Bananas: Chaos out of Order

Ashley Buchanan

Going Bananas

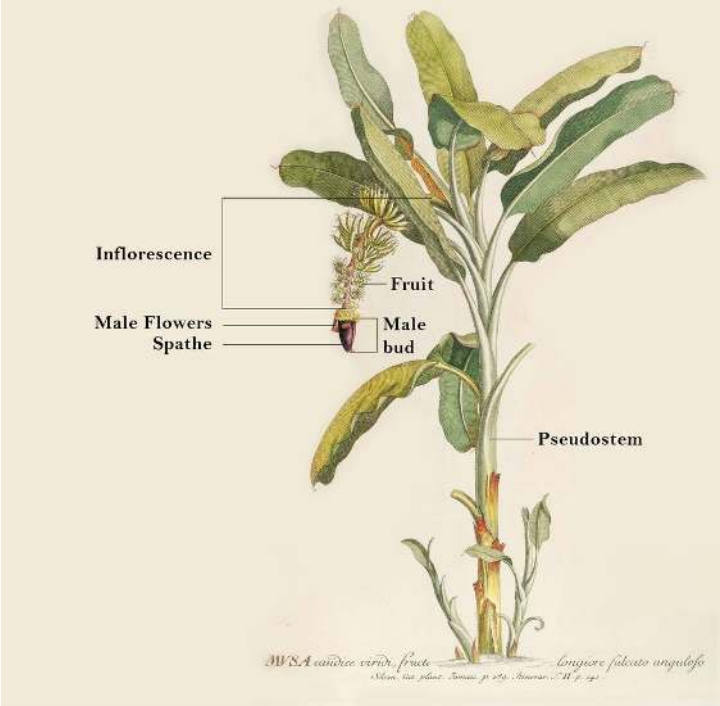
Everybody knows what a banana is. At least we think we do. Today, the banana is a ubiquitous and easy-to-recognize fruit that even shares the same name or sounds the same in many modern languages. Yet, despite this commonality across cultures, the actual identification and classification of our modern-day banana is, to quote a popular idiom, “bananas.” The identity of the wild ancestor, or ancestors, of our most common modern-day edible banana, the Cavendish, remains something of a mystery and scientists are still attempting to document the approximately 500 banana cultivars that have been grown for centuries.

English: banana | Brazilian Portuguese: banana
Croatian: banana | Czech: banán | Danish: banan
Dutch: banaan | Finnish: banaani | French: banane
German: Banane | Greek: μπανάνα (banan)
Italian: banana | Japanese: バナナ (banana)
Korean: 바나나 (banana) | Norwegian: banan
Polish: banan | European Portuguese: banana
Romanian: banană | Russian: банан (banan)
Spanish: plátano and banano
Swedish: banan frukt | Ukrainian: банан (banan)

Banana Across Modern Languages

From Seedy to Seedless

Bananas are a tree-like perennial herb, and while they resemble palms, they are not related. When the plant matures, it begins to form a large inflorescence (thyrse)-cluster of flowers-which emerges from the center of the leafy shoot and produces both male and female flowers. As the inflorescence grows, a softball-size magenta bud forms at the tip, weighing down the stem, which begins to arch toward the ground. Petal-like bracts—specialized leaves—grow between the overlapping scales surrounding the bud. These fall away to reveal clusters of female flowers (pistillate). While the female flowers develop into fruit, the distal portion of the inflorescence continues to elongate, eventually producing clusters of male flowers (staminate), which produce pollen. As the stem continues to grow and droops under the weight of the magenta bud, the tips of the fruit grow toward the sun, giving bananas their distinctive curved shape.



Parts of the Banana Plant

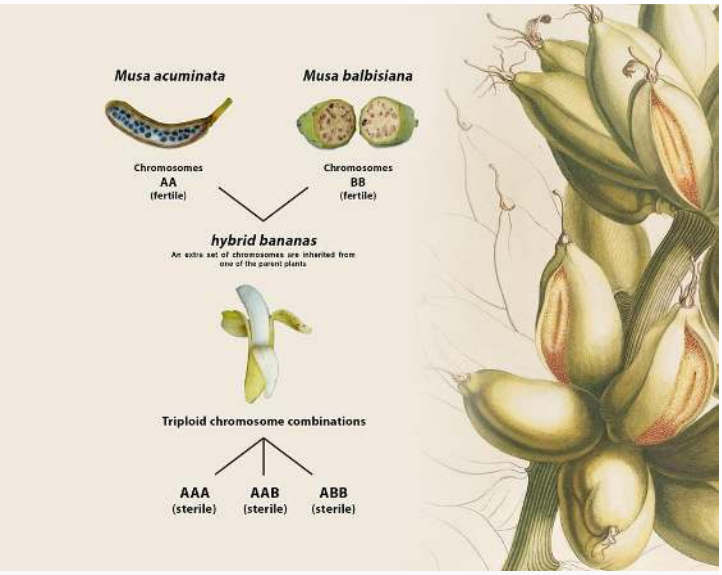
Bananas belong to the genus *Musa*, which is divided into four sections, the members of which include wild and domesticated bananas. There are more than 50 accepted species of *Musa* and its native range is tropical and subtropical Asia to the western Pacific. Through trade and migration, banana cultivars were introduced to Africa, where further distinct sub-groups of varieties developed, most notably the plantain. Wild bananas are pollinated by bats and birds, which also disperse their seeds away from the “mother” plant. Bats are particularly important banana pollinators as some species co-evolved, resulting in several wild bananas being almost exclusively pollinated by bats. For millennia, bats and birds successfully pollinated the plant’s flowers and scattered banana seeds, producing important genetic variability, which yielded highly productive plants.

