at the 2nd IOS Conference in 1997. A few yards away is a multi-stemmed *Q. phillyreoides* planted in the early 90s. Recently, both these trees were the beneficiaries of selective felling that cleared several young but vigorous *Q. rubra* and *Q. robur* growing a little too nearby. These trees were probably planted by Duncan before he began the oak collection, and being common oaks that left the two rarer oaks with precious little elbow room, it was not too difficult a decision to bring in the chain saw.

A little further into the quercetum we stopped at a *Q. baloot*, probably the ex-situ champion of the species. The tree was grown from seed collected by Shaun Haddock in Afghanistan in 1995 (Haddock 2016) and it has developed faster than other specimens grown in Europe from the same accession. The new growth in spring of pink holly-shaped leaves is particularly attractive.

A group of *Q. cerris* dominates a corner of the quercetum, and several of its hybrids have been planted close by. *Q. cerris* is to be strongly recommended for planting in Argentina as an alternative to *Q. suber* and *Q. robur*, as it is not susceptible to disease such as sooty mold and powdery mildew. Our trees put on over 15 meters in two decades. Next to *Q. cerris* we saw a large specimen of *Q.* ×*hispanica* 'Ambrozyana', which has grown well despite having inherited from its *Q. suber* parent the susceptibility to sooty mold, *Q.* ×*libanerris* 'Rotterdam' (Dick van Hoey Smith's selection from Trompenburg Gardens), displaying

its plump oversized acorns, and the unusual hybrid *Q.* ×*kewensis*, a rare (though putative) case of an intersectional hybrid (*Q. cerris* × *Q. wislizeni*), whose ortet was found as a spontaneous seedling in Kew Gardens. *Quercus* ×*hispanica* cultivars are well represented in the collection: we also saw specimens of 'Wageningen', 'Lucombeana', and 'Diversifolia', all displaying characteristic hybrid vigor. A nice specimen of *Q.* ×*warburgii* (*Q. robur* × *rugosa*) with long *Q. robur* peduncles and *Q. rugosa* spoon-shaped leaves provoked an interesting discussion about such transcontinental hybrids, often appearing in nurseries or botanic gardens.

Moving beyond the main section of the quercetum, into the last area planted by Duncan, we stopped by a fine young *Q. leucotrichophora*, whose graceful elongated leaves with pale undersides were much admired. It is in a relatively exposed position, so has had a hard time of it and still grows at a slight slant, but it is otherwise in good shape.

Photo 4/ New growth on *Quercus baloot* (Grigadale Arboretum).

Photo 5/ The plump acorn of *Q.* ×*libanerris* 'Rotterdam' (Grigadale Arboretum).

Recent plantings

Next we advanced a few meters into a new plantation, a semicircular area protected from westerly winds by a stand of young *Q. palustris* that lines the serpentine access road and was just starting to turn color. In this section we saw young trees of Asian origin (and hybrids with at least one Asian parent) that we have planted over the last couple of years, including *Q. acuta*, *Q. myrsinifolia*, *Q. gilva*, *Q. hondae*, *Q. dentata* 'Carl Ferris Miller', *Q. Pondaim* Group, and also seedlings grown from acorns from Grigadale's specimen of *Q.* ×*vilmoriniana*.

Here we discussed the many challenges faced in establishing oaks in Grigadale. Once planted out oak seedlings may be attacked by Argentine ants, mighty defoliators that can leave a young tree quite bare overnight. Or hares might nibble their tops off or ring bark them. Winds are relentless on the pampas, and shelter and staking are important. Summer drought can be fatal, and many seedlings have bitten the dust during such episodes, particularly in the summer of 2008/09. Finally, though only more recently, as the arboretum is surrounded by no-till farmland, herbicide drift can be a nuisance for

Photo 6/ Young *Quercus variabilis* with polypropylene "mulch" (Grigadale Arboretum).

Photo 7/ *Quercus dentata* planted in 1998 measures 13 m today (Grigadale Arboretum).

established specimens and a serious concern for seedlings. The good news on that front is that the extremely volatile 2,4-D has this year been banned.

In this section, as with all new plantations, seedlings are placed at a distance of 10 meters from each other and protected with a 50-cm cylinder of black wire netting or a PVC tube, and a 2 m × 2 m square of woven black polypropylene is placed around it to suppress weeds and retain moisture. Another less obvious advantage of the plastic mulching is that the black squares show up on Google Earth imagery, making it very easy to map the plantation!

We took a well-deserved break in the form of sparkling rosé and hors d'oeuvres featuring home-grown oyster mushrooms, before returning towards the house through the rest of the quercetum. Our first stop was to admire one of the stars of the collection, a 13-m-tall *Q. dentata* planted out in 1998. Duncan noted in his diary: "Planted Dentata [sic] where I lost one last year (dug up by the dogs in order to eat the bone meal)." This tree used to have a notorious fork at a height of about 50 cm and two large co-dominant stems. On the advice of IOS's Guy Sternberg, we gradually subordinated one of the stems, over three years, finally removing the stump last year. The result has been positive, and though at first the tree's crown was of course lopsided, it has recovered and grown out into a regular shape.

Also of interest was a *Q. semecarpifolia* that is growing well despite suffering every autumn from sooty mold. This was an interesting

Photo 8/ New growth on *Quercus semecarpifolia* (Grigadale Arboretum).

case of a bit of sleuthing to obtain data of origin. My father noted in his diary on November 26, 1999: "…from Seaforde Nursery in N. Ireland I got semecarpifolia, a rare one indeed from Nepal." An internet search and an email allowed us to get in touch with Lady Anthea Forde of Seaforde House in County Down, who was able to inform me that her late husband and keen plantsman Patrick Forde had collected seed of this species in 1995 on the bank of the Yarlong Tsangpo River in Tibet. It is a slow grower with us (perhaps due to the effect of the mold), but it means that it is still at a height that allows us to admire the dangling catkins, the golden undersides of the leaves, and the russet new growth in spring and midsummer.

Growing opposite is a specimen labelled *Q. crenata*, a taxon still under discussion (is it a fixed hybrid or is it *Q.* ×*hispanica*?) (Ducousso 2013). Sadly,

Photo 9/ *Quercus crenata* with very corky bark (Grigadale Arboretum).

we have not been able to obtain information regarding this accession: it simply appears in the 2001 diary as "in a pot." Nevertheless, it is an interesting tree with beautiful cork-like bark that is responding well to sorely needed corrective pruning.

By the specimen of *Q.* ×*vilmoriniana* also hangs a tale: it grew from an acorn collected by Peter Laharrague in Arboretum national des Barres in France in 1999, from the ortet tree of this intercontinental hybrid (*Q. dentata* × *Q. petraea*). The tree died that year so this collection would have been from one of the last crops. The Grigadale specimen displays characteristics from both putative parents, as well as hybrid vigor displayed in swift growth and copious fruiting. Its progeny, some of which are planted in the new plantation of Asian oaks mentioned above, show a high degree of variability, but consistently display characteristics of the original parents.

The collection contains only a handful of established trees of Mexican species, but they include a finely structured *Q. rugosa*, currently close to 11 meters tall, and a *Q. rysophylla* that on occasion displays remarkable bright red fall coloring in midwinter.[1] This tree showed signs of decline in 2011 and was pruned back severely in the hope that it might react with renewed vigor. So far the results have been encouraging and it appears to be in good health.

We ended our tour of the quercetum back near the entrance, where a number of *Q. robur* cultivars have been planted. A golden oak (*Q. robur* 'Concordia') was planted in honor of the Golden Jubilee of Elizabeth II, as stated on a bronze plaque set in a stone at its foot. (The letter from Buckingham Palace, expressing Her Majesty's gratitude, was framed and proudly displayed in Grigadale's bar!) Sadly the tree is in decline, and preparations are being made to replace it. 'Filicifolia', 'Strypemonde', 'Irtha', 'Argenteomarginata', 'Fastigiata', 'Purpurea', and 'Pendula' are the other *Q. robur* cultivars planted nearby. 'Pendula' perhaps should be renamed 'Semipendula', as in 2015 it virtually broke in half and it still displays the unsightly scar, with a clear border of included bark on top, where a co-dominant stem broke in a relatively light wind: it serves as a good illustration of the importance of correcting this structural defect as early as possible!

Our final stop before lunch was by a stand of sawtooth oaks (*Q. acutissima*), which have flourished in Grigadale's conditions, as evidenced by the mass of spontaneous seedlings that have grown beneath them. In the discussion we agreed that *Q. acutissima* and *Q. dentata*, two Asian species that are unknown in Argentina, can be recommended for horticultural and landscaping purposes.

Lunch, consisting of the typical Argentine *asado* (barbecue) washed down with Malbec wine from Mendoza, was served on two sets of placemats: one featured art work by IOS member from Japan, Keiko Tokunaga, the other were laminated transparencies containing dried leaves of Mexican oaks, each identified in ink handwriting on the underside. Following a brief post-prandial respite, we gathered for a group photo under the largest oak at Grigadale, a *Q. suber* dating from the earliest plantations in 1993. We then embarked on a short tour of a group of oaks next to the tennis court. A *Q. bicolor* is doing well here and we decided that this species likewise deserved more attention by Argentine nurseries and landscapers, particularly as an alternative to *Q. robur*, as it does not suffer from powdery mildew, and offers the additional attractions of pale leaf undersides and flaky bark. In this area there is also a *Q. douglasii* that is not happy in our climate, as is the case with other Californian species, with the notable exception of *Q. agrifolia*. Perhaps high humidity is to blame.

1. For a detailed discussion of *Q. rysophylla* in cultivation, see Coombes 2016.

Photo 10/ A stand of *Quercus acutissima* (Grigadale Arboretum).

Water, water everywhere…

Our tour ended with two *Q. texana* (Nuttall oak) that grow close to the lake. They were originally part of a larger plantation of oaks that succumbed to a "once-in-a-century" flood in 2002 that had the area under water for eight months. The *Q. texana* survived, showing

their resistance to water-logged conditions – and they had to perform the trick again in 2014, when a second "once-in-a-century" flood submerged their trunks for a similar long spell. This more recent flood unfortunately did away almost entirely with a new plantation we had laid out, including several new taxa for the collection, amongst them *Q.* ×*jackiana*, *Q. ellipsoidalis* 'Hemelrijk', *Q. velutina* 'Oakridge Walker', and *Q.* 'Mauri'. Only a young *Q. lyrata* survived, also used to flooding in its native habitat. As periodic flooding may be a permanent feature of our climate now, we have deliberately selected flood-friendly trees to replant the area (e.g., *Q. phellos*, *Q. similis*, *Q.* ×*ludoviciana*, *Q.* ×*tottenii*, *Q.* ×*humidicola*, etc.). The *Q. texana*, in this exposed position, have developed a globular habit, their crowns kept low and wide by the wind. This is another species that can be recommended for local propagation and use, especially for any low-lying areas. Our *Q. texana* fruited for the first time in 2015, and true to form the acorns ripened late in the season and remained on the branches well after leaf drop. We harvested them at the end of August (late winter) and for the first time were able to contribute acorns to an IOS seed exchange in October at the 8th International Oak Society Conference in Chicago.

After tea we closed proceedings relatively early at 5 p.m., so as to leave time for the 275-km drive to the town of Coronel Pringles, where most participants spent the night.

Photo 11/ *Quercus texana* in full autumn splendor (Grigadale Arboretum).

Estancia San Miguel

The next morning we convened at Peter Laharrague's arboretum at Estancia San Miguel. Peter began by telling us of the history of the property and the arboretum, how

Photo 12/ Participants at Estancia San Miguel.

he inherited it from his father together with a love of trees and from an early age began planting. The first plantations at San Miguel were some eucalyptus in 1927, about 50 years after the property was first acquired, but then Peter's father began planting in 1949 and through the 50s.

San Miguel lies 20 km south of Coronel Pringles, a town founded in 1882 and once a center of wool production. As the crow flies, San Miguel lies 235 km west of Grigadale and

Photo 13/ Venerable conifers at Estancia San Miguel.

Photo 14/ One of the 7 querceta at Estancia San Miguel.

Photo 15/ Peter Laharrague and *Quercus pontica*. Peter is the one with the Basque beret (Estancia San Miguel).

only about 10 minutes of latitude further north at 38°10' S. However, it is at a greater distance from the mollifying effects of the Atlantic Ocean, which lies 90 km away to the south. The result is a climate that is one USDA Hardiness Zone lower, with colder winter temperatures. Frosts of -5 °C are frequent (12 below has been recorded twice) and can last through the night, with fatal results for tender plants. In comparison with Grigadale, generally harsher conditions prevail in San Miguel: annual rainfall is significantly lower, 700 mm versus 900 mm; San Miguel is only about 200 km from the northern limit of the semidesert of Patagonia; and, situated in the foothills of the Sierra de la Ventana, low-lying hills of Precambrian origin, San Miguel's soil, on a base of calcareous rock, is shallower, less fertile and slightly alkaline. Lying in the foothills of the Sierra, the arboretum includes some gradients and high points, unlike the flatlands of Grigadale, and there are beautiful views of the hills from several points of the park.

As far as the arboretum goes, the contrast with Grigadale is striking both in terms of scale, San Miguel's park covers 100 hectares, and in maturity, Grigadale's oldest trees were planted in 1992 whereas San Miguel's towering eucalyptus were planted almost 90 years ago, and most of the other established trees are over half a century old. The oaks are more recent, but planted well over a decade before the oldest ones at Grigadale.

Basque beginnings

Peter told us that he developed an interest in collecting oaks in the 1980s, perhaps, he says, because of the connection to his Basque ancestors in France, in whose lives oaks would have played an important part. At first he received acorns from foreign nurseries and botanical gardens, including Kew Gardens. After spotting an advertisement for the IOS in a publication of the International Society of Arboriculture, he joined the Society and later attended the 2nd Conference in California. Peter planted tirelessly: over 5,500 trees since 1975, at an average rate of 150 a year, with the majority of the trees being grown from seed. His oak collection numbers 114 taxa, mostly species and some hybrids. Cultivars are eschewed as he prefers to raise his plants from seed. Unlike Grigadale,

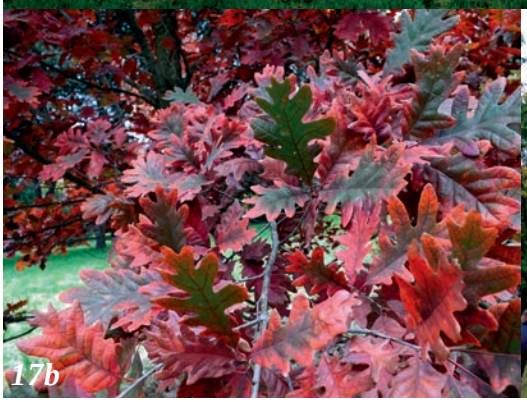
Photo 16/ A group of *Quercus cerris* (Estancia San Miguel).

where in general each taxon is represented by a single specimen, Peter often has several accessions for each species or hybrid in his collection.

Not one, but seven querceta

We began our tour of San Miguel on foot, stopping by several notable trees, (e.g., *Pinus wallichiana* with its banana-shaped cones, *Pinus ayacahuite* var. *veitchii*, a fine-needled Mexican pine, *Metasequoia glyptostroboides*, rarely seen in Argentine parks) on the way to the first oak plantation. Whereas some arboreta have a quercetum (i.e., an area planted exclusively with *Quercus*), San Miguel has seven. In the first quercetum, known as the Rain Gauge Quercetum after the weather station that stands at one end (Peter wryly commented, "It receives more paint than rain!"), we admired a squat and bushy *Q. pontica*, the bristly cupules on the acorns of *Q. variabilis*, the velvety touch of *Q. aliena*'s leaves, and a vigorous *Q. germana* (when I visited San Miguel in 2013, this tree was about 1m tall, it now towered above us, probably over 4 m).

