Gifts of the Amazon Flora to the World

Richard Evans Schultes

Many valuable plants were originally domesticated in the now threatened rain forest of the Amazon basin.

When the famous Russian botanist Nikolya Vavilov outlined the major regions of the world that had given man most of his principal cultivated plants, he did not include the Amazon Valley. Nor did his nineteenth-century predecessor Alphonse De Candolle, the pioneer in the field of phytogeographic study, look to the Amazon as the source of important cultivated plants. Since the exploratory work of these two botanists, most modern specialists have concentrated either on one species or on members of one genus or family rather than on entire regions. As a result, the Amazon basin, with few exceptions, has never been accorded the intensive research that such a rich flora deserves, especially as a potential source of useful species.

The Amazon drainage area, as large as the United States, is for the most part covered with a dense tropical rain forest and is bathed by one-fifth of the world's fresh water; it has a rich and varied flora of an estimated 80,000 species of higher plants. The more accessible areas have already given the world some of its more important economic plants while the vegetation of many of the hinterland regions is still unexplored, awaiting both botanical and chemical investigation.

Unless strong conservation measures are strictly enforced, many species and even some genera may become extinct. It is vitally important to preserve as many sources of germ plasm as possible for the benefit of future generations.

Among the most important species that have entered the world economy as major players, as discussed in detail in the following article, are the pineapple, *Ananas comosus*; the Brazil nut, *Bertholletia excelsa*; achiote, source of an orange-red dye for foods and cosmetics, *Bixa Orellana*; the curares, *Chondrodendron tomentosum*; the cocaine-yielding shrub, *Erythroxylon Coca*; the edible peach palm, *Guilielma speciosa*; the rubber tree, *Hevea brasiliensis*; the tapioca plant or cassava, *Manihot esculenta*; and cacao, source of chocolate, *Theobroma Cacao*. Of the numerous ornamental plants that have come from the Amazon, we will discuss only one, the royal water lily, *Victoria amazonica*.

PINEAPPLE

Ananas comosus (L.) Merrill
Family: Bromeliaceae

The pineapple is unknown in the wild, but it may sometimes escape from cultivation and give the appearance of being wild. There is every indication that the plant is Amazonian in origin, although, as with other cultigens, some uncertainty remains. One theory holds that the Tupi-Guarani Indians first cultivated it in Paraguay and with their migrations took it to Amazonia. Evidence for this theory is the presence in Paraguay of several species

The wild pineapple, Ananas ananassoides, *considered by some botanists to be the ancestor of the cultivated pineapple,* Ananas comosus. *Rio Piraparana, Comisaria del Vaupes, Colombia.*

believed to be related to *Ananas comosus*. All of these wild species are seedy types in contrast to the generally seedless pineapple. They all have the same chromosome number, and they all are capable of hybridizing with one another.

Close relatives of the pineapple are also found in the Amazon, especially *Ananas microstachya* and *A. ananassoides;* and the area of greatest variability of *A. comosus* is the western Amazon. The Colombian Witoto Indians of the Igaraparaná River area, for example, have more than twenty-four "varieties" of the pineapple, each with its native Indian name. Such variation suggests that *A. comosus* originated as a cultigen in the Amazonia of Colombia or Peru.

By the time that Europeans arrived in the New World, the pineapple was widely distributed throughout tropical America. Records before 1600 place the pineapple along both the Pacific and Atlantic coasts of South and Central America. Columbus saw the pineapple on his second voyage, and one of his officers attempted to describe it: "There were some fruits like artichoke plants but four times as tall which gave a fruit in the shape of a pine cone, twice as big, which fruit is excellent; and it can be cut with a knife like a turnip, and it seems to be wholesome." A pineapple was taken as a special gift to the Emperor Charles V of Spain, and one was presented to King Charles II of England in 1672.

The many references to the pineapple in the early chronicles indicate that this strange fruit caught the fancy of Europeans. It was introduced very early to the Old World tropics and reached virtually all parts of the Far East before the end of the sixteenth century. Today, as is well known, the commercial center of cultivation is in Hawaii.

The pineapple is unique among fruits in containing a chemical constituent that aids digestion, a proteolytic enzyme known as *bromelin*. Bromelin is milk-clotting and is employed in tenderizing meat and in the leather industry. In modern pharmacy, it is used in treating sprains, contusions, and other injuries since it is a depolymerizer and modifier of permeability.

BRAZIL NUT
Bertholletia excelsa Humboldt et Bonpland
Family: Lecythidaceae

One of the most majestic trees of the humid forests of Brazil, Guiana, and Venezuela, *Bertholletia excelsa* is the source of the Brazil nut of commerce. An enormous tree, primarily of the Amazon, it frequently attains a height of 160 feet. The globular fruit, which ripens from January to June, is often called the "monkey pot." A woody or boney capsule with a terminal lid, the fruit measures six inches in diameter and weighs up to five pounds. Each fruit contains from twelve to twenty-four nutritious three-sided nuts, the white "meat" of which consists of 70 percent fat and 17 percent protein. Each tree can produce three hundred or more fruit pods.