Greater Indian fruit bat @ Kanjirappally 02

Prior to domestication, wild banana fruits were (and remain) incredibly seedy and difficult to eat. Scientists now believe that many wild bananas had a genetic predisposition to parthenocarpy, or the ability to produce fruit without fertilization. Beginning some 7,000 years ago, humans noticed that some banana plants produce seedless fruits. Since sterile wild bananas were easier to eat, humans began propagating the wild banana plants with this mutation. To propagate a sterile plant, humans cloned the banana by collecting and planting the ramets—vegetative suckers—of the original plant.

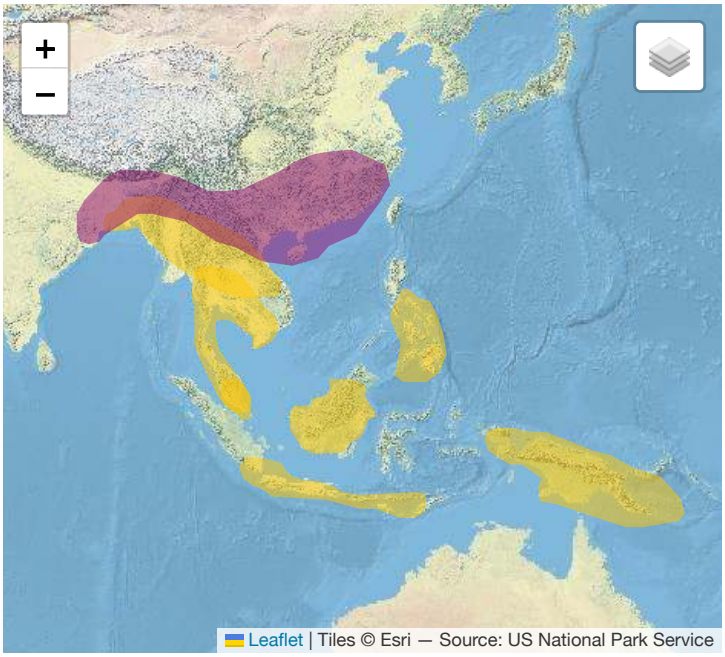
An edible and seedless Cavendish banana next to its ancestor…

Selecting for edibility and propagating parthenocarpic bananas was just the first step in the process of banana domestication. The next phase began as various human populations migrated, bringing their previously isolated banana species and subspecies along the way. Like humans, wild bananas are diploids: they have two sets of chromosomes and at fertilization receive one set from each "parent." Thanks to human selection, migration, and exchange, triploid banana hybrids that did not produce seeds were created. Hybridizing distant banana relatives produced plants that possessed three sets of chromosomes, rather than two. This rendered the progeny plant sterile and ensured it would produce fleshy, seedless fruits. In addition to being sterile, triploid banana hybrids could still mutate. Further diversity of the sterile hybrids was produced as farmers selected and propagated for desirable mutations, such as a starchy or sweet pulp. The genetic diversity of triploid bananas and their environmental adaptability ensured not only the survival of sterile banana hybrids, but also their ability to spread across geographic areas and cultures.[1]



From Diploids to Triploids.

While wild bananas are more diverse than previously understood, scientists have identified *Musa acuminata* as the primary wild parent of parthenocarpic banana. The morphological variation that is sometimes caused by parthenocarpy, however, makes identifying and classifying banana species more difficult. As Jean Kennedy explains, "Although it is clear that parthenocarpy within section *Musa* has occurred only in *Musa acuminata*, the parentage of the resulting edible bananas is greatly complicated by the diversity of *Musa acuminata* at subspecies level. Parthenocarpy probably developed in at least two of these subspecies, and there are many edible hybrids between these and additional wild subspecies."[2] Further complicating matters are hybridizations between *Musa acuminata* and *Musa balbisiana*. The natural variation and geographic distribution of *Musa balbisiana* remains less understood than *Musa acuminata* and much remains to be learned about the distribution, wild/cultivated status, and genetic characterization of *Musa acuminata* and *Musa balbisiana* hybrids.

