A Trip to Study Oaks and Conifers in a Californian Landscape with the International Oak Society

Harry Baldwin and Thomas Fry - 2018

Table of Contents

Acknowledgments

We would both like to thank all the bursaries that funded our trip to study oaks and conifers in California, as well as being able to attend The 9th International Oak Society Conference. Special thanks goes to: Merlin Trust, Kew Guild, Hardy Plant Society and the Royal Horticultural Society. In addition, without the help of Tony Kirkham, Dave Barnes and a great deal of many others, this trip would have not come to fruition. We therefor thank all who helped and contributed to this trip.

Introduction

Both Harry Baldwin and Thomas Fry proposed to travel to California to undertake a field trip to primarily study the genus Quercus, as well as other major tree species in a variety of habitats, in addition to attending the 9th International Oak Society Conference at U.C Davis Arboretum. The field trip was an organised pre-tour which was led by Stewart Winchester, a dendrologist who is very familiar with the flora of the west coast of the USA. The week long tour took participants around some of the most species rich areas of California, from the coastal redwoods in the north, to the dry oak chaparral savannas of the Sierras and to the mountainous regions of Inyo Mountains. In just a week, we were able to explore these oak rich habitats, understand the ecology, and ask why many Californian environments rely on oaks and conifers. Following the tour, we attended the triennial 9th International oak Society Conference, which took place at UC Davis Arboretum over three consecutive days. With over 35 speakers varying in topics, ranging from climate change, pest and disease, oaks in practical horticulture and arboriculture, conservation and scientific research (among many others), allowed us to gain a broad insight into the importance of oaks worldwide in several different capacities. This not only allowed us to improve our knowledge in the genus Quercus, but also allowed us to undertake some important networking opportunities with oak experts and enthusiasts from all over the world.

We hope that this report demonstrates the importance of oaks in the Californian landscape, as well as portraying the great opportunity we had as well as the knowledge gained from the trip. We thoroughly recommend travelling to the west coast to gain an insight into this fascinating landscape as there is a huge amount to learn and see in a relatively small area.

Aims and Objectives:

1. To identify as many Californian Quercus as possible (*Q. douglasii, Q chrysolepis, Q. agrifolia, Q. engelmannii, Q. wislizenii, Q. garryana, Q. lobata, Q. kelloggii, Q. dumosa, Q. durata, Q. sadleriana* and Q. *vaccinifolia*) as well as identifying wide ranging of habitats including riparian, savannah, evergreen, sub-alpine and montane forests.

2. To understand better cultivation techniques as well as recognising what plants are associated with Quercus, in order to enhance gardens, education and knowledge.

3. To converse, build contacts and further the authors knowledge in the genus *Quercus* by attending the 9th International Oak Society Conference.

How to achieve set objectives:

1. To produce a simple table listing taxonomic characters of oaks in order to allow for identification.

2. Taking reliable notes and photos of the surrounding flora in order to identify individual species. In addition, taking reliable notes concerning soil type, aspect, elevation and measurements of certain species in question.

3. Produce a set number of questions for individual speakers that will cover; climate change and urban oak landscape, natural land management and oak conservation, plant collections and public garden conservation initiatives and horticulture.

Sharing knowledge of experience gained:

* Producing a joint lecture at RBG, Kew

* Information gained from both practical and theoretical experience; to propose different approaches and techniques as to how RBG, Kew can manage, conserve and educate for the next generation.

* To pass information through hands on learning activities for apprentices and diploma students in the Arboriculture Unit.

* Produce a fully detailed report of the tour and conference

Map of Places Visited:

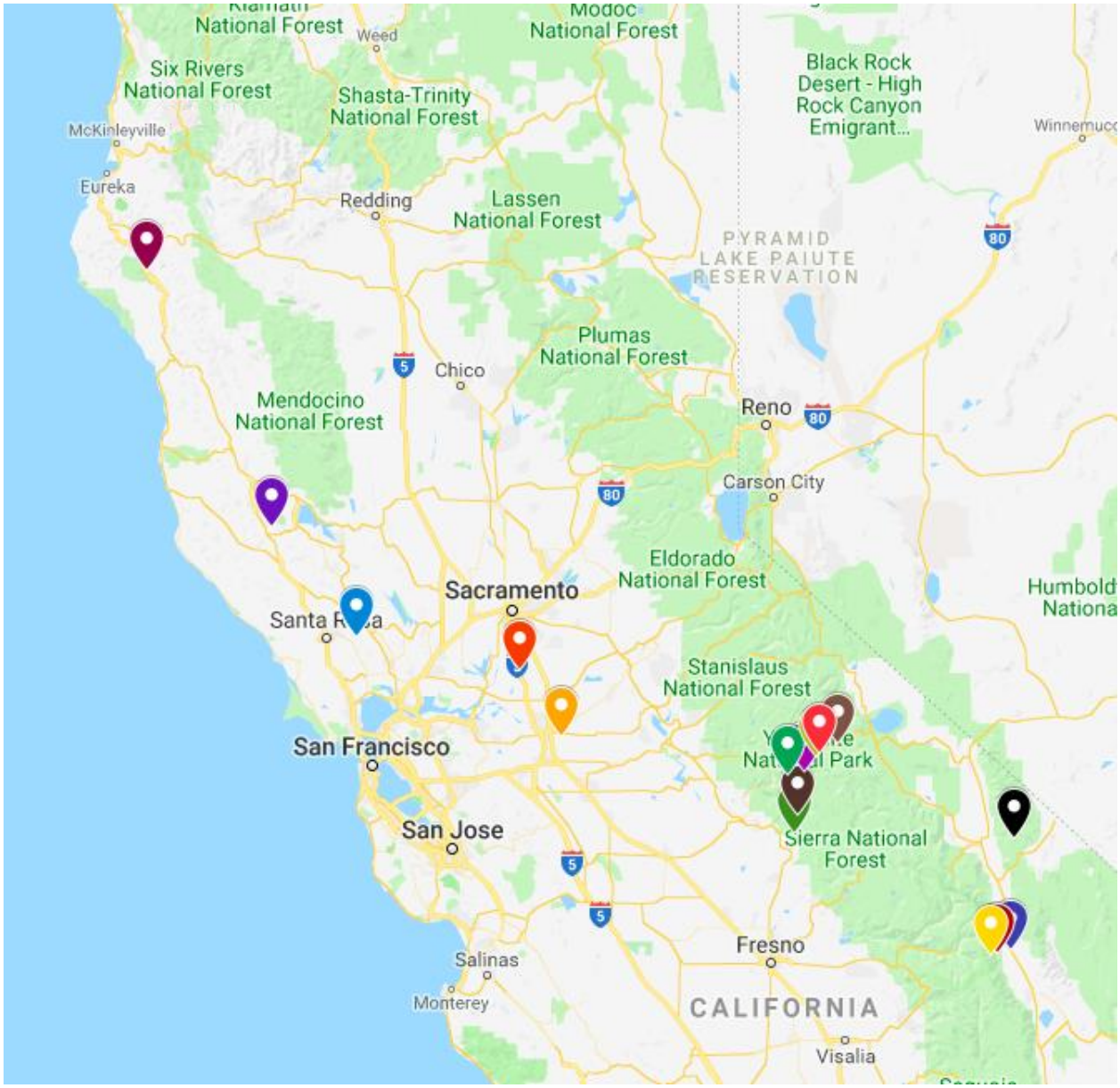

Figure 1: Map of sites visited on tour of California. Credit: Harry Baldwin 2018

Itinerary

Day 1 (12/10/18)

Left Kew station at 06:37 to arrive at London Heathrow for 08:02
Flight 10:25 (GMT) arrived at Sacramento at 16:35 (GMT -7)
Cab taken from Sacramento airport to Hyatt place hotel on UC Davis campus
Accommodation for 2 nights at Hyatt place hotel.

Day 2 (13/10/18)

Rest Day

Day 3 (14/10/18)

Toured UC Davis Arboretum, studied *Quercus* spp. that are cultivated whilst gaining a preliminary understanding of native trees that were likely to be encountered on the trip.

Day 4-8 (15/10/18 - 19/10/18)

The International Oak Society's (Sierra Nevada tour, led by Stewart Winchester and Abbey Hart, exploring California's oak habitats in different elevations.

The pickup point for the tour was Hyatt Place Hotel at 8am 15/10/18. The tour started at California's Central Valley and moved through riparian forest up to the Sierra Nevada foothills viewing *Q. lobata, Q. douglasii and Q. chrysolepis.* Yosemite Valley and Tioga Pass were then visited, as well as viewing *Q. kelloggi* and *Q. wislizeni.* The tour then took us to the eastern Sierras and the White Mountains to see *Q. x morehus* and cultivated specimens of *Q. agrifolia.* The last destination of the tour was the ancient forests of *Pinus longaeva.* The tour ended at 8am 19/10/18 returned to Hyatt Place Hotel.

Day 8-9 (19/10/18 – 20/10/18)

The International Oak Society's Northern California Tour.

The tour commenced at 8am 19/10/18 at the Hyatt Place Hotel and headed north from Davis to view *Q. lobata* and *Q. douglassi* in the Sacramento Valley. *Abies magnifica, Chrysolpis sempervirens* and *Q. vacciniifolia* were seen as the tour ascended into the subalpine forests. The tour then headed north east to view *Sequoia semperiverns*. The trip ended on the return to Hyatt Place Hotel at 8pm 20/10/18.

Day 10-13 (21/10/18 – 24/10/18)

Attended The 9th international Oak Society Conference.

The conference was held at the UC Davis Arboretum.

The conference ended 24/10/18.

Day 14 (25/10/18)

Left Hyatt place hotel at 12:00 to catch cab to Sacramento airport.
Flight from Sacramento Airport returning to London Heathrow left at 15:31 (GMT-7) and arrived in London at 12:20 (G.M.T)

Train taken from Heathrow to Kew concluding the trip.

Background to Oaks

Harry Baldwin

The genus *Quercus* is one of the most important groups of woody plants in many regions of the Northern Hemisphere. Oaks dominate various temperate, subtropical, and tropical forest types, and are also a major component of several chaparral and scrub vegetation's. Although the popular conception of oaks is of a temperate tree that dominates temperate forests of North America and Europe, the centre of diversity for the genus in the New World is in the montane forests of Mexico, where oaks species occur as mostly evergreen and semi-evergreen trees, as the sole dominant, or often in association with pine. However, numerous shrub species also occur in association with these forests, sometimes as dominants in chaparral vegetation. Less known are the truly tropical species of *Quercus*, occurring at elevations from near sea level to 1,500 m on both the Atlantic and Pacific slopes, from Mexico to Panama, with one species in Colombia. But for myself (H.B), Oaks of North America, specifically the west coast has fascinated me. There are over 20 species of native California oaks. Several of these are endemic and grow naturally nowhere outside of California, while others are more wide ranging and grow from Canada to Mexico. There are both shrubby oak species that never grow more than a few feet tall, as well as oaks that attain a tree form. Whoever is reading this, I hope inspires and encourages to explore North America for not only its oaks, but also its fantastic pine oak habitats.