It is said that the monetary value of Brazil nut exportation from Amazonian Brazil is second only to that of rubber, but as the slow-growing tree is not cultivated, virtually all production of Brazil nuts comes from wild forest trees. Dutch traders began exportation of Brazil nuts in the early 1600s. Today many thousands of tons are exported, more than ten thousand tons to the United States alone.

ACHIOTE
Bixa Orellana Linnaeus
Family: Bixaceae

This small, profusely fruiting tree, known as *achiote* in Spanish and *annatto* in Portuguese, yields enormous amounts of seeds (up to 600 pounds per tree), each covered with a reddish aril, the source of an orange-yellow dye. The crushed seeds are usually soaked in water, and the water is then evaporated to make a

An early drawing of achiote, Bixa Orellana. *The pods contain seeds that are covered with a reddish aril, the source of an orange-yellow dye. Left: from Hernandez,* Rerum Medicarum Novae Hispaniae Thesaurus *(1651). Right: from Piso,* De Indias Utriusque Re Naturali et Medica Libri *(1658).*

brightly colored paste. The dye is added as a spice to soups, cheeses, and other foods, especially in tropical countries in both hemispheres. The dye is a good source of vitamin A, which is often deficient in the diets of many hot, humid areas.

Much achiote is now exported to industrial countries in North America and Europe, particularly to color oleomargarine, since some of the synthetic aniline dyes formerly used are now believed to be carcinogenic. It is also employed as a dye for woolens and is sometimes employed in the paint, varnish, lacquer, cosmetic, and soap industries.

Among many South American tribes, who know the plant by one of its Brazilian names (such as *urucú*), achiote is valued as a source of decorative body paint. *Bixa Orellana*, named for the early Spanish explorer of the Amazon river, Francisco de Orellana, is not known in the wild. Some suggest that it was domesticated from the large forest tree *B. excelsa* of the southwest Amazon of Brazil.

Long before Europeans arrived in the New World, achiote had spread throughout tropical America. When the Spaniards conquered Mexico, it was already firmly established. The Aztecs, who called it *achiotl* ("medicine good for dyeing"), extracted a strong fiber from its bark, valued it as a dye, and even added it to their chocolate drinks. Medicinally, it is used as a gentle purgative.

CURARE

Chondrodendron tomentosum Ruiz et Pavón
Family: Menispermaceae

The use of arrow poisons by Indians of the South American rain forests is a very old practice. Although many different kinds of arrow poisons are prepared from many different kinds of plants, they are all indiscriminately called *curares*. The two most important types—the so-called true curares—use, as their basic source of toxicity, species of the loganiaceous genus *Strychnos* or the menispermaceous genera, particularly *Chondrodendron*. The name *curare* is a corruption of two Tupi Indian terms meaning "bird" and "to kill."

The early traveler Peter Martyr first chronicled curares in numerous works written during the quarter century following Columbus's first voyage to the New World. He mentions several "varieties" of arrow poisons and records that the natives had an antidote for the poison and practiced cauterization for arrow-poison wounds. Martyr is responsible for a story, often repeated and embellished by later writers, of old women "skilled in the art, who are shut in at certain times and furnished with the necessary materials; during the two days they watch and distill the ointment . . . If the women are well and not found half dead from the fumes, they are severely punished; and the ointment is thrown away as being valueless; for the strength of the poison is such that the mere odour of it . . . almost kills its makers."

In the early nineteenth century, sundry naturalists and travelers wrote about curare—von Humboldt, Waterton, von Martius, the Schomburgk brothers, and others—but it was Baron von Humboldt who recorded the first eyewitness account of its preparation. Probably all these early accounts referred to *Strychnos*-based curare, since they came from travelers who had encountered the poison in Venezuela or the Guianas.

Reports of the menispermaceous-based curares of the Amazon are of a much later date. The most important is undoubtedly that of the German plant explorer von Martius who, in the 1820s, found a species of *Chondrodendron* used in curare-making by Indians on the River Japurá on the Brazilian-Colombian frontier.

Nine species of the Menispermaceae are known to be employed in the preparation of curares. It is, however, the arrow poison made

A Kofan Indian medicine man and his student preparing curare. This tribe produces a wide variety of curares, many prepared from bioactive plants unknown in other parts of the Amazon. Comisaria del Putumayo, Rio Sucumbios, Colombia.

basically from *Chondrodendron tomentosum* that has become important in Western medicine during the last sixty years. This curare has a number of alkaloids but owes its activity as a skeletal muscle relaxant primarily to d-tubocurarine, which has become an indispensable adjunct of modern surgery and is used for treating various neurological conditions.