All trees at San Miguel are clearly labelled with a metallic label on which the scientific name has been painstakingly stenciled, one letter at a time, a task that keeps the maintenance staff busy on rainy days. For new plantations, Peter uses cattle ear tags with a unique number that is entered into his "database", which consists of a complex series of annotations in exercise books, combined with many-colored maps that include a code of geometric shapes ("like when we were at school," is how Peter describes it). The system is not infallible, as labels can get lost, and he hopes soon to have it all computerized and every tree precisely mapped using GPS technology.



Photos 17/ (a) Autumnal beauty contest; (b) *Quercus alba*; (c) *Q. acutissima* (Estancia San Miguel).

To reach the other querceta in San Miguel we had to resort to vehicular transport. Fortunately Peter had procured a people-carrying trailer from an agricultural firm he does business with, and the bulk of the party climbed aboard. The remainder piled into several cars (including Peter's vintage Russian jeep), making up a jovial caravan that drove up hill and down dale around the entire park, stopping at numerous points of interest.

Autumnal beauty contest

A group of three *Q. cerris* has grown into an impressive feature, further evidence that this species is well suited to our climes and should be more widely used. Being further inland than Grigadale, autumn was more advanced in San Miguel and several

oaks were beginning to turn and hence received most attention and admiration. A magnificent *Q. alba* won first place in the fall color beauty contest, with a *Q.* ×*bebbiana* (*Q. alba* × *macrocarpa*) coming a close second. Some of the contenders had not yet turned but, based on past performance, a *Q. ellipsoidalis* given to Peter by his brother-in-oaks, Duncan Cameron, was likely to have worn the crown. A stand of *Q. acutissima* was also making an autumnal statement, though in more subdued tones, its leaves just starting to turn yellow, giving an overall impression of chartreuse.

Photo 18/ *Quercus coccinea* (Estancia San Miguel).

All of Peter's oaks modestly cover their ankles, as he does not prune low-lying branches. He cites two reasons for this practice: he considers the trees deserve all the photosynthesizing they can get, but more importantly, the low branches serve as protection against lawn mowers and over-zealous trimmers. He does not hesitate to prune, however, when he spots a co-dominant stem, as San Miguel is subject to punishing tree-toppling gales, and structural weakness can spell doom for a tree. He keeps careful records of each tree's origin and development, noting heights and the first time an oak fruits. So he was especially pleased when, as he presented a fine young *Q. nigra* with the observation that it had not yet fruited, a shout rang out from one of the party who had spotted a solitary acorn on the tree. Amongst the evergreens, a *Q. gilva* was looking luxuriant despite having suffered damage when a tree fell across it, and a *Q. agrifolia* was fruiting copiously.

Photo 19/ The caravan getting ready to depart (Estancia San Miguel).

After a lunch featuring *empanadas*, a typical Argentine stuffed pastry, we formed up for a group photo in front of a flamboyant *Rhus typhina*, and then we motored to more distant querceta on the western end of the park. These more recent plantations are the

Photo 20/ Peter Laharrague and Roderick Cameron examining an oak thought to be *Quercus petraea* (Estancia San Miguel).

result of Peter's participation in IOS seed exchanges. One of his favorite acquisitions is a *Q. crassipes*, which has grown well and swiftly from acorns obtained at the 2nd IOS Conference in California. Here also, the deciduous oaks that were turning color stole the show: amongst the reds *Q. shumardii*, *Q. coccinea*, *Q. buckleyi* stood out, and *Q. phellos* and *Q. dentata* led the team in yellow.

At the far end of the park we walked into a mixed wood, towards a stand of *Q. ilex*, and discovered under their low branches a host of eye-catching mushrooms, the typical toadstools with red tops and white polka dots that one associates with fairy tales. The scientific name is *Amanita muscaria* and it is an introduced species in the Southern Hemisphere, but seemed to be thriving in symbiosis with holm oak. It is apparently hallucinogenic, and may be safely ingested only after parboiling, but we were not able to find a volunteer among us to try. In the same wood *Q. imbricaria* also flourished.

Water, water everywhere (San Miguel version)

In these far flung plantations (we were almost one kilometer away from the homestead) we learnt of Peter's principal tree-related concern: water. He has a large 5,000-liter tank that is pulled along by the tractor, and in summer months especially, a staff member will spend all day visiting the entire oak collection like Kipling's Gunga Din, watering each tree with a hose from the tank, or leaving the entire tank to drain out in an area with four or five trees close by.

It was nearing tea-time (and more importantly, seed distribution time), so the caravan wended its way back through an impressive avenue of *Q. robur* and past the final quercetum with a fine array of young oaks. Peter has created a wood of *Q. robur* by

Photo 21/ *Quercus robur* avenue (Estancia San Miguel).

planting acorns in a plantation of poplars and later felling the poplars once the seedlings were established. The method has proved very successful, and he has written it up in an article in *International Oaks* (Laharrague 2001). The tour ended in Peter's polytunnel, which was crammed with seedlings grown from acorns picked up at the IOS Conference at The Morton Arboretum (2015). As evening fell, a smorgasbord of acorns was offered to all participants, with acorns from both collections we had visited: 47 different taxa. To round off the event, Peter was presented with a seedling of *Q. pringlei* (recall that San Miguel sits in the district of Coronel Pringles) grown from acorns provided by Texan IOS member David Richardson.

Truffles of the New World

The next day saw us 150 km to the northwest, in Espartillar, where we visited the 50-hectare truffle-oak plantation of Trufas del Nuevo Mundo. After an introductory presentation where we learnt about truffle production and the characteristics of the commercial project, we braved a stiff, chilly breeze to visit the planting of over 20,000 trees, principally *Q. robur* and *Q. ilex*.[2] It was an exciting time as the first truffles were likely to be found soon: around several trees we could see the area of weed-free soil, known as *brûlé* ("burnt" in French), which indicates the presence of the truffle fungus underground. We have since learnt that the first truffles were indeed found in August this year, some

2. For detailed information about truffle growing see Cameron 2015; Sourzat 2013.

Photo 22/ Truffle plantation

of them weighing over 200 g and qualified by Spanish experts as being of premium quality.

The visit ended with an *asado* lunch at a nearby restaurant, where we said farewell to new and old friends, bringing to a close a memorable weekend during which many seeds of "oak enthusiasm" were sown. Perhaps this experience can inspire other Southern Hemisphere members to organize local Oak Open Days (New Zealand and Australia, you're on!).

Acknowledgements

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Photographers. Photos 1-11, 14-17a, c, 18, 20, 22: Roderick Cameron. Photos: 12, 13, 17b, 21: Gustavo Belén

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The History of the Fagaceae at Caerhays Castle

Béatrice Chassé
Les Pouyouleix
24800 Saint-Jory-de-Chalais, France
pououleix.arboretum@gmail.com

Introduction

In September 2015, I was contacted by Charles Williams, who had prepared a review of the history of the oaks at Caerhays and thought, justly so, that it would be an interesting subject for this Journal. As I looked through the historical references I thought that indeed it would be exciting to visit Caerhays, and we agreed on the first week of June 2016.

The gardens at Caerhays Castle in Cornwall (UK) are first and foremost recognized for the Magnoliaceae[1], *Rhododendron*, and *Camellia* collections, from both a horticultural and historical point of view. Breathtakingly towering over Porthluney Cove on one side and dominated by the gardens that spread out over 50 hectares on hilly woods on the other, the Caerhays Estate is currently owned by Charles Henry Williams. His great-grandfather, John Charles Williams (or JCW as he was called), who inherited the Caerhays Estate in 1880, is at the origin of the gardens at Caerhays. According to Williams et al. (2011) the purchase by JCW in 1885 of Werrington Park, with its large greenhouse used for orchid propagation, is perhaps what sparked his interest in gardens and in plants, as well as in the business that could be developed with them. His first successful endeavor was with daffodils, of which he produced hundreds of new varieties, becoming a major producer at a time when the market for daffodils exported from the island of Scilly had grown from 68 tons to 197 tons (Williams 1998).

JCW's interest in *Rhododendron*, a genus to which he was to devote much time until the end of his life, dates at least from 1899, as we learn from an article devoted to

Photo 1/ A view from the garden overlooking Porthluney Cove.

1. *Magnolia*, and the genera formerly known as *Michelia* and *Manglietia*, now synonymous with the former.

Caerhays written by a mysterious "V", that appeared in the November 18, 1899 issue of *The Garden* (in Williams 2016): "The happy owner has a fine notion of wild gardening with such things as Azaleas, Hydrangeas and he would like to plant Rhododendrons on a large scale if seedling plants could be got in sufficient quantities." In 1903, "the happy owner" had bought his first 25 Chinese rhododendrons from Veitch Nursery (Exeter) and by 1906, the records of the Caerhays garden show that 50 new species of rhododendrons were being planted (and many of these plants are alive and well at Caerhays today).

Where were these plants coming from? And how did they end up in this Cornish garden? In the answers to those questions lies the root of the extraordinary adventure and historical importance of this garden: JCW was a major sponsor of the botanical expeditions of one of the most important plant hunters of all time, E.H. Wilson. Though this name is most often associated with the Arnold Arboretum of Harvard University, Mr. Wilson began his plant hunting working for Veitch Nursery (with whom JCW collaborated closely) and even when Wilson eventually left for the United States and his new employer, the ties between Wilson and Caerhays were never severed. It is likely that all of the new plants discovered by Wilson were trialed by J.C. Williams at Caerhays. At the end of the description of *Rhododendron williamsianum*, Wilson writes in *Plantae Wilsonianae*, "This species is named for Mr. J.C. Williams of Caerhays Castle, Cornwall, England. The first amateur to appreciate the value of the Rhododendrons of western China; in his garden the best collection of these new introductions is now to be found." (Wilson and Sargent 1913, 538).

One would think that it was luck enough for one person interested in gardening to have had the occasion to collaborate with E.H. Wilson, but JCW was apparently not a man to leave things to luck, and when George Forrest – another of the great plant hunters of the first half of the 20th century – left for China in 1912 for what was to be one of his most successful expeditions, he had one sponsor: John Charles Williams, who continued to finance Forrest's expeditions until the end of his career.

ORIGINAL COLLECTION NUMBER	CURRENT NAME
4506	*Acer caesium* subsp. *giraldii* (Pax) A. E. Murray
498	*Aesculus chinensis* var. *wilsonii* (Rehder) Turland & N. H. Xia
304	*Catalpa duclouxii* Dode
4116	*Magnolia dawsoniana* Rehder & E. H. Wilson
914	*Magnolia sargentiana* Rehder & E. H. Wilson
204	*Prunus pilosiuscula* (C. K. Schneid.) Koehne
4257	*Rhododendron decorum* Franch.
1250	*Rhododendron oreodoxa* var. *fargesii* (Franch.) D. F. Chamb.
4255	*Rhododendron hanceanum* Hemsl.
10955	*Rhododendron morii* Hayata
1810	*Rhododendron orbiculare* Decne.
291	*Styrax hemsleyanus Diels*
313	*Trochodendron aralioides* Siebold & Zucc.

Table 1/ Original Wilson introductions surviving at Caerhays today (adapted from Williams et al. 2011).

Photos 2/ From Forrest's collections: (a) *Rhododendron stamineum* and (b) *Magnolia doltsopa*; From Wilson's collections: (c) *R. davidsonianum* and (d) *R. oreodoxa* var. *fargesii*.

ORIGINAL COLLECTION NUMBER	CURRENT NAME
25184	*Acer pectinatum* subsp. *taronense* (Hub.-Mor.) A. E. Murray
25156	*Camellia saluenensis* Stapf ex Bean
27393	*Camellia reticulatum* Lindl.
24190	*Cinnamomum glanduliferum* (Wall.) Meisn.
25197	*Camellia sinensis* (L.) Kuntze
24030	*Lindera communis* Hemsl.
26509	*Magnolia nitida* W. W. Sm.
24214	*Magnolia campbellii* Hook. f. & Thompson
26506	*Magnolia insignis* Wall.
26580	*Magnolia doltsopa* (Buch.-Ham. ex DC.) Figlar
24183	*Quercus lamellosa* Sm.

Table 2/ Original Forrest introductions surviving at Caerhays today (adapted from Williams et al. 2011).

J.C. Williams' interest in Fagaceae

In the Caerhays Castle library can be found a copy of Vol. 23, No. 151 of the *Botanical Journal of the Linnean Society*, which contains the second part of "An Enumeration of all the Plants known from China Proper, Formosa, Hainan, Corea, the Luchu Archipelago, and the Island of Hongkong, together with their Distribution and Synonymy" (Forbes and Hemsley 1886). It includes the Quercineae of the Cupuliferae, and the text is annotated by J.C. Williams, showing that these plants were lighting a new fire of interest for him.

The situation with oak planting at the beginning of the 20th century in the UK is fairly well summed up by Bean (1915, 299): "Perhaps no genus of trees is so extensively represented at Tortworth[2] as *Quercus*. Unhappily it has long ceased to be the fashion to plant exotic oaks and owing to this neglect nurserymen do not find it worth while to stock representative collections such as one might have found in older days….Mr. Vicary Gibbs has got together an extensive collection at Aldenham, but many are yet comparatively small. And at Kew there is a collection (of trees) unequalled as far as I know…but the Kew soil is too light and dry for oaks as a whole." Four years later, in 1919, Mr. Gibbs published an article in the *Journal of the Royal Horticultural Society* about the oaks of Aldenham, that begins: "Just seventeen years ago, namely in 1902, I was in Dresden. Having heard of a fine tree nursery some thirty miles to the east…made an expedition… to visit it. I found there, among other interesting trees, a great many out-of-the-way oaks, and…secured a number of them…Although arboriculture is in much greater vogue than it was when I first started to collect…yet oak-growing is necessarily such a slow business that any comprehensive gathering of the order Cupuliferae is still, and is likely long to remain a rarity." (Gibbs 1919, 155).

According to Charles Williams, Mr. Gibbs' article may have been what prompted his great-grandfather's interest in oaks. This seems quite plausible given the reputation of the gardens at Aldenham House, particularly renowned up until the mid-20th century. "There are few gardens which command attention from every point of view: gardens which contain numerous exquisite pictures in the natural style, yet in parts are formal; gardens in which trees and shrubs are used lavishly to produce fine landscape effects, and yet are treated as individuals of botanical interest, forming collections which embrace the

2. The arboretum at Tortworth Court, was created by the 3rd Earl of Ducie. Today the property is a hotel (the De Vere Tortworth Court) that boasts one of Britain's finest arboretums with 300 rare and protected trees.

Photos 3/ (a) *Rhododendron keysii;* (b) *Magnolia wilsonii*.

newest and rarest species; gardens which have the area of great public parks and yet have the distinction and refinement of the best private places; such a garden exists, however, a few miles from London. In the whole history of garden art, long and remarkable as it is, there has been no achievement more admirable, more satisfying, than that which has been accomplished at Aldenham House, in Hertfordshire." (Gothein 1928, 372). The estate was sold in 1932, after the death of Vicary Gibbs, and most of the plant collection, reputedly larger than the one at Kew, auctioned (Le Lievre 1986).

After spending much time reading through Caerhays' records, Charles Williams has come to the conclusion that "…while many rhododendrons came to Caerhays from Forrest's 1921/2 expedition, very few did so from his 1924/5 expedition. JCW's interest and emphasis in the garden had moved on." (Williams 2016). In the Caerhays Garden Diary[3], started in 1897 by JCW, there are entries as early as 1920 indicating that oaks retained his interest in between magnolias and rhododendrons. From October 11, 1920: "The villages and towns of Cornwall all lack water in many places as never before, but things like evergreen oaks, magnolias and the smaller rhodo's [sic] in well dug and well mulched beds look very well indeed." By 1921 Caerhays was home to at least 26 evergreen oaks and 28 deciduous oaks (Williams 2016) and a Garden Diary entry from that same year tells us that planting was underway: "We have just finished the big rookery clearing except for the planting of five evergreen oaks."