California has long been blessed by the diversity, abundance, and beauty of oaks. At present, 18 species of oak enrich the states native flora, each strikingly different in growth form and physiology. Some grow as tall, stately trees, while others are diminutive, ground-hugging shrubs. Some retain their foliage all year round, while others drop it at the onset of winter or drought. So many are the variations in shape, colour, texture and size that botanists have divided the 18 species into nearly 30 distinct varieties. This high diversity rivals, if not surpasses, the richness exhibited by California's magnificent pines, firs and cypresses. To whiteness such a diversity, California is certainly one of the hotspots in the world to visit.

Figure 2: Quercus rysophylla 'Maya'. Credit: Baldwin 2018

Cosumnes River Preserve

Thomas Fry

Figure 3: Quercus lobata at Consumnes River Preserve with the IOS group. Credit: Baldwin, 2018

Our first stop was the beautiful Cosumnes River Preserve, which is a protected 46,000-acre wetland and oak woodland, located south of Sacramento. The unique point of this preserve is that it is an undammed river unlike the many others in the Central Valley, it is manipulated for the extensive production of crops including pecan, citrus and rice.

These lands many centuries ago, would have been the stomping ground of the Miwok people. Up until the late 1700's, with the arrival of Spanish settlers, the tribe would have been free to roam with unrestricted access to the plethora of foods available to them including acorns, fish and deer (Elliot, C. (2018). The new settlers thought this area to be valuable grazing for cattle and soon took advantage. This meant the heavy grazing of grasses and seedlings had an adverse effect on the ecology of the land. Inevitably, grasses prevented the native flora to flourish which essentially unbalanced the ecosystem. This left a less diverse landscape for many species to populate. It was the Californian gold rush of the mid 1800's that took its next toll on the landscape and indigenous inhabitants by the Miners establishing settlements and all that that entailed. The centuries of exploitation of this land led to a weakening population of *Quercus lobata.* In 1987 the Nature Conservancy surveyed the lands recording the *Q. lobata* numbers and found the lower Cosumnes River had the best stands, and in light of this study created the preserve (Purcell, K. 2018). To this day the preserve is used as a valuable recreational and educational resource.

Upon arrival, the group was given clear instruction: "No Squirreling of Acorns!"; meaning no collecting so as not to interrupt the regeneration potential. This was tricky considering this was to be our first *Quercus* stop and we were all eager 'Querciphiles'. Our journey around the preserve

started with the clunking of footsteps along the raised boardwalk leading us through young examples of *Q. lobata*. Everyone was extremely keen to botanise. It was here I had my first introduction of *Toxicodendron diversilobum* (thankfully not physically!!!!) This visual delight showing its glorious autumnal colour is not to be taken lightly…. Touch at your own peril! We walked along paths shaded by larger specimens of *Q. lobata* with interspersing *Fraxinus latifolia*, *Acer negundo*, *Salix exigua* and even the odd *Q. agrifolia* which had been introduced to the area by fauna. The understory was a jumble of *Vitis californica* and invasive species like *Vitis vinifera*, another introduction by fauna from vineyards and in addition, *Rubus fructicosa* was also brought over by European settlers. Finally, we had reached what we had all be craving, large and true examples of mature *Q. lobata*. These twisting and gnarling specimens stood proudly amongst the grass and showed character and age. With the camera lenses clicking and the crowds admiring, it was evident the stop was a success.

The Miwok people lived as a community in tune with the land and nature. The miners and farmers viewed this land as a commodity and exploited it, mans contradictory nature will at the end of the day determine the future of this important and significant landscape. It truly makes the mind wonder what the Central Valley may have been like centuries ago.

San Joaquin Experimental Range

Thomas Fry

Figure 4: San Joaquin Experimental Range with Quercus douglasii. Credit: Baldwin, 2018

Our next stop would take us to the San Joaquin Experimental Range. The journey to this location saw a change in topography from the flatness of the Central Valley to a glorious golden rolling landscape as we reached the foothills of the Sierra Nevada mountains. It was here we saw our first examples of *Q. douglasii* which was growing alongside *Pinus Sabiniana*; which coincidently, I recently worked on at Kew. The occasional *Q. wislizeni* was spotted around the hills. *Arctostaphyllus viscidus, Ceanothus leucodermis* and *Ceanothus cuneatus* were all dominant shrub species.

The experimental range was developed in the 1930's to determine cost effective agricultural techniques, mainly cattle farming that would not jeopardise the ecosystem (Purcell, K. 2018). In more recent years, the work has been more focused on sustaining this landscape. The range is also used as an educational resource for state universities and colleges. The site is said to have a Mediterranean climate with winter lows of around 4°C and summer highs exceeding 38 °C(Purcell, K. 2018).

Quercus douglasii has a preference for dry soils and sunny sites, and it is this species that truly dominates the landscape. The blue/green tinge of the shallowly lobed leaves, the long-pointed acorns and the light deeply fissured bark makes it an attractive species. The leaves contain a bluish pigment as protective measure to reflect some of the harsh rays of the summer sun, along with a thick waxy cuticle to reduce evaporation from the leaf allowing *Q. douglasii* to thrive in such hot conditions. However capable the *Q. douglasii* may be in this climate, there seems to be only semi-mature and mature specimens present, which gave the group a large question to contemplate.

The *Q. douglasii* at this location is said to be in an area of poor regeneration (Fryer, J. 2007). This is due to excessive grazing from livestock and other herbivores, acorn predation from

Figure 5: Quercus douglasii acorn. Credit: Baldwin, 2018

woodpeckers and scrub jays, a lack of rainfall and the competition from grasses. We were told of the "Lucky Coincidence Hypothesis" by the staff, which was the thought to be due to several factors needed to for regeneration. Those include; a mast year for *Q. douglasii* with enough rainfall, low populations of acorn predators and grazing herbivores and a lack of livestock. With only one of these factors out of place, successful succession to recruitment size (6ft) will not take place.

We were told by the staff that an experiment was undertaken in 1955 to grow on acorns to reach recruitment size. Fences were put up to make what is called the Elephant Pen, weeds were suppressed, and irrigation was put in place. Unfortunately, this experiment was proven to be unsuccessful due to the persistence of gophers to the irrigation in summer.

The future of *Q. douglasii* on this range has a very uncertain future, however, there is one missing factor in this ecosystem, fire. Due to being privately owned land with little funding, wildfires are suppressed and controlled burns are not an option at this moment in time. It left us wondering would fire help the regeneration of this landscape as this is key to many habitats across California?

Figure 6: Arctostaphylos sp. growing amongst oak chaparral landscape. Credit: Fry, 2018

Mariposa Grove and Yosemite

Thomas Fry

Figure 7: Sequoiadendron giganteum at Mariposa Grove, Yosemite. Credit: Baldwin, 2018

Yosemite is perhaps one of the most iconic national parks. It is 1,169 square miles of varying landscape and vegetation, changing from oak woodland to chaparral scrublands, lower montane, upper montane, subalpine and alpine habitats. Nearly 95 percent of the park is left as designated wilderness (Jackson, P. (2017). With its many world-famous granite cliffs towering from the valley floor and diverse ecosystems, it truly stops you in your tracks and allows you to peacefully stand in awe. John Muir once said: "It is by far the grandest of all the special temples of nature I was ever permitted to enter." This is genuinely reflected as soon as you arrive.

Figure 8: Quercus kelllogii at Mariposa Grove, Yosemite. Credit: Baldwin, 2018

As the journey progressed from the previous site, we gained significant elevation, we were now travelling through dense dark forest on winding mountain roads. These were comprised of large specimens of *Pinus lambertiana, P. ponderosa, Calocedrus decurrens, Abies concolor* and *Q. kelloggii*. As the roads meandered along the Sierras, we reached the southern border of Yosemite to Mariposa Grove. As we approached the grove, we were seeing progressively larger specimens of

Sequoiadendron giganteum dotted along the roadside. Every passenger on the bus seemed to rush from side to side, pressing their faces against the windows to see these impressive trees.

We soon reached Mariposa Grove we began a hike through the forest. Mariposa Grove is the largest grove of redwoods in Yosemite with many mature examples of the species. The bulging and flaring buttresses of the *S. giganteum* and the mammoth towering structures left me silent and unexpectedly emotional. It has been a life long ambition to walk amongst the redwoods, and there I was, like a school child with a massive grin on my face. Amongst the giants was a rich ecosystem with a wide range of species, such as the previously seen *Pinus lambertiana, P. ponderosa, Calocedrus decurrens, Abies concolor* and *Q. kelloggii.* However, now we were able to see the understorey of *Cornus nuttallii, C. sericea, Notholithocarpus densiflorus, Rhododendron occidentale* and *Rubus parviflorus*.

The most notable tree at the grove was a specimen known as the Grizzly Giant, which was significantly larger than the other redwoods. Reaching a staggering 64 metres into the air and with a girth of 7.8 metres, the Grizzly Giant is considered the 25th largest tree in the world and it is thought to be around 2000 years old (Stephenson, N.L., 2000). Comparing this to Kew's seemingly small 37 metre specimen, makes you realise the enormity of this species when given time and space.

On almost every specimen, we were seeing charring which is caused by previous fires. This a common occurrence as fire is an important process for the regeneration of the redwoods. The redwoods have an extremely thick bark which allows them to withstand extreme heat from the fires. The heat in turn speeds the process of releasing the seeds from the cones. Along with the removal of competition of species that are less capable of surviving fire, therefore the environment is ideal for seeds to germinate, creating a high potential for regeneration (Swetnam, T, 2004). Due to recent fires at this site, several pioneering species were present, including; *Ceonothus parviflorus, Ceonothus cordulatus* and *Lupinus* ssp. These species are important as they all fix nitrogen into the soil. As expected with fire, nitrogen is removed from the soil making it an

Figure 9: Notholithocarpus densiflorus. Credit: Fry, 2018

undesirable growing medium. Nitrogen fixing plants are capable of drawing nitrogen from the air and storing them in their nodules which are located on the root system. This is released when the plant dies, and decomposition allows the nitrogen to be released in an available form to the redwoods.

Olmestead point

Thomas Fry

Figure 10: Quercus vaccinifolia growing as a shrub beneath Juniperus grandis, Yosemite. Credit: Baldwin, 2018

One short stop we made was to Olmstead point located at Tioga Pass. It is a viewing area above the canyon with glorious panoramic views across the valley. It was here the tour stopped and gave us the opportunity to scale the raw sloping granite rock face and view the mighty *Juniperus grandis*. From the road we could see the stout yet old trees spreading across the rock face. On closer inspection we could see the trees have the tendency to twist and wrap around themselves, this is due to being exposed on the mountain side with no protection from strong winds and snow. *Juniperus grandis* has the ability to reach 3000 years old, some of these specimens were believed to be around the 1500 year mark. The trees were growing straight from the granite rock with no soil and forcing themselves through cracks which gave them their buttresses and 'lava flow' like appearance.

