International Oaks

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Q. utilis in Vietnam, Ontario's eleven,
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Photos. Cover: Guy Sternberg (*Quercus macrocarpa* Michx.); p. 7: Guy Sternberg (*Q. rubra* L.).

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FOREWORD

The Difference We Make

Recently my attention was caught by this headline in a modest, regional newspaper *(The Oregonian*, Portland, January 16, 2015): "Earth changes likely dire, say researchers." The article, picked up from the *Washington Post*, went on to cite the journal *Science* that published in their January 15 edition a report by the Stockholm Resilience Centre. Four of nine "planetary boundaries" have been crossed, said the report, those being extinction rate, deforestation, level of carbon dioxide in the atmosphere, and flow of nitrogen and phosphorous into the ocean. Led by Will Steffen of the Australian National University and the Resilience Centre, 18 researchers had collaborated in preparation of the paper.

According to the Stockholm Resilience Centre website, the concept of planetary boundaries was introduced in 2009 as a means of identifying levels of particular human-induced Earth conditions that cannot be exceeded if humanity is to develop and thrive into the future. Abrupt or irreversible environmental changes could result from crossing the boundaries, while respecting the boundaries reduces the risk of such changes.

The planetary boundaries framework does not aim to point fingers, recommend remedial actions, or proscribe certain behaviors. It acknowledges uncertainties in calculations and does not guarantee inevitable catastrophe. The idea is to identify theoretical limits and to wake us up to the risks of unbridled human contributions to environmental destabilization.

Here is the list of the Nine Planetary Boundaries, newly and more inclusively restated:

1. Climate change.
2. Change in biosphere integrity (biodiversity loss and species extinction).
3. Stratospheric ozone depletion.
4. Ocean acidification.
5. Biogeochemical flows (phosphorus and nitrogen cycles).
6. Land-system change (for example deforestation).
7. Freshwater use.
8. Atmospheric aerosol loading (microscopic particles in the atmosphere that affect climate and living organisms).
9. Introduction of novel entities (e.g., organic pollutants, radioactive materials, nano-materials, and micro-plastics).

Gloomy information, this, but the upside is emphasized: **knowledge gives us the opportunity to turn things around.** Reversal of ozone depletion is noted as an example of swift and effective response to looming disaster.

And this brings me to the point of my lecture. We lovers of oaks can congratulate ourselves, and renew our efforts, because we are doing more than most to reverse the loss of biodiversity and the destruction of Earth's woody cover. We are important, not like the state of Brazil could be, not like India and China could be, not like the mass of American consumers could be, but each of us by action and example makes changes to prospects for Earth's future. Each seedling we plant, each piece of lumber we recycle, each land-use hearing and restoration work-party we attend, each of a thousand small steps we take, contributes to the total body of individual actions that makes a difference.

We haven't assumed that science will come up with fixes, or that we can save ourselves by colonizing Mars, or that we as individuals will die, all privileges and comforts intact, before we live to see all those things we didn't think we would live to see, or that nothing matters anyway because Sun will consume Earth in a few billion years. We IOS supporters have not slipped into paralysis and inertia because of eco-despair. Some of us have more opportunity than others to create wider impact, working on a landscape or ecosystem scale and with institutional funding (Doug McCreary and his illustrious career at the University of California come to mind), but those large conservation efforts occur because there is popular demand for a reversal in established processes and outcomes.

In this issue of *International Oaks* we are informed of the announcement of yet another new oak species in Mexico, three new hybrids in Spain, the incredible richness of the intricate ecological complex that oaks and their forests represent, as well as the efforts of many of us to get out there and become acquainted first-hand with the world of oaks. All these are triumphs in our mission to spread appreciation of this grand group of trees, and to ensure that it flourishes into the distant future.

Diana Gardener

Should Hybridization Make Us Skeptical of the Oak Phylogeny?

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"*Quercus macrocarpa* in fact, looks and acts very much like any good species; the only criterion in which *Q. macrocarpa* fails as a modern concept is in the area of gene flow."
Burger 1975, *Taxon* 24

"It may well be that *Quercus macrocarpa* in Quebec exchanges many more genes with local *Q. bicolor* than it does with *Q. macrocarpa* in Texas."
Van Valen 1976, *Taxon* 25

"All [eastern North American white oak] species have maintained their distinctiveness in face of this local 'contamination,' and I see no justification for considering the entities anything less than good taxonomic species."
Hardin 1975, *Journal of the Arnold Arboretum*

Hybridization in oaks has long been of interest to botanists and evolutionary biologists. In the first edition of his *Manual of the Botany of the Northern United States*, Asa Gray (Gray and Sullivant 1848) included two hybrids in the genus *Quercus*, both reported to be "founded on" a single tree or individual. In the 1857 through 1862 editions (Gray 1857, 1859, 1862) this number increased to three, which Gray described as "the following remarkable forms, by some regarded as species."[1] The 1867 edition (Gray 1867) increased the number to five, and Wiegand (1935) notes that in this edition, "we find hybrids scarcely mentioned except in one genus, *Quercus*" (Wiegand 1935). Oak hybridization – or at least our perception of it – as a taxonomic phenomenon is familiar to every good field botanist and reader of this journal (Fig. 1).

Beyond the taxonomic implications, the effects of interspecific hybridization on oak species' origins, coherence and evolutionary trajectories have been a research topic for more than 140 years: Palmer notes that Engelmann was aware that species could be too "distinct" to produce viable hybrid offspring (Engelmann 1876; Palmer 1948). Muller (1952) similarly wrote that "Remotely related oaks… apparently do not hybridize." Between the 1940s and the early 1960s, plant biologists such as Edgar Anderson (reviewed in Anderson 1948), G. Ledyard Stebbins (1950), and Verne Grant (1971, 2004) undertook serious quantitative research into hybridization and its role in plant speciation. During this same period, rigorous specimen-based research into oak character evolution got a foothold, and several studies were published on oak hybridization and its consequences for populations and species (e.g, Allard 1932; Stebbins, Matzke, and Epling 1947; Palmer 1948; Allard 1949; Muller 1952; Tucker 1963; Ledig et al. 1969). But I think of a trio of now-classic papers from the mid 1970s as setting the stage for modern studies of oak evolution. In 1975, James Hardin published an article in the *Journal of the Arnold Arboretum* showing patterns of potential gene flow among 16 White Oaks of Eastern North America (Hardin 1975). His first figure (reproduced in the current article as Fig. 2) says it all: among the group, only two species were thought at that time to be reproductively isolated from the others: *Quercus oglethorpensis* W.H. Duncan and *Q. chapmanii* Sarg., both regional endemics. We now know that not even those two are isolated: *Q. oglethorpensis* is believed to be capable of hybridizing with *Q. margarettae* (Ashe) Small (Coombes and Coates 1997), and a hybrid between *Q. chapmanii* and *Q. minima* (Sarg.) Small is distributed on the coastal plain along eastern Florida (Muller 1961). Hardin's work in characterizing patterns of hybridization among all the potentially hybridizing White Oaks of Eastern North America, demonstrating that none are reproductively isolated, is still one of the most taxonomically thorough studies of oak hybridization in a system of interbreeding oak species.

At about the same time, a pair of articles in *Taxon* by Chicago scientists William Burger (The Field Museum) and Leigh Van Valen (University of Chicago, best known for his description of the Red Queen Hypothesis: Van Valen 1973) argued that gene flow in oaks is dominated by local gene flow among individuals that are closely enough related to exchange genes, rather than among populations within species (Burger 1975; Van Valen 1976). These papers argue that our concept of species needs to be fundamentally rearranged to account for oaks. Because of hybridization and gene flow between oak species, Burger and Van Valen argue, the criterion of reproductive isolation cannot

1. Perhaps not coincidentally, Gray's language changes between 1848 and 1862 – years flanking the publication of *Origin of Species* – from suggesting that these hybrids are mere sports to suggesting that they might be species of hybrid origin. Darwin had, in fact, sent a letter to Asa Gray in 1857 outlining his theory of natural selection. Does Gray's change in language reflect a change in his view of the evolutionary implications of hybridization?

Figure 1/ Herbarium specimen of a putative hybrid between *Q. macrocarpa* Michx. and *Q. alba* L., collected by Michael Nee, Wisconsin. Botanists commonly look for hybrids where the parents are both found, especially in oaks. On this specimen label, Nee writes: "Growing in yard of farmhouse, but undoubtedly natural and not deliberately planted. Both *Q. macrocarpa* and *Q. alba* are common in the vicinity and are the common trees of the broad, often sandy, Pine River valley here, formerly in prairie – oak savanna until European settlement in the 1840's and cessation of prairie fires. *Q. alba* is more abundant on hillslopes; *Q. macrocarpa* on alluvial soils and rocky hilltops. This tree [is] intermediate between the two parents in bark, leaf and acorn characters. The acorns have been on the ground for a few weeks." Scan courtesy of The Wisconsin State Herbarium (WIS) and Michael Nee.

work for these species. Rather, oak species represent ecologically discrete lineages with distinct evolutionary trajectories. "Species," Van Valen writes, "are maintained for the most part ecologically, not reproductively." They both argue that local gene flow among species may well exceed gene flow between populations of a single species, and that reproduction cannot therefore be the hallmark of oak species. Burger goes so far as to suggest erecting subgenera or sections that are equivalent to reproductive species, but allowing our named species in oaks to represent ecologically and morphologically defined evolutionary lineages. The idea that gene flow might be insufficient to cause species to cohere across their range had been discussed previously (Ehrlich and Raven 1969), but these papers were novel in stating that oak species are not reproductively defined entities but ecologically defined entities. What is troubling about this is that it is not clear what mechanism might shape species coherence in the face of ongoing local gene flow. A measured skepticism about oak species is not uncommon among botanists even today.

We now know, however, that while there is certainly hybridization and introgression among oak species (Whittemore and Schaal 1991; Dumolin-Lapegue et al. 1997; Dumolin-Lapegue, Kremer, and Petit 1999; Petit et al. 2003; Dodd and Afzal-Rafii 2004; Tovar-Sánchez and Oyama 2004; Lexer, Kremer, and Petit 2006; Curtu, Gailing, and Finkeldey 2007; Hipp and Weber 2008; Chybicki and Burczyk 2010; Moran, Willis, and Clark 2012), gene flow *among* species appears to be swamped by gene flow *within* species (Gerber et al. 2014). As Hardin (1975) wrote, "Rather extensive hybrid swarms or introgressed populations… are generally localized…. Neither Baranski (1975) nor I agree with Minckler (1965), who thinks that hybridization may mask evidence of races within white oak." Moreover, much of the variation in oaks that has been interpreted as evidence of hybridization appears to be morphological variation within highly variable species. As Muller wrote in 1952, "The species of *Quercus* are notoriously variable in trivial characters. This variability has given rise to the belief that the oak species hybridize freely. It is quite evident from a study of herbarium specimens, however, that the bulk of claims of hybridity are based upon trivial variations of the sort one may encounter in a relatively pure population of a single species." (Muller 1952). The result is that oak species are genetically coherent across wide geographic and even ecological ranges (Muir, Fleming, and Schlötterer 2000; Hipp and Weber 2008; Cavender-Bares and Pahlich 2009). This is what we expect of organisms with long-distance gene flow (Petit and Excoffier 2009). Oaks, with their great stature and volumes of wind-borne pollen, certainly fall in this category (Whittemore and Schaal 1991; Dow and Ashley 1998; Gerber et al. 2014). The concerns raised 40 years ago by Van Valen and Burger, that oak species do not constitute genetically coherent systems of populations, appear not to have been borne out. Oak species, we can say confidently against the backdrop of the last 20 years of oak research, are real.

Yet the phenomenon of hybridization in oaks still troubles our ideas of what we mean by "the phylogeny of oaks." Phylogenetic studies in oaks using a few nuclear markers (Manos, Doyle, and Nixon 1999; Oh and Manos 2008; Denk and Grimm 2010; Deng, Zhou, and Li 2013; Hubert et al. 2014) have illuminated many relationships, but these studies have not resolved many of the fine-scale relationships among oaks, nor even recovered deep splits that are generally recognized (e.g., the split between the Eurasian and American White Oaks). We do know broad-scale phylogenetic patterns based on these studies. For example, we know that the American oaks form a distinct clade comprising the sections *Quercus* (the White Oaks), *Lobatae* (the Red Oaks), and *Protobalanus* (the

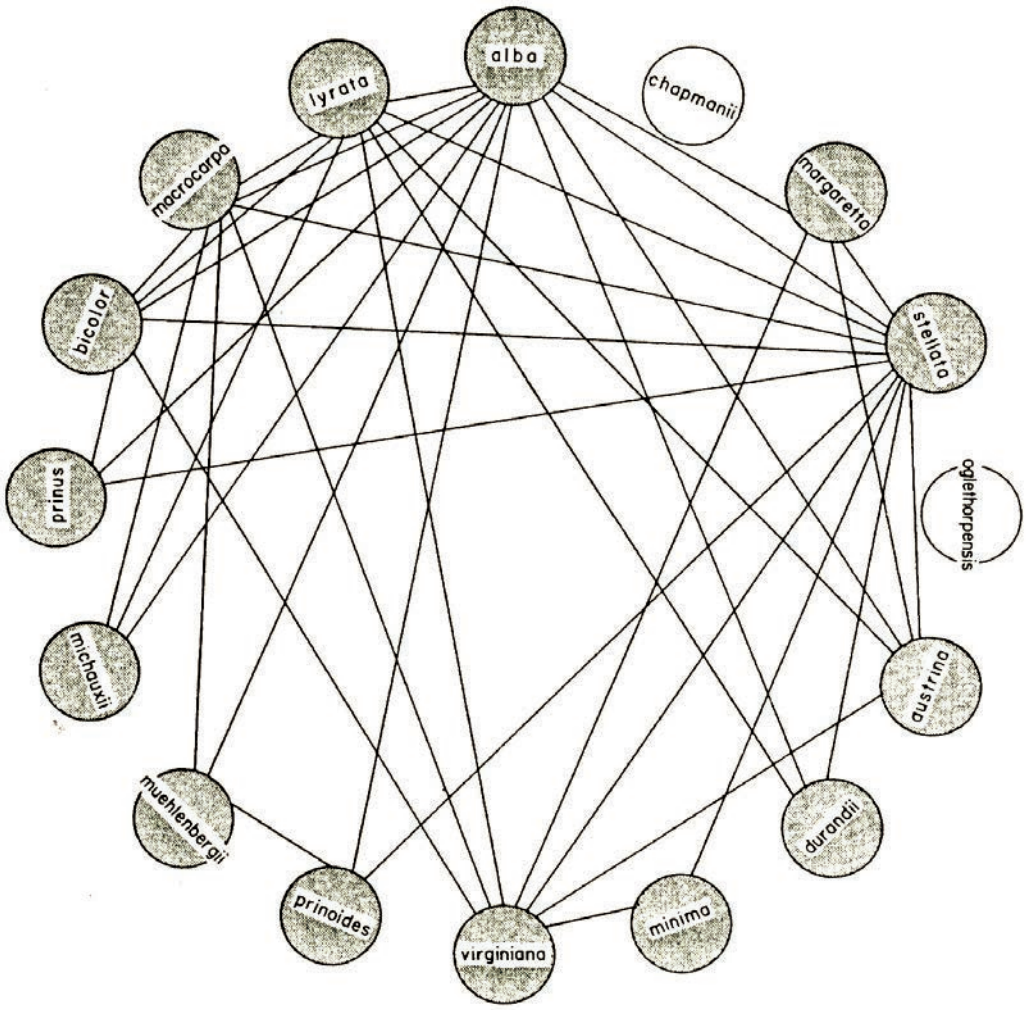

Figure 2/ "The white oak syngameon of eastern North America (shaded areas)", reproduced from Hardin (1975), Figure 1. Hardin focused his study on white oak (*Quercus alba*), but in this figure he summarizes all crosses that are known between any species of White Oak believed at the time to be indigenous to North America east of Oklahoma and Texas. Crosses were inferred from literature, Hardin's own collections, and herbarium specimens. Figure courtesy of *Journal of the Arnold Arboretum*, released by the Missouri Botanical Garden, Peter H. Raven Library under Creative Commons Attribution-NonCommercial-ShareAlike 4.0 (CC BY-NC-SA 4.0) license; non-commercial reuse is permitted under the same license, with source attribution.

Intermediate Oaks) (Manos, Doyle, and Nixon 1999). We know that the Eurasian White Oaks (*Quercus robur* L. and relatives) are derived from a North American White Oak ancestor (Denk and Grimm 2010; Hubert et al. 2014). More recent work using genome-scale data (Pearse and Hipp 2009; Hipp et al. 2013; Hipp et al. 2014) has been successful in resolving relationships at a variety of depths throughout the phylogenetic tree, including relationships much closer to the tips of the tree. The Eurasian White Oaks are now resolved as monophyletic (Pearse and Hipp 2009), though their placement relative

to the White Oaks of Eastern North America is ambiguous (Hipp et al. 2013; Hipp et al. 2014). An out-of-Mexico scenario for the American oaks appears to be rejected (Pearse and Hipp 2009; Hipp et al. 2013; Hipp et al. 2014). Fine-scale relationships appear to be within reach.

These successes notwithstanding, in the face of hybridization, even limited in scale, one must ask, what are we finding in our phylogenetic inquiries? The methods we are constrained to using at this point are extremely broadbrush, genome-scale methods that, at least to date, have not resolved the histories encoded by genes individually, but have relied on analysis of the data in combination. Even if we get single, well-resolved phylogenies, what do they mean against the backdrop of oak hybridization and introgression? Should we trust the phylogenies that we see? It seems to me that the reality may be one or more of at least three scenarios:

- *Perhaps we are being misled: our phylogeny may really represent local gene flow masquerading as the history of species divergence.* In the worst case, our estimate of the oak phylogeny might just be a representation of local gene flow. We know, in fact, that chloroplast phylogenies in oaks tend to track geography rather than species boundaries (Whittemore and Schaal 1991; Dumolin-Lapegue et al. 1997), and in the beginning, there was some concern that multi-locus nuclear markers might do likewise. However, the fact that oak species cohere genetically at wide geographic ranges in both fine-scale population-level studies (Hipp and Weber 2008; Cavender-Bares and Pahlich 2009) and our first phylogenetic studies (Pearse and Hipp 2009) suggests that the patterns we are recovering are *not* patterns of local gene flow between populations. Rather, we are tracking a population history that is separate from, if not independent of, localized gene flow between species.
- *Gene flow may be sufficient to homogenize species and lineages*. Based on what we know from species-level studies, intraspecific gene flow (the gene flow among members of a single species) dominates the pattern of genetic variation that we find in and among oaks. This idea has been presented convincingly as a mechanism for species coherence in introgressing lineages (Petit and Excoffier 2009), and if true, such intraspecific gene flow might just as easily retain the history of population divergence even in the face of interspecific hybridization. Despite the known patterns of introgression and hybridization among oak species, high rates of gene flow within species should homogenize species genetically and transfer among individuals of those species the history of species divergence encoded in mutations and changing allele frequencies. Given the high rate of species coherence in both microevolutionary studies (at the species and population level) and macroevolutionary (phylogenetic) studies, this scenario seems plausible.
- *Divergence history may be stored preferentially at selected regions of the genome.* Genomic "islands of divergence" are putative regions of the genome at which species or populations diverge, even as hybridization may homogenize the genome as a whole (Michel et al. 2010). Such islands of divergence require either very strong selection (Beaumont and Balding 2004; Via and West 2008) or chromosomal rearrangements (Rieseberg 2001; Noor and Bennett 2009). While the genome of *Quercus* is believed to be rather stable (Duffield 1940; Aykut, Uslu, and Babaç 2011; Kremer et al. 2012), genomically heterogeneous selection is known in the genus (Sork, Stowe, and Hochwender 1993; Bodénès et al. 1997; Dodd and Afzal-

Rafii 2004; Saintagne et al. 2004; Lexer, Kremer, and Petit 2006; Goicoechea, Petit, and Kremer 2012; Guichoux et al. 2013; Lind-Riehl, Sullivan, and Gailing 2014) and may well play a role in both speciation and species coherence (Morjan and Rieseberg 2004). If so, phylogenetic estimates might be expected to track selected genes better than neutral regions of the genome. In the most recent phylogenetic study in the genus (Hipp et al. 2014), my colleagues and I investigated this question by mapping genomic markers back to a functional gene database (more formally, an expressed sequence tag or EST collection for plants), and found that EST-linked markers (which we expect to be enriched for genome regions under selection, because they code for genes) are no more phylogenetically conclusive than non-EST-linked markers. The only other genome-scale study of oak phylogeny was based on amplified fragment length polymorphisms, AFLPs (Pearse and Hipp 2009), which are presumed to sample mostly from neutral regions of the genome. But these relatively coarse analyses only suggest that phylogenetically informative sites are relatively widespread across the genome rather than localized. It may still turn out that divergence is concentrated in selected regions of the genome. For example, genes contributing to drought resistance may have a fundamentally different history from those contributing to freezing tolerance. It might also turn out that lineage diversification is encoded heterogeneously and in a predictable manner, such that common regions of the genome tend to harbor the history of lineage diversification while other regions tend to share readily among lineages. Fine-scale genomic data, coupled with multilocus phylogenetic data at a range of phylogenetic scales, will be needed to investigate the genomic architecture of differentiation, and ultimately to understand what genes shape the oak tree of life.

Given recent successes in fine-scale oak phylogenetics and past success in resolving species boundaries in oaks using molecular markers, a phylogenetic reconstruction for oaks, representing a meaningful history of species divergence, appears an achievable goal. It is not clear, however, how hybridization may still tamper with our understanding of oak species divergence. Even if there is strong phylogenetic structure in oaks, hybridization may drag branches of the tree around, and such effects may be difficult or impossible to detect. Moderate levels of hybridization and introgression may be detectable, but widespread interspecific gene flow is likely to be a history-effacing process (Sober 1991). Will we fully tease apart evolutionary history from ongoing introgression? Can we distinguish between ancient introgression events and shared ancestry? Recent statistical methods will certainly help (Eaton and Ree 2013; Eaton 2014), but as we attack the evolutionary history of oaks on a large scale, identifying histories of hybridization will be increasingly complex and essential to our understanding of the oak phylogeny. The history of oak evolution – the phylogeny of oaks – is certainly real, and largely understandable. How far we can go remains to be seen.

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Photographers. Title page: Béatrice Chassé (*Quercus ×bebbiana*). Photo 1: Guy Sternberg.

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1/ *Quercus macrocarpa*

Did Early Human Populations in Europe Facilitate the Dispersion of Oaks?

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ABSTRACT

This review contends that early human populations, while invading Europe during the Upper Paleolithic or while migrating in response to postglacial warming, contributed to the dispersion of oaks. Evidence suggests that humans, while migrating along the Danube route, facilitated acorn dispersal as they transported goods that could help them survive the local harsh climate. Some of the dispersed acorns very likely developed micro-populations, and may have finally resulted in cryptic northern populations, very far north of contemporary oak distribution. The human vector of acorn dispersal in Europe would have resulted in a scattered distribution of what we call today cryptic refugia. Such a scenario may explain why the Balkan genetic lineage is so widespread in Central and Eastern Europe (even in Western Europe) north of the Alps.

Keywords: acorn dispersal, oak migration in Europe

Introduction

Oak colonization of Europe during the postglacial period was extremely rapid. Rates of migration inferred from pollen deposit maps show a rate of more than 500 m/1,640 ft per year, exceeding by far the dispersion by jays, squirrels or rodents (Brewer et al. 2005). To explain this paradox, occurrences of rare long-distance dispersal events have been invoked. This mechanism has been tested by computer simulation and shows that dispersal events of a few dozen kilometers, even if very rare, would have substantially accelerated the overall migration rate (Le Corre et al. 1997). To date no conclusive evidence for a long-distance dispersion vector has been found. An alternative scenario has been proposed, suggesting that cryptic refugial populations persisted during the glacial period in more northern areas, and would have acted as source populations for recolonization (Stewart and Lister 2001). It is likely that both dispersal mechanisms can be advocated in the case of oaks. Currently however, clear evidence – based on genetic or fossil data – exists only for the northern refugia scenario. Archeological or historical evidence for long-distance dispersion is very scarce and there has been no specific research to determine what the possible vectors may have been.

We contend in this review that early human populations, while invading Europe during the Upper Paleolithic or while migrating in response to postglacial warming, contributed to the dispersion of oaks. It is suggested that early humans collected acorns for their food needs, probably storing them in pits before their consumption. Furthermore they brought part of their harvest along with them when they moved to new settlements. Any "lost" acorns dropped along the route, or any non-consumed acorns would constitute a dispersion event. This article mainly reviews evidence from different sources that support this scenario; indeed, recently there have been a number of contributions in human history, archeobiology and in population genetics that, when put all together, lead to such conclusions.

Acorns in the diet of early human populations

Acorns are a valuable food resource. Like cereals they are rich in carbohydrates, and fibers but also have a high fat content (Salkova et al. 2011). They contain tannins (responsible for their very bitter taste) that are soluble in water and can thus be removed through soaking. Acorns have always been a major component of human diets, and, quite interestingly, their potential human consumption in modern societies has recently been advocated in *Scientific American* as a possible means to overcome future food shortages (Starin 2014). There is ethnographic, archeological, and also historically documented evidence that humans have been consuming acorns since their presence in Europe and that in extant traditional tribes they continue to do so (McCorriston 1994; Mason and Nesbitt 2009). While this is well accepted (Aurenche 1997; Karg and Has 1996), more recent data suggests that acorns were used as a dietary staple (Zalkova 2011; Haws 2004; Liu et al. 2010) and not only when other resources became exhausted. Acorn-processing techniques do not always result in detectable remains or charred material, and have therefore been underestimated in archeological remains. It is known that preservation constraints of starch-rich seed hampers their detection. This has led to an underestimation of their presence and to the realization that acorn consumption has been overlooked (Deforce et al. 2009; Mason 1995). This picture has changed since other methods are

now used that have confirmed the wide-spread use of acorns as a food source. These new methods include, for example, the analysis of dental caries or of food remains in teeth (Humphrey et al. 2014; Villa and Reybroeks 2014).

Archeological investigations have detected acorn remains in human settlements in different parts of Europe and at different periods. In the Middle East, the oldest remains found date from 60,000 to 40,000 BP (Lev et al. 2005). In Morocco, the substantial prevalence of dental caries analyzed from human remains (14,000 BP) has been attributed to starchy plant foods such as acorns (Humphrey et al. 2014). In Spain, acorn remains were discovered in the Nerja caves at the lake-dwelling site of La Draga from 14,000 BP up to 5,000 BP (see Haws 2010, for a review for Iberia; Antolin and Jacomet 2015). In more northern latitudes, prehistoric finds of acorn remains have been documented in France at 3,000 BP (Bouby 2000), in Belgium at 2,200 BP (Deforce et al. 2009), in Germany dating from the Bronze Age (Knörzer 1972), in Denmark from the Stone Age (Jorgensen 1977), and in Sweden at 8,000 BP (Regnell 2012). To illustrate some of these findings, the remains discovered by Deforce and coworkers (2009) were contained in an oval pit (2.3 m long, 1.75 m wide and 0.30 m deep/7.5 ft × 5.74 ft × 0.98 ft) almost completely filled with acorn samples. In total it has been estimated that this pit could have contained 69,000 acorns!! The authors discussed the various purposes for storing such a large quantity of acorns, and finally concluded that food provision (either for humans or animals) is the most likely interpretation. It has also been shown that acorn consumption was practiced since very early times by modern humans (Lev et al. 2005) and even earlier by Neanderthals (Villa and Roebroeks 2014). The recent and increasing number of reports on archaeological acorn remains as well as reviews on the presence of acorns in the human diet (Rosenberg 2008; Salkova et al. 2011; Rimavera and Fiorentino 2013) underpin the reconsideration of acorns as a dietary staple in early human populations.

Finally, acorn consumption has been well documented in more recent times in historical texts written by classical authors such as Strabon (the Greek geographer) or Pliny the Elder (the Roman historian) when they first discovered Iberia or France, and reported on the customs of the local people. Quoting Strabon (*Geografia 2*) "These people live in very austere settings: water is their only drink, they sleep on the ground. During most of the year, they eat acorns. First they dry them, then they grind them and bake a kind of bread that can be conserved over long time." Pliny the Elder in *Naturalis Historia* reports very similar practices "When the cereals become rare, they dry the acorns, they shell them and grind them to make a flour and finally to produce bread. Today, even in the Hispanias, acorns are also part of desserts." These excerpts stem from Arsuaga (1999); a more exhaustive review of historical writings, mostly by Greek authors, confirm these ethnographic observations (Aurenche 1997)

These archeological and historical reviews clearly suggest that human populations collected acorns, stored and further processed them (tannin removal and charring) for future consumption, and that this was probably largely practiced over the ages and across Europe.

Oak migration following environmental change

Oak migration in Europe has only been retraced since the last glacial maximum (LGM) based on pollen deposits (Brewer et al. 2002, 2005). At the end of the LGM, oak forests were largely restricted to the Iberian Peninsula, Italy, and the Balkan Peninsula

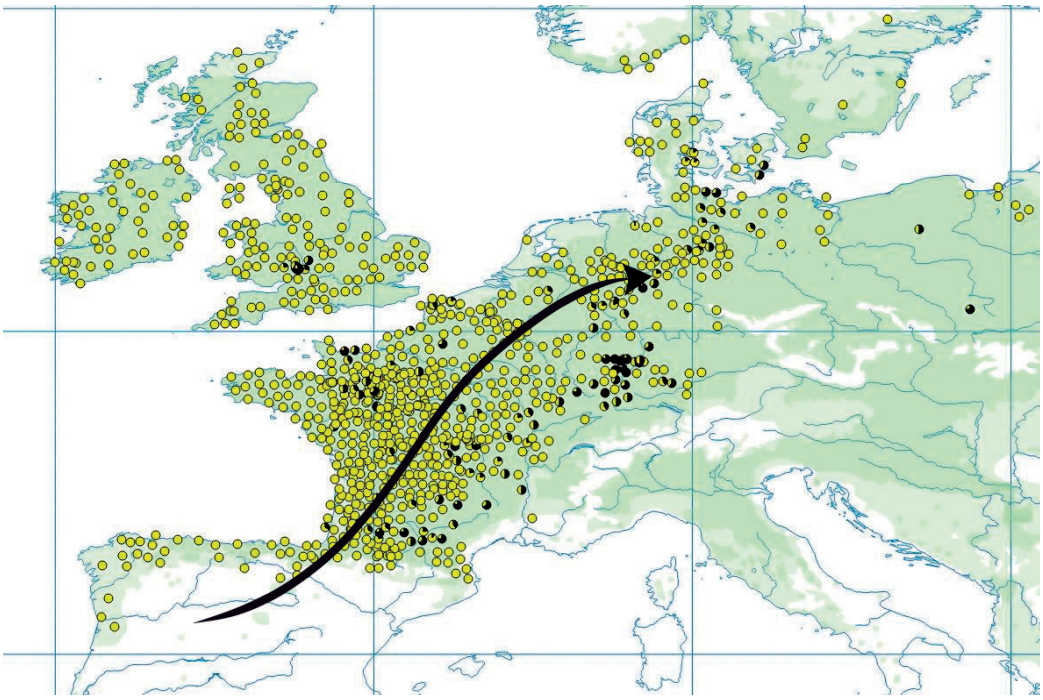

Figure 1a/ Distribution of oak stands belonging to the Atlantic lineage. The green shaded area corresponds to the joint extant distribution of *Quercus petraea* (Matt.) Liebl. and *Q. robur* L. Only populations bearing haplotypes 10, 11, 12 (according to Petit et al. (2002), belonging to the Atlantic lineage) are plotted here. The black arrow indicates the most likely postglacial migration route from the Iberian refugial area to Northern Europe. Data extracted from the GD2 database (Georeferenced Database of Genetic Diversity): https://w3.pierroton.inra.fr/QuercusPortal/index.php?p=gd2

(Greece and the western coast of the Black Sea). These refugial areas bear distinct genetic fingerprints in chloroplast DNA (Petit et al. 2002). Hence, migration from the three genetic refugial areas can be reconstructed based on the extant distribution of these fingerprints. As the climate warmed up, between 13,000 and 10,000 BP, oaks increased in abundance, attaining the Pyrenees, the Alps and the Carpathian Mountains. The cooling of temperatures from 11,000 BP to 10,000 BP temporarily stopped the expansion that accelerated again after 10,000 BP. Oaks reached their extant distribution at about 6,000 BP. This is the reconstructed scenario of the colonization waves inferred from fossil pollen deposits (Brewer et al. 2002). Locally, the colonization process was a mix of dispersion by biological vectors (jays, squirrels, etc.) and by rare long distance "jumps" (Le Corre et al. 1997).

As indicated earlier, migration routes can be inferred by the geographic distribution of the chloroplast genetic fingerprints (so called genetic lineages). We illustrate in Figure 1 the colonization route followed by the Atlantic lineage (Figure 1a), and by the Balkan lineage (Figure 1b). The Atlantic lineage went from southwest to northeast (Spain to Scandinavia) while the Balkan lineage most likely followed an east to west route, north of the Alps, and later a northern direction (Figure 1b). It is quite surprising that the eastern part of France is inhabited by the Balkan lineage rather than the Atlantic lineage. Somehow the former was present there before the latter arrived.

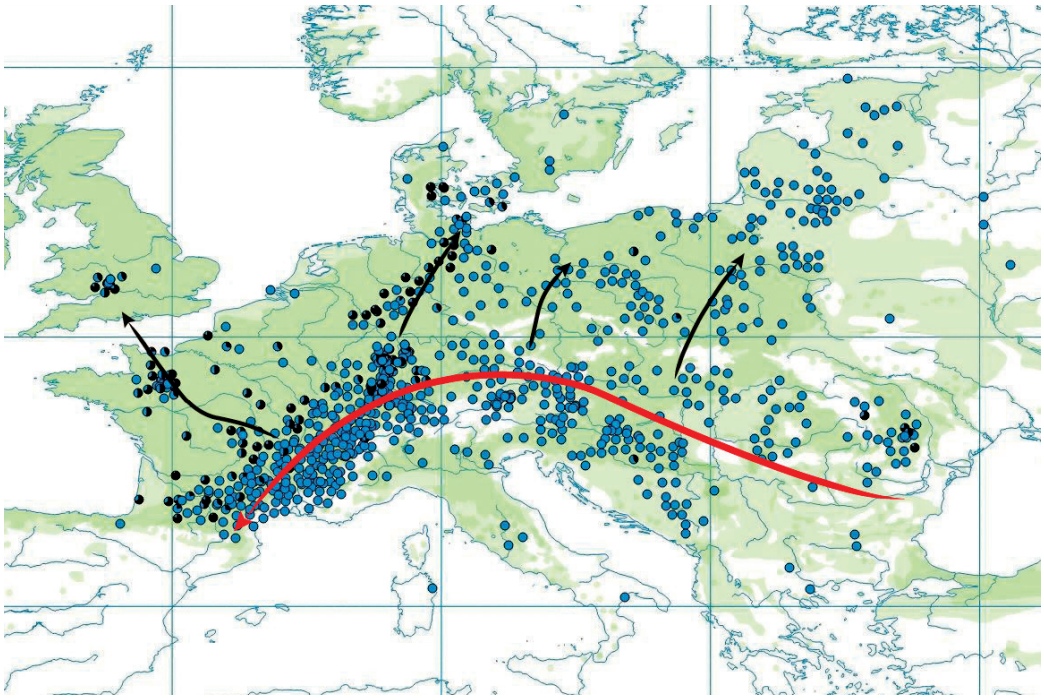

Figure 1b/ Distribution of oak stands belonging to the Balkan lineage and possible migration routes of oaks. The green shaded area corresponds to the joint extant distribution of *Quercus petraea* (Matt.) Liebl. and *Q. robur* L. Only populations bearing haplotypes 4, 6, 7, 26 and 30 (according to Petit et al. (2002), belonging to the Balkan lineage) are plotted here. The red arrow mirrors the possible early dispersion pathway of oaks due to the modern human migration (see text and Figure 2) that took place from 45,000 to 40,000 BP. Human presence along the Danube route may have facilitated the dispersion of oaks from 45,000 BP up to the LGM resulting in the possible installation of cryptic oak refugia north of the Alps (along the red arrow). Black arrows indicate the most likely migration route after the LGM, when the climate improved (18,000 BP and thereafter). Data extracted from the GD2 database (Georeferenced Database of Genetic Diversity): https://w3.pierroton.inra.fr/QuercusPortal/index.php?p=gd2

Human migrations in Europe during environmental changes

Humans were present in Eurasia since about 600,000 BP. While settlements as early as 1.4 Ma have been reported (Moncel et al. 2004), the expansion of *Homo heidelbergensis* Schoetensack takes place after 600 ka and contributed to the emergence of *H. neanderthalensis* King. From 230,000 BP to 40,000 BP Neanderthals inhabited most of Northwestern Eurasia (Stewart and Stringer 2012). Finally, modern humans (*H. sapiens* L.) colonized Europe at 45 to 40,000 BP and they have occupied the Old World ever since (Mellars 2004; Henn et al. 2012). It is generally accepted that *H. heidelbergensis* and *H. sapiens* migrated from Africa to Eurasia at different times while *H. neanderthalensis* emerged in Western Europe and subsequently migrated eastwards in Asia during the Upper Pleistocene (75,000 to 57,000 BP) (Bar-Yosef and Belfer-Cohen 2013).

These historical perspectives clearly suggest that hominid populations faced at least four interglacial/glacial periods while modern human populations experienced the most recent glacial/interglacial transition. How did they respond to the recurrent major environmental changes that occurred during the Pleistocene? Much as for other organisms (Taberlet et al. 1998; Hewitt 2000) there is evidence that human presence expanded and

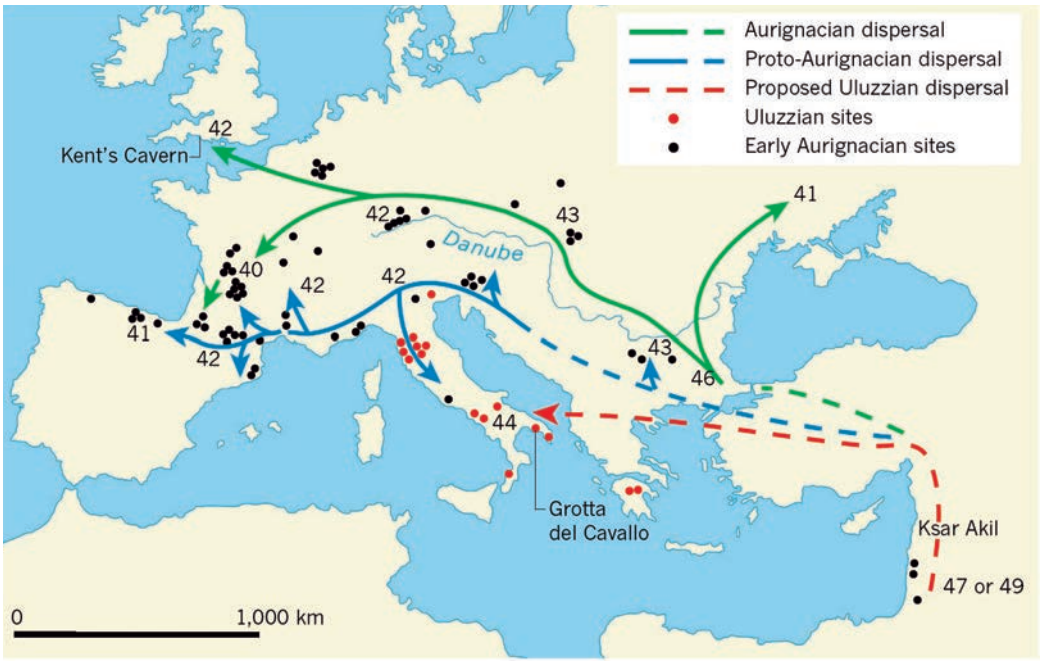

Figure 2/ Dispersal routes of modern humans in Europe (Mellars 2011). Numbers indicate k years BP.

retracted in response to climatic oscillations, and these migration routes or refugial areas have been retraced (Stewart and Stringer 2012). Such periods of contraction or expansion have been reported to be a result of climate changes (Gamble et al. 2004). For example, the Gravettian industry disappeared from Northwestern Europe about 23,000 years ago, with recolonization of that area dating from after the LGM (Gamble et al. 2004). Extreme rapid cooling during the Heinrich events H4 and H5 have been invoked as possible drivers of the Neanderthal extinction (Bradtmöller et al. 2012).