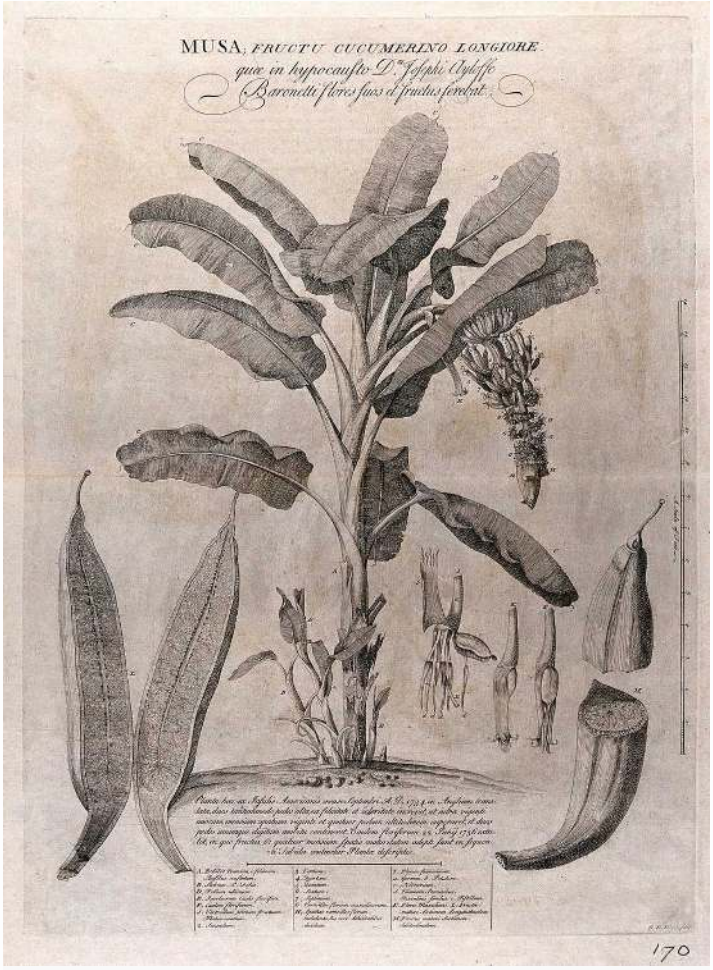


Geographical distribution of *Musa balbisiana* and subspeci…

What's in a Name?

In 1753, Carl Linnaeus' formative work, *Systema Naturae,* formalized a system of nomenclature that standardized plant names and botanical terminology among botanists across the globe. The system used Latin binomial names—the first name indicating the genus, and the second the species—to identify all living organism in the natural world. In addition to binomial names, Linnaeus also proposed a new system of classifying plants. Unlike earlier attempts to group or classify plants, Linnaeus's system focused solely on the reproductive features of wild plants (not domesticated) to characterize, organize, and group related plants. While Linnaeus's system was a somewhat artificial structure of classification and hierarchical divisions placed on the plant world, it provided order and standardization from the chaos of plant names and groupings created by centuries of disparate European collecting and cataloguing of the plant world. While the Linnaean system of classification has been revised, modified, and added to over the centuries, the system of binomial names has remained largely unchallenged for nearly 250 years.

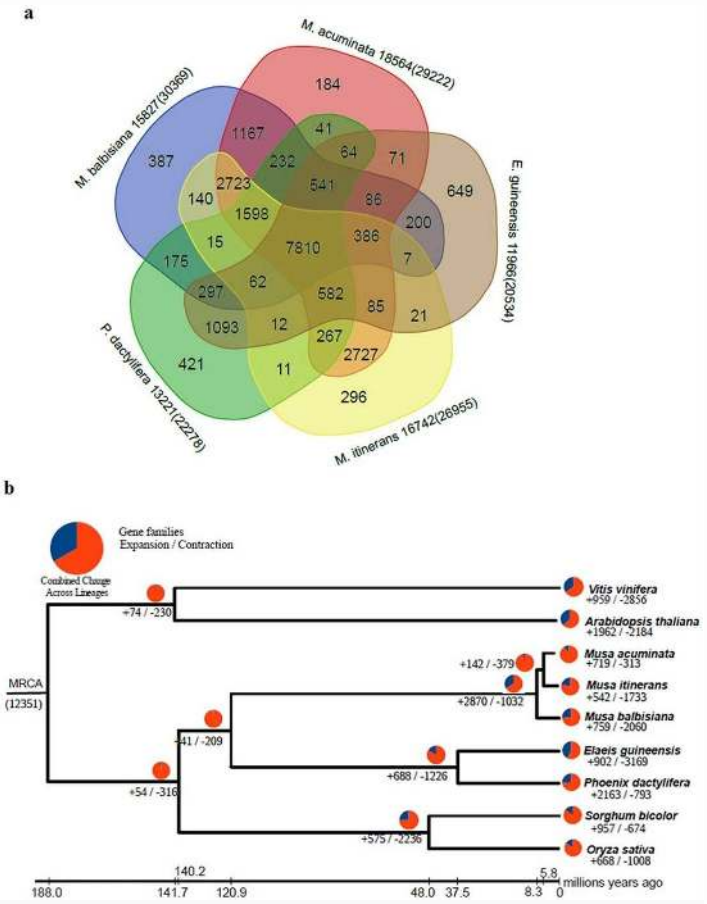
Yet, despite Linnaean taxonomy's international acceptance and longevity, Linnaeus's naming system does have its limitations, which we can see in the case of the banana. Linnaeus did not consider domesticated plants species, since they were the product of human manipulation. The two "wild" species of banana identified by Linnaeus–*Musa x paradisiaca* and *Musa sapientum*-were in fact domesticated edible cultivars. Linnaeus was unaware of the banana's long and complex history of domestication.