Growing alongside the *J. grandis* was the small shrubby evergreen *Q. vaccinifolia*. This tree grows no more than 1.5 metres tall and spreads along the ground, maintaining a shrub like appearance. With the group being oak enthusiasts, much of the attention was focused on the *Q. vaccinifolia* and

its dense structure. The leaves were entire and the cupules of the acorn were incredibly small. Its was amazing how this oak survives on this exposed location.

Figure 11: Juniperus grandis with Quercus vacinifolia at the base, Yosemite. Credit: Baldwin, 2018

Bristlecone Pines

Thomas Fry

Figure 12: Ancient Bristlecone Pine in the White Mountains. Credit: Baldwin, 2018

From Yosemite we headed over Tioga Pass and descended the eastern slopes of the Sierras. It was on this journey we started seeing different flora than previously seen on the Sierras, this was due to the orientation of the slope and different climatic conditions that came with it. *Populus tremuloides, P. fremontii* and *Fraxinus angustifolia* were all scattered down the valleys, just starting to show autumn colour. We were also seeing *Pinus jefferyi* and *P. albicaulis* and the occasional *P. monophylla* on the descent.

Once reaching Owens Valley, we headed north to Big Pine and then east as we began our ascent of the White Mountains. As we climbed to roughly 6500 ft. we noticed *P. monophylla* was growing as far as the eye could see, with the occasional *J. osteosperma* dotted throughout. As the elevation increased, we began to see *P. flexilis* and *P. longaeval*. We soon arrived at Schulman Grove, which is part of the Ancient Bristlecone Pine Forest. This grove is situated at roughly 10,000 ft and is host to some of the oldest non-clonal living organisms in the world. Some *P. longaeva*, are believed to be just short of 5000 years old (Brown, P. 2010).

The twisting and gnarly appearance of these trees set in a seemingly barren landscape created an eerie feel. We walked a short trail that climbed higher up the slopes, with the strict instruction to stay on the path to minimise compaction. *Pinus longaeva* were scattered along the mountain side, each one with its own individual character with specimens of all ages. One particular tree was around 6ft tall and was predicted (by our tour guide) to be about 100 years old, whilst the largest we saw was expected to be in excess of 4000. We saw evidence of logging for fire wood which was

surprisingly legal up until the 1960's, this meant we were able to see the extraordinarily tight growth rings inside the wood making it seem as if annual growth was as little as one cell in a year.

Considering the exposed nature of these trees and the extreme colds and strong winds that come with this terrain it is incredible that *P.longaeva* is able to survive. Survival is partly due to the wood being extremely dense and highly resinous preventing insects, fungi and bacteria from colonising. The dry conditions in which the *P.longaeva* live helps by preventing the trees from rotting. The longevity of the bristlecone needles and the inability of other plants to grow in the substrate prevents little groundcover. This distance in between each individual, combined with the lack of ground cover, is how a tree can sustain a lightning strike, catch fire, and not have the fire spread to surrounding trees. (Miller, L. 2005)

Figure 13: Ancient *Pinus longaeva*. White Mountains. Credit: Baldwin, 2018

Foxtail Pines

Harry Baldwin

Figure 14: A grove of Pinus balfouriana growing on granite. Credit: Baldwin, 2018

We had the exciting opportunity to see another ancient conifer, *Pinus balfouriana*, also known as the foxtail pine. This species grows at high elevation between 10 – 12,000 feet, so we had a large climb (by bus!) up the tight winding road. Before we ascended, we stopped in a layby that was flourishing with autumn colour, with many tree genera that I am already familiar with that grows at Kew. By the stream were many small, but tight arching stems of *Betula occidentalis* that was in full autumn colour. Other riparian species included *Populus fremontii* and *Salix orestera*. Away from the streams were fantastic bright yellowed leaves of *Fraxinus velutina* which may well be one of my favourite trees of the trip. As seen in plate xxx, it had a wonderful arching habit with soft ribbon bark, criss-crossing its way up the stem. The leaves were compound with thick velutinous indumentum which was particularly attractive. In my eyes, this species is very ornamental and deserves to be used in horticulture; but like many ash, they are in discontinuous use due ash borer and ash dieback scare. Oaks were in the vicinity included both *Quercus kelloggii* and *Q. wislizeni* scattered amongst *Pinus jeffreyi* and strangely enough, *P. coulteri* which is not native to the area. Another highlight was that we saw an interesting hybrid between the two oak species, known as *Q.* x *morehus* (*Q. kelloggii x Q. wislizeni*). This specimen in particular presented both parent characteristics very well; the leaves were generally quite small, semi-evergreen, sharply lobed with rounded sinuses and a rather elongated acorn. This is another species which in my opinion has great horticultural potential.

As we began to ascend, it was clear we were gaining elevation as *Populus fremontii* and *Salix orestera* were lightening in colour due to the colder temperatures. Evergreens started to dominate the landscape; *Abies magnifica, A. concolor, Pinus jefreyi, P. albicaulis and P. Flexulis* grew over the

craggy granite rock slopes. Even at 8000 feet, *Q. kelloggii* was still present which was astonishing. We pulled over in a layby next to a towering giant: *Abies magnifica*. This must have been several hundred years old. It Appeared to have lightening strike damage down the trunk which had scarred its bark. Next grew a beautiful small maple, *Acer glabrum var. diffusum* which held wonderfully small leaves and was dripping with fruit. Looking at 'Calflora', this species is mostly found on the eastern side of the Sierra's, but one small relict population is found in the Klamath Mountains (Calflora, 2018). This is similarly seen with *Pinus balfouriana*, where a small relict population is also found there.

Figure 15: Eastern Sierra's, Onion Valley. Abies magnifica, Pinus balfouriana and Populus fremontii. Credit: Baldwin, 2018

It was evident when we reached the top, *Pinus balfouriana* littered the landscape with their bright orange bark. The community was typically open, with a sparse understory and scattered woody debris. Arid, high-elevation conditions allow woody debris to persist for many years without decay. This mountain climate is largely dominated by the Californian Mediterranean climate, characterised by cold, wet winters, with long, warm and dry summers. Precipitation is low and only occurs small amounts after the snowmelt. This environment was clearly hostile!

Tom and I decided to climb the steep granite slopes to encounter some of the ancient giants. Not only was the sun blinding, but also its reflection on the white granite, it was almost impossible to guide yourself at times. This was a common reminder why we were not seeing any broadleaves; there is no chance that they could survive in this hot dry landscape. Looking into the distance and spotting the *Salix orestera* and *Populus fremontii* indicated the nearby streams – which in spring must be gushing after the ice melt. It was evident from some trees that there was damage to the stems from perhaps small avalanches and granite movement.

The main understory vegetation was shrub associates, which included; *Chrysolepis sempervirens*, *Holodiscus discolor*, *Ribes cerum*, *R. montigenum* and *Symphoricarpos rotundifolius*. *Chrysolepis sempervirens* was particularly stunning. It grew in large swath patches, with its golden brown indumentum glowing in the bright sunlight. Interestingly, there was plenty of fruit, but all the cases were empty. I wonder if this is due to bad weather in the spring, or is because they are so isolated they are genetically infertile? I expect the latter is doubtful as Fagaceae pollen can travel for many many miles.

Sugarloaf Ridge State Park

Harry Baldwin

Figure 16: Sugarloaf Ridge State Park. Credit: Baldwin, 2018

Sugarloaf Ridge State Park encompasses 1142 hectares and is located in the mountain range between Sonoma and Napa valleys, just a few miles east of Santa Rosa. Despite its proximity to urban areas and many institutions of higher learning, Stewart relays that Sugarloaf is a top underutilized teaching resource. Not only is this site supporting one of the easternmost *Sequoia sempervirens* stands, but is home to eight different vegetation types, as well as representing much edaphic endemism resulting from serpentine-derived soils (Stewart Winchester pers. comm). It's a sight which has remained relatively unchanged in its natural and cultural character; we had only had a morning to explore this 'outdoor floristic museum'.

Upon pulling in, we were greeted with our first encounter, *Q. agrifolia* which stood large but alone in a distant field. The vegetation had somewhat changed dramatically from the day before at Mammoth Lakes, Sierra Nevada. One could gaze in many directions and see a multitude of plant communities, including; mixed evergreen forest dominated by *Pseudotsuga menziesii*, *Umbellularia californica* and *Arbutus menziesii*. Also, oak woodland was dominated by *Q. agrifolia* with scattered stands of *Q. kelloggii*, *Q. chrysolepis* and *Q. garryana*, and amongst others including, riparian woodland, chamise chaparral and perennial and annual grasslands.

Sadly, upon the drive in, it was evident that *Notholithocarpus densiflorus* was infected with *Phytophthora ramorum*. Stewart mentioned that it was first recognised in California in the mid 1990's, the disease kills some oak species including *Q. agrifolia* and has apparently had devastating effects on coastal forests in California and Oregon (Stewart Winchester, pers comm.). The pathogen

also infects rhododendrons, camellias, and other common horticultural plants, causing ramorum blight. In the UK and Ireland, the pathogen is causing extensive damage on Japanese larch (*Larix kaempferi*) in plantations. At Kew it seems to be under control, but removing hosts such as Viburnum spp. helps prevents the spread of this deadly disease.

Figure 17: Quercus durata presenting its blue foliage at Sugarloaf Sate Park. Credit: Baldwin ,2018

Perhaps the most interesting areas for the Querciphiles was the Serpentine Chaparral. This is a distinctive chaparral community occurring on serpentine-derived soils; *Ceonothus jepsonii* var. *jepsonii, Q. durata* and *Festuca californica* all serve as strong indicator species. What gives this soil its metallic composition is the surface runoff from small rocky outcrops that contain 70% iron and 70% magnesium. These compounds give rises to the lack of essential nutrients and high concentration of heavy metals within the soil, all of which are detrimental to plant growth (USDA, 2018). Plants found within these areas often share similar vegetative characteristics; stunted growth, dull waxy grey blue leaves and shallow rooting, such as those seen: *Q. durata* and *Ceonothus jepsonii*.

Figure 18: Quercus durata in fruit at Sugarloaf State Park. Credit: Baldwin, 2018

Despite these harsh conditions, *Q. durata* was laden with its short stumpy fruit. As expected, IOS members rallied up the hill as quick as they could to collect their stash. On approach, you would often get a bright flash of exquisite blue which would light up the chaparral grasslands; that was the neighboring scrub jay (*Aphelocoma californica*) - more than likely upset with the depletion of their winter food. Another interesting surprise was something much smaller and rather edible looking: a strawberry gall (*Disholcaspis plumbella*) or also known as the Beaked Twig Gall. *Disholcaspis plumbella* is known to live on a few white oaks including *Q. douglasii*, *turbinella* and *berberidifolia*, but there is sadly little known about this attractive gall. From my experience, most galls are usually a dull green in colour, I wonder why this oak produces something so colourful – would not such colours attract the attention of predators?

It seemed wherever you cast your eye there was always an oddity or a unique feature to see at Sugarloaf Park, as usual there is never enough time to see everything, but the trip must press on!