Northward expansion, albeit documented, is not as strongly linked to climate change as is contraction because dispersal usually occurred within wide climatic tolerances (Gamble et al. 2004). This latter review, that retraces past population distribution based on radiocarbon dating in Western Europe, shows that Iberia appears as a southern refugium of human populations. Less documentation is available on the impact of earlier interglacial/glacial periods for Neanderthals. Indeed Neanderthals witnessed the last interglacial period (Eemian) that occurred 125 to 127 ka ago and the subsequent cooling that led to the LGM. At what rate did human populations migrate? Based on archeological records and genetic data, Henn et al. (2012) estimated that human populations expanded at a minimum rate of 0.5 km/1.6 ft year during the out-of-Africa expansion. Furthermore these figures are also consistent with the spatial distribution of genetic diversity and correspond to a colonization process with repeated serial founder effects (Despande et al. 2012).

How may human populations have facilitated the migration of oaks?

To answer this question we need to compare the migration pathways and dynamics of both organisms. This comparison can only be made for the periods for which the best records of migration are available for both. Although oaks and humans can be found

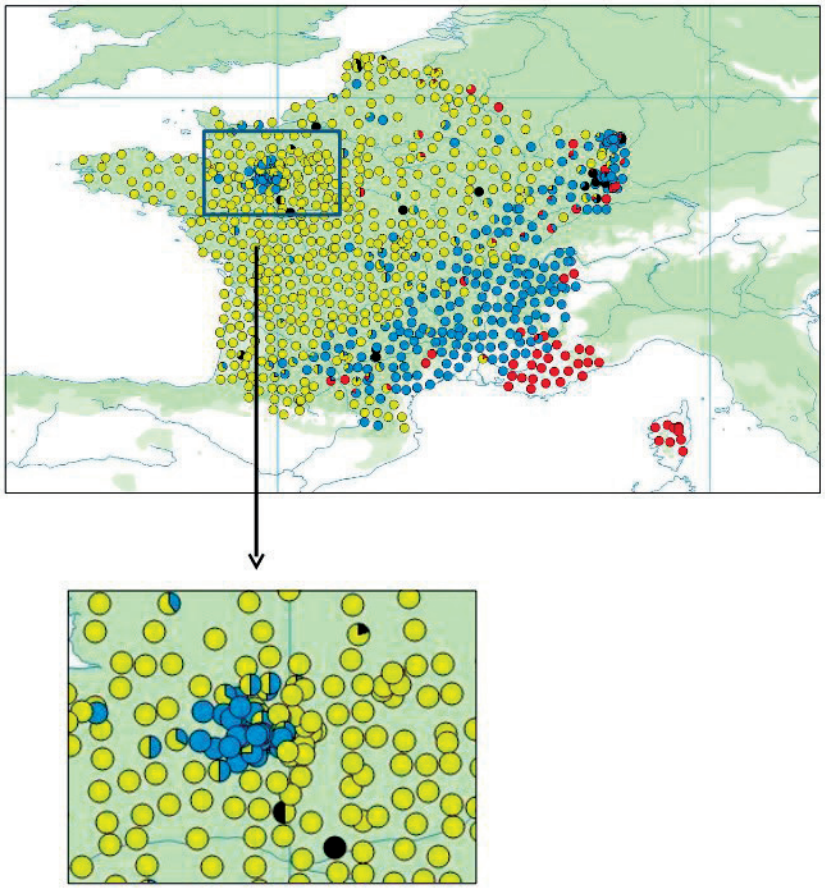

Figure 3/ Distribution of the oak genetic lineages in France and illustration of a long-distance dispersal event. Blue dots indicate oak stands belonging to the Balkan lineage (similar to Figure 1b). Yellow dots indicate oak stands belonging to the Atlantic lineage (similar to Figure 1a). Red dots indicate populations belonging to the Italian lineage (haplotype 1 according to Petit et al. 2002). A close up illustrates the « blue island » within the Atlantic lineage, witnessing a long-distance dispersion possibly due to a human mediated transfer (see text). Data extracted from the GD2 database (Georeferenced Database of Genetic Diversity): https://w3.pierroton.inra.fr/QuercusPortal/index.php?p=gd2

together much earlier, our comparison will therefore be restricted to the last 50,000 years (Upper Paleolithic), i.e., since the presence of modern humans (*Homo sapiens*) in Europe. This was actually the time (45,000-40,000 BP) when the very first modern humans coming from the Middle East colonized Europe (Mellars 2011). This spread is well-documented and followed basically two routes (Figure 2): the northern along the Danube River, and the southern (south of the Alps) along the Balkans, Slovenia, Italy and the south of France (Mellars 2011; Hoffecker 2009). During these periods, human populations were hunter-gatherers, and the climate in Central Europe (along the Danube river) dry and cold (tundra-like).

Our suggested scenario is that humans, while migrating along the Danube route, facilitated acorn dispersal as they transported goods that could help them survive the local harsh climate. Some of the dispersed acorns very likely developed micro-populations and may have finally resulted in cryptic northern populations very far north of contemporary

oak distribution. At this time, 20,000 years before a period of climate warming, these micro-populations would have had enough time to develop in stands that may have then acted as source populations for recolonization later on. However, these populations may have been too small to produce enough pollen deposits that would be detectable today. The human vector of acorn dispersal in Europe along the two routes would therefore have resulted in a scattered distribution of what we call today cryptic refugia. Such a scenario may explain why the Balkan genetic lineage is so widespread in Central and Eastern Europe (even in Western Europe), north of the Alps (see Figure 1b).

Humans may have also facilitated oak dispersion during the northward migration from the southern refugia and from the cryptic more northern refugia, following the LGM (18,000 BP). As mentioned earlier, humans (Gamble et al., 2014) and plants expanded northwards as the climate warmed. Interestingly the migration rate of man and oaks was very similar (Brewer et al. 2002; Henn et al. 2012). Both migrated in the same direction and at similar speed, thus suggesting that man may have acted as the vector of the rare long-distance dispersal events of oaks. An imprint of the human contribution is shown by the peculiar extant distribution of oak chloroplast haplotypes. For example, in Brittany, in a region that is entirely inhabited by oaks belonging to the Atlantic lineage, an "island" of Balkan origin (representing a circle with a 50 km/31 mi radius) can easily be shown. This feature is most likely the imprint of a long-distance dispersal event of acorns belonging to the Balkan lineage, some 8 to 10,000 years ago (Figure 3). Incidentally, the small blue "islands" in Figure 3 also exist in the British Isles (Cottrell et al. 2002). This may represent the western outcome of the original northern migration of *Homo sapiens* along the Danube River (Figure 3).

Conclusion

Referring to our introductory hypothesis, this review suggests that humans may have actually contributed to the installation of very early populations (late cryptic refugia) north of the Alps along the Danube migration pathway (43 to 42,000 BP). In addition they may have facilitated the northward migration along the postglacial colonization routes (15 to 6,000 BP). Our conclusions are at this time supported by only coincidental migration pathways and dynamics. More evidence is needed to confirm or dismiss them.

One possibility would be to conduct a detailed genetic spatial analysis based on fossil remains of humans and oaks collected in the same region. Similar mitochondrial (for man) and chloroplast (for oak) narrow-scale distribution would be a strong argument of human involvement in oak migration. Should such a scenario be confirmed, one could ask if intentional sowing or some kind of proto-silviculture for establishing new oak stands was not implemented. Beyond the consumption of acorns, oaks were indeed used for a variety of purposes including for firewood, construction, charcoal, and tannins. This then raises the issue of attempts of domestication. Haws (2004) suggested that hunter-gatherers probably used rudimentary techniques such as pruning to increase acorn production. Mason (2000) also raises the possibility that fire management may have improved seed crop. Finally, some sort of phenotypic selection of trees bearing sweet acorns has been mentioned by Haws (2004) for Mediterranean oaks (*Quercus suber* L.) as well as by Mason and Nesbitt (2009). These attempts further reinforce the general contention of this review that early human populations contributed to the dispersion of oaks in Europe

Photographers. Title page: Michel Timacheff (*Quercus petraea* (Matt.) Liebl.).

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Quercus barrancana Spellenb.: a New Species of Oak from Northwest Mexico

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Unmounted holotype of *Quercus barrancana* (Spellenberg and Anderson 13487).

In November 2014, Dr. Richard Spellenberg of New Mexico State University described a new species of White Oak from Northwestern Mexico. While exploring the flora of the northern Sierra Madre Oriental, he and his colleagues had been aware of the plants for some time. Previous collections were usually identified as *Quercus toumeyi* Sarg. or *Q. arizonica* Sarg., or as intermediates between these species.

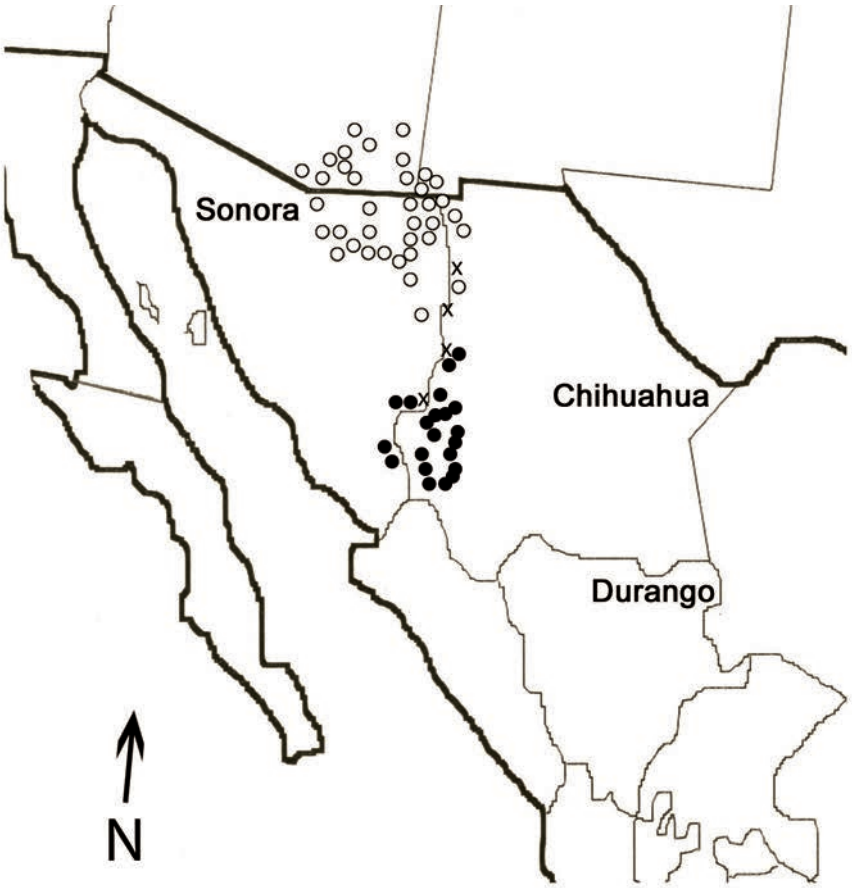

Figure 1/ Distribution of *Quercus barrancana* and *Q. toumeyi* in Southwestern USA and Northwestern Mexico. Closed circles = *Q. barrancana*, open circles = Q. toumeyi, × = intermediate specimens between the species (Spellenberg 2014).

Description

Q. barrancana Spellenb. is an evergreen (possibly drought-deciduous) shrub or small tree, often with several trunks and reaching up to 6 m tall.[1] Shoots densely stellate, hairy when young, becoming glabrous or nearly so by the third year. Leaves dark green, ovate to slightly obovate, to 36 × 15 mm or slightly more on vigorous shoots, hairy on both sides with branched hairs when young, they become smooth or nearly so and glossy above, paler and hairy beneath. The branched hairs on the lower surface are contorted, as if twisted (easily seen with a hand lens). The margin is usually edged with 1-4 short, blunt

1. For measurement conversions see page 152.

teeth mainly in the distal portion of the leaf. The flowers open from March to early June and the acorns ripen in the first year from June to September. They are fusiform, to 19 × 10 mm and 1/4 to 1/3 covered by the cap. The bitter acorns are edible raw or are made into *esquiate* (roasted, ground and mixed with water).

1/ a) *Quercus toumeyi* b) *Q. arizonica* c) *Q. barrancana*

Quercus barrancana is found in steep-sided, rocky *barrancas* in SE Sonora and SW Chihuahua, Mexico, where it grows in oak or pine-oak woodland at altitudes of 1300-2115 m. It is most similar to *Q. toumeyi* which differs in its usually entire leaves without contorted hairs beneath and occurs to the north of the distribution of *Q. barrancana*. In the northern part of the distribution of *Q. barrancana* and the southern end of the distribution of *Q. toumeyi*, intermediates between the two species can be found. *Q. barrancana* is not known to be in cultivation.

2/ Electron micrograph of abaxial leaf surface showing the contorted multirayed hairs.

3/ Quercus barrancana in its habitat in Chihuahua, Mexico.

Acknowledgements

Adapted with permission of the author from Spellenberg, R. 2014. *Quercus barrancana* (Sect. *Quercus*, White Oaks), a new species from northwestern Mexico. *Phytoneuron* 2014-105: 1-12. The original article can be accessed at:
http://phytoneuron.net/2014Phytoneuron/105PhytoN-Quercusbarrancana.pdf

Photographers. Title page: Richard Spellenberg. Photos 1a-b: Béatrice Chassé. Photo 1c: Wynn Anderson. Photo 2: NMSU Electron Microscopy Lab. Photo 3: Richard Spellenberg.

Quercus utilis Hu & W.C. Cheng Found in Vietnam

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***Quercus utilis* isolectotype (Chang & Liu 81298).**

Members of the IOS will remember the article in *International Oaks*, Issue No. 25, written by our Editor, "In Search of Vietnam's Elusive Oaks" (Chassé, 2014). Three members of the Oak Society visited several different provinces in Northern Vietnam searching for *Fagaceae*, in particular oaks. Near the end of their trip they visited the Ha Giang Province (pp. 155-59), the northernmost part of Vietnam.

Much of the Ha Giang topography consists of heavily eroded karst limestone outcrops and cliffs. The scenery is stunning but walking through this country is slow due to the razor sharp rocks, weathered holes and prickly, animal-proof scramblers that thrive here due to the largely cutover trees and shrubs which have let the light in. The soil is shallow and confined to the sumps and hollows.

These rocky outcrops are botanically very rich and interesting even though the local Hmong people were heavily cutting for firewood and animal fodder. The main woody constituents were *Coniferae, Magnoliaceae, Lauraceae* and *Fagaceae*. Due to the periodic cutting most of the tree flora wasn't attaining a large enough stature to flower or produce fruit and seeds; it was all largely secondary growth.

I was lucky to have visited this area with Keith Rushforth and Steve Hootman in 2007 where we stayed in a largish regional market town called Meo Vac. Our day spent exploring the surrounding countryside dawned very misty so we confined our sights to local areas close to road-heads. Just 6 km/4 mi from Meo Vac, at about 1,300-1,400 m/4,300-4,600 ft., was a small hill (image attached) where we spent an hour or so climbing around in the mist. Amidst a fascinating mix of plants including *Rhododendron, Podocarpus, Acer, Pistacia, Carpinus* and *Mahonia*, at the top there were a few small, heavily branched trees of an oak that has subsequently been identified as *Quercus utilis* Hu by Dr. Min Deng in 2014. I noted at the time that the trees looked very tough and tolerant of seasonal dry spells. These trees had produced a few acorns probably because they were at the top of the hill and far from local needs.

1/ The hill (left) near Meo Vac where *Quercus utilis* was found.

It must exist elsewhere in Vietnam but was originally described in 1951 from, and since then only recorded in, China (Hu, 1951). The type location in Yunnan province is Chanshing, Xichou Xian at 1000 m/3,300 ft, an area of similar topography, approximately 70 km/43 mi west-northwest of Meo Vac. It is also distributed in south Guizhou and Guangxi provinces. According to the Flora of China, the Chinese vernacular for *Q. utilis* is 炭栎 or *tan li*, (charcoal oak). The epithet *utilis* means useful and the original description states "wood useful for charcoal". It is cleverly able to set acorns when young therefore able to maintain genetic diversity under extreme human pressure.

There are now two plants in cultivation in the UK, one at Chevithorne Barton with Michael Heathcoat Amory and one at Tregrehan House. They have both survived the last few winters outside with no frost damage and are already branching which means they are most likely going to make small multi-stemmed trees.

2/ New growth on *Quercus utilis* (Chevithorne Barton).

Description

Trees to 10 m tall,[1] evergreen. Branchlets thin, finely striate, sparsely stellate tomentose, grayish with age, glabrescent. Petiole thin, 2-5 mm, glabrescent; leaf blade ovate, elliptic-lanceolate, or obovate, 2.5-5.5 × 1.5-2.5 cm, thinly leathery, abaxially greenish and with stellate hairs in axil of secondary veins, adaxially brightly green and sparsely stellate on midvein, base cuneate and decurrent on petiole, margin glandular serrulate, apex shortly mucronate; secondary veins 9-11 on each side of midvein, slender, evident, adaxially impressed; tertiary veins abaxially conspicuous. Infructescence with 1 or 2 cupules; rachis ca. 5 mm thick, with stellate hairs. Cupule bowl-shaped, 6-7 mm in diam., enclosing ca. 1/3 of nut; bracts ovate, ca. 1 mm, crowded, densely yellowish brown tomentose. Nut ovoid to narrowly ellipsoid, ca. 10 × 7 mm, brown, glabrous but

1. For measurement conversions see page 152.

apex with filiform hairs and acuminate; scar ca. 2 mm in diam., raised; stylopodium ca. 1 mm in diam., easily broken. Fl. Apr-May, fr. Sep-Nov. Found in open or dense woods on rocky hills; 1000-1500 m. SW Guangxi, S Guizhou, SE Yunnan (Xichou Xian). Data extracted from *www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=210001868.* See also Hu (1951).

3/ Mature leaves of *Quercus utilis* (Tregrehan House).
4/ Mature leaves of *Quercus utilis* (Chevithorne Barton).

Photographers. Title page: courtesy Chinese Virtual Herbarium. Photos 1, 3: Tom Hudson. Photos 2, 4: James MacEwen.

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Quercus mannifera Lindl.: a Confused East Anatolian Endemic

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***Quercus mannifera* Lindl. holotype (Cambridge University Herbarium 13085).**

Introduction

Oaks are a common and often dominating genus of many plant communities, and are often notoriously difficult to identify correctly. They have "fooled" many excellent botanists. Therefore the true identity and taxonomic status of many species is still doubtful. Given the rapid destruction of many indigenous oak woodlands in the Near East, this creates the danger of an important element of the arboreal biodiversity of this part of the world being lost forever. *Quercus mannifera* described by John Lindley in 1840 is a good example of this.

History

This oak species was first observed in 1839 by James Brant, the then resident British Consul in Erzurum, during a tour in Eastern Anatolia (now Turkey). Herbarium material was collected and sent for identification to John Lindley, who described and published it a year later (1840) in the Appendix to *Edward's Botanical Register* on page 41.

1/ Kotschy's original drawing of *Quercus cedrorum* (Kotschy 1862).

The sample that served Lindley in his publication was purchased in 1866, along with John Lindley's entire herbarium that is now deposited at the Cambridge University Herbarium **(C).** Unfortunately, though validly published by an eminent botanist, very few botanists have checked the original sample. Thus A. de Candolle accepted it as a legitimate name for a variety of *Quercus sessiliflora* in 1864 in his *Prodromus* (Vol. 16, pt. 2: 15). Boissier (1879) in his *Flora Orientalis* (Vol. 4: 8) refers Kotschy's materials to the variety *cedrorum* of the subspecies II *sessiliflora* of *Q. robur* L.

It was recognized as a distinct species by O. Schwarz in his monograph of oaks (Schwarz 1936-37).

The first to collect similar material in the area was Karl Koch (1809-1879). However, unaware of

Lindley's publication, he published his collections from the same region in 1849 as *Q. pinnatiloba* in the German botanical journal *Linnaea* (K. Koch 1849).

Theodor Kotschy, in 1859, was the first to use the name *Q. mannifera* when he distributed to European herbaria the herbarium (Ky 425 and Ky 550) he had collected (*Iter cilicio-kurdicum*, 1859) under this name. But in 1862, when his classical book, *Die Eichen Europas und des Orients*, was published, he failed to recognize the species and published his collections under a new name: *Q. cedrorum*.

Both Alphonse de Candolle, in his monumental *Prodromus* (1864) and Edmund Boissier, in his comprehensive *Flora Orientalis* (1879), referred parts of the herbarium materials to this new name and failed to check Brant's original specimen.

Theodor Wenzig rightly criticized both of his predecessors for failing to use Brant's herbarium material as published by Lindley and that is deposited in the Herbarium of the Botanical Garden and Museum in Berlin (Dahlem). But he too repeated the same mistake of disregarding Lindley's 1840 publication, when, in 1886 he published his treatise about the oaks of the Euro-Mediterranean and Oriental regions (l.c.).

The two great twentieth century monographers of the genus, A. Camus (1936) and O. Schwarz (1934 and 1936) differed in their approach. A. Camus followed the approach of K. Koch because she was not familiar with Lindley's specimens – she never traveled or saw materials abroad. Schwarz did not see the material and thought Brant's specimen was not typical and more likely to be a hybrid form from the *iberica-boissieri* or *dschorochensis-boissieri* combinations (Schwarz 1936-1937). Nevertheless he included *Q. mannifera* Lindl. in his monograph of the oaks of Europe and the Mediterranean region.

M. Zohary in his 1961 contribution on the oaks of the Middle East failed to discuss the whole assemblage of glabrous, sessile oaks.

Menitsky (1972), while initially citing Kotschy's no. 425, completely disregards Lindley's binomial – apparently because he did not go to see the type material at Cambridge. However, while disregarding the priority of Lindley's name over Koch's from 1949, he recognized the uniqueness of the material by assigning it the status of a subspecies of *Q. petraea* (Matt.) Liebl. Finally, in his most important treatise, *Oaks of Asia*, he quotes Lindley's binomial as a synonym of *Q. infectoria* subsp. *boissieri*.

When, in 1982, I. Hedge and F. Yaltirik prepared the chapter on the oaks of Turkey for P. Davis's *Flora of Turkey*, (Vol. 7, pp. 659-683) they adopted Menitsky's 1972 species concept and nomenclature. However they included in it the quite different and geographically well-isolated samples validly published in 1862 by Kotschy as *Q. cedrorum* Kotschy. Later A. Ertas repeated this species concept (Ertas 1995).

Govaerts and Frodin (1998), on the basis of this state of affairs, rejected Lindley's name as valid for a distinct species, assigning only hybrid status (with *Q. boissieri* Reut. or *Q. araxina* (Trautv.) Grossh.)[1] to Kotschy's samples from Eastern Turkey.

Discussion and description

The present author disagrees with this solution. On the basis of extensive studies conducted over the past forty years at the most important Herbaria of Europe (including the one in Cambridge where Lindley's herbarium is kept), as well as field collections made in Eastern Turkey, it is herewith proposed to resurrect Lindley's name for a distinct species native to the highlands of Eastern Turkey.

1. Today both of these names are considered synonyms of *Q. infectoria* subsp. *veneris* (A. Kern.) Meikle.

2/ Michael Avishai's original drawing of the taxon that he considered in 1967 to be *Q. pinnatiloba* K. Koch (Avishai 1967).

***Quercus mannifera* Lindl.** *Edward's Botanical Register* **26,** Appendix 41' misc. note 72 (1840).

Derivation: The specific epithet is based on the presence on the leaves of a sugary substance, "manna", produced by aphids, reputed to be one of the features of this species (Lindley 1840). No common English name is known.

Subgenus: ***Quercus*** Section: ***Roburiformes*** Schwarz in *Notizbl. Bot, Gart.*13: 12 (1935).

Synonyms: *Q. robur* L. *sessiliflora* Salisb. var. *cedrorum* DC., *Prodr.*, 16(2): 8 (1864) p.p (*Q. sessiliflora* Salisb. var. *pinnatifida* Boiss., *Fl. Orien.* 4: 1164 (1879) p.p.

Icon: Schwz., *Mongr. d. Eichen*, Atlas, tab. 12 (1936). Camus, l.c., Atlas 2, pl. 142 Avishai, Thesis, fig. 4 (as *Q. pinnatiloba*)

Type: (HOLO): **C. '**Collected during a tour in Kurdistan 1839 by James Brant, H.M. Consul, Erzurum'

Selected specimens: It. Cilic-Kurd.,1859, Kotschy 550; Plantae in Karduchia lectae ad lacum Wan devexa - in littore australis fruticetis vastis obtegit gallasque optimas produit alt 5,000[2] ped. Sept (C!, W!, BM!, B!). Turkey, Province Tunceli, 72 km. N. of Elazig on Tunceli road, low patches of oak shrubbery, 1,250 m. M. Avishai 178/22 HUJ. Prov.Erzurum: 60 miles north of Mus on road to Erzurum, oak shrubberies, 1,950 m M. Zohary 57343 HUJ. Betw. Erzurum and Erzincan, about 70 km east of Erzican, Quercetum pinnatilobae near river banks, 1,490 m, M. Zoharuy and U. Plitman, 2663-16 HUJ. ProvGiresun: 27 km N. of Egribel Pass, Quercetum with small shrubs and trees on grey soil, 1,070 m M. Avishai 384, HUJ.

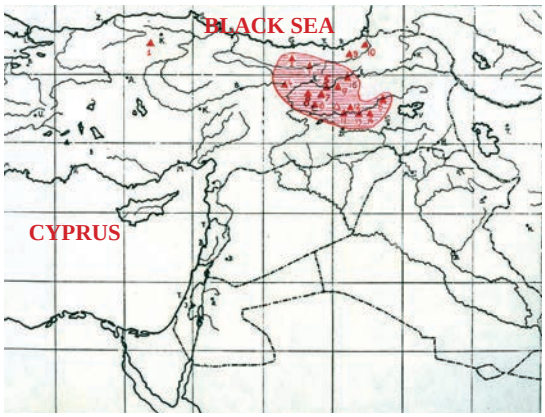
Description: Deciduous large shrub or small (3.0-6.0 m) very branched tree. TWIGS: Glabrous, buds 0.5 cm glabrous, stipules caducous, filiform to lanceolate. LEAVES: large, thick-leathery, 10.0-18.0 × 4.0-9.0 cm, broad ovate, petiole glabrous 2.5-3.5 cm long. Blade dull gray green above, yellowish green beneath; at base unequal, attenuate to cordate; leaf margin pinnatilobate or lobate, sinuses narrow, veins 7-8, intercalaries very few, in lower half of/or near leaf base, few stellate hairs in vein axils.

Fruit: Peduncle of cupule 0.0-2.0 cm, stout, cup thick walled 1.5-2.5 × 0.7-1.5 cm, scales ovate, grey tomentose, with subacute, brown inserted tips.

Habitat: Mountain slopes and sheltered valleys between 750 m and 2,000 m. In mountainous regions of Eastern Turkey it forms pure stands or occurs in association with other oak species in transition to Zagrosian steppes. This is a conspicuous native of the Subeuxinian enclave in the large mountain blocks of Bingöl. Though limited currently

2. For measurement conversions see page 152.

to thickets, there can be little doubt that in the past it formed extensive forests that were destroyed by man and his beasts. A characteristic form was noted by Zohary at 1,500 m above sea level, 4 km west of Bingöl. This is the center of the distribution of this type of oak woodland, composed of *Q. libani* G. Olivier, *Q. aff. longipes*, *Crataegus* sp., *Berberis cretica* L., and *Cotoneaster nummularius* Fisch. & C.A. Mey., with steppe perennials invading this community in many places.



3/ Distribution of *Quercus mannifera* (Avishai 1967).

Range: Endemic to E. Turkey.

Distinct characters and affinities: *Q. mannifera* is one of the glabrous, annually ripening species with distichous stipules. The two species that are most often confused with *Q. mannifera* are the more southerly occurring *Q. cedrorum*[3] and the more northerly occurring *Q. iberica.* Steven ex M. Bieb.[4] differs from both of these with its thick, leathery leaves and thick-walled, larger cup on a thick, distinct peduncle. differs from . in the diverging secondary veins and the smaller, mostly sessile, clustered fruits. It differs from in the distinctly thick-peduncled, not-sessile fruit. differs from in the short, thick petiole, the distinctly narrow, deeply lobed blade margin often with secondary lobes and diverging secondary veins as compared to the regularly crenulate-dentate margin and parallel secondary veins of *Q. boissieri*.

Economic importance: Locally important for grazing and firewood.

Comments: In nature two varieties can be distinguished, often occurring together in many stands: 1) var. *mannifera* with elliptic-oblong leaves, truncately lobed margin, shallow, narrow sinuses and no secondary lobes; 2) var. *pinnatiloba* (K. Koch) Avishai – comb. et stat. nov. Basionym *Q. pinnatiloba* K. Koch. *Linnaea* 22: 326 (1849) with ovate leaf, pinnatilobate, wide sinuses between subacute lobes and 1-2(-3) secondary lobes at margin.

Conclusion

Though accepted by T. Kotschy, who collected extensively throughout its natural range, this taxon has been confused in most modern studies. Much of this confusion seems to have been caused by Kotschy himself who distributed under the name many of his collections from southern parts of this area, which were in fact Reut., a common associate of in this part of Turkey.

Only my acquaintance with these taxa, and personal field collections as well as a study of the type material from Lindley's herbarium in Cambridge, and material in collections elsewhere, has enabled me to clarify this confusion.

This is a most valuable plant, native to some of the harshest parts of Turkey. It would be most promising if introduced for afforestation or ornament. It is highly in need of protection and conservation – an aim hampered by its mistaken affinities.

3. Considered by some authors to be a synonym of *Q. petraea* subsp. *pinnatiloba* (K. Koch) Menitsky.
4. Considered by some authors to be a synonym of *Q. petraea* subsp. *iberica* (Steven ex M. Bieb.) Krassiln.

Feature	*Q. mannifera*	*Q. boissieri*	*Q. iberica*	*Q. cedrorum*	*Q. syspirensis*
Branch color	Brown	First yellowish later grey brown	Red brown	Red brown	Rusty, olive brown
Indumentum of young twigs and leaves	Glabrous	Glabrous	Glabrous	Glabrous	Tomentose, olive, rusty brown
Leaf shape	Ovate to obovate	Oblong - obovate	Obovate	Obovate	Obovate
Leaf texture	Thick-leathery	Hard-leathery	Softish	Softish	Soft
Blade margin	Deep-narrow or wide lobed often with minute secondary lobules	Regularly ascending, crenulate, teeth mucronulate	Shallowly and irregularly lobed	Irregularly lobed	Regularly and shallowly crenate-lobate
Secondary veins	Few, divergent	Many, parallel	Few, divergent	Few, divergent	Parallel
Intercalary veins	Few, basal	Lacking	Few, basal	Few, basal	Lacking
Apical stipules	Caducous	Caducous	Caducous	Caducous	Persistent, hairy-villose
Fruit peduncle	Thick, up to 2 cm long	Mostly absent or thin, and less than 2 cm.	Absent, fruit in small clusters	Absent, fruit in small clusters	Absent, fruit in clusters with stipules
Scales and cupule wall	Appressed, wall thick	Appressed, wall thin	Tightly appressed to thin wall	Tightly appressed to thin wall	Loosely appressed to thin wall
Floristic element	Subeuxinian mountain	Tauro-Libanesian- Zagrosian Steppe	Euxinian	Taurian Mountain	Subeuxinian-Hyrcanian

Table 1/ Distinguishing features

Credits. Title page and Figs. 2, 3: courtesy of Michael Avishai. Figure 1: courtesy of Dušan Plaček.

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Three New Oak Hybrids from Southwest Iberia (Spain and Portugal)

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ABSTRACT

The study of oak diversity in the Southern Iberian Peninsula resulted in the nomenclatural revision of following nothotaxa: *Quercus* ×*beturica* (F.M. Vázquez, Coombes, Rodr.-Coombes, Ramos & Doncel) F.M. Vázquez, C. Villaviçosa, C. Meireles & C. Pinto-Gomes stat. nov.; *Q.* ×*numantina* Ceb. & C. Vicioso nothosubsp. *discreta* F.M. Vázquez nom. nov., and *Q.* ×*tentudaica* (F.M. Vázquez) F.M. Vázquez stat. nov. Also, three new nothospecies are described: *Q.* ×*ordenensis* F.M. Vázquez, García Alonso & Márquez nothosp. nov. (sterile and rare shrub), *Q.* ×*alentejana* Pinto-Gomes & F.M. Vázquez nothosp. nov. (fertile and frequent Lusitanian tree), and *Q.* ×*pastorae* M.A. Pineda, F.M. Vázquez & Sánchez Gullón nothsp. nov. (fertile and rare tree).

Keywords: *Quercus, Fagaceae*, nothotaxa, Iberian Peninsula, taxonomy, nomenclatural review

Introduction

The oak species from the southwestern Iberian Peninsula have often been studied because of the difficulty of segregation between species, especially in section *Galliferae* (Spach) Gurke which includes the following species: *Q. broteroi* (Cout.) Rivas Martínez & Saénz de Rivas, *Q. canariensis* Willd., *Q. faginea* Lam., and *Q. lusitanica* Lam., all easily producing fertile hybrids that increase the identification problems and the introgression process, which is frequent in many oak groups and species. (Palmer 1948; Muller 1952; Saénz de Rivas et al. 1971; Burger 1975; Van Valen 1976; Vázquez 1995; Vázquez et al. 2000; Dodd et al. 2004.)

Previous studies of the genus *Quercus* L. from the Iberian Peninsula revealed new taxa such as *Q. pauciradiata* Penas, Llamas, Pérez-Morales & Acedo (Penas et al. 1997); *Q. orocantabrica* Rivas Mart., Penas, T.E. Díaz & Llamas (Rivas Martínez et al. 2002) and *Q. ×celtica* F.M. Vázquez, Coombes, Rodr.-Coombes, Ramos & Doncel (Vázquez et al. 2003). These studies revealed the high oak diversity of the Iberian Peninsula and showed the connection between European and North African oak diversity, with the southwestern Iberian Peninsula as a refuge for ancient European and North African oaks such as *Q. estremadurensis* O. Schwarz and *Q. canariensis* (Huguet del Villar 1958; Costa et al. 1997). The Iberian Peninsula is an area of very high oak diversity when compared with the rest of the Mediterranean (Vasconcellos et al. 1954; Franco 1971; Rivas Martínez et al. 1991).

Oak hybridization processes are frequent and they are important mechanisms of evolution, for the colonization of new habitats and for the creation of new species (Palmer 1948; Muller 1952; Rushton, 1993; Vázquez et al. 2000; Sánchez de Dios et al. 2006; Villaviçosa et al. in press). The aim of this work was to study the diversity of the genus *Quercus* in the southwestern Iberian Peninsula, specifically the deciduous hybrid taxa that have been conserved during the last 15 years in the Herbarium HSS (Holmgren et al., 1991, 2003) of the research centre "La Orden-CICYTEX" (Badajoz, Spain).

Methodology

The oak diversity of the southwestern Iberian Peninsula has been reviewed in the existing literature (Coutinho 1888; Sampaio 1910; Schwarz 1936a, 1936b, 1936-39; Camus 1938; Vicioso 1950; Vasconcellos et al. 1954; Huguet del Villar 1958; Sáenz de Rivas 1968; Franco 1971, 1990; Saénz Rivas et al. 1971; Rivas Martínez et al. 1991; Vázquez 1995; Penas et al. 1997; Vázquez et al. 2003, 2013). Material of the deciduous oaks preserved in the Herbarium HSS, collected from numerous populations where at least three deciduous oak species occur, was also studied. The morphological studies were based on characters that best allow the identification and recognition of each taxon as indicated in the review of oaks from the Iberian Peninsula by Franco (1991), while the study of foliar trichomes was based on Hardin (1979) and Vázquez (2013).

Results

The results are presented in two parts: a) the nomenclatural revision of deciduous oak hybrids from the southwestern Iberian Peninsula, and b) the new oak hybrids found there. These results are presented in tables and specific descriptions are given for each

new taxon, accompanied by drawings that emphasize the defining characters of each new hybrid. Finally we provide a list of the studied material (Appendix 1).

Nomenclatural revision of deciduous oak hybrids

The oak hybrids recognized from the SW Iberian Peninsula (with deciduous species as parents) are listed below. (KEY: in **bold** = new names; underlined = hybrids with parents from different sectons; [ster.] = sterile hybrids].)