To the modern oak lover, "evergreen oak" evokes images of *Cyclobalanopsis*, along with some of the Mediterranean and, of course, the more tropical species. In JCW's time, the distinctions between *Lithocarpus*, *Castanopsis*, and *Quercus* had not been clearly defined, and many, many species that today are part of the genus *Lithocarpus* were at that time classified as *Quercus*. Most, though not all, of the evergreen oaks referred to as such by JCW were, as far as can be surmised from existing records, *Lithocarpus*.

3. Started in 1897 by J.C. Williams this Garden Diary has been kept alive with no interruption by four generations of the Williams family: J. C. Williams, Charles Williams, F.J. Williams, and Charles H. Williams, with an entry for nearly every day. Charles H. Williams, who continues to make entries nearly every day, has had all of the entries since 1897 transcribed (an enormous task) and they are available on the Caerhays website (http://thediary.caerhays.co.uk).

Two entries by J.C. Williams, on loose sheets of paper tucked into the Garden Diary, one dating from 1922 and one from 1927/1928, list the oaks planted in those years. Warburg and Warburg (1933, 176), in an article on the oaks in cultivation in the British Isles, indicate that "…many rare species from Eastern Asia are growing at Caerhays." The situation had apparently changed significantly since Bean's 1915 article, because by 1933 the "network" of oak enthusiasts in the UK included, in addition to those referred to by Mr. Bean (Kew, Tortworth, and Aldenham), Wakehurst, Woburn, Borde Hill, Westonbirt, Headley… and Caerhays, where both *Q. championii* and *Q. augustini* are listed as growing (Warburg and Warburg 1933). In addition, most of the oaks cited by Bean (1915) are from North America and Europe, with the only two Asian representatives being *Q. glauca* and what was called at the time, *Q. vibrayeana*, (today, *Q. myrsinifolia*). From what I have been able to ascertain, today *Q. championii* is not in cultivation anywhere.

NAME GIVEN	CURRENTLY VALID NAME	ORIGINS
dentata	Unchanged (author: Thunb.)	Edinburgh RBG
acuta	Unchanged (author: Thunb.)	Kew RBG, Dickinson's (Chester)
phyllireoides [sic]	*Q. phillyreoides* A. Gray	Wakehurst Place
engelmanni [sic]	*Q. engelmannii* Greene	
densiflora	*Notholithocarpus densiflorus* (Hook. & Arn.) Manos, Cannon & S. H. Oh	
marilandica	Unchanged (author: (L.) Münchh.)	
agrifolia	Unchanged (author: Née)	
glabra	*Lithocarpus glaber* (Thunb.) Nakai[1]	Veitch Nursery, Wakehurst Place, Kew RBG

Table 3/ From the Garden Diary, a list of the oaks planted at Caerhays in 1922. The origin of some of the oaks that arrived at Caerhays before 1922 has been established by Williams (2016). 1. Very probably *Lithocarpus edulis*.

FORREST'S COLLECTION NUMBER	NAME GIVEN	CURRENTLY VALID NAME
21200	fenestrata	*Lithocarpus fenestratus* (Roxb.) Rehder
21115	delavayi	Unchanged (author: Franch.)
24122	concolor	*Castanopsis orthacantha* Franch.
24189	lamellosa	Unchanged (author: Sm.)
24758	caudata	*Castanopsis eyrei* (Champ. ex Benth.) Hutch
25330	tribuloides	*Castanopsis tribuloides* (Sm.) A. DC.
26102	henryi	*Lithocarpus henryi* Seemen
26010	lamellosa	Unchanged (author: Sm.)
26563	tribuloides	*Castanopsis tribuloides* (Sm.) A. DC.
26612	hystrix	*Lithocarpus hystrix* (Korth.) Rehder
26600	hystrix	*Lithocarpus hystrix* (Korth.) Rehder
27431	augustini	Unchanged (author: Skan)

Table 4/ From the Garden Diary, a list of the oaks planted at Caerhays between 1927 and 1928. Only specific epithets are indicated except for the entry *"caudata"*, that is followed by the word *Castanopsis*.

Photos 4/ ***Craibiodendron yunnanensis***

The Fagaceae *at Caerhays today*

With some notable exceptions, nearly none of the original Wilson or Forrest collections of Fagaceae that arrived at Caerhays are still alive today, and many of the plantings from before 1939 from other sources have also disappeared. Nevertheless, planting of oaks and lithocarps have continued into the 21st century. Admittedly, in this garden one has to search for the Fagaceae and not be distracted by all of its other marvellous inhabitants that include, in addition to the magnolias and rhododendrons, *Meliosma alba* (labeled as *Meliosma beaniana*), *Stewartia pteropetiolata* (one of Forrest's original collections), and *Craibiodendron yunnanensis* along with a great many *Enkianthus*.

a) Mature specimens

Entering the garden by the "Red Route"[4] (that we followed for a bit, eventually cutting across secondary paths to join up with the "Blue Route"), we are greeted by a magnificent *Lithocarpus pachyphyllus* (a UK Champion Tree, planted in the early 1920s) that I'm sure attracts even rhododendron and magnolia lovers with its incredible "stone fruit" and lovely leaves. Not far, there is a group of four (though there used to be six) very

Photos 5/ The "stone fruit" of *Lithocarpus pachyphyllus.*

healthy and vigorous *Q. myrsinifolia*. A 36-year old, not-very-often-seen-in-collections *Nothofagus fusca* attracts my attention, as does a very beautiful *Q. dentata*. A *Q. phillyreoides* growing in the midst of a few *Q. acuta* snakes its way up to the sky in search of light. This is not a tree that grows very vigorously in my arboretum in France (Arboretum des Pouyouleix) so it was a pleasure to see one with such a gust for life! Set off from this group of trees though not very far, is one of the *Quercus* stars of the show: an extraordinary multi-stemmed *Q. acuta*, also a UK Champion Tree (14 m tall with a girth of 1.77 m) planted in the 1920s.

4. There are many paths one can take to visit this garden (the Red, Blue, Green, and Yellow Routes, plus numerous others that are not named). Along the "colored" routes, many plants are labeled and information about them can be found, along with the garden map, in the Caerhays Castle Garden Guide that can be bought in the shop at the garden entrance.

Photos 6a-b/ *Quercus acuta*

Within this group of trees, there is one that is not labeled that I think is *Q. aliena*. In the records that exist, *Q. aliena* var. *acuteserrata* is listed as having arrived at Caerhays, but the tree that I saw seems more like the type, based on the size of the leaves and the absence of greyish pubescence on their undersides. The brown spots on the leaves are apparently the result of salt spray – the price to pay for having such a spectacular view!

Photos 7/ *Quercus aliena*

At least three plants of *Q. glabra* are recorded as having been planted at Caerhays, one of which survives today as a vigorous side shoot. Today this plant is considered a member of the genus *Lithocarpus*, but the question is: *L. glaber* or *L. edulis*? My opinion, shared by others, is that it is *L. edulis*. The fact that *L. edulis* is not recorded as having been planted at Caerhays is not conclusive proof for we do not know if what was received as *Q. glabra* was correctly identified to begin with (see Bean 1973).

Lithocarpus is not a genus that one generally finds well-represented in collections in Europe but here at Caerhays there are many splendid specimens that I have never seen in cultivation. These include, in addition to the above-mentioned *L. pachyphyllus*: *L. uvariifolius*, with its hand-sized, wrinkly textured leaves,

Photos 8/ *Lithocarpus edulis*

L. cleistocarpus, with its dainty, red, new growth, and *L. henryi* and *L. hancei* both planted in the 1920s. A more recently planted tree, labeled *L. corneus*, with long, slender leaves and bronze red new growth looks more like *Q. sessilifolia*.

A fine (and absolutely impossible to misidentify) *Q. lamellosa*, that pays tribute to Forrest's 1924 expedition to Burma and Yunnan (No. 24183), was waiting for us not far away. Though it suffers during even mild frosts and has often to be cut back, it is yet another UK

Photos 9/ (a) *Lithocarpus uvariifolius*; (b) *L. cleistocarpus*; (c) *L. corneus* or *Q. sessilifolia?*

Champion Tree. I was surprised to see that the tree had already dropped nearly all of its leaves although we were only at the very beginning of summer, but new growth was already apparent in many spots.

Three unlabeled trees, obviously Fagaceae, give us reason to stop and ponder. My opinion is that the first one (see Photo 11) is *L. variolosus*, also obviously suffering

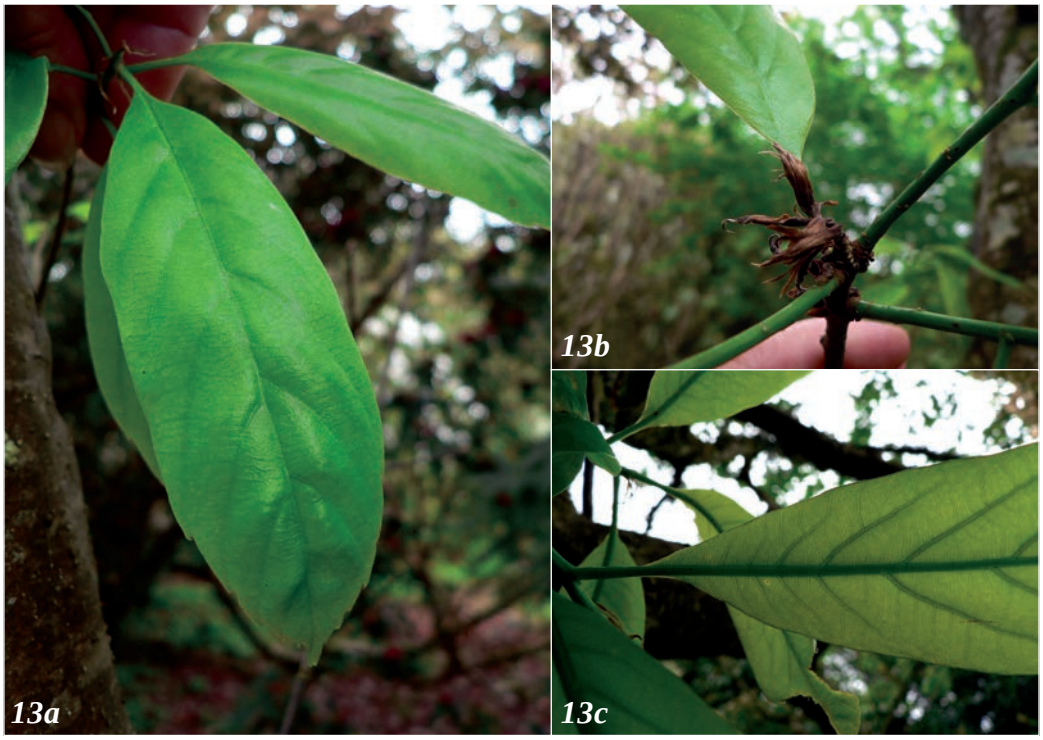
Photo 10/ *Quercus lamellosa*

Photo 11/ *Lithocarpus variolosus*

from salt spray; the second perhaps *Q. augustini* (see Photos 12 a-b); the third remains a mystery (see Photos 13 a-c): *Cyclobalanopsis* or *Lithocarpus*?

The morning was coming to an end as we passed by a very elegant *Q. ×libanerris*, and a medium-sized, as always very pretty, *Q. semecarpifolia* on our way to see a much sought-after rarity for oak lovers, *Q. oxyodon*. This one, planted before 1920, is alive and well, and still another Champion Tree for this garden – though today not the only mature specimen in the UK (the one planted at Nymans fruited abundantly in 2013 and the seed seems to breed true). A younger *Q. oxyodon*, planted in the 90s from seed collected by Tom Hudson in Vietnam, is also doing well. Although certainly one can find morphological differences between the two, both are well within the variability of the species. We know today, from various studies, including the recent sequencing of the entire genome of *Q. robur*, that, generally, genetic variation between two individuals of the same species of tree is significantly higher than between two individuals of the human species. Therein lies the

Photos 12a-b/ *Quercus augustini*



Photos 13a-c/ *Cyclobalanopsis* or *Lithocarpus*?

importance of seeing plants in their natural environment in order to grasp the scale of intraspecific variation…and to think twice the next time we feel like saying, "Oh no, that doesn't look like my *Quercus* (fill in the blank).

Photo 14/ *Quercus oxyodon*

Photo 15/ *Quercus griffithii*

b) Younger trees

During the afternoon I went off on my own to check out an area that we had only passed along during the morning and where there were young, recently planted oaks. A specimen labeled *Lithocarpus* sp. 5956 is, I believe, *Q. griffithii*. *Quercus stenophylloides* (CMBS 640; planted in 2008) and *Q. morii* (CMBS 642; 2009), two Taiwan endemics, looking very healthy, can be found here as well as *Q. gilva* (CMBS 691; planted 2009), all three gifts from Allen Coombes. There were also several young Red Oaks, seemingly having a bit of a hard time, including *Q. velutina*, *Q. buckleyi*, and *Q. wislizeni*.

In Giddle Orchard, a part of the Arboretum that is not open to the public and that is near the ruins of a walled kitchen garden, a handful of Mexican oaks were planted in 1999, and had been pretty much left to their own devices since then. So on my second day at Caerhays Michael Levett took me to go and look for them. Michael is responsible for labeling and recording details of new plantings, as well as for propagation. Of the four species that were planted – *Q. acutifolia* (the plant grown under this name is

Photo 16/ *Quercus grahamii*

Photo 17/ *Quercus candicans*

now known as *Q. grahamii*), *Q. candicans*, *Q. lancifolia*, and *Q. uxoris* – only the first two are still present, although the *Q. candicans* is not in the vertical position that trees generally assume. It must have been knocked down by wind, and from the now horizontal trunk dozens of traumatic reiterations have been produced. The bright red new growth of the leaves, typical for this species, is what signaled its presence to me through the brush and branches. While we deplored the disappearance of the other Mexican species, a stroll further behind and lower down from the *Q. candicans* revealed a *Q. variabilis* struggling to have its head in the sun but alive nevertheless.

Photo 18/ *Quercus affinis?*

Photo 19/ *Quercus macranthera*

Behind Caerhays Castle, towards the bay, there is another area called Penvergate, also not open to the public, which Michael took me to see after Giddle Orchard, to hunt for a few oaks that were presumably planted there in the year 2000. If indeed we were looking in the right place, all of those seem to have gone

missing except for one brave little plant who has obviously been mowed over or chomped on more than once. It seems to me that this is a Mexican oak – maybe *Q. affinis*? In this same area there are several other mature oaks including *Q.* ×*hispanica* and what I think is *Q. macranthera* though it is labeled *Q. canariensis*.

Conclusion

The gardens at Caerhays, like any garden with such a long history, have been through many ups and downs. Amongst the latter, exceptionally cold winters, historic drought, devastating storms, and two world wars. Included in the former would be the uninterrupted line of enthusiastic owners who have inherited the estate and a passion for plants. Charles Williams believes that to be a great garden Caerhays must continue to provide an esthetic dimension that caters to the general public while continuing to preserve and propagate rare and unusual plants.

Acknowledgements

My gratitude goes to Charles Williams for having had the idea to contact me about the oaks at Caerhays, for taking the time to show me around the garden, and for his lovely gift of *Lithocarpus uvariifolius*; and equally to Charles and Lizzie Williams for their generous hospitality. My appreciation goes to Michael Levett and Jaimie Parsons for taking time out of their busy schedules for me. Thanks also to Antoine Kremer and Harry Baldwin for their help in obtaining certain historical documents about oaks in cultivation in the British Isles, and to Allen Coombes, Min Deng, Jean-Louis Hélardot, Thierry Lamant, and Keiko Tokunaga for spending time puzzling over some identification questions.