Figure 19: Disholcaspis plumbella, Beaked twig gall on Quercus durata. Credit: Baldwin, 2018

Redwoods at Rockefeller Grove

Harry Baldwin

Figure 20: Giant redwoods - Sequoia sempervirens. Credit: Baldwin, 2018

The Rockefeller Grove stands on an alluvial floodplain at the confluence of Bull Creek and the Eel River, just south of Eureka. This quintessential lowland grove is known to be one of the most scenic in Humboldt Redwoods.

Rockefeller, also known as Tall Tree (worlds 16th tallest tree) is the 10th tallest tree in Humboldt Redwoods State Park, and the tallest tree on Upper Bull Creek Flat. Rockefeller was named in honour John D. Rockefeller who, between 1926 and 1929, donated $2,000,000 to Save the Redwoods League in order to purchase Dyerville Flat from the Pacific Lumber Company. In 1931, this 14.6-mile 2 tract of old-growth redwood forest, since renamed Rockefeller Forest, became the core of Humboldt Redwoods State Park (Old Growth Forest, 2018).

We had just enough time to appreciate it upon arrival as it was beginning to become dusk. Being my second occasion (HB) and to some others, countless, is always and every time, astonishing. As John Steinbeck (John Steinback, 2013) once said: "*The redwoods, once seen, leave a mark or create a vision that stays with you always…. they are not like any trees we know, they are ambassadors from another time*." Trees towered above us like natural skyscrapers, their trunks wider than the coach itself and nothing but silence, not even footsteps could be heard on this mattress of needles. As you can imagine, no pictures can ever do these trees justice, we all found ourselves cranking our necks to find a glimpse of the tops of trees, but merely impossible.

California's distinct Mediterranean climate is far too harsh for the survival of the redwoods; the occurrence of the Californian Fog Belt allows these large trees and the dynamic ecosystem below to thrive (Brown, 1982). Large understory trees such as *Acer macrophyllum* lit up corners of the forest like big yellow beacons, whilst it's close and smaller relative *A. circinatum* warmed the lower canopy with its deep crimson red. As expected, deciduous species such as *Acer* spp., *Alnus rubra* and *Populus trichcarpa* inhabited breaks in the canopy or along riparian banks. Evergreen trees such as, *Notholithocarpus densiflorus*, *Umbellularia californica* and *Arbutus menziesii* grew happily in areas of low light. Parts of the canopy floor were sparse, as it was out of season for the flush of *Trillium ovatum*, *Oxalis oregana* and *Aquilegia formosa*, but mounds of emerald green from *Polystichum munitum* were present in their thousands.

Figure 21: Admirring Acer macrphyllum in a riparian setting. Credit: Hart, 2018

Almost every vascular, non-vascular plant and fungi that grows within the redwood community, can also be found as an epiphyte some 80-100 meters above ground level. Due to their sheer size and complex architecture, this allows the accumulation of large amounts of needles which composes into an organic canopy soil; essentially a mini redwood forest! According to Sillett and Van Pelt (2000), an *Umbellularia californica* was found in the canopy of an old-growth redwood and is the highest recorded epiphytic tree in the world, growing out of a knothole located 98.3 meters above ground level. This fact alone displays only a glimpse of the complex interactions and ecology taking place in an old growth redwood forest. Despite not being an 'oak woodland', I believe I can say that this took the breath away of all IOS members and might have even inspired additional memberships to the International Conifer Society!

Champion *Quercus lobata* at Covelo.

Harry Baldwin

Figure 22: Site of champion Quercus lobata situated within a valley. Credit: Baldwin, 2018

Upon reading the proposed itinerary, I couldn't quite believe nor imagine that we would be seeing an oak in excess of 50 meters tall. Consequent to this, I immediately left my office and rushed over to the Waterlily House at RBG, Kew, where the TROBI Champion, *Quercus castaneifolia* stands some 37 meters in height. Eying up an additional 13 meters sounded almost unfathomable; I gleefully awaited the day to see this entity in its landscape.

Before long, I remember stepping off the coach on a beautiful cloudless sunny day in California, and being confronted with the mightiest and grandest oak I have ever encountered. After a brief silence, everyone made a dash with their cameras armed at the ready and their collecting bags tied to their hips, it was manic. Reaching the dripline of the tree I have never quite seen so many acorns, the ground was littered with caps and nuts in their thousands. For the first time on this trip, there were no quarrels or disputes that Abbey had to resolve, there was more than enough to go around.

This *Quercus lobata* stood in a beautiful open location amongst a farm of various vineyards in Covelo. Within the area there were a few smaller individuals of a similar age, growing in its vicinity, but no where near as large. It is clear that before agriculture came to this valley in the 1880's, forests of Valley Oak would have extended for miles taking advantage of the ground water and resisting fire, wind, drought and disease. Valley oak is likely the largest North American oak, and descriptions of

its remarkable stature appear in the diaries of many early visitors to California. Describing the open groves of the Santa Clara Valley in 1796, English explorer George Vancouver (1798) wrote:

"For about twenty miles it could only be compared to a park which had originally been closely planted with the true old English oak…. they had the appearance of the stately lords of the forest…. How I wish one stood in our yard at home".

However, over the last 150 years Valley Oaks have been the victims of widespread agricultural and residential development; it is now rare to see extensive groves of this monarch species (Stewart Winchester pers comm).

This small relict grove has managed to thrive in this location between the last 400 - 600 years. It was clear from inspecting the tree that there is much wear and tear, but considering its historic wounds, the tree has responded well. The two co-dominant stems are of equal size supporting the trees weight, but a large historic wound which has failed to seal may cause a slow decline in the future for this veteran. It is apparent that the tree has responded by compartmentalization (ie. by shutting down a part of its vascular system in order to prevent the spread of decay), which is noticeable by the loss of bark plates within that region. Luckily it stands away from heavy foot traffic and busy roads, allowing this veteran to continue its natural life with minimal human interference.

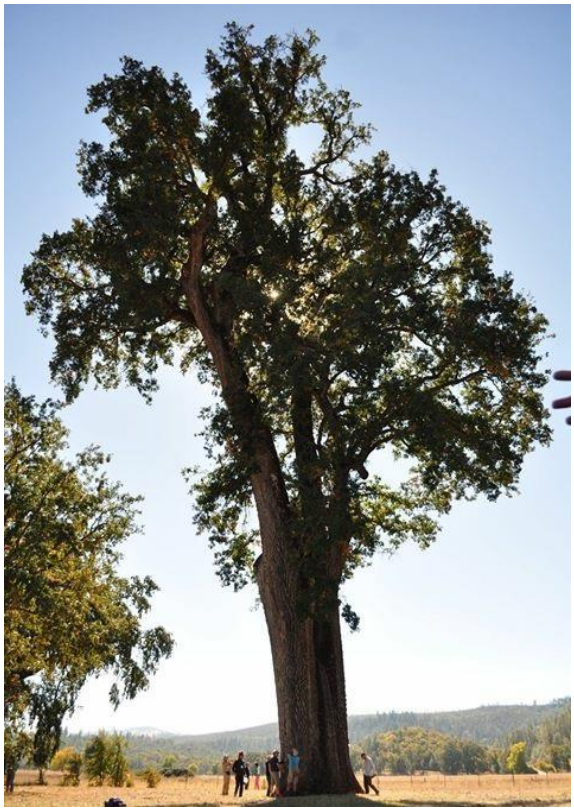

Figure 23: Champion Quercus lobata. Credit: Fry, 2018

Figure 24: Champion Quercus lobata. Credit Baldwin, 2018

Acorn Woodpecker (Melanerpes formicivorus)

Thomas Fry.

In relation to the champion *Quercus lobata* at Covelo, it was apparent that many holes filled the trunk and the main branches. We had also noticed this at San Joaquin Experimental Range as well as at a few other sites on the trip. According to Stewart Winchester, this was caused by the acorn woodpecker: *Melanerpes formicivorus*.

The acorn woodpecker shares an intimate relationship with California's *Quercus.* Its range covers most of the western coast in all habitats where Quercus coexist. The woodpecker collects acorns directly from trees and stores them in individual holes drilled over the bark of many trees, these are called granaries and are a communal storage spot for acorns. Holes are reused, and more are made, making the so-called granaries an interesting site to see. Whole trees can be peppered with these acorn sized holes and in autumn each hole will be filled an acorn, all stored in the same direction. The depth of which these holes are drilled is such that does not disrupt the cambium layer of the tree.

Figure 25: Acorn woodpecker on Quercus lobata. Credit: Fry, 2018

Acorn woodpeckers don't solely rely on acorns as a food source however they are highly dependent on them, especially in colder seasons. The birds will spend roughly a quarter of a year at the granary protecting the cache from other animals and moving shrunken acorns to smaller holes. They live in communities with each bird tasked with maintaining this vital food source. The family groups can be up to 15 birds which will control territories. Within the group will be a breeding core of 4 or more males sharing up to 3 females, communally the birds will raise the offspring. The store of acorns is seen as the communities meaning any acorn can be taken by any bird within the group, however this is no longer the view when there is a low yield of acorns, the more dominant birds will exclude others from access to the acorns to the point of the group disbanding.

Hopland Research and Extension Centre

Harry Baldwin

Figure 26: Quercus lobata dripping with Ramalina menziesii. Credit: Baldwin, 2018

We arrived at Hopland Research and Extension Centre, our final stop of the tour. This outdoor research station encompasses 5,300 acres, where a diversity of soils, plant and animal communities can be found; this allows for the vast amounts of research to be undertaken on wildlife, watersheds and rangelands. Unexpectedly, on July 27th 2018, the River Fire burned over 2/3rds (3000 acres) of the research area; we were told despite this dramatic event, it has created a unique opportunity for research, especially with oaks.

The site is home to a vast amount of oak species including, *Q. agrifolia, berberidifolia, douglasii, garryana, kelloggii, lobata, parvula* and *wislizeni* and amongst a vast collection of oak hybrids. Other tree species dotted the landscape to a lesser degree, such as *Aesculus californica* and *Arbutus menziesii,* most of which showed charred stems but with some promising regrowth. Other than the charred and cleared landscape, many of the trees were clothed in a silky green web, which appeared to be the lace lichen, *Ramalina menziesii*. Its distinctive lace-like pattern is unlike any other lichen in North America and is known to be hugely beneficial to wildlife, in particular birds for nest building. Apparently after many years, the California Lichen Society were able to honour this lichen as the state lichen of California, and to be the first ever state lichen. Somehow, despite the intense fires, this lichen seemed to be thriving more than ever!