1. *Q.* ×*andegavensis* Hy. nothosubsp. *henriquesii* (Franco & Vasc.) Rivas Martínez & Sáenz de Rivas in *Rivasgodaya* 6: 108. 1991. (= *Q. pyrenaica* × *robur* subsp. *broteroana*)
2. *Q.* ×*aruciensis* C. Vicioso in *Rev. Gen. Quercus España* 139. 1950. (= *Q. broteroi* × *lusitanica*)
3. *Q.* ×*battandieri* A. Camus in *Les chênes. Monographie du genre* Quercus. Texte 2: 411, 792. 1939. [ster.] (= *Q. broteroi* × *coccifera*)
4. ***Q.* ×*beturica*** (F.M. Vázquez, Coombes, Rodr.-Coombes, Ramos & Doncel) F.M. Vázquez C. Villaviçosa & C. Pinto-Gomes **stat. nov.** (Basionym: *Q.* ×*coutinhoi* A. Camus nothosubsp. *beturica* F.M. Vázquez, Coombes, Rodr.-Coombes, Ramos & Doncel in *Int. Oaks* 14: 53. 2003. (= *Q. broteroi* × *estremadurensis*)
5. *Q.* ×*carrissoana* A. Camus in *Les Chenes, Monogr. Gen. Quercus*, Atlas II. Expl. Pl. (Encycl. Econ. Sylv.VII.): 59. 1935. (= *Q. canariensis* × *estremadurensis*)
6. *Q.* ×*celtica* F.M. Vázquez, Coombes, Rodr.-Coombes, Ramos & Doncel in *Int. Oaks* 14: 52. 2003. (= *Q. lusitanica* × *suber*)
7. *Q.* ×*clementei* C. Vicioso in *Rev. Gen. Quercus España* 140. 1950. (= *Q. broteroi* × *faginea* subsp. *alpestris*)
8. *Q.* ×*coutinhoi* Samp. in *Man. Fl. Port.:* 123. 1910. (= *Q. faginea* × *robur* subsp. *broteroana*)
9. *Q.* ×*diegoi* F.M. Vázquez, C. Pinto-Gomes, C. Vinagre & C. Villaviçosa, *Fol. Bot. Extremadurensis* 8: 95. 2014 [ster.] (=*Q. lusitanica* × *pyrenaica*)
10. *Q.* ×*diosdadoi* F.M. Vázquez, A.J. Coombes, M. Rodríguez, S. Ramos & E. Doncel in *Int. Oaks* 14: 52. 2003. [ster.] (= *Q. pyrenaica* × *rotundifolia*)
11. *Q.* ×*ferreirae* A. Camus, *Riviera Sci.* 21: 45. 1934. (= *Q. estremadurensis* × *faginea*)
12. *Q.* ×*fontqueri* O. Schwarz in *Cavanillesia* 8: 85. 1936. (= *Q. canariensis* × *pyrenaica*)
13. *Q.* ×*jahandiezii* A. Camus in *Les Chenes* (*Encycl. Econ. Sylv*. VII.) Texte 2: 409, 791. 1939. (= *Q. canariensis* × *faginea* subsp. *alpestris*)
14. *Q.* ×*jahandiezii* A. Camus nothosubsp. *viciosoi* (Sáenz de Rivas & Rivas Martínez) Rivas Martínez & Sáenz de Rivas in *Rivasgodaya* 6: 110. 1991. (= *Q. canariensis* var. *mirbeckii* × *faginea*)
15. *Q.* ×*neomairei* A. Camus, *Riviera Sci.* 24: 38. 1937. (= *Q. broteroi* × *pyrenaica*)
16. *Q.* ×*numantina* Ceb. & C. Vicioso in *Anal. Jard. Bot. Madrid* 2: 200. 1941. (= *Q. faginea* × *pyrenaica*)
17. ***Q.* ×*numantina*** Ceb. & C. Vicioso nothosubsp. ***discreta*** F.M. Vázquez (Basionym: *Q.* ×*coutinhoi* A. Camus in *Bull. Soc. Bot. France* 82: 438. 1936, nom. illeg.., non Sampaio 1910; (= *Q. faginea* subsp. *alpestris* × *pyrenaica*)
18. *Q.* ×*pacensis* F.M. Vázquez in *Anales Jard. Bot. Madrid* 53(2): 249. 1996. [ster.] (= *Q. broteroi* × *suber*)
19. *Q.* ×*senneniana* A. Camus in *Les Chenes, Monogr. Gen. Q.*, Atlas II. Expl. Pl. (Encycl. Econ. Sylv. VII.) 55. 1935. (= *Q. faginea* × *rotundifolia*)
20. *Q.* ×*subandegavensis* A. Camus, *Chênes* Atlas 2: 60 1935. (= *Q. estremadurensis* × *pyrenaica*)
21. ***Q.* ×*tentudaica*** (F.M. Vázquez) F.M. Vázquez ***stat. nov***. (Basionym: *Q.* ×*senneniana* A. Camus nothosubsp. *tentudaica* F.M. Vázquez in *Anales Jard. Bot. Madrid* 53(2): 250. 1996. (= *Q. broteroi* × *rotundifolia*)
22. *Q.* ×*tingitana* A. Camus in *Les Chenes* (*Encycl. Econ. Sylv*. VII.) Texte 2: 411, 792. 1939. (= *Q. faginea* subsp. *alpestris* × *lusitanica*)
23. *Q.* ×*villariana* A. Camus in *Les Chenes* (*Encycl. Econ. Sylv*. VII.) Texte 2: 409, 791. 1939. (= *Q. faginea* subsp. *faginea* × *faginea* subsp. *alpestris*)

The main hybrids are formed between species of the same section (*Quercus* section *Quercus*) (16/23, all fertile), but sporadically one can observe hybrids between species of different sections (6/23, underlined) and they are mainly sterile (4/23, labeled: [ster.])

Q. estremadurensis has often been considered as a subspecies (Camus 1938) of *Q. robur* L., however, the study of its distribution, habitat and ecological behavior, phenology, morphological characters such as the hairiness and shape of leaves, as well as the form and development of the embryo, can justify the separation of this taxon as an independent species, as argued originally by Schwarz (1936b) and again suggested by Villaviçosa et al. (in press).

1/ *Quercus ×ordenensis*

2/ *Quercus ×ordenensis*

New oak hybrids

The study of oaks from different geographical locations has revealed the presence of the following new intersectional hybrids: a) *Q. canariensis* (*Quercus* L. sect. *Quercus*., subsect. *Galliferae* (Spach) Gurke) × *coccifera* L. (*Quercus* sect. *Cerris* Spach subsect. *Cocciferae* A. Camus); b) *Q. robur* (*Quercus* sect. *Quercus*) × *suber* L. (*Quercus* sect. *Cerris*). Also, the study of the deciduous southwestern Iberian forest has revealed a new hybrid between species of the same subsection (*Quercus* sect. *Quercus*, subsect. *Galliferae*: *Q. broteroi* × *marianica* C. Vicioso , pro nothosp.).

Figure 1/ *Quercus* ×*ordenensis* F.M. Vázquez, García Alonso & Márquez. A: Branch with leaves; B: Leaf diversity; C: Leaf trichome diversity (drawing by F.M. Vázquez Pardo).

1) ***Quercus* ×*ordenensis*** F.M. Vázquez, García Alonso & Márquez **nothosp. nov.** ≡ *Q. canariensis* × *coccifera* (Fig. 1).

Type: SPAIN (HS): Extremadura: Badajoz (Ba): Guadajira, Centro de Investigación La Orden, [38°51'09.20''N 6°40'07.93''W], 213 m alt., 14 Sep 2012, *F.M. Vázquez*; (Holotype: HSS 56533! (Single specimen), Isotype: HSS 56532!).

Diagnosis. Fruticetum sterile usque ad 1.8 m,[1] altus ramosis. Foliis perenne coriaceous, oblongis-lanceolate vel lanceolate, cuneato-attenuatis, serratis, dentibus acutis, spinescent, adulta subtus pubescentis, petiole (3)5-10(12) mm. Hybrida a parentibus Q. coccifera et Q. canariensis, Q. coccifera similis in habitum, folium adseveratione (perennis) et folium margine, et Q. canariensis similes in petiolum et lamina.

Etymology. The nothospecific epithet refers to the origin of the new nothotaxon: La Orden, Research Centre, Badajoz, Spain.

Description. Sterile shrubs up to 1.8 m, rounded, very branched. Short young branches pilose, canaliculate. Buds globose, with ciliate bracts, concave, red. Leaves persistent, oblong lanceolate to lanceolate, glabrescent above with frequent fasciculate trichomes, glabrescent to pubescent below with radiate, stellate, and frequent multi-stellate trichomes, coriaceous, plane, margins serrate and spiny, (2.5)4-7(8) × (1)2-3.5(4) cm with more than 9 parallel vein pairs, veins yellow abaxially, green adaxially, with long and short simple hairs below; petiole glabrous, coriaceous, yellow, (3)5-10(12) mm. No male (catkins) and female (racemes) flowers (inflorescences).

Distribution. In southern Spain, in local populations of *Q. canariensis* together with *Q. coccifera* in Badajoz, Cadiz, Ciudad Real and Malaga provinces.

Habitat. The original shrub was discovered in an experimental plantation, but the origin of the acorns was a mixed oak forest including *Q. canariensis*, *Q. coccifera*, *Q. lusitanica*, *Q. rotundifolia* Lam., and *Q. suber*. The area has up to 1,200 mm (47 in) annual precipitation, deep (up to 160 cm/63 in) acidic (<6,5 pH) soil, with relictual vegetation such as *Laurus nobilis* L., *Rhododendron ponticum* subsp. *baeticum* (Boiss. & Reut.) Hand.-Mazz., *Ruscus hypophyllum* L., and *Ilex aquifolium* L.

1. For measurement conversions see page 152.

Characters		*Q. canariensis*	*Q. ×ordenensis*	*Q. coccifera*
Habit		Tree to 35 m	Shrub to 1.8 m	Shrub to 3.5 m
Bud	Morphology	Obovate	Ovate	Ovate
	Bracts	Long-ciliate	Short-ciliate	Pubescent
Leaf blade	Persistence	Deciduous	Evergreen	Evergreen
	Size (cm)	6-10(14) × 1.8-3.5(4)	(2.5)4-7(8) × (1)2-3.5(4)	0.8-2.5(3.5) × 0.7-1.4
	Morphology	Oblong-lanceolate	Oblong-lanceolate to lanceolate	Ovate to oblong
Leaf blade margin	Type	Crenate	Serrate	Dentate
	Spines	-	+	+
Leaf petiole	Size (cm)	(1)1.5-2.5	(0.3)0.5-1(1.2)	0.2-0.6
	Pubescent	Pubescent	Glabrous	Glabrous
Leaf blade midrib	Pair number	>10	>9	Up to 7
	Type/Angle	Straight/<32°	Straight/<37°	Sinuous/>40°
	Pubescent	Pubescent	Pubescent	Scabrous
Abaxial leaf surface trichomes	Simple	+	+	+
	Uniseriate	+	+	+
	Stellate	+	+	+
	Fasciculate	+	+	-
	Radiate	+	+	-
	Multi-stellate	+	+	+
	Fused-stellate	-	+	+
Adaxial leaf surface trichomes	Simple	+	+	-
	Uniseriate	+	+	-
	Stellate	+	+	+
	Fasciculate	+	+	-
	Radiate	+	+	-
	Multi-stellate	-	-	-
	Fused-stellate	-	-	-
Reproductive state		Fertile	Sterile	Fertile

Table 1/ Morphological and micromorphological characters for *Quercus ×ordenensis* nothosp. nov., and its parents.

Key for distinguishing *Q. ×ordenensis* nothosp. nov., from its parents

1 Leaves deciduous, margin crenate, spineless, petiole pubescent (1)1.5-2.5 cm, bud bracts long-ciliate..... *Q. canariensis*

1' Leaves persistent, margin spiny, serrate, petiole pubescent to scabrous, 0.2-1.8 cm, bud bracts short-ciliate or not ciliate..... 2.

2 Leaf adaxial surface pubescent to pilose, vein pairs more than 9 diverging from the midrib at up to 37°. Sterile shrub..... *Q. ×ordenensis* nothosp. nov.

2' Leaf adaxial surface glabrous, vein pairs up to 7, diverging from the midrib at more than 40°. Fertile shrub..... *Q. coccifera*

Figure 2/ *Quercus* ×*alentejana* Pinto-Gomes & F.M. Vázquez. A: Branch with leaves; B: Leaf diversity; C: Leaf trichome diversity (drawing by F.M. Vázquez Pardo).

2) ***Quercus* ×*alentejana*** Pinto Gomes & F.M. Vázquez **nothosp. nov.** ≡ *Q. marianica* pro nothosp. × *pyrenaica* (Fig. 2).

TYPE: PORTUGAL (LU): Alto Alentejo (AAl): Montemor o Novo a Arriolos, [38°40'56.49''N 8°08'00.03''W] 285 m alt., 26 Oct 2010, *J. Blanco, M. Cabeza de Vaca, D. García, C. Pinto-Gomes, F.M. Vázquez* (holotype: HSS 49040, single specimen)

Diagnosis. Arbor fertile usque ad 35 m, altus. foliis deciduis coriaceous, lanceolate vel oblong-lanceolate, cuneato-attenuatis, serratis, dentibus acutis vel spines, adulta subtus pubescentibis, petiole (4)5-10(12) mm. Hybrida a parentibus Q. pyrenaica et Q. marianica; Q. pyrenaica similis in foliis pubescentibus et floribus bracteis; et Q. marianica similes in petiolum foliis, et lamina margines.

Etymology. The nothospecific epithet refers to the geographic region of origin of the new nothotaxon (Alentejo, Portugal).

Description. Fertile trees up to 35 m, young branches pubescent. Buds globose, with pubescent bracts, concave, brown. Deciduous leaves lanceolate to oblong-lanceolated, pubescent (below/above) with large diversity of trichome types, coriaceous, plain, serrate and with frequent spines to mucronate margins, 4-10(12) × (2)2.5-4(5) cm; up to 13 parallel pair ribs, below yellow ribs, above green ribs, with long, simple, stellate types, fasciculate types and ramified hairs below; petiole pilose, coriaceous, green, 5-10(12) mm. Catkins long up to 9,5 cm, with (17)21-38(44) male flowers. Female inflorescences are variable; peduncle (3)5-21(28) mm; with 1-7(9) female flowers. (Figure 2)

Distribution. The populations of *Q.* ×*alentejana* are distributed throughout the southwestern Iberian Peninsula and are quite frequent in the provinces of Algarve, Baixo and Alto Alentejo and Estremadura (Portugal), also small groups or isolated individuals are found in the Badajoz and Huelva provinces of Spain.

Habitat. The populations and individuals grow in deep (>1 m) clay soils, with pH >6,5, moderate precipitation 700-1000 mm/annual, in deciduous to mixed forest with evergreen (*Q. suber*) and deciduous species (*Q. broteroi*, *Q. marianica*, *Q. pyrenaica* Willd., or *Q. estremadurensis*), together with evergreen shrubs such as: *Arbutus unedo* L., *Viburnum tinus* L., *Cistus populifolius* L., and *Q. lusitanica* Lam.

Characters		*Q. pyrenaica*	*Q. ×alentejana*	*Q. marianica*
Habit		Tree to 42 m	Tree to 35 m	Tree to 38 m
Bud	Morphology	Ovate	Ovate	Lanceolate
	Bracts	Pubescent	Pubescent	Shortly pilose
Leaf blade	Persistence	Deciduous	Deciduous	Deciduous
	Size (cm)	(5)7-16.5(19) × 3.5-8.5(11)	4-10(12) × (2)2.5-4(5)	(4)4.5-11(12.5) × (1.5)2-3.5(4.5)
	Morphology	Oblong	Oblong-lanceolate to lanceolate	Lanceolate
Leaf blade margin	Type	Lobulate to pinnate	Serrate	Serrate
	Spines	-	+/-	+/-
Leaf petiole	Size (mm)	5 -17(19)	5-10(12)	(8)10-15(18)
	Pubescent	Pubescent	Pubescent	Pilose
Leaf blade midrib	Pair number	<10	7-11(13)	>10
	Type/Angle	Sinuous/>37°	Straight/<37°	Straight/<35°
	Pubescent	Pubescent	Pubescent	Scabrous
Abaxial leaf surface trichomes	Simple	+	+	+
	Uniseriate	+	+	+
	Stellate	+	+	+
	Fasciculate	+	+	-
	Radiate	+	+	-
	Multi-stellate	+	+	-
	Fused-stellate	+	+	-
Adaxial leaf surface trichomes	Simple	+	+	+
	Uniseriate	+	+	+
	Stellate	+	+	+
	Fasciculate	+	+	+
	Radiate	+	+	-
	Multi-stellate	+	+	-
	Fused-stellate	+	+	-
	Ramified	-	+	+

Table 2/ Morphological and micromorphological characters for *Q. ×alentejana* nothosp. nov. and its parents.

Key for distinguishing *Q. ×alentejana* nothosp. nov., from its parents

1. Leaves spineless, lobulate to pinnate. Veins sinuous, diverging at more than 37° from midrib. Leaf hairs unbranched..... *Q. pyrenaica*

1' Leaves serrate with mucronate to spiny teeth. Veins straight, diverging at less than 37° from midrib. Leaves with branched hairs..... *2.*

2 Shoot, bud, petiole and lamina pubescent. Leaf margin with mucronate to spiny teeth. Veins distributed irregularly..... *Q. ×alentejana* nothosp. nov

2' Shoot, bud, petiole and lamina pilose to glabrous. Marginal teeth frequently mucronate. Veins distributed regularly..... *Q. marianica*

3 a-c/ *Quercus* ×*alentejana*

3) *Quercus* ×*pastorae* M.A. Pineda, F.M. Vázquez & Sánchez Gullón nothosp. nov. ≡ *Q. robur* × *suber* (Fig. 3).

Type. SPAIN (HS): Andalusia: Sevilla (Se): Sanlúcar la Mayor, [37°21'54.47''N 6°12'01.07''W], 129 m alt., May 2012, *M.A. Pineda, E. Sánchez Gullón*; (holotype: HSS 57709, single specimen).

Diagnosis. Arbor fertile usque ad 8 m, altus. Foliis deciduis subcoriaceous, lanceolate, cuneato-attenuatis, serratis, dentibus subacutis vel obtusis, adulta subtus glabrescentis, petiole (6)7-11 mm. Fructis bractea libera. Hybrida a parentibus Q. robur et Q. suber; Q. robur similis in petiolum frutis et foliis deciduis; et Q. suber similes in petiolum foliis, lamina pubescentis et bractea fructis.

Etymology. The nothospecific epithet refers to the common name of the Sanctuary of El Rocío (Huelva, Spain) (Sanctuary of the "Divina Pastora"), near to Sanlúcar la Mayor (Seville, Spain).

Description. Fertile trees up to 8 m, long young branches glabrous, canaliculate.

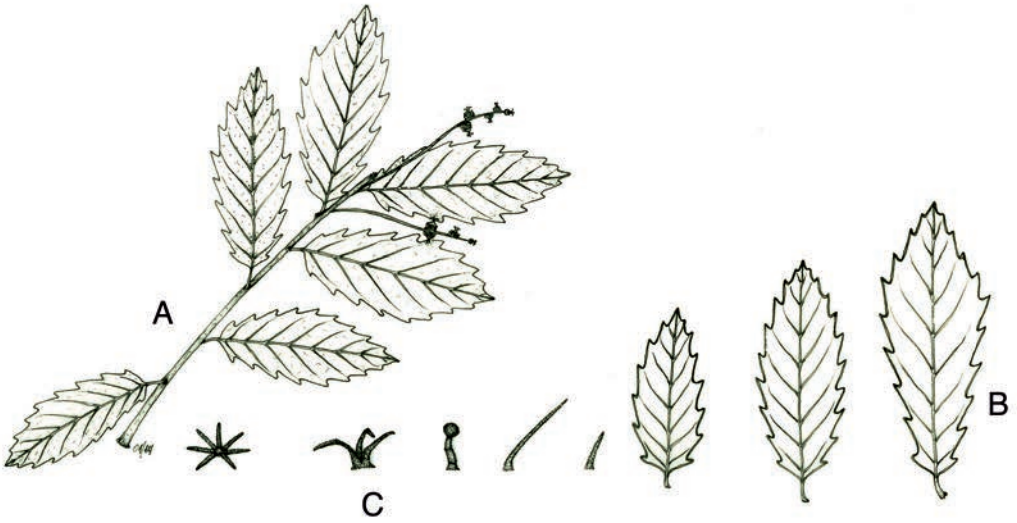

Figure 3/ *Quercus* ×*pastorae* M.A. Pineda, F.M. Vázquez & Sánchez Gullón. A: Branch with leaves; B: Leaf diversity; C: Leaf trichome diversity (drawing by F.M. Vázquez Pardo).

4/ *Quercus* ×*pastorae*

Buds globose, with ciliate bracts, concave, brown. Leaves deciduous, lanceolate, glabrescent above with frequent simple trichomes, glabrescent below with fasciculate and multi-stellate trichomes, coriaceous, plane, with serrate and mucronate to smooth margins, (5.5)6-8(8.5) × (1.5)2-4(4.5) cm; up to 10 parallel vein pairs, veins yellow-red to green-red on the abaxial side, green on the adaxial side with long and short simple hairs below; petiole pilose, coriaceous, red, (6)7-11 mm. Catkins up to 7.5 cm long with 12-37 male flowers. Female inflorescences with peduncle up to 3.5 cm long with 2-6(8) female flowers. (Figure 3).

Distribution. This single tree appeared in an area in which *Q. robur* has been cultivated for reforestation close to a natural cork oak (*Q. suber*) forest in the south of the province of Seville (Spain).

Habitat. The area is one with moderate rainfall (up to 900 mm annual precipitation), the soil is

acidic (<6,7 pH), deep (up to 240 cm) and sandy. In the habitat are species representative of cork oak forests from the south of the Iberian Peninsula such as *Arbutus unedo*, *Viburnum tinus*, *Pistacia terebinthus* L., and *Smilax aspera* L.

Characters		*Q. robur*	*Q. ×pastorae*	*Q. suber*
Habit		Tree to 40 m	Tree to 8 m	Tree to 25 m
Bud	Morphology	Ovate	Globose	Ovate
	Bracts	Short-ciliate	Long-ciliate	Pubescent
Leaf blade	Persistence	Deciduous	Deciduous	Perennial
	Size (cm)	5-15(17) × 2-6(8)	(5.5)6-8(9.5) × (1.5)2-4(4.5)	2-8(9.5) × 1-4(5.5)
	Morphology	Lanceolate	Lanceolate	Ovate to ovate-lanceolate
Leaf blade margin	Type	Crenate/Serrate	Serrate	Dentate
Leaf petiole	Size (mm)	0.5-1	(6)7-11	5-9(12)
	Pubescent	Glabrous	Pilose	Pubescent
Leaf blade midrib	Pair number	Up to 11	Up to 10	Up to 7
	Pubescent	Glabrous	Pubescent	Scabrous
Abaxial leaf surface trichomes	Simple	+	+	-
	Uniseriate	+	+	+
	Stellate	+	+	+
	Fasciculate	-	+	+
	Radiate	-	-	-
	Multi-stellate	-	+	+
	Fused-stellate	-	-	+
Adaxial leaf surface trichomes	Simple	+	+	-
	Uniseriate	+	+	-
	Stellate	-	-	+
	Fasciculate	-	-	+
	Radiate	-	-	-
	Multi-stellate	-	-	+
	Fused-stellate	-	-	-
Reproductive state		Fertile	Fertile	Fertile

Table 3/ Morphological and micromorphological characters of *Q. ×pastorae* nothosp. nov. and its parents.

Key for distinguishing *Q. ×pastorae* nothosp. nov., from its parents

1 Leaves persistent, denticulate. Fruits with curved and free bracts..... *Q. suber*
1' Leaves deciduous, crenate to serrate. Fruits with plane imbricated or free bracts 2
2 Petiole (>6mm) pilose, Leaves glabrescent below.
Fruits with free bracts..... *Q. ×pastorae* nothosp. nov.
2' Petiole glabrous, up to 1 mm. Leaves glabrous below. Fruits with imbricated bracts ..... *Q. robur*

5/ *Quercus ×pastorae*

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Appendix 1 (Specimens examined)

SPECIES

***Quercus broteroi* (Cout.) Rivas Mart. & Sáenz de Rivas**

SPAIN (HS): Andalusia: Cádiz (Ca): Arcos de la Frontera - El Bosque, cerca de Arcos de la Frontera, [36°44’52.45’’N 5°34’09.12’’W] 278 m alt., 14 Ago 2003, *A. Coombes, F.M. Vázquez* (HSS 10384). Huelva (H): Santa Ana la Real, bosques de Q. suber en vaguadas profundas muy sombrías, [37°52’07.46’’N 6°43’48.68’’W], 679 m alt., 13 Nov 2000, *J. Blanco, F.M. Vázquez* (HSS 5219). **Extremadura**: Badajoz (Ba): Monesterio, Sierra de Tentudía, [38°04’14.97’’N 6°15’45.80’’W], 740 m alt., 07 Feb 2001, *Salvador, F.M. Vázquez* (HSS 7232). Cáceres (Cc): Villareal de San Carlos, Salto del Gitano, [39°49’41.32’’N 6°02’22.06’’W], 228 m alt., 16 Mar 2006, *S. Aguilar, J. Blanco, M. Gutiérrez, F. M. Vázquez* (HSS 18037).

PORTUGAL (LU): Algarve (Ag): Loulé, Salir, sierra calcárea, [37°15’41.98’’N 8°02’09.11’’W] 410 m alt., 26 Apr 2012, *C. Pinto-Gomes, F.M. Vázquez, C. Villaviçosa* (HSS 54332). **Alto Alentejo** (AAl): Aldeia Velha, zonas de margen de bosque y cultivos, [39°47’51.38’’N 8°16’23.08’’W], 213 m alt., 10 Dec 2011, *L. Concepción, C. Pinto-Gomes, F.M. Vázquez* (HSS 54827). **Baixo Alentejo** (BAl): Odemira, Sao Teotónio, proximidades del cementerio, [37°31’22.13’’N 8°40’41.04’’W], 181 m alt., 20 May 2011, *C. Villaviçosa, C. Pinto-Gomes, F.M. Vázquez* (HSS 50547). **Estremadura** (E): Setúbal, Sierra de la Arrábida, [38°31’29.06’’N 8°58’06.88’’W], 103 m alt., 30 Oct 2010, *J. Blanco, D. García, F.M. Vázquez et al*., (HSS 53553).

***Quercus canariensis* Willd**.

SPAIN (HS): Andalusia: Cádiz (C): Los Barrios, paraje de La Montera del Torero, [36°09’58.84’’N 5°31’32.63’’W], 98 m alt., 20 Nov 2000, *J. Blanco, S. Ramos, F. M. Vázquez* (HSS 26058); Ubrique a Cortés de la Frontera, [36°36’53.06’N 5°25’03.36’’W], 737 m alt., 14 Ago 2003, *A. Coombes, F. M. Vázquez* (HSS 10378). Málaga (Ma): Cortes de la Frontera, [36°35’49.13’’N 5°22’29.17’’W], 675 m alt., 29 Jul 1992, *M. Pérez, F.M. Vázquez* (HSS 3465a).

MOROCCO (MO): Tanger: Chauen, Talassemtane, en bosques de Quercus pyrenaica Willd., Q. suber L. y Q. canariensis Willd., [35°09’06.36’’N 5°10’20.10’’W], 1778 m alt., 15 May 2010, *R. Ferreira, R. Gavilán, C. Pinto-Gomes, D. Sánchez, F.M. Vázquez, B. Vilches* (HSS 49187).

***Quercus coccifera* L.**

SPAIN (HS): Extremadura: Badajoz (Ba): Valle de Santa Ana, [38°21’39.06’’N 6°46’55.32’’W], 497 m alt., 14 Oct 2010, *J. Blanco, M. Cabeza de Vaca, D. García, F.M. Vázquez* (HSS 48789).

PORTUGAL (LU): Alto Alentejo (AAl): Estremoz, Orada, [38°52’11.61’’N 7°28’31.34’’W], 328 m alt., 20 Mar 2010, *F.M. Vázquez* (HSS 44226)

***Quercus marianica* C. Vicioso**

SPAIN (HS): Andalusia: Cádiz (Ca): Ubrique a Cortés de la Frontera, [36°36’53.06’N 5°25’03.36’’W], 737 m alt., 14 Ago 2003, *A. Coombes, F.M. Vázquez* (HSS 10373). Huelva (H): Santa Ana la Real, Bosques de Q. suber en vaguadas profundas muy sombrías, [37°52’07.46’’N 6°43’48.68’’W], 679 m alt., 13 Nov 2000, *J. Blanco, F. M. Vázquez* (HSS 5234). Jaén (J): Santa Elena, parque Natural de Despeñaperros, [38°21’45.78’’N 3°32’58.73’’W], 639 m alt., 30 May 2011, *M. Hervé, A. LeHardy, M. Timacheff, F.M. Vázquez* (HSS 50961). **Extremadura**: Badajoz (Ba): Valle de Santa Ana, [38°20’12.43’’N 6°44’42.02’’W], 512 m alt., en bosques de alcornoques, 30 Jun 2002, *F.M. Vázquez* (HSS 11523). Cáceres (Cc): Alía, La Calera. Parte baja del Collado de Sobacorbas, [39°28’48.79’’N 5°16’54.72’’W], 830 m alt., 21 Jun 2011, *D. García, F. Márquez* (HSS 51233).

PORTUGAL (LU): Algave (Ag): Monchique, Ctr. EN267, Km. 32,4, [37°19’07.68’’N 8°35’20.37’’W], 814 m alt., 20 May 2011, *C. Pinto-Gomes, F.M. Vázquez, C. Villaviçosa* (HSS 50531). **Baixo Alentejo** (BAl): Grândola, [38°09’28.22’’N

8°35’42.24’’W], 186 m alt., 13 Jan 2012, *C. Villaviçosa* (HSS 56732).

***Quercus pyrenaica* Willd.**

SPAIN (HS): Extremadura: Badajoz (Ba): Cabeza la Vaca, sierra de Tentudía, [38°05’24.03’’N 6°22’05.38’’W], 713 m alt., 21 Oct 1994, *M. A. Suárez, M.P. Baselga, F. M. Vázquez* (HSS 1144). Cáceres (Cc): Navatrasierra, ctra. CC20, pto. km. 33,35. Turbera de Hospital del Obispo. Garganta del Hospital, [39°34’42.42’’N 5°20’59.12’’W], 1057 m alt., 26 Jun 2012, *J. Blanco, D. García, F. Márquez, F.M. Vázquez* (HSS 55451).

PORTUGAL (LU): Alto Alentejo (AAl): Ctra. Escorial - Montemor-o-Novo, [38°33’54.96’’N 8°10’10.98’’W] 281 m alt., 08 Oct 2010, *J. Blanco, M. Cabeza de Vaca, D. García, C. Pinto-Gomes, F.M. Vázquez* (HSS 48695). **Baixo Alentejo** (BAl): Évora, Freguises, [38°34’10.90’’N 7°52’46.58’’W] 262 m alt., Oct 2011, *C. Villaviçosa* (HSS 56709). **Beira Baixa** (BB): Fundão, Serra da Estrela, [40°07’38.30’N 7°30’20.23’’W], 686 m alt., 14 Jun 2012, *F.M. Vázquez* (HSS 55055).

***Quercus robur* L. subsp. *broteroana* O. Schwarz**

SPAIN (HS): Extremadura: Cáceres (Cc): Garganta la Olla, Ctra. Garganta la Olla-Cuacos de Yuste. Garganta de Pedro Chate, [40°06’00.32’’N 5°45’02.28’’W], 647 m alt., 03 Oct 2006, *J. Blanco, F.M. Vázquez* (HSS 28172).

PORTUGAL (LU): Beira Baixa (BB): Manteigas, Penhas Douradas, entre Manteigas y Penhas Douradas, Robledal, [40°26’37.01’’N 7°35’58.34’’W], 1168 m alt., 06 Jun 2000, *M. Ladero, S. Rivas Martínez* (HSS 54198).

***Quercus suber* L.**

SPAIN (HS): Extremadura: Badajoz (Ba): Salvatierra de los Barros, [38°28’56.32’’N 6°41’18.81’’W], 684 m alt., 2 Oct 1992, *A. Burzaco, L. Mateos, M.C. Pérez, F.M. Vázquez* (HSS 1282)

PORTUGAL (LU): Alto Alentejo (AAl): Ponte do Sor, Ervideira, [39°13’43.27’’N 8°11’36.90’’W] 175 m alt., 21 Nov 1999, *F.M. Vázquez* (HSS 3855).

NOTHOSPECIES (HYBRIDS)

***Quercus* ×*alentejana* Pinto-Gomes & F.M. Vázquez nothosp. nov**

SPAIN (HS): Extremadura: Badajoz (Ba): Valle de Santa Ana, [38°21’39.06’’N 6°46’55.32’’W], 497 m alt., 14 Oct 2010, *J. Blanco, M. Cabeza de Vaca, D. García, F.M. Vázquez* (HSS 48794).

PORTUGAL (LU): Alto Alentejo (AAl): Lavre, salida a Coruche, [38°46’49.65’’N 8°21’52.23’’W], 125 m alt., 8 Oct 2010, *J. Blanco, M. Cabeza de Vaca, D. García, C. Pinto-Gomes, F.M. Vázquez* (HSS 48733); Montemor o Novo a Arriolos, [38°40’56.49’’N 8°08’00.03’’W] 285 m alt., 26 Oct 2010, *J. Blanco, M. Cabeza de Vaca, D. García, C. Pinto-Gomes, F.M. Vázquez* (HSS 49040 (Holotype)); ibídem, Foros de Vale de Figueira, [38°40’51.09’’N 8°08’02.25’’W] 271 m alt.,, 8 Oct 2010, *J. Blanco, M. Cabeza de Vaca, D. García, C. Pinto-Gomes, F.M. Vázquez* (HSS 48653).

***Quercus* ×*andegavensis* Hy. nothosubsp. henriquesii (Franco & Vasc.) Rivas Martínez & Sáenz**

PORTUGAL (LU): Beira Baixa (BB): Fundão, Serra da Estrela, [40°07’38.30’N 7°30’20.23’’W], 686 m alt., 14 Jun 2012, *F.M. Vázquez* (HSS 55056).

***Quercus* ×*beturica* (F.M. Vázquez, A. Coombes, M. Rodriguez-Coombes, S. Ramos & E. Doncel) F.M. Vázquez, C. Villaviçosa & Pinto-Gomes**

SPAIN (HS): Extremadura: Badajoz (Ba): Valle de Santa Ana, [38°21’41.16’’N 6°46’52.22’’W], 482 m alt., May 1993, *F.M. Vázquez* (HSS 2451 (Holotype); HSS 2452 (Isotype)).

PORTUGAL (LU): Baixo Alentejo (BAl): Odemira, Sao Teotonio, próximo a Espedanas, [37°31’17.65’’N 8°40’40.21’’W], 173 m alt., 20 May 2011, *C. Vila-Viçosa, C. Pinto Gomes, F.M. Vázquez* (HSS).

***Quercus* ×*neomairei* A. Camus**

SPAIN (HS): Extremadura: Badajoz (Ba): Salvatierra de los Barros, Salvatierra de los Barros a Salvaleón. Finca “El Chorrero”, [38°29’27.02’’N 6°44’43.37’’W], 761 m alt., 04 Dec 2009, *J. Blanco, M. Gutiérrez, F.M. Vázquez*, (HSS 43896).

PORTUGAL (LU): Baixo Alentejo (BAl): Cemitério de São Teotónio, São Teotónio, Odemira, [37°31’22.13’’N 8°40’41.04’’W], 181 m alt., 20 May 2011, *C. Villaviçosa, C. Pinto-Gomes, F.M. Vázquez* (HSS).

***Quercus* ×*ordenensis* F.M. Vázquez, García Alonso & Márquez nothosp. nov**

SPAIN (HS): Extremadura: Badajoz (Ba): Guadajira, Centro de Investigación La Orden, [38°51’09.20’’N 6°40’07.93’’W], 213 m alt., 14 Sep 2012, *F.M. Vázquez* (HSS 56533 (Holotype)).

***Quercus* ×*pastorae* M.A.Pineda, F.M.Vázquez & Sánchez Gullón nothosp. nov**

SPAIN (HS): Andalusia: Sevilla (Se): Sanlúcar la Mayor, [37°21’54.47’’N 6°12’01.07’’W], 129 m alt., May 2012, *M.A. Pineda, E. Sánchez Gullón*; (HSS 57709 (Holotype)).

***Quercus* ×*subandegavensis* A. Camus**

PORTUGAL (LU): Baixo Alentejo (BAl): Odemira, Sao Teotónio, proximo a Espedanas, [37°31’17.65’’N 8°40’40.21’’W], 173 m alt., 20 May 2011, *C. Villaviçosa, C. Pinto-Gomes, F.M. Vázquez* (HSS 50583).

Ontario's Eleven: One Man's View

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ABSTRACT

Ontario boasts eleven species of oak, far more than any other province in Canada. The only indigenous oak in Canada that is not present there is *Quercus garryana* Douglas ex Hook. The recent past has been marked by great forest destruction so what may have been a plentiful species in 1800 is, in too many instances, either very rare or even extirpated today. The author reviews the distribution and ecological needs of Ontario's eleven oaks in the context of his personal experience with each of them.

Keywords: ***Quercus alba, Q. ellipsoidalis, Q. rubra, Q. palustris, Q. macrocarpa, Q. prinoides, Q. muehlenbergii, Q. ilicifolia, Q. shumardii, Q. velutina, Q. bicolor***

Introduction

I had posted a few notes as feedback on *International Oaks*, Issue No. 25, on the IOS website forum.[1] Béatrice Chassé had wondered if I might wish to write an article for the IOS Journal. I demurred, but she was persistent. What follows is that article. The qualifier "one man's view" is so that the reader will not mistake me for an expert. My curriculum vitae will reveal four years studying mechanical engineering (and subsequent, miraculous graduation) followed by forty years in software development with IBM. There would be nothing at all about botany via academia.

My learning started at an early age in Hamilton, Ontario (Canada), the former steel town at the western end of Lake Ontario. My maternal grandparents had a large, Tudor-style house about one-third of the way up the Niagara Escarpment. The most significant feature of this limestone cliff, if you will, is Niagara Falls. Water flowing from Lake Erie to Lake Ontario thunders over this part of the Escarpment in unimaginable torrents. I first saw "the Falls" as a child and to this day, many decades later, it never ceases to amaze me. There was a talus slope behind my grandparents' house, and it was covered with trees. Many would have been oaks but my thinking at that age was simple: trees are neat!

1/ The author with a muti-stemmed *Liriodendron tulipifera.*

An epiphany in the Carolinian Zone

Once Linda and I married, bought a house, and had a son, gardening re-entered our lives. What we observed was that some trees purchased from a big nursery did well while others did not. I saw that the keys that almost literally rained down from our two silver maple trees (*Acer saccharinum* L.) sprouted and grew; and by golly, did they ever grow! That piqued my interest, and next was black walnut (*Juglans nigra* L.). Using chicken wire to cover where I had planted the nuts meant that the local squirrels could not abscond with every nut, and so these trees got started off. We kept three and they are now very large and 38 years of age. In 1981, ten years after purchase of house and birth of son, I attended a tree tour hosted by a forestry association. They had an "Honor Role of Ontario Trees" and

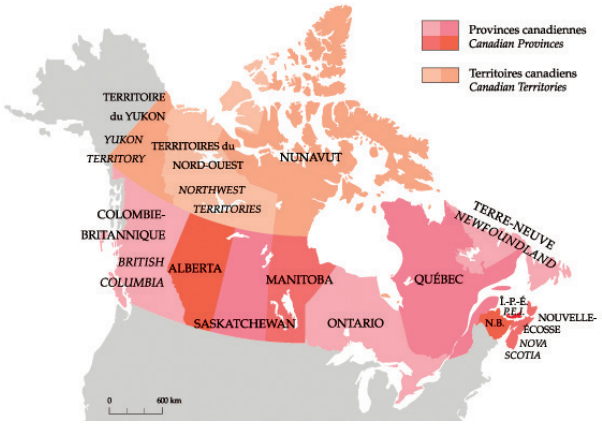
1. http://www.internationaloaksociety.org/content/feedback-international-oaks-no-25

the chap who did all the work to keep this list going was to be our leader. That day was an epiphany for me, and I knew that from now on trees were "my thing." The tour was in what we refer to as the Carolinian Zone of Ontario. If you draw a line from Grand Bend on Lake Huron over to Toronto, and thence hug Lake Ontario to Kingston, south of that line is a region in which trees from further south and further west are found: tulip trees (*Liriodendron tulipifera* L.), cucumber magnolia (*Magnolia acuminata* (L.) L., Shumard oak, the Kentucky coffee tree (*Gymnocladus dioica* (L.) K. Koch) and Shellbark hickory (*Carya illinoinensis* (Wangenh.) K. Koch), for example.

With a big garden – it's pie-shaped and the longest side is about 70 meters/230 feet – we had a large canvas on which to grow trees. And like a kid in a candy shop, once I saw a tree I liked, I wanted one. But how to find them? First, the big box nurseries did not carry many of these trees. But secondly, and far more important, I believe in "pride of place": that is, if a red oak grows across all of the south of the province, I'd like to grow one from acorns found in the naturally forested area of a local wilderness park. Toronto is blessed with three major rivers, the Humber, the Don (with two forks) and the Rouge (from west to east). These river valleys, especially where steep, were never farmed and therefore the majority of trees found there are native and of local provenance. Today, these are all public parkland and so access to these trees is quite easy. The red oak acorns went in at the same time as the black walnuts and the offspring (I kept one) is a splendid, tall tree.

Ontario's Eleven

Let's talk just about oaks now. Ontario, as you will see from my short note in the forum, has 11 species of oak. That is far more than any other province in Canada, so we are indeed fortunate in that regard. In fact, the only other indigenous oak in Canada that we do not have here is the Garry, or Oregon, oak (*Q. garryana* Douglas ex Hook) found in the very southwest of British Columbia. It would be too tender to try to grow here, alas. If you are interested in these oaks and their ranges, I recommend *Trees in Canada* by John Laird Farrar. Amazingly, tree ranges do not start nor end at the border between Canada and the USA, and Farrar follows suit. Another superb book is Guy Sternberg's *Native Trees for North American Landscapes*; if you want poetry in prose, and details that will amaze and delight, this one's for you.