Ehret, Banana plant, 1742

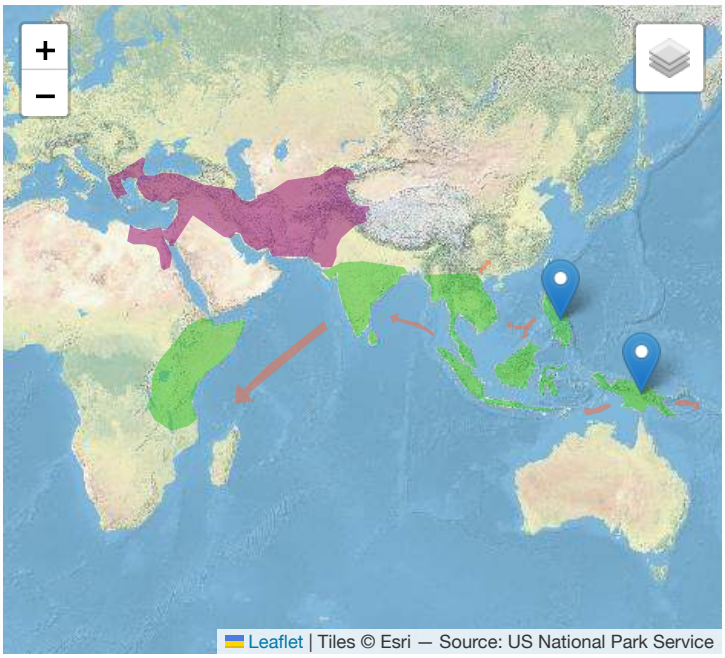
The Banana Goes Global

Thanks to domesticated bananas' long history of human intervention and migration, modern plant taxonomy did little to clear up the confusion surrounding identifications and names of banana plants. While scientists eventually deduced that Linnaeus had identified two domesticated banana cultivars, not species, the wild progenitors of cultivated bananas as well as the origin of banana domestication remained a mystery until recently. Twenty-first century genomics and genetic testing have revealed that the origin of banana domestication was geographically further east than originally thought.



Whole Genome Sequence of a Wild Banana Relative

In 2002, a comprehensive study of relationships among wild and cultivated bananas determined that the parthenocarpic “A genotype” of almost all the edible banana groups was derived from either subspecies *banksii* (from the Papua New Guinea region) or subspecies *errans* (Philippines) of *Musa acuminata* (or from both of subspecies).[3] These findings reveal that the origin of banana domestication was in the regions of the Philippines and Papua New Guinea. Archaeobotanical remains identified as the genus *Musa* attest that edible bananas were indeed present in Papua New Guinea at least 10,000 years ago and were being cultivated as early as 7,000 years ago.[4]

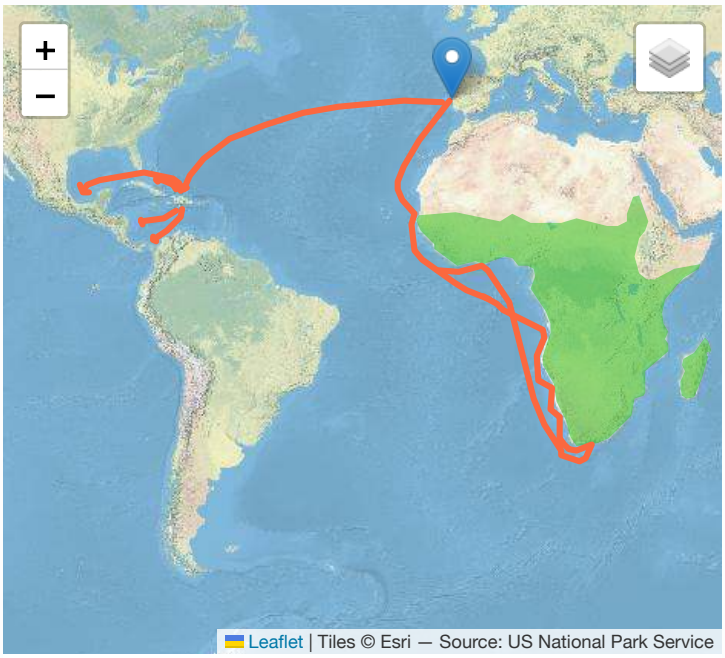


Origins of Banana

From the Philippines and Papua New Guinea, domesticated parthenocarpic bananas traveled along trade routes and with settlers and merchants both east and west. Along the way, these early domesticated bananas were hybridized with local subspecies in the Malay Peninsula and Indonesia, before eventually making their way to India. Finally, around 5,000 years ago domesticated bananas (of the genus *Musa*) arrived in Africa from across the Indian Ocean.

Europeans first learned of bananas through Alexander the Great’s Asiatic campaign in 331–323 BCE. According to the Greek naturalist Theophrastus and the Roman naturalist Pliny the Elder, one of the plants Alexander saw, recorded, and brought back to Asia Minor was the banana. Europeans, however, had neither the climate to grow bananas nor the proximity to their natural habitat to import the fresh fruit. So, while bananas became a staple food crop in Africa, India, Southeast Asia, and the Pacific, they remained an exotic curiosity in Europe.

The rise of European maritime powers in the late fourteenth and fifteenth centuries brought renewed interest in the banana. By the time the Portuguese began exploring the west coast of Africa in the late fifteenth century, propagation of banana cultivars had spread through Africa south of the Sahara. Eventually, Portuguese slavers began transporting bananas alongside enslaved Africans to the West Indies. Unlike later periods, however, bananas were not viewed as a cash crop. Instead, they served as cheap and portable sustenance for enslaved individuals during their horrific transatlantic crossing.