The plant is an enormous forest liana, climbing into the crowns of the tallest trees. The active principles are contained in the bark, which must be scraped off. As a consequence, repeated exploitation eventually kills the vine. The plant has never been cultivated, mainly because it is extremely slow-growing. There appears, however, to be a danger that the source of the brownish, resinous syrup may become scarce as a result of intensive exploitation and increasing forest devastation. When the curare syrup can no longer be procured from natural sources, is there anything that can successfully supplant it?

Barasaba Indians collecting leaves from the coca plant, Erythroxylon Coca *var.* Ipadu. *Comisaria del Vaupes, Rio Piraparana, Colombia.*

COCA LEAF

Erythroxylon Coca Lamarck
Family: Erythroxylaceae

Recent research has established that there are two distinct species of *Erythroxylon* and two varieties, all of which are excellent sources of the active principle, cocaine. *Erythroxylon Coca,* the most important species, is cultivated in the Andes at relatively high altitudes, between 1500 and 4500 feet, from Colombia south to Bolivia and northern Argentina. From this species the variety *Ipadu* has been developed, unusual in its ability to thrive in the tropical climate of the western Amazon. From *E. novogranatense,* a distinct variety *truxillensis* has developed on the drier parts of the Andean slopes, up to 4500 feet. This variety is now widely cultivated in the coca fields of the Trujillo region, and archeologic records indicate that it was formerly grown along the dry coastal regions of Peru as early as 1900 B. C.

The method of coca use in the Amazon regions varies considerably from that of the highlands where there are natural sources of calcium or lime necessary for the extraction of cocaine within the user's acid mouth. In the Amazon, where sources of the alkaline admixtures are not readily available, the Indians have discovered that the ashes of a number of leaves are alkaline and can, when mixed with a powder of the coca leaves, result in the extraction of the active principle during mastication of the leaves.

The principal alkaloid, cocaine, was isolated in 1860, and its physiological effects were studied in 1862. Two years later, it was

recommended in Western medicine as an excellent local anesthetic. It is still valuable, especially in ophthalmological and ear, nose, and throat surgery. It is the use of the purified alkaloid—not the aboriginal employment of the leaves or powder as a masticatory among South American Indians—that may lead to dangerous addiction.

PEACH PALM

Guilielma speciosa Martius
(=Bactris Gasipaes HBK.)
Family: Palmae

Every Indian settlement in the western Amazonas has *Guilielma speciosa* planted around the houses as an excellent source of food in the fruiting season. The fruit—the size and color of a peach—is rich in carbohydrates (primarily starch) and has copious oil. Of high nutritional value, it is extremely delicious when roasted or boiled. Many of the native tribes have festivals during the first week of April at the time of the principal harvest; the Yukunas of Colombia hold their *kai-ya-ree* dance for four days at this time. At these festivals, flour of the fruit often takes the place of flour of *Manihot esculenta*, and unleavened bread is prepared from it in great quantities.

While the edible fruit represents by far the most important economic value of *Guilielma speciosa*, the palm has a number of other uses in aboriginal societies. Some Indians esteem the palm heart; others employ the inflorescence as a flavoring agent in cooking. The hard "wood" is fashioned into bows, lances, and other weapons; and the usually spine-covered trunk has been used to make fences around houses to protect inhabitants from enemies. Even the root has often been considered medicinal.

The precise locality of domestication of this palm is apparently unknown. The early explorer Henry Walter Bates wrote: "[It] grows wild nowhere on the Amazons. It is one of those few vegetable productions . . . which the Indians have cultivated from time immemorial and brought with them in their original migration to Brazil." Modern botanical research suggests that the plant probably originated on the eastern slopes of the Peruvian Andes, either from the wild *Guilielma mattogrossensis*, spreading into the central part of the Amazon by way of the Madeira River, or from *G. microcarpa* and *G. insignis*.