2/ Canada

Southern Ontario is, by and large, limestone-based. Most of the province is, however, part of the ancient Canadian Shield, and therefore soils tend more to the acidic. Oaks in the province can be found through the southern part and well into the Shield area as well. Some are generalists and will grow well almost anywhere. Others are demanding: fail their nutritional demands and these will bid you adieu.

We live in Toronto, and in our central location are found white oak (*Q. alba* L.), red oak (*Q. rubra* L.), and bur oak (*Q. macrocarpa* Michx.). In other parts of the city, where the

3/ *Quercus alba*

soils are lighter, even sandier, is found black oak (*Q. velutina* Lam.). *Q. alba* in our area is being adversely affected; some trees seem immune to whatever the assailant is, while others slowly wane and then perish. Recruitment of this species hereabouts is shockingly low, which bodes ill for the tree and for those of us who love it dearly. *Q. rubra* and *Q. macrocarpa* are common, produce masses of acorns some years, and seem to be thriving. On my walks through the parks it is blindingly evident that recruitment of the former is abundant. 2010 was a *Q. rubra* year with huge numbers of acorns. The next spring I was showing a friend where two large leatherwood shrubs (*Dirca palustris* L.) were. There seemed to be what appeared to be grocer's lettuce growing on this forested hillside. When I got close I whooped with glee: scores of *Q. rubra* seedlings! There was a fallen log, and when the fall and spring rains came, a rivulet washed many of the acorns down the hillside. The log arrested their descent, the acorns germinated, and bingo, new forest! *Q. macrocarpa* also produces many acorns some years but evidence of their sprouting and growth is far from easy to find. Where *Q. rubra*

4/ *Quercus velutina*

and *Q. velutina* are sympatric, hybrids do occur. It is never clear that there will be a hybrid until the acorn that was collected and planted grows, matures, and shows characteristics which are neither pure *Q. rubra* nor pure *Q. velutina*. The latter seems to be quite fussy as to provenance of acorn. In our garden the soil is slightly acidic, but a clay loam: great for market gardening. But *Q. velutina* find it as palatable as would a philosopher a tractor pull.

In far southwestern Ontario two other oak species are found: pin oak (*Q. palustris* Münchh.) and Shumard oak (*Q. shumardii* Buckley). The latter has been identified as an Ontario native only within the past 20 years, and is a sparse, rare find. I arranged with the naturalist group in that area to purchase acorns of both species and now have small trees growing in our garden. *Q. shumardii* – if true – does not disappoint in the autumn when the leaves show fall color. But for most (even my diehard tree-loving friends) Shumard oak is perceived as "just" a red oak. The *Q. palustris* acorns that I received along with the *Q. shumardii* acorns were left in a cardboard container at our door one day when I was at work. When I arrived home, quite oblivious to the delivery, I saw a few acorns scattered outside the front door. If you know our Eastern grey squirrels (most here are of the melanistic type), you will know who chewed the package open. They left me maybe 20% of the original set of acorns. My reaction, as I did have some acorns left to grow, was one of amusement and, frankly, admiration for these little devils. *Q. palustris* is rarely planted in Toronto these days as the trees need moist to wet soils with some acidity to them; many become yellowish-green in leaf color due to chlorosis. Will ours follow suit in time? We shall see. This species is also found in a narrow band along the Niagara River and it is splendid in that location. Some of the galls on these trees are so large they must be seen to be believed.

Q. shumardii has been reported as growing in the hinterlands west of the Niagara River but there is no agreement on that score. My friend George Meyers brought me acorns from these trees 25 years ago, and they grew into tall, robust specimens. But the fall color is far from the Shumard red, and the leaves vary considerably (but then, is that not true of almost every oak?) from "true" *Q. rubra* leaf-form to "true" *Q. shumardii* leaf-form. So the jury is out on this lot.

5/ *Quercus shumardii*

Our next oak: northern pin, or Hill, oak (*Q. ellipsoidalis* E.J. Hill) is an oak of the Midwest and upper Midwest in the USA. In Ontario, it creeps across the border west of Lake Superior. For many years it was there and there alone that I believed it was found in Canada. Some years later I read a report that stated with

certainty that *Q. ellipsoidalis* was found in the glacial moraines and kames which ran south from Paris (that would be the Ontario version) and Brantford down toward Lake Erie. When one is exposed to such a claim, the reaction is somewhere between "Holy cow!" to "I don't believe it!" But the claim is quite true. There are magnificent, mature specimens which I have seen in this area, and from which I have collected acorns. Now if any oak in Ontario captures my soul it is this one. But like the prom queen, she don't do my bidding. Every single *Q. ellipsoidalis* I have ever tried growing in our garden has been slow to grow, and within a year the leaves are chlorotic and shriveled. Would it were not so, but reality bites.

6/ *Quercus prinoides*

7/ *Quercus muehlenbergii*

There is another oak that is found in only a few locations in the province, all within the Carolinian Zone. That is what our tree crew refer to as "Dco's", or dwarf chinquapin oaks (*Q. prinoides* Willd.). They prefer very dry conditions, or can do well in xeric soils where other trees would not. Though it is reputed that they require acidic soil, in our garden the leaves are a lustrous dark green and the trees thrive. The first ones I planted, grown from acorns, flowered, in their seventh year of life. They are a precocious tree and one I recommend for the oak lover with a smaller garden. Here, only native plant nurseries carry these gems. One anomaly I observed when we visited the Brantford stand in autumn is that the leaf color can be burgundy, very similar to what is seen in *Q. ellipsoidalis*. At other sites, and certainly here in our garden, leaves have red veins and petiole in fall, but the color of the leaf itself is at best a caramel shade, attractive yet not showy.

Closely related to dwarf chinquapin oak is the chinquapin oak (*Q. muehlenbergii* Engelm.). It is a calciphile, so is very happy in the southern part of the province. Unlike its dwarf cousin, this tree can attain a substantial size. Hamilton is found in the Dundas Valley which in turn is formed as the Niagara Escarpment does a slow, 180

degree turn; where it commences at the Niagara River below the Falls, it runs due west. Then, after its lazy turn, it runs almost due east for a short spell, and then north to northwest, through the Bruce Peninsula (home to myriad native orchids) and eventually into Wisconsin. East of the Niagara River the Escarpment runs just south of the south shore of Lake Ontario into New York State. So the Dundas Valley, with all the calcium locked up in the limestone of the Escarpment, makes for ideal growing conditions for *Q. muehlenbergii*. One time the tree crew was hiking through the talus slopes along the north side of the Dundas Valley and we came across what we thought was a very large *Q. alba*. But looking up, we saw those almost chestnut-like leaves, a rich brown as it was autumn, and remarked that this must be the largest *Q. muehlenbergii* in the whole valley. Acorns of these oaks, as well as those of the dwarf version and of *Q. palustris* are of a size to make blue jays (the avian kind, not those who play baseball) drool.

One of the delights of the European settlers when they came to "Upper Canada" in the early 19th century, as Ontario was then known (Quebec being "Lower Canada") was the rich farmland. The history from then until relatively modern times has been the annihilation of the forests to obtain more agricultural land. So, what may have been a plentiful species in 1800 is, in too many instances, either very rare or even extirpated today. This situation might account for there being no chestnut oak (*Q. montana* Willd.) or scarlet oak (*Q. coccinea* Münchh.) for Canadians to claim as native trees: pity. *Q. coccinea* was reported in the late 19th century as growing in the Niagara Peninsula.[2] But there is great skepticism – to put it mildly – as to the existence of these trees in the province.

Swamp white oak (*Q. bicolor* Willd.) is found in southern Ontario, about as far north as Toronto. I have found that despite the "swamp" in its name it can do well even with far less than soggy soils. The one in our garden tells me that it is quite pleased with what it finds here, and thanks very much for that. The long acorn pedicel is close to a necessary and sufficient condition for recognizing this oak if one is in Ontario. The indumentum on the underside of the leaf is also a sure sign in distinguishing it from that other long-pediceled-oak *Q. robur* L. or English oak, not native of course, but unfortunately planted in some quantity, even by trained city foresters.

The final species in "Ontario's Eleven" (hmm, could make a great movie with that title!) is bear oak (*Q. ilicifolia* Wangenh.). This is a scrubby oak and was identified as being native to the province within the past 20 years or so. It is found on the Canadian Shield just north of where the Shield runs south – through and under the St. Lawrence River – into New York State. A chap phoned me once and was after *Q. coccinea* acorns. These trees are planted (far too infrequently) here and I knew where one was so agreed to send him a few acorns. He asked me if I wanted anything in return. I said that I thought not and then he said what about *Q. ilicifolia* acorns? Not listed in any field guide as occurring here I thought, "What oak is that?" As soon as he said what it was, and that it was growing where he lived, I changed my mind instantly. He sent me acorns and I wish I could tell you that the rest is history. One and only one has done well here and it is planted in our regular garden soil, versus the acidic soil that would be found on the Shield. The shrub grows slowly, and I have learned that chicken wire is necessary as a fencing to reduce rabbit predation over winter. Rabbits never used to be a problem here

2. The Niagara Peninsula is that portion of southern Ontario that lies between the south shore of Lake Ontario and the north shore of Lake Erie. The presence of *Q. coccinea* is reported in the *Catalogue of the Niagara Flora* published in 1888 By David. D. Day.

8/ ***Quercus ilicifolia***

but they are now everywhere. These days, on bicycle rides along the paved trails in the river valleys one must be attentive for rabbits and, of late, deer. So may this specimen of *Q. ilicifolia* live long and prosper.

In closing, I would tell you that oaks have always appealed to me, as a child and as an adult. During the years when I did woodworking/cabinetry as a hobby, oak was one of the mainstays of that craft: tough, easy to work (unlike bird's-eye maple!),[3] and lovely when finished. And of course oenophiles treasure oak, used traditionally and still today, to make the barrels for aging wine.

Photographers. Title page: Guy Sternberg (*Quercus bicolor*). Photo 1: Tom Atkinson. Photos 3-7: Guy Sternberg. Photo 8: Béatrice Chassé.

Further reading

Day, David D. *Catalogue of the Niagara Flora*. Troy: The Troy Press Company. 1888.
Farrar, John L. *Trees in Canada.* Ontario: Fitzhenry & Whiteside. 1995.
Sternberg, Guy. *Native Trees for North American Landscapes.* Oregon: Timber Press. 2004.

3. Bird's-eye maple is not a distinct species of maple, but rather a figure occasionally found in *Acer saccharum* Marshall resembling small bird's eyes and caused by lack of light. The maple attempts to start numerous new buds to capture more sunlight, but the new shoots are aborted, leaving a number of tiny knots.

Oaks and the Biodiversity They Sustain

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ABSTRACT

The present article describes the biodiversity sustained by oak trees and shrubs, both aboveground and below. They support mammals (e.g., deer, monkeys, rodents, flying squirrel and bears), birds (e.g., jays and woodpeckers); gall-forming and other herbivorous insects, parasites, weevils that depend on oak acorns, and ants that colonize remains of the acorn shells; numerous epiphytes including lichens, bryophytes, ferns, and orchids; semi-parasites that in turn support a variety of birds and fruiting fungi both ectomycorrhizal and non-ectomycorrhizal; earthworms, springtails and others. Oaks also provide fodder for livestock, firewood for cooking, tools for agricultural activity and leaves for fertilizing fields. In India, in terms of natural coverage, no other genus matches *Quercus*.

Keywords: oak leaf, acorn, epiphyte, soil, oak gall, lopping, forest ecosystems

Introduction

The genus *Quercus* is one of the most important groups of woody plants in many regions in the Northern Hemisphere (Nixon 2002). It also contains the most economically useful trees, providing high quality timber, firewood, tannins for leather, natural dyes, long-lived horticulture shade trees, wildlife habitat, food for animals (leaves and acorns) and even food for human beings (acorns are still eaten in parts of Asia) (Nixon 2009). In comparison to other forests such as pine, oak forests are characterized by higher species diversity, stratification, litter production, and soil fertility (Shrestha 2003). The bole and branches of mature oak trees support a luxurious growth of nonvascular (e.g., bryophytes) and vascular (e.g., orchids) epiphytes. Sultana and Khan (2000) reported about 382 species of birds from the oak forests of Kumaun Himalaya, India. Many oaks are keystone species without which the complex web of the ecosystem cannot be completed. Their presence has been related to the quality and quantity of spring water. In the Indian Himalayas, oak forests are the basis of age-old subsistence agriculture (Bargali et al. 2013; Pande et al. 2012; Bargali et al. 2014).

Aboveground

Life on leaves

Oak leaves provide food to a wide variety of animals. Because of their wide range over diverse habitats and their plentiful and tasty leaves, oaks have become the target of many, many organisms (Singh et al. 2005). The oak leaf-blotch miner (*Cameraria agrifoliella* Braun.) and live oak ribbed case-maker (*Bucculatrix albertellia* Busck) are two common moths that feed on the leaves of American oaks. *Tortrix* sp., *Dasychira* sp., *Medasina albidaria* Walker, and others, feed on Himalayan oaks when they are young. In both cases the early caterpillar stage is a green larva that feeds exclusively on the softer tissues such as palisade and spongy parenchyma that are confined between the two epidermal layers of a leaf blade. Oak moths cause more damage to oak leaves than other organisms. Often larvae appear in such great number that they can defoliate a tree. *Phycita*, *Acrobasis*, *Cryptoblaus*, and *Endotricha* are the names of some other moth genera whose larvae can appear in sufficiently large numbers to seriously damage the tree canopy.

1/ The *Quercus rysophylla* Weath. caterpillar in Mexico.

In the Chinese and Indian Himalayas silk worms have been raised on oaks for centuries; apparently the caterpillars have a preference for their leaves.

Fungi, particularly mildews, grow vigorously when tender new leaves are subjected to humid conditions; they can cover entire leaf surfaces in a white powder. The main feeding body of these fungi remains inside the leaf tissue, digesting it continuously, while the conidia at the surface are dispersed to other vulnerable leaves.

In addition, there are many mammals that make oaks an integral part of their diet: deer, cattle, sheep, monkeys, langurs and agoutis are some of them. New oak leaves are vulnerable to browsing by deer. In mature oak, branches are high beyond the reach of the tallest deer, but saplings and seedling are severely browsed. This in turn poses a threat to oak regeneration. In regions where the forest is regularly used for browsing by cattle, oaks fail to regenerate (Singh et al. 2005; Bargali et al. 2013) as severely browsed saplings and seedlings cannot replace mature trees when they die. All the Himalayan oaks are regarded as good fodder species and are thus heavily lopped for stall-feeding of cattle, particularly in winters when little green fodder is available. Humans also use oak leaves in different ways. In the Himalayas, for example, leaves are harvested for cattle fodder and for raising silkworms, and leaf litter is used to manure crops.

Life on acorns

Acorns provide a major portion of the food supply of a vast array of wildlife: Hanuman langur (*Semnopithecus entellus* Dufresne), red giant flying squirrel (*Petaurista petaurista* Link), mule deer (*Odocoileus hemionus* Rafinesque), acorn woodpecker (*Melanerpes formicivorus* Swainson), turkey (*Meleagris gallopavo* L.), and wild pig (*Sus scrofa* L.) It has been estimated that acorns constituted up to half the diet of most tribes of California Native Americans (Pavlik et al. 1991). Acorns of all species of oak may be stored and eaten (Koenig and Haydock 1999). A list of organisms that feed on acorns is given in Table 1. There are numerous weevil species[1] that infest acorns of Himalayan oaks (Kalia 1988; Bora 1989). The two most common and important are *Sitophilus glandium* and *Dicranognathus nebulosus*, which mainly infest acorns of *Q. leucotrichophora* A. Camus. Kaushal et al. (1993) reported that 83.7% of *Q. leucotrichophora* acorns and 5.6% of *Q. floribunda* Lindl. ex A. Camus acorns were infested by these acorn weevils in Nainital, India. *D. nebulosus* attack acorns both on the tree and on the ground, whereas *S. glandium* infest only those on the ground. The weevil bores a long cylindrical hole into the acorn where it lays an egg and then passes to the next acorn for a repeat performance. After some time, worm-like larvae hatch that feed on the acorn. The larvae eventually shove their way out of the acorn for the next stage of life.

2/ Mule deer enjoying *Quercus grisea* Liebm. acorns in Texas.

1. The common name "weevil" refers to a group of insects spread across seven different families in the super family *Curculionoideae*.

If the acorn has not been completely consumed by the weevil's larva, the acorn moth (*Valentina glandulella* Riley) may lay eggs on what is left of the acorn embryo. The larvae will either stay inside the acorn throughout the winter season emerging only in spring but they may also die within the acorn and end up serving parasitic wasps that lay their eggs on the decaying larvae. If they remain alive they eat their way out and proceed to their next stage of development. At this point the acorn embryo dies and several saprophytes including snails, beetles, and mites feed on the acorn's rotting remains. Various fungus spores also enter the holes and grow inside. When all the soft material has been eaten and the acorn shell lies empty, many ants begin new colonies inside these snug, waterproof homes. Finally, the acorn's shell will be fragmented and broken down by soil bacteria and fungi, providing nutrients for the tree (Keator and Bazell 1998).

Some animals benefit oaks by dispersing their acorns. The most important among these are the rodents and birds that harvest acorns for food but bury them in caches for later use. Of all these, the jays (several genera in the family *Corvidae*) of the Northern Hemisphere (including Mexico and Central America) play one of the most precise and interesting roles in the life of an oak. Many species of jay make acorns the main staple of their diet. Scrub jays, such as the Western scrub jay (*Aphelocoma californica* Vigors) and others of Southwestern North America, may depend on the success of an acorn harvest for rearing their young. Troup (1921) described that in Shimla (India) jays stayed throughout the winter and by the time they left not many acorns remained on *Q. leucotrichophora*. The distribution of jay species and their diversification coincides closely with the distribution and diversification of oaks. The two areas of the world most noted for their great variety of oaks, Southeast Asia and Mexico, are also areas of high jay diversity.

Other animals, including cattle, langur, pigs, deer, wild turkeys, bear, monkey and woodpeckers may play a less positive role in the life of an oak tree. The life of an acorn woodpecker (*Melanerpes formicivorus* Swainson), for example, is intimately associated with oaks (Koenig and Haydock 1999). These birds have a unique method of storing acorns in trees that they transform into "storage trees" or granaries. Thus one can see old trees with their trunks riddled with thousands of carefully drilled holes each occupied by an acorn. Since the acorns are stored well above the ground and diligently pounded into the holes of the granary, they seldom fall out to germinate and grow into new trees.

Human beings throughout the world have found many uses for acorns. For example, *Q. leucotrichophora* acorns are used as a diuretic, to treat gonorrhea, as an astringent for indigestion, and to cure diarrhea especially in children.

The epiphyte community

A number of plants including lichens, bryophytes, pteridophytes, orchids, and some other flowering plants live on oak trunks and branches. Epiphytes favor oak bark because there is less competition (in relationship to the bark of other trees) for resource utilization, better light, and higher oxygen circulation for their roots. The density of epiphytes on oak depends on bark texture and chemistry, both of which vary from species to species. Most oaks, particularly of the White Oak group, have crevices, furrows and troughs providing a larger surface to support a great number of epiphytes.

In mountain climates oak trees often host luxuriant growth of a wide variety of epiphytic lichens. There are thousands of species that present a wondrous array of shapes: flattened and blade like (foliose), branched and twiggy (fruticose), or crust forming and

inseparable from the bark they cover (crustose). In a site-specific study Sah (1995) reported 13 species of lichens from trunks and branches of *Q. leucotrichophora*. However, assessments at a regional scale suggest that oak forests may support more than 100 species of lichen. Lichens do not harm their host in any way: in fact some of them are beneficial. Recent evidence suggests that some of the nitrogen that lichens fix, is shared with the host (Bates et al. 2011).

3/ *Aphelocoma californica*

Lichens are the first plants to colonize the fresh bark of young oak trees and when they die their decomposing bodies provide nutrients to the bryophytes that follow. Among the first new settlers are the leafy liverworts and mosses that form bright green cushions on the damp base of trees. Mosses grow as tufted bunches of leafy branches with a spongy texture. Leafy liverworts[2] also grow in the form of dense mats. Joshi (1993) reported a higher number of epiphytic bryophytes (17) on *Q. semecarpifolia* Sm. in comparison to other associated species (14 on *Aesculus indica* (Wall. ex Cambess.) Hook., and 15 on *Abies pindrow* (Royle ex D. Don) Royle) in a high-altitude forest (2,500-3,000 m/8,200-10,000 ft) in Western Himalaya. Tewari and Pant (1994)

4/ *Melanerpes formicivorus*

2. Bryophytes in the class *Hepatopsidae*.

reported about 85 species of epiphytic bryophytes associated with the Himalayan oaks *Q. leucotrichophora, Q. floribunda, Q. lanuginosa* D. Don[3], and *Q. semecarpifolia*. These bryophytes have no adverse effect on oak trees but when wet during the rainy season can weigh several kilograms. Such a great weight spread over a large oak tree adds to its burden and may cause it to keel over during an intensive windstorm.

Oak trees also support a large number of pteridophytes, mostly ferns. Khullar (1981) reported that the pteridophytes form an important component of the Himalayan flora with both ground and epiphytic ferns. He also suggested that the nature of tree bark, altitude, and forest composition play important roles in the distribution and frequency of epiphytic ferns. In the Himalayan region Tewari (1995) reported 12 epiphytic fern species on *Q. leucotrichophora* and *Q. floribunda* and 4 on *Q. semecarpifolia*. Indeed, the highest species diversity was observed on tree trunks with rough-textured bark (as is the case for the three oaks mentioned above) that provide large surfaces accompanied by high humidity and heavy moss cover. When it rains these epiphytes also benefit from stemflow that provides them with extra nutrients (Tewari 1995). In general, the frequency of epiphytic ferns declines with increasing elevation (Khullar 1981), possibly because of low temperature accompanied by high wind velocity. At high elevation (2,500-3,000 m/8,200-10,000 ft), *Q. semecarpifolia* appeared to be a good host for some epiphytic ferns like *Araiostegia pseudocystopteris* (Kunze) Copel., *Polypodiodes microrhizoma* (C.B. Clarke ex Baker) Ching, *Lepisorus kashyapii* Mehra[4], and *Drynaria mollis* Bedd.

Some parasitic flowering plants, most commonly mistletoes (*Loranthus* spp.) of which there are 1,200 species, also grow as epiphytes on oak trees. These mistletoes are semi-parasites i.e., they still photosynthesize, but have lost the ability to absorb water

5/ *Loranthus* sp in *Quercus cordifolia* in Mexico.

3. Considered a synonym of *Q. lanata* Sm.

4. The accepted name for this species is *Lepisorus mehrae* Fraser-Jenk.

and minerals from the soils. Most have taken to the air, perched high in the crowns and branches of trees, and their roots have been converted into massive sucking organs (haustoria) that pierce and penetrate the bark. Inside the tree the haustoria fan out into the tree's conducting tissues to suck water and minerals. Some of these haustoria are so large that they cause a conspicuous swelling of the branch. Mistletoes with conspicuous tubular flowers and tasty nectar attract a variety of birds in different regions of the world (humming birds in America, sunbirds in tropical Africa and Asia, and honeyeaters in tropical Australia and Southern Asia). Other mistletoes, especially those that infest oaks in Temperate North America and Europe (*Phoradendron* spp. and *Viscum album* L.), do not have conspicuous flowers. A few parasites on a healthy oak tree do little damage, but on old or weakened oaks, flourishing mistletoe can further weaken the tree and lead eventually to death. Semi-parasites have expanded in the Himalayas due to of the lopping of branches that creates easily penetrable cut surfaces and allows for greater light penetration in the understory that in turn encourages the growth of semi-parasites.

Galls and associated life

Galls are unusual deformations and outgrowths of plants that are caused by a wide variety of organisms including bacteria, virus, fungi, and insects. Oaks are common hosts to gall-forming insects (Ronquist and Liljeblad 2001); indeed they harbor more kinds of galls than all other plants combined (a list of common oak galls is given in Table 2.). One highly specialized group of insects, the cynipid wasps (family *Cynipidae*) are responsible for the majority of oak galls. The gall is produced by the oak in a complex reaction to the saliva produced by the feeding larva. About 82% (roughly 1,300 species) of cynipids use oaks for their home (Ronquist and Liljeblad 2001; Zargaran et al. 2012). Many species are host-specific but not all, and some are often restricted to one particular part of the tree at one particular time of the year. Galls can be found on every conceivable part of an oak, even on roots and acorns. White Oaks host the greatest number of gall species, with *Q. douglasii* Hook. & Arn. harboring the most lavish diversity of them all (Keator and Bazell 1998). Not much has been studied on the galls associated with Himalayan oaks.

Oak leaves are host to several species of gall. One of the most common is the silk button gall of *Neuroterus numismatis* Olivier with which the underside of oak leaves is frequently studded. The galls are tiny flat discs with a central depression. They are fixed to the leaf by only a filmy stalk which makes it easy for them to be detached. Another leaf gall is the spangle gall produced by *N. quercusbaccarum* L. This galls is larger than the previous ones and is purplish brown with a concave center. Two other gall wasps are the cherry gall wasp *Dryophanta scutellaris* L. and the hop gall or artichoke gall wasp *Andricus fecundator* Hartig. Both of these species exhibit an alternation of generations in their reproduction (as is the case with most of these species). In contrast to the minute galls of the first two species mention above are the large, conspicuous apple galls that occur on many members of the White Oak group. Midges (*Bainidiplosis championi* Mani) form galls on *Q. floribunda* trees.

The hedgehog galls of the Eastern white oak (*Q. alba* L.) form on leaves when the female wasp *Acraspis erinacei* Beutenmüller lays her eggs on the young leaves in spring. These green, spine-encrusted galls are round to oblong and develop on both sides of the leaves. There are also several jumping galls (*Neurotarus saltatorius* Edwards) in different parts of the United States. California's magnificent valley oaks (*Q. lobata* Née)

6/ *Neuroterus saltatorius* Edwards
7/ *Andricus quercuscalifornicus* Bassett in *Quercus lobata* Née.
8/ *Disholcaspis plumbella* L. in *Quercus berberidifolia* Liebm.
9/ *Heteroecus dasydactyli* Ashmead in *Quercus chrysolepis* Liebm.

are host to one of them. Appearing on the leaves, these tiny, glossy brown, spherical galls generally occur in large numbers. Unlike most galls they complete their development on the ground as they fall off the leaves. The galls "jump" about each time the larva inside flips its body.

None of these galls present a serious problem to the mature oak that has learned to live with them for a long time, but when too numerous on young saplings they can diminish their strength.

Although known in Southern Europe for several hundred years, the Knopper gall wasp *(Andricus guercuscalicis* Burgsdorff) was first reported in England in the second half of the 20th century. During summer the galls of the asexual generation appear on the developing acorns of *Q. robur* L. and can grow to such an extent that they cover the entire acorn, sometimes resulting in as much as 90% acorn mortality. The galls of the sexual generation develop in spring on the male inflorescences of *Q. cerris* L., a species not indigenous to England.

All of these galls provide food for a wide variety of other animals, mostly predacious insects. The acorn woodpecker supplements its diet of oil-rich acorns with protein-rich wasp grubs. Galls may host filbert worms (*Cydia latiferreana* Walsingham) and other wasps, some of which parasitize the host wasp, while others eat the food stores of the gall itself. Galls produced on *Q. serrata* Murray are a good source of tannin (16-21%).

Belowground life

Soils under oaks sustain a large number and great variety of organisms. These range in size from visible creatures, such as slugs, snails, millipedes, woodlice, and larger insects, to microscopic life, such as bacteria, fungi and algae. Bacteria are among the most abundant of the soil denizens and they are crucial in the chain of life as their function is to break down organic substances. Fungi of many types are important soil inhabitants and include numerous molds and mildews besides the mycelia of larger fungi such as mushrooms. Molds feed on decaying organic matter, absorbing and recycling the proteins and carbohydrates in plants and animal residues. When they die they are metabolized by bacteria, liberating accumulated nitrogen and other important components that can be used by other organisms. Some fungus hyphae show symbiotic association with oak roots (mycorrhizal association). This symbiosis increases the absorption surface of roots and is vital in the capture of certain soil nutrients that the trees would not otherwise be able to absorb. Pande (unpublished data) reported 40 genera and 102 species of sporocarp-forming fungi in the oak forests of the Indian Central Himalayan region. Of these, 40 species are known to have mycorrhizal associations with oak trees. *Phoma hibernica* Grimes, M. O'Connor & Cummins, and *Cladosporium cladosporioides* (Fresen.) G.A. de Vries are two of the common pioneer species that initiate succession on leaf litter in Himalayan oak forests.

Among the microarthropods found in Himalayan oak-forest litter *Acarina* is the dominant genus, contributing 60-73% of the total litter fauna population (Singh and Singh 1992). Most numerous of the arthropods are the *Acarinae* or mites. They live predominantly on decaying vegetable matter but some also on decaying animal matter, including animal droppings. They thus perform a useful service in recycling the debris that falls to the ground. In Himalayan oak forests the most numerous (30% of the total population) soil microinsects belong to the genus *Collembola*, commonly known

as springtails (Singh and Singh 1992). These have elongated, segmented bodies with prominent antennae and are useful recycling agents as they feed on both plant and animal residues.

Of the larger fauna in the soil beneath an oak the most prevalent are the earthworms that plow through the decaying vegetable matter on which they largely feed. Other soil inhabitants include millipedes, woodlice, the larvae of numerous insects, slugs, snails, and ants. Some of them live on vegetable matter while some are carnivores. In general they are an important food source for larger and more advanced forms of animal life such as birds. Oli and Gupta (2000) reported 10 species of snails and 3 species of slugs from Central Himalayan oak forests. An oak forest in Central Himalaya supports far more belowground life than an adjacent pine forest, even when all other factors are similar.

Threats to oaks and the diversity they sustain

The economical and ecological value of oaks is generally higher than those of other woody species associated with oaks. There is a very strong relationship between oak forests and human activity and this poses a threat to *Quercus* species in different regions of the world. Pressures on oaks have increased due to the rapid increase and spread of population, increasing land value, the development of practices and machinery for clearing range land, channelizing streams, road building, and urban development. In the Indian Himalayan region, the subsistence economy is dependent on energy and nutrient input from forests. Chronic disturbance caused by biomass removal – lopping of trees for fuel wood and leaf fodder – is the dominant disturbance in these forests particularly in the vicinity of villages (Singh and Singh 1992). According to Singh and Rawat (2010) there are very few patches of intact oak forests left in the Himalayan region today and those that do remain intact are changing rapidly due to alien invasive species such as *Eupatorium adenophorum*, Hort. Berol. ex Kunth[5], *Lantana camara* L. and more aggressive species such as *Pinus roxburghii* Sarg. In many areas, where *Q. leucotrichophora* was the primary species it is giving way to *P. roxburghii* as a result of heavy lopping of the former. Heavy lopping also results in poor acorn production. Thadani (1997) reported that in areas of heavy lopping, acorn production was low, and many trees had almost no acorns. Zobel et al. (1995) and Zobel (1996) reported that in *Q. leucotrichophora* forests, one-year old twigs had lower starch levels in heavily disturbed forest stands in comparison to less disturbed stands. This indicates that sparse foliage of lopped trees may result in a deficiency of stored starch with no surplus available for acorn production.

Litter removal from the forest floor (used as fertilizer) changes the microclimate that acorns are exposed to once they fall, and this reduces acorn viability. The removal of litter from forests leads to a deficit of soil nutrients. Soil carbon and nitrogen are significantly lower in areas subject to human disturbance particularly where leaf litter is collected. Soil phosphorus is also lower in areas subject to heavy litter removal.

The nutritional richness of acorns makes them tempting targets for rodents and birds that hide them for times of scarcity. In the Central Himalayas as much as 90-100% of the acorn crop can be destroyed by mammal herbivory (Anonymous 1928). Troup (1921) reported the destruction of a promising acorn crop in Shimla by jays in 1916. Thadani (1997) reported that in the Kumaun region the 1997 crop was severely depleted by jays that came into the area in November and feasted on the unripe acorns. While the birds can

5. This is an unresolved name.

eat only a limited quantity of acorns, the intensive feeding activity causes an even greater amount to fall to the ground. In a poor seed year an entire crop can be destroyed this way thus restricting regeneration. Oak seeds are also attacked by a number of weevils that cause serious damage: Bora (1989) reports as much as 70-80% with *Q. leucotrichophora*. Weevil infestation is reported to be about 50% higher in disturbed *Q. leucotrichophora* stands than in the adjacent undisturbed stands (Upreti et al. 1985).

Fires are also a threat to oak forests. Fire can kill the stem outright or cause feathering along the stem from epicormic branching. Fire-damaged stems are especially susceptible to pathogens which weaken the tree and result in wind throw and breakage. The damage may immediately or eventually reduce the economic value of a tree. The most common fire damage is a basal wound caused by death of the cambium. As time goes by new cambium may eventually cover a wound. However, if decay is active and old cambium of the wound face is destroyed the growing cambium may curve inward and back on itself forming a wound that may remain open for many years. Subsequent fires may enlarge the wound until all that remains of the trunk is a thin partial ring of live wood at which point the tree may be too weak to face another stressful situation. Many of these wounds can also be infested with various insects, creating further damage.

Healthy forests and healthy trees contribute to many things that are lost due to disturbance: wildlife enhancement, watershed protection, recreation, and aesthetic value are among the most important.

Photographers. Title page: Guy Sternberg (*Acraspis erinacei* Beutenmüller). Photos 1-5: Béatrice Chassé. Photos 6, 8, 9: Ron Russo. Photo 7: Emily Griswold.

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Taking Oaks to the Limit in the Czech Republic

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ABSTRACT

The Plaček Quercetum in Kanín, comprises to date about 200 taxa of the genus *Quercus*. Extreme winter cold, severe and frequent late frosts, 600 mm/24 in of rain annually, and very hot summers set the stage for this ambitious collection started by Dušan Plaček in 2008. The Průhonice Dendrologická Zahrada, Prague's young botanical garden, headed by Mr. Zdeněk Kiesenbauer, started their oak collection in 2010. The search for hardy plants is a priority for both, and indeed one could say it is the leitmotiv of horticultural history in the Czech Republic.

Keywords: Plaček Quercetum, oak hardiness, Průhonice Dendrologická Zahrada

Introduction

Dušan Plaček is a man who likes a challenge and for this particular one he must bring to bear all of his implacable optimism and enthusiasm to battle the odds. Is it even imaginable to want to have an oak collection in a place where winter starts early and ends late, bringing with it deep snow and ice, and temperatures habitually around -20/-25 °C (-4/-13 °F) though sometimes as horrific as -29°C/-21 °F? And then of course there are the severe and very frequent late frosts in May that damage sometimes beyond repair the growth of many trees. On his side, in addition to his exuberance and inexhaustible energy, there is the light, sandy soil and deep ground water that encourage strong, deep root-growth, very hot summers, and a very good team.

Since the first plantings in 2008, several hundred oak trees representing about 200 taxa have been planted. The successes – and the failures – continue to fuel Dušan's determination and strategy. Over a three-day period, Dušan presented to me not only his "old garden" and his new Quercetum but also the places and people that were – and still are – instrumental in the conception and development of this collection.

1/ Dušan Plaček and *Quercus imbricaria* (Průhonice Park).

Love at first sight: Quercus imbricaria *Michx.*

Those of us who met Dušan for the first time at the 6th International Oak Society Conference in Puebla, Mexico, or at the 7th IOS Conference in Bordeaux, France, will have also met his two genial friends and close collaborators, Josef Souček and Ondřej Fous. Together, the three of them are indeed the backbone of the collection in Kanín, united by friendship, a great interest in the genus *Quercus* and their equal commitment to the Plaček Quercetum.

"Between 1998 and 2006, when I bought the house and the land, I did some renovation of the old garden but did not really devote much time, although the idea of doing something here was always in the back of my mind. I thought to myself that many decades before me someone planted in the old garden all of these trees that I am now enjoying, and so I too must plant trees so that decades from now someone else will be able to enjoy them. 2006 was a pivotal year because it was then that I met Ondřej (landscaper and horticulturist) and Josef (dendrologist)." Ondřej, impressed with the site and its uniqueness, quickly convinced Dušan that there were vast possibilities to create something special. A collection? Dušan's first choice was for *Fagus* to which Ondřej

replied, "That would be good…*Quercus* would be better." Once the decision was made, Josef thought indispensable to take Dušan on an excursion that would include both parks and natural populations in the Czech Republic and in Slovakia so that he could get a better idea of what was hidden behind the word "oak".

Their first stop was the 240-hectare/618-acre Průhonice Park (12 km/8 mi from Prague and 70 km/44 mi from the Plaček Quercetum) founded in 1885 by Count Arnošt Emanuel Silva-Tarouca. Although it is the conifers in this park that first attract one's attention there are many magnificent old oaks including specimens of *Q. robur* L., *Q. palustris* Münchh. *Q. rubra* L. and an absolutely magnificent *Q. velutina* Lam. On his first visit though, none of these caught Dušan's eye as much as a nice, medium-sized *Q. imbricaria*. Perhaps because it was the beginning of what he was to discover about the incredible variation in oak leaf, habit and acorn during this initiatory journey: what? that's an oak?!!

When we visited Průhonice Park at the end of my first day here we were pleased to see some recently planted *Q. macrocarpa* Michx., *Q. acutissima* Carruth., *Q. trojana* Webb, *Q. castaneifolia* C.A. Mey, and *Q. montana* Willd.

Silva Tarouca Research Institute

Through Josef's influence, developing a collection of high botanic value with plants raised from wild-collected seeds is a major goal. To this end, Dušan has financed or contributed to financing several expeditions including to Turkey, Mexico, China, Vietnam, and Taïwan. Before the construction of his greenhouse the acorns that resulted from some of these adventures were raised for him in the various greenhouses of the Silva Tarouca Research Institute for Landscape and Ornamental Gardening in Průhonice. Still today, he

2/ *Quercus velutina* (Průhonice Park).

shares his seed with this Institute one of whose missions is to propagate historical plants of the Czech Republic. For example, the only *Q. marilandica* (L.) Münchh. growing in the Czech Republic (before the collection in Kanín) died during the terrible floods in 2009. Cuttings were quickly taken and today dozens of them are happily growing in the Institute's mist unit, and will be planted out in different locations sometime in the future. Mr. Jiří Obdržálek, in charge of the propagation activities at the Institute, kindly showed us around the facilities, giving us the chance to observe the growth of many oak seedlings from around the world as well as to marvel at the enormous variation in the many *Quercus cerris* L. seedlings that are growing here from seeds collected by Josef and Dušan during their two trips to Turkey.

Before we left, Mr. Obdržálek offered Dušan a gift of *Cupressus vietnamensis* (Farjon & T.H. Nguyên) Silba. raised from a scion grafted on *Cupressus nootkatensis* D. Don. This species, from Vietnam, was described in 2002 by A. Farjon, Nguyen Tien Hiep, D. K. Harder, Phan Ke Loc and L. Averyanov as *Xanthocyparis vietnamensis*.

With this precious gift safely stowed in the trunk of the car, and accompanied by Ondřej Fous who had joined us earlier, off we went to our second stop of the day.

