Global Colors

DYES AND THE DYE TRADE

Elena Phipps

In September 1766 the Spanish frigate *El Nuevo Constante*, bound for the port of Cádiz, ran into a hurricane in the Gulf of Mexico and sank.[1] Part of an annual flotilla that traversed the Atlantic from the New World to Spain (see fig. 27), the ship had left Veracruz, Mexico, laden with valuable goods such as silver, copper, and gold.[2] In addition to precious metals, however, the ship's cargo contained a relatively new form of wealth: raw materials for the flourishing global trade in dyestuffs, including 2,896 pounds of indigo, 10,627 pounds of cochineal, 5,440 pounds of annatto, and 1,032 cut lengths of logwood weighing approximately 40,000 pounds (figs. 107, 108).[3]

As the manifest of the *Nuevo Constante* makes clear, dyes and colorants were among the first and most valued of the exotic products that stimulated long-distance trade across the Atlantic, Pacific, and Indian Oceans beginning at the end of the fifteenth century. Within this global network, indigo from India was exported to England, France, Italy, and the Netherlands, ultimately transforming the European textile and printing industries.[4] After indigo was discovered in Central and South America, the species native there was also extensively exported both within the American colonies and, by the sixteenth century, to Europe as well.[5] Cochineal, an insect used to make a brilliant red dye, was shipped from the Americas to Europe, Asia, and the Middle East over both land and sea routes.[6] Bernardino de Sahagún (1499–1590), a Franciscan friar active in Mexico in the mid-sixteenth century, observed that cochineal "is known in this land and beyond and there are great quantities of it [sent] to China and then to Turkey and from there all around the world, [where] it is appreciated and highly desired" (fig. 109).[7] Tropical dyewood trees such as the logwood that sank aboard the *Nuevo Constante* were another important source of color on the international market. In addition to certain species from Southeast Asia and India that had been valued commodities in Europe since antiquity, a motherload of related dyewoods was discovered in the Americas in the sixteenth century, significantly accelerating the growth of European textile industries (see detail p. 120; fig. 110).[8]

The crimson reds, deep blues, and wide range of purples, grays, and blacks achieved with these dyestuffs—raw materials that previously had been either unavailable to European dyers or found only in small quantities, and even then for high prices—were quickly incorporated into the palettes of the royal workshops of Spain and France and the extensive British and Dutch dyeworks. Arriving via carracks and frigates (and occasionally through pirate activity in the Atlantic) to the trading entrepôts of Lisbon, Seville, Antwerp, and London, they were then reshipped and distributed throughout Europe via local trade fairs and, after passing through other points of exchange, around the world.

Access to large quantities of foreign dyestuffs stimulated the transformation of the European textile industry into the center of what was becoming a truly global commercial network. Beginning in 1565, the fleet of Spanish ships known as the Manila galleons opened trade across the Pacific, sending silver mined in the Americas to Asia, where it was exchanged for Chinese silks and other goods. The silk was then shipped via the Philippines to Mexico and Peru and thence to Europe, resulting in a surge in the consumption of silk there and in the American colonies. Silk, which is easy to dye with an array of dyestuffs, arrived in Europe and Latin America either as undyed raw silk, cloth, or thread ready to be processed or as a finished textile already dyed and patterned with Asian colorants, including brilliant, fast yellows and highly saturated safflower pinks. Safflower had been used in China since at least the sixth century and was already known in Europe, having been introduced to Spain (where it was later cultivated) by the Arab rulers of Al-Andalus in the eighth century. It was eventually used in England to supply the color for the red tape used to tie legal documents, hence the phrase "red tape" to describe a cumbersome bureaucracy.[9]

European dyes and dyed goods also found their way to the Americas, as evidenced in an eighteenth-century Mexican table cover whose yellow silk was dyed with European weld, indicating that the silk was exported to Mexico already dyed (cat. 9). Perhaps no single dyed item from Europe contributed to the international exchange more than the "fiery" red woolen cloth produced in Spain, England, and the Netherlands, which was used as both economic and diplomatic currency (cat. 30).[10] Ironically, by the eighteenth century this cloth, which originally was dyed with local madder, was primarily being colored with dyestuffs that were themselves part of the global exchange, including lac from Southeast Asia (acquired by the Dutch from their regional trading partners) and cochineal from the Americas (used by the English and Spanish; fig. 111). It was in part the popularity of this red woolen cloth (referred to as "trade cloth") as a barter item that enabled European merchants to import the colorfully dyed Indian cottons and fine muslin that spurred a craze in the seventeenth century for such textiles and, later, for fabrics that mimicked or were inspired by Indian cottons but were made in Europe.