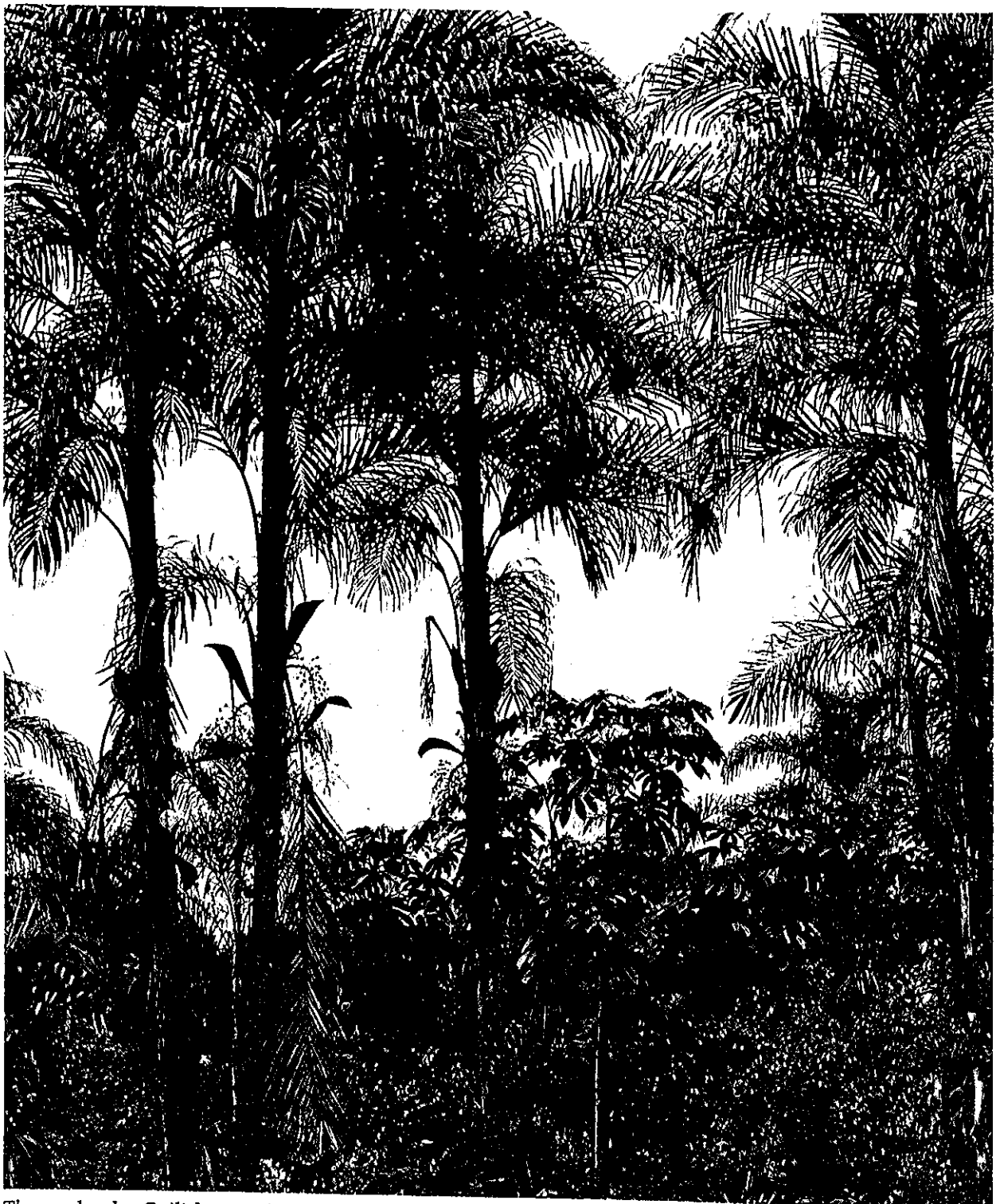
In the western Amazon, especially in Colombia, there are many types of *Guilielma speciosa* in which the seed aborts, and the whole fruit then consists of starchy endosperm. Furthermore, there are types without the usual horrible spines on the trunk, making collection significantly easier. Recently, a comprehensive collection of germ plasm of the palm over a wide area has been initiated. It behooves these collectors to penetrate the northwest Amazon of Colombia—difficult because of rapids and waterfalls throughout the region—to salvage some of these interesting clones before they disappear.

Guilielma speciosa is destined to play a very important part of future tropical agriculture, especially for third-world people living in overpopulated areas unsuited to modern agriculture. It is one of the most promising gifts of the Amazon forests.