Photographers. Photos 1-19: Béatrice Chassé.

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Oak Open Days
Heanley Farm and Thenford House, UK
July 17-18, 2016

Christopher Carnaghan
Kings Langley, WD4 8EY, Hertfordshire, UK
cc@ilex.me.uk

Heanley Farm,[1] 17 July

It's a particular pleasure to visit the collections of fellow IOS members, and so it was when a score of fellow members gathered at the house of David and Carol Gooder, some 15 miles northeast of Birmingham in the English Midlands. After a warm welcome (and a tasty breakfast for the hungry) we were in fine fettle for a day studying and admiring a very promising young collection of oaks.

Being further inland than Gredington (an Oak Open Day 2015 destination, see this volume pages 95-104), which lies 50 mi northwest, the climate is slightly drier and cooler, annual rainfall being about 28 in, including the occasional drought. The clay soil is fairly heavy but good for most woody plants as long as the ground is neither compacted nor liable to become waterlogged – wet ground can be a particular problem here for new plantings.

The mean annual temperature is around 48 °F, satisfactory conditions for most temperate oaks. There can be rapid fluctuations of 18 °F or more from one winter's day to the next, but David noted that while there is frost most winters, mainly at night, during the last 30 years the temperature has fallen below -10 °C in only two or three years. His aim is to challenge this climate by growing oaks that would seem unlikely to do well in central England. So all new plantings are protected from the cold (and rabbits) by tree guards, more tender subjects being coddled in winter in two strips of material up to 6 ft.

The collection is split in two: the garden of some 3 ac that spreads around the house, developed from 2005, and the 13-ac arboretum created in nearby Halloughton Grange, developed from 2011, that is devoted principally to oaks. David lists roughly 400 oak taxa throughout the two sites, 300 botanical taxa (of which 100 are hybrids) and 100 cultivars. David gets his plants/seeds from many sources, including from commercial nurseries (e.g., BlueBell, Birchfleet, Mallet Court, Pan-Global, Pavia – really, as David exclaims, "from any nursery that claims to have oaks!"), fellow enthusiasts (notably, the late Michael Heathcoat Amory, and Béatrice Chassé), and from IOS seed exchanges. David has also contributed over the past few years to financing various expeditions to Mexico, Vietnam, and Taiwan.

Summing up his experience to date, David comments that "The Asian oaks seem perfectly happy. *Q. castaneifolia* is particularly successful. *Quercus semecarpifolia* always looks healthy and *Q. dentata*, including its cultivars and hybrids, as well as *Q. acutissima*, also appear happy. *Quercus griffithii* and *Q. fabri* have struggled and the jury is out on *Q. leucotrichophora* and *Q. aliena*. Most of the *Cyclobalanopsis* are not very enthusiastic, and at best are very slow. For the American species, most Red Oaks are growing well and are among the most vigorous trees we have. The White Oaks on the other hand are a fairly sickly group, although some of the bushy species such as *Q. pacifica* are White Oak successes. Some Mexican oaks are growing really well. *Quercus rysophylla* and its hybrid *Q.* 'Zehra' (*Q. rysophylla* × *falcata*), *Q. acherdophylla*, and *Q. affinis* plus a number of hybrids seem to like the conditions. *Quercus rugosa*, *Q. castanea*, and *Q. laurina*, plus less hardy plants including *Q. delgadoana* are coping so far. As one might expect, most European oaks are doing well, starting with *Q. alnifolia*, the golden oak endemic to the Troodos mountains of Cyprus,[2] but also including those from southern Europe that seem to enjoy a good supply of rain. *Quercus coccifera* subsp. *calliprinos*, *Q. faginea*, and

1. For additional information about the oak collection at Heanley Farm see Van Hulle 2016 ; Snyers 2014.
2. For a full account of the history of this taxon, see Jablonski 2013.

especially *Q. canariensis* and *Q. frainetto* are particularly successful. Having grown up with *Q. robur* it is easy to overlook it, but various cultivars including fastigiate types are becoming real trophies."

Oaks in the garden

The Gooders' lovely garden contains many different plants in addition to the oaks that can be found there. More than many Mexican species, *Q. affinis* seems at ease in temperate (but occasionally freezing) west European maritime climates – and the tree here is no exception. Other Mexican oaks that are happy here include *Q. candicans*, a very versatile oak that grows on calcareous or volcanic soils across a very wide distribution in its home country, and *Q. miquihuanensis*. The latter species is a pretty little shrub oak with a pale indumentum under the leaves, sometimes accused of being a rhododendron when not sporting its precocious acorns. It was introduced to France by Carl Max Schoenfeld in 2000 and first grown by IOS member Olivier Colin near Paris. It was subsequently introduced to the UK by IOS member and nurseryman Nick Macer.

David considers that *Q. miquihuanensis* may well be his favorite oak, and has four of them. The largest was acquired from Nick Macer at about 2 ft and was planted straight into the garden. It seems very hardy, has masses of acorns and after some four years is now about 8 ft tall – a delightful addition to the collection. Two smaller specimens that came from Mark Fillan are bushier in form. A

Photo 1/ *Quercus affinis* (Heanley Farm).

Photo 2/ *Quercus candicans* (Heanley Farm).

Photo 3a-b/ *Quercus miquihuanensis* (Heanley Farm).

fourth, received from Béatrice Chassé, and still in the polytunnel, is actually *Q.* aff. *miquihuanensis* (originally referred to as *Q.* 'Autopista'); it is waiting to be officially described and named.

Quercus alnifolia, with its rich yellow indumentum, is indeed doing well as David remarked earlier, as is *Q. castaneifolia* that is starting to show its "elephant-skin" bark, one of the few non-Mexican oaks (perhaps the only one) that develops this characteristic when young. Always an eye-catcher, *Q. dentata* 'Carl Ferris Miller', selected at Arboretum Hemelrijk in Belgium from South Korean seed, and named after the noted American-born collector who founded the Chollipo Arboretum in Korea, is also a fine specimen here. The acorns of *Q. dentata* are amongst those used in Korea to produce a jelly called *dotorimuk*; does this handsome selection perhaps offer jelly of a superior quality?

Another fine Asian oak here, *Q. leucotrichophora***,** has delightful, almost purple, young shoots. It is morphologically close to both *Q. lanata* and *Q. franchetii*, and it is also somewhat of a taxonomic headache. In the Oak Name Checklist these three species are considered valid taxa. In the *Flora of China*, however, *Q. leucotrichophora* has been put into synonymy with *Q. lanata*, while in the World Checklist of Selected Plant Families *Q. leucotrichophora*, *Q. lanata*, and *Q. franchetii* are all accepted as species, but *Q. leucotrichophora* has changed names to become *Q. oblongata* for reasons of priority.

Photo 4/ *Quercus alnifolia* (Heanley Farm).

David's specimen of *Q. cerris* 'Curly Head', an interesting recent selection from the Netherlands, is a fine illustration of the name, showing the small, curly foliage that turns bronze in autumn and developing the characteristic dwarf upright habit.

Photo 5/ *Quercus cerris* 'Curly Head' (Heanley Farm).

David has four *Q. oglethorpensis*, named after Oglethorpe County, which was named to honor General Oglethorpe who established the British colony (later state) of Georgia. This species is considered Endangered on the IUCN Red List, having such a limited range in the Southeastern USA.[3] In Europe, as elsewhere in cultivation, it often suffers from the disfiguring fungus anthracnose, with multiple shoots sometimes forming where the original shoot was killed; but happily one of the trees here appears healthy. One of a pair that came from IOS member Dirk Benoit has been "drawn up" by surrounding trees to more than 8 ft and thus tends to flop a bit. David doesn't feel that any of them look particularly healthy, but will stick by them as they are endangered. He mentioned that Grimshaw and Bayton (2009) state that the species in Europe tends to look "unshaven" due to the anthracnose problem.

I also noted a fine specimen of *Q. palustris* 'Green Dwarf', a slow-growing selection of the North American pin oak, with a dense, bushy habit, that has glossy leaves that turn a rich red and orange in autumn, as well as an attractive *Q. semecarpifolia*, an evergreen from the Himalayas with glossy leathery leaves, growing strongly. Like *Q. alnifolia* it's a golden oak, sporting a rich and appealing yellow indumentum.

Two recent cultivars studied and named by IOS member Eike Jablonski also caught

Photos 6a-b/ *Quercus pacifica* (Heanley Farm).

3. See Coombes and Coates 1996; Lobdell 2017, this volume, pages 41-48.

my eye: a hardier-than-average selection of *Q. suber*, named 'Sopron', and the striking *Q. texana* 'New Madrid' (selected by Guy Sternberg from seed collected from a tree at a roadside rest area in southern Missouri).

A small nursery area, including a polytunnel, houses promising young saplings, including *Q. mohriana* with its pleasing grey-green leaves, a drought-tolerant species, mainly from West Texas but also found in Oklahoma, New Mexico, and Mexico (Coahuila). *Quercus insignis* from southern Mexico and Central America is unlikely to be fully hardy here but is happy in the polytunnel. Last year a specimen produced acorns at Hackfalls Arboretum in New Zealand, the first record of this species fruiting outside its home range, serving as a tribute to the 100th birthday of Hackfalls founder and IOS member Bob Berry. Two good specimens of the scrub oak *Q. pacifica*, native to the Channel Islands of California, also caught my attention.

The wide palette of Mexican oaks that have been made available over the past ten years are well-represented here in the garden and in Halloughton Grange – with at least one extremely rare in cultivation, *Q. albocincta*. David has two *Q. albocincta*, grown from seed by Nick Macer, that were planted about five years ago. The specimen in Halloughton Grange is already 6 ft tall, boasting handsome grey bark and soft shiny foliage in green and bronze. David is concerned that this species is not very hardy, and it has as yet only been through very mild winters. (The other specimen is in the Gooders' garden).

Photos 7a-b/ *Quercus albocincta* (Heanley Farm).

Halloughton Grange

Photo 8/ Halloughton Grange (Heanley Farm).

From the Gooders' garden we moved to Halloughton Grange. Prior to 2011 this was arable land, with heavily compacted clay that lies over faster-draining gravel. Extensive soil testing was helpful in determining the work needed to reduce compaction and improve drainage before planting could begin. Mature woodland, including *Q. robur*, provides good windbreaks on two sides, but the other two sides were largely open to the prevailing southwest winds, so David began by planting vigorous species – *Pinus sylvestris* (Scots pine) and *Betula pendula* (silver birch) – to shelter the young oaks. The pines may stay, but the birches will surely have disappeared before the oaks reach maturity.

Protection also comes from *Nyssa*, *Liquidambar*, and *Sorbus* mixed among the oaks. Most planting is in avenues – some curving, some straight – to facilitate mowing. In contrast, towards one corner of the arboretum there is a sturdy young hedge, curling around some of the more tender oaks, that incorporates many of the 100-plus taxa of *Crataegus* planted by David. In Halloughton Grange the range and variety of oaks is impressive – too many to highlight in this short report, but I include here those that for one reason or another attracted our group's attention.

Of the Asian oaks, there is a good example of the handsome, hardy, and widely-grown East Asian native, *Q. acutissima*. *Quercus salicina*, a rare and charming medium-sized evergreen from Japan, Korea, and Taiwan (close to *Q. stenophylloides*) produces small yellow-green leaves with touches of bronze in the young growth. David has had some trouble with this species, though this is perhaps because the first two he planted were too small (and died in their first year). After keeping two others in the polytunnel for four years, they were planted last summer and so far are looking good.

There is an especially good specimen of the all-too-rarely planted *Q. dentata* subsp. *yunnanensis* and a handsome tree, 3-ft-tall tree, of the very frequently planted Trompenburg hybrid *Q.* Pondaim Group (*Q. dentata* × *pontica*) that appears to be settling

Photos 9/(a) *Quercus dentata* (b) *Q. dentata* subsp. *yunnanensis* (Heanley Farm).

Photos 10/ (a) *Q. sartorii*; (b) *Q. greggii* (Heanley Farm); (c) *Quercus laurina*; (d) *Q. emoryi*.

in nicely. David planted *Q. pannosa* (Chinese golden oak that can be found at up to 14,000 ft) in June 2015 and it has grown about 30 cm since then. *Quercus phillyreoides*, the hardy evergreen from the Far East, of variable habit (sometimes shrubby) is not extremely vigorous, but it is perhaps too soon to tell what its future will be.

Quercus canbyi, a medium-sized Red Oak from northeastern Mexico, endangered in the wild, fast-growing and semi-evergreen, is a good first choice if one only has one Mexican in the garden, as David's fine specimen attests. IOS member Thierry Lamant has been heard to suggest that *Q. canbyi*, *Q. cupreata*, *Q. graciliformis*, and the as yet undescribed "Langtry" oak (alleged by some to be *Q. canbyi* × *gravesii*) are all part of a cline of fast-growing oaks stretching from Texas southwards into Mexico. *Quercus delgadoana*, previously part of *Q. eugeniifolia*, from which it was split in 2011, is a rare species of high altitude forests in a small area of eastern Mexico. It is one of the very good introductions of the past few years, performing well for many – and the tree here is proof of this. *Quercus* ×*dysophylla*, a fixed hybrid between *Q. crassifolia* and *Q. crassipes*, can be found in the wild without its parents. David obtained a pot from Mark Fillan that contained around 15 plants of *Q.* ×*dysophylla* with a variety of different forms. This, which we took to be the real thing, is a rather gawky specimen around 12 ft tall.

Quercus germana is a handsome evergreen White Oak from Mexico, where it is

becoming rare in the wild. Rather tender, it may struggle to reach maturity in this part of the UK. David will have to keep us posted on their progress as the four in his collection were planted in June of last year, and have thus only gone through a very mild winter. *Quercus laurina*, with rich red to light green foliage, is a tall-growing Mexican Red Oak close to *Q. affinis*. These two species have struggled here a bit, although David notes that one of the *Q. laurina* has now reached a height of 9 ft and seems to be coping well. *Quercus rugosa* that comes from the temperate Mexican highlands is also doing quite well.

Photo 11/ *Quercus libani* 'Angustifolia' (Heanley Farm).

The roll call of North American oaks includes *Q.* ×*bushii*, the well-established cross between *Q. marilandica* and *Q. velutina* (often labeled as the latter in European collections) that occurs readily in nature, is a beautiful tree, here as elsewhere, as is *Q.* ×*capesii*, a naturally occurring cross between *Q. nigra* and *Q. phellos*, found locally in Alabama, Arkansas, the Carolinas, Louisiana, New Jersey, and Texas, that prefers moist or even wet soils. It has narrow leaves, like those of *Q. phellos*, but with the typical lobing of *Q. nigra*. It can be semi-evergreen, and can make a tall tree. *Q. palustris* 'Green Pillar', a provisionally accepted name, is another excellent pin oak selection doing well here, that grows first narrow and upright, then slightly spreading, with fine red to orange autumn color. To be noted also, *Q.* ×*runcinata*, found in Central and Northeastern USA, is one of many hybrids between *Q. rubra* and other species, in this case, *Q. imbricaria* (shingle oak).

Quercus wislizeni, interior live oak, is an evergreen Red Oak from California and Baja California with dark green leaves and pleasing bark – and was fruiting well for us! It was named after Frederick Wislizenus (1810-1889), the German-born botanist, explorer and plant collector who travelled extensively in the Southwestern United States. According to David, here *Q. wislizeni* does better than *Q. agrifolia*, coast live oak, another Red Oak from California and Baja California, which is surprising given the relative performances of the two in cultivation in many other places.

As David had remarked earlier, the European oaks are generally good performers and among these to be noted in Halloughton Grange is *Q. frainetto* 'Dözce' a provisionally accepted name for a vigorous selection of the splendid Hungarian oak – here it has grown already up to 10 ft. Though it's native range is the Mediterranean Basin and North Africa, *Quercus coccifera* subsp. c*alliprinos*, a subspecies of the Kermes oak, also seems quite at home in the English Midlands

Photo 12/ *Quercus vulcanica* (Heanley Farm).