Figure 27: Quercus parvula var. shrevei x agrifolia. Credit: Fry, 2018

Interestingly we happened to be at a site where it was essentially a cross roads for some of the oak species outermost ranges; *Q. douglassii* western most range, *Q. garryana* southern, and northern most limit for *Q. agrifolia*. We were therefore able to see some fantastic oak hybrid examples; *Q. x morehus* (*kelloggii* x *wislizeni*), *Q. x jolonensis* (*douglasii* x *garryana*), and *Q. eplingii* (Q. *douglasii* x *garryana*). Perhaps one of the most striking and peculiar hybrids we came across was *Q. parvula var. shrevei* x *agrifolia*. It held dense clusters of elongated acorns resembling *Q. parvula*, and glossy green involute leaves, tapering to an acute point similar to that of the Coast Live Oak. We were told that the offspring is fertile, which in my opinion, could make a valuable ornamental tree to arboreta. Another interesting hybrid we came across was *Q. kellogii x parvula var. shrevei* which held beautiful kelloggii like leaves but retaining the majority of its leaves throughout the winter. It is understood that John Tucker spent the last remaining years working on these hybrid oaks which were included in the revised version of the *Jepson Manual: Higher Plants of California.*

Returning to the coach offered many sullen faces as we knew we were at the end of the road for the pre-tour trips for 2018. Over a period of a week, we have managed to see coastal, mountain and dessert habitats stretching all over Northern California. Not only were we lucky to see so many diverse environments, but we were in the great company of Stewart Winchester who was able to narrate and share his tremendous knowledge along each step of the way and would have been greatly missed if unattended. This also goes for Abbey Hart, who without, this trip would have never of taken place; we were in the good company of trees and friends.

Figure 28: Lunch under Quercus lobata. Credit: Fry, 2018

9TH International Oak Conference at UC Davis California

Harry Baldwin

Figure 29: IOS Conference group photo. Credit: Anon, 2018.

The 9th International Oak Society Conference held at UC Davis in October 2018 (in my eyes) was probably the most ambitious IOS Conference to date – and it was a memorable success. Though the conference took place over four days from October 21-24, the associated tours (that we attended) took place before. There were 282 registered participants, not including spouses and guests. There were 60 speakers, 15 poster presenters, 5 workshop leaders, 15 local tour leaders, 1 cast study presenter, 1 film presenter, and 80 friendly, ever-smiling staff and volunteers who ensured everything ran smoothly.

The 2018 Conference introduced several novel features:

- We had concurrent sessions for most of the Conference, following an initial plenary session for all. The concurrent sessions involved two tracks, sometimes three, and were constructed so as to group presentations by theme and by level of technical complexity, allowing participants to choose tracks most suited to their interest.

- The Conference had an overriding theme: "Oak Landscapes for the Future: Adapting to Climate Change", which was reflected in the subjects chosen for the Keynote Addresses at the Opening Reception and Gala Dinner, and also in many of the presentations. However, there was still a great variety of subjects, as is typical for our diverse Society. The theme was revisited in a wrap-up discussion at the Meeting of Members at the close of the Conference.

- Lightning Talks, an exciting new format of strictly timed 5-minute talks, were included in a session, and 13 presenters opted for this format.

In addition, the schedule included an afternoon of local tours, the traditional Gala Dinner (held in the Sacramento Library Galleria), our second silent auction, presentation of IOS Service Awards, satellite meetings, workshops, a meeting of members, and a mammoth seed exchange.

Figure 30: Conference Committee Chair Emily Griswold welcomes attendees at the Plenary Session. Credit: Abbey Hart 2018

Figure 31: Dining with the IOS Credit: Guy Sternberg 2018

Figure 32: Awards ceremony. Credit: Baldwin, 2018

Oak Gall Wasps (Lucy Hart lecture)

On our tours, we came across a huge array of different oak galls. From bulbous tan lumps, tiny spiny projections, and bloated stems riddled with holes all embody *galls*– tumor-like growths induced by parasitic organisms wishing to make themselves a home. While many different plants are hosts to galls, California's oak trees contain the largest assortment.

Oak gall wasps belong to the *Cynipidae* family, which makes up over fifty percent of California's gall-inducing insects. These fascinating insects and their unusual life cycle are known almost entirely from the galls where they spend most of their life.

Depending on the species and the generation, the female oak gall wasp chooses a host oak and lays her eggs inside a specific region of the tree's meristematic tissue (the undifferentiated tissue that has yet to become a particular part) via a long, penetrating ovipositor. Some species oviposit in bud tissue, others in leaf tissue, and yet others right through the bark into the cambium. Once inside the host, the egg takes control and gall initiation begins.

The egg secretes various plant hormone replicas, causing a chamber to form around it. Further hijacking the host tree, the larval chamber then produces its own vascular system, tapping the vascular system of the plant and creating nutritive cells which feed the larval wasp as it grows.

On the outside of this alien incubator, a hard layer of cells form which become the shell of the gall. Gall shape and size varies widely by the host species, wasp species, and the location on the tree. The oak apple gall, caused by *Andricus californicus*, can be up to 15cm across; while the diminutive dot of *Dryocosmus minisculus* reaches only 1mm in width.

While developing, the gall wasp larvae take care not to bespoil their oaken palace – their intestine remains disconnected from the anus, and only hooks up for deposit immediately prior to pupation. Don't defecate where you eat, the old adage goes. Larvae may remain in the gall for weeks, months, or even years, depending on the climate and species of wasp.

Upon maturation, the larvae pupate into adult wasps, bore a hole through their gall, and emerge into the outside world. Here is where the cynipid wasp life cycle gets even more complicated (as if egg-injecting and meristematic hijacking wasn't enough) – many cynipids have an alternating-generation lifecycle – a sexual generation featuring a male and female wasp mating and the female laying eggs, and an asexual generation in which the female wasp creates an offspring with no male involved, also known as parthenogenesis. Typically the sexual generation will occur in the spring and the asexual female generation in the fall, often creating overwintering galls.

Many cynipid wasps, including the aforementioned oak apple gall wasp (*A. californicus*) are known only from the asexual generation, and there are *no recorded males* of the species. These ladies have found a way to carry on life with no guys involved, and the only cost is a slight loss of genetic diversity.

Other wasp species have discovered their ingenious evolutionary strategy, and developed their own methods to capitalize on these cozy homes. Parasitoid wasps, also members of the cynipid family, invade the gall with their own eggs, their larvae consuming the original gall-former. Yet other hyper-parasitoid wasps prey upon the larvae of the parasitoid wasps. In response, some oak galls secrete nectar which recruits ants, which then defend the gall against potential invaders. One study from the U.K. found 17 different wasp species developing inside a single gall. The resulting

trophic levels in this closed community are enough to make even a hardened naturalist's head spin. Persistent oak galls can be found year-round, but autumn is the time when many of the asexual generation galls are forming with the female larvae inside.

We were able to spot a number of different oak galls in California, one of which is presented below:

Figure 33: Quercus lobata gall. Credit: Harry Baldwin

American Oaks Share a Common Northern Ancestor

North American oaks have a northern temperate origin and only later colonised Mexico and Central America, according to a new study. Species diversity did not originate in Mexico, but rather all American species descend from a distant ancestor found in northern Canada 45 million years ago. That single species gave rise to 220 more and to two distinct lineages—Red Oaks (Section Lobatae) and White Oaks (Section Quercus)—that moved south through the boreal zone to populate large swaths of the continent all the way into Mexico. These two findings—simultaneous evolutionary diversification in the Red and White Oaks, each following the same geographic routes, and the relatively recent origins of the Mexican oaks—represent a surprise conclusion to a scientific mystery that went unresolved until now. Research published in September 2017 in the journal New Phytologist tells this story of the evolutionary history of American oaks for the first time.

Using a combination of next-generation DNA sequencing and statistical ecological methods, the researchers inferred the most detailed and comprehensive evolutionary history to date for the oak genus *Quercus*. Their work demonstrates that the two major groups of oaks in North America—the Red Oaks and the White Oaks—independently and simultaneously radiated over the past 45 million years from a common ancestor, filling ecological space in California while also filling available habitats of eastern North America. Then, between 10 and 20 million years ago, both groups made their move down to the mountains of Mexico, where the two groups began to diversify at an increased rate, rapidly moving around to fill ecological (niche) space and producing species more rapidly than they had done in the north.

“Despite the fact that the genus *Quercus* dominates wooded ecosystems of North America and Mexico in both number and biomass, we knew very little prior to this study about relationships among species, and even about genetic distinctiveness of many of the oaks we sampled for the paper,” said lead author Andrew Hipp of The Morton Arboretum. “Our finding that the Red Oaks and White Oaks diversified simultaneously and in parallel in the Americas explains much of the diversity of American oaks: there is not just one major oak lineage in the Americas, but two, and a few smaller ones. When you add these together, you find you have a lot of oak diversity.”

The results explain a long-standing question that collaborator Jeannine Cavender-Bares of the University of Minnesota has been studying: why do distantly related oak species occur together more often than expected? Cavender-Bares spent her sabbatical in Mexico in 2011 funded by a Fulbright grant at the Universidad Nacional Autónoma de México with Antonio González-Rodríguez, an oak specialist and collaborator on the study. They collected and studied the Mexican oaks for the project. “Including the Mexican oaks in the analysis was critical,” says Cavender-Bares, “because they revealed starkly increased rates of diversification as a consequence of the dynamic rise of the mountain chains in that region with volcanic activity some 10-15 million years ago.” The Mexican oaks are particularly numerous, not because Mexico is a center of origin, but because of high rates of lineage diversification associated with high rates of evolution along moisture gradients and between the evergreen and deciduous leaf habits.

To reach their conclusions, the lead researchers spent years collecting specimens and extracting DNA from more than 300 oak samples from the U.S., Mexico, and Central America. The scientists read large numbers of regions of the genome from each sample using next-generation DNA sequencing methods, then reconstructed roughly 40,000 regions of the genome using computational methods. They then analyzed these regions of the genome statistically, to estimate the tree of life for oaks. This estimate of oak evolutionary history served as the framework to infer the distribution of each species

in biogeographic and ecological space, and to reconstruct the evolutionary history of ecological and species diversification in the genus.

“The incursion of temperate lineages like the oaks into Latin America marks an interesting biogeographic catalyst in the development of the montane plant communities of Mexico,” said study collaborator Paul Manos of Duke University. “Scattered pollen fossil records from lake sediments provided some evidence on when the oaks arrived, but we now have an independent estimate based on a calibrated phylogeny, and reasonable hypotheses on the ecological drivers of these two parallel radiations of Red and White Oaks.”

The study is the result of a collaboration among scientists at The Morton Arboretum, the University of Minnesota, Duke University, and the Universidad Nacional Autónoma de México. The study was funded by a collaborative four-year National Science Foundation grant to these institutions and by a Fulbright grant to Cavender-Bares to work in Mexico.

* Reference found in bibliography section: Hipp *et al*., (2018)

Conclusion

Harry Baldwin

I have now travelled to United States each year for the last consecutive 3 years to study conifers, oaks and attend the 8th International Oak Society Conference at The Morton Arboretum, Illinois. Despite all these visits, I have managed to meet many different people, explore many wonderful environments which have all furthered my passion for oaks but also for temperate trees as a whole.