Průhonice Dendrologická Zahrada

Created in 1974, this young garden is also a part of the Silva Tarouca Research Institute and as such the main focus is on studying the hardiness of ornamental and horticultural plants that can be used in Czech landscapes and gardens. Many different breeding programs are run including for rhododendrons, tulips, roses, and weigelas. Recently several very successful rhododendron cultivars have been made available: 'Kokorin', 'Karlstejn', and 'Orlik' (all names of Czech castles); as well as several tulip cultivars: 'Gavota', 'Rajka', and 'Havran'

The Director of the Dendrologická Zahrada, Mr. Zdeněk Kiesenbauer, whom I had met in 2010 when he came to visit the Arboretum des Pouyouleix with Dušan and Josef, greeted us at the main entrance. An extremely jovial and enthusiastic man, Mr. Kiesenbauer is justifiably proud of what has been accomplished here in 40 years. With 12 gardeners (out of a total staff of 20) this 74-hectare/183-acre garden that harbors nearly 8,000 woody plants and perennials is simply extraordinary: beautifully designed, impeccably well tended, and botanically and horticulturally fascinating. From 6,000 visitors 10 years ago, the garden attracts today over 36,000. As the Dendrologická Zahrada receives only a little under 300,000 € from the government annually, public interest in, and commitment to, the garden is essential. Educational activities, exhibitions and other programs are continually being developed to ensure the future of this unique site, registered in 1994 as Significant Landscape Element by the Czech National Council.

3/ Průhonice Dendrologická Zahrada.

The oak collection (currently including a little over 100 taxa) is quite young, started only four years ago and the accent is on hybrids and cultivars. It starts in the northeast corner of the garden, just after the *Fagus* collection. The planting scheme is to develop an "oak road" that will wind through the entire garden. Significantly, this road of oaks will go through what has been identified as the hottest and driest part of the site (the only place here where *Actinidia deliciosa* (A. Chev.) C.F. Liang & A.R. Ferguson, for example, is hardy) in hopes that some of the more fragile oaks will prosper.

4/ *Quercus* 'Zehra' (Dendrologická Zahrada).

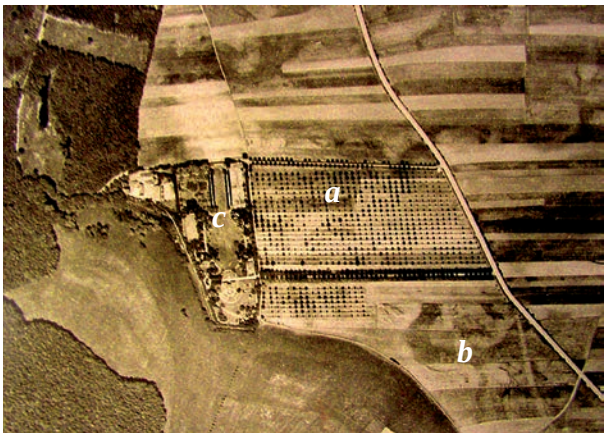
Here are just a few of the oaks of this collection that caught my attention. *Quercus falcata* Michx. × *rysophylla* Weath. 'Zehra' with the thick, rough texture of *Q. rysophylla* and the falcate leaf of its other parent. Although this name is presently only provisionally accepted (because originally published without a description) it is nonetheless a very nice tree. *Q.* ×*tridentata* Engelm. ex A. DC., the hybrid between *Q. imbricaria* Michx. and *Q. marilandica* Münchh. with very shiny leaves and a reddish hue to the midvein is doing very well here. Another very attractive tree, with bicolored young leaves, reddish orange at the distal end fading to a yellowish green near the petiole, was labeled as *Quercus* ×*saulii* 'Montalba' (hybrid between *Q. alba* and *Q. montana*). The correct published name for this cultivar is, however, 'Atlas' (Jablonski 2007). 'Montalba', never published, is not a valid name, although it is still in use in some nurseries and gardens.

Leaving the garden and walking through the oldest part, Mr. Kiesenbauer points out a clump of *Q. robur* L. trees that represent the remains of what used to be a very extensive forest. Although these trees are over 200 years old they are only about 15 m/50 ft tall, growing in a spot where there is only 1-2 cm/0.4-0.8 in) of soil under which is gravel and solid rock (cambisol).

It is nearly five o'clock when we take leave of Mr. Kiesenbauer and the Dendrologická Zahrada, as well as of Ondřej. And suddenly we realize that since I had arrived at around ten o'clock we had done nothing but talk about, look at, and nourish ourselves with, trees!

The "old garden" in Kanín

Dušan was born in the town of Poděbrady in 1973. While growing up Dušan was surrounded by people raising plants: his maternal grandmother had a garden and talked to him about her plants, using their exotic scientific names; his grandfather, who was an auto mechanic, had a greenhouse in which he indulged in developing his passion for orchids; and, finally, his father raised fish and aquatic plants for aquariums. During the political changes that occurred in the communist world after 1989, Dušan saw a potential to develop his father's hobby and decided to turn it into a real business that today represents a vast network of wholesale, retail and e-commerce outlets for a wide range of pet products in several countries.



5/ Aerial photograph of the property in 1947. Today the Quercetum occupies a and b, and the old garden, c.

With his business headquarters in Poděbrady, it was quite natural, when he decided to buy a house in 1998, to want to stay in the neighborhood. Kanín is 9 km/6 mi from Poděbrady and the land he purchased there was originally owned by Antonín Švehla, one of the most influential politicians of the First Czechoslovak Republic (1918-1938). He served as the first Minister of the Interior (1918-1920) and went on to serve twice as Prime Minister (1922-1926; 1926-1929). The house was built in 1918 by Švehla's daughter who was married to Josef Černý, Minister of the Interior from 1934 to 1938. When the communists came to power the family fled to Canada and France, and the property was appropriated by the State. Between 1939 and when Dušan purchased the house and surrounding grounds, the house had served many different purposes but the garden (today called the "old garden") had been left to its own devices. It was designed by Josef Kumpán, a leading landscape designer in Czechoslovakia at the time. Some examples of his work in the Czech Republic include the Rose Garden in Petřín (1932) and Jubilee Park in Znojmo (1928). In 2006 Dušan and Ondrej found archives containing the original drawings, aerial photographs and plans of the garden as it was in 1938. Thanks to these archives, the results of fifty years without a gardener could be evaluated, providing invaluable information on how to undertake the restoration.

The old garden covers about 2 ha/5 ac and faces north. The oak collection proper is not planted here but in adjacent meadows to the southeast, covering, in its actual layout, 11.5 ha/28.5 ac. These are part of about 40 ha/100 ac of land adjacent to the house and old garden that Dušan acquired after the initial purchase of the house. An impeccable lawn stretches out in front of the house across 200 m/700 ft (in its widest part 100 m/300 ft) and is bordered on either side with stately trees planted more than 80 years ago as well as with some new plantings that are part of the restoration which included removing about 70% of the old trees. The greenhouse, built in 2013, is at the very northern end of the lawn, with, to the west, the outdoor nursery and an impressive vegetable garden.

6/ *Q. pontica* K. Koch.

Part of the old garden is on the other side of the house, a sheltered area with woods on one end and the house on the other. This is where we start our tour on this second day of my visit. A magnificent *Fagus sylvatica* L. 'Purpurea' steals the show to be sure – but there are also many interesting young

oaks. *Q. rugosa* Née (from seed) has flourished in three years, surviving two winters with temperature lows of -26 °C/-15 °F and one fairly mild winter at only -16 °C/3 °F during which it did not lose its leaves. *Q. ilicifolia* Wangenh., a *Q. dentata* Thunb. of the Pinnatifida Group, a magnificent *Q. pontica* K. Koch (grafted) that has grown more than a meter in three years, and *Q.* ×*hispanica* 'Ambrozyana' Simonk., are some of the oaks planted in this relatively protected spot.

This last cultivar was named after *Count István Ambrózy-Migazzi*, a Hungarian nobleman of the Austrian Empire. Author, with Camillo Schneider, of several standard dendrology works in German (still important today), he is also the founder of the well-known Botanic Garden of Jeli. His first creation however was a garden in Malonya, near Nyitra, that was destroyed during the Second World War. His passion for botany was driven by his desire to seek out and propagate plants that would be evergreen in the tough Czechoslovakian climate. He understood that soil conditions and the concept of plant communities were important factors in plant hardiness. From the seedlings he raised he eventually propagated two oaks that are, if not evergreen, usually semi-evergreen in an average Czech winter. The first one was described in 1909 by Simonkai as *Q.* ×*hispanica* 'Ambrozyana', and the second one, *Q. pubescens* 'Migazziana' was described by Jablonski in 2006.

7/ *Q.* ×*hispanica* 'Ambrozyana' Simonk.

Before we skirt around the house to arrive on the main lawn of the old garden, my attention is drawn to some other notable plants growing quite happily here: *Magnolia acuminata* (L.) L., *Nothofagus antarctica* (G. Forst.) Oerst., *Ulmus laevis* Pall. and *Taiwania cryptomerioides* Hayata that has survived three winters, one with temperature lows of -26 °C/-15° C.

With the main lawn now in front of us, Dušan explains that the key issue in restoring this garden was deciding which of the big trees needed removing so that the garden could evolve with the new plantings that would provide for its future. At the time the garden was created, in addition to the (still very) popular *Fagus sylvatica* L. 'Purpurea', it was quite common to plant native North American trees and these are still fairly represented amongst the big trees that remain today (*Abies grandis* (Douglas ex D. Don) Lindl., *Pseudotsuga menziesii* (Mirb.) Franco, etc.).

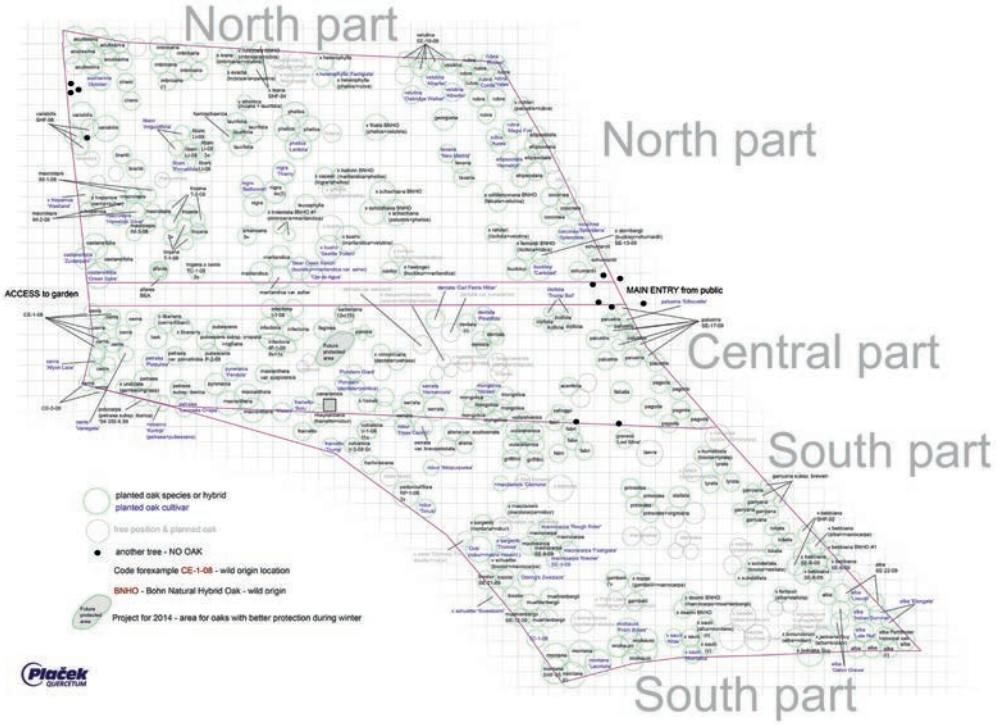
A majestic *Q. rubra* L. to the left of the house spreads its branches as though pointing to another tree, *Q. robur* (Heterophylla Group) 'Pectinata' Hort. ex Kirchn., a very old cultivar named in 1864. As we walk along the path that borders the right side of the main lawn we pass through what remains of a small poplar grove planted before Dušan's time that is gradually being transformed by local birds into a *Q. cerris* L. grove. Over time, as the poplars have died, birds have brought acorns from the adjoining woodland and planted them in the poplar trunks. Apparently, it is only to this spot in the garden that the birds bring the acorns.

It was rather astounding to compare the enormous variation between these *Q. cerris*,

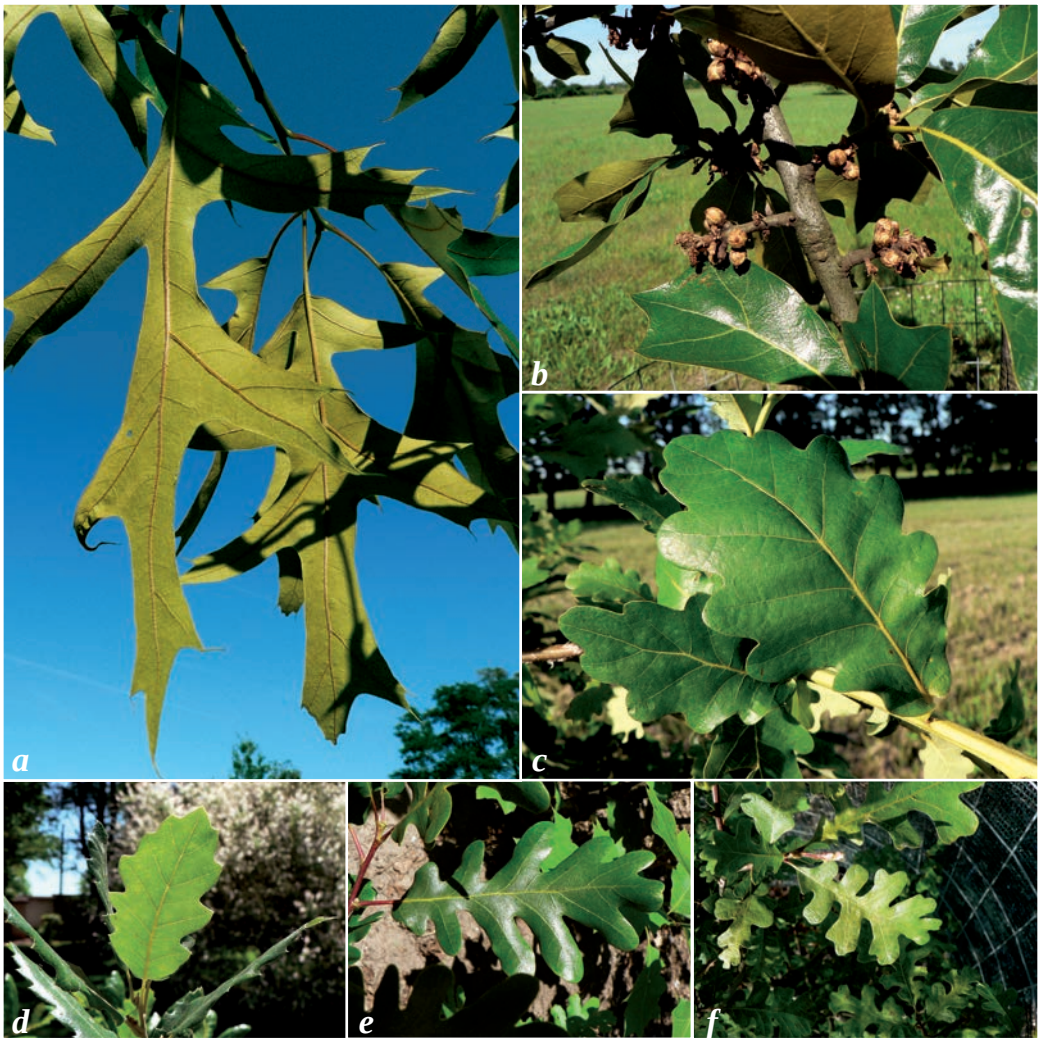
the ones seen this morning grown from seed collected by Josef and Dušan in Turkey, and the ones we will have seen in the Quercetum at the end of this day. Although Mme Camus rejected as individual variations the sixteen species created by Mr. Gandoger she herself creates or retains six varieties (Camus 1936-38). Today all six are considered synonyms of *Q. cerris* by most authors.

A grafted *Q. robur* × *turbinella* Greene is growing nicely, showing off pretty, red new growth even though it is perhaps in more shade than it would ideally like. But this is intentional: much as the *Q. coccifera* L. and *Q. ilex* L. seen previously, planting under the shelter of larger trees offers the plants some protection from the cold. Throughout this area of the garden are signs that Dušan did not entirely abandon the idea of constituting a *Fagus* collection: many fine specimens of this genus are to be admired. Before taking a break, we visit the outdoor nursery where there are many plants of *Q. vulcanica* Boiss. & Heldr. ex Kotschy (grafted, scions collected in Turkey), *Q. dolicholepis* A. Camus, *Q. macrocarpa* Michx., *Q. trojana* Webb, *Q. libani* G. Olivier and others. After a quick foray into the mysteries of the Czech language wherein *dub* means oak, *dubař*, oakman, and *žalud*, acorn, off we go to lunch and a well-deserved cold drink of Becherovka (made with 20 herbs macerated for two months in sugar and water resulting in this 38° proof rather interesting drink). The weather has been nothing but blue sky, and a hot, bright sun (34 °C/93 °C) will surely be waiting for us for this afternoon's visit. I think to myself that it would be interesting to come back in the wintertime….

The Quercetum



8/ Plaček Quercetum.



9/ a) *Quercus* ×*wildenowiana* b) *Q. marilandica* c) *Q.* ×*vilmoriniana* A. Camus d) *Q.* ×*hispanica* 'Ambrozyana' e) *Q. vulcanica* f) *Q. lobata*.

The oak collection proper occupies land to the east and south of the house and old garden and resembles roughly the shape of Florida. It is crossed at about a third of its length by a 300 m/1,000 ft driveway, lined with *Robinia pseudoacacia* L. trees, that leads to the house from the main road.

The landscape aspect of the Quercetum has been an important consideration since the beginning. The choice to base the planting strategy and design on the classification system developed by Adolf Engler (1844-1930) and Karl A. E. Prantl (1849-1893) was an esthetic one. In their system, species are grouped based on similarity in leaf shape. Engler and Prantl produced a 20-volume work, *Die natürlichen Pflanzenfamilien* (1887-1899), published by a Leipzig publisher, W. Engelmann (a slightly revised version was produced by Engler in 1964, *Syllabus der Pflanzenfamilien*, and published by the Berlin

10/ *Q.* ×*schochiana* Dieck

publisher, Gebrüder Borntraeger).[1] They divided the genus *Quercus* into three subgenera: *Cyclobalanopsis*, *Erythrobalanus* with four sections *(Phellos, Nigrae, Rubrae* and *Stenocarpae)*, and *Lepidobalanus* with seven sections *(Cerris, Suber, Ilex, Gallifera, Robur, Alba* and *Dentatae)*.

Entering the Quercetum from the northwest we are in subgenus *Lepidobalanus*, section *Cerris*. Planted around two or more individuals of a botanic taxon are their various hybrids and cultivars. For example, the first group of four trees includes two *Q. castaneifolia* C.A. Mey and two cultivars: 'Zuiderpark' Coombes & Jablonski, and 'Green Spire' Hillier & Sons. Not far away, the typical *Q.* ×*hispanica* Lam. is planted along with its well-known cultivar 'Waasland Select' Jablonski. Included in this "island" are also *Q. libani* G. Olivier (and 'Angustifolia' Dippel), *Q. ithaburensis* subsp. *macrolepis* (Kotschy) Hedge & Yalt. (and 'Hemelrijk Silver' J. Hillier & Coombes) *Q. acutissima* Carruth. (and 'Gobbler' Dirr), *Q. trojana* Webb., *Q. afares* Pomel and, of course, many *Q. cerris* L. (along with 'Afyon Lace' Coombes & Jablonski). The theme of this oak collection – a botanic taxon planted with all or a selection of its cultivars and hybrids – is an idea that promises an interesting future.

Obviously the cultivars and (most of the) hybrids are grafted. Each botanic taxon is often represented by both grafted trees and those grown from seed. The experience here, as elsewhere, is that grafting seems to be less successful with the Red Oaks than with the White Oaks.

The six other White Oak sections spread out to fill up most of the central and all of the southern part of the Quercetum whereas the Red Oak sections occupy most of the north sector with a small area descending into the central part to host the tail end of the *Rubrae* section species (*Q. ilicifolia* Wangenh., *Q. palustris* L., *Q. acerifolia* (E.J. Palmer) Stoynoff & W.J. Hess, *Q. gravesii* Sudw.). As yet, there are no *Cyclobalanopsis* planted. Still in the northern area of the Quercetum, moving east, we are in *Erythrobalanus* territory, with three (*Phellos, Nigrae* and *Rubrae*) of the four subsections well represented by many, many trees. A lone specimen of *Q.* ×*filialis* Little (the hybrid between *Q. phellos* L. and *Q. velutina*) stands symbolically between sections *Phellos* and *Rubrae*.

According to Dušan, the Red Oaks have the hardest time. It is true that the White

1. This system, that was never very widespread, is not used today for purposes of classification. It was used by Gerd Krüssmann in his *Manual of Cultivated Broad-Leaved Trees & Shrubs* (Krüssmann 1978).

Oaks, like *Q. michauxii* Nutt., *Q. bicolor* Willd., *Q. gambelii* Nutt., and *Q. montana* that are often slightly to very unhappy trees in many places in Western Europe (there are exceptions to this of course) seem to rather enjoy Czech weather. A laciniate form of *Q. montana* was showing off brilliant green foliage and Q. ×*saulii* C.K. Schneid. (*Q. alba* L. × *montana*) new growth of velvety orange. Extremely healthy and vigorous *Q. lobata* Née was remarkable to see and *Q. canariensis* has done well for 6 years, never suffering winter damage. Undeniably, many of the Red Oaks show signs of bark splitting at the base, but a great majority of the trees here are in good health if not fast growing.

Future directions

The construction of the greenhouse, finished in 2013, marked the commitment to raising plants from wild-collected seeds in order to gradually replace, for the botanic taxa, trees planted earlier that are either grafted or from seed of unknown or garden origin. The planting philosophy is "plant many to cut many". There are currently about 2,500 seedlings in the greenhouse, more than 99% of which are oaks, some of which are more than 5 years old and already quite large. Obviously, Dušan is reluctant to introduce many of the Mexican oaks to the Czech winter, but he does have a plan…

11/ The greenhouse (Plaček Quercetum).

According to Ondřej Fous, in the Czech Republic, as in other places with extremely cold winters, horticulturists have developed techniques to cultivate non-hardy fruit trees.[2] Although there are variations, the main idea is to dig a trench (between 1-1.5 m/3-4.5 ft deep) in which the trees are planted and can then be easily protected during winter by filling the trench with organic or inorganic material for insulation. This technique is going to be tried in Kanín for the Mexican oaks.

The harsh cold spell of February 2012 in Northern Europe occasioned many surprises about hardiness. *Q. liebmannii* Oerst., for example, that survived -18 °C/0 °F for a prolonged period in an arboretum near Brive-la-Gaillarde (France). A 3-year old *Q. alnifolia* Poech in a garden near the city of Grenoble, that went unscathed at -19 °C/-2 °F; a *Q. leucotrichophora* A. Camus in the Dordogne region of France that survived -18 °C/0 °F, and a *Q. myrsinifolia* Blume did fine at -24 °C/-11 °F in the Creuse

2. It is very difficult to find documentation on this subject. See, http://www.citrusy-trutnov.mstu.cz/w09/soubory_10/transej.htm; http://www.tropichukvaldy.cz/clanky-a-navody/pestovani-rostlin-v-transeji

(center of France) (Roux 2014). In Kanín, *Q. hemisphaerica* Bartram. has been doing well for a number of years and both *Q. dolicholepis* A. Camus and *Q.* ×*undulata* Torr. have survived two winters planted in the outdoor nursery (where they are protected and thickly mulched).

Whenever I think about the history of hardiness the first thing that I think of is "A plant is hardy until I kill it." I have always attributed this pearl to Peter Smithers but as is often the case with such "great quotes", this one has been adopted, modified, and repeated by so many others, that the author's identity as well as the exact initial form of the quote are often obscured. In a recent conversation, a friend quoted someone else as being the author to which I replied, but no, Peter Smithers is the author – which we both thought more probable for chronological reasons. But when I went to check exactly what Peter Smithers had written what a shock it was to discover that he is not the author either! He himself had received this wisdom in response to a question about hardiness asked to a *Rhododendron* subsection Maddenni specialist, a response that he found to be "scathing but perfectly correct". It would be interesting to get to the bottom of this one day…

On the same subject, Dan Hinckley said to me a few months ago, "It is, in the end, three or four days every ten years that determine what you can grow in your garden." This may very well be true, but in the meantime, we all dream a little and try a lot. By exploring the limits of oak hardiness in the tough Czech climate the Plaček Quercetum's resident quercophiles are continuing in the footsteps of numerous Czech plantsmen by investigating the limits of hardiness and plant adaptability in this part of the world.

We spent the better part of the third day with Josef Souček checking all of the impeccably labeled and preserved herbarium samples that he had collected during his recent trip to China (for a full report, see *Oak Adventures in China,* pp. 89-96). There are still some mysteries to be resolved on that front.

Acknowledgements

I am grateful to Dušan Plaček for his hospitality, and to all of his collaborators for having taken the time to make my visit so interesting. My thanks to Eike Jablonski and Ryan Russell for clarifying some issues about cultivar names and their history.

Photographers. Title page: Béatrice Chassé (*Quercus imbricaria*). Photos 1-11: Béatrice Chassé. The aerial photograph and map of the Plaček Quercetum reproduced courtesy of Dušan Plaček.

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Oak Adventures in China September 24-October 27, 2013

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Introduction

China is one of the two great centers of diversity for the genus *Quercus*, ranking second only to Mexico in terms of number of species.

According to the Flora of China, there are 35 species in section *Quercus*, of which 15 are endemic, and 69 species in section *Cyclobalanopsis*, of which 43 are endemic.

Deciduous species are more suitable for the conditions prevalent in Central Europe (Hardiness Zones 5 and 6) but some section *Quercus* evergreen oaks, mainly from suitable provenances (higher altitudes and harsher climates), could flourish under these conditions in sheltered locations. At least 17 species never previously cultivated in Central Europe are worthy of consideration. Ten of these are deciduous and at least 7 are strictly evergreen. In the Czech Republic, long-term successful growth is probably wishful thinking with the *Cyclobalanopsis*. Certain species do stand a chance in theory, but others will need to be in a conservatory or greenhouse over the winter months.

1/ *Cathaya argyrophylla*, a rare endemic.

Getting started

The four-week expedition was to cover an area crossing the provinces of Guangxi, Guizhou, Yunnan and the municipality of Chongqing, where the diversity is substantially higher than anywhere else in China. The actual pinpointing of the locations was performed with a range of maps, both in hard-copy format and using Google Earth online resources. The publications *Oaks of Asia* (Menitsky 2005), Flora of China (Part 3) and a number of other subtexts were selected as the basic dendrological tools.

Securing a car and a driver required a series of meetings, as did the identification of a translator to take part in the expedition. International driving licenses are not valid in China and it is very difficult to get hold of driving licenses for foreigners. After much deliberation, we opted for four main stops at roughly five-day intervals and adapted the route to those stops. The stops that constituted the nodal points of our itinerary were planned to ensure that we would have the opportunity to investigate in thorough detail relatively well-preserved sites with documented occurrences of certain species of oak and other trees.

The "giant panda of the plant kingdom"

At the start of our route we selected a special stop at a location where a highly prized conifer grows: *Cathaya argyrophylla* Chun & Kuang.[1] This very rare, and according to

1. *Cathaya argyrophylla* is a relict conifer that had a much wider distribution in the geologic past. Its taxonomic position has been the subject of some dispute in the past, but recent phylogenetic studies in the *Pinaceae* have confirmed its status as a genus, probably related to *Pseudotsuga* in a pinoid clade.

the IUCN Red List, vulnerable, species is endemic to China and only grows in a few locations. One of the largest populations is to be found in a wildlife reserve in Huaping in the northeast of Guangxi Province near the town of Longsheng. This "giant panda of the plant kingdom" was first recorded in the area in 1958. This is the largest site where it grows (several other smaller sites have been found elsewhere in Central China) and it has been under strict protection since 1978. In the end our efforts to gain access to the reserve were successful. We came across this rare species on a rocky ridge, bathed in sunlight, above a ribbon of evergreen and deciduous trees.

Species from the genera *Lithocarpus*, *Castanopsis*, *Cinnamonum* and *Schima* made up most of the stands along with more isolated specimens of the deciduous *Sassafras tzumu* (Hemsl.) Hemsl., *Liquidambar formosana* Hance, *Fagus longipetiolata* Seemen *Rhus* sp., *Acer* sp., *Stewartia* sp., and many others. Shrubs from various genera such as *Lespedeza*, *Schefflera*, and *Corylopsis* were also abundant. Herbaceous plants worthy of mention included in particular flowering *Anemone hupehensis* (E. Lemoine) E. Lemoine[2], *Macleaya* sp., and *Codonopsis* sp. In the rocky locations where *Cathaya* is found, one is also likely to come across *Pinus wangii* subsp. *kwangtungensis* (Chun ex Tsiang) Businsky[3] and even *Fokienia hodginsii* (Dunn) A. Henry & H.H. Thomas as well as various species of large-leaved *Rhododendron* and other woody species from the family *Ericaceae*.

Specimens of *C. argyrophylla* grow here in sparse clumps or as solitary specimens with the above-mentioned species. Many of these trees are very old (estimated 150 years) but there were younger specimens and saplings to be seen. Higher up from the *C. argyrophylla*, we encountered small groups and whole stands of *Quercus annulata* Sm. These were merely shrubs at the highest, most windswept points at approximately 1,800 m/5,900 ft above sea level. Here and there, other species, including what we thought to be *Q. semiserrata* Roxb., were also present.

2/ *Quercus annulata*

In Guizhou

The first stop dedicated to oaks was in a karstic landscape between the counties of Dushan and Libo, in Guizhou Province. The area is densely covered with limestone mogotes (that can reach heights of 950-1,000 m/3,100-3,300 ft) on which there are very well-preserved stands, primarily on upper sections, attained after battling through the *Miscanthus* and various thorny creepers and shrubs. Many woody plants here are growing from stumps, having been felled approximately 30-50 years ago. But one can also find

2. This is an unresolved name.
3. Considered a synonym of *P. wangii* Hu & W.X. Cheng.

3/ *Quercus setulosa* showing its elegant acorns and characteristic flaky bark.

specimens that have never been cut; as is customary in China, these are often very close to villages, virtually right behind the last houses.

Evergreen stands can be found at lower altitudes and are a mix of *Liquidambar formosana*, *L. acalycina* H.T. Chang and *Eucommia ulmoides* Oliv. At higher, less disturbed levels, *Q. thorelii* Hickel & A. Camus and *Q. delavayi* Franch. can be found.

Amongst the true oaks the dominant species is *Q. setulosa* Hickel & Camus with its very flaky, and highly decorative, bark. The height of the trees ranges from 3 to 10 m (10 to 30 ft), depending on exposure, and they were fruiting abundantly. At the uppermost levels, specimens of *Q. phillyreoides* A. Gray. are present sporadically.

On the peaks are abundant specimens of *Pinus kwangtungensis* subsp. *varifolia* Nan Li & Y.C. Zhong[4], *Fokienia hodginsii*, *Sorbus folgneri* (C.K. Schneid.) Rehder, *Taxus* sp., *Carpinus* sp., *Ostrya* sp., and on north-facing slopes, *Torreya grandis* Fortune ex Lindl., *Platycarya* sp., *Acer* sp., *Rhus* sp., etc. Herbaceous plants here include, for example, *Asarum* sp. and *Epimedium* sp. In a number of towns *Q. variabilis* Blume was growing amongst the paddies together with *Castanopsis* sp., *Q. hypargyrea* (Seemen ex Diels) C.C. Huang & Y.T. Chang and *Castanea mollissima* Blume. Alongside the paths between villages there are old specimens of *Cupressus funebris* Endl. with their slightly weeping foliage.

The next major stop was near the Tiansheng Bridge in Liupanshui District. Nearby there are limestone (karst) formations and ridges with a sandstone substratum. Our research focused on part of the karst near the Tiansheng Bridge and 15 km/9 mi to the south in a sandstone massif above the small town of Suobujia, 40 km/25 mi northeast of Liupanshui (altitudinal range: 1,700 to 2,000 m/5,500 to 6,500 ft). There were isolated stands as well as dense populations of, in particular, deciduous species of oak, including many hybrids.

4. Considered a synonym of *P. fenzeliana* Hand.-Mazz.

4/ Near Tiansheng Bridge.

The primary species found here were *Q. serrata* Murray and *Q. yunnanensis* Franch.[5] and their hybrids. There were also sporadic specimens of *Q. dentata* Thunb., *Q. acutissima* Carruth., and *Q. aliena* Blume. It seemed to me that many of the *Q. aliena* that we saw were hybrids. Amongst the evergreen section *Quercus* oaks we found a number of specimens of *Q. engleriana* Seemen and *Q. senescens* Hand.-Mazz. The *Cyclobalanopsis* present here included *Q. hypargyrea, Q. lamellosa* Sm., and perhaps *Q. xanthotricha* A. Camus.

There was also considerable diversity of other genera of evergreens including *Cornus macrophylla* Wall., *Euptelea pleiosperma* Hook.f. & Thompson, *Stranvaesia davidiana* Decne.[6], and many different species of *Lithocarpus, Castanopsis, Michelia, Camellia, Cinnamonum, Aesculus, Celtis, Corylus*, etc., as well as many *Magnoliaceae*. The conifers that we noted include *Pinus armandii* Franch., *Tsuga chinensis* (Franch.) Pritz., and *Juniperus* sp.

On the sandstone substratum we came across *Zelkova serrata* (Thunb.) Makino, *Davidia involucrata* Baill., a number of species of *Rhododendron*, *Lyonia compta* (W.W. Sm. & Jeffrey) Hand.-Mazz., and other *Ericaceae*, as well as different species of *Viburnum* and *Tetradium.*

Areas rich in species diversity were not easy to find: much of the landscape has been transformed into agricultural fields and pastureland or, in some places, into plantations of *Cryptomeria japonica* (Thunb. ex L.f.) D. Don or *Pinus yunnanensis* Franch.

In Yunnan

Our third stop was in Yunnan Province near the border with Sichuan Province in the mountain massifs in Qiaojia County. The mountains here rise fairly steeply from the

5. Considered a synonym of *Q. dentata* subsp. *yunnanensis* (Franch.) Menitsky.
6. Considered a synonym of *Photinia davidiana* (Decne.) Cardot.

5/ a) *Q. longispica* b) *Q. guyavifolia* c) *Q. dolicholepis*.

Yangtze River up to 3,000 m/10,000 ft above sea level. The landscape at lower altitudes, to at least 1,000 m/3,000 ft above sea level, is intensively farmed. The southern slopes of the central parts of the mountains are bedecked with *Pinus yunnanensis* (evidently of secondary origin). Previously felled evergreen woody plants are gradually taking over the areas between the stands. The steeper northern slopes are often covered with forests comprising deciduous and evergreen species. The upper sections are covered with grass and only scattered evergreen and deciduous species of shrubs.

At lower and medium altitudes there are various species of the genera *Castanopsis* and *Lithocarpus*. As the altitude rises one also finds deciduous *Q. variabilis* and *Q. aliena* together with various species of *Cyclobalanopsis*. Higher up, at approximately 2,000 m/7,000 ft, the dominant species are *Q. longispica* (Hand.-Mazz.) A. Camus, *Q. guyavifolia* H. Lév., *Q. rehderiana* Hand.-Mazz. On north-facing crags at approximately 2,000 m/7,000 ft *Q. dolicholepis* A. Camus is present. At the uppermost altitudes, approximately 2,100 m/6,900 ft, scattered specimens of *Q. monimotricha* (Hand.-Mazz.) Hand.-Mazz. can be found. Nearly all of the species that we found were fruiting. The majority were older specimens, ranging from 80-100 years old. The oaks do not generally dominate the area but instead grow in small groups or as isolated individuals.

The other predominant species of woody plants in the area at or above 1,800-2,000 m/5,900-7,000 ft include the following: *Pinus armandii* and *P. yunnanensis*, *Spiraea*

veitchii Hemsl., *S. sargentiana* Rehder, *Abelia* sp., *Rosa* sp., *Berberis* sp., *Cotoneaster* sp., *Acer* sp., *Photinia* sp., *Rhododendron* sp., *Rubus* sp., and *Philadelphus* sp. On the northern slopes, representatives of the genera *Tilia, Carpinus, Acer,* sometimes *Keteleeria,* and others can be found. Notable amongst the many species of herbaceous plants are *Anemone hupehensis, Rodgersia pinnata* Franch., *Begonia* sp., various ferns, *Polygonatum, Arisaema,* etc. One of the locality's unique dendrological curiosities is *Pinus squamata* X.W. Li, probably the world's rarest pine, native only to this locality where there are more than 30 adult specimens. It probably does not exist in cultivation outside of China.

Jinfo Shan Nature Reserve

The last site we visited was the Jinfo Shan Nature Reserve in the Chongqing Municipality. Unlike the previous localities, Jinfo Shan is a nature reserve with all the pros (very well-preserved stands of various species) and cons (total tourism industry) that this sort of attraction brings in China. The nature reserve is situated in a limestone area, rising to an altitude of approximately 2,000 m/7,000 ft above sea level. The core of the reserve features an enormous variety of deciduous and evergreen species of broad-leaved trees. Conifers are relatively rare here.

6/ *Q. monimotricha* growing with *Pinus densata* var. *pygmaea*.

At lower altitudes, 1,000-1,500 m/3,000-4,900 ft, species such as *Q. variabilis* and *Q. fabri* Hance grow in the predominantly deciduous forest, along with oaks from section *Cyclobalanopsis* and different representatives of the genera *Lithocarpus* and *Castanopsis.* The other species found here include *Liquidambar formosana, Euptelea pleiosperma, Nyssa sinensis* Oliv., *Sassafras tzumu, Camptotheca acuminata* Decne., *Liriodendron chinense* (Hemsl.) Sarg., *Cercidiphyllum japonicum* Siebold & Zucc. ex J.J. Hoffm. & J.H. Schult. bis, *Tetracentron sinense* Oliv., different species of *Sorbus, Acer, Stewartia, Camellia, Euonymus,* and representatives of the family *Magnoliaceae.* At altitudes of approximately 2,000 m/7,000 ft various evergreen species dominate, in particular *Q. engleriana, Q. myrsinifolia* Blume, *Lithocarpus rosthornii*, and *Castanopsis platyacantha* Rehder & E.H. Wilson but also *Buxus sinica* (Rehder & E.H. Wilson) M. Cheng and species of the genera *Sorbus, Tilia, Acer, Rhododendron, Viburnum, Abelia, Taxus, Spiraea*, etc. A majority of the stands in the core of the reserve are very well preserved with many species represented by

7/ *Q. franchetii* (Jinfo Shan Nature Reserve).

8/ Meeting in the mountains.

specimens that are well over 100 years old.

During our travels between the various principal localities, we documented a number of other subsites where different species of oak were present, generally as solitary specimens, or small copses or chopped stands in the countryside. The most interesting species of these included: *Q. franchetii* Skan, *Q. guyavifolia*, *Q. senescens*, *Q. longispica*, *Q. rehderiana*, and *Q. pannosa* Hand.-Mazz. In certain mountain localities we found the smallest species of oak growing together with the smallest species of pine: *Q. monimotricha* with *Pinus densata* var. *pygmaea* Hsueh f.[7].

Conclusion

During our expedition we documented more than 50 taxa of the family *Fagaceae*, primarily oak species from both sections *Quercus* and *Cyclobalanopsis*. Significant specimens of all species were localized using GPS and documented with both photographs and herbarium collections, (essential in our ongoing efforts to identify the species that we could only put a question mark on at the time). Generally, the identification of certain species has proved fairly difficult especially since the key in the *Flora of China* is wholly inadequate and often the outcome is quite misleading. All together 34 herbarium specimens were collected representing 12 species from section *Quercus* and 8 from section *Cyclobalanopsis*. In the case of some species this involved multiple collections from different provenances and altitudes, and from specimens presenting interesting characteristics. Many species growing at very high altitudes, especially the evergreens, adjust to less favorable conditions by modifying both habit and leaf size. Observing their growth in optimum conditions could prove very interesting. Collecting seed from a wider diversity of specimens and conditions might ensure successful cultivation of at least certain species.