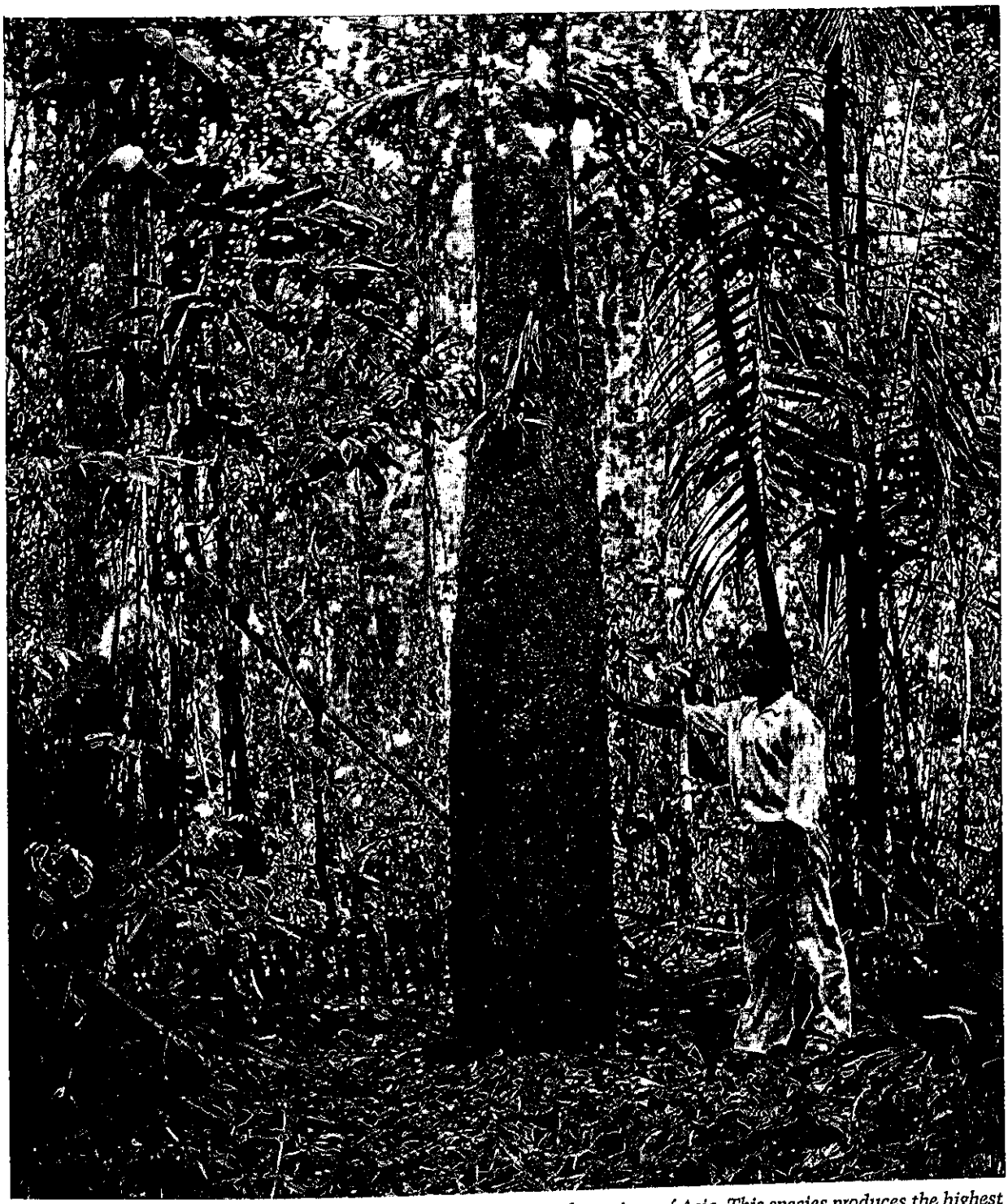
RUBBER

Hevea brasiliensis (Willd. ex Adr. Juss.) Muell.-Arg.
Family: Euphorbiaceae

Undoubtedly the most important Amazonian gift to the world has been the source of Para rubber, *Hevea brasiliensis*. No other plant has had so rapid and drastic an effect on civilization as this tree, which today is the source of more than 98 percent of the world's natural rubber. It is also one of the most recently