Carol and David provided us with a delicious lunch in an airy marquee erected in the center of the arboretum. Lunch was prolonged by animated discussion about oaks, as was the tea and cake that they served us on our return to their garden from Halloughton Field – a very agreeable way to round off an excellent day.

Thenford House,[4] 18 July

Photo 13/ Part of the formal gardens.

After spending the night in nearby Banbury, we arrived at the substantial Thenford Estate, of medieval origin, that lies at the southern end of the Midlands in the fertile farming land where Oxfordshire and Northamptonshire meet. The fine 18th century house, with largely neglected gardens, was purchased by Anne and Michael Heseltine in 1976. Forty years on, the now Lord and Lady Heseltine describe how they have restored and developed the garden, notably reviving the arboretum, in the just-published *Thenford: The Creation*

4. Since 2017, the grounds are open to the public several times a year. Access details, as well as more information about the oak collection are available on the new website (http://thenfordarboretum.com/).

of an English Garden (Heseltine and Heseltine 2017).[5]

Thenford is today a dexterous and significant reworking of the original landscape design. The tree-girted park still winds around the house, the latter looking down a long grassy slope to the lake, beyond which lie medieval fish-ponds, now dredged, and the expanding arboretum. Two small new bridges – one wooden, one stone – have been designed by the innovative engineer Christopher Wallis. Surface water draining down the slope has been channeled into a peaceful rill that, adorned by fountains and flanked by finely-clipped yews, runs gently through a series of small basins.

For their landscape development and planting the Heseltines called on the help of Lanning Roper, the American landscape architect and garden designer (who also worked for the Prince of Wales). The distinguished nurseryman Sir Harold Hillier recommended and supplied material; and after his death in 1985 he was succeeded as adviser by expert plantsman Roy Lancaster. Former IOS President Allen Coombes has also given advice, not least on the growing oak collection.

The walled garden has been restored and entirely remodeled. It now includes herbs, pleached fruit trees, ornamental borders, climbers relishing the high brick walls, glasshouses, an elegant aviary replete with gaudy parrots, works of art, and a handsome central fountain. Nearby is a striking sculpture garden. All is immaculate, and – like the rest of the estate – a credit to the gardening team.

Photos 14a-c/ *Quercus semecarpifolia* (Thenford House).

5. Intended for a broad readership, the book does mention the oak collection, and contains photographs of an interesting selection of just a few of the oaks, including *Q. affinis*. *Q. argyrotricha*, *Q. coccifera* subsp. *rivasmartinezii*, *Q. dentata* 'Carl Ferris Miller', *Q. durata*, *Q. rubra* Aurea Group, *Q. rotundifolia*, and *Q. semecarpifolia*.

Photos 15a-b/ *Quercus affinis* (Thenford House).

The oak collection

Thenford's plethora of plants comprises some 3,500 taxa, mainly of woody plants, including over forty national or county champion trees and national collections of *Cotoneaster*, *Buxus*, and *Galanthus*. While there is much else to enjoy this report will naturally focus on the outstanding collection of oaks. It is currently being examined, digitally relisted and mapped by IOS member Hugh Angus, but safe to say that there are over 350 different taxa, many of them from wild-collected seed. Michael is one of a group of quercophiles (of which the late Michael Heathcoat Amory was a leading light) that has sponsored the pursuit of *Quercus* in the wild by notable collectors such as Chris Chadwell, Béatrice Chassé, Allen Coombes, and Keith Rushforth. The garden bears rich witness to their efforts, and Michael has generously shared surplus seed with other enthusiasts and botanic gardens.

Some 30 strong, our group was welcomed at the smart new Visitor Center by Michael, assisted by IOS members Allen Coombes and Hugh Angus, and by Head Gardener Darren Webster. Later on we were treated to a tasty lunch there to sustain us through the afternoon.

East of the house are the first oak cultivars planted on the estate: *Q. robur* 'Salicifolia' over 30 ft high and many *Q. robur* cultivars from both Cristata Group and Fastigiata Group, along with several *Q. rubra* cultivars including 'Bolte's Gold' from the Aurea Group. In the same area is *Q. frainetto* 'Hungarian Crown', another of the first specimens planted in the late 1970s, growing very well.

Certainly one of the oak stars of this collection is a superb specimen of *Q. semecarpifoli*a, that came to Thenford as a 6-ft transplant in 1987 from the Hampshire garden of Keith Rushforth, who was moving house; a tough species, it survived this indignity in midsummer. This beautiful tree has subsequently qualified for mention in Owen Johnson's *Champion Trees of Britain and Ireland*.

Photos 16/ (a) *Quercus fabri*; (b) *Q. aquifolioides* (Thenford House).

Also from Mexico, a young specimen of *Q. affinis*, near the main drive, a highly commendable evergreen Mexican, grown from wild-collected seed, that is already producing acorns. *Quercus rysophylla*, by the top drive, is a fine species of Red Oak from Mexico. John Grimshaw has written that "it is perhaps not too much to say that *Q. rysophylla* is the outstanding single new introduction of the past 30 years [and] …if only one 'new tree' were to be grown, this should perhaps be it." (Grimshaw and Bayton 2009; 695, 749). Certainly, Michael's tree is upholding the reputation of the species![6]

Amongst the Asian oaks doing well at Thenford, a very nice *Q. kiukiangensis*,[7] (*Cyclobalanopsis*, from China) was introduced to Europe in 2004 by Allen Coombes. *Quercus dentata*, the Far Eastern daimyo oak, the attractive selection of this species 'Carl Ferris Miller', as well as *Q.* Pondaim Group, introduced by the late Dick van Hoey Smith of Arboretum Trompenburg, are good performers here as well. A handsome deciduous species, *Q. look*, is represented at Thenford by two trees, one of which merits a mention in *New Trees* (Grimshaw and Bayton 2009). The seed from which this plant was raised comes from a tree at Arboretum Waasland in Belgium, which was in turn raised from seed from a plant considered to be *Q. look* that has grown for well over 40 years in the Dijon Botanic Garden. Truly a euro-pedigree! IOS member Michael Avishai kindly provided seed of this Levantine species to several institutions and notably also brought some to the IOS Oak Open Days in France in 2004.[8]

The North American oaks are well represented in the collection starting with a surprisingly fast-growing *Q. berberidifolia*, a Californian scrub oak growing against a south wall in the rose garden. Although for Michael, "A mistake, looming, has taken off and is heading who knows where!" Another Californian oak doing well here, growing in a trough, is *Q. durata*, the leather oak, a small shrubby evergreen, endemic to the Coast Ranges and northern Sierra Nevada of California, horrible for hikers but here safely contained.

Quercus ×*bushii*, the hybrid between *Q. marilandica* and *Q. velutina*, was planted (with his consent) in honor of George H.W. Bush after Michael gave a speech during a Presidential visit to the UK. It is named after the distinguished botanist Benjamin Franklin Bush (who was unsurprisingly a US citizen). Here, as always, it is a beautiful tree with dark, green foliage. A now sizeable *Q. coccinea* is one of two plants provided from Duchy of Cornwall nursery in exchange for surplus granite setts given to Prince

6. For a comprehensive review of *Q. rysophylla*, see Coombes 2015.
7. Distributed under the name *Q. argyrotricha*, this collection was later identified by Min Deng as *Q. kiukiangensis*.
8. For a complete review of the history of this taxon, see Avishai (2017), this volume, pages 73-88.

Photos 17/ (a) Q*uercus agrifolia*; (b) *Q. ellipsoidalis*; (c) *Q. mohriana* × *stellata*; (d) *Q.* ×*ludoviciana* (Thenford House).

Photos 18/ (a) *Quercus* ×*bushii*; (b) *Q.* ×*riparia*.

Charles, who spotted them whilst riding over the property with the Bicester Hunt. A good grower and as splendid a tree here as wherever it grows, *Q. ellipsoidalis*, is a medium-sized, Midwestern American Red Oak, known variously as the northern pin oak or Hill's oak, perhaps closer to *Q. coccinea* and/or *Q. velutina* than *Q. palustris*. A fine specimen of *Q. palustris*, the pin oak, near the main drive shows the characteristic shape of this species, with downward-drooping lower branches, horizontally oriented middle branches, and upper branches raised in victory towards the sky. A few other of the North American oaks that attracted our attention were: *Q. kelloggii*, the California black oak that is closely related to *Q. velutina* and reportedly sometimes difficult to establish in Europe; *Q. laurifolia*, a medium to large semi-evergreen Red Oak with dense foliage, native to Southeastern USA; and *Q.* ×*ludoviciana*, introduced to the UK in 1880, a natural Red Oak cross between *Q. pagoda* and *Q. phellos*, found, though rarely, in Southeastern

Photo 19/ *Quercus coccifera* subsp. *rivasmartinezii* (Thenford House).

Photo 20/ *Quercus ×hispanica* (Thenford House).

USA (e.g., Louisiana).

Near the church there is a nice specimen of *Q. macranthera* subsp. *syspirensis*, whose distribution is more westerly (Lebanon and central Turkey) than that of the type (Caucasus). Michael considers that his *Q. petraea* 'Laciniata Crispa', near the water garden, is a freak, adding, "The most you can say about it is that it's different and few collections have one!" There are attractive specimens of *Q. ×libanerris* 'Trompenburg', the handsome selection of the natural hybrid between *Q. cerris* and *Q. libani*, and of *Q. coccifera* subsp. *rivasmartinezii*, which is endemic to a small area of southern Portugal. This species was described just in time for the first IOS tour in the region in 2001, and thereafter quickly introduced to the UK. Like the subsp. *calliprinos* from the eastern Mediterranean, it can eventually form a medium-sized tree up to around 50 ft. We noted also *Q. ithaburensis* subsp. *macrolepis* – or is it *Q. macrolepis*? Either way it's the Valonia oak, native to Asia Minor and the Levant, and its edible acorns are used in tanning. Also noteworthy was *Q. rotundifolia*, similar to *Q. ilex* and with a western Mediterranean distribution, a species that is of particular importance in Spain where the sweet acorns are used to fatten a special breed of pigs (*cerdo ibérico*) to produce one of the best hams in the world.

And finally, in tribute to the English oak, *Q. robur*, we reproduce from the Heseltines' book this account of probably the oldest specimen in the garden:

"*The second stone bridge*

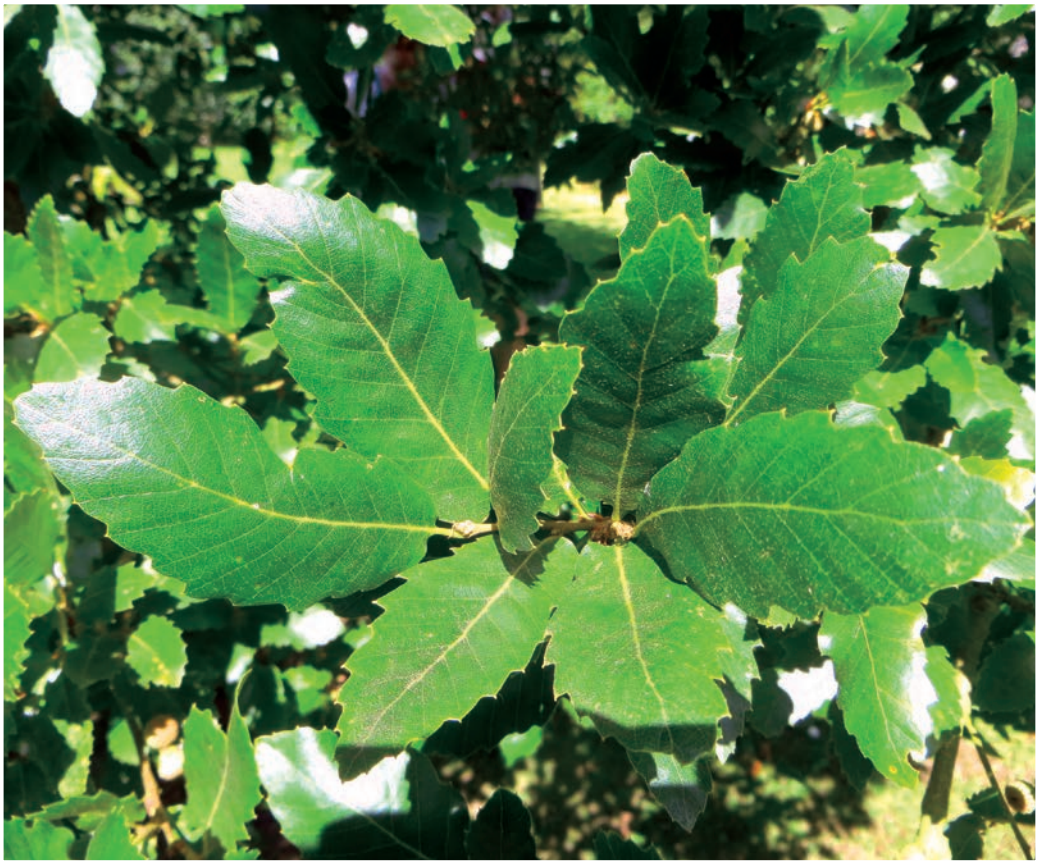

Photo 21/ *Quercus trojana* (Thenford House).

between the two lower fishponds was particularly interesting because of the pipe that took the water from the sluice in the Middle Fishpond into Lower Fishpond. We found that it was a ten-foot-long oak tree trunk with a four-inch diameter hole drilled through its centre. Oak is capable of surviving underwater in good conditions and thus we were pleased to be able to re-incorporate it in the rebuilt drainage system."

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Participants: **Heanley Farm**: Christof van Hulle, Vita van Hulle, Marleen de Muyt, Patrick Veerecke (Belgium); Dušan Plaček, Ondřej Fous, (Czech Republic); Shaun Haddock, Cécile Souquet-Basiège (France); Christopher Carnaghan, James Harris, Chris Reynolds, George Roberts, Jill Roberts, Peter Wells (UK). **Thenford House:** Christof van Hulle, Vita van Hulle, Marleen de Muyt, Patrick Veerecke (Belgium); Dušan Plaček, Ondřej Fous, (Czech Republic); Shaun Haddock, Cécile Souquet-Basiège (France); Allen Coombes (Mexico); Hugh Angus, Timothy Baxter, Caroline Boisset, Christopher Carnaghan, Dan Crowley, Michael George, Laura Haddock, Robert Haddock, Jonathan Heron, Anne Hoyle, Ralph Hoyle, Nick Macer, Duncan Miles, Margaret Miles, John Parsons, Jane Rackley, Chris Reynolds, Tim Routen, Harriet Tupper, Peter Wells (UK).

Photographers. Photos 1-6b, 8, 10c-d, 11, 12, 15b, 16a, 17b: Charles Snyers d'Attenhoven. Photos 7a-b: David Gooder. Photos 9-10a-b: Shaun Haddock. Photos 13, 17a,c,d, 18a-b, 19, 21: Harriet Tupper. Photos 14a-b, 15a, 16b, 20: Béatrice Chassé. Photo 14c: Hugh Angus.

