SOLVING THE JEFFERSON TREE MYSTERY

Maria Monteros, Ph.D., visits France to identify the genetic history of a 233-year-old pecan tree and learn what makes it so resilient.

BY JESSICA WILLINGHAM

PHOTOS COURTESY OF MARIA MONTEROS

A pecan tree grows in the courtyard of the Chateau Carbonnieux Estate in Bordeaux, France, where Thomas Jefferson visited in 1778 during his time as a U.S. ambassador to the country. Jefferson, a farmer from Virginia, was known to experiment with different agricultural production techniques. One of the crops he was interested in was pecan.

Think of pecans and you might remember Thanksgiving pie or a forgotten snack found in a farmer's pocket. Or — for many who live in the South — you might picture low-hanging fog over a pecan bottom on a cold October morning, right before a sunrise illuminates a series of trees. Pecans represent generations of stewardship and cultivation. The native nut's history is rooted in American lore, frozen in time and partially lost.

In 1846, a master gardener and slave named Antione grafted a superior wild pecan branch to a seedling on the Bon Séjour Plantation — known today as famous Oak Alley — along the Mississippi River in Louisiana. The result was an exceptional fruit: at the end of twisting gray bark and underneath bright green leaves grew a long, narrow nut with an unmatched flavor and remarkable resilience. In 1876, the new tree became known as Centennial and is now recognized as the first grafted pecan — the first named pecan cultivar that started the industry.

Rewind history again to 1787 and another agronomist fatefully finds a similar, closely-related wild pecan variety, likely from the same region near the Mississippi River where Antoine would later work. Thomas Jefferson,

ambassador to France and future president of the United States, wrote a letter home to America from his trips abroad, asking for "two or three hundred Paccan nuts from the Western country . . . they should come as fresh as possible, and come best, I believe, in a box of sand."

The seeds were shipped and planted on the European Continent, where they would grow for the next 233 years. Until now, that was all the information modern agriculture had: an American tree in France, our Founding Father's letters and a pecan cultivar first described by a plant pioneer we only know by first name.

Thankfully, trees have longer memories than we do.

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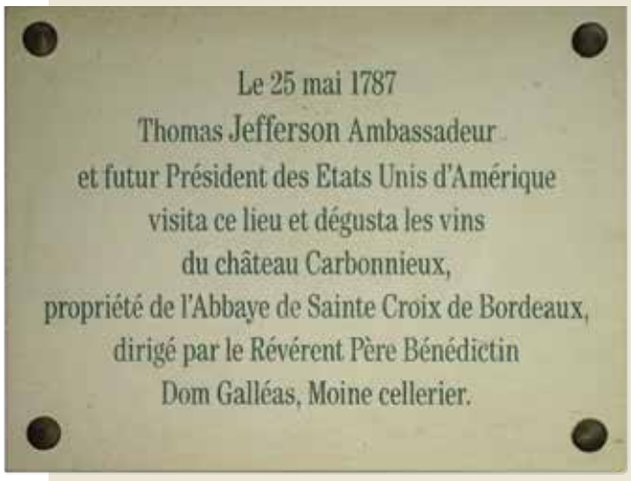

AN AMERICAN IN FRANCE

A plaque at the Chateau Carbonnieux Estate in Bordeaux, France, commemorates Thomas Jefferson's visit to the region. It says:

May 25, 1787: Thomas Jefferson, Ambassador and Future President of the United States of America, visited this place and tasted the wines of the Chateau Carbonnieux, property of the abbey of Saint Croix de Bordeaux, directed by the Reverent Father Benedictin Dom Galleas, Monk Cellarier.

Madame Perrin (middle), whose family has managed the Chateau Carbonnieux Estate since 1956, and Bernard Dalisson, president of the Jefferson Pecaneers, (right) pose with Maria Monteros, Ph.D., Noble Research Institute professor. The Jefferson Pecaneers invited Monteros to take samples of the Jefferson Tree for her research, with permission from the Perrin family.

ABOVE: Bernard Dalisson, president of the Jefferson Pecaneers, holds a pecan from the tree that Thomas Jefferson planted in Bordeaux, France, in 1787. Maria Monteros, Ph.D., collected the nut to bring back to the U.S. for her research study aimed at understanding the tree's genetic makeup.

TOP: Maria Monteros, Ph.D., collects small leaf samples from the Jefferson tree.

THE JEFFERSON TREE

Maria Monteros, Ph.D., professor of legume genomics at Noble Research Institute, made a stop at the Chateau Carbonnieux in southern France in May 2019 during an invited trip to share advancements in genomics and their application to solve practical questions in agriculture.

She didn't come to the vineyard for wine or grapes but to see the Jefferson Tree — a gift to France from Jefferson himself during his 1787 goodwill tour — at the invitation of the Jefferson Pecaneers. The volunteer group is dedicated to planting and caring for saplings grafted from Jefferson's experimental French orchards and to expanding relationships between the U.S. and France.

Monteros found the original pecan tree, and three others, still alive in the courtyard, standing 98 feet tall and nearly 15 feet around, with young leaves emerging after the tree went dormant during the winter. Littering the ground below were a handful of pecan nuts, long and narrow from the previous production season.

A plaque in the courtyard and Jefferson's historical correspondence provided evidence confirming this tree's story and ancient age. The rest of the story, including the likely origin and the modern varieties most closely related to this majestic tree, still standing after more than 200 years, was a mystery — one Monteros aimed to solve.

"Having worked mostly with plants that are productive for only one to five years, I was intrigued by this opportunity to collect fresh leaves from a tree that is still producing nuts more than two centuries after it was planted," Monteros says. "The historical secrets hidden within the tree's DNA, or genetic blueprint, could explain the origins of the Jefferson tree and the unique composition that has allowed it to grow for so many years."