This trip allowed myself to cover some of the most important oak habitats across California, including; riparian, savanna, evergreen, sub-alpine and montane forests. Having Stewart Winchester leading the tour allowed me to ask endless questions until I was blue in the face! Because of him, I was able to fill in many gaps in my knowledge as well as asking various queries along the way. As I have experienced before in 2017 (on a previous travel scholarship to study conifers on the west coast), you are never able to gain more from a trip alone than if you have someone who is very knowledgeable alongside you. Learning out of books as you hike and on rest stops is certainly not practical. I therefore took huge advantage of this opportunity, by taking many notes and photos; all of which has furthered my knowledge hugely.

I have had a strong interest in oaks for over 4 years and have managed to gain a somewhat 'solid foundational' understanding of the group. I have travelled to many different arboreta, botanic gardens, private collections and nurseries, which allowed me to view these species in the wild with a different perception. I was able to answer many personal questions, such as; why certain species do not thrive in the British Isles, how may we cultivate them better, how may we present certain Californian oak habitats in botanic garden settings. This also allowed me to ask many questions as well in terms of oak ecology, Californian climate, soil composition, identify hybrid taxa and pest and disease. Being able to see these species at home, in the wild, and gain a solid theoretical understanding at the conference was a great combination.

The only downside I could mention is the fact we had little time to spend at each visit. This prevented myself from being able to make additional notes and photos but also to soak in the surrounding landscape. Of course this is not easy as there were in excess of 40 people on the tour and we had many places to see in a rather small amount of time. The conference was excellent, there was a lot of information to take in, but I am unable to fault it as it was organised particularly well and covered a huge range of topics. If I were to visit the States again, I would like to visit Texas and New Mexico as there is a huge wealth of oak diversity there, and I also have a many contacts who would be able to accommodate me and take me to visit many different species.

Thomas fry

Apart from the sheer joy of seeing some of the most incredible trees on earth I feel this trip has left with a new wealth of knowledge. I feel I am now able to better understand *Quercus* by recognising its characteristics, favoured habitats, its lineages and its modern and historic uses. I feel I could confidently identify many taxa in which we have mentioned within this report as well as identify any potential disorders.

From seeing these trees growing in their natural environment, I have been able to see their true form. With this insight, I feel I am able to develop a more accurate management techniques to those we have in our collection at Kew, whether it be structural pruning at a young age, or regenerative pruning on mature specimens.

At the conference, I was introduced to plant tissue culture which is the growth of plants cells in media under sterile conditions. The cells will form a callus within the media which are dependent on a growth hormone which is added which enables the development of roots, shoots and eventually entire plants. Once the cells haves developed into plants, they can be transferred into test tubes then eventually into soil when once reached a suitable size. Benefits of this process include the capability of producing exact copies of plants with desirable traits such as, disease resistance, good crop production or attractive floral display. The plants grown via tissue culture mature at a quicker pace than other methods of propagation. This does come with its down falls; its process is expensive, labour intensive and creates a monoculture as all plants are clones. The child scientist within me had appeared during this talk, with the desire of being able to micro propagate my wardrobe.

The opportunity to network with members of the society has left me with links to enthusiasts, private collectors, arboreta and die-hard fanatics across the globe. With this link comes a lifetime worth of expertise in which I can question and absorb knowledge. I feel I am now able to travel to many locations and be welcomed by the global members of the International Oak Society.

A huge benefit of this trip is that I am now able to pass on my knowledge to my colleagues and teach our apprentices and students. Which could potentially mould the future of Arboriculture, not only at Kew, but across every sector of the industry. The tour took me to a country I haven't had the luxury of visiting and has left me with the desire to be a lifelong member of the International Oak Society.

References

Brown, J.E. 1982. Monarchs of the Mist: The Story of Redwood National Park and the Coast Redwoods. Redwood Natural History Association.

Brown, P. (2010). OLDLIST, A Database Of Old Tree. Available: http://www.rmtrr.org/oldlist.htm. Last accessed 07/01/2019.

Calflora. (2018). Acer glabrum var. diffusum. Available: https://www.calflora.org/cgibin/species_query.cgi?where-calrecnum=56. Last accessed 11/01/18.

Elliot, C. (2018). Consumnes river preserve. Available: http://www.cosumnes.org/about-thepreserve/. Last accessed 12/01/2019.

Fryer, J. (2007). Quercus douglasii. In: Fire Effects Information System. Available: https://www.fs.fed.us/database/feis/plants/tree/quedou/all.htm. Last accessed 12/01/2019.

George Vancouver (1798). A voyage of discovery to the North Pacific ocean. Unknown: G. G. and J. Robinson. 34.

Jackson, P. (2017). Nature and science. Available: https://www.nps.gov/yose/learn/nature/index.htm. Last accessed 09/01/2019.

John Steinback. (2013). John Steinback. Available: https://www.savetheredwoods.org/tag/johnsteinbeck/. Last accessed 11/01/18.

Old Growth Forest.(2018). RockefellerForest. Available: http://www.oldgrowthforest.net/rockefeller-forest--humboldt-redwoods-s. Last accessed 11/01/18.

Miller, L. (2005). The Ancient Bristlecone pine. Available: http://www.sonic.net/bristlecone/growth.html. Last accessed 16/01/2019.

Purcell, K. (2018). San Joaquin Experimental Range. Available: https://www.fs.fed.us/psw/ef/san_joaquin/. Last accessed 13/01/2019.

Sillett, S.C., and R. Van Pelt. 2000. A redwood tree whose crown is a forest canopy. Northwest Science 74: 34-43.

USDA. (2018). Serpentine soils. Available: https://www.fs.fed.us/wildflowers/beauty/serpentines/adaptations.shtml. Last accessed 11/01/18.

Pers. comm.

Winchester, S. (2018) Discussions on the oak society tour.

Photo References

Baldwin, H (2018). International Oak Society Tour and Conference.

Fry, T (2018). International Oak Society Tour and Conference.

Hart, A (2018). International Oak Society Tour and Conference.

Sternberg, G (2018). International Oak Society Tour and Conference.

Bibliography

Alexander, E. B., R. G. Coleman, T. Keeler-Wolf, and S. P. Harrison. 2007. Serpentine Geoecology of Western North America, Geology, Soils, and Vegetation. Oxford University Press. New York, New York. 512p.

Brown, J.E. 1982. Monarchs of the Mist: The Story of Redwood National Park and the Coast Redwoods. Redwood Natural History Association.

Davis, Douglas F. and Dale F. Holderman. 1980. The White Redwoods. Happy Camp, CA: Naturegraph. 45pp.

Eckert, A. J., and J. O. Sawyer. 2002. Foxtail pine importance and conifer diversity in the Klamath Mountains and southern Sierra Nevada, California. Madroño 49:33-45.

Hipp, A. L., Manos, P. S., González‐Rodríguez, A. , Hahn, M. , Kaproth, M. , McVay, J. D., Avalos, S. V. and Cavender‐Bares, J. (2018), Sympatric parallel diversification of major oak clades in the Americas and the origins of Mexican species diversity. New Phytol, 217: 439-452. doi:10.1111/nph.14773

Kruckeberg, A. R. 1992. Plant life of western North American ultramafics. Pages: 31-74. in B. A. Roberts and J. Proctor, editors. The ecology of areas with serpentinzed rocks: a world view. Kluwer, Dordrecht, Netherlands.

Rourke, M. D. 1988. The Biogeography and Ecology of Pinus balfouriana Grev. & Balf. in the Sierra Nevada of California. Ph.D. dissertation, University of Arizona, Tucson. 225p.

Ryerson, D. A. 1983. Population structure of Pinus balfouriana Grev & Balf along the margins of its distribution area in the Sierran and Klamath regions of California. MS thesis, California State University, Sacramento. 198p.

Ryerson, D. A. 1984. Krummholz foxtail pines Pinus balfouriana occurrence, California. Fremontia 11:30.

Stephenson, N.L., (2000). Estimated Ages of Some Large Giant Sequoias: General Sherman Keeps Getting Younger

Swetnam, T,(2004). Multi-millennial fire history of the giant fores

Costings

*This is based on two people for the entire trip. Compared to the proposed costings, some expenditures ended up being more expensive and some others cheaper. Additional taxes on accommodation as well as the weak pound against the dollar, made the trip more expensive than planned.

Air fare: £1000
Via Wow Air to the California and back.

Taxi's, buses and trains: £250
Using Taxis to get the accommodation and arriving at the airports and using trains to get to home etc.

Visa Waivers: £90
Legal Visa required when travelling to the USA

Insurance: £110
Included travel and health insurance.

Sierra Nevada and North Coast Tours: £1550
Both tours.

Conference: £520

Accommodation: £1580
Accommodation through the tours and the conference.

Food: £1680
Based on £60 a day each. Mostly lunch and dinner and breakfast on occasion.

Tips and additional expenditure: £400

Total: £6950

Amount received:
RHS: £4000
Merlin: £500
Hardy Plant Society: £1400
Kew Guild: £1000

Key to *Quercus* sections.

Thomas Fry

Characteristics of the three evolutionary lineages in *Quercus*			
Lineage	***Whites Oaks*** (*Lepidobalanus*)	**Red Oaks** (*Ertythrobalanus)*	**Intermediate Oaks** (Protobalanus)
Leaves			
Lobes	Lobed or unlobed	Lobed or unlobed	unlobed
Lobe shape	Round	Pointed	
Margins	Smooth or with blunt, green teeth or spines	Tawny bristles and spines	Smooth or with green teeth or spines
Acorns			
Inner shell	Smooth	Densely hairy	Smooth or hairy
Cup scale	Thick and knobby	Thin and flat	Thick, often knobby
Matures in	1 year	2 years	2 years
Bark	Light grey or brown	Dark grey, blackish	Light grey or brown
(mature trees)	Scaly or rough	Brown, smooth	Light brown
Wood	Light brown or yellowish	Reddish brown	Light brown

Quercus spp. profile

Harry Baldwin

Quercus agrifolia

Description:

A medium to large tree, generally 15-23 m tall or up to 28 m, short trunk 0.6-1.2 m in diameter, large long limbs that may rest on the ground, broad crown up to 45 m across; bark 5-7.5 cm thick on old trees, often whitish and quite smooth, but may be dark brown to black, tinged with red, divided into broad rounded ridges surfaced with small scales on younger trees; leaves evergreen, persisting until new leaves appear, oval, orbicular or oblong, entire or sinuate-dentate, with slender, rigid, spinose teeth, leathery, smooth, dull or lustrous dark green above, paler below with tufts of rusty hairs in the axils of the veins; may vary from 1.8-10 cm in length, but generally about 3 cm long; fruit, acorn matures in one year, sessile or nearly so, 1.9-3.9 cm long, slender-conic, pointed, chestnut-brown, enclosed only at the base or up to one-third of its length in bowl-shaped cup.

Ethnobotanic uses:

Unknown.

Distribution and habitat:

From Sonoma County, California, south along the Coast Ranges to San Predo Martin Mountains of Baja California. Most abundant and of largest size in valleys south of San Francisco Bay.