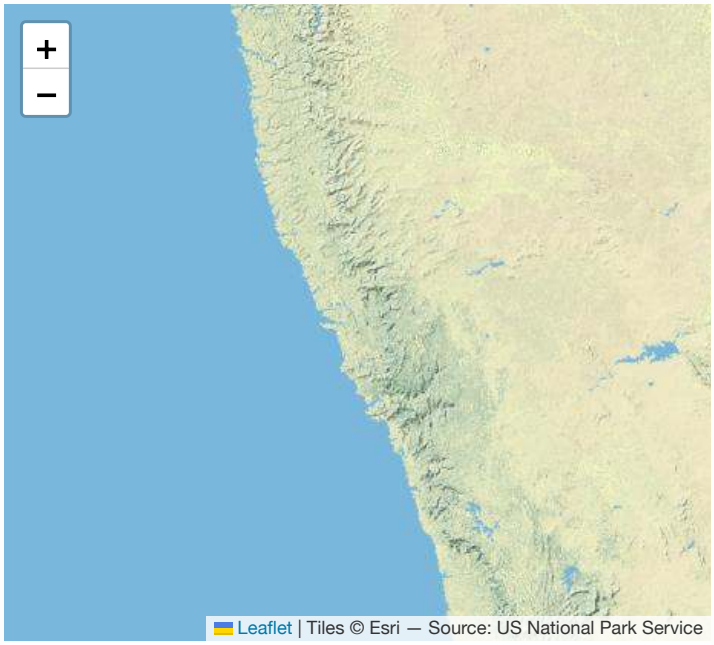


Voyage of Bartolomeu Dias (1487-88)

In 1516, Friar Tomas de Berlanga, then a Catholic missionary, landed on the Island of Hispaniola (now comprising Haiti and the Dominican Republic) and planted banana stems (or suckers) as a means to continue to feed the growing enslaved African population. When Friar Tomas was made Bishop of Panama in 1534, he took banana plants with him to the mainland. Bananas were also carried to Mexico by the Spanish and eventually spread rapidly throughout Central America.[5]

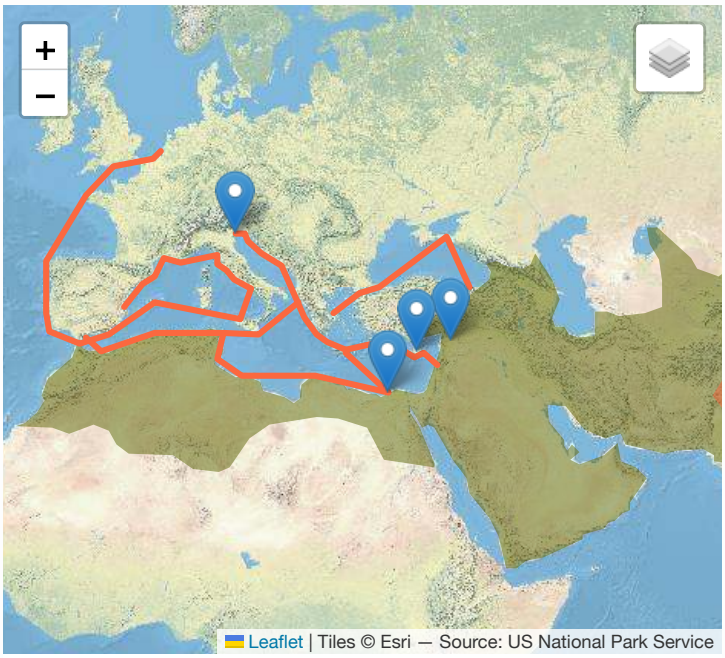
Many Names, One Plant

During this early period of renewed European interest in the banana, there was great uncertainty surrounding the identification, depiction, and name of the abundant yellow fruits Europeans encountered throughout Africa, India, Southeast Asia, and, thanks to their own transmission, the New World. While living in Goa, India, a Portuguese physician and naturalist, Garcia de Orta, adopted the name “banana” for the fruit. In 1563, de Orta published an herbal detailing the *materia medica* of India, in which he wrote of a fruit found in India, Malaysia, and Arab lands as well as “in Guinea, where they call them bananas.” In the early modern period, however, the use of the name banana was far from universal.



Goa

The most influential European author of the period, Italian physician Pietro Andrea Mattioli, referred to the banana plant as “musa” and the individual fruits as “muse” in his important herbal published in 1554. Musa, which was eventually adopted by Linnaeus as the name of the genus, is believed to be an adaptation of the Arabic word for banana, *mauz* or *mawzah*. By the eighth century, Islamic expansion under the Umayyad Caliphate (661–750) had reached the Indian subcontinent, creating a region of trade, exchange, and communication stretching from India to Iberia. Through these vast commercial networks, bananas were traded and became popular throughout the Islamic Empire.



Medieval Venetian Commerical Traderoutes

Italian physicians and naturalists like Mattioli adopted the Arabic name for banana since it was through contact with the Islamic Empire in the late Middle Ages, as well as the writings of Islamic physicians such as Avicenna (Ibn Sina in Arabic), that Italy was first introduced to the plant. Although Mattioli did not mention or describe the “musa tree” in the first edition of his famous herbal, its appearance in a later edition in Latin in 1554 is likely the first printed European herbal entry to describe banana.