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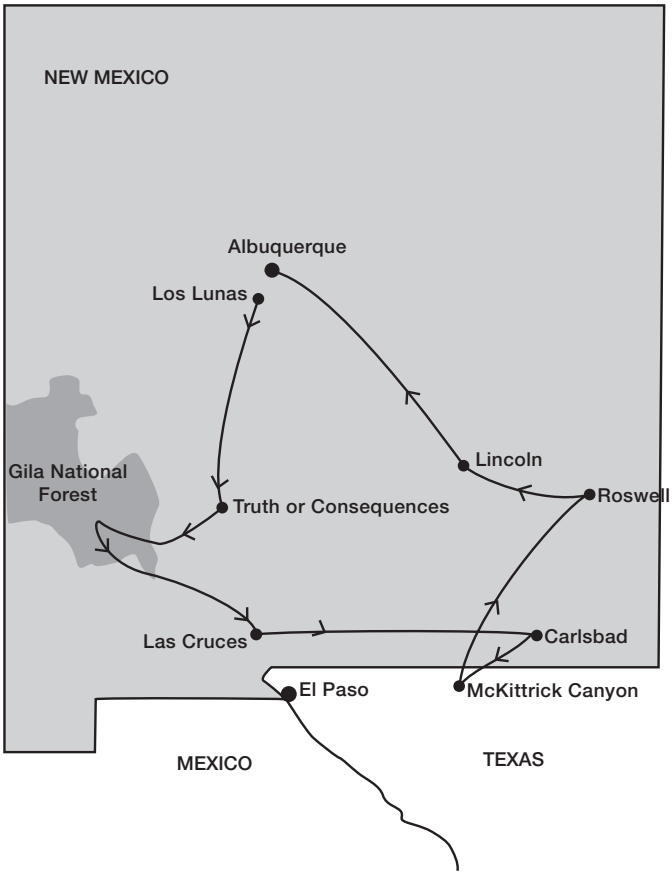
For more information on Thenford House, see http://thenfordarboretum.com

Oak Open Days
Southern New Mexico
September 24-30, 2016

Ryan Russell
Fulton, MO 65251, USA
ryan.russell@como.gov



Introduction

Founding IOS member Michael Meléndrez of Los Lunas, New Mexico led a group of eager IOS tourists through the mountains of south Central New Mexico with a short jaunt into Texas. Participants gathered on the evening of Friday, September 23 at the home of Michael and Kari to share a few bowls of wonderful homemade chili and to discuss the route and highlights of the following days.

Animas Creek Canyon

Photo 1/ *Platanus wrightii*

On the morning of the 24th we left Los Lunas and headed 160 miles south to Animas Creek Canyon, with a quick stop in the town of Truth or Consequences for lunch. The road to Animas Creek runs at an elevation of about 4,700 feet; as you take the road into the canyon, it abruptly drops off 300 feet and near the bottom we began to see *Quercus grisea* (gray oak) along the hillsides. Most of these oaks were large shrubs to small trees with a shrubby habit. We briefly pulled off the road for a few photos and a quick check on a sizeable tree for acorns that we didn't find (but this stop was not about oaks anyway). Across the road was an impressive multi-trunked specimen of *Platanus wrightii* (Arizona sycamore). Trees of this species are larger here than anywhere else in the state.

Photo 2/ *Quercus grisea* near Hillsboro.

It is closely related to *P. occidentalis* (American sycamore), but its foliage looks like *P. orientalis* (oriental sycamore). We continued to a homestead called Sycamore Ranch, a former carrot farm, where Michael worked from time to time in his youth. After meeting one of the owners, we walked along the creek to see the former National Champion *P. wrightii*. This tree is a double-forked monster with massive girth, and is well over 100 feet tall. Several people stood in front for photos and you could see sizeable pieces of trunk on either side. We saw several other large sycamores in this valley as well as *Populus deltoides* subsp. *wislizeni*, *Robinia neomexicana*, and *Celtis laevigata* var. *reticulata*.

Leaving the canyon, we drove 45 minutes west toward Kingston, NM. We made a quick stop near the small town of Hillsboro to see a magnificent specimen of *Q. grisea*. It is an old, sprawling, majestic tree growing in sand along the bank of a dry creek bed (called an arroyo). We found a few more along the bank, none as nice as the first, but all had acorns.

Gila National Forest

Along New Mexico Scenic Byway 152 (part of the Geronimo Trail National Scenic Byway), on the way to Gila National Forest, the plant life began to change a bit as we drove up the canyon, leaving the *Cylindropuntia* sp. (cholla) and *Yucca* sp. behind, transitioning into *Juniperus deppeana* (alligator juniper) and one of my favorite plants in the area, *Dasylirion wheeleri* (sotol). We checked into the Black Range Lodge, in Kingston, and met Mark Bennett, a local rancher and friend of the hotel owner. Mark volunteered to drive the group up Percha Creek; saving us a two-mile hike. Along the way we stopped to look at large single-trunked *Q. gambelii*, a few small *Q. emoryi*, and massive *Alnus oblongifolia* (Arizona alder), the largest species in the genus that can reach heights of around 125 ft and girths of around 17 ft. Unfortunately, a fire resulting from a lightning strike killed many of the large alders a few years ago, but several impressive specimens remain. We were able to find small seedlings in the area, so they appear to be regenerating nicely. About a mile up the trail, we stopped at a large *Q. gambelii*. As we looked around I noticed that there were four species of oaks, *Q. gambelii*, *Q. emoryi*, *Q. grisea*, and *Q. hypoleucoides* (silverleaf oak, my first wild sighting of this species) all happily growing in the same spot. It was clear to see that the recent fire had claimed many of the larger trees on this slope with the exception of the aforementioned *Q. gambelii*. The other oaks were small, only about 3-4 ft tall. A little farther up the canyon, we came to one of the highlights of the trip: several huge *Q. hypoleucoides* growing on a hillside at an elevation of about 6,800 ft. The largest specimen stood over 80 ft tall and had a trunk girth of 7 ft.

Photo 3/ *Quercus hypoleucoides* near Emory Pass (Gila National Forest).

Growing alongside the *Q. hypoleucoides* were *Juniperus deppeana*, *Pinus ponderosa*

Photo 4/ *Quercus rugosa* in Gila National Forest.

(ponderosa pine), and *Pseudotsuga menziesii* (Douglas fir). There were other large multi-stemmed specimens growing there, and a mature *Q. hypoleucoides* was a sight to behold. The Chiricahua Apache (also called the Warm Springs Apache and the Red Paint people) once called the Gila home, and it was a humbling thought to be walking in the same mountain range that Geronimo (whose Indian name was Goyahkla) and his people roamed more than 130 years ago. They were relocated to Florida in 1886 after conflicts with miners and early settlers. With fading daylight, we headed back to the lodge for a home-cooked meal, to make plans for the following day, and to rest.

The morning of the second day we took a slight detour from the planned route and headed west on the Scenic Byway 152 deeper into the Gila. Through mile after mile of switchbacks, we slowly climbed to an elevation of 8,200 ft. We encountered many of the species we had seen the day before, adding *Pinus strobiformis* to the list. As we neared Emory Pass, the lasting damage from the Silver Fire of 2013 (the result of another lightning strike which coalesced with the aforementioned fire, burning nearly 300,000 ac) became more evident. Hundreds of acres of forest had been burned out, primarily on the ridge tops, and only little pockets of forest in draws and canyons had escaped the flames. We stopped at Emory Pass to enjoy the view and read the signage. The oak and the Pass are named after Lieutenant W.H. Emory of the U.S. Army who led his troops, under the guidance of Kit Carson, through the area in 1846. *Pinus ponderosa*, *Q. hypoleucoides*, *Q. gambelii*, and *Pseudotsuga menziesii* were all found along the way.

As we headed further west, we descended about 1,000 ft, arriving at Iron Creek Campground, where we started to see *Juglans major* and *Alnus oblongifolia* again. However, we had yet to see the reason for this detour from our planned route. Three miles

west of the Campground, around a sharp bend in a narrow canyon, Michael slammed on his brakes, and quickly pointed out his window at a shrubby tree beside the road. We decided we shouldn't sit in the middle of the road so we found a wide shoulder and pulled the vehicles over and got out to look at *Q. rugosa* (netleaf oak), precariously perched on a steep hillside that dropped straight down to the creek below. To the dismay of passersby, we scrambled to take photos of the tree, happy as we were to have found this species. We noticed another specimen at the bottom of the ravine, but none of us ventured down to it. With images of that oak in our heads and cameras, we headed back east, up and out of the Gila towards Las Cruces. We stopped at Hillsboro for a quick rest stop and near the bathrooms was a huge *Sambucus cerulea* var. *neomexicana*. I had no idea *Sambucus* could get so large!

Southbound on Highway 27, we headed off to see the next interesting species. We had seen a few small *Q. emoryi* in the Gila, but nothing comparable to the mature specimens growing in an arroyo along this road, although it was a bit late in the season to see acorns. I had never seen a *Q. emoryi* over 10 ft tall before, and one of these was nearing 70 ft tall and 10 ft in circumference. Another had a huge burl on its trunk, nearly 12 ft in circumference.

Dripping Springs Natural Area

Nearing lunchtime, we headed for the globally famous village of Hatch, the "Chile Pepper Capital of the World".[1] The Hatch Chile Festival draws 30,000 visitors each year to this small town of around 1,600 citizens. We stopped at a local diner for lunch and had our pick of chile-topped entrees. From Hatch, we continued on to Las Cruces, which lies at the foothills of the Organ Mountains. Our destination was Dripping Springs Natural Area, on the western side of the Organs at around 6,100 ft. We arrived at the Visitor Center shortly before the official closing time, so we briskly walked the mile and a half from the parking lot to the trail. Here we found familiar species like *Juniperus deppeana*, *Dasylirion wheeleri*, different agaves and yuccas, and also a few new species like *Fallugia paradoxa* (Apache plume), *Fouquieria splendens* (ocotillo), *Cercocarpus montanus* (mountain mahogany), and *Vachellia constricta* (whitethorn acacia). As we walked, the red granite rock faces could be clearly seen jutting 5,000 ft skyward. Farther up the trail, we began to see our first *Q. arizonica*. Michael had told us earlier that *Q. ×organensis* (*Q. arizonica* × *grisea*) could be seen in this area and I was very eager to see that hybrid. He pointed to three trees along a dry creek bed on the south side of the

Photo 5/ *Quercus ×organensis* (*Q. arizonica* × *grisea*)

1. All of the chile peppers grown in the Hatch Valley are called Hatch chile, but no variety of chile pepper is specific to that area. The chiles produced in this Valley are of such quality that the quantity of chile peppers sold with the Hatch label exceeds what is produced in the Hatch Valley!

trail. As I headed off through the brush, Michael reminded me about the sign we had seen earlier warning about rattlesnakes. Undeterred, I headed to look at the hybrids. Indeed the first tree was unusual for *Q. arizonica*. The second and third trees were not as clearly hybridized as the first, but I would hate to guess what the parentage truly is. Surely, these are not the same trees Trelease described in 1917, so it is difficult to say. More research is needed for sure on this matter. As I was photographing the first tree, I heard my boys yelling about a snake. Sure enough, coiled up at the base of an *Opuntia engelmannii* var. *lindheimeri* (Engelmann prickly pear cactus) was a rattlesnake, only a few feet from where I walked earlier. It was well behaved and sat still for a few photos before we slowly snuck away.

Continuing up the trail towards the Springs, we came up to the remains of an old tuberculosis sanitarium, built in the early 20th century. Along this path we stopped to look at more *Q. arizonica*, as well as *Agave neomexicana*, *A. lechuguilla*, and *Celtis laevigata* var. *reticulata*. My sons braved the steep climb on top of the huge rock outcropping to see the source of the springs: an artificial pool built long ago which now seeps water continuously. Farther up the trail, we stopped to look at a few more *Q. arizonica*, one which looked to be a hybrid, but did not look the same as the hybrid we had seen earlier. We continued up to the ruins of a resort built in the late 19th century to take a few photos and then headed back down for the long hike to our cars with the sun setting below us.

Photo 6/ *Fallugia paradoxa* at Dripping Springs.

Carlsbad Caverns

The third day began with a short tour around Las Cruces to see a few monumental trees including two gigantic specimens of Italian stone pine (*Pinus pinea*), each over 100 ft tall, and a huge *Taxodium*. Heading out of town, we drove up the eastern slope of the Organ Mountains, and made a quick stop along the highway at San Augustin Pass. Here we found a hillside full of *Q. turbinella*, with blue-green, prickly leaves and short, shrubby habit. Continuing down the other side of the pass, we made a quick stop at Aguirre Springs to see one last *Q. arizonica*, which was larger than those we had seen the day before. Michael pointed out some red color higher up in the draws above us and told us those were *Q. gravesii*, known locally as Chisos oak (a common name also applied to *Q. graciliformis*) showing fall color. This is an apparently disjunct population, and more exploration is needed to document these trees, perhaps a return trip is in order as we were unable to climb that high due to time constraints.

Our destination for the day, Carlsbad Caverns, lay some 240 miles to the east, so we got moving. Driving across the largest military installation in the US, the White Sands Missile Range (covering 3,200 square miles), we had planned to stop at the White Sands National Monument, but running short of time, stopped instead along the highway for photos and kept driving. We drove up through Cloudcroft, part of the Lincoln National Forest, and several species such as *Q. gambelii* and *P.*

Photos 7/ (a) *Quercus turbinella* at San Augustin Pass; (b) *Q. arizonica* flowering.

Photo 8/ Barbary sheep along the road to Carlsbad Caverns.

ponderosa were plentiful and easy to spot. We reached Carlsbad Caverns minutes before they closed the entry gates for the day. Carlsbad Caverns lie on the eastern edge of the Guadalupe Mountain Range that runs from West Texas into Southern New Mexico. The Caverns are an amazing geological occurrence, and the "Big Room" is one of the largest natural limestone chambers in the US. Although lacking in oak species, it is worth a visit for sure. As we were leaving, of course, we had to do a little botanizing, stopping to look at *Q. mohriana*, and shrubby *Dermatophyllum secundiflorum* (also known as *Sophora secundiflora*) with tantalizing whitish seedpods. Back in Carlsbad, we had supper and made plans for the next day's adventures.

McKittrick Canyon

Day four found us traveling into Texas, to McKittrick Canyon at the southwestern edge of the Guadalupe Mountain Range. Sitting at 5,000 ft elevation, this canyon is an unusual environment, and a few anomalies occur here. The soil substrate is limestone, so a higher pH is to be expected, and the pH is very high indeed at 8.2. From the Visitor Center, we took a trail that follows a streambed into the canyon and immediately we began to see *Q. pungens* (sandpaper oak) all along the trail on both sides. Standing around 6 feet tall, these cool little oaks feature small, gray-green, coarse leaves and tiny acorns. We also saw many of the plants we had seen on the previous days but were treated to multiple new species as well. Perhaps the oddest and most beautiful was *Arbutus xalapensis* (Texas madrone). A remnant from another time, this species seems very out of place in this environment with its tropical-looking fruit, foliage, and red to white to

green peeling bark. We stopped to admire several amazing specimens of this plant and each one warranted a second look.

Following the trail (from which visitors are not allowed to stray), we found many species we had not seen previously, such as *Rhus lanceolata*, *Rhus microphylla*, *Juniperus ashei*, *Juglans major*, and the very rare *Ostrya knowltonii* (Knowlton's hop hornbeam). We encountered Vasey oak (*Q. vaseyana*) in a few spots along the trail as well. I've always struggled telling it apart from *Q. pungens*, but it was easy once we saw them growing in the same area. This species has glabrous, bright green leaves as opposed to *Q. pungens*, described above. *Quercus mohriana* grows in the canyon as well and forms dense stands up to 10-12 ft tall in several spots. Following the dry creek bed, we noticed

Photos 9/ (a) *Q. pungens* (Sitting Bull Falls); (b) *Quercus mohriana* (McKittrick Canyon); (c) *Q. muehlenbergii* (McKittrick Canyon).

that in a few areas water flows as in any regular stream and is adorned with various herbaceous plants. In fact, the surface water can appear and disappear without warning because an underground river runs through here.

