International Oaks

The Journal of the International Oak Society

…the new classification of oaks, truffles, treehouses, oaks of Lebanon and Iran, desperately seeking Q. tardifolia, *the IOS 25th anniversary…*

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This issue is dedicated to
Michel Timacheff
whose memory will live on in his beautiful photographs and in the hearts of the many in this Society who were his friends.

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Photos. Cover: John Harris (*Quercus robur*). Page 7: Béatrice Chassé Page 9: Cécile Souquet-Basiege.

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Brief Encounters with Copey Oak (*Quercus copeyensis*) in Costa Rica October 27-30, 2017

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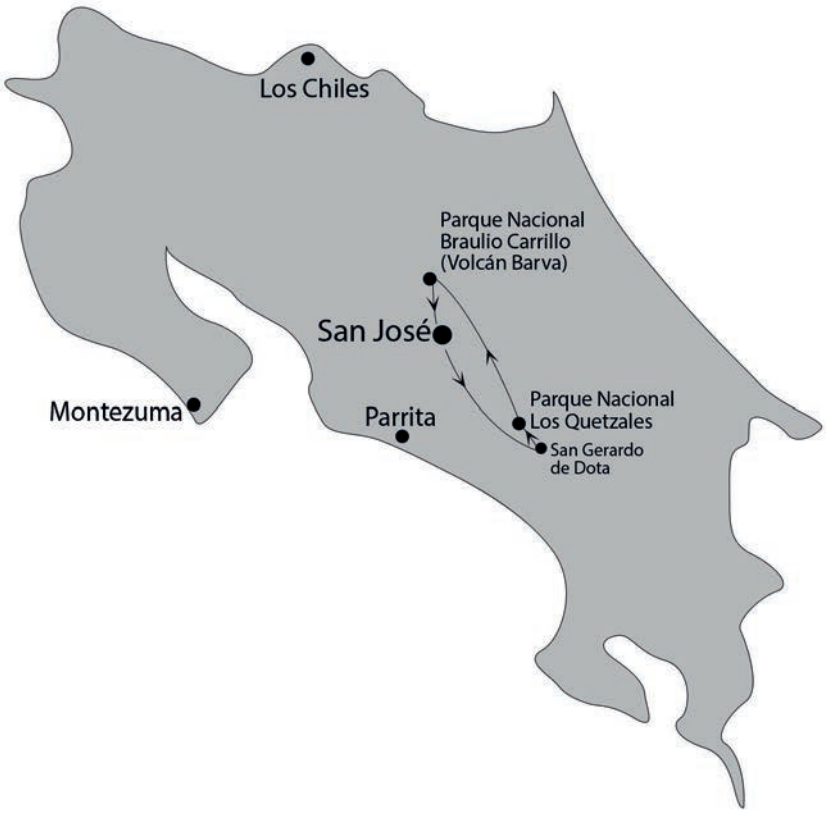

Introduction

In the October 1943 issue of *American Forests*, Arthur Bevan wrote about a remarkable discovery:

Nine degrees of latitude north of the Equator – the same latitude that runs through the Panama Canal – and here we were walking through what is perhaps the largest single stand of oak timber in the world. If that surprises you, you are in good company. The foresters in our party were amazed. It simply couldn't be true … Magnificent giants 125 feet or more tall, heavily buttressed at their base to a height of ten or twelve feet, and with diameters above the buttresses of from seven to eight feet. Here were trees to excite the imagination, a whole forest of them … To add to our awe, clouds swirled through the trees giving the whole setting a ghostly appearance … one almost expected to see witches on broom sticks and large hats flying out of the timber … We immediately dubbed the forest "The Ancestral Home of the Gremlins."