The Flemish physician and botanist Rembert Dodoens used the term “musa” in his herbal published in 1563. Unlike Mattioli and de Orta, Dodoens provided an image of the musa or “Mose” tree (Mattioli would not add an illustration of banana to his herbal until 1565). Dodoens’s description of the banana tree as well as his image were taken directly from the work of Andrè Thevet, a French Franciscan priest who published a description of his travels through the Levant in 1556. Thévet described bananas as resembling cucumbers, yet the inaccuracy of his accompanying image casts doubts on whether Thévet saw an actual banana plant. It is more likely that European travelers in the Levant came in contact with banana fruits in the markets and not on the fruiting trees. In his herbal, Dodoens stated that bananas were trafficked through the merchants of India, Persia, and Venice, while Mattioli asserts the plant was already growing in Cyprus, Egypt, and even Sicily. Contact and trade with Islamic territories combined with southern Italy’s warm climate meant that Italy was likely one of the first regions in European to learn about and attempt to cultivate bananas in private as well as in botanical gardens.

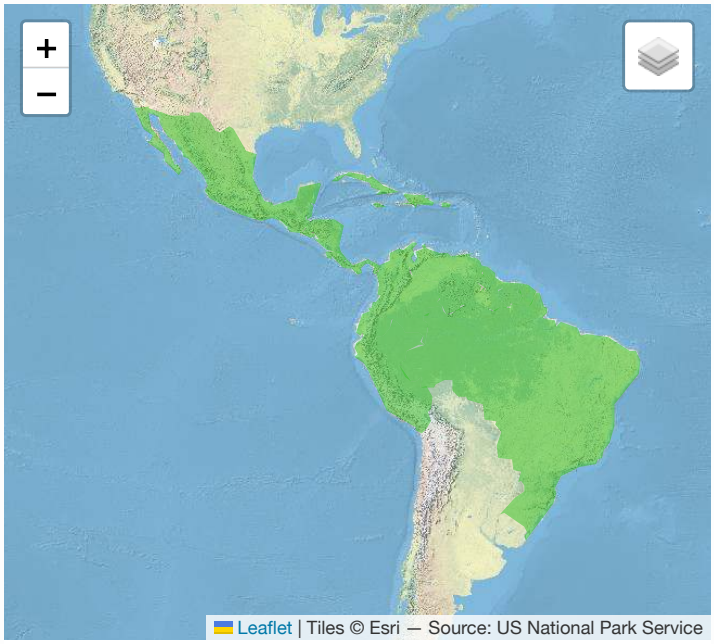
Cosmographie de Levant

Dodoens, Crŭÿde boeck, 1563, p. 616

While the adoption of the Arabic word for banana provided some standardization of nomenclature, it was far from universally used. In fact, numerous names, sometimes contradictory, were given for banana. Confusing matters further was the enduring description of banana, rather than the fig or apple, as the forbidden fruit of the garden of Eden. The authors of many sixteenth and seventeenth century herbals, including Mattioli, Dodoens, Carolus Clusius, and Andrea Cesalpino described the banana plant as the tree growing in the Garden of Eden. The persistence of this tradition continued well into the eighteenth century. Even Linnaeus, in his treatise on the banana palm, weighed in on the topic, ultimately dismissing the idea as a metaphor in his penultimate chapter. Finally, thanks to their geographic origin and early association with palm trees and dates, and enduring associations with the Garden of Eden, bananas were also often referred to as “Indian figs.”