In the Americas, with their vast quantities of raw materials, European merchants and dyers were less interested in the ways in which these colors had been used in their native lands than in the dyestuffs themselves. A 1523 dispatch from Charles I of Spain (r. Spain 1516–56) to Hernán Cortés encouraged the conquistador to ascertain whether there was *grana* (the Spanish term for cochineal) in the New World and, if so, to gather as much of it as possible (fig. 112).[11] Cochineal, in fact, was among the exotic dyestuffs traders most desired, in addition to indigo, annatto, and the tropical wood dyes: the very treasures that sank aboard the *Nuevo Constante*. Along with gold and silver, these dyestuffs were not only an important focus of international trade, they were the basis of the colonial economy of the New World and contributed significantly to the financial stability and growth of the Spanish Empire in the sixteenth century, when it enjoyed a virtual monopoly on such trade from the Americas.[12]

Spanish imports of dyestuffs and all other goods from the Spanish colonies were processed exclusively through the port of Cádiz. From there they were sent to the Casa de Contratación, the customhouse in nearby Seville whence the raw materials were distributed throughout Europe and to eastern regions of the Mediterranean, Turkey, Persia, India, and Asia via regional merchant trade. By the late sixteenth century the French, Dutch, and English were all attempting to participate in the Spanish trade and undermine its monopoly by means both legitimate and illicit: by "force or stealth," according to English natural historian Mark Catesby.[13] The Spanish monopoly persisted until 1778, when reforms enacted by Charles III of Spain (r. 1759–88) opened both Spanish and American ports to foreign ships, which allowed French, English, and Dutch traders to engage in legitimate trade and largely forgo piracy and plunder.

Cultivation of dyestuffs in colonial territories, particularly cochineal and indigo, intensified after the mid-sixteenth century in response to surging worldwide demand and increased exponentially in the seventeenth and eighteenth centuries. As colonial administrations took hold around the world, new techniques of planting and cultivation were introduced to maximize production of these "renewable" resources. In Mexico, Guatemala, and South America, for example, the Augustinians and Jesuits introduced methods of increasing cochineal and indigo yields as well as seeds of particularly robust strains of plants. Similarly, engineers sent by the French government to its Caribbean colony of Saint-Domingue (modern Haiti) devised a means of increasing the efficiency of aerating indigo dye vats (fig. 118).[14] In India, English merchants and traders established a plantation system for growing indigo that supplanted much of the local crop production. Tropical redwoods of the Yucatán and Brazil were subject to intense logging by the Portuguese, Spanish, English, Dutch, and French.

As production of these dyestuffs escalated in the New World, it frequently had a corrosive effect on many of the local communities where it was practiced, acutely so when factoring in the decimation of native populations from introduced European diseases and the adoption of abusive labor practices. The scourge of slavery, moreover, was in part a direct response to the labor-intensive dye industry. The Portuguese slave trade brought hundreds of thousands of enslaved Africans to Brazil to work at first in dyewood harvesting and hauling and later in the sugar mills and mineral mines. The Spanish turned to slavery as a source of labor in the *obrajes* (textile workshops) of Peru after protective legislation in Spain prescribed "that the Indians not work in the cultivation of Indigo unless they volunteer."[15] In this regard, the worldwide trade in dyes and dyestuffs can be said to have forever altered the course and evolution of global human relations.[16]

SOURCES AND PREPARATION OF DYES

Until the second half of the nineteenth century, when synthetic dyes were developed, all colors used to dye cloth—from English woolens to Chinese silks to Peruvian camelid hair—came from natural sources. These dyestuffs ranged from plants whose roots, leaves, and flowers yield color, such as madder, weld, or indigo, to trees, including brazilwood and logwood, whose heartwood is the color's source. Certain animals, too, were important dyestuffs, from the tiny scale insects, such as cochineal, that yield a range of brilliant reds, to the *Murex* genus of marine snails and related species, which have a gland used since antiquity to make the famous Tyrian (or royal) purple.