Monteros knew the trees must have come from hardy stock, and Jefferson's letters have fueled her thoughts on what he might have been going through in the 1700s. Jefferson was experimenting with growing pecans in a different environment, and his work could have a farther reaching legacy than he might have imagined.

"The same tools used to identify the genetic blueprint of the Jefferson Tree could be used to identify the specific cultivars grown in existing orchards around the world," Monteros says.

"Unlocking these genetic secrets could help develop solutions to address current and emerging challenges for pecan growers."

A DNA FINGERPRINT

To know where you're going, you have to know where you've been. That's a tough journey to follow in a pecan orchard.

Different pecan varieties express different characteristics. Each pecan nut is a genetic combination of the mother tree and the paternal airborne pollen, which can be sourced from any nearby tree. Together, this random pairing in a tree produces individual nuts with a unique DNA composition.

Pecan trees take nearly a decade to produce nuts, and the unique DNA instructions determine the size, shape and color of those nuts. Right now, growers rely on these physical characteristics to identify what cultivars they have growing in their orchards.

"One of the historic challenges of pecans is the wait," Monteros says. "It can take eight to 15 years for a tree to produce the nuts that are needed for identification of the variety."

The leaves of the 233-year-old Jefferson Tree in Bordeaux, France, hold the secret combination of genetic materials that have enabled the tree to remain productive for so long. Maria Monteros, Ph.D., and her team aimed to unlock those secrets for the benefit of modern pecan growers.

In addition, orchards are often inherited, sold or combined without passing on genetic knowledge through a paper trail. Growing conditions, including the amount of water available, and disease can affect the shape of the nuts from year to year, resulting in potential misidentification.

To bring an orchard's history to present-day growers, Monteros and her team developed a DNA fingerprinting toolkit for pecans. Unlike the visual characteristics of the nut, the order of the four possible letters in the DNA genetic code is more stable and is passed on from generation to generation.

The DNA fingerprint approach uses a young leaf to identify the tree's unique order of letters. Similar to the unique ridges on the fingers of different individuals, the genetic code of a pecan tree can be used to find its closest relatives. Trees that share the highest number of letters that are in the same order are more closely related.

It was this approach that Monteros used to learn whether the Jef-

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AN AMERICAN NUT GROWING IN FRANCE

This plaque is placed in front of the tree that Thomas Jefferson planted at Chateaux Carbonnieux Estate in Bordeaux, France. It says:

This pecan, American nut, tree was planted May 25, 1787, by Thomas Jefferson during his visit to Bordeaux. It is the oldest of its kind present in European soil.

Pecan trees, including the one that Thomas Jefferson planted (not pictured here), grow in the courtyard of the Chateau Carbonnieux Estate in Bordeaux, France. Maria Monteros, Ph.D., and her team used the DNA fingerprinting technique they developed to determine that the tree planted by Thomas Jefferson is most closely related to a variety called Centennial.

LOOKING TO THE PAST FOR THE FUTURE

Discoveries like Monteros' create opportunities to help provide the industry with improved cultivars that reduce on-farm inputs and offer higher international demand.

> "With new genetic tools, we'll be able to develop new trees that improve production in the face of climate variability and generate a greater return for the grower." —CHARLES ROHLA, PH.D.

ferson Tree is related to any known pecan varieties or if it was the only known survivor of a completely different variety.

The answer: The Jefferson pecan trees growing at the Chateau Carbonnieux are most closely related to Centennial when compared to more than 100 other named pecan varieties, providing a thread of connection between the trees that Jefferson brought during historical trips to France with the tree first grafted by Antoine.

LOOKING TO THE FUTURE

Now that Monteros and her team, including Yanina Alarcon, have solved a puzzle from the past, they are excited for the future with new opportunities for research and using the pecan genome to deliver practical solutions to production challenges.

A future industry-wide DNA-identification system could help growers understand the unique characteristics of the trees in their orchards. For example, knowing if the trees are susceptible to fungal pathogens provides information to promptly develop an integrated management plan deploying fungicides with complementary modes of action.

Maria Monteros, Ph.D., records notes and carefully prepares leaf samples from the Jefferson tree so that the DNA within them can be analyzed. The research will provide information that can help develop trees better able to solve growers' challenges.

These same technologies can also inform decisions to develop new pecan varieties with specific disease resistance capabilities as well as more desirable flavor profiles and nutritional characteristics.

"Producers are always looking for the perfect cultivar," says Charles Rohla, Ph.D., pecan and specialty agriculture systems manager at Noble Research Institute.

This new era of research takes time, Rohla adds, but discoveries like Monteros' create opportunities to help provide the industry with improved cultivars that reduce on-farm inputs and offer higher annual production to meet an increasingly higher international demand. It's only a matter of time before the health foods market demands greater production of the original superfood nut.

"We're late to the game and the market compared to other nuts, but we're making huge strides," Rohla says. "With new genetic tools, we'll be able to develop trees that improve production in the face of climate variability and generate a greater return for the grower."

When asked about the pecan tree of the future, Monteros envisions new varieties that survive droughts or flooding and fungal pathogens, and that are more resilient in variable weather conditions. These technologies can also provide insights on pecan flowering and promote more uniform nut yields from year to year or alter a nut to have a more complex depth of flavor.

Through research and the ingenuity of producers, the pecan could be as nuanced as wine.

"We can start thinking of what the ideal tree would look like," Monteros says. "We're trying new things and solving puzzles. That's what drives science today."