Acknowledgements

This expedition would not have been possible without the generous support of Dušan Plaček.

Photographers. Photos 1-8: Josef Souček.

7. Considered a synonym of *P. yunnanensis* var. *pygmaea* (Hsueh f.) Hsueh f.

Oak Open Days
The Mud, Mosquitos, and Oaks of Mississippi USA
June 27-29, 2014

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1/ Dudley Philips introducing Nativ Nurseries.

Introduction

In March 2012, my family and I went to visit Dudley Phelps and family in Starkville, Mississippi. I became acquainted with Dudley through phone calls and e-mails, in which we talked about many things but especially oaks. Dudley works for the Mossy Oak Corporation (West Point, MS) and runs the day-to-day operation of their nursery, Nativ Nurseries. Mossy Oak started out as a camouflage hunting apparel company in 1986, and has since expanded their lines into numerous endeavors. Mossy Oak's founder, Toxey Haas, and employees are people who are deeply connected with nature and conservation, so recognizing unique trees comes naturally. Many times, these trees are found during hunting trips. Hunters might notice that the acorns of a certain tree draw more wildlife or that a different tree drops acorns very early in the season, while another, very late, thus providing food sources for wildlife at varying times.

Mossy Oak Corporation and Nativ Nurseries

Toxey began experimenting with seedlings of these unique trees in the early 2000s, growing them in his backyard before finally purchasing a nursery in 2005. The fledgling nursery began by growing a few hand-collected seedlings along with purchased bare-root stock. At first, these trees were only marketed to local customers. When Dudley was hired in 2007, the decision was made to grow trees from seed they collected by hand and to switch over to air-pruning pots. The results have been amazing. Nativ Nurseries now grows and sells up to 300,000 seedlings each year, mostly from hand-collected seed, with most trees sold online. One skillset they did not possess initially was the ability to graft these trees. A series of tornados in 2010 leveled a couple of the original seed trees, and that loss stressed the importance of vegetatively propagating the remaining trees to form seed orchards. Dudley invited me to come down and teach him how to graft and I accepted.

During that first trip in 2012 when Dudley showed me around the area, I saw a number of these unique trees and decided right then that others had to see them as well and so the idea was formed to organize an Oak Open Day (OOD) in Mississippi. A couple of issues stood in the way of organizing an event there, however. First was the fact that many of these trees were located on leased hunting ground. This meant that the months of September to May were off limits. This cut out acorn picking and almost certainly ensured that we would have very warm weather for our tour. Second was the time needed to organize the event. In March 2014, I made the 8-hour drive back to Mississippi to help organize the tour. After much deliberation, we settled on late June, with hopes of good attendance and weather. We also decided that the tour would focus around the many beautiful hybrid oaks found in the area. Mississippi is home to more than twenty species of oaks, and many well-known hybrids exist in the state. Past OODs have showcased

Southern species like *Quercus falcata* Michx., *Q. nigra* L. and *Q. lyrata* Walter, but none had focused on hybrid trees (see, for example, Aiken Oak and Horticultural Tour, *International Oaks*, Issue No. 25, pp. 123-134).

Reception at the cabin

2/ *Quercus nigra*

On Friday evening, June 27, attendees met at the Mossy Oak World Headquarters in the small town of West Point. Members and non-members from seven states came to see the beauty that the area is known for. From the Mossy Oak headquarters, we headed to the welcome reception about 20 miles/32 kilometers outside of town. On a private farm sits an original log cabin built in 1832 out of American chestnut (*Castanea dentata* (Marshall) Borkh.). This cabin was relocated from its original site and set up as a meeting and retreat spot for Mossy Oak guests. The front porch is shaded by a mature *Q. nigra* and three young *Q.* ×*comptoniae* Sarg. (*Q. lyrata* × *virginiana* Mill.) were planted on one side of the cabin. We were greeted by Toxey Haas, who shared a bit of information about the cabin and land, before taking the group on an impromptu tour of a few special trees on the property before dinner.

The first tree we visited was a large *Q. falcata* flanked by a gigantic *Q. phellos* L. It was suggested that the *Q. falcata* may be a hybrid, but after a lengthy conversation no consensus was reached. Regardless, it was a fantastic tree! Toxey then asked if we would like to see more of the trees on the property before dinner – we readily agreed and so hopped into some trucks and off we went. The paths were quite muddy and rutted as the area had received an unusual amount of rainfall, but we made it to the back of the property without incident. Along the way we passed a beautiful lake before stopping at a monster *Q. nigra*. We then looked over several mature *Q. pagoda* Raf. and a couple of *Q. sinuata* Walter var. *sinuata*. Nearing dusk, we headed back towards the cabin where our dinner waited. On the way back, the muddy paths became a larger problem. One of our trucks slid off the road and ended up stuck in a deep rut. Everyone piled into the other truck and headed back to the cabin. Once there, we all took some time to relax and catch up before a delicious dinner of shish kebab, salad, and dessert, prepared by our gracious hosts. We ate, visited, and made plans for the morning tours before thanking our hosts for the evening and heading back to our hotels.

The Cotton Mill

The next morning we gathered at a private property known locally as the Cotton Mill. This property has an amazing diversity of species from hardwoods to herbaceous plants. The property is made up largely of seasonally flooded alluvial soils. The Mossy Oak crew provided all-terrain vehicles for the attendees as it was a mile or so walk to the first tree and the area was still very swampy in spots from seasonal flooding.

3/ *Quercus alba* × *lyrata*

We started down a long power-line cut when someone noticed the shiny leaves of *Sideroxylon lycioides* L. After a short stop we headed to a grove of *Q.* ×*beadlei* Trel. ex E.J. Palmer (*Q. alba* L. × *michauxii* Nutt.). There are five individual trees in this grove, and these are the first hybrid trees Nativ Nurseries began growing. Among this grove are *Q. sinuata*, *Q. michauxii*, *Q. lyrata*, *Carya carolinae-septentrionalis* (Ashe) Engl. & Graebn. and *Arundinaria gigantea* (Walter) Muhl. The group quickly noticed and grabbed up chanterelle mushrooms (*Cantharellus cibarius* Fr.) growing near the giant cane. The bright yellow fungus is a local delicacy. We moved on to another spot of the property where Toxey had found a very large, mature *Q. alba* × *lyrata* hybrid.[1] Since it is growing in a forest, the nearest limbs were well above our heads, so we enjoyed it from below and many of us took advantage of the zoom feature on our cameras to get closer. On the way to the last stop, we detoured to another *Q. alba* × *lyrata* found recently by Toxey. Again, its branches soared above our heads, but we managed to examine a few leaves courteously dropped by squirrels. These two specimens looked remarkably similar and features from both species were hard to deny. Interestingly, both of these hybrids were found growing in the seasonally flooded area near the *Q. lyrata* parents. The *Q. alba* are found close by but they are growing slightly upland from these hybrids.

Moving on to the last stop, we made yet another detour. A mature *Q. similis* Ashe was found growing at the wood's edge. Another was spotted across the path. This is a fairly rare species and it was the first time most of the group had encountered one. *Q. similis* can be differentiated from *Q. stellata* Wangenh. by its growing environment and spatulate

1. Work is under way by Dudley Phelps and the author to typify this hybrid and establish a proper hybrid epithet.

leaves. We entered the woods just past the *Q. similis* and began the short walk back to the last two highlights of the property. Three *Q.* ×*tottenii* Melvin (*Q. lyrata* × *michauxii*) are found here and they are the parents for Nativ Nurseries seedlings. All are large, mature trees with branches well out of our grasp. Again, we grabbed up a few leaves and last season's caps to discuss and compare. Right near these Totten oaks was a group of *Carya myristiciformis* (F. Michx.) Nutt. ex Elliott., commonly known as the nutmeg hickory. These are also rare trees and most of us had never seen this species. The epithet means shaped like *Myristica*. The nut matures in the autumn and falls in September-December. It is reddish brown with silver stripes, resembling a nutmeg (*Myristica fragrans* Houtt.), thus inspiring both the common and scientific names. This tree has a scattered range through seven Southern states but can be grown in colder climates as well. As we headed out, Toxey remembered one more tree that he wanted the group to see. We walked a little deeper into the mosquito-filled woods and finally stopped at another large tree. Found during the previous year's hunting season, we admired the only *Q.* ×*sterrettii* Trel. that I have ever laid eyes on. The leaves of this specimen are thick and leathery like its *Q. stellata* parent, but the tree is adapted to swampy conditions thanks to its *Q. lyrata* parent. Similar to the *Q. similis* we saw earlier, this hybrid can be distinguished by larger acorns with a thinner cap covering over half of the acorn. Most of these hybrids were found by Toxey Haas who has a very keen eye for finding unusual oaks.

4/ *Quercus similis*

5/ *Quercus* ×*tottenii*

The morning tour concluded and we headed for town to a local burger joint, the Twisted Burger, to grab lunch and talk over the morning's expedition.

6/ *Quercus ×neopalmeri*

A hybrid afternoon

After lunch we headed to a property adjacent to the McCharen Field Airport. A mature *Q. alba* × *lyrata* stands majestically in a field flanked by a few old specimens of *Q. stellata*. This individual exhibits characteristics split equally between both parents. The leaves, bark, acorns, caps, and peduncles show obvious introgression from both species. A beautiful tree and one that shows how extraordinary hybrid oaks can be. As the group discussed the virtues of this amazing tree, Bob McCartney and Henry (Weeds) Eilers slipped off to do some prairie botanizing. Proving to the rest of us that they can still climb over fences if there is something worthy on the other side, they brought back the flower spike of an obedient plant (*Physostegia virginiana* (L.) Benth.) to show my daughter Maya how the plant got its common name (you can move the flowers into different positions and they stay in place). This area is so diverse with plant life that Henry made the trip down several days early to spend time exploring the local prairies. A portion of the Blackland Prairie runs through this area and Dudley put him in touch with local experts who were able to point out various areas to explore.

With everyone gathered up we headed back to town to the next tree. Behind the Mossy Oak brand licensing office and right on the property line sits a large hybrid tree. There has been some disagreement among Mossy Oak staff concerning the parentage of this tree. After some consideration, it was decided that this tree is a *Q.* ×*subfalcata* Trel.[2] From our observations, it appeared to have some *Q. falcata* genes due to the rounded leaf bases. The other possible parent was thought to be *Q. phellos* or *Q. pagoda* but these were ruled out because of the acute leaf base of these species. Our next stop was at a private residence in West Point to see a cultivated hybrid of unknown origin. The Mossy Oak crew has determined that it is a *Q.* ×*moultonensis* Ashe (*Q. phellos* × *shumardii* Buckley). This particular tree is fairly young (less than 25 years old), but Dudley reports that it is a heavy acorn producer. He also says that a seedling from this tree is their record holder for growth in a season. From a very small seedling, it grew to over 8 ft/2.4 m in a single season!

Finishing off our long day, we stopped at the residence of Jimmy Bryan and saw three hybrid oaks growing side by side. These are also cultivated trees, bought as *Q. shumardii*.

2. *Q.* ×*subfalcta* is a homonym of *Q. subfalcata* originally applied to a fossil specimen. Conservation of the hybrid epithet is under way (*nom. cons. prop. in prep*).

7/ *Quercus ×subfalcata*

Dudley has been able to determine that one of these attractive hybrids is *Q.* ×*neopalmeri* Sudw. (*Q. nigra* × *shumardii)*. This determination has been made after careful examination of leaves, acorns, and growth habits as well as from observing seedling populations. The other two trees have been identified as *Q. nigra* × *texana* Buckley. Both of these trees exhibit leaves similar to *Q. nigra*, but acorns and caps are more reminiscent of *Q. texana*. Seedlings of these trees bear out a range of characteristics of both parents. As the rain clouds gathered, we went over the next day's events and decided to call it a day, head back to clean ourselves up, and have supper.

The oaks of MSU

The following morning we met at the Mossy Oak headquarters in West Point and carpooled to Starkville, home of Mississippi State University (MSU). We were welcomed by campus extension arborist, Jason Gordon, and were given a history of the University and its forestry program. Founded in 1878, MSU covers 4,400 ac/1,800 ha including campus and statewide research facilities. Jason is leading an inventory project of campus trees and led us on a meandering tour of some of the notable oaks. Our first stop was to see the "tennis court tree" – a huge *Q. alba* × *lyrata*. At first glance this tree has a strong affinity with *Q. alba*, but Dudley grew seedlings from this tree for a few seasons before he noticed that there are a few features that are not *Q. alba*-like. Notably, this tree has longer, skinnier peduncles, thin cups that cover up to half of the acorn, and leaves with a slight *Q. lyrata* influence. This particular tree could indeed be a backcross to *Q. alba* (*Q. alba* × *lyrata* × *alba*).

We crossed the street and stopped at a young tree that had been difficult for campus personnel to identify. Growing in a row of cultivated *Q. phellos* was a very nice *Q.* ×*capesii* W. Wolf (*Q. nigra* × *phellos*). Identified by its lobed leaves (1-3 lobes per side) and slightly larger-than-*Q. phellos* acorns, this is a very attractive hybrid. Our next stop was a real head scratcher. It is unknown where this tree came from or who planted it. It is thought to be *Quercus* ×*harbisonii* Sarg. (*Q. virginiana* × *stellata*), exhibiting characteristics of both species. However, it is quite possibly *Q. polymorpha* Schltdl. & Cham., but none of the attendees were familiar enough with the latter species to make a definite decision. This is out for review.

A short walk past a squat, flat-topped *Q. virginiana* brought us to an excellent hybrid of *Q. nigra* × *pagoda*. This is a mature tree at least 70 years of age and is growing right outside a busy classroom. It's unclear whether this tree was planted or is a lucky survivor of campus expansion, but its parentage was determined by MSU forestry professor and IOS member Dr. Andrew Ezell and later confirmed by Dudley. Our next stop was at a large *Q. macrocarpa* Michx. that was planted in 1976, and is already as large as specimens twice as old but growing much farther north. We stopped for our group photo under a beautiful

8/ *Quercus nigra* × *texana*

Q. michauxii. Nearing lunch time, we headed across the campus quadrangle to look at the last tree of the morning, a young specimen of *Q. nigra* × *texana*. The leaves of this tree are highly ornamental as the tips splay out into a fantastic trident shape, and the growth habit maintains a straight upright leader. The acorns exhibit features of both parents with a domed cup and dark striations on the acorn, like *Q. texana*, but with a rounder shaped acorn, like *Q. nigra*. The hot, hungry, and tired group headed to the student center to cool off, have a bite to eat, and to prepare for the last stop of this OOD: a visit to Mossy Oak's Nativ Nurseries. Dudley showed us around their greenhouses and growing facilities. The peak season had passed, as far as seed sowing was concerned, but we were shown the air-pruning pots that the liners are grown in as well as the mass of seedlings that had already been moved outside for the season. Following some interesting conversation about the great trees we had seen and places we had been to, each participant was given the opportunity to take some seedlings courtesy of our hosts, and we said our goodbyes.

Pleasant weather, with no rain, accompanied us throughout this Mississippian adventure that was, for me, well worth the hard work involved in organizing it.

Acknowledgements

I would like to thank Dudley Phelps, Toxey Hass, Vandy Stubbs, Jesse Raley, and Jason Gordon for their hospitality and for taking the time out of their schedules to talk about oaks with us. Thanks also to the attendees who braved the mosquitos and potentially hot weather to explore this beautiful area of the country.

Participants. Dan and Kathy Daniel (Arkansas); Henry Eilers (Illinois); Robert Routon (Louisiana); Toxey Haas, Dudley Phelps (Mississippi); Ryan, Tammie, Ryder, Taran, and Maya Russell (Missouri); Guy Meilleur (North Carolina); Bob McCartney (South Carolina); William Fleming, Ruth McDonald (Texas).

Photographers. Photos 1-8: Ryan Russell.

Further reading

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Oak Open Days
Congrove[1, 2], Leigh Delamere[2], Westonbirt[2]
Gloucestershire, United Kingdom
July 6-7, 2014

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Congrove Arboretum, July 6

The kick-off to these Oak Open Days was at Manor Farm, Upton Cheyney where IOS members and other guests assembled for a delicious lunch generously provided by Christine and Ben Battle. After this we all proceeded to Congrove Arboretum, approximately half a mile from the farm.

Sadly, Christine had injured her ankle and was unable to show the group around this remarkable collection that she began some 16 years ago. Today it comprises a wide range of genera, including some 235 oak taxa. Congrove Arboretum is situated in a south-facing valley and covers an area of aproximately 65 acres/26 hectares with the land sloping down to a stream.

1/ The warmest and most protected location where less-hardy species have been planted at Congrove Arboretum.

There are areas that offer reasonable protection and the experiment of growing less hardy species has been attempted. These include *Quercus insignis* M. Martens & Galeotti, *Q. corrugata* Hook. and *Q. rubramenta* Trel. – all on the edge of what could possibly survive in the UK. At Kew the *Q. insignis* is cut down every year and regrows from the ground. Christine's plants of these three species have survived two winters although these have been relatively mild. As has been found in other UK collections, a number of the oaks introduced from Mexico have grown incredibly well: *Q. acutifolia Née, Q. acherdophylla* Trel., *Q. affinis* Scheidw., and *Q. crassifolia* Bonpl. to name but a few.

Attempting to lead oak fanatics to where their favorite trees could be found in the collection was obviously going to be a challenge: it can only be compared to herding Soay sheep...they all disappear in different directions! Hopefully IOS members had a chance to see most of the oak collection.

Particular thanks must go to Béatrice Chassé and Eike Jablonski for identifying certain species. Unfortunately there is never enough time to fully explore an arboretum such as this to one's satisfaction but there are many gems (not all oaks) in the collection of which Christine is particularly proud. Favorites include her specimen of *Pinus armandii* Franch. (that has coned well for the first time, aged just 12), a *Callitris rhomboidea* R. Br. ex Rich. & A. Rich. from the Southern Hemisphere, *Populus lasiocarpa* Oliv. with its huge leaves and dramatic crimson petioles, and a collection of species *Magnolia* including a four-year-old *M. rostrata* W.W. Sm. which is growing well in its woodland setting and already has leaves well over 18 in/46 cm long.

With great good fortune the Arboretum is now in the hands of Tam and Sandra Gorst who have shown great appreciation for the collection and so hopefully it will continue to develop and grow under their thoughtful and sensitive stewardship.

It is a very special place.

2/ *Quercus hirtifolia* M.L. Vázquez et al. at Congrove (2a) and in Puebla (2b). Discovered in 1996 in Venta Grande (Puebla, Mexico) along the road that goes from Huauchinango to Tulancingo, the name was officially published in 2004 and the first seeds introduced to Europe in 2007 by Allen Coombes. It is endemic to the southern part of the Sierra Madre Orientale and only eight disjunct populations are known. According to the Red List of Oaks, there is not enough data available to determine its status. During the Post-Conference Tour of the 6th International Oak Society Conference in Puebla, one of the stops was to see these trees in their natural habitat.

3/ *Quercus insignis* growing at Congrove (3a) and the huge acorn of this species (3b). First described in 1843, this species was introduced to cultivation in 1995 by Allen Coombes. Its natural distribution range covers southern Mexico (Chiapas, Jalisco, Oaxaca and Veracruz), Belize, Costa Rica, Guatemala, Honduras, Nicaragua and Panama. According to the Red List of Oaks it is endangered in Mexico and Near Threatened in Guatemala, although reports indicate that it is still abundant in Nicaragua. *Q. insignis* would certainly have a place on the podium in a "who-has-the-most-spectacular-acorn?" contest.

4/ A few of Congrove's residents. a) *Quercus acuta* Thunb. b) *Q. repanda* Bonpl. c) *Q. germana* d) *Q. candicans* Née.

5/ Christine Battle's expertise with plants goes beyond raising them. Today she is widely recognized as a talented artist, as shown here. *Quercus guyavifolia* H. Lév, painted by Christine Battle for *Curtis's Botanical Magazine* t. 734 (2012), and reproduced here with their permission.

Leigh Delamere House, July 6

Harriet Tupper, Chairman of the International Dendrology Society and member of the IOS kindly invited the participants to visit her private garden at Leigh Delamere House, only a short drive from Congrove, at the end of the day.

There are many things to marvel at in this well-kept garden, and amongst them, about 20 species of oak, all set off by vestiges of ancient oak woodland. *Q. frainetto* Ten., *Q. phillyreoides* A. Gray, *Q. pontica* K. Koch and *Q. rysophylla* Weath. are doing well here, and a quick stroll by the greenhouse revealed that there may soon be more oaks at Leigh Delamere House: numerous seedlings of a recent collection in Turkey of atypically large acorns of *Q. pubescens* Willd. were all looking very healthy.

We also had the occasion to admire three very nice trees showing remarkable variation between them although all were grown from seeds collected in 2002 in Iran from one individual of *Q. castaneifolia* C.A. Mey. One of the trees has very typical *Q. castaneifolia* leaves whilst the other two present very marked *Q. cerris* characteristics. The group discussed whether or not these could be hybrids.

6/ Leigh Delamere House.

7/ *Quercus pubescens* seedlings.

I was intrigued by this and decided to look a bit further into the matter. Harriet very kindly put me in touch with David Sayers, who was the tour guide for the trip to Iran. What he told me was that the *Q. castaneifolia* in question live in a reserve of 136 ac/55 ha in Dasht-e Naz at very low altitude (approximately 33 ft/10 m) where the only oak to be found is *Q. castaneifolia*. Still, it has been shown that pollen can come from afar.

But in fact, according to Michael Avishai, *Q. cerris* is not found anywhere in Iran. From the Far East to Morocco, different species replace one another along the southern boundary of the Temperate Zone. These species (*Q. afares* Pomel, *Q. castaneifolia* and *Q. cerris*, on one end, and the Chinese-Japanese species, on the other) never occur in the same area.

In *Oaks of Asia*, Menitsky (2005) comments about *Q. castaneifolia*, "Morphologically quite stable, although occasionally, particularly on shoots arising from the trunk, there appear leaf forms that are similar to the varieties of *Q. cerris*." Mme Camus writes that *Q. castaneifolia* var. *obtusiloba* Freyn (today a synonym of *Q. castaneifolia*) presents leaves with deeper sinuses at the base and generally smaller, more papery-like leaves with obtuse rather than acute teeth. She notes also that a range

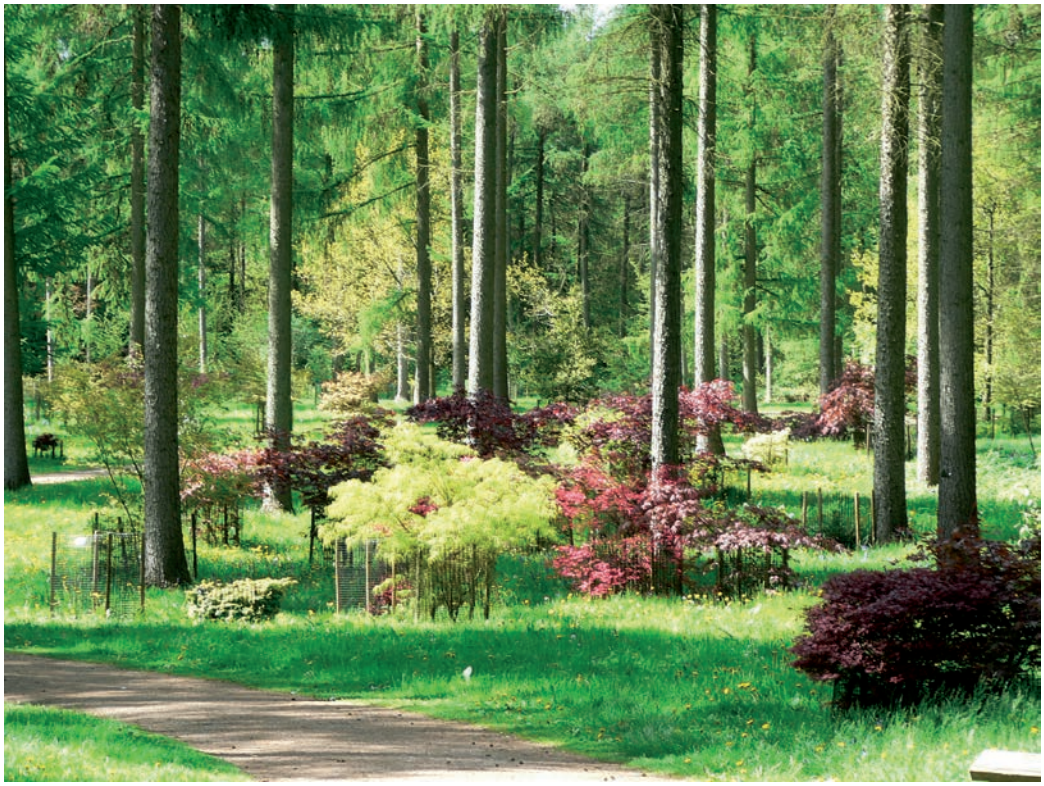
of intermediate forms exists and that this particular one seems to be characteristic of low-altitude forests. These descriptions seem to fit the trees that we saw (Camus 1936-1954).

The wonderful weather that we had enjoyed all day held true to the end as we finished the wine graciously offered us by our hostess. We then got bundled back into cars and headed to our hotel in a nearby village before rejoining Harriet for dinner at a local pub that she had recommended.

8/ *Quercus castaneifolia* showing remarkable phenotypic variation.

Westonbirt, the National Arboretum, July 7

Comprising about 2,500 woody-plants (represented by about 15,000 specimens) Westonbirt consists of three main areas: the Old Arboretum, the Silk Wood (ancient, semi-natural woodland) and the Grade I Registered Downs (grasslands). This 600-acre/240-hectare arboretum holds five national collection labels, harbors 80 champion trees and attracts 350,000 visitors a year.



9/ The renowned Acer Glade at Westonbirt.

10/ A magnificent *Quercus frainetto* Ten. (more than 82 ft/25 m tall) grafted on *Q. robur* and planted at the end of the 19th century in the Silk Wood.

Today, Westonbirt is run by the UK Forestry Commission who acquired it in 1956 from the Holford family. Major work – including rerouting several roads, diverting streams, and actually moving the village of Weston Birt – had been completed in the 1840s by tree and landscape enthusiast Robert Staynor Holford (1808-1892). His objective was to enlarge the original park created in 1674 that had been subsequently divided into two parks in the 1700s. Robert S. Holford was the son of George Peter Holford, himself the second son of Peter Holford who founded the family fortune by supplying London with fresh water through a canal. Robert Holford's son, Sir George Lindsay Holford, shared his father's horticultural inclination, adding to it his particular passion for orchids. He was the driving force in the Arboretum's development through the 1880s, expanding it into the Silk Wood, planting new species in the natural woodlands that are part of the Arboretum, developing the vast rhododendron and maple collections that Westonbirt is known for today, and contributing to botanic expeditions like Ernest Wilson's various trips to China. Between 1926 when Sir George died and 1956 when the Forestry Commission bought the land the Arboretum had first been placed under the care of W.J. Mitchell and was subsequently requisitioned by the Air Ministry for use during World War Two.

Dan Crowley, Dendrologist, and Hugh Angus, former Head of Collections and now retired, met us at the gate for a warm and informative welcome by Simon Toomer, Westonbirt's Director since 2009. To be highly recommended to anyone interested in planting trees is Simon Toomer's book, *Planting and Maintaining a Tree Collection* (Toomer 2010).

The oak collection, comprising a little over 300 taxa, is in two different areas. In the Old Arboretum (that we visited in the afternoon) can be found the original plantings plus native *Q. robur* L. that have been preserved and have had the time to become regal. The younger oak collection (that we visited in the morning), begun in the second half of the 20th

century, has been developed in the part of the Arboretum referred to as Silk Wood, where some oaks had already been planted. This part of the collection includes specimens of eight oak species that are classified by the IUCN as either endangered (EN) or vulnerable (VU). And the oak collection continues to grow: plantings in 2014 include several trees of *Quercus ilex* L., *Q. phillyreoides* A. Gray, and *Q. sideroxyla* Bonpl.

Westonbirt boasts three UK champion oaks. One for height: *Q. macranthera* Fisch. & C.A. Mey, 92 ft/28 m, measured in 2007; and two for height and girth: *Q. pyrenaica* 'Pendula' Ottolander, 79 ft/24 m tall with a girth of 104 in/264 cm, measured in 2008; *Q. frainetto* Ten. × *pyrenaica* Willd. 40 ft/12 m tall with a girth of 31 in/79 cm. The Arboretum also lists *Q. pyrenaica* as one of its signature trees, i.e., trees that, over time or by selection, have come to perform a particular role in Westonbirt's landscape owing to their size, location or number.

Majestic specimens of *Q. robur* L. can be found growing throughout

11 a-b/ Discussion around a *Quercus macrocarpa* of the Oliviformis Group F. Michx., characterized by a very shallow, sometimes inexistent "waist" (see above photo) and by very small acorns.

the Arboretum with a particularly remarkable one near the Main Drive/Circular Drive junction. Several venerable trees dominate the Downs and there is hardly a visitor whose eyes are not attracted to them, their ageless presence an invitation to contemplation and possibly wishful thinking. There are many *Q. canariensis* Lam. planted here and a particularly beautiful one can be found toward the northern edge of the oak collection in Silk Wood, near the end of Broad Drive.

Two of the (easier) puzzles that we encountered during the day included a *Quercus* sp. which most of us agreed was very likely *Q.* ×*hispanica* Lam., and a tree labelled *Q. engelmannii* Greene, that was without question *Q. agrifolia* Née. The latter, although growing a bit in the shade, is a beautiful and very healthy tree.

Westonbirt is spectacular and one would need a week to do it justice. It is a dynamic place with a motivated team that is confronting the problems faced by any such institution in these troubled economic times. This inevitably involves finding the right balance between the need, on the one hand, to attract an audience, and, on the other, to maintain the botanical and scientific value of the individual collections and of the Arboretum in its global functioning.

Acknowledgements

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Photographers. Photos 1-3a, 4c, 4d, 6-8, 10-11b: Charles Snyers d'Attenhoven. Photos 2b, 9: Béatrice Chassé. Photo 3b: Guy Sternberg. Photos 4a, 4b: James MacEwen.

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Oak Open Days
Trompenburg Tuinen & Arboretum
the Netherlands
August 28-29, 2014

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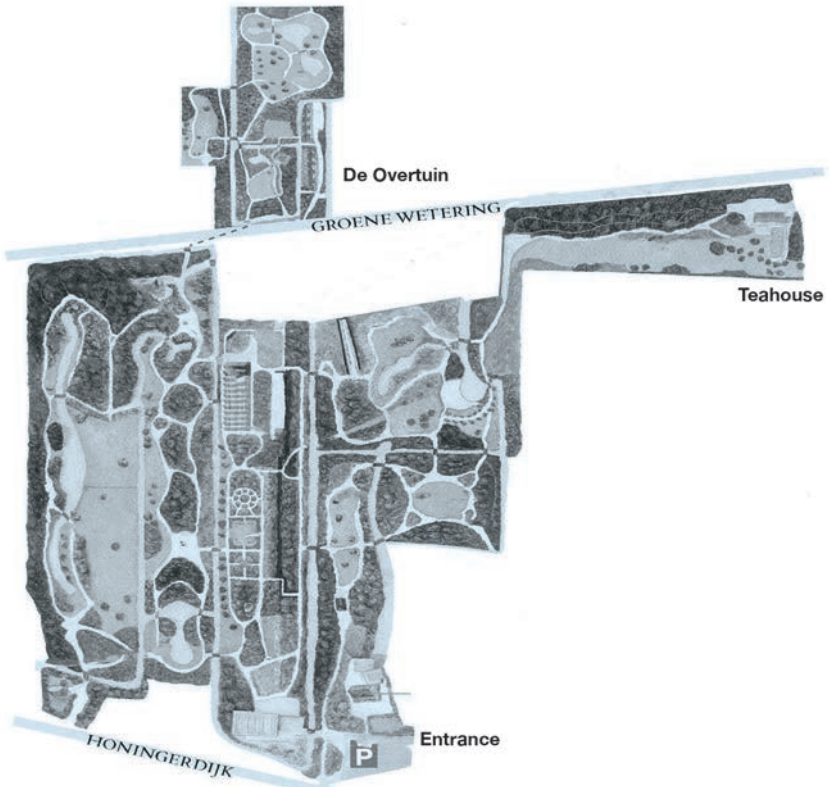

Introduction

On 28-29 August, 28 people from seven different countries met for a two-day visit at the Trompenburg Tuinen & Arboretum in Rotterdam (the Netherlands). Visiting an arboretum with such a vast collection of oaks is always most exciting, as much for the amateur, as for the more experienced dendrologist.

James van Hoey Smith (1891-1965) really started the collection around 1925, after the removal of more than 400 dead elms, mostly *Ulmus* ×*hollandica* Mill. (*U. glabra* Huds. × *minor* Mill.).

After the Second World War, James Richard Pennington (Dick) van Hoey Smith continued his father's work by gradually extending the collection with more interesting oaks. Following a visit to Kew Gardens in London, this young dendrologist brought home a suitcase full of acorns, giving the collection another boost. Today the collection counts no fewer than 698 species, cultivars, and hybrids (compare with Hoey Smith 1997).

Morning musings with oaks

On the first day of this event we were welcomed at the entrance building by Gert Fortgens, curator of the Arboretum and IOS Board Member, and by Sophie Kling, a young and charming French intern who assisted Gert in preparing this event.

Each of us received the program, a map, a list of the oaks and where to find them, and a very original badge made from a cross section of an oak branch into which our first-names and an oak tree (the Trompenburg logo!) had been burned. Once assembled in the Theehuis (Teahouse), Gert officially welcomed us all and especially IOS Tour Director Shaun Haddock and President Béatrice Chassé. Béatrice welcomed Dr. Pan and Dr. Ju from Taiwan. Gert followed with a presentation on the oaks of Trompenburg and the history of the Arboretum. Then, after tea and biscuits, off we went for the start of our visit of the living collection.

A group of recently planted oaks near the Teahouse showed some of the new selections of fastigiate habit. The trees were all in a semi-shaded position and it was interesting to observe that they were not as tightly fastigiate as would have been the case in a more open position. Some new and very interesting selections that we saw here included *Quercus* ×*bimundorum* 'Crimschmidt' W.N. Wandell (CRIMSON SPIRE™ is the trade designation for this plant), *Q.* ×*warei* 'Long' E. Cully (REGAL PRINCE®), *Q.* ×*warei* 'Windcandle' Jablonski and *Q.* ×*warei* T.L. Green & W.J. Hess 'Chimney Fire'. The formal publication of this name is in preparation (Eike Jablonski, pers. comm.) Each of these cultivars has its own qualities, but for autumn color, the first and last are the best.

1/ Shaun Haddock, Li-Ping Ju, Fuh-Jiunn Pan, and Gert Fortgens

CRIMSON SPIRE™, already heavily propagated by grafting, is the offspring of the perfect marriage

between fastigiate forms of the European *Q. robur* L. and the American *Q. alba* L., combining the best qualities of both trees. *Q. dentata* 'Sir Harold Hillier' J. Hillier & Coombes is one of the two cultivars of *Q. dentata* Thunb. selected and named by Mr. and Mrs. De Belder from the Hemelrijk Arboretum in Essen (Belgium). Both this one and *Q. dentata* 'Carl Ferris Miller' J. Hillier & Coombes have proven to be perfectly hardy in most parts of Western Europe. The former has a slightly smaller leaf but it has a better autumn color. In this part of the Arboretum some of the Red Oaks showed some chlorosis probably due to the high soil pH. Treating through iron chelation has only temporarily solved the problem.

2/ *Quercus* 'Macon' van Hoey Smith

We gathered around a *Q.* ×*hispanica* 'Waasland Select' Jablonski (*Q. cerris* L. × *suber* L.) and the discussion about the true origin of this beautiful evergreen hybrid was opened again. The tree only fruits occasionally and the acorns show a marked resemblance to those of *Q. ilex* L., especially in the cups, which are not typical of the other cultivars of this hybrid. Who can solve this problem? Allen Coombes has remarked that this selection does appear to be a form of *Q. ilex* (Allen Coombes, pers. comm.).

On a recently created sandhill some of the Californian oaks have been planted and *Q. wislizeni* A. DC., *Q. dumosa* Nutt., and *Q. agrifolia* Née all looked to be in good shape. The rare *Q. acerifolia* (E.J. Palmer) Stoynoff & Hess, a Bill Hess collection from Magazine Mountain in Arkansas, attracted our attention and someone pointed out that this oak, together with *Q. buckleyi* Nixon & Dorr., is one of the few oaks that thrive on calcareous soils. Gert pointed out a huge *Q. trojana* Webb, introduced as a seedling from Kew Gardens (planted in 1970), that was showing off its nice, big acorns whilst the pigeons showed us their love of *Q. acuta* Thunb. acorns. This big multistemmed specimen was grafted onto *Q. robur*.

3/ *Q. trojana* acorns.

In another section of the garden, *Q. robur* (Heterophylla Group) 'Salicifolia' Hort. ex Loud. looked somewhat shaggy and *Q. crispula* Blume was full of yellow dots on the leaves caused by aphids, while a huge *Q.* ×*libanerris* 'Rotterdam' J. Hillier & Coombes, (*Q. libani* G. Olivier and *Q. cerris*) looked wonderful with its big, fat acorns. I was surprised to see a healthy looking *Q. garryana* Douglas ex Hook., which always gets leaf spots in my nursery, and *Q.* ×*andegavensis* Hy (*Q. pyrenaica* Willd. × *robur*) was new to me. Two oaks that we saw could be of use in a smaller garden: *Q. prinoides* Willd. and *Q. ilicifolia*, Wangenh. A little farther on Gert wanted to show us the only acorn on *Q. chrysolepis*

4/ *Q.* ×*libanerris* 'Rotterdam'

Liebm., the golden oak of California, but unfortunately some animal or person had picked it already.

Passing by a *Q.* ×*kewensis* Osborn (*Q. cerris* × *wislizeni*) I pointed out that this taxon is sometimes confused with *Q.* ×*hispanica* 'Fulhamensis' Loud. I showed the group that the underside of the leaf of the former is glabrous and shiny while that of the latter is velvety and that even on young trees, the bark of *Q.* ×*hispanica* 'Fulhamensis' is corky while that of *Q.* ×*kewensis* is smooth. Under a beautiful *Q. frainetto* Ten. Jo Bömer had a story to tell that once again underlined the fact that if you gather acorns in an arboretum you often get surprising results. Sometime ago, with her husband Martin, they gathered acorns under this *Q. frainetto* and apparently a few had been pollinated by a nearby *Q. robur* Cristata Group A. Henry. Out of these seedlings were born *Q.* ×*haynaldiana* 'Concrist' Coombes & Jablonski and 'Crisnetto' Coombes & Jablonski.

We saw a nice specimen of *Q. velutina* Lam. that used to be called *Q. tinctoria* Bartram, from the fact that a yellow dye (quercitron) used to be made with the quercitrine that can be extracted from the bark. Finally, on our way to the Teahouse for lunch we passed a *Q. pontica* K. Koch, grown from wild-collected seed from Turkey. This particular one has a beautiful, more elongate leaf than most individuals of *Q. pontica* that I have seen. A delicious lunch prepared by Trompenburg staff awaited us and we all took the opportunity to make new acquaintances and to exchange information about our collections.

Grafting in the afternoon

In the afternoon there was a forum discussion about the propagation of oaks. After a brief introduction Gert invited questions and comments from the group. It was an interesting discussion and we all agreed that if you want to build up a collection of botanic species, it is always best to try and find young trees grown from wild-collected seed. I suggested that from seedlings of wild-collected origin it is important to select the

strongest plants and those that show the most typical morphological characters of the species. It is also important to take into consideration your particular climate: if it is a species that is known to have good autumn color, for example, then you must choose the seedlings that show this in your climate (as not all of them may).