For much of human history these plants and animals tended to be consumed locally, either within or near their native habitats. Kermes (*Kermes vermilio*), for example, a small insect that lives on the kermes oaks of the Mediterranean coastal shrublands, was a primary source of red dye for much of Europe from prehistory through the Renaissance. Lac (*Kerria lacca*), a different species of scale insect that yields a similarly brilliant red, is native to tropical regions of Southeast Asia and was relied on for red color throughout Thailand (Siam), Myanmar (Burma), India, and parts of China. This pattern of local consumption began to expand as early as the first century B.C., if not before, with the early Silk Road trade, which brought Asian goods, including dyestuffs, to the West, and it only increased in scope during the late medieval and early modern periods. Trade within Europe was particularly active among the cities of Kraków, Paris, and Antwerp as well as in the international fairs that traveled through Flanders, England, and France, while diplomatic activity between Venice and Constantinople often brought dyes, including cochineal, from as far away as the Americas to the East.[17]

With the onset of the worldwide sea trade in dyestuffs in the sixteenth century, the long-distance transfer of dyes and their varied applications to existing or developing textile industries increased substantially. The superior quality and

Fig. 107
Dried cochineal insects (*D coccus*) from Peru, with ty silvery sheen

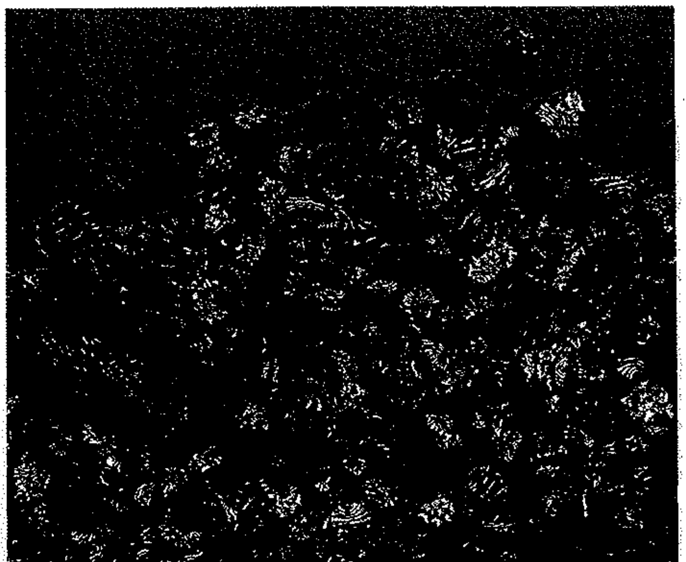

Fig. 108
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Fig. 109
nio de Alzate y Ramírez
1737–1799). *Cochineal*
ale with Wings and Female
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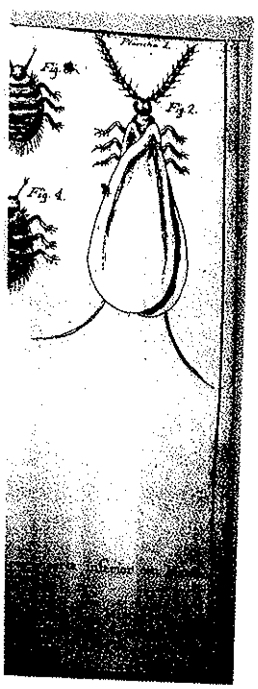