In southern California, *Q. agrifolia* is often the most common and abundant oak growing between the mountains and the sea, covering low hills extending to 1375 m in elevation in the canyons of the San Jacinto Mountains. This oak is intolerant of shade and is slow-growing on dry sites.

Associated species:
It is associated with *Arbutus menziesii*, *Notholithocarpus densiflorus*, *Umbellularia californica*, *Pinus jeffreyi*, *Arctostaphyllus* spp., *Q. berberidifolia.*

Cultivation at Kew and the British Isles:
The Coast Live Oak is one of the only California native oak that actually thrives in the coastal environment, although it is rare on the immediate shore; it enjoys the mild winter and summer climate by its ocean proximity. Similar to other Californian oaks, it enjoys its Mediterranean climate, but is tolerant in a garden setting. At Kew, we have 26 accessions, ranging from 1966 to 2010 and are all generally growing fairly well. They prefer to keep dry with little watering throughout the year, but of course in the British Isles that is tricky. Growing it in a well drained soil will allow the species to tolerate the additional precipitation. It's fruit very rarely reaches maturation stage, as our summers are generally not long enough for the acorns to ripen. They will tolerate a mixture of soils, will prefer more neutral to acidic. I have known for the species to reach -15o degrees Celsius, so is certainly hardy.

Hybrids
Q. x *gander* (Q. *agrifolia* x *kelloggii*); Q. *agrifolia* x *parvula var. shrevei*.

Figure 34: Quercus agrifolia

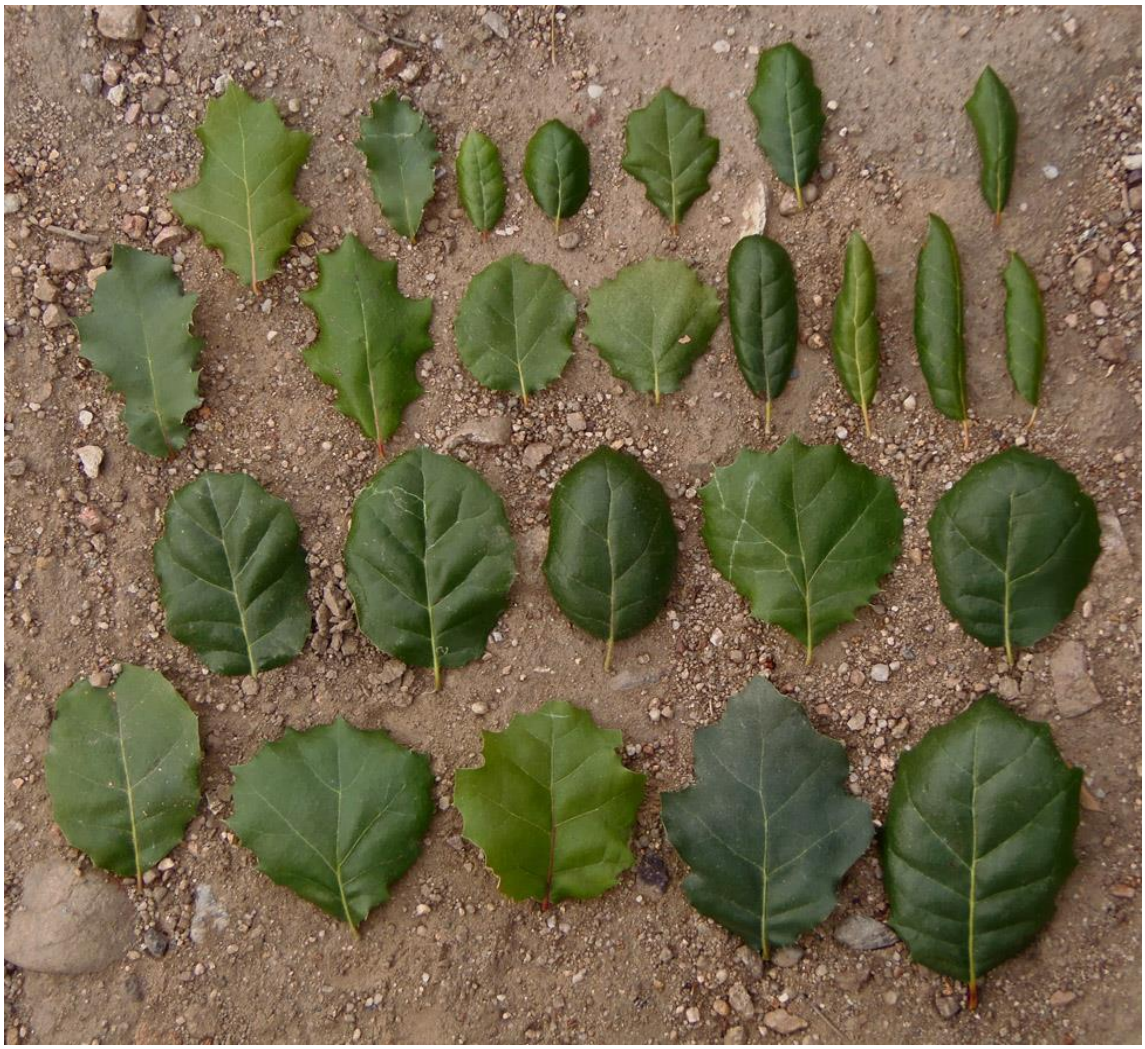

Figure 35: Quercus agrifolia

Quercus chrysolepis

Description:
Growth habit, shrub to medium or large tree up to 30 m tall and occasionally 1.5 m in diameter, dividing into large horizontal branches giving it a broad crown; bark, thick, light to dark-grey brown, smooth or scaly with age; leaves, evergreen, retained for three or four years, oblong-ovate to elliptic, 2.5-7.5 cm long, mostly entire on older trees but spiny on young trees, resembling *Ilex,* but often both forms on one tree, leathery bright yellow-green and glabrous above, often smooth and blue-green below. The yellowish-green appearance distinguishes this oak from the bright green of *Q. agrifolia*; fruit matures in two years, usually solitary, sessile or short-enclosed only at base by shallow, thick-walled cup sometimes covered by a thick yellow tomentum – hence why this oak/group is known as the gold cup group.

Ethnobotanic uses:
Historically used locally in manufacture of farm implements such as mauls, wagon wheels and axels. This is not a commercial timber at this time.

Distribution and habitat:
This is the most widely distributed of the Protobalanus group, it extends from southwest Oregon, south, through the Coast Range and the Sierra Nevada Mountains into Baja California and east into central Arizona where the species *Q. dunnii* appears. The range in California extends to 2400 m in elevation.

Q. chrysolepis best development is found in the canyons of the Coast Range and in the foothills of the Sierra Nevada on dry rocky hillsides and stream banks. It is very slow growing. Several species of oaks occupy much of the same territory in the Coast Ranges and Sierra Nevada Mountains of California, and together make up a very important part of the wildlife food and cover. No species is too important in itself, but, where oaks in general are the major hardwood species, they become vital to the total environmental picture. The species is tolerant or shade as a young tree, thereby reproducing successfully under a canopy of older trees.

Associated species:
Associated species include; *Arbutus menziesii*, *Calocedrus decurrens*, *Pinus ponderosa*, *Pinus jefferyi*, *Q.chrysolepis*, *Q. engelmannii*, *Q. kelloggii*

Cultivation at Kew and the British Isles:
At Kew, we have seven wild collected accessions ranging from 1904 to 2015. This species is growing fairly well at Kew and some have reached to be sizeable specimens, yet this is a slow growing species in this climate. This species has a huge range, starting from Oregon all down the west coast into Mexico; it is possibly one of the most morphologically variable oaks in North America. Both myself and Tom saw this species as a spreading perennial that ranged from 15 feet to 100 feet. Due to its large range, it is fairly adaptable to many soils and climates; as they can receive as little as 150 mm and as much as 1750 mm of a rain a year. It is fairly hardy and has reached down to at least -15 **°C**. It

therefore it is certainly an oak which can be more widely grown across the British Isles. As we live in such a wet climate, it would be worth growing it in well drained soil in a sheltered location in almost any soil other than clay and pure calcareous soil.

Hybrids:
No hybrids are listed.

Figure 36: Quercus chrysolepis

Quercus douglasii

Description:
A medium sized tree 5 – 18 m in height, 25-40 cm in diameter, and with compact crown. May be a shrub in the southern extension of its range. Trees can live up to three hundred years. Bark; thick, grey and scaly, sometimes brown; Leaves, 3-10 cm in length, deciduous, oblong, quite variable (from entire to wavy margined or shallowly lobed) with generally rounded lobes and sinuses, dark blue-green above with scattered groups of hairs, pale and hairy below. The blue-green colour is distinctive and gives the tree its name; fruit, acorn matures in one season, sessile or nearly so, 2 or 3 cm long, thick, chestnut-brown when dry, enclosed only at base in thin, shallow cup.

Ethnobotanic uses:
It may be cut for firewood locally, or used sparingly for ornamental woodworking.

Distribution and Habitat:
California from Mendocino County and the upper Sacramento River, southward along the west slopes of the Sierra Nevada, up to 1250 m elevation, and through the valleys of the Coast Range to Tehachapi Pass and to San Fernando, Los Angeles County.

Locally abundant on dry sites in foothills and low mountain slopes of the mountains and interior ridges of the Coast Ranges south of San Francisco Bay. Due to its abundance within its range and its large sweet acorns, *Quercus douglasii* is valuable to wildlife as food and cover, especially for deer and smaller mammals.

Associated species:
Although *Q. douglasii* often grows in pure, open stands, it also associated with *Q. lobata*, *Quercus chrysolepis, Q. wislizeni* and *Pinus sabiniana*.

Cultivation at Kew and the British Isles:
Similarly to *Quercus lobata*, this species also grows in dry areas of California, but even more severe conditions. It receives the odd shower during the winter and spring and may not receive any water in the summer at all. This species has clearly filled a niche in this extremely dry and fire prone habitat where summer temperatures can reach in excess of 45° C. We have three young specimens growing at Kew, but quite often suffer from *Anthracnose* (like many white oaks) and the excessive wet. Even though it appears hardy, it requires long, dry, hot summers to thrive, as well as being able to mature its annual acorn crop. As with *Q. lobata* and some other members of the white oak section, well drained calcareous, rocky soils is a must, as well as a sheltered location. This species can grow with some dappled shade, but prefers a sunny warm position.

Hybrids:
Quercus x *eplingii* (*Q. douglasii* x *lobata*); *Q.* x *alvordiana* (*Q. douglasii* x *turbinella*)

Figure 37: Quercus lobata

Quercus durata

Description:
Growth habit, shrub or small tree rarely 6 m tall, 30 – 46 cm in diameter, with small branches forming a round-topped tree; bark thin, dark brown, and scaly; leaves mostly deciduous, oblong, rounded or acute at apex, broad and rounded at base, about 2 cm long, entire or coarsely spiny, often 2-3 or more shallow lobes per side, dark green and smooth upper surface, paler and hairy below, leaves smallest of the southern California oak leaves; Fruit, acorn sessile or short-stalked, 1.2-2.4 cm long, enclosed one-half to two-thirds of its length in deep cup-shaped or hemispheric cup, light brown and widely varying in size.