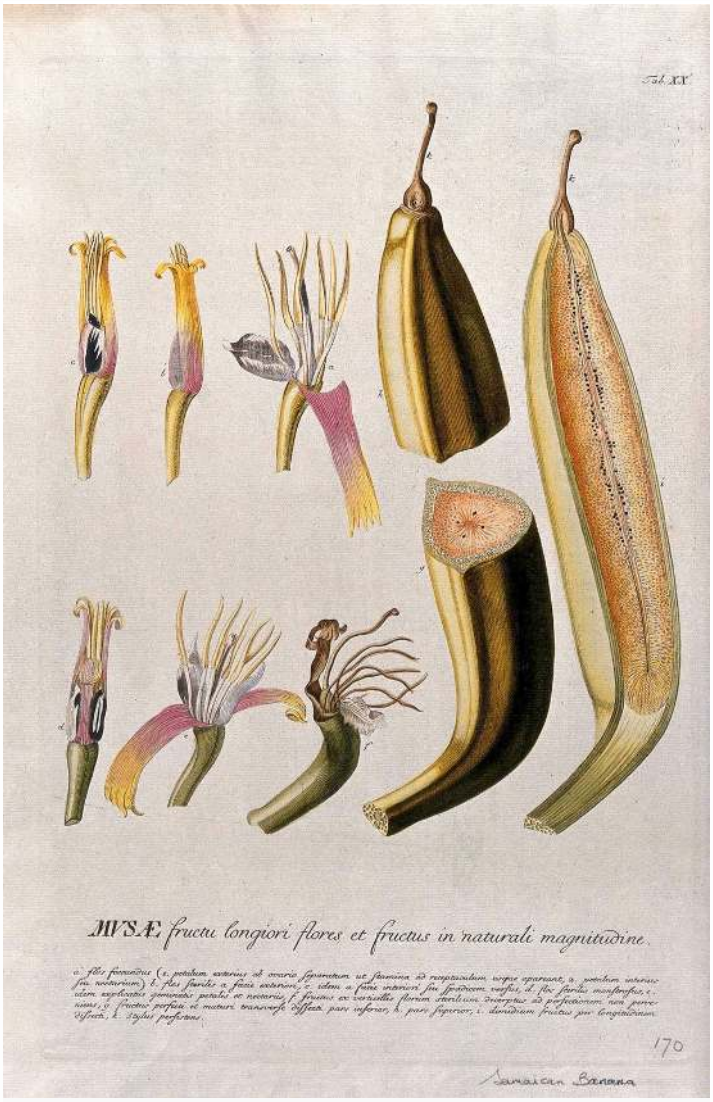
Early Modern Names for Banana

By the seventeenth century, bananas had spread throughout the Caribbean and the tropics of Central and South America, becoming a dietary staple along the way. While bananas were known to Europeans through herbals, natural histories, and travel narratives, they remained a rarity on the continent—a lush, exotic fruit only travelers enjoyed.



Distribution of Banana in the New World by the 17th…

Even Linnaeus had to rely on the garden and hothouse of the wealthy financier and director of the Dutch East India Company, George Clifford (1685–1760), to see and study a live banana plant. At his estate in Hartekamp, Holland, and with the assistance of Linnaeus, Clifford successfully flowered a hybrid of *Musa acuminata* and *Musa balbisiana*. The successful flowering and subsequent fruiting of the rare and exotic banana plant was so momentous that Linnaeus wrote a treatise on the plant, *Musa Cliffortiana*, published in 1736. The German botanical artist Georg Ehret provided the illustrations of Clifford's flowering banana plant for the treatise and diagrammed Linnaeus's new plant classification system. It was also at the direction of Linnaeus that Ehret began adding details of the plant's reproductive structures, or flowers, creating a new standard for botanical illustrations.



Plantain banana (Musa x paradisiaca L.): nine sections of fl

Banana Republics

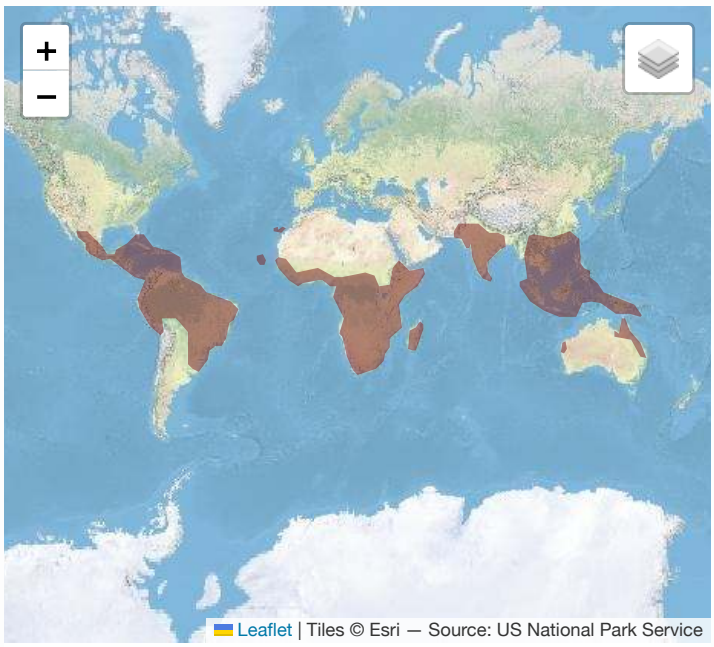
It was not until the nineteenth century, with the development of steamships and refrigeration, that the Central and South American banana would become a major global trade commodity. Thanks to these innovations, bananas began pouring into American cities after the Civil War. In Reconstruction America, bananas became increasingly popular as they were seen as a healthy and affordable commodity. Eventually, small-scale, independent cultivation was consolidated and replaced by large-scale production conglomerates, such as the United Fruit Company (UFC)—now Chiquita Brands International. Conglomerates like the UFC focused on cultivation practices and varietals that were easier to ship, more profitable, and desired by consumers. Over time, thanks to its hardy peel and sweet taste, one selected mutation of one banana cultivar in particular came to dominate the market, the Gros Michel. Monocultures of Gros Michel swiftly supplanted most other banana cultivars in Latin America produced for the American and European markets.

Banana Cart in New York City, 1902

In the early twentieth century, multinational American corporations like the UFC were also implicated in the creation of what was referred to as the “banana republic” phenomenon. The UFC and other companies bought huge swaths of land and built massive infrastructure in Central and South American countries with environments that could support banana production, such as Honduras and Guatemala. Many of these countries had nascent democratic or unstable governments and quickly became economically dependent on exporting a single product—the banana. With such a grip on a country’s infrastructure and wealth, these companies also came to dominate the countries’ governments, propping up corrupt dictatorships that exploited the working class and favored the economic interests of foreign corporations.[6]