We continued on our way up the canyon and as we slowly gained altitude, we began to see *Acer grandidentatum* (bigtooth maple), just beginning autumn coloring, and several nice specimens of *Q. muehlenbergii*. Once we reached Pratt Cabin, summer home of former owner Wallace Pratt, we sat beneath the shade of *Arbutus xalapensis* and *Q. muehlenbergii* to eat our lunch. We then began the two-mile walk back to our cars, and of course made a few more stops for photos and for Michael to identify plants for us. Leaving McKittrick Canyon, we traveled a few miles west to Frijoles Ranch, an old homestead now owned by the National Park Service. Michael wanted us to see the huge *Q. muehlenbergii* here, and they are truly large, especially for this area. Previous owners had diverted a nearby spring to flow into the yard and perhaps these trees were able to grow so large due to the extra moisture. A very large specimen of *Q. mohriana* was also on the property, much larger than those in the Canyon, and I wondered if it too may have prospered from the added water.

With just enough time left in the day, we quickly headed northeast to Sitting Bull Falls. Like McKittrick Canyon, Sitting Bull Falls is located at an elevation of 5,000 ft, but is not quite as botanically blessed. What it does boast is a spectacular view and a breathtaking 150 ft waterfall and a pool below. *Quercus pungens* grows all over the area and some reach 12-15 ft in height. A terrible fire in 2011 destroyed many old specimens of *Q. muehlenbergii*, *Pinus ponderosa*, and *A. xalapensis*. A few members of our group hiked up to the top of the Falls and found one remaining madrone bearing seed. Hopefully these seeds will repopulate the area someday. We also saw *Fallugia paradoxa*, *Juglans microcarpa* (little walnut) and a beautiful specimen of *Penstemon cardinalis*. With fading light, we headed to our cars and started the drive back into New Mexico towards Roswell, home of Area 51[2] and numerous reported UFO sightings. The city has certainly embraced the "alien culture", making arrival in Roswell at night quite interesting. The McDonald's is shaped like a flying saucer and we saw several humorous signs and artwork on buildings – we even saw an alien mariachi band!

Billy the Kid and Q. ×undulata

The next morning we began by taking a short trip to the New Mexico Military Institute, a boarding school with surprisingly nice landscaped grounds. We looked at the *Q. fusiformis* and *Q. buckleyi* planted on campus and then were off to Lincoln County, 60 miles to the west. I was particularly excited to visit this area (as I also love history) because it is best known for the Lincoln County War,[3] where Billy the Kid achieved his infamous legendary reputation. Lincoln is also the hometown of Michael's maternal family, the Mirandas, who settled the area in the early 1800s (known then as Las Placitas del Rio Bonito). Michael showed us the home his mother was raised in, which is still in the family. Driving west on Route 380, we ascended from 3,500 ft to 5,900 ft to our first

2. A remote detachment of Edwards Air Force Base whose purpose is unknown to the general public, though it most likely supports the development of experimental aircraft and weapons. The existence of the base was only recognized by the CIA in 2005.

3. An "old west" conflict fought by two rival companies in the year 1878: Murphy & Dolan Mercantile and Banking, and J.H. Tunstall & Co. (that was also a bank). The dispute centered largely on the lucrative cattle contract that supplied nearby Fort Stanton with its beef and other items.

Photos 10a-b/ *Quercus* ×*undulata*

stop before Lincoln. A small grove of hybrid oaks growing alongside the road, called *Q.* ×*undulata* by some, was particularly interesting. These oaks are near 40 ft tall, have single trunks, flaky bark, and blue-green leaves with 4-6 shallow pointed lobes. These trees reportedly have nice red fall color. More research is needed in my estimation to determine the parentage of these trees, but they are beautiful regardless.

We spent a few hours touring the town of Lincoln, which is wonderfully preserved, learning about the Lincoln County War, its prominent characters, and what led to the feud. As with many things of this nature, power and money were the driving forces behind the disputes, and led to murders, gunfights, cattle rustling, and citizens fleeing their homes. William H. Bonney (a.k.a. Billy the Kid) is probably the most recognizable name to come from this War and is either regarded as a cold-blooded killer or a folk hero. I came away with the feeling that he was used as a pawn between the two feuding powers and the territorial governor of the time. Sherriff Pat Garrett supposedly killed Billy in 1881, bringing his life of crime to an end, but many believe Billy escaped and lived to a ripe old age, furthering his legend.

Before leaving Lincoln, Michael made a call to local cattle rancher James Sánchez to see if we could look at a few oaks on his property bordering the Lincoln cemetery. Though hesitant about receiving a visit by a bunch of strangers, Mr. Sánchez obliged us and we were excited to see the trees on his property that are locally referred to as Fendler oaks. Originally described in 1854 by Danish botanist Frederik Liebmann, the specific epithet honors Augustus Fendler (1813-1883) who was one of the first botanists to collect plants in the area around Santa Fe, New Mexico. (Fendler no. 805 is the type specimen for this taxon). Today, *Q.* ×*fendleri* has been put into synonymy with *Q.* ×*undulata*, but the trees on this property do not fit the descriptions of either of those taxa. We saw three trees that were alive and well and a fourth that had died and fallen over. The biggest one is around 40 ft tall and nearly as wide. It has a single trunk and dark colored bark that rises in furrowed flaky ridges, more reminiscent of *Fraxinus* than *Quercus*. The blue-green leaves are oblong with an occasional lobe. Mr. Sánchez allowed me to collect specimens to send off to try to ascertain its parentage. I believe that *Q. oblongifolia* certainly plays a role, but what of the other parent(s)? The dead tree remains, and Mr. Sánchez offered to save a piece of the trunk for me to determine the age the tree. I would guess it dates to

Photo 11/ James Sánchez with the "Fendler" oaks.

the time of the Lincoln County War, but that remains to be seen. We thanked Mr. Sánchez for his hospitality and were back on the road.

We drove west along the Billy the Kid Trail to the town of Capitan, and then headed north on Highway 246 to Boy Scout Mountain in the foothills of the Capitan Mountain Range. Along the way, we began to see *Q. oblongifolia* (Mexican blue oak), so naturally we stopped to take photos. We saw a few tiny acorns and a very unusual bright green and black species of caterpillar that we only saw on *Q. oblongifolia*. Michael was keen to show us the large *Q. muehlenbergii* in the canyon so we continued on the badly deteriorated canyon road, where the pavement gave way to rock and dirt. I was worried my van would not make it, but it did! We got out of our vehicles and scampered up the draw to look at several large specimens of *Q. muehlenbergii* along with *Amorpha fruticosa*, *Q. oblongifolia*, *J. deppeana*, and *P. ponderosa*. Further up the canyon, as *Q. muehlenbergii* began to give way to *Q. gambelii*, we found a putative hybrid of these two species growing on a steep embankment. We found another hybrid of *Q. oblongifolia* and either *Q. gambelii* or *Q. muehlenbergii*. I hope to have helped determine the parentage of this plant by remarking that the foliage appears identical to the hybrids found along the road outside of Lincoln mentioned earlier. Perhaps one is the key to unlocking the other. We had supper and stayed the night in Ruidoso.

Sierra Blanca and Gran Quivira

Day six began with a short drive from Ruidoso up to the Sierra Blanca Mountain Range (White Mountains) the majority of which lies in the Lincoln National Forest, with the highest mountain (Sierra Blanca Peak) lying in the Mescalero Apache Indian Reservation. As we climbed from Ruidoso (6,800 ft) the plant life changed, as expected. The *Q. gambelii* began to morph into short, multi-stemmed shrubs, and new species such as *Populus tremuloides*, *Acer glabrum*, and *Pseudotsuga menziesii*, began to appear. We pulled off into an overlook to enjoy the view and read a few signs. Down in the

valley below we could hear bull elk bugling as the rut was in full swing. We spent a few minutes just sitting and listening; really, a cool moment and not one very many people get to enjoy. Continuing to the top, we stopped at the Ski Apache Lodge and got out for a hike. We had said goodbye to the oaks farther down the mountain, and here at 9,800 ft, there were mostly coniferous tree species. We came across *Sambucus cerulea* (blue elderberry), *Ribes* sp. (possibly *R. cereum*), and fine specimens of herbaceous plants such as *Iris*, *Penstemon*, *Lupinus*, and *Carex*. Hiking further up the path, we began to see huge *Abies lasiocarpa* var. *arizonica* (corkbark fir), *Picea engelmannii* (Engelmann spruce), and *Pseudotsuga menziesii*. Unfortunately, a terrible fire had devastated much of the mountain top, and burned conifers stretched for acres and acres. It was an odd-looking sight as some of the trees still hung onto their blackened bark while others had shed this layer, to become white totem poles, resembling tombstones in a graveyard. Nevertheless, some trees had escaped the flames and appeared to be thriving still. We even measured a huge *P. engelmannii* to nominate for a New Mexico state champion.

Photos 12a-b/ *Quercus oblongifolia* along the road to the Capitan Mountains.

With a two-hour drive north to get to the next stop, we headed back down the mountain towards the ruins of Gran Quivira, part of the Salinas Pueblo Missions National Monument. These centuries-old ruins are of structures built some time in the early 14th century either by the Anasazi or the Mogollon (ancestors of the Pueblo peoples). Traces of Spanish settlement dating from the 16th century can be seen at the southern edge of the ruins in what is left of the mission churches that were built by them. Gran Quivira was known as Las Humanas during the Spanish colonial period and

Photo 13/ Conifers after fire in the Sierra Blanca.

Photo 14/ Ruins of Gran Quivara.

has seven kivas (underground rooms traditionally used for religious ceremonies) and more than 200 individual rooms. The precision and craftsmanship that went into the building of these structures was amazing to see. At this site we found *Juniperus monosperma* (single-seed juniper), *Pinus edulis* (piñon), and various *Yucca* and *Cylindropuntia* species. With day six in the books, we continued our journey.

Manzano Mountains

During the final day of the tour, we drove north to Albuquerque and then east around the Manzano Mountain Range. Michael had told us that the *Acer grandidentatum* should be in peak fall coloring, so we were excited to see that. The Manzanos get their name from early Spanish settlers that brought apple trees with them and planted orchards in the foothills of the range (manzano means apple tree in Spanish). Alongside the road, we stopped to look at three apple trees (*Malus pumila*). Local tradition holds that the two remaining orchards in the area were planted during the late 17th century by Spanish monks visiting the local pueblos. However, growth-ring analysis dates the orchard trees to about

Photo 15/ *Acer grandidentatum*

1800 (Ellis 1936). I like to think that these trees are the descendants of those original orchards. Two had nice red fruit, the third yellow. They were tart and crisp and made a nice little treat.

Our destination was the Fourth of July Canyon, and, as we got closer, we started to see red coloring on the distant mountains. Once we got to the canyon, the fall coloration on the *A. grandidentatum* was beautiful. The colors ranged from pinks, to reds, to bright oranges and yellows. They were especially lovely with the backdrop of *Pseudotsuga menziesii* and *Pinus ponderosa*. Michael took us to see a couple of huge *Q. gambelii* with straight single trunks. This species has a very wide morphological range, as we saw on this trip.

We took a nice hike about a mile up into the canyon and saw more of the species already mentioned as well as *Ptelea trifoliata* and *Juniperus scopulorum*. On the way back to Los Lunas, we made a quick stop to look at odd little oaks growing along the road. No two were quite alike with heights and forms ranging widely. Most had clear *Q. gambelii* influence, but I could not determine the other possible parent, as we did not see another species nearby. I suppose these could be lumped in with the *Q.* ×*undulata* complex. We stopped for a farewell supper in old town Albuquerque as some of our party had an early flight home the next morning. We exchanged information to keep up with one another, made tentative plans to meet up again, and said our goodbyes.

Acknowledgements

Many thanks to Michael Meléndrez (honestly I cannot imagine a better guide) and to Anna Forester for all their hard work in organizing this amazing tour and for taking us to places we could have never found on our own. Thanks also to Mark Bennett and James Sánchez for their hospitality.

Participants: Ulla Dunkle, Plummer Dunkle, Anna Forster, Amanda Meléndrez, Kari Meléndrez, Michael Meléndrez, Maya Russell, Ryan Russell, Ryder Russell, Tammie Russell, Taran Russell.

Photographers. Photos 1-16: Ryan Russell.

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Photo 16/ *Pinus ponderosa* in the Fourth of July Canyon.

Checking Out the Oaks in Chiriquí

Roderick Cameron
Américo Ilaria 6615
Montevideo, Uruguay
roderickcameron66@gmail.com

Photo 1/ Oak (*Quercus* sp.) and vines in Parque Internacional La Amistad.

Introduction

In October 2016 I was in Panama for a couple of weekends and spent most of the time there looking for oaks. Panama is not precisely a hot spot for *Quercus*. It is at the southern end of the range, and other Central American countries boast more species (e.g., Guatemala), but I chose it as a destination because I could fit it into a business trip going from home in Uruguay to New York, via Copa Airlines, the Panamanian airline, with

Photo 2/ Gigantic near La Amenaza, Cerro Punta, Chiriquí; estimated height: 60 m.

extended layovers in Panama City.

As an uninformed amateur, prior to the trip I tried to contact people with more knowledge of the area and read up what I could. It quickly became apparent that for oaks I needed to focus on the western end of the country, in the province of Chiriquí, next to Costa Rica, where most of the *Quercus* species are to be found. (I had been under the false impression that the country runs roughly along a north-south axis, based on the notion, I suppose, that the Isthmus of Panama connects North and South America. The opposite

Species epithet	Oak Name Checklist	World Checklist of Selected Plant Families (Kew Gardens)	Smithsonian Tropical Research Institute	Guides illustré de Chênes	The Central American Oak Species of *Quercus*	No. of sources that accept the species as present in Panama	IUCN Red List status
Q. aaata C.H. Mull.	Synonym of *Q. lancifolia*; Not in Panama	Synonym of *Q. lancifolia* Schltdl. & Cham.	Synonym of Q. lancifolia Schltdl. & Cham.	Ok as species, no distribution data	Not in Panama	0	Not listed
Q. baruensis C.H. Mull.	OK	Synonym of *Q. benthamii* A.DC.	Synonym of *Q. benthamii* A.DC.	Synonym of *Q. benthamii* A.DC.	Not listed	1	Not listed
Q. benthamii A. DC.	OK	OK	OK	OK	Not in Panama	4	Endangered
Q. boquetensis Standl.	Not listed	Synonym of *Q. seemannii* Liebm.	Synonym of *Q. salicifolia* Née	Not listed	Synonym of *Q. seemannii* Liebm.	1	Not listed
Q. bumelioides Liebm.	OK	Synonym of *Q. sapotifolia* Liebm.	OK	Synonym of *Q. sapotifolia* Liebm.	Synonym of *Q. eugeniifolia* Liebm.	1	Not listed
Q. copeyensis C.H. Mull.	OK	OK	Synonym of *Q. bumelioides* Liebm.	OK	OK	4	Likely threatened
Q. corrugata Hook.	Synonym of *Q. lancifolia* Schltdl. & Cham.	Synonym of *Q. lancifolia* Schltdl. & Cham.	Synonym of *Q. lancifolia* Schltdl. & Cham.	OK	Not in Panama	2	Endangered
Q. cortesii Liebm.	OK	OK	OK	Ok as species, no distribution data	Not listed	3	Near threatened
Q. costaricensis Liebm.	OK	OK	OK	Not in Panama	Not in Panama	3	Near threatened
Q. costaricensis Liebm.	OK	Synonym of *Q. insignis* M. Martens & Galeotti	Synonym of Q. insignis M. Martens & Galeotti	Not listed	OK	2	Not listed
Q. eugeniifolia Liebm.	OK	*Synonym of Q. seemannii* Liebm.	Not listed	OK	OK	3	Possibly threatened
Q. gulielmitreleasei C.H. Mull.	OK	OK	OK (*gulielmi-treleasei*)	OK	OK (*gulielmi-treleasei*)	5	Near threatened

Species epithet	Oak Name Checklist	World Checklist of Selected Plant Families (Kew Gardens)	Smithsonian Tropical Research Institute	Guides illustré de Chênes	The Central American Oak Species of *Quercus*	No. of sources that accept the species as present in Panama	IUCN Red List status
Q. humboldtii Bonpl.	OK	OK	OK	OK	OK	5	Least concern
Q. insignis M. Martens & Galeotti	OK	OK	OK	OK	Not in Panama	4	Critically endangered
Q. lancifolia Schltdl. & Cham.	OK	OK	OK	OK	Not in Panama	4	Near threatened
Q. oocarpa Liebm.	OK	OK	Synonym of *Q. insignis* M. Martens & Galeotti	OK	OK	4	Critically endangered
Q. panamandinae C.H. Mull.	OK	OK	Not listed	OK (no distribution data)	OK	3	Not listed
Q. pilarius Trel.	Synonym of *Q. lancifolia* Schltdl. & Cham.	Synonym of *Q. lancifolia* Schltdl. & Cham.	Synonym of *Q. lancifolia* Schltdl. & Cham.	OK (no distribution data)	Not in Panama	0	Not listed
Q. rapurahuensis Pittier ex Trel.	OK	Synonym of *Q. benthamii* A.DC.	Synonym of *Q. benthamii* A.DC.	Synonym of *Q. benthamii* A.DC.	Synonym of *Q. seemannii* Liebm.	1	Vulnerable
Q. salicifolia Née	OK	Not in Panama	OK	Not in Panama	Not listed	2	Likely least concern
Q. sapotifolia Liebm.	OK	OK	Not listed	OK	OK	4	Vulnerable
Q. seemannii Liebm.	Synonym of *Q. salicifolia* Née	OK	Synonym of *Q. salicifolia* Née	OK	OK	3	Vulnerable
Q. seibertii C.H. Mull.	Synonym of *Q. insignis* M. Martens & Galeotti	Synonym of *Q. insignis* M. Martens & Galeotti	Synonym of *Q. insignis* M. Martens & Galeotti	Not listed	OK	1	Vulnerable

Figure 1. Status of *Quercus* species in Panama, according to selected sources.

is the case: due to the kink in the isthmus, the country extends east-west, and the Canal runs not parallel to the Equator, as you might expect, but in fact northwest to southeast.) The other areas where oaks can be found are the province of Darién, at the eastern end of Panama next to Colombia, where *Q. humboldtii* grows, but access is difficult in that area, and in the Azuero Peninsula in the central southern section, where a limited number of oaks grow. So I booked domestic flights to David, in the province of Chiriquí, reserved rental cars, and then tried to determine what species I should look out for.