5/ *Q.* ×*haynaldiana* 'Concrist'

On the other hand, grafting is still a very common practice in the nursery trade and there are some good reasons to continue (Jablonski 2014; Benoit 2009). Hans van Gemeren, Jo de Martelaer, Jo Bömer, and myself, who are all professional nurserymen, did our very best to explain why grafting is still very important when you want to maintain certain qualities which can be lost when plants are grown from seed. Very good examples of this are: *Q. robur* 'Concordia' J. Booth ex Kirchn., *Q. robur* Fastigiata Group Lam., a laciniate form of *Q. montana* Willd.,[1] *Q. alba* (Pinnatifida Group) 'Lincoln' Jablonski, *Q. palustris* 'Isabel' Coombes & Jablonski. None of these plants come true from seed. Similarly, it is very difficult to find true F1 natural hybrids of many oaks such as *Q.* ×*bimundorum* 'Crimschmidt', *Q.* ×*turneri* Willd. (*Q. ilex* × *robur*), and *Q.* ×*bushii* 'Seattle Trident' J. Hillier & Coombes (*Q. marilandica* Münchh. × *velutina*) so these have to be grafted or they will lose their most conspicuous characteristics.

It is very important that we nurserymen not deny or underestimate the problems that exist with grafted oaks: for some clones grafting incompatibility is a big problem. The choice of the right rootstock, one that is as close as possible to the plants that we wish to graft, is imperative. Another problem that needs further study is the splitting of the bark near the ground in cold winters. I have the impression that grafted oaks are more susceptible to this problem than trees grown from seed. A good example of this is *Q.* ×*hispanica* and its cultivars. Over the past 25 years we have grafted thousands of *Q.* ×*hispanica* 'Fulhamensis', 'Waasland Select', 'Diversifolia' Hort. ex G. Nicholson, and 'Wageningen' Grootendorst. During cold winters, such as the one we had a few years ago, quite a lot of these trees were lost due to this problem, whereas seed-grown trees of *Q.* ×*hispanica* (seed from *Q.* ×*hispanica* 'Fulhamensis') survived unharmed. Protecting the base of the trees with some insulating material during winter solves the problem partially.

Only seven hectares… and so many trees

After the forum discussion we went to another part of the garden where *Q. kelloggii* Newb. 'Grey Ghost' immediately caught our attention with its nice grey leaves. Plants with this name can already be found in some Dutch nurseries but the official description

1. This plant is/has been sold under two different names, *Q. montana* 'Laciniata' and *Q. montana* 'Arnold Laciniata'. The correct name, as yet unpublished, should be *Q. montana* 'Arnold Laciniate'.

and publication are still in preparation (Eike Jablonski, pers. comm.). Gert Fortgens added that this selection has beautiful velvety orange-red foliage when coming into leaf in spring. I have asked Gert for some scion wood to graft with the hot callusing pipe this winter. Passing *Q.* ×*schochiana* Dieck (*Q. palustris* Münchh. × *phellos* L.) we noted *Q.* ×*brittonii* W.T. Davis (*Q. ilicifolia* × *marilandica*) and someone pointed out that it had the same broad habit as *Q. ilicifolia*. It is rare to see a healthy looking *Q. lobata* Née in Europe, but the one here at Trompenburg looked quite happy.

The big *Q. pontica* near the entrance building, one of Dick van Hoey Smith's favorite trees, is grafted and there were still a few ripe acorns on the ground. Not far from it are the two stately columnar trees that appeared here in 1960 as seedlings of *Q.* ×*rosacea* 'Columna' H.A. Hesse (*Q. petraea* (Matt.) Liebl. × *robur*), probably pollinated by *Q. petraea* Mespilifolia Group Wallr.: *Q.* ×*rosacea* 'Eastcolumn' Jablonski and 'Westcolumn' Jablonski. Near the entrance gate a very healthy looking unnamed putative hybrid between *Q. macrocarpa* Michx. and *Q. pubescens* Willd. attracted our attention and Gert said that it had come from Bob Berry in New Zealand (Hackfalls Arboretum). On the other side of the entrance building some evergreen oaks including cultivars of *Q.* ×*hispanica* and *Q. ilex*, and *Q. phillyreoides* A. Gray (China, Korea, Japan) have all survived many cold winters. It is interesting to note that until the late 1990s *Q.* ×*turneri* was the only evergreen oak that was freely available in most nurseries in Holland and Belgium. Another grafted specimen of a *Q. acuta* had clearly formed roots of its own, something that I have often observed on grafted plants of *Q. pontica*. It is therefore wise to plant grafted trees with the grafted section a little below the ground.

In an arboretum like this it is difficult to see every oak tree on the list, but Gert did his very best to guide us through every little corner to show us yet another interesting oak, like a forty-year-old *Q. semecarpifolia* Sm. from seed collected in Nepal. Surprisingly, it has survived here in Rotterdam while mine at home in Belgium has frozen back to the ground several times. One of the largest and most impressive trees in the garden is an old *Q. frainetto*. I always love to stand under the immense crown and admire these beautifully lobed leaves against the sunlight. Not far from it is a big *Q. macranthera* Fisch. & C.A. Mey. ex Hohen. (planted in 1943) and we all wondered why it had been grafted at 1.5 m/5 ft above ground level and not near the ground as most nurserymen would do. The tree has a very attractive flaky bark almost like *Q. muehlenbergii* Engelm. We also saw *Q.* 'Macon' van Hoey Smith, a hybrid between *Q. frainetto* and *Q. macranthera*, that appeared here in the Arboretum. On our way to the greenhouse we gathered around yet another Trompenburg introduction: *Q.* Pondaim Group van Hoey Smith (*Q. dentata* × *pontica*). This tree has a neat habit and a nice big leaf that is perfectly intermediate between its parents.

6/ *Q. kelloggii* 'Grey Ghost' (publication in preparation).

Champagne and other comforting goodies were waiting for us in the charming setting

of the greenhouse cactus collection where we arrived just in time to avoid the rain. Riet, Dick van Hoey Smith's widow, joined the party here and for many of us it was nice to see her again, for others, a pleasure to meet her for the first time. What a pity that her late husband Dick was not there to be our guide.

As the day drew to an end, Gert informed us that dinner would be served in the entrance building where beautiful tables had been laid out for us to feast on a delicious Indonesian-style buffet called *rijsttafel*. I joined the Dutch contingency, amongst whom were a few nurserymen. We spoke about how difficult business has been during the last few years, but that each of us still finds it a fascinating job. There is the recession and the fact that most gardens are getting smaller, but also the problem of overproduction. Later that evening I joined Béatrice Chassé, Jo Bömer, Ondřej Fous, and Dušan Plaček, who was telling the eventful story of his life and how he became interested in oaks (see pp. 77-88). Dušan is a successful businessman but also a good entertainer, and he could have gone on for hours, but it was getting late, the bottles were empty, and the staff wanted to go home.

A passion for hybrids

The next morning, Friday 29, we greeted Harriet Tupper, member of the IOS and Chairman of the International Dendrology Society, who graciously shared one day of her Dutch holiday with us. We gathered again in the Teahouse for a presentation on hybrid oaks by Jeroen Braakman. In his introduction, Jeroen gave us a summary of the systematics of the genus *Quercus* and then explained his interest in hybrids naming a few examples: natural hybrids like *Q.* ×*heterophylla* F. Michx. (*Q. phellos* × *rubra* L.) in the US or *Q.* ×*rosacea* and *Q.* ×*haynaldiana* in Europe; those that

7/ *Quercus* ×*rosacea* 'Westcolumn' and 'Eastcolumn'.

have arisen in cultivation between species that normally don't grow in the same area like *Q.* Pondaim Group, *Q.* ×*warei* 'Chimney Fire', and *Q. rubra* × *rysophylla*; and the artificial hybrids resulting from hand-pollination. Very good examples of this are the Cottam hybrids made by Dr. Walter Cottam in the late 1950s and planted out at Red Butte Arboretum in Salt Lake City, Utah and in Shields Oak Grove at the UC Davis Arboretum in California.

Jeroen concluded the first part of his presentation by noting that hybrid oaks can be very interesting and an improvement for some species, but they can also be a difficult mess to identify. In the second part of his presentation Jeroen showed us where we could find discussion groups and information on *Quercus* on the internet and on Facebook.

De Overtuin

After this interesting presentation we headed for a part of the Arboretum called De Overtuin, a garden on the other side of the road that I had never visited.

We passed Dick van Hoey Smith's beautiful house along the side of which can be found a bonsai-like *Q. robur* 'Tromp Dwarf' van Hoey Smith and a massive *Q. imbricaria* Michx. planted in 1939. In De Overtuin many oaks are planted along with with other interesting and rare trees and shrubs. *Q.* ×*rosacea* 'Columna' a neat and stately tree, rarely seen in nurseries, was planted near the path and a little farther on, *Q. ellipsoidalis* E.J. Hill. that, according to Gert, has better autumn color than *Q. palustris*. Other trees that we found interesting in this part of the garden were *Q. robur* var. *thomasii* (Ten.) A. DC.[2], *Q. robur* Cristata Group and another *Q.* Pondaim Group with marcescent foliage. *Q. palustris* 'Windischleuba' Jablonski does best when pruned back from time to time to promote growth of its nice variegated foliage. A very old cultivar of *Q. petraea* that I had never seen before is *Q. petraea* 'Insecata' Rehder. Its leaf has a narrow white edge and is surprisingly beautiful when seen from below against the sunlight. Sophie took a group picture under a *Q. kelloggii* and then we went back to the Teahouse for lunch.

8/ *Q. palustris* 'Windischleuba'

A tour of Taiwan

In the afternoon Dr. Li-Ping Ju gave a presentation on the ecology and conservation of the endangered *Fagus hayatae* Palib. ex Hayata from Taiwan. This beech is closely related to *F. japonica* Maxim. and in Taiwan represents the southernmost distribution of the genus *Fagus*. It grows on north-facing mountain slopes in cloud forests at 1,500-2,000 m/4,900-6,500 ft. Dr. Ju explained to us that seed survival of this species is very low and that even in nurseries, germination rate and survival are poor. Due to global warming the habitat of *F. hayatae* is under serious threat and the trees have nowhere

2. Today considered a synonym of *Q. robur* subsp. *brutia* (Ten.) O. Schwarz.

9/ *Q. petraea* 'Insecata'

to go to since they already grow on the summit of these mountains. Other threats are typhoons that buffet the island from June to September, as well as a fast-growing bamboo that competes with the much slower-growing young beech seedlings, putting them in too much shade for them to survive.

In the second afternoon presentation, Prof. Fuh-Jiunn Pan presented the systematics and morphology of the 42 species of *Fagaceae* in Taiwan (in the genus *Quercus* from sections *Cyclobalanopsi*s and *Quercus*, and in the genera *Castanopsis* and *Lithocarpus*). The endemics of Taiwan like *Q. longinux* Hayata, *Q. tatakaensis* Tomiya, and the ornamental *Q. repandifolia* J.C. Liao[3] were new to most of us. Prof. Pan's presentation was very nicely illustrated with splendid photos and systematic overviews, all of which would have been more than enough material for a long and interesting article on its own.

After tea and cake, we all went to the greenhouse for an interesting exhibition of oak wood especially arranged for us by the Dutch Wood Collectors Society. Having been a cabinetmaker in my former life, I recognized most of it as oak wood, but I was surprised how they all differed in color and texture. To finish this warm and instructive meeting we all went to the entrance building for the plant sale where Gert, Jeroen, and I had prepared some rare young seedlings and grafted oaks that participants could purchase to add to their collections.

Finally we all said goodbye thanking Gert and his staff for these wonderful two days, as we set off to return to our homes with very good memories and lots of new ideas for our own oak collections. We saw many more oaks and other trees and shrubs than I could possibly mention in this article, but I hope that I have made all of you who read this eager to visit this dendrological paradise and perhaps to discover even more hidden treasures!

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Participants. Dirk Benoit, Andréa De Cock Stiers, Ronny Van Keer, Fanny Vanschoelant, Philip Stiers (Belgium); Ondřej Fous, Dušan Plaček (Czech Republic); Béatrice Chassé, Shaun Haddock, Sophie Kling (France); Jo Bömer, Jeroen Braakman, Gert Fortgens, Hans van Gemeren, Gerard Heerebout, Anne Hilder, Hans Janssen, Jo de Martelaer, Nelis Mourik, Gerda Roerink, Bart Schipper, Frans Steenland (the Netherlands); José Luis Vallines, Mario Vallines (Spain); Fuh-Jiunn Pan, Li-Ping Ju (Taiwan); Rama Lopez-Rivera, Harriet Tupper (United Kingdom).

Photographers. Photos 1-9: Gert Fortgens.

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3. *Q. repandifolia* is an accepted name in the *Red List of Oaks* (2007) but is treated today as a synonym of *Q. glauca*.

Oak Open Days Southern Italy October 19-22, 2014

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Introduction

On the evening of October 19, participants coming from abroad met in the Bari airport and were transferred to Riva del Sol Hotel in Giovinazzo. After a short welcome meeting in the lobby and garden of the hotel most of the participants decided to visit Bari, notably to see the Basilica de San Nicola and to have a good but expensive meal in a typical restaurant. Bari is a city that lies on the east coast of Italy slightly north of the 41st parallel. It is a well-known port and university city and the second most important economic center of mainland Southern Italy after Naples.

The following morning we received a briefing from IOS member Christof Van Hulle, one of the organizers of this event, along with IOS members Dirk Benoit and Morgan Santini. Outside, the bus was ready and waiting so off we went for the start of what promised to be a very interesting three days.

October 20: from Bari to Sfilzi

Following the northbound A14 highway we admired the landscape of vast areas of cultivated land hosting vegetables, olives, almonds, kiwis, grapes, and other fruit trees. In the uncultivated areas, we noted *Pinus halepensis* Mill. and *P. pinea* L., so characteristic of the Mediterranean. Leaving the A14 in an eastward direction we took a road that follows the coastline, passing along the way the Riserva natural Salina di Margherita di Savoia located between the Orfanto River and the town of Manfredonia.

The Riserva is a Ramsar Convention[1] site that includes the largest salt lake in Europe and the second largest in the world (3,870 ha/9,560 ac). Seventy-five percent of the country's salt production comes from here. The entire reserve includes 75,000 ha/185,000 ac of prime wetland. The associated flora of salt-tolerant plants and the rich macroinvertebrate fauna represent an ideal food source for thousands of sedentary and migratory shorebirds.

From our bus posted at a convenient viewing point along the roadside, we were able to observe hundreds of greater flamingos (*Phoenicopterus roseus* Pallas), little egrets (*Egretta garzetta* L.), black-winged stilts (*Himantopus himantopus* L.), pied avocets (*Recurvirostra avosetta* L.), different curlews (*Numenius* spp.), and slender-billed gulls (*Chroicocephalus genei* Brème). The marshes are a favored breeding site for Eurasian spoonbills (*Platalea leucorodia* L.), glossy ibis (*Plegadis falcinellus* L.), five species of heron and many others. One of the few remaining breeding colonies of the little tern (*Sternula albifrons* Pallas) is here.

1/ The Gargano Promontory and the Foresta Umbra.

On both sides of our observation spot, we saw several bushes of *Myoporum* sp. (possibly *M. tetrandrum* Labill.) Domin. Indigenous to Australia, New Zealand and New Caledonia, this genus includes many drought- and

1. Officially known as the Convention on Wetlands of International Importance, it is referred to as the Ramsar Convention because it was signed in Ramsar (Iran) in 1971.

salt-tolerant trees and shrubs, some of which have become naturalized, even invasive, in Italy. In the surrounding areas we saw giant clumps of *Arundo donax* L., also known to be drought- and salt-resistant.

Continuing northward to Gargano, we passed through the province of Foggia, with its important industrial infrastructure. In economic regression and suffering from increasing unemployment, it is a vast landscape of industrial archeology.

Manfredonia: gateway to the Gargano[2]

At a distance, in the sunlight, we saw the highlands of the Gargano Promontory behind the city of Manfredonia that lies at the foot of the southern slopes. The sub-region of the province of Foggia, the Gargano, is in fact a detached piece of Central Europe that remained an island until the accumulation of silt and conglomerated soils, combined with sea-level lowering during the last Ice Age, joined it to the mainland. It is a limestone plateau extending 30 km/19 mi into the Adriatic Sea to form the spur of the Italian boot. Relictual populations of Alpine, Appenine, Mediterranean and Dalmatian (trans-Adriatic) flora are found here, especially in the Foresta Umbra (the remains of ancient oak and beech forest that once covered Central Europe).

The strong influence of postglacial *Quercus petraea* (Matt.) Liebl. and *Q. robur* L. on the southern *Q. pubescens* Willd., has created an ideal situation for hybridization, and identifying individual trees based on external characteristics is very difficult. Whether hybrids or representative of a very high degree of intraspecific polymorphism, the nomenclatural history of the above-named taxa clearly shows that a wide range of phenotypes exist and

2/ Intraspecific variation in *Quercus pubescens*.

2. The word "Gargano" refers to many things: the Gargano as sub-region of the province of Foggia; the name of the mountain peaks in that sub-region, the Gargano Promontory; the name of the highest peak, Monte Gargano; and the name of the National Park created in 1991.

that at one time or another many of these were given different names by different authors. *Q. amplifolia* Guss., *Q. appenina* Lam., *Q. banja* Endl., *Q. cupaniana* Guss., *Q. laciniosa* Boreau, *Q. tommasinii* Kotschy ex Vis., and *Q. virgiliana* (Ten.) Ten. are just a few of the myriad names that have been published for the various forms of *Q. pubescens*.

The dryer slopes of the Gargano are typical maquis with xerophilous and fragrant, low-growing vegetation including the white flowered *Thymus spinulosus* Ten. and the smaller, very strong-smelling *T. capitatus* L., *Rosmarinus officinalis* L., *Cytisus villosus* Pourr., *Genista acanthoclada* A. DC., *Spartium junceum* L., *Artemisia* spp., *Ferula communis* L. with its distinctive dried seed-bearing skeletons, and the naturalized *Opuntia ficus-indica* (L.) Mill. that can be seen everywhere along the road,

Climbing through a number of hairpin turns we made a short stop for *Pinus halepensis* seedlings growing along the roadside. Here we also found small suckering bushes of *Ulmus canescens* Melville exhibiting its corky twigs and from what we could see at a distance, there appeared to be *P. nigra* var. *maritima* (Aiton) Melville.[3]

The Foresta Umbra

In our approach to the Foresta Umbra, we drove through a small city on the eastern edge of the Gargano, Monte Sant'Angelo, where I asked myself, why are there almost no cars in the streets? My hypothesis is that the inhabitants hide their cars from the very hot sun!

Depending on which explanation you choose, Foresta Umbra means either the "shady forest" or the "forest of the Umbrians". The protected part of this forest covers 10,000 ha/25,000 ac. Due to the particular climatic conditions found here, it is composed of species normally associated with colder regions like *Fagus sylvatica* L., *Carpinus betulus* L., *Tilia platyphyllos* Scop., *Salix alba* L., *Abies alba* Mill., *Euonymus europaeus* L., mixed together with more oriental (trans-Adriatic) species like *E. latifolius* (L.) Mill., *Carpinus orientalis* Mill., and *Ostrya carpinifolia* Scop.

Before we reached the heart of the forest a number of interesting deciduous trees invited us for a short stop and very quickly everybody was excitedly exploring the roadside and neighboring bushes. We immediately made friends with a flock of free-ranging domestic pigs, as interested in the acorns as we were. Podolica cattle, a breed of domestic cattle with a registered pedigree in Italy since 1931, are also free-ranging in this region. Fallow deer (*Dama dama* L.) and argali or wild mountain sheep (*Ovis ammon* var. *musimon* L.), introduced for hunting, can also be seen.

As we moved further into the forest, we found a number of *Quercus cerris* L., *Q. pubescens* Willd., and *Quercus ilex* L. Also to be found here: *Acer obtusatum* Waldst. & Kit. ex Willd,[4] *Fraxinus ornus* L., *Pyrus amygdaliformis* Vill., *Prunus spinosa* L., *Cistus creticus* L., and *C. monspeliensis* L. A species of crocus was in full bloom (possibly *C. longiflorus* Raf.) and *Hedera helix* L., very successful here, decorates the entire forest.

On the rocky, dry soil on the edge of the forest, young flowering racemes of *Urginea maritima* (L.) Baker[5] were popping out of the large bulbs. This plant, in the family *Asparagaceae*, is used in medicine and the scilliroside-containing leaf bases can be used as a rat poison. This species forms its leaves and seeds in winter and spring, with the

3. Considered a synonym of *P. nigra* subsp. *laricio* Maire.
4. Considered a synonym of *A. opalus* subsp. *obtusatum* (Waldst. & Kit. ex Willd.) Gams.
5. Considerd a synonym of *Drimia maritima* (L.) Stearn.

3/ a) *Arisarum proboscideum* (?) b) *Phillyrea latifolia* L. c) *Arbutus unedo* d) *Pistacia terebinthus* e) *Ruscus aculeatus*.

flowers appearing in autumn on the naked and dry aboveground bulbs.

Passing through beautiful undulating landscapes the vast forest on the green hills contrasted dramatically with treeless valleys, whitish calcareous slopes, and meadows strewn with rocks and stones. Where the forest becomes denser and higher, the ground was covered with the rosy flowers of *Cyclamen hederifolium* Aiton. We noted the presence of different ferns (*Ceterach officinarum* Willd., *Adiantum* sp., and *Asplenium* sp.) in the drier areas and, in shadier spots, *Phyllitis scolopendrium* (L.) Newman[6] and *Dryopteris* sp.

Several species of oak were to be admired, including *Q. pubescens*, a monumental *Q. cerris*, and a few enormous *Q. ilex*. Also present here: *Carpinus betulus*, *Tilia platyphyllos* and a few maples that we had not previously seen: *A. obtusatum* var. *neapolitanum* (Ten.) A. DC.,[7] *A. opalus* Mill.), *A. pseudoplatanus* L. and *A. campestre* L. We made a point of stopping to see the Tasso dell'Ispettore, the most famous of the many very large and very old *Taxus baccata* L. in the Foresta Umbra. Along the roadside, we admired a great variety of plants including *Rosa sempervirens* L., *Laurus nobilis* L., *Ilex aquifolium* L., *Viburnum tinus* L., *Rhamnus alaternus* L., *Ulmus glabra* Huds., *Sorbus torminalis* (L.) Crantz, *Lonicera etrusca* Santi, and *Asparagus acutifolius* L.

As each stop was the signal for a busy exploration of the area, the picnic in the forest that was to be our lunch was heartily welcomed by hungry oak lovers! The menu, consisting of regional specialties, was a revelation! Our compliments to Renzo Basile, Christof Van Hulle's brother-in-law, who had made all the arrangements for the feast. It was my first try of a strong-tasting *caciocavallo* (a generic term for a kind of stretched-curd cheese). Combined with a generous amount of Primitivo di Manduria (the local red wine) it was a successful combination that I will always remember!

Around our picnic site, with food-in-hand, we still didn't stop exploring! Here we saw *Daphne laureola* L., the extremely prickly *Smilax aspera* L., the remarkable marmorated leaves of the spring-flowering *Cyclamen repandum* Sm., and a prickly member of the family *Asparagaceae*, *Ruscus aculeatus* L., with fruiting female plants and their strikingly red berries.

Sentiero N° 1: Sfilzi to Casalini

4/ *Quercus ilex*

After lunch we embarked on the Sentiero N° 1 (one of the 15 *sentieri* in the Foresta Umbra). We began our walk on this very pleasant 2.5 km/1.6 mi route from Sfilzi, at 600 m/2,000 ft, and descended slightly to 520 m/1700 ft to reach Casalini. The roundtrip took us about 3 hours.

Besides the species already mentioned, we saw exceptionally large, tree-sized *Pistacia terebinthus* L., as well as the smaller, albeit respectably sized, *Pistacia lentiscus*

6. Considered a synonym of *Asplenium scolopendrium* L.

7. Considered a synonym of *Acer opalus* subsp. *obtusatum* (Waldst. & Kit. ex Willd.) Gams.

L. This forest path is literally a parade of interesting species: *Paliurus spina-christi* Mill., *Cercis siliquastrum* L., *Ceratonia siliqua* L., *Erica arborea* L., *Arbutus unedo* L., *Olea europaea* var. *sylvestris* (Mill.) Lehr.,[8] *Pyrus pyraster* (L.) Burgsd., and *P. amygdaliformis* Vill.). At the end of the route, near a small building, we found a *Juniperus oxycedrus* L. and not far from it a small European black scorpion (*Euscorpius flavicaudis* De Geer) that is not dangerous although the sting is very painful. A few extremely polite attempts were made to get it to pose for a photograph!

On the road again, a short ride took us to the Convento dei Cappuccini in Vico del Gargano to admire a very large and very old *Q. ilex*. It shows the marks of an eventful past, with a big hole and scar on one side from a lost head-branch and/or a lightning strike. Tourists love to use the large cavity in the massive trunk as a background for photographs! The tree is otherwise healthy with a dense crown and fresh leaves. Though it was fruiting most of the acorns were out of reach. Disappointed IOS members were soon happy again as we were invited to have a drink at the local bar very appropriately named Panninoteca la Quercia.

To end this very long and exciting day, we headed for the Rifugio Sfilzi. Once a resting place for shepherds leading their animals from Abruzzo to Puglia and back, it is now a farm-type B&B. After settling into our rooms we were invited to taste some of the regional alcoholic specialties before dinner. Many thanks to our very busy hostess and chef, although regretfully, several of our group, unaware of the complete menu, ate too much of the many starters and could not honor the lamb and mushroom main course!

Day 2: from Sfilzi to Martina Franca

The next morning, everybody was ready for an 8:30 am departure and off we went, southbound, for our 260 km/160 mi drive to Martina Franca. Along the way we had occasion to remark how fertile the land is in this region: everywhere there are vineyards, almond orchards, figs, olives, industrial vegetable fields, cereal crops (wheat, corn, maize) as well as small, individual gardens near houses. Some 30 minutes from Taranto (due south of Bari on the opposite coast) the open landscape changes into an open oak forest.

Our study site for the day was the Riserva Naturale Regionale Orientata Bosco delle Pianelle. Theoretically only 15 minutes from Martina Franca, it took us a little longer as we got stuck in the Massafra weekly market traffic congestion.

Upon arrival at the Visitors Center, a wonderful picnic, prepared by Renzo, was waiting for us. As delicious as the previous one, it was a wonderful combination of fruit (including cactus figs, kaki and grapes), cheese, dried ham and other regional meat specialties, different traditional types of bread, a variety of delicious pies and…more than enough wine!

To explore the forest, we chose an itinerary that was an estimated 8 km/5 mi walk beginning in open vegetation and ending in a denser, darker part. Seven species of oak are found here, *Q. pubescens, Q. robur, Q. cerris, Q. ilex* and three that we had not yet seen: *Q. trojana* Webb., Q. *dalechampii* Ten., and Q. *coccifera* L. Other interesting plants along the road included several species in the genera *Phillyrea* and *Prunus*, and perhaps a third species of cistus (*Cistus salviifolius* L.). In order to make the trip even more exciting, Christof led us off of the trail through the bush to a steep descent, fortunately

8. Considered a synonym of *Olea europaea* L.

5/ *Quercus coccifera* acorns.

ending on a road. This adventure resulted not only in a few more interesting discoveries, but it also convinced us of the ecological value of the area.

We visited the city of Martina Franca (where Christof Van Hulle was married and where his parents-in-law live) on the way to our lodgings for the night in Alberobello, a reconverted farmhouse called Madonna dell'Arco with very comfortable rooms in individual *trulli*. The town of Alberobello is famous for these greyish, cone-roofed, little buildings used as storehouses, shelters, or houses, and that are made with traditional 19th century Apulian dry-stone masonry (i.e., without the use of mortar). We were invited for a swim, but most of us were too hungry and moved into the dining room rapidly where we had the pleasure of meeting Christof's family. The owners had prepared an amazing dinner, a real promotion for the farm products that are their specialty. Fine food, good company, great spirits all around, but, exhausted as we were, we soon retired to our beds!

October 22: all the way to Tricase

After a copious breakfast, we were off again for a 170 km/110 mi drive to Tricase that would take us nearly to the tip of the boot heel. Our first stop on arrival was to see the Quercia dei Cento Cavalieri di Tricase, a monumental *Q. macrolepis* Kotschy. The tree is in a fenced area of 5,000 m^2/50,000 ft^2 and is growing with a few other trees, presumably, *Q. dalechampii*. Classified as a natural monument by UNESCO in 1979, the oldest estimate dates it from the 11th century (but I think that this is an exaggeration!). Certain enthusiastic oak lovers soon got over the fence, and walked over one of the heavy vertical branches, perhaps without realizing that this was not very respectful towards this old lady! As I have seen a few of these giant trees growing in Dymokastro in Northwest Greece, I was more attracted by other oaks nearby that had similar hybrid characteristics to an oak that we would see later on with Oreste Caroppo.

With enough time left before lunch we had a stroll through the Bosco Monotipico di Tricase, a landscaped area and educational plant garden with conservation status. We walked along an interesting wild hedge of fairly typical *Q. coccifera* with large leaves, long acorns, and cups that cover only one third of the nut. The mountain form of the species has smaller, very prickly leaves, and the cups cover only half or less of the acorn. The cohabitation of these two types of *Q. coccifera* is familiar to me; it is common on the southeastern slopes of the Kalodiki marshes near Morfi (Parga) in Greece. Some of the indigenous oaks were labeled,

6/ Tricase Harbor, a beautiful setting for a picnic lunch.

and we were glad to see *Q. macrolepis* and *Q. pubescens* with fruit, as well as *Q. ithaburensis* (a species not native to Italy) that had been planted.

Here we also found *Dioscorea communis* (L.) Caddick & Wilkin, the rare *Ephedra foemina* Forssk., *Cistus incanus* L. and a female plant of *Ceratonia siliqua* L. with ripe seed pods. Highly rich in protein, it has been planted in the Mediterranean as fodder for centuries so its distribution has been largely extended.

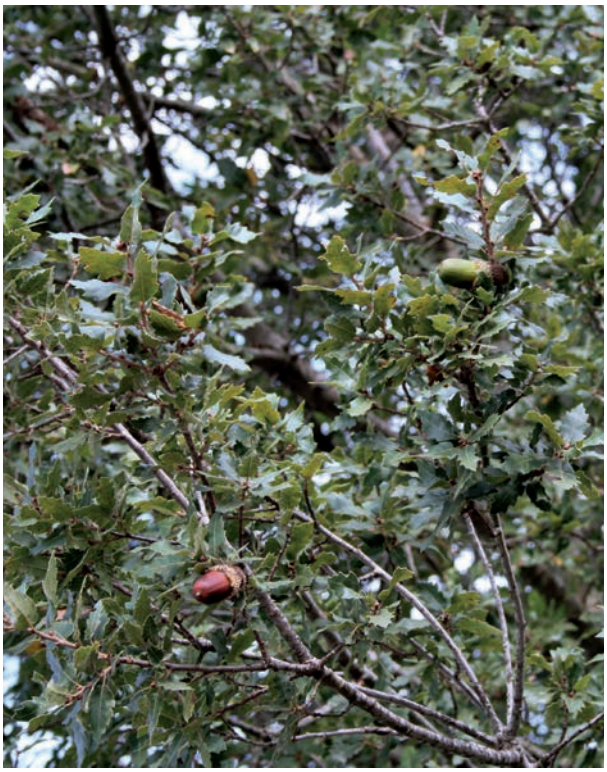
7/ From left to right: Morgan Santini, Dirk Benoit, Christof Van Hull, Oreste Caroppo.

A very inconspicuous small flower proved upon examination to be the autumn-flowering *Narcissus serotinus* L. (confirmed by Morgan Santini, and his father, Claudio, who we contacted on several occasions for more botanical information!). We also found a member of the family *Araceae*, probably *Arisarum proboscideum* (L.) Savi. This perennial dies off in summer, leaving only a spike with orange berries, grows back in autumn, and flowers in the spring with a distinctly "tailed" spathe. Climbing over and into shrubs in the undergrowth between the oak trees, *Smilax aspera* L., a common liana in Southern Europe. Though exhibiting beautiful marmorated leaves, and long bunches of attractive blood-red fruit, it is above all dreaded by hikers and field botanists for the cruel wounds it can inflict if one tries to walk through the clumps it forms.

For our last picnic, after this short but very instructive visit, we sat along the docks of Tricase Harbor where *Capparis spinosa* L. that we had seen on several occasions was growing. The flowers are pure white with purple stamens, and the immature flower buds, conserved in salt or vinegar are known in kitchens around the world: in English, capers.

After lunch, we drove to the town of Maglie, where we met with botanist Oreste Caroppo. In 2012, Oreste discovered a putative hybrid between *Q. coccifera* and *Q. cerris*. Apparently only one tree – very healthy though recovering from drastic pruning by city authorities – is known to date. We noticed that the tree was fruiting but that there were

8a-b/ Putative hybrid between *Quercus cerris* and *Q. coccifera.*



9/ Putative hybrid between *Quercus cerris* and *Q. coccifera.*

no young saplings nearby – due to over zealous urban maintenance, according to Morgan Santini who has raised seedlings from acorns collected here. The shiny, long-lasting, dark green leaves are interesting and Dirk Benoit collected scions for grafting. The name that has been proposed to designate this plant is *Q.* ×*caroppoi* (publication is in preparation by Dott. Piero Medagli of the Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Universià del Salento).

Following Oreste's suggestion, we moved on to a station of *Q. frainetto*, passing on the road many *Q. coccifera* and numerous trees and shrubs that we had seen before. We saw several very typical *Q. frainetto* and a few rather atypical types that seemed to be intermediate between this species and *Q. robur.* In Greece there seems to be a range of transition between *Q. frainetto* and *Q. pubescens*, and it is not always easy to distinguish between the two.

Oreste then led us to our final destination to see an interesting, large oak, representative of that form of *Q. pubescens* that used to be called *Q. amplifolia*. Originally described and named in 1844 by Giovanni Gussone it was subsequently renamed *Q. lanuginosa* var. *amplifolia* by Borzí in 1880 and then, by Nyman, in 1881, as *Q. appenina* subsp. *amplifolia*. Today, these are all considered to be heterotypic synonyms of *Q. pubescens* subsp. *pubescens* (today several hundred names are considered synonyms of *Q. pubescens* or heterotypic synonyms of *Q. pubescens* subsp. *pubescens*!).

Although I looked carefully at the leaves, acorns and cups, it was difficult to draw any conclusions especially since we did not have that much time to examine the surrounding trees of the same population. I have seen very similar trees in Bulgaria, Turkey and Northwest Greece, and I thought at the time that they seemed to be intermediate between *Q. robur* subsp. *pedunculiflora* (K. Koch) Menitsky and *Q. pubescen*s.

After this very interesting excursion in such a floristically rich region, thus far not explored by IOS members, we returned to Bari, happy and tired.

Participants. Dirk Benoit, Gert Dessoy, Dominique D'Haene, Jacques Dheedene, Josée Segers, Christof Van Hulle, Ronny Van Keer, Bruno Van Puyenbroeck, Fanny Vanschoelant (Belgium); Nora Vogel (France); Oreste Caroppo, Morgan Santini, Renzo Basile (Italy); Wiecher Huisman, Bart Schipper (the Netherlands).

Photographers. Photos 1-6, 8 a-b: Geert Dessoy. Photo 7, 9: Bruno Van Puyenbroeck.

Glimpses of the Oaks of Bhutan October 12-29, 2014

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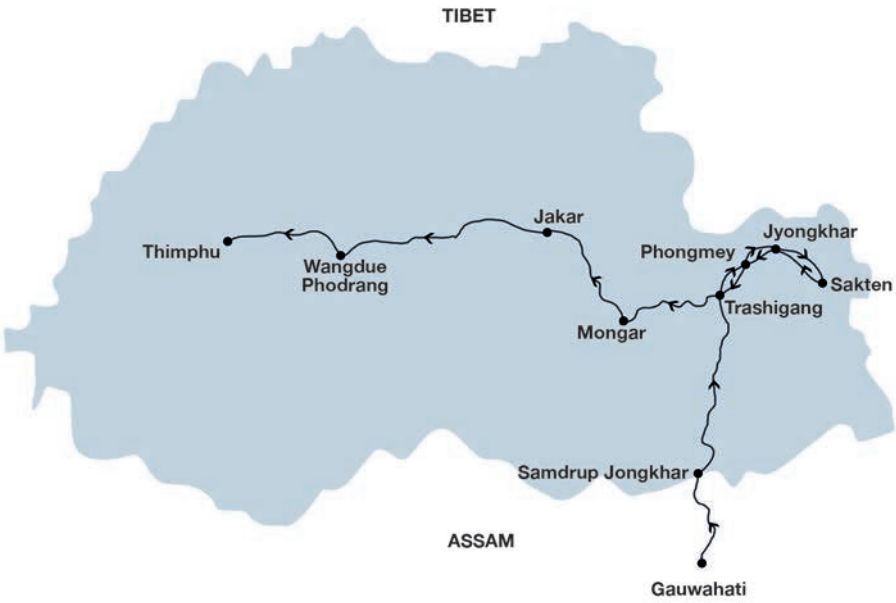


Introduction

On the International Dendrology Society (IDS) Tour of Bhutan, 8 of the 18 native *Fagaceae* of Bhutan (in the genera *Quercus*, *Castanopsis*, and *Lithocarpus*) were observed in their natural habitats. The IDS promotes international collaboration in the study and conservation of forests and woody plants around the world, particularly through its tours to many different countries. The first IDS tour to Bhutan took place in 2004 and explored the more accessible western parts, but it was felt that a second tour centered on the east of the country was needed to see more of the colorful culture, extensive forests and diversity of conifers, oaks, rhododendrons, and other woody plants with which Bhutan is richly endowed. The indefatigable organizer of the 2014 tour was Anke Mattern from Germany.

Bhutan is a relatively small country in the Himalayan foothills, 300 km/190 mi east to west and 150 km/90 mi north to south, rising from the subtropical north Indian plain to snowy peaks of over 7,000 m/23,000 ft in the north. It is bordered by China (Tibet) to the north, and then, clockwise from the east, the Indian states of Arunachal Pradesh, Assam and West Bengal. There is only one road across Bhutan linking the sparsely populated east with the capital Thimphu in the west, and as it frequently falls victim to landslides during the summer monsoon, travel can be unpredictable (many Bhutanese prefer the longer Indian alternative in summer). The river systems run from north to south, bringing monsoon rain and snowmelt down to the Indian plains: thus the east/west road zigs and zags its way up and down from valley to pass and back again. The advantage of this to those of botanical inclination is that they are presented again and again with the same succession of vegetation between as low as 900 m/3,000 ft and as high as 3,400/11,200 ft, each time with slight modifications due to aspect or soil. Although found between 1,100 and 3,200 m/3,600 and 10,000 ft, oaks concentrate in the band between 2,000 and 2,600 m/7,000 and 8,500 ft, where they are often the dominant tree species and frequently home to a rich diversity of epiphytic vegetation from lichens, mosses, orchids and ferns to rhododendrons.

On the 2014 tour we used the eastern option by flying to Guwahati in the Brahmaputra Valley of Assam, then by road into east Bhutan. Thus on October 12 the group who assembled at Guwahati comprised 18 IDS members from Argentina, France, Germany, Ireland, the Netherlands, Switzerland, and the UK, along with botanist David Long from the Royal Botanic Garden, Edinburgh, and 3 UK students sponsored by the IDS. After a smooth drive across the river and surrounding Assam plains of just over two hours, we entered Bhutan through the ceremonial arch at Samdrup Jongkhar where we met our four Bhutanese partners – the very capable tour leader Tsewang Rinzing of Sakten Tours & Treks, senior Bhutanese botanist Raling Ngawang, National Herbarium Curator Rinchen Yangzom, and her assistant Tshering Dorji, to complete the group of 26 participants.