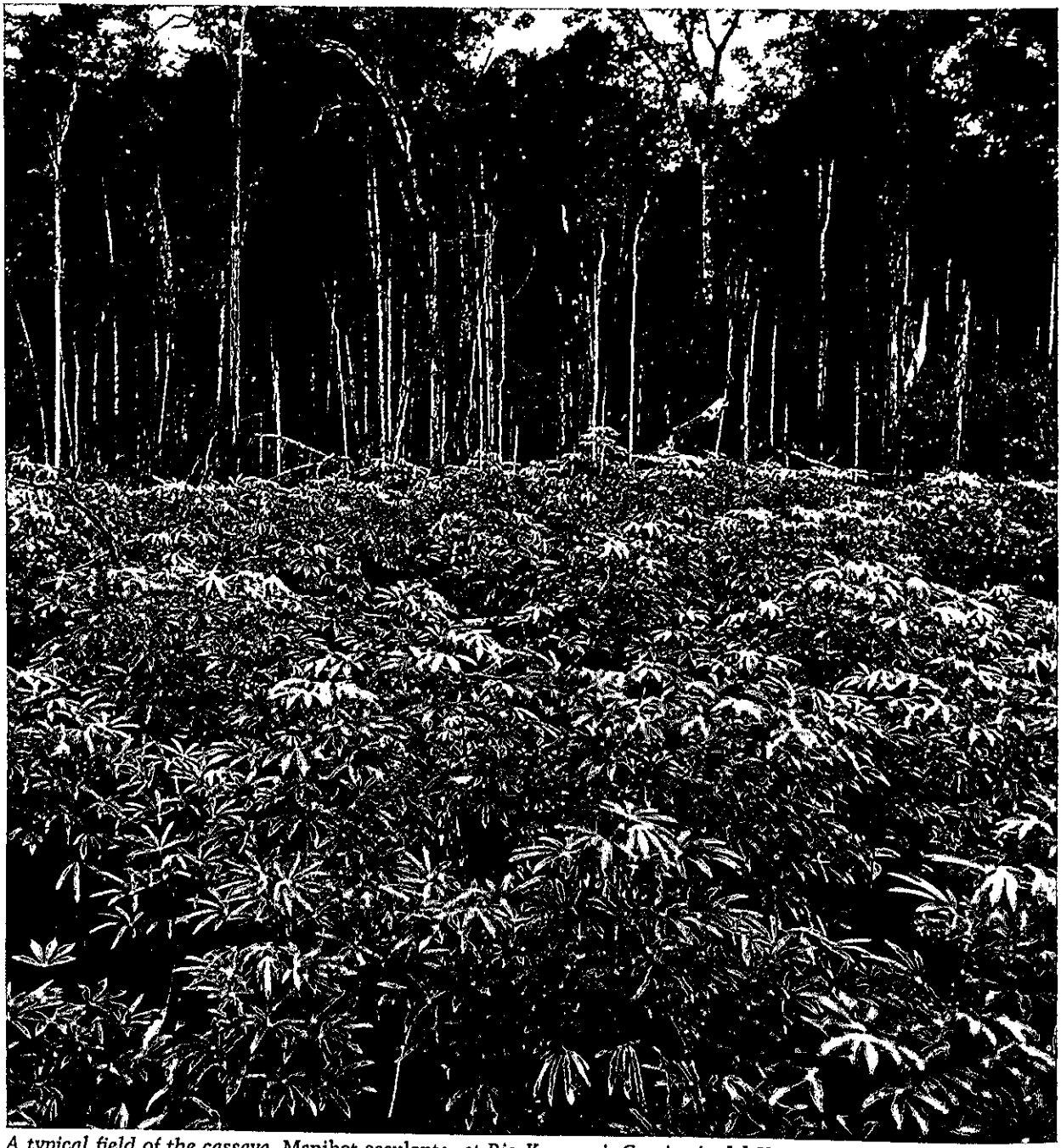
The peach palm, Guilielma speciosa, *is usually planted in circular or rectangular rows around Indian houses. The highly nutritious fruit ripens in late March or early February in the Western Amazon. Rio Kananari, Amazonian Colombia.*



Hevea brasiliensis, *the source of commercial rubber produced in plantations of Asia. This species produces the highest quality rubber, and is one of the ten* Hevea *species native to the humid rain forests of South America. Comisaria del Amazonas, Rio Loretoyacu, Colombia.*

domesticated of the major crop plants. Prior to its introduction to the Old World by the English in 1876, and its adaptation to plantations in the British and Dutch colonies of Asia, wild trees of the Amazon had satisfied the global needs of rubber.

The production of rubber from forest trees led to an industry reducing thousands of



A typical field of the cassava, Manihot esculenta, *at Rio Kananari, Comisaria del Vaupes, Colombia.*

Amazonian Indians to near slavery—in some regions amounting to actual slavery, torture, and wanton murder. When the plantations began to supply the world demand for rubber prior to World War I, the nefarious forest industry gradually disappeared, for the well-supervised Asiatic plantations could make available a better and cheaper product than that obtained by the uncontrolled tapping of wild trees widely scattered in the jungle.

Thus the domestication of *Hevea brasiliensis* has had two beneficial results: it created a dependable source of high-quality rubber at a reduced price, making possible the development of numerous new industries, especially modern automotive and later air transportation; and it saved countless thousands of Amazonian Indians and their cultures from annihilation.

The changes that selection and genetic research have brought about in *Hevea brasiliensis* have been unbelievable, particularly in the yield of latex. The early plantations, based on seed material, gave 350 to 400 pounds of rubber per acre per year; numerous "improved" clones now yield more than 3000 pounds per acre.

There are ten species of *Hevea*, all native to the tropical forests of South America, especially in Amazonia. In addition to *Hevea brasiliensis*, two (*H. Benthamiana* and *H. guianensis*) yield usable rubber—but of an inferior quality. The latex of the other seven species is very low in *cautchouc*, the rubber molecule.

CASSAVA

Manihot esculenta Crantz
Family: Euphorbiaceae

Hundreds of thousands of human beings living in the tropics of both hemispheres receive their carbohydrate nourishment from a euphorbiaceous shrub variously known as *yuca, cassava, mandioca* (Spanish), or *macacheira* (Portuguese). The same plant is also the source of tapioca used by peoples in temperate zones around the world where *Manihot esculenta* cannot be grown. While we know hundreds of cultivated strains of this species, cassava is unknown in the wild. All the strains are grouped in two categories as either "bitter" or "sweet" cassava, depending on the amount and distribution in the root of a cyanide-producing, highly toxic cyanogenic glycoside.