That was easier said than done. Comparing different sources, it became apparent that there is disagreement as to what oak species grow in Panama. In relation to Panamanian oaks, I kept encountering the phrase "there is more work yet to be done," which in taxonomic talk sounds like Facebook's "It's complicated" when defining relationship status. I consulted five sources (Oak Name Checklist, Kew Garden's World Checklist of Selected Plant Families, Cornelius H. Muller's *The Central American Species of Quercus* (published in 1942, so significantly older than the other sources, but still very respected), the Smithsonian Tropical Research Institute, and le Hardÿ de Beaulieu and Lamant's *Guide illustré des Chênes*). Of the 23 species mentioned as native to Panama, only two were accepted by all sources (see Fig. 1). As a dilettante accustomed to botanical gardens, the prospect of seeking out oaks in the wild, where trees have the effrontery of growing without labels, provokes feelings of mild panic, on a par with blind wine tasting. I tried in vain to procure the services of a knowledgeable guide prior to arrival and in the end simply leapt in the deep end, hoping to be able to distinguish oaks on my own.

The area I decided to focus on was the northern section of Chiriquí province, where it borders the province of Bocas del Toro. The main landmark in the area is Volcán Barú (there's a species named after it, *Q. baruensis*, which was encouraging) and the main towns are Cerro Punta to the west and Boquete to the east. Cerro Punta is close to Parque Internacional La Amistad (PILA), a 400,000-hectare national, or rather binational, park that extends from Costa Rica to Panama. The area I visited was in the foothills of the Talamanca Range, the Central American section of the American Cordillera that forms the backbone of the American continent and runs from Alaska to Antarctica. Based on the sources I had read, most oaks in Panama seem to grow at over 1,200 meters above sea level, so I had to be close to the mountains and the cloud forest in order to get in range.

On my first morning, on the recommendation of a park ranger at PILA, I was introduced to a guide who would be able to show me oaks, the aptly named Eymos Carrasco (*carrasco* is one of the common names in Spanish for *Q. coccifera* and the word may be derived from the Latin word *cerrus*). Eymos was not a botanist but would be able to show me trees that he knew as *roblito* and *mamecillo*, names that appear to be applied to a number of *Quercus* species. Based on these names, one concludes that Panamanians have a certain capacity for understatement: *–ito* is a diminutive suffix, so *roblito* would be "little oak" or "oak-let", and yet in Panama I would come across the tallest oaks I had ever seen, towering giants that dominate the cloud forest and probably exceed 60 meters in height. The same applies for *–illo*, though I have not be able to determine what *mamecillo* would be a diminutive of. It is best to not ask to see *robles*, the Spanish name for oaks in much of Latin America, as a *roble* in Panama is something quite different: *Tabebuia rosea*, as I learned to my chagrin after making a special trip to Parque Natural Metropolitano in Panama City to see the widely publicized El Roble trail.

Another aspect of vernacular terminology that Eymos was able to help me with was the denomination of seasons. Panama has only two seasons, a cool, dry season running

Photo 3/ Canopy of oaks over Los Quetzales trail, in Parque Nacional Volcán Barú (Cerro Punta entrance) illustrating what Francis Hallé has named *la timidité des grands arbres* (the shyness of huge trees) observed in tropical forests where the uppermost branches seem to respect "territorial limits".

from January to April, and a hot, rainy season from April to January. The dry season is called *verano* (summer), but is cool and occurs in Northern Hemisphere winter—Panama is roughly 7 to 9 degrees north of the Equator. The rainy season is called *invierno* (winter), but is hot. Oaks pay little heed and acorn season, I was told, can stretch from April to November, with species picking different stages of winter to drop their fruit. (Interestingly, a park ranger I spoke to mentioned that he had noticed that fruiting time had varied significantly in recent years, a modification he ascribed to climate change.)

Panamanian oaks are most impressive in their natural cloud-forest habitat, where they reign supreme as unassailable colossi. Viewing them is not simple: in PILA, walking along the *senderos* (paths) one comes across massive, buttressed trunks that disappear into the canopy, with leaves way out of reach and often out of sight. Equally awe-inspiring is the spectacle of the forest canopy from the occasional viewpoint in the park, where the oaks form the upper story. These are sights that nourish the soul but are not helpful for identification, though Eymos was able to distinguish for me the trunks of *roblito* (smooth) from *mamecillo* (rougher and flakier) in mature trees. In order to get up close to oaks, I had to rely on human intervention in the form of roads that traverse or border the forest and at whose sides oaks were approachable, or agriculture, which has resulted in fields cleared for cattle pasture and plantations with oaks left to grow in isolation, or which exposed a slab of forest where large trees could be viewed entire.

Here are some of the species I was able to see and tentatively identify:

Quercus seemannii

Photo 4/ Leaves of *Quercus seemannii* in Parque Nacional Volcán Barú.

As I walked into the Parque Nacional Volcán Barú from the Cerro Punta side, along the Los Quetzales trail, I was stopped in my tracks by the sound of dropping acorns, something like a slow motion hail storm. The source of this precipitation was two tall oaks I estimated to be over 50 meters high. The acorns were relatively small and spherical, about 1 cm in diameter, and they littered the path, some of them already sprouted. I was able to find leaves on the ground and also to photograph some of the lower branches: lanceolate with a short petiole and an acute tip, and prominent veins. Francsico Garín, an IOS member with extensive experience with Central American oaks, helped me identify these trees as *Q. seemannii* (according to the Oak Name Checklist and the Smithsonian Tropical Research Institute, a synonym of *Q. salicifolia*).

Quercus oocarpa

Photos 5/ (a) *Quercus oocarpa* acorn; (b) Looking up into the canopy of *Q. oocarpa.*

The most successful tactic for sighting oaks turned out to be to look out for unpaved side roads, preferably ones that ascend into surrounding hills, pick one at random and keep your eyes peeled for *Quercus*-like features. While on one of these dirt tracks, I spotted shallow-lobed obovate leaves that looked familiar and, on stepping out of the car, found the ditch below these trees littered with large golf-ball-sized acorns. Some of the acorns had evidently been lying there for some time, and the seedlings that had already sprouted grabbed my attention: furry and burgundy, similar to the young leaves of *Q. insignis*. The acorns were different from the *Q. insignis* acorns I have seen: not saucer-like or flat, but nearly spherical, though like *Q. insignis* they had the characteristic

large hilum, or attachment scar of the cupule. There were several of these trees by the side of the road and also one further up the hill. I climbed up the field and under this tree found a mass of seedlings, which also looked a lot like the *Q. insignis* seedlings I had in my nursery at home. When I shared my photos with Francisco Garín, he identified this as *Q. oocarpa*. The epithet is apt: *oo* derives from "egg" in Greek, and so the name describes the acorn as egg-shaped. This is certainly true, and I was also able to observe that it behaves a bit like an egg, as when it germinates the pericarp cracks open like an eggshell, revealing an embryo inside. For the Smithsonian Tropical Research Institute this species is a synonym of *Q. insignis*. Other related species would be *Q. davidsoniae* and *Q. siebertii*, listed by C.H. Muller but defined today as synonyms by other sources. Interestingly, the specimens Muller names in his descriptions were located in Chiriquí Province, close to where I found these trees.

Quercus copeyensis

Aside from *Q. oocarpa*, another White Oak I found was identified by Francisco as *Q. copeyensis*. I found these trees growing together with a Red Oak species along a path north of Boquete, known among the large expat community as the Pipeline Trail (the owner of the hotel where I stayed recommended it). Here too, acorns were to be found on the ground, having fallen some time before, though some of them still looked fresh. The leaves of these trees were thick and firm, ovate to obovate with a rounded tip. As can be seen in Figure 1, not all of the sources agree to the validity of this name.

Quercus gulielmitreleasei

The Red Oak that was growing in the same location is probably *Q. gulielmitreleasei* (far away my favorite *Quercus* epithet among the Panamanian oaks, named after U.S. botanist William Trelease): leaves firm and coriaceous, tip acute, margin entire and finely revolute, upper surface smooth and shiny, lower surface slightly tomentose with prominent veins. The acorns under these were smaller and darker than those of *Q. copeyensis*, and the acorn caps smaller and with smaller scales.

Quercus lancifolia?

Eymos helped me find a third White Oak in a coffee plantation in Santa Clara, halfway between Cerro Punta and the Costa Rican border, a few kilometers off the main road on a track that leads up to Juturungo. This species is characterized by its pale brown, flaky bark and large, warty acorn caps. The leaves are lanceolate, coarsely toothed with the teeth directed forward. Eymos referred to this tree as *mamecillo*, both here and when we encountered

6a

Photos 6/ (a) Acorns of *Quercus lancifolia* (?); (b) *Q. lancifolia* (?) with epiphyte.

it in the cloud forest, where all we could perceive was the flaky bark. According to the Smithsonian Tropical Research Institute, *mamecillo* is the local name for *Q. lancifolia*, but Francisco Garín was intrigued by photos of this oak and believes it may be *Q. excelsa*, an oak usually found in Mexico, and considered by the Oak Name Checklist and the Kew Checklist to be a synonym of *Q. lancifolia*.

Quercus benthamii

The one occasion where I was able to get up close and personal with an oak was when I came across a dairy field with several isolated oaks, oddly reminiscent of the English countryside. About a hundred yards in from the road stood the stump of an oak that had been struck by lightning or suffered some such calamity and had resprouted quite close to the ground. As it grew on a slope, I was able to climb to the ground just above the tree and be at arm's length from the trees and the slightly green acorns. This species I believe is *Q. benthamii*, leaves similar to *Q. gulielmitreleasei*, but acorns larger and fatter, with a shallow cap, similar to *Q. rubra*. A characteristic that allowed me to recognize this type of acorn on other trees I saw was that the diameter of the acorn (about 2 cm) is in most cases larger than that of the cupule. When exploring with Eymos on a side road west of Cerro Punta, a location he referred to as Alto de los Guerra, we found this species growing together with what I

Photos 7/ (a) *Quercus benthamii* resprouting from damaged trunk in a dairy field; (b) *Q. benthamii* leaves and acorns, with shallow acorn cap and acorn wider than cupule.

understand was *Q. gulielmitreleasei.* Eymos knows these trees as *roblito blanco* ("little white oak", *Q. benthamii*) and *roblito rojo* ("little red oak", *Q. gulielmitreleasei*), which can be confusing, as they are both Red Oaks (section *Lobatae*).

Conclusion

Human interference in the shape of roads and clearings for plantations and animal-rearing may have allowed me closer access to *Quercus* and made identification easier, but it was in their natural habitat in the cloud forest that the trees made their greatest impact. Most memorable was a foray into the forest on my last afternoon in Chiriquí: Eymos took me to a *finca* (farm) next to La Amistad International Park, owned by a friend of his, a foreigner who acquired it purely for conservation purposes. Here we advanced into the forest, Eymos ahead hacking the way clear with his machete, towards the huge trunks of *Quercus* giants that soared into the canopy, covered with epiphytes and vines.

Over the four days I spent in Chiriquí I had the opportunity to see oaks nothing like I had seen before and had perhaps found 6 different species, tentatively identified, out of the 10 or so accepted species known to grow in Panama. As Montevideo-New York is a route I will have to fly again in the future, I hope to repeat the routine and revisit the region. For me as well, with Panamanian oaks "there is more work yet to be done."

Acknowledgments

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Photographers. Photos 1-8: Roderick Cameron.

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Photo 8/ Parque Internacional La Amistad

International Oak Society Institutional Members

Forrest Keeling Nursery
Gainesway Farm
The Huntington Botanical Gardens
The Morton Arboretum
US National Arboretum
Possibility Place Nursery
Scott Arboretum
Westonbirt, The National Arboretum

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Joseph Lais
Francesco Rosa
Martin Sturge

Conversion Table

1 mm = 0.039 in	1 cm = 0.39 in	1 m = 3.28 ft	1 km = 0.621 mi
5 mm = 0.195 in	5 cm = 1.95 in	5 m = 16.4 ft	5 km = 3.1 mi
7 mm = 0.273 in	7 cm = 2.73 in	7 m = 22.9 ft	7 km = 4.34 mi
12 mm = 0.468 in	12 cm = 4.68 in	12 m = 39.4 ft	12 km = 7.45 mi
20 mm = 0.78 in	20 cm = 7.8 in	20 m = 65.6 ft	20 km = 12.42 mi

Index of Latin Plant Names

M

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Q

MISSION

To further the study, sustainable management, preservation, appreciation, and dissemination of knowledge to the public about oaks (genus *Quercus*) and their ecosystems.

GOALS

To advance the state of scientific knowledge regarding oaks and oakland ecology

To locate, preserve and catalog significant oak-related literature

To facilitate the location and distribution of living material for propagation of oaks

To foster communication among members via a journal, newsletter and website, and periodic meetings

To promote the study, development, naming, and distribution of superior cultivars and cultivar groups for horticultural use, and the study of oaks for the production of timber, mast, and other useful products

To sponsor the preservation, display, and interpretation of oak-related traditions, art, and lore; and encourage the development and curation of appropriate and useful collections of oak-related pieces, such as wood samples, taxonomic specimens, or historic oak artifacts

To develop the capability and to serve as a registrar authority for oak cultivars, historic and champion oak trees, ancient oak groves, unusual or rare oak specimens, or objects of significance involving oaks

To provide information regarding the use, preservation, and appreciation of oaks, and successful techniques for oak culture and management

To encourage, recognize and honor outstanding achievements by individuals and organizations, members and non-members, in advancing these goals of the International Oak Society

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