1/ Raling Ngawang introducing the group to Bhutan.

Three oaks to greet us

For those new to Bhutan, the next day's (October 13) drive north to the eastern capital of Bhutan, Trashigang, was a complete revelation. The journey began at Samdrup Jongkhar at 220 m/720 ft altitude, in the subtropical belt which clothes the southern border area of Bhutan, dominated by dense jungle with trees such as *Bombax ceiba* L., *Dillenia indica* L., *Duabanga grandiflora* (DC.) Walp., *Erythrina arborescens* Roxb. with striking red flowers, and the screw pine *Pandanus nepalensis* H. St. John. It was difficult to resist the temptation to stop every kilometer, but as the long journey was to take us up through zones of warm broadleaf forest into cool evergreen broadleaf forest to up to 2,700 m/8,800 ft on Yonphu La then back down to the hot dry valley of Trashigang at 900 m/3,000 ft, roadside stops had to be severely rationed.

On occasion, our stops were enforced by road works (in fact road widening which seems to be taking place on every road in Bhutan) and at such a halt our first oak was seen amid the clouds of dust from the blasting and bulldozers, just south of the village of Narfong. This was *Quercus glauca* subsp. *annulata* (Sm.) A. Camus[1] with leathery, lanceolate leaves, growing with *Alnus nepalensis* D. Don, *Betula alnoides* Buch.-Ham. ex D. Don, and *Corylus ferox* Wall. Lunch was delayed until after the turnoff to Pemagatshel, and an unscheduled stop at Nangshi to admire perhaps the most splendid of the Bhutanese oaks, *Q. lamellosa* Sm., with its large, dark green, glossy leaves and enormous cupules consisting of concentric rings of lamellae. We were later to admire this handsome oak many times. By now we were seeing one of the real East Bhutanese specialities, *Pinus bhutanica* Grierson, D.G. Long & C.N. Page, described as recently as 1980, forming very handsome stands in quite moist forest, with its characteristic long pendulous glaucous-green needles. Picnic lunch at Moshi at 2,230 m/7,320 ft was in dry woodland of two species of *Theaceae*: *Schima wallichii* Choisy and *S. khasiana* Dyer, mixed with our third oak *Q. lanata* Sm.,

2/ *Quercus glauca* subsp. *annulata*

3/ *Quercus lamellosa*

1. Considered today a synonym of *Q. annulata Sm.*

4/ Bhutanese woven cloth.

with lovely soft woolly undersides to its evergreen leaves. Our arrival in Trashigang was well after dark, thanks to a stop at the Khaling weaving center where we watched young trainees weaving some of the colorful Bhutanese cloth under the close tuition of an older expert. Needless to say, some participants' luggage gained somewhat in weight from this stop, while others admired the fruiting trees of *Cornus* (*Benthamidia*) *capitata* Wall. outside.

From Trashigang to Sakten and back

Trashigang is dominated by its historic *dzong* (a Bhutanese fortress both religious and administrative in function) overlooking the deep Drangme Chhu[2] Valley flowing south to India. Without delay we made preparations for the start of our trek early next morning (October 14) beginning at 8:00 a.m. with a two-hour road journey east up the Gamri Chhu Valley to Phongmey. A roadblock at a sawmill enforced a halt amidst rich shrubberies with many woody plants, some in flower, such as *Bauhinia purpurea* L., *Butea buteiformis* (Voigt) Mabb., *Ficus semicordata* Buch.-Ham. ex Sm., the brilliant red *Holmskioldia sanguinea* Retz., *Rhus chinensis* Mill., and *Woodfordia fruticosa* (L.) Kurz amongst open forest of the subtropical chir pine (*Pinus roxburghii* Sarg.). Another stop was to admire the flowering orchid, *Arundina graminifolia* (D. Don) Hochr., as well as the beautiful shrub *Luculia gratissima* (Wall.) Sweet with its fragrant tubular flowers.

5/ Trashigang Dzong.

6/ Gamri Chhu Valley and evergreen forest.

At Phongmey (about 1,700 m/5,500 ft altitude) our trek started, with a gradual assembly of ponies and oxen, quickly loaded with camping gear and baggage, while we made a start up the trail, having first admired our fourth oak species, the deciduous *Quercus griffithii*

2. In Dzongkha (the official language of Bhutan, sometimes referred to as Bhutanese), *chhu* means river.

Hook f. & Thomson ex Miq. with its coarsely-toothed obovate leaves. This species is named in honor of its discoverer William Griffith, the first botanist to visit the country, who, in 1838, traversed Bhutan along much of the same route we were taking. Our destination was the remote valley of Sakten, close to the eastern Bhutan border with Arunachal Pradesh, which we would reach after three trekking stages and two camps on the way. Our party being extremely diverse in ages, and with some participants never having camped before, Sakten Tours indulged us with comforts such as hot-water bottles and roaring camp fires, and with local villagers in traditional costumes brought in to dance and sing in the evenings. The daily walks were relatively leisurely, giving us ample time to study and photograph plants and collect specimens for the Thimphu herbarium.

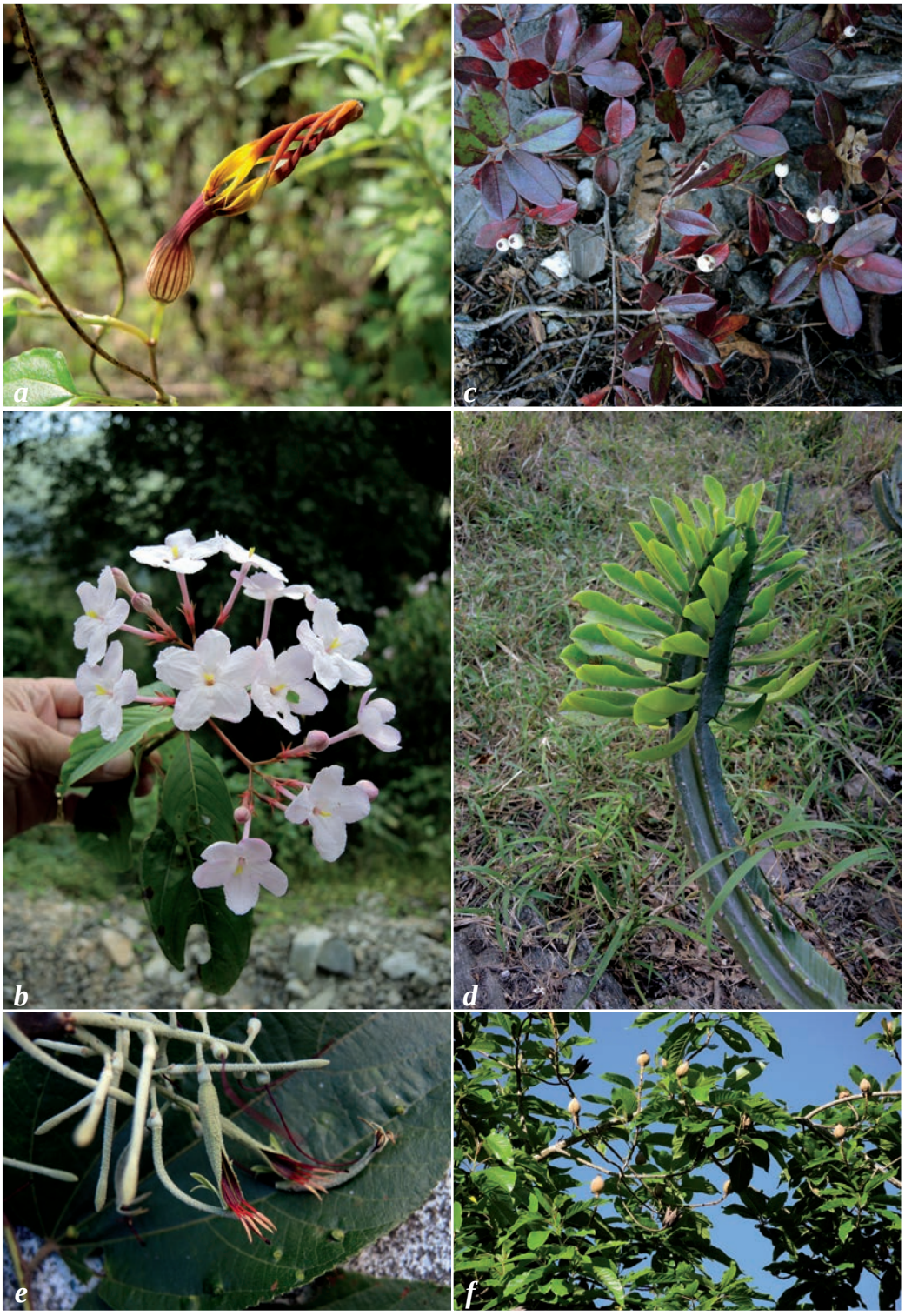
7/ The trek begins in the Gamri Chhu Valley.

8/ Sakten camp.

On the way to Sakten we passed through rich and relatively undisturbed forests (except for the new hydropower road now under construction) through zones of warm then cool broadleaf forest, and finally into temperate conifer forests. At lower altitudes on the first day we encountered our first chestnut, *Castanopsis tribuloides* (Sm.) A. DC. with its spiny cupules, forming extensive stands in places, along with *Rhododendron arboreum* Sm. and occasional trees of *Pinus bhutanica*, *Magnolia doltsopa* (Buch.-Ham. ex DC.) Figlar and an arborescent *Schefflera* species.

Our first camp at Jyongkhar was in a secluded clearing on the riverbank in an area with many plants of interest, including much *Q. lanata* and *Q. griffithii*, the latter suffering from the parasitic mistletoe *Scurrula elata* (Edgew.) Danser with striking pink and green tubular flowers. Above Jyongkhar the forest was dominated by these two oaks mixed with *Schima wallichii* and *Alnus nepalensis*. Occasional leafless trees of *Prunus cerasoides* Buch.-Ham. ex D. Don were very conspicuous with their pink flowers, but the walk was

9/ *Quercus griffithii*



10/ a) *Ceropegia pubescens* Wall. b) *Luculia gratissima* c) *Sorbus macallisteri* Rushforth d) *Euphorbia royleana* Boiss. e) *Scurrula pulverulenta* (Wall.) G. Don f) *Itoa orientalis* Hemsl.

spoiled when we had to join the new road under construction and scramble up and down some unstable landslips. After the second camp at Thokthri (October 16) we were back on the proper trail, and were treated to spectacular giant trees of *Pinus bhutanica* and *Tsuga dumosa* (D. Don) Eichler in a sacred grove. Rhododendrons, not in flower in this season, became more conspicuous, notably the big-leaved species *R. grande* Wight and later *R. falconeri*. Hook f. Hanging over the path, the rare shrub *Clethra delavayi* Franch. was unexpected, and trees of *Magnolia campbellii* Hook f. & Thomson became more abundant. As we entered *Tsuga*-dominated forest at about 2,700 m/8,900 ft, another oak, *Q. semecarpifolia* Sm., became common, both short, shrubby forms with toothed, holly-like leaves, and taller trees with entire leaves.

Sakten, where we camped for two nights at 2,900 m/9,500 ft on a grassy terrace above the river, proved to be a beautiful village with broad meadows dotted with yaks and horses, surrounded by forested mountains in all directions and overlooked by the monastery or *lakhang*. The delightful local people (the Brokpas) are famous for their colorful costumes and unique hats made from Yak wool – like French berets but with five tails hanging down for drainage. On the steep slope above the river opposite our camp was a wonderful forest vista, bathed in autumn sunshine, of hemlock (*Tsuga dumosa*), fir (*Abies densa* Griff.), juniper (*Juniperus recurva* Buch.-Ham. ex D. Don), larch (*Larix griffithii* Hook. f., and some deciduous trees, particularly maples and birch (*Betula utilis* D. Don), coming into fine autumn color. Noisy choughs[3] circled overhead, while a steady stream of yaks with wooden packsaddles headed downhill through the village. After the frost lifted and an outdoor breakfast, we spent October 17 walking up to the monastery, hard work in the thin air at 3,200 m/10,500 ft.

The *lakhang* commands a superb view over the Sakten valley, right up to the border ridge with India. It stands amidst open meadows and shrubberies with *Q. semecarpifolia*, *Rhododendron arboreum*, *R. kesangiae* D.G. Long & Rushforth, *R. barbatum* Wall. ex G. Don, and *Daphne bholua* Buch.-Ham. ex D. Don. After removing shoes and inspecting the interior, we took lunch outside before a leisurely stroll back to the village. A huge *Q. semecarpifolia*, of great antiquity, was a commanding presence in the village; its height was calculated (after some discussion) at 21 m/69 ft, and the trunk, 5.76 m/18.89 ft at dbh.

On our return walk to Trashigang we retraced our steps over two rather than three days, but nevertheless spotted several good plants overlooked on the way up. Most notable was a small rowan with beautiful white-flushed pink berries that we identified as *Sorbus macallisteri* Rushforth known before only from Arunachal Pradesh, and named in honor of Hugh McAllister, the British rowan expert who later confirmed the identification. This was a most unexpected but welcome addition to the Bhutan flora.

After returning to the warmth and comfort of Trashigang we spent a day exploring the Kulong Chhu Valley north to the village of Trashi Yangtse, and the nearby Chorten Kora, a splendid religious monument by the river. Although a dry valley, the flora was subtropical with stands of *Cycas pectinata* Buch.-Ham., trees of *Duabanga grandiflora*, *Radermachera sinica* (Hance) Hemsl., *Sloanea tomentosa* (Benth.) Rehder & E.H. Wilson and *Ulmus lanceifolia* Roxb. ex Wall. The now familiar oaks *Q. griffithii* and *Q. lanata* were again common.

3. The common name for the two species in the genus *Pyrrhocorax* of the *Corvidae* (crow) family.

Westward bound

On October 21 we began the long journey westwards across central Bhutan following first the hot dry Drangme Chhu Valley where the abundant lemon grass (*Cymbopogon*) from which is extracted fragrant oil grows by the roadside amongst *Pinus roxburghii*. We then climbed the numerous hairpins up to the Kori La[4] at 2,298 m/6,561 ft altitude. Here a great deal of logging of oaks and other trees has taken place in recent years but scattered mature trees of *Q. lamellosa* survive amongst beautiful stands of *Daphniphyllum chartaceum* K. Rosenthal. Fruiting shrubs such as *Ardisia macrocarpa* Wall., *Dichroa febrifuga* Lour., and *Viburnum erubescens* Wall. formed an understorey.

The night was spent in the comfort of the Wangchuk Hotel in Mongar with an early start the following day (October 22), down the steep descent to the Kuru Chhu Bridge, followed by the long ascent to Thrumseng La National Park. First we passed the ruined Shongar Dzong, then gradually climbed through cultivated terraces and patches of forest where *Talauma hodgsonii* Hook. f. & Thomson[5] related to *Magnolia*, was common. Our colleague Raling spotted some trees of a species known locally as *golonang shing* but never identified botanically though reported to us from several places in east Bhutan. The trees bore erect ovoid pods which first dehisced from the top, then later from the base revealing hundreds of winged seeds. Browsing the *Flora of Bhutan* drew a blank so images were later sent to David Boufford in Harvard, specialist on Chinese plants, who solved the mystery – the tree is *Itoa orientalis* Hemsl. in the tropical family *Flacourtiaceae*. Previously it was known only from China and Vietnam, so it is new not only to Bhutan but the whole Himalaya. Nearby were fine trees of *Engelhardia spicata* Lesch. ex Blume, a large tree in the *Juglandaceae* with pendulous racemes of winged seeds, and also our first sight of the genus *Lithocarpus*, characterized by its fused cupules with only the apex of the acorn protruding. This is *Lithocarpus fenestratus* (Roxb.) Rehder.

11/ *Lithocarpus fenestratus*

Soon after we entered the truly spectacular Thrumseng La National Park, a magnificent wilderness of forested ridges and steep south-facing slopes which catch an exceptionally high rainfall from the summer monsoon. Here the narrow road teeters along precipices with views of big waterfalls and dense forest. Only a brief stop was possible to admire the panorama and trees such as *Magnolia campbellii*, *Tetracentron sinense* Oliv. and *Taxus wallichiana* Zucc. Lunch was a picnic at the Latong La at 2,745 m/6,560 ft, where we noticed a new oak, *Q. thomsoniana* A. DC., related to *Q. lamellosa* but with smaller leaves with fewer veins and cupules only half enclosing the acorns. The Thrumseng La was then crossed, at over 3,500 m/9,800 ft, in spectacular *Abies densa*/*Rhododendron* forest. After a very brief stop we continued our long journey to Jakar, arriving long after dark, to a warm welcome at the Kaila Guest House.

4. In Dzongkha (the official language of Bhutan, sometimes referred to as Bhutanese), *la* means mountain pass.
5. Considered a synonym of *Magnolia hodgsonii* (Hook. f. & Thomson) H. Keng.

12 a-b/ *Quercus thomsoniana*

The next day (October 23) we awoke to a sunny morning in the broad Bumthang Valley, where we were led on a leisurely stroll through the town to the Wangdi Choling Palace by Raling, who gave us a description of its history and significance. Outside were very old trees of the native Himalayan pear (*Pyrus pashia* Buch.-Ham. ex D. Don) bearing abundant ripe and edible fruit, tasty both to us and numerous bees. The colorful murals as well as the magnificent wood carving in the Palace were much admired. We were then taken on a short drive up the Bumthang Chhu Valley past the historic Kurje Monastery to Nasphel, where a good diversity of woody plants of the dominant blue pine (*Pinus wallichiana*) forest were evident. These included *Acer campbellii*, *A. pectinatum* Wall. ex G. Nicholson, *Cotoneaster bacillaris* Wall. ex Lindl., *Hippophae salicifolia* D. Don, *Holboellia latifolia* Wall., *Malus baccata* (L.) Borkh., *Philadelphus tomentosus* Wall. ex G. Don, *Populus rotundifolia* Griff.,[6] *Rosa macrophylla* Lindl., *R. sericea* Wall. ex Lindl, and *Viburnum mullaha* Buch.-Ham. ex D. Don. The only oak was *Q. semecarpifolia*, very typical of *P. wallichiana* forest, including some ancient specimens. Later a group went to visit Jakar Dzong, in its prominent situation overlooking the valley, while others explored more conifer forest above Lami Goemba where the transition from pine to *Tsuga dumosa* supported a very rich woody flora, for example *Corylus ferox*, *Enkianthus deflexus* (Griff.) C.K. Schneid., *Lindera heterophylla* Meisn.[7], *Rhododendron triflorum* Hook. f., *Schisandra grandiflora* (Wall.) Hook. f. & Thomson, and the bright red herb *Euphorbia griffithii* Hook. f.

13/ *Quercus semecarpifolia*

On October 24 we had another long drive, at first through wonderful pine forests, (stopping at the Chhume weaving center for more shopping), then slowly climbing up to the Yutong La at 3,420 m/11,220 ft, forested right to the summit with *Abies*/*Rhododendron* forest but with much bamboo (*Yushania microphylla* (Munro) R.B. Majumdar) dying,

6. Considered by some authors as a synonym of *P. tremula* L.
7. Considered a synonym of *Lindera obtutsiloba* var. *heterophylla* (Meisn.) H.B. Cui.

14/ The Dang Chhu Valley looking north.

15/ A warm welcome in Tokaling.

presumably as part of its natural life cycle. The steep descent to Trongsa with its huge *dzong* gave us commanding views of the remote Black Mountain range to the southwest. We then repeated our transect of vegetation zones on the long climb up to the Pele La at 3,390 m/11,120 ft with a stop for lunch in a roadside restaurant during a rare shower of rain. In fading light we descended a few kilometers on the west slope to Nobding, where our splendid buses turned north along a dirt road, in places almost washed away, for what seemed an endless journey in total darkness. A real mystery tour! This was the Dang Chhu Valley, well known to Tsewang and Raling as a botanist's paradise. Finally we stopped to find a luxury camp fully in place below us on a riverbank, tents with camp beds, bedside tables and lamps, not to mention a roaring camp fire and dinner ready in the dining tent, followed by a real Bhutanese welcome from the headman and villagers.

The next morning (October 25) all was revealed: we were camped in a delightful spot by the Dang Chhu stream near the village of Tokaling, and during breakfast (porridge, eggs, toast and coffee) we watched the black-capped sibia (*Heterophasia capistrata* Vigors) feeding on the nectar of the shrub *Leucosceptrum canum* Sm. beside the camp. The brilliant red flowers of another shrub *Colquhounia coccinea* Wall. brightened up the campsite. Due to our short stay here, we took a ride up more rough zigzag tracks into the forest, eventually reaching another monastery with a splendid view right up the Dang Chhu Valley to the high snow peaks of the main Himalayan range on the Tibetan frontier. Here were, for many, one of the real highlights of the whole Tour: gigantic trees of the Himalayan cypress or *tsenden shing* (*Cupressus himalaica* Silba[8]), the sacred national tree of Bhutan and also the biggest tree in the country.

The trees here had probably been planted hundreds of years ago and dominate the valley; later we noted large natural stands in a nearby valley. The very durable timber is highly prized for *dzong* construction, and the villagers expressed their fears that for the reconstruction of the Wangdu Phodrang Dzong, recently completely destroyed by fire, their precious cypresses would be felled. In discussions with the headman, the IDS agreed to look at the possibilities of raising funds to grow young trees for replenishing the

8. Considered by some authors as a synonym of *Cupressus cashmeriana* Royle ex Carrière.

wild population. Near some of the cypresses we found more ancient trees of *Q. semecarpifolia*, some of these host to many epiphytes such as *Cymbidium* orchids, *Mahonia* and *Rhus hookeri* K.C. Sahni & Bahadur.[9] The villagers took time out from their farming to welcome us into the village for us to picnic (and watch the traditional ploughing with oxen). We also had time to study the mossy oak/rhododendron forests where *Q. lanata* and *Q. griffithii* were the dominants. On the walk back to camp some fruiting giant Himalayan lilies (*Cardiocrinum giganteum* (Wall.) Makino) were seen amongst the shrubs. To make the camp even more memorable, the villagers had laid on some wooden "stone baths", where water from a health-giving spring was heated in the open-air baths for us by boulders from the campfire. A real treat!

16/ A warm hug for *Cupressus himalaica*.

Conclusion

The penultimate day of the westward journey was spent travelling the busy road to Wangdu Phodrang and Punakha (where we stayed in the comfortable Densa Resort) and the final travelling day (October 27) over the Dochu La to the capital of Bhutan, Thimphu. That day, an early morning visit was made to the splendid Punakha Dzong with its superb religious murals (and formerly the winter capital of Bhutan) led by our guide Yonten. Finally we reached the ever-expanding city of Thimphu where progress with the Royal Botanical Garden and National Herbarium at Serbithang were admired. A ceremonial tree planting was carried out in the Botanical Garden and in the evening, the IDS hosted a dinner in honor of our Bhutanese hosts and collaborators.

The next day, the main party departed for India from Paro airport, while a few of us stayed on in Thimphu for an extra day (October 28) for meetings and another tree planting at the Royal University of Bhutan, where we were hosted by the present and former Vice Chancellors. It was then our turn to drive to the nearby Paro valley, prior to our sad departure from Bhutan (October 29) on the spectacular Druk Air flight to Delhi.

Notes on the Fagaceae of Bhutan

The 18 species of *Fagaceae* known to occur in Bhutan at the present time (Grierson & Long 1983) comprise 8 species of *Quercus*, 6 species of *Lithocarpus* and 4 species of *Castanopsis*. In contrast to some of the other familiar trees of Bhutan, such as *Abies densa*, *Cupressus himalaica* and *Pinus bhutanica*, which were first discovered and described from Bhutan, not one single species of *Fagaceae* was first described from this country. These were first described from other parts of the Himalayas (Nepal and Darjeeling), NE India, Bangladesh, Burma, China, Java, and Japan. One of the duties of the taxonomist is to check that historical application of names in a particular country matches material from the type locality. Therefore an effort has been made to ensure that the names of the oaks in Bhutan are correctly applied. A past misapplication relevant here is the use of the name *Quercus serrata* Thunb. for some Himalayan plants. *Q. serrata* Murray was first described from Japan but it is now generally accepted that

9. Considered a synonym of *Toxicodendron hookeri* (K.C. Sahni & Bahadur) C.Y. Wu & T.L. Ming.

the Himalayan plants for which this name was used should be called *Q. acutissima* Carruth., which was described from Chinese material.

Eight species of *Fagaceae*, from the three genera found in the country, were seen on the IDS Bhutan Tour. When sterile, these genera can sometimes be distinguished only with difficulty, but searching under a tree (only when it is safe to do so!) usually reveals some old fruiting cupules and acorns which are immediately diagnostic.

The largest and most familiar genus is *Quercus*, which can be evergreen or deciduous, with toothed leaves. When in flower it can be recognized by having male and female flowers in different inflorescences, the male flowers in pendulous catkins and female flowers single or few together. In fruit the acorns are solitary, and cupules bear scales or annular lamellae. In Bhutan two sections are recognized: the first is section *Quercus*, that includes *Q. acutissima*, *Q. griffithii*, *Q. lanata*, and *Q. semecarpifolia*. Species in this section can be evergreen or deciduous and have cupules bearing scales united at their bases. Section *Cyclobalanopsis* is always evergreen and in Bhutan includes *Q. glauca* subsp. *annulata*, *Q. lamellosa*, *Q. oxyodon*, and *Q. thomsoniana* with concentric lamellae on the cupules. This section is still taxonomically problematic in the Himalayas (Camus 1936-1938).

The genus *Lithocarpus* is evergreen, usually with very large, entire-margined leaves. Flowers of both sexes occur in the same inflorescence and male spikes are rigid and erect. The male flowers have lanceolate bracts. The fruit usually consists of a woody spike of partly-fused cupules, which partly or sometimes almost completely enclose the single acorn. Both acorn and cupule are symmetric, and the cupules are armed with scales or stout warts but not spines.

The genus *Castanopsis* is similar in flower to *Lithocarpus*, but the leaves are smaller and usually toothed, and the male bracts are usually minute and rounded. Up to 4 nuts are completely enclosed in each cupule, which are asymmetric and covered in sharp, branched spines that dehisce to release the acorns, or, in one species, covered in wavy bands that break irregularly when ripe.

The notes below focus on the widespread and familiar species primarily, with shorter notes on the rarer ones. Only the first two (*Q. griffithii* and *Q. acutissima*) are truly deciduous, the rest are evergreen, although *Q. semecarpifolia* can occasionally lose all its leaves briefly.

The species in bold are those seen on this Tour of Bhutan.

1. **Quercus *L.***

Q. griffithii **Miq. This is a common species in Bhutan between 1,300 and 2,500 m/4,300 and 8,200 ft, growing in relatively dry forests often with blue pine. Its wood is prized for furniture making. It is distinctive in its deciduous obovate serrate leaves up to 25 cm/10 in long clusters at the end of shoots. The cupules are small and scaly and acorns ovoid. Large scaly galls, sometimes mistaken for fruit, are common. Although named after William Griffith who visited Bhutan in 1838 and first discovered the species, the type specimens were collected later by J.D. Hooker and T. Thomson in the Khasia Hills.**

Q. acutissima Carruth. (*Q. serrata* Murray in sense of earlier works). This is the other deciduous oak in Bhutan, with oblong or elliptic leaves up to 18 cm/7 in long, and very distinctive in its marginal serrations which end in a needle-like point up to 7 mm/0.3 in long. Its cupules are unique amongst the Himalayan oaks in being 2 to 3 cm/0.8 to 1 in broad and covered with long narrow curved spreading scales. It appears to be rare in Bhutan in cool broadleaf forests between 2,000 and 2,500 m/6,500 and 8,200 ft altitude. It was first described from China in 1862.

Quercus lanata **Sm. (syn. *Q. lanuginosa* D. Don). This species often grows with *Q. griffithii* in drier temperate forests throughout much of Bhutan, up to 2,200 m/7,200 ft altitude, but is evergreen. It has toothed oblong to lanceolate leathery leaves up to 15 cm/6 in long, which are densely pale woolly beneath and somewhat rugose above. The cupules are small and scaly, half enclosing the rounded acorn. It was first described from Nepal where it was discovered by Francis Buchanan-Hamilton.**

Q. semecarpifolia **Sm. This plant can grow both as a shrub with spiny-toothed leaves or as a large broad-crowned tree up to 25 m/82 ft tall. It has small elliptic or oblong leathery leaves up to 10 cm/4 in long, rounded at the apex. The cupules are scaly, clasping only the base of the subglobose acorns, which are produced abundantly only every 2 years. In can form low shrubberies under *P. wallichiana* or can grow with *R. arboreum* in mixed forests. It is a common species in Bhutan at between 2,400 and 3,200 m/7,900 and 10,500 ft altitude. It is often harvested for firewood. It was originally described from Nepal.**

***Q. lamellosa* Sm. This and the following three species belong to the evergreen section *Cyclobalanopsis.* Their taxonomy has been clarified by Menitsky (2005). (A fourth, the more tropical *Q. semiserrata* Roxburgh, has been reported almost certainly in error from Bhutan). *Q. lamellosa*, the most striking of the more widespread Bhutanese oaks, is a very large evergreen tree which forms extensive stands in many parts of temperate Bhutan, between 1,800 and 2,600 m/5,900 and 8,500 ft, where it has often been harvested for its durable timber. Its leaves are oblong to elliptic, up to 40 cm/16 in long and with striking close parallel veins (15 to 25 pairs), which are impressed above and raised beneath, contrasting sharply with the whitish undersides. The cupules are large, 4 to 7 cm/1.6 to 2.8 in in diameter, with conspicuous concentric lamellae. The acorn is almost completely enclosed. It was discovered in Nepal in 1802 by Buchanan-Hamilton.**

***Q. thomsoniana* A. DC. In foliage this oak is very like a miniature version of *Q. lamellosa* with 12 to 15 pairs of strong veins impressed above and raised beneath, contrasting with the white undersides. However, its leaves are much smaller, up to 15 cm/6 in long. The cupules are up to 3 cm/1 in in diameter, and bear striking spreading concentric pale tomentose lamellae with a somewhat crenate margin, half enclosing the rounded ovoid acorn that is up to 2 cm/0.8 in tall. It was described from Sikkim where it was discovered by Joseph Hooker and Thomas Thomson in 1849. The only confirmed record from Bhutan appears to be that from the IDS tour.**

***Q. glauca* subsp. *annulata* (Sm.) Camus. This is characterized by its relatively narrow lanceolate elliptic leaves up to 15 cm/6 in, with acuminate apex, sharply toothed in the upper half and pale and softly hairy beneath. The veins are not sunken above or raised beneath. The cupules are 1 to 1.5 cm/0.4 to 0.6 in across and bear low concentric appressed lamellae, and that enclose the lower 1/3 of the small acorns that are much longer than broad (1.2 to 1.8 cm/0.48 to 0.70 in long). It is widespread in warm evergreen forests between 1,100 and 2,100 m/3,600 and 6,900 ft. This is a widespread species throughout Eastern Asia, originally described from Japan.**

Q. oxyodon Miq. This is similar to *Q. glauca* but the leaves are more strongly serrate with finely pointed ascending teeth. The cupules are up to 2 cm/0.8 in in diameter and bear appressed almost entire or crenate lamellae, and half enclose the subglobose acorn that is up to 1.7 cm/0.67 in tall. It was first described from the Khasia hills in Assam, and in Bhutan has been reported from evergreen oak forests between 2,400 and 2,700 m/7,900 and 8,900 ft altitude.

2.* Lithocarpus *Blume

Six species of this more tropical genus are known in Bhutan of which only *L. elegans* is well-known and relatively common, the others are relatively rare and require further taxonomic study; fruit are essential for identification but can usually be found under the trees. They are mostly found in subtropical and warm broadleaf forests, especially in the south of Bhutan.

Lithocarpus elegans (Blume) Hatus. ex Soepadmo This is a large evergreen tree with large dark green leathery leaves up to 35 × 10 cm/14 × 4 in, with entire margins; the petioles are very short up to 1.5 cm/0.6 in. The flower spikes are unbranched. The cupules are fused at their bases in a stout woody infructescence, each cupule about 2 cm/0.8 in diameter, scaly, enclosing the lower third of acorn. Occurs throughout southern and central Bhutan, 900 to 2,200 m/3,000 to 7,200 ft altitude. Originally described from Java.

***Lithocarpus fenestratus* (Roxb.) Rehder (syn. *Quercus fenestrata* Roxb.) is similar to *L. elegans* but the leaves are smaller and the fruiting cupules almost completely enclose the acorns with only up to 1/3 showing at tip. A local plant from southern Bhutan, 1,000-1800 m/3,000-6,000 ft altitude. Described from Silhet in northern Bangladesh.**

Lithocarpus dealbatus (Hook. f. & Thomson ex Miq.) Rehder (syn.: *Quercus dealbata* Miquel). Differs from *L. elegans* in its smaller leaves up to 18 × 6 cm/7 in × 2 in, and smaller cupules which enclose the lower 2/3 of the acorns. Only reported from Geylephu district at 1,350 to 1,650 m/4,450 to 5,410 ft. Described from the Khasia Hills of Assam.

Lithocarpus pachyphyllus (Kurz) Rehder (syn. *Quercus pachyphylla* Kurz) is similar to *L. elegans* but distinguished by its fruiting cupules which are completely fused together. Known only from Geylephu district at 1,650 m/5,410 ft, but described from Darjeeling district in West Bengal.

Lithocarpus listeri (King) Grierson & D.G. Long (syn.: *Quercus listeri* King) differs from *L. elegans* in its leaves on longer petioles up to 5 cm/2 in, and flower spikes with many short branches, but the fruit is similar. Described from Assam.

Lithocarpus jenkinsii (Benth.) C.C. Huang & Y.T. Chang (syn.: *Quercus jenkinsii* Benth.) This species

was described from Assam and Myanmar and only relatively recently found in Bhutan. It differs strikingly from the other *Lithocarpus* species in its stout woody fruit with acorns completely enclosed by the cupules which are covered by stout woody angular scales. It has been found only in three places in Sarbhang and Chukka Districts at 1,020 and 1,480 m/3,350 and 4,860 ft altitude.

3.* Castanopsis *(D. Don) Spach

Four species of this genus are found in Bhutan, the first three quite similar in foliage and with densely spiny cupules, each containing 1 or up to 4 acorns. The fourth has smooth cupules with wavy bands and contain only 1 acorn.

Castanopsis indica (Roxb. ex Lindl.) A. DC. (syn. *Castanea indica* Roxb.) This is a subtropical evergreen tree with sharply toothed leaves which are finely brownish hairy beneath. The cupules are about 2.5 cm/1 in in diameter, covered in needle-like spines up to 1 cm/0.4 in long. It is common in the forests of southern Bhutan up to 1,500 m/4,900 ft. Described from northern Bangladesh.

Castanopsis hystrix A.DC. Similar to *C. indica* but its leaves are reddish tomentose beneath and almost without teeth on the margins, and the cupules are larger, up to 5 cm/2 in in diameter, with similar long spines, but containing only a single acorn. It is not very common in evergreen oak forests across central Bhutan between 2,000 and 2,300 m/6,600 and 7,500 ft. It was discovered by Hooker & Thomson in the Khasia Hills of Assam.

***Castanopsis tribuloides* (Sm.) A. DC. (syn. *Quercus tribuloides* Smith) This is very similar to *C. hystrix* but the leaves are almost glabrous beneath; however the cupules differ in their much shorter stouter spines which have a broad base and are not needle-like. It is common across central Bhutan between 1,200 and 2,400 m/3,900 and 7,900 ft and was first discovered in Nepal by Buchanan-Hamilton.**

Castanopsis lanceifolia (Oerst.) Hickel & A. Camus (syn. *Castanea lanceifolia* Kurz) At first glance this could be mistaken for a *Lithocarpus* species vegetatively but its ovoid cupules are not fused together, completely enclose the single acorn, and bear concentric wavy rings not scales. It is only known in the southern subtropical forests in two localities in Sarbhang district at 285 and 800 m/935 and 2,600 ft. It was first described from Burma.

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Photographers. Photos 1-18: David Long.

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17/ ***Pinus bhutanica***

18/ ***Cupressus himalaica***

In 1994, professionals and tree lovers came together at The Morton Arboretum (just outside Chicago, Illinois) to found the International Oak Society. The Society is dedicated to the appreciation, conservation, and study of these magnificent and important trees worldwide. For its 20th anniversary conference, the Society returns to the Arboretum. Conference highlights will include presentations from many of the world's leading oak researchers, opportunities to discuss and contribute to ongoing work in oak conservation worldwide, workshops in oak collecting and collections management, tours of the Arboretum's world-renowned oak collection, and a seed exchange. Speakers will report on a wide range of current oak research topics including ecology and natural history, evolution, biodiversity and conservation, selection and propagation, pests and diseases, ethnobotany, and more.

8th
International Oak Society *Conference*
at THE MORTON ARBORETUM 2015

October 18-21, 2015

Confirmed speakers include:

KEYNOTE: Sara Oldfield, former Secretary General, Botanic Gardens Conservation International
Anthony Aiello (Morris Arboretum, University of Pennsylvania, USA)
Mary Ashley (University of Illinois, Chicago, USA)
Janet Backs (University of Illinois at Chicago, USA)
Nina Bassuk (Cornell University, USA)
Jeannine Cavender-Bares (University of Minnesota, USA)
Béatrice Chassé (Arboretum des Pouyouleix, France)
Min Deng (Shanghai Chenshan Plant Science Research Center, Chinese Academy of Science, China)
Robert Fahey (The Morton Arboretum, USA)
Antonio González-Rodríguez (Centro de Investigaciones en Ecosistemas, Universidad Nacional Autónoma de México)
Matthew Kaproth (University of Minnesota, USA)
Jon Kay (Indiana University, USA)
Antoine Kremer (INRA, BIOGECO, France)
Paul Manos (Duke University, USA)
Ken Oyama (Centro de Investigaciones en Ecosistemas, Universidad Nacional Autónoma de México)

Greg Paige (Bartlett Tree Experts, USA)
Ian Pearse (Illinois Natural History Survey, USA)
Jeanne Romero-Severson (University of Notre Dame, USA)
Joseph Rothleutner (The Morton Arboretum, USA)
Victoria Sork (University of California, Los Angeles, USA)
Weibang Sun (Kunming Botanical Garden, China)
Guy Sternberg (Starhill Forest Arboretum, USA)
Christina Walters (USDA Agricultural Research Service, USA)
Murphy Westwood (The Morton Arboretum, USA)

GALA DINNER and LECTURE by acclaimed natural history writer Joel Greenberg, Tuesday, October 20

October 13-17

Pre-Conference Tour of Central and Southern Illinois. This five-day tour will visit oak habitats ranging from classic southern cypress swamps to sandstone ridges and canyons; flatwoods communities; mesic and riparian forests; barrens; sand prairie, and savannas. Expect to see 20 native species and other species of oaks, including some state and national champion specimens, as well as their companion species. Details are available through the IOS website at http://www.internationaloaksociety.org/content/pre-conference-tour.

October 22-24

Post-Conference Tour of the southern Lake Michigan region in Indiana and Michigan. This three-day tour will take in native plants including unique fens and bogs; black-oak dunes woodlands that also include red, white, and Hill's oaks; Warren Woods State Park, the last untouched beech-maple forest in this region, with many of the tallest native trees in the state of Michigan; Fernwood Botanical Garden and Nature Preserve; and the sunset beaches of Lake Michigan. Details are available through the IOS website at http://www.internationaloaksociety.org/content/post-conference-tour.

Register today!

For full details and to register online go to mortonarb.org/IOS2015.

You must be a member of the International Oak Society to attend the full Conference and Tours. You can join the Society while registering for the Conference at mortonarb.org/IOS2015 or beforehand through the IOS website at internationaloaksociety.org.

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

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

Graphic design : Marie-Paule Thuaud / www.lecentrecreatifducoin.com

www.internationaloaksociety.org