Ethnobotanic uses:
It is not considered useful in an economic way as it is too small to provide fuel.

Distribution and Habitat:
Coast Ranges, from south of San Francisco bay through southern California, southward into Baja California and also eastward to the borders of the Mojave Desert.

Q. durata reaches its best development as a small tree in sheltered canyons of off-shore islands. It serves as a component of wildlife food and cover, though it is limited in range to be of much value.

Associated species:
It is associated with *Arctostaphyllus* spp. *Pinus jeffreyi*, *Q. kelloggii* and *Pinus sabinana*.

Cultivation at Kew and the British Isles:
As far as I am aware, this species is barely cultivated in the British Isles and only found in two collections: Sir Harold Hillier Gardens, Hampshire and Chevithorne Barton, Devon. It seems to growing slowly at Hilliers, where it is growing in a sheltered, and a sandy loam soil. It seems the Devonshire climate is too wet for this white oak, as it needs that warm Mediterranean climate in order to grow well. It is hardy and has been known to with stand -14 °C at Hillier's. It is best adapted to relatively dry, rocky, nutrient-poor soil. I have it seen it growing well in two collections in France, where they have long hot summers which somewhat mimics it's Californian habitat.

Hybrids:
Q. howellii (*Q. durata x garryana*); *Q. x townie* (*Q. durata x lobata*).

Figure 38: Quercus durata

Quercus garryana

Description:

Growth habit, a large tree, nearly as large as Q. alba; specimens noted up to 30 m tall and 0.6 to 0.9 m in diameter, spreading crown and a life span of 300-500 years; bark up to 2.5 cm thick, divided (by shallow fissures) into broad ridges, separating into light brown or grey scales; leaves deciduous, obovate to oblong 7.5 to 15 cm long, 5-9 deep lobes, sinuses extend deep into the leaf, lobes and sinuses both rounded; leathery dark green above, paler and hairy below; fruit, acorn matures in one growing season, usually sessile or very short stalked, 2.5- 3.0 cm long, set in a hairy cup.

Ethnobotanic uses:

Used locally in cabinetry and the making of fine furniture. It is also in heavy demand as firewood. The very durable heartwood formerly made the wood valuable in ship building.

Distribution:

Vancouver Island and the Fraser River Valley in Canada, south through western Washington, western Oregon and the California Coast Ranges to Marin County north of San Francisco, at elevations up to 1800 m.

Q. garryana is reduced in size to a low shrub at high elevations. Locally abundant in valleys and on dry slopes of low hills, its best development is in dry valleys with 50-100 cm of annual rainfall. As this is the only oak over much of the northern part of its range, it is valuable not only for its wood but as food cover for wildlife. Deer and livestock browse the leaves, which have a protein content nearly equal to that of alfalfa. As it has a sweet kernel, steps should be taken to favour its growth throughout its natural range in Washington and Oregon.

Associated species:

Arbutus menziesii, Alnus spp, Acer macrophylla, Fraxinus sp., *Pinus ponderosa, P. sabiniana, Pseudostuga menziessi, Quercus kelloggii.*

Cultivation at Kew and the British Isles:

Q. garryana is very intolerant of shade and often killed from overtopping of conifers such as *Pseudostuga menziesii* in its own habitat. It is rather slow growing as it inhabits dry sites but not quite as dry as *Q. douglasii*.

Hybrids:

Quercus x *eplingii* (Q. *garryana* x *douglasii*); Q. *howellii* (Q. *garryana* x *dumosa*); and *Q. subconvexta* (*Q. garryana* x *durata*).

Figure 39: Quercus garryana

Quercus kelloggii

Description:

Growth habit, a medium sized tree but occasionally 30 m tall and 1-1.25 m in diameter with large rounded crown; or a small shrub at higher elevations; bark on young branches smooth and light brown, aging on old trees to dark brown or black, divided into broad ridges at the base, and broken higher up into the thick, irregular, oblong plates, or, sometimes, divided into quite small squares or oblong pieces; leaves deciduous, 10-25 cm long, oblong or obovate, bristle-tipped, rarely 5-lobed, generally 7, 3-toothed at the apex, thick, firm and lustrous green above, paler below, generally hairy, sinuses narrow and rounded at base, autumn colour yellow to brown; fruit acorn matures in two seasons, short stalked, 2.5-3.0 cm long, ellipsoidal or obovoid, quite fully rounded at apex or pointed, light chestnut brown, enclosed one-third to three-fourths in deep cup with large scales, kernel bitter, but was an important source of food for native Americans.

Ethnobotanic uses:

Used as fuel locally and has possibilities for flooring and furniture.

Distribution:

McKenzie River in western Oregon, southward over the coast ranges and western slopes of the Sierra Nevada at 300-2400 m elevation, and on the southern border of California where it may be seen around Julian. Locally it reaches its best development in the valleys of the Sierra Nevada where it is the most abundant oak, sometime forming large groves in the coniferous forest, usually below 1800 m.

Q. kelloggii, in addition to its value for fuel, flooring and furniture, contributes to the food and cover for wildlife. Mule deer, elk, bear, squirrels, rodents, and many species of birds share its range. It is relatively intolerant of shade and grows on dry soil.

Associated species:

It is associated with *Pseudotsuga menziesii, Pinus ponderosa, Pinus lambertiana, Pinus sabiniana, Arbutus menziesii, Calocedrus decurrens, Cornus nuttallii*

Cultivation at Kew and the British Isles:
This species is perhaps one of the more well cultivated oaks from California. It is a relatively fast grower and is able to withstand low temperatures. Myself and Tom both saw this species as high as 8000 feet near *Pinus balfouriana* which is pretty incredible for an oak. It does require a well drained soil as it usually inhabits disturbed rocky slopes. It is tolerant of water all year round, but well drained substrate is important. It thrives in a sunny position but needs a sheltered location to some extent. Being a red oak, it needs two years in order for the acorns to mature; therefore, growing in Britain is unlikely to be ever able to produce fruit. It is able to grow in all soil conditions.

Hybrids:

Q. *ganderi* (Q. *kelloggii* x *agrifolia*); Q. x *moreha* (Q. *kelloggii* x *wislizenii*)

Figure 40: Quercus kelloggii

Quercus lobata

Description:
Growth habit, a very large tree, perhaps the largest of the western oaks, up to 30 m tall (or 50!) and to 3 m in diameter, with short trunk. Open-growing specimens (like that of Covelo) have huge spreading limbs and may live to be four hundred years old. Bark, thick on older trees, light grey and scaly, or broken into broad, flat plates crosscut into 'squarish' plates; leaves deciduous, leathery-textured, 6-10 cm long, oblong to obovate, 7-11 oblique lobes often cut nearly to the midrib, extremities and sinuses rounded, dark green and pubescent above, pale and pubescent below; fruit, acorn matures in one season, solitary or in pairs, short-staked, nut elongated, slender and pointed, 2.5-3.75 cm long, enclosed one-third in hairy cup.

Ethnobotanic uses:
Used locally for firewood, but not good for timber

Distribution:
California, western valleys between Sierra Nevada and the coast, from Shasta County in the north to Los Angeles County in the south.

Quercus lobata grows abundantly as open groves in the Central Valley of the state. Locally it is found in moist hot valleys away from the coast, from sea level to 1200 m. it is an indicator of fertile soil and the best sites for its growth have been taken over by agriculture. It is important component of wildlife food and cover. The acorns are eaten by band-tailed pigeons, acorn woodpeckers, grey squirrels, deer and pigs. It has also provided food for native Americans that lived in the area, such as the Wintun Indians. The grove of large trees add a pleasant aspect to the landscape.

Associated species:
Arbutus menziesii, *Pinus sabiniana*, *Pseudostuga menziesii* and *Calocedrus decurrens*

Cultivation at Kew and the British Isles:
Quercus lobata grows into the largest of North American oaks. It ranges over the hot interior valleys of California where there is a water table within reach of the roots. Valley Oaks grow quickly, reaching 20 feet in 5 years, and 40 feet in 10 years, and up to 60 feet in 20 years.; mature specimens may attain an age of up to 600 years. Of course this is in its natural habitat. In England it does survive but never achieves a grand age or height such in its own habitat. Like many of the oaks of North America, it needs those long hot summers where it can ripen its bark and age seasonally. It will receive some rain during the winter and slightly more in the spring, but will then likely have no rain between 3-6 months during the summer. In comparison to the UK where we receive much more precipitation and have colder winters, prevents this species from being able to thrive. At Kew, it does grows reasonably as it grows in free draining alluvial soil which allows water seep through the soil allowing good drainage. In addition London is slightly warmer, so it is able to enjoy a longer summer than most other places in the UK. A sheltered, sunny and free draining position would give this species a good chance at surviving to a medium sized tree in the UK.

Hybrids:
Quercus x *jolonensis* (*Q. lobata* x *douglassii); Quercus* x *townie* (*Q lobata* x *dumosa*); *Q. munzii* (*Q. lobata* x *turbinella*)

Figure 41: Quercus lobata

Quercus wislizeni

Description:

Growth habit varies from intricately-branched shrub to a medium sized tree 18-25 m tall and 1.2-1.8 m in diameter, crown large and stout with a wide-spreading branches; bark up to 7.5 cm thick on old trees, nearly black or red-tinted, deeply furrowed, and divided into broad, rounded, connected ridges, scaly on surface; leaves evergreen, persisting two years, lanceolate or broadly elliptic, margins entire or with many shallow sinuses and with spiny teeth, leathery, smooth dark green upper surface, yellow-green underneath, 2.5-3.8 cm long; leaves are flat compared to the cupped leaves of Q. chrysolepis; fruit maturing in two years, sessile or short-stalked, slender, oblong, pointed at apex, 1.9-3.8 cm long, cup varying from shallow to 2.5 cm deep so that the acorn may be up to two-thirds enclosed.

Ethnobotanic uses:

Unknown.

Distribution and habitat

Widely scattered in California from lower slopes of Mt Shasta on both the Coastal Ranges and the lower slopes of Sierra Nevada to elevations of 600 m in the north and 1375 m in the south.

Q. wislizeni is important as a component of wildlife food and cover.

Associated species:

Q. engelmannii, Q. lobata, Q. chryslopis, Q. douglasii, Notholithocarpus densiflorus,

Cultivation at Kew and within the British Isles:

This is a very versatile species; like *Q. chrysolepis*. it has a large distribution, ranging from California into Mexico which has allowed this species adapt to wide array of environments. At Kew, we have eleven accession, ranging from 1960 – 2012. Like most evergreen Californian oaks growing in Britain, it is particularly slow growing which is most likely due to the colder summers. It is tolerant of all soils and is particularly hardy as I know the specimen at Hilliers has reach down to at least -10 °C.

It is tolerant and slow growing on dry sites

Hybrids:

Q. x *moreha (Q. wislizeni x kelloggii*).

Figure 42: Quercus wislizeni