Both strains contain the poison. In the bitter one, the glycoside is concentrated primarily in the rind, which must be peeled from the starchy root before use. In the sweet varieties, the glycoside is in the rind and also throughout the starch of the root. In the Amazon, the bitter strain is almost exclusively cultivated.

From a taxonomic point of view, *Manihot esculenta* is one of the most complex economic plants known, and many "species" have been described, which we now know represent strains, races, or ecotypes. Early writers tended to identify northwestern Brazil as the region where this cultigen had its origin, while later authors favored the savannas of Venezuela and Bahia, Brazil. Mexico and Central America—and even Africa—have been suggested as sources, but without reliable supporting evidence.

Recent botanists postulate that the "sweet" and "bitter" strains of *Manihot esculenta* originated separately and developed independently. And a most recent survey of the evidence—botanical, ethnobotanical, ethnological, and archeological—concludes that "sweet" cassava was first domesticated in Mesoamerica, whereas "bitter" cassava was probably first cultivated in northern South America. Since Brazil exhibits extreme cultigen diversity, as well as an abundance of related species of *Manihot*, that country would offer favorable conditions for the hybridization and development of new strains.

Although there is no firm evidence, it is possible that cassava was among the first food plants to sustain man in the American tropics. Archeological remains indicate that

the plant has been used as a food in the humid tropics of the New World for at least 2500 years; secondary and circumstantial evidence suggests that its cultivation may go back some 4000 years.

Early European voyagers to the New World tropics mentioned cassava. As early as 1696, one British writer on plants stated it was "one of the most generally used of any provision all over the West Indies, especially the hotter parts, and used to victual ships." Now *Manihot esculenta* has spread throughout the tropics of the world, and in the warm parts of Africa and southeast Asia especially, it has become a staple food. It is one of the dozen plants that quite literally feed the human race.

CHOCOLATE
Theobroma Cacao Linnaeus
Family: Sterculiaceae

The source of chocolate and cocoa butter is a relatively small bushy tree believed to be of hybrid origin and native to the Amazonian slopes of the eastern Andes of Colombia and Ecuador. When and how it traveled to Mexico in pre-Conquest times are still mysteries, as it would have had to pass over high and cold mountains where this tropical cultigen could not survive. One theory proposes that *Theobroma Cacao* "spread throughout the central part of Amazonia-Guiana westwards and northwards to the south of Mexico." But if it took this route, it would have had to traverse desert areas on the coast of Venezuela and Colombia where the cacao plant could not grow. Its odyssey remains a mystery to this day.

The word *chocolate* comes from the Nahuatl name of the plant—*chocolatl*—among the Aztecs. In every European language except English, it is known correctly as cacao. *Cocoa*, which is a corruption of cacao, is not only wrong, but often leads to confusion with the names *coca* and *coconut*.

The chocolate plant, Theobroma Cacao, *escaped and growing wild at Amanaven, Comisaria del Vichada, Colombia.*