Bevan and his colleagues were members of a project field party that was in Costa Rica in connection with the construction of the Inter-American Highway that would run through all of Central America. They had been requested by army engineers building the highway to examine a stand of large timber along the right-of-way. "The giant oaks were our reward," wrote Bevan. The foresters were not able to identify the species of oak, but samples were sent to the Chicago Museum of Natural History, where Dr. Paul Standley declared them to be *Quercus copeyensis*, or Copey oak, a species named by C.H. Muller the previous year. In his article, Bevan expresses concern that a considerable portion of the stand would be logged for the construction of the highway and other uses. However, plans were in place to create a national park to preserve the remainder of the trees. "Perhaps," he concludes, "some day tourists driving over this jungle road will experience the same thrill on entering the forest of oaks that we – a group of exploring foresters – did."

In October 2017 I was fortunate enough to be one of those tourists.

San Gerardo de Dota

Photo 1/ A resplendent quetzal (*Pharomachrus mocinno*) poses on a branch of *aguacatillo* (*Persea caerulea*).

An extended layover in San José de Costa Rica on a trip from New York to Montevideo allowed me three nights in the country, the first two of which would be in San Gerardo de Dota, a valley in the Talamanca Cordillera about 50 km southeast of San José, at an elevation of around 2,300 m. I arrived in the evening and procured for the next morning a guide I was told would help me identify oaks, though his specialty was birds, which is what most tourists go there to see. Next morning at 6 a.m. sharp I met Marino Chacón who

informed that we would first go to see the quetzals, a visit that was de rigeur for anyone visiting the Sagevre Valley, and we could then see a few oaks. The resplendent quetzal (*Pharomachrus mocinno*) is an attractively colored bird with a long tail. It is of little interest to the quercophile, save perhaps for the fact that it is surely the bird that stands closest to *Quercus* in the dictionary. But we climbed a hill and took our place among the multilingual battery of telephoto lenses and indeed saw several quetzals feeding on the fruit of *aguacatillo* trees (*Persea caerulea* – the common name is the diminutive of *aguacate*, Spanish for avocado).

Having paid homage to the quetzal, Marino introduced me to my first *roble blanco*, the local name for Copey oak. To the human observer it is a massive trunk disappearing into the canopy. This aspect of the trees had also impressed Bevan: "The most striking feature of the trees is the long sheer bole before the first limbs branch off about eighty feet above the ground. The trunk tapers but slightly." Marino drew my attention to the bark: light brown/grey and extremely flaky, from a distance like the shaggy fur of an animal. Flakes of bark are easy to break off and in fact can be an important resource for someone needing to survive in the forest. As cloud forests are very damp environments, it is often difficult to find wood that will readily catch fire. The bark of Copey oak is useful because it makes excellent kindling. Another characteristic that Marino pointed out is that these oaks always have one side of the trunk that is damp and mossy, while the other remains dry and clear of lichens and other vegetation. Bark from the dry side can always be counted on to start a campfire. He had learnt this from his father, who had been a cowherd and was accustomed to having to spend nights in the forest when rounding up cattle that had wandered far from home. In fact, it was on such a trek in 1954 that Efraín Chacón stumbled across the beautiful valley of the Savegre River in Dota, at that time uninhabited and unclaimed. Impressed with the picture-perfect lush and green surroundings, he applied to the government for ownership and it became the family's prosperous estate and a village his wife named San Gerardo de Dota. On the advice of visiting ecologists from the U.S., the Chacón family had converted the enterprise from agriculture to ecotourism and built cabins that became the Sagevre Hotel and Spa where I was lodging.

Photo 2/ High up the trunk the bark of *Quercus copeyensis* is sometimes extremely shaggy, forming large flakes that peel back from the inner bark at the lower end.