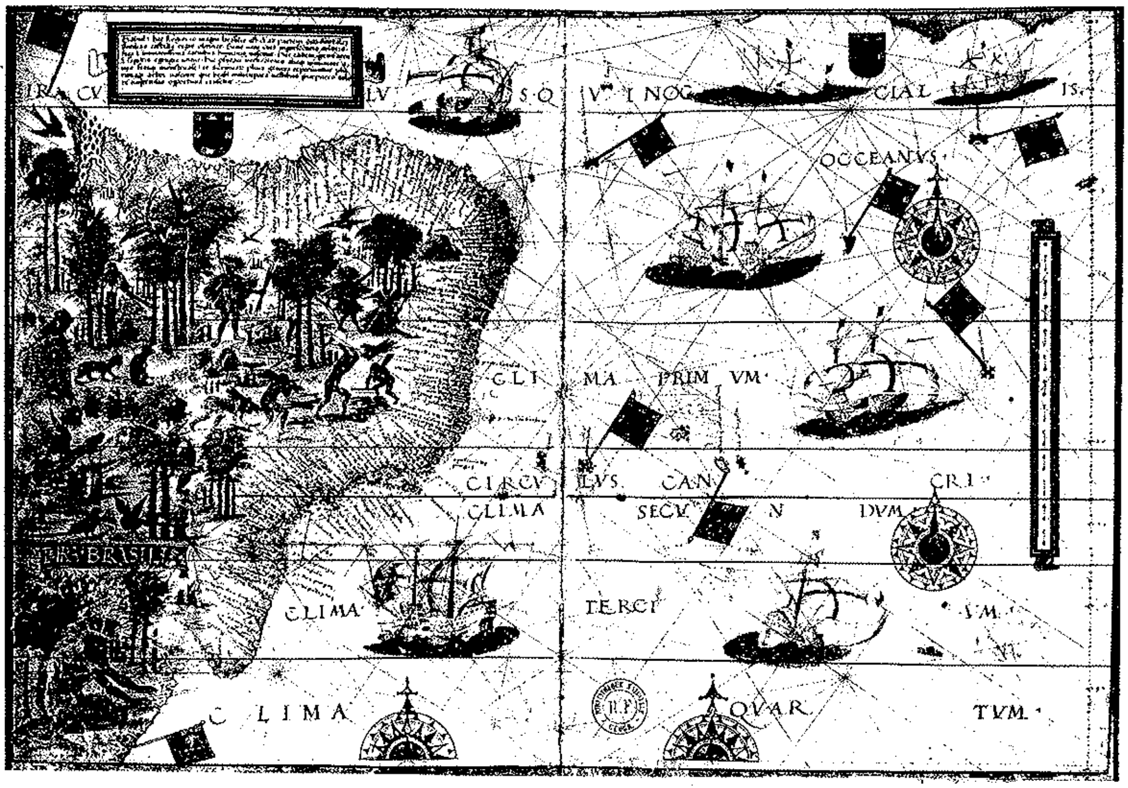
larger available quantities of certain regional dye sources, most notably the Indian species of the indigo plant and the American species of the cochineal insect, were immediately apparent to merchants, textile producers, and their customers. Cochineal, for example, yields its deep crimson color with greater ease than dyes made from kermes and lac, both of which contain resinous substances that necessitate additional, complex dyeing procedures. Moreover, cochineal can be cultivated, unlike the other wild species of scale insect, and contains a greater quantity of dye component per insect, thus requiring smaller amounts to be used in the recipes that measured dye ingredients per pound of cloth to be dyed. In the sixteenth century, when global trade made cochineal readily available outside its native range for the first time, it quickly overtook all other insect dyes as the premier source of red color in worldwide textile production.[18]

COCHINEAL REDS

"Cochineal" refers specifically to *Dactylopius coccus*, a parasitic scale insect native to South America and Mexico whose host plant is the prickly pear cactus (genus *Opuntia*). Prior to the arrival of the Spanish, cochineal had been cultivated for centuries in Mexico and Peru, where it was used to dye textiles and paper for both ritual and daily activities. The Oaxaca region of central Mexico, in particular, was a major center of cochineal production. Fifteenth-century documents record that certain towns paid a bimonthly tribute of forty bags of cochineal to the Aztec emperor Moctezuma I (fig. 113).[19] In Peru, although no written records predate the arrival of the Spanish, thousands of textiles dyed with the characteristic red of cochineal have been preserved, attesting to the dye's long history there. Recent analysis of Precolumbian textiles shows that cochineal was, in fact, the primary source of red cloth in the Andes by at least the fourth century A.D., if not earlier.[20]

In the great markets of Tepoztlán, Mexico—at the heart of the Aztec Empire—dyers traditionally prepared cochineal for sale by forming masses of dried insects into round cakes, which were then emended with other materials to increase their weight (fig. 114).[21] Spanish traders, mistrusting these subsidiary ingredients, insisted on