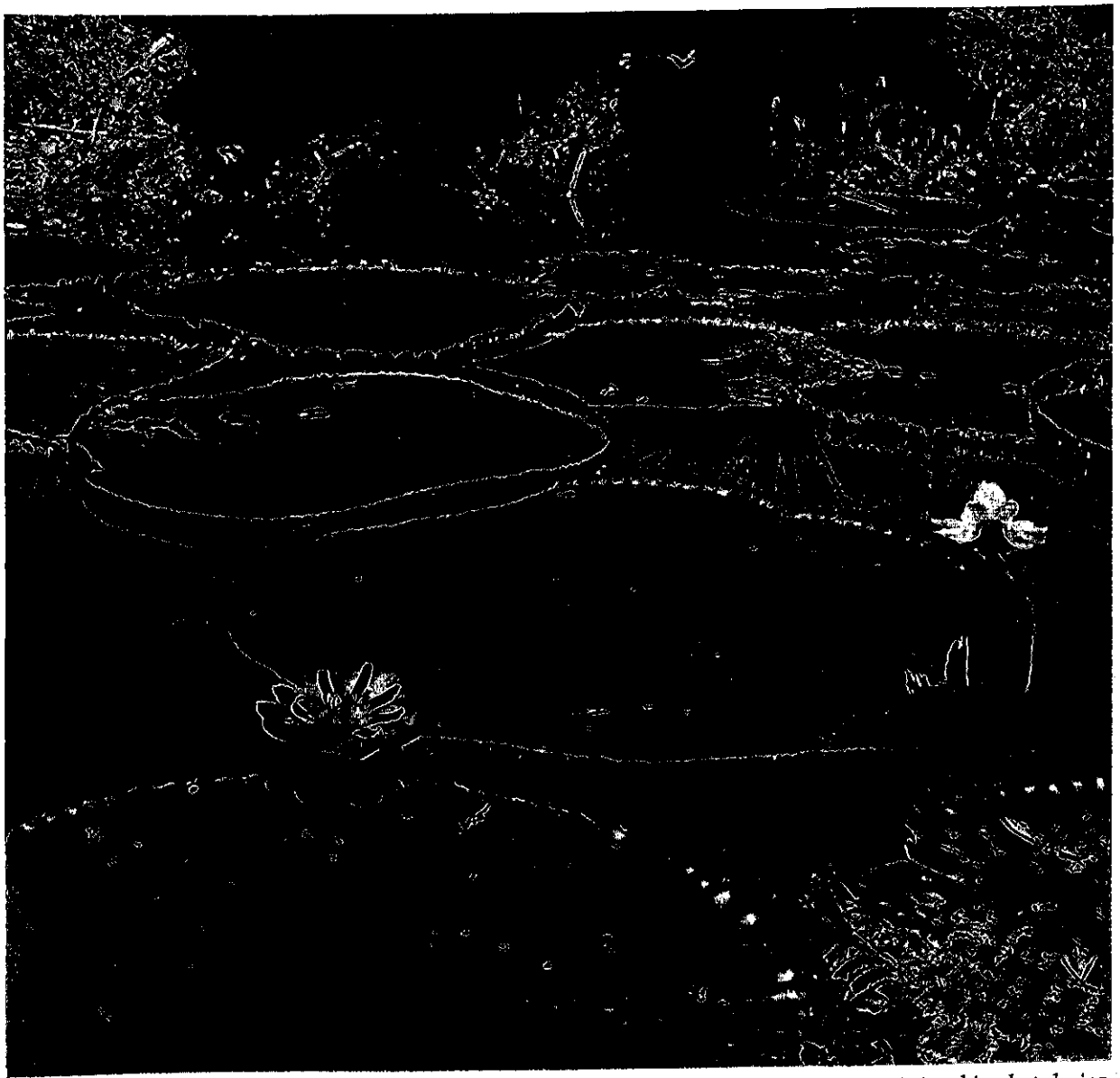
Although apparently not used by South American Indians before the arrival of Europeans, *Theobroma Cacao* was highly prized in Mexico where the Aztec ruler received cacao seeds as tribute from subjugated tribes of the tropical parts of the empire. Throughout Mexico and Central America, it was probably grown for more than two thousand years, and the natives believed that it was a gift directly from the gods. Perhaps Linnaeus considered this belief when he named the genus *Theobroma* from the Greek "food of the gods."

One of the earliest and most reliable of the Spanish chroniclers, Hernandez, the physician of the King of Spain, spent five years studying the medicinal plants of the conquered Aztecs. He distinguished four kinds of cacao in Mexico and wrote of the use of the seeds as food, drink, currency, and medicine (a treatment for dysentery). He warned, however, that immoderate use "obstructs the intestines, destroys the complexion and caused a general degeneration of the health."

The Aztecs had special spices or flavoring agents for their various chocolate preparations

including vanilla (*Vanilla planifolia*) and red pepper (*Capsicum* spp.). Another, that is still in use today in Oaxaca, is the aromatic, fenugreek-flavored flowers of a bombacaceous tree, known today as *flor de cacao* (*Quararibea funebris*).

Of the six New World plants rich enough in caffeine or caffeine-like compounds to be used as stimulants, only *Theobroma Cacao* has acquired enough worldwide fame to take a place alongside coffee (*Coffea arabica*) and tea (*Camellia sinensis*) of the Old World.



The world's largest water lily, Victoria amazonica. *Each flower lasts one day: in the morning it is white, but during the day the floral parts turn first pinkish, then purple. By nightfall, the flower has been pollinated by a beetle. Comisaria del Amazonas, Leticia, Colombia.*

ROYAL WATER LILY

Victoria amazonica Sowerby
Family: Nymphaeaceae

The world's largest water lily, *Victoria amazonica*, stands out as probably the most spectacular of Amazonia's gifts to ornamental horticulture. Better known as *V. regia*, named in honor of Queen Victoria, this beautiful denizen of inlets, oxbows, and lakes of still waters is one of the natural wonders of the Amazon. It is remarkable for its enormous leaves, measuring up to six or more feet in diameter, and its huge fragrant flowers, reaching eighteen inches across when fully open. The leaves, green above but reddish on the lower surface, have an upturned margin five or six inches high, and underneath they are strengthened with a lattice-like network of thick, spiny ribs. The nocturnal flowers, open ing in the cool of the afternoon and closing by noon the following day, are pollinated by a large beetle. The fifty or more petals change in this short period from white to dark pink The local inhabitants employ a poultice of the leaves to soften ulcers and to treat infected wounds.

Discovered in 1801, the Royal Water Lily, as it is called in English, was not well known for some thirty-five years, but during the past century and a half, it has been avidly sought as a greenhouse ornamental and may be seen among the water lily displays of most botanical gardens.

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