Hurricane Nate had passed through that area in early October, and the Sendero Los Robles (The Oaks Trail), the main trail into

the hills above the hotel, was off limits due to fallen trees. However, Marino made an exception and led me through a section that was for the most part accessible. Here we saw more Copey oaks, including seedlings and young trees, which allowed us a look at their leaves. They are thick and firm, frequently polymorphic on the same tree or even on the same branch, ranging from ovate and obovate to elliptical, the tip obtuse or acute, the base slightly rounded, cuneate, or even slightly cordiform. The margin is entire, though exceptionally I saw leaves of newly sprouted seedlings with one or two minute bristle-tipped lobes. Mature leaves are 5 to 15 cm long and 2 to 6.5 cm broad. The upper surface is glabrous (hairless), but the lower surface displays tufts of hairs along the midrib and along the veins close to the midrib. We found branches that had fallen from the tops of trees, with leaves that were more rounded and bore more pubescence on their undersides than was the case with leaves growing close to the ground. These twigs came with male catkins, which can be up to 12 cm long, and the plump flowers are distinct on the rachis, with a clear gap between each one.

Acorns were scarce, and according to Marino the main season for acorns in Dota is July, but we found a few on the ground. (Acorn season for Copey oak seems to be a movable feast, and mature fruits may apparently be found in April, June, July and October). They are spherical, up to 3 cm in diameter, with a large scar at the base. I observed some

Photo 3/ *Quercus copeyensis* with its characteristic combination of yellow catkins and red new leaves.

acorns displaying epigeal germination: the strong radicle pushes the acorn up and it remains slightly above ground, the cotyledons opening either side of the stalk. This type of germination is common with beans, but most oaks have hypogeal germination, i.e., the acorn remains underground and only the plumule or stalk of the plant emerges above the surface. The cupule of Copey oak is distinctive, with a thick peduncle (2 mm in diameter) that can be up to 3 cm long.

La Georgiana

Quercus copeyensis is usually described as being up to 35 m tall, and on the trail above Sagevre Hotel we were able to see specimens which seemed to fit that description. Marino suggested I explore the area around La Georgiana, a restaurant 15 kilometers further south from the turn off to San Gerardo de Dota on the Inter-American Highway, where aside from large stands of *Q. costaricensis*, the companion Red Oak to *Q. copeyensis*, I would find a giant Copey oak, "El Roble". *Quercus costaricensis*, known locally as *encino*, is easily distinguished from *Q. copeyensis* due to its dark bark, which is fissured rather than flaky, and the thick, rounded, coriaceous leaves that are shiny and dark green above, and densely tomentose below, with tan pubescence covering the whole lower surface rather than only appearing along the midrib and veins. The specimens I saw were heavily laden with immature acorns, so this was possibly a mast year.

Photo 4/ *Quercus costaricensis* with the typical dense tomentum covering the underside of the leaf (San Gerardo de Dota).

La Georgina stands near the top of the formidably named Cerro de la Muerte (Death Mountain), at an elevation of 3,090 m, on the Inter-American Highway's highest point in Costa Rica. The mountain got its name due to the perils involved in traveling over it in the days before the highway, and to the many ill-prepared travelers that succumbed there to the cold and rain. The building dates to 1947, the year before the 44-day Costa Rican Civil War brought yet more deaths to that area. Despite these foreboding omens, the folk at the inn gave me a friendly welcome and a hand-drawn map of the trails behind the restaurant, including the location of El Roble, the giant oak. After a good half-hour walking through dark stands of *Q. costaricensis* I began to encounter *Q. copeyensis*, as I drew closer to the stream at the bottom of the valley. When I reached El Roble, I found a decapitated tree, as the oak had evidently lost its crown during Hurricane Nate a few weeks before. It appears the hosts at La Georgina were not yet aware of the fact. A topless Copey oak is still a formidable sight, and of course a lack of crown does not affect the massively buttressed base.

I did measure the trunk of the tree, at something close to breast height (easier said than done, as the buttresses raise the base of the tree onto a slippery pedestal covered in damp moss, and at one stage I practically disappeared into the gap between two

Photo 5/ A giant *Q. copeyensis* showing clearly the division between the "damp" and "dry" sides of the trunk.

buttresses; thankfully the concealed space did not harbor wildlife). The measurement obtained (an impressive 6.90 m) is not really meaningful, as the buttresses distort the true circumference of the trunk. Opinions differ as to the function of buttresses in tropical oaks (and many other tropical trees), but to my untrained eye it seemed to be clear that it is an efficient way for a tree to obtain a wider, lighter, and more stable base, using a minimum of resources. This particular tree had the added attraction of buttresses that gently spiraled as they receded up the trunk.

I did not have equipment that could measure the giant trees around me, but I suspected these oaks were 40 to 50 m tall. Not far from where I stood, near the village of Villa Mills, grows a Copey oak known as "El Abuelo" (Grandfather Oak). In a post on the Bulletin Board System of the Eastern Native Tree Society, arborist Bart Bouricius reports the tree is 60.4 m tall, with an above-buttress circumference of 5.8 m (measured at a height of 4.3 m – the circumference at breast height, which is of course augmented by the buttresses, almost exceeded Bart's 50-foot measuring tape: 14.2 m). The website www.monumentaltrees.com, which lists champion trees worldwide, states that "till now this is the tallest accurately measured oak worldwide, over 10 meters taller than all oaks measured in the United States or Europe." The same oak is pictured in le Hardÿ de Beaulieu and Lamant's *Guide Illustré des Chênes*, with three people standing comfortably in between the massive buttresses, occupying only one side of the trunk.

Nomenclatural labyrinths

I should clarify that Bart Bouricius uses a different name for the species: *Q. bumelioides*. Indeed, nomenclature of Costa Rican oaks, as with other Central American oaks, is complex. The case of Copey oak is a good illustration. The species began binomial life as a form of *Q. costaricensis*, distinguished by Trelease as *Q. costaricensis* f. *kuntzei* in his monograph *The American Oaks*, published in 1924. The type specimen was collected by German botanist Otto Kuntze in 1874, on Volcán Irazu in Costa Rica, and is preserved in the New York Botanical Garden Herbarium as Kuntze #2282, with an isotype in the Kew Gardens Herbarium. According to Trelease, what characterized the form were the less prominent veins and the scarcer pubescence on the underside of the leaf: "with cellular-pitted less impressed-veiny leaves glabrous except for long brown fleece in sheltered

places beneath." *Quercus costaricensis* was named by Liebmann in 1854, based on specimens collected by Danish botanist Anders Ørsted while in Costa Rica between 1846 and 1848. However, Ørsted's collection seems to have been a mixture, as it included true *Q. costaricensis* (a section *Lobatae* oak) and the form Trelease named *kuntzei* (section *Quercus*). C.H. Muller pointed this out in his *Central American Oaks* (1942), elevating f. *kuntzei* to species status and introducing the new name *Q. copeyensis*. According to Muller, "The forma *kuntzei* is very thoroughly confused," for Kuntze's collection was also a mixture, including both true *Q. costaricensis* and *Q. copeyensis*. However, Muller's description is not entirely satisfactory, for example falling short as regards to height: "Large tree to 15 m in height or taller." Elbert Little, Jr., one of Bevan's companions in the party of foresters that stumbled on the stands of giant oaks next to the Inter-American Highway, felt that a correction was called for and published an article in *Caribbean Forester* in 1948, in which he aimed to "amend slightly the botanical description of this important species." He pulled no punches when describing the appearance of the tree: "Very large tree of forest canopy, becoming 27 to 37 m (90 to 120 ft) in height and 0.6 to 1 m (2 to 3 ft) up to 2.4 m (8 ft) in trunk diameter; larger trees having buttressed bases with somewhat larger basal trunk diameters and having clear lengths as much as 80 ft to first branches." Muller made no mention of the bark (which is understandable if he was only working from herbarium samples), but as I mentioned above, it is a useful feature for identification. Little includes in his amendment: "Bark whitish, rough, scaly to shaggy." The specific epithet *copeyensis* apparently derives from the location of Muller's type specimen, collected by Standley in 1925 near the town of El Copey, in San José Province (*copey* is the local name for several trees in the genus *Clusia*).

So much for *Q. copeyensis*. However, in the same 1854 publication in which he published the name *Q. costaricensis*, Liebmann also published *Q. bumelioides*, based on another specimen collected by Ørsted (*bumelioides* refers to a similarity to *Bumelia*, now *Sideroxylon*, a genus that includes chittamwood, a plant native to southern U.S. and northern Mexico). In 1913 Trelease identified an isotype of Kuntze's specimen #2282 in the Kew Herbarium as *Q. bumelioides* Liebm. (before Muller verified it in 1958 as *Q. costaricensis* f. *kuntzei* and therefore *Q. copeyensis*). But *Q. bumelioides* Liebm. has since been buffeted by nomenclatural storms, being sunk into synonymy by some authors, who find it to be in fact a Red Oak: for Burger it is *Q. seemannii* Liebm., for Muller *Q. eugeniifolia* Liebm., and for Valencia Avalos *Q. sapotifolia* Liebm. Other authors keep the name afloat and hold it to be the accepted name for the *roble blanco* in Costa Rica, thus reducing *Q. copeyensis* C.H. Mull. (a White Oak) to a synonym of *Q. bumelioides* Liebm. This is the interpretation of, amongst others, and the Smithsonian Tropical Research Institute in Panama. (At this point the reader may be excused for feeling, to borrow Muller's phrase, "very thoroughly confused.")

Parque Nacional Los Quetzales

Marino Chacón had also recommended I visit the Parque Nacional Los Quetzales, a 5,000-hectare national park to the southwest of the Inter-American Highway, a few kilometers north of the turn-off to San Gerardo. A reasonably well-maintained public road allows access into the park and I descended down the side of a valley from an elevation of close to 3,000 m at the entrance to 2,500 m. The road offered a different perspective for viewing Copey oaks, as I enjoyed vistas across the forest canopy, with the oaks' crowns

Photo 6/ A young Copey oak in Parque Nacional Los Quetzales, its crown flushing with new growth.

emerging clear of surrounding competitors. Close to the road, some oaks had remained standing while the forest around them had been cleared, revealing massive straight boles topped by globular crowns. More mature specimens had smaller crowns, reduced to a few leaves at the end of contorted branches, or had even lost branches or their tops, their wracked skeletons now a record of each storm and circumstance that shaped them. The remains of a recently broken trunk lying by the side of the road (Nate gratias) revealed the characteristic yellow to light brown sapwood and pinker heartwood of *Q. copeyensis*. I also came across crowns covered in flushes of ruby new growth, another typical feature of the species, and a specimen in full flower, dripping pendulous yellow catkins.

Parque Nacional Los Quetzales is the most recently created of Costa Rica's 26 national parks. The country is a world leader in conservation policies, and its protected areas, many of which are national parks, cover 25 % of the country's landmass – the highest

such ratio in the world. All this is good news for *Q. copeyensis*, currently listed as Vulnerable on the IUCN Red List (as *Q. bumelioides*). Protection is necessary, as Copey oak has been a much sought-after resource. Reading between the lines in Arthur Bevan's 1943 article, you can sense the forester in him salivating, as he describes what he believes to be the largest pure stand of oak in the world in terms of potential lumber: "Estimates from a few circular sample plots indicate that the heaviest stands will run as high as 60,000 board feet an acre. In fact, an estimate of from 20,000 to 25,000 board feet an acre for the entire stand is conservative." Copey oak has been logged extensively, primarily to fuel the charcoal industry. According to Cordero and Boshier, it is estimated that in the 30 years since the creation of the Inter-American Highway through 1972, some 374,000 large oaks were felled, mostly *Q. copeyensis*, to produce around 6,000 50-kg sacks of charcoal per week, consuming between 120 and 300 hectares of forest each year. Following the creation of natural reserves, production was drastically reduced due to the limited availability of oaks outside of the reserves. In 1986, production still continued at a rate of 4,000 tons per year, consuming between 30 and 75 hectares per year. The species has also been logged for other purposes, initially for the constructions of bridges on the Inter-American Highway, and later for sleepers and pilings. During the 1960s, oaks were logged and exported to Europe for the manufacture of wine barrels and furniture. Currently, conservation and sustainable forestry programs exist to involve local communities in helping to protect the forest.

Photo 7/ The catkins of *Quercus copeyensis* can reach a length of 12 cm (Parque Nacional Los Quetzales).

Volcán Barva

For my final day in Costa Rica I planned a visit to Volcán Barva, a volcano at the entrance to Parque Nacional Braulio Carrillo, some 30 km north of San José. Fancisco Garín, an IOS member with extensive experience collecting Costa Rican oaks, had recommended the destination and had asked me to photograph an oak of uncertain identity he had found standing close to the entrance to the park. The approach to the park requires a 4×4 vehicle and is more like an assault on a fortified position, given the steepness of the track and its woeful state, more like the dry riverbed of a mountain stream than a road. Impressive Copey oaks are on view as one climbs to an elevation of 2,600 m. At the entrance of

Photo 8/ *Quercus copeyensis* (Parque Nacional Los Quetzales).

the park I was reminded of Baven's broomstick-borne witches with large hats, for the gnarled, mutilated, ancient oaks created a landscape that justified the "ancestral home of the gremlins" nickname.

From the entrance to the park, trails lead up towards the summit of the volcano. The upper section of the trail had received the Nate treatment and was closed, but in one of the lower ones, called Cacho de Venado (local name for *Oreopanax xalapensis*) I came across several large Copey oaks, which, unlike the ones I had seen in Dota, had recently dropped a plentiful crop of acorns. These acorns, which littered the ground, some still green, were larger than the few I had seen further south, and in fact larger than the sizes described by some authors for the species (according to Muller the acorns are about 1 cm in diameter, whereas the ones I found were more like 3.5 cm in diameter, closer to the 4 cm stated in the description in *Guide Illustré des Chênes*).

The specimen Francisco Garín had told me about has acorns that are quite different in shape, not spherical or quasi-spherical like standard *Q. copeyensis*, but elongated and tapering towards the tip. Another interesting feature is that a high proportion of these acorns germinate from the side rather than from the tip of the acorn, something also seen in *Q. corrugata*. Francisco has never encountered acorns this shape on Costa Rican oaks, and believes this may be in fact a species that has not yet been described, though it may also be a form of *Q. copeyensis* (see *Oak News & Notes*, Vol. 22, No.1, pp. 7-8).

Photo 9/ On the road leading to Volcán Barva, one can only wonder how tall this *Quercus copeyensis* that appears to have lost its top would have been!

Photo 10/ Atypical *Quercus copeyensis* acorns from a tree at the entrance to Parque Nacional Braulio Carrillo (top row) compared with typical acorns (bottom row).

Photo 11/ Large acorns litter the ground below *Quercus copeyensis* on the Cacho de Venado trail on Volcán Barva.

On Volcán Barva I made it up to Laguna de Barva, a lagoon that fills one of several craters on the volcano. From the viewing platform it was an eerie sight, partially concealed by mist that thinned, cleared, and then returned as clouds rolled past. On the way down I came across a mighty Copey oak that had met its match with Nate and now lay flat, its base by the side of the road. The massive trunk and roots formed a vertical wall that must have been about 5 m high and 8 m across, which implies that the tree's point of contact with the earth covered an area of around 40 m^2.

In the three-day sojourn in Costa Rica I had seen Copey oak in many forms: as a straight, flaky bole disappearing into a canopy obfuscated by cloud, as a lush ruby-tipped crown heavy with yellow catkins, as a seedling levitating the acorn from which it sprang, as a stag-headed declining giant, raising its gnarled limbs to the heavens in defiance, as a lord of the cloud forest poking its crown through the blanket of the jungle. And now, here an oak that had stood for centuries was summoning me to witness its final act, as it prepared to spend its last years dissolving back into the forest floor. It was as if it were inviting me to stand in the lee of its upturned buttresses, next to its core that for so many years had remained hidden to the world. Awed by the gesture, I lingered as long as I could before hurrying down to my rental pick-up and driving to the airport in time for my flight home.

Photographers. Photos 1-12: Roderick Cameron.

Further reading

Anywhere: Costa Rica. *National Parks of Costa Rica*. Accessed December 28, 2017. https://www.anywhere.com/costa-rica/attractions/national-park

Bevan, A. Giant Oaks of Costa Rica. *American Forests* 49 (1943): 486-487, 503.

Blaser, J., and M. Camacho. *Estructura, composición y aspectos silviculturales de un bosque de robles (*Quercus *spp.) del piso montano en Costa Rica*. Centro Agronómico Tropical de Investigación y Enseñanza, CATIE, Programa Manejo Integrado De Recursos Naturales, Proyecto Silvicultura De Bosques Naturales, 1991.

Burger, W. *Flora costaricensis. Fieldiana: Botanical Series. Vol. 40*. Chicago: Field Museum of Natural History, 1977.

Bouricius, B. *Costa Rica: Astounding high altitude "Grandfather Oak"*. Post on the Eastern Native Tree Society Bulletin Board System. Accessed December 28, 2017. http://www.ents-bbs.org/viewtopic.php?p=28399

Cordero J., and D.H. Boshier. Árboles De Centroamérica: Un Manual Para Extensionistas. Oxford Forestry Institute/CATIE, 2003.

IUCN. Oaks of the Americas Species List. International Oak Society website. Accessed January 28, 2017. http://www.internationaloaksociety.org/content/oak-red-listing-project-update

Jiménez, Q., A. Estrada, and M. Arroyo. *Manual dendrológico de Costa Rica*. Cartago, Costa Rica: Instituto Tecnológico de Costa Rica, 1996.

Little, E.L., Jr. Copey oak, *Quercus copeyensis* in Costa Rica. *Caribbean Forester* Vol. 9 (1948): 345-353.

Le Hardÿ de Beaulieu, A., and T. Lamant. *Guide illustré des Chênes*. 2nd ed. Geer, Belgium: Edilens, 2010.

MonumentalTrees.com. Q. bumelioides *'Grandfather Oak' in Parque Nacional Cerro de la Muerte in Cartago*. Accessed December 28,2017. https://www.monumentaltrees.com/en/cri/centralvalley/cartago/9751_parquenationalcerrodelamuerte/

Muller, C.H. *The Central American Species of* Quercus. Washington: United States Dept. of Agriculture, 1942.

Oak Name Checklist. Accessed December 28, 2017. http://www.oaknames.org/

Smithsonian Institution, Smithsonian Tropical Research Institute. Accessed December 28, 2017. http://www.stri.si.edu/

Standley, P.C. *Flora of Costa Rica, Part 1*. Chicago: Field Museum of Natural History. Vol. 18 (1937).

Trelease, W. The American Oaks. *National Academy of Science Memoirs*. Vol . 20 (1924).

Valencia Avalos, S. Diversidad del Género *Quercus* (*Fagaceae*) en México. *Boletín de la Sociedad Botánica de México* 75 (2004): 33-53.

World Checklist of Selected Plant Families: Royal Botanic Gardens, Kew. Accessed January 28, 2017. http://apps.kew.org/

Photo 12/ Author standing in the lee of a fallen *Quercus copeyensis* on Volcán Barva.