Detroit Publishing Co., United Fruit Company banana conveyors…

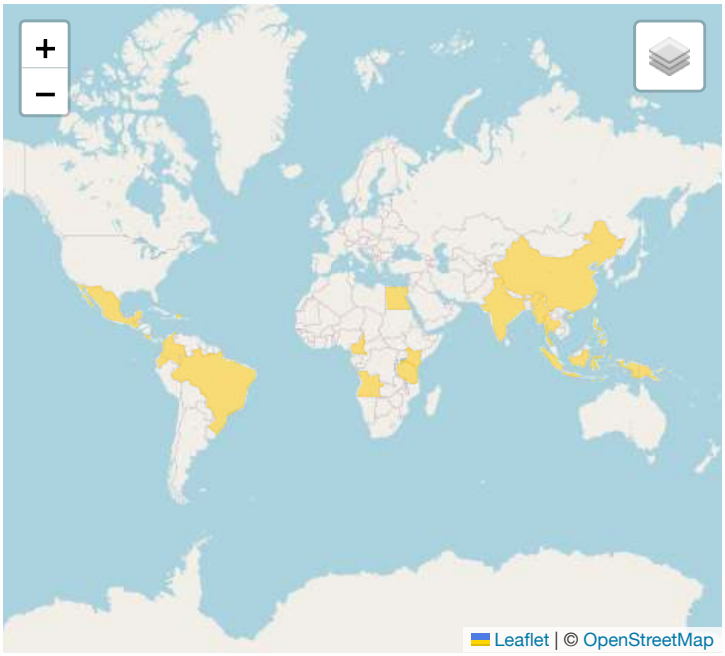
An intense monoculture focused on the vegetal propagation of one mutation of one banana hybrid proved unsustainable. Lacking genetic diversity, Gros Michel banana plantations across the globe fell victim to a pathogen known as Fusarium oxysporum, or “Panama Disease.” From 1899 to the 1950s, Panama Disease destroyed Gros Michel crops throughout the Americas. Desperate to replace the valuable export, fruit conglomerates abandoned the Gros Michel for a new varietal, the smaller and less flavorful Cavendish banana.



Distribution of Fusarium wilt of banana (races 1 and 2)

Bananas Today

Today the Cavendish banana remains the dominant cultivated and exported varietal of bananas. Just as it did in the twentieth century, the current global production of more than one million tons of bananas is based on large-scale vegetative propagation of a small number of genotypes derived from a handful of ancient sexual recombination events. This makes the Cavendish varietal, like the Gros Michel, particularly susceptible to diseases, as well as pests and climate change. Recent scientific studies on banana genetics and genomes, however, could hold the key to diversifying and revitalizing banana hybrids. For many scientists, the goal is to figure out banana's origin story in order to produce new polyploid hybrids through genetic recombination, genetic engineering, and manipulation of fertile diploids, just as societies in Southeast Asia did thousands of years ago.[7]



Top 20 Banana Producing Countries 2012

While we need to rethink how we select, hybridize, and propagate bananas, scientists have also been rethinking how banana cultivars are classified. In 1955, an informal nomenclature system to classify banana cultivars was developed by Norman Simmonds and Kenneth Shepherd. Instead of assigning binomial names, Simmonds and Shepherd organized edible bananas into genome groups, according to the chromosomal contributions of their ancestral wild species (i.e., AAA, AAB, and ABB) and subgroups for closely related cultivars derived from mutation selection and propagation (i.e., the Gros Michel and Cavendish).[8] While Simmonds and Shepherd had to rely on chromosomal classification based on the visible morphology of banana cultivars, scientists today have more reliable genome techniques, allowing them to analyze and reclassify the genetic make-up of hundreds of banana cultivars. And so, we have two systems of nomenclature for the banana: one for wild, seedy bananas and another for the seedless edible cultivars. This work has revealed that more than 100 subspecies of Musa acuminata have been implicated in the domestication of bananas. Despite this work, scientists still do not know just how many banana cultivars actually exist and are still working to formalize a genome-based classification system in the hopes of finally creating an internally coherent list of names for banana species, subspecies, and cultivars.[9]

References

1. Xavier Perrier et al., “Multidisciplinary perspectives on banana (*Musa* spp.) domestication,” *PNAS* 108 (28) (2011): 11311–11318. http://dx.DOI.org/10.1073/pnas.1102001108 ↩
2. Jean Kennedy, “Pacific Bananas: Complex Origins, Multiple Dispersals?,” *Asian Perspectives* 47, no. 1 (2008): 75–94, DOI:10.1353/asi.2008.0004 ↩
3. Jean Kennedy, “Pacific Bananas: Complex Origins, Multiple Dispersals?” ↩
4. T. P. Denham, et al., “Origins of Agriculture at Kuk Swamp in the Highlands of New Guinea,” *Science*, Vol. 301, Issue 5630 (2003): 189–193, DOI:10.1126/science.1085255 ↩
5. Virginia Scott Jenkins, *Bananas: An American History* (Washington, DC: Smithsonian Institution Press, 2000). ↩
6. Peter Chapman, *Bananas: How the United Fruit Company Shaped the World.* 1st American ed. (New York: Canongate US, 2008). ↩
7. Xavier Perrier et al. “Multidisciplinary perspectives on banana (*Musa* spp.) domestication.” ↩
8. N. W. Simmonds and K. Shepherd, “The taxonomy and origins of the cultivated bananas.” *Journal of the Linnean Society of London, Botany* 55: 359 (1955): 302–312. https://DOI.org/10.1111/j.1095-8339.1955.tb00015.x ↩
9. ProMusa, Diversity of banana cultivars portal: http://www.promusa.org/Diversity+of+banana+cultivars+portal?page_ref_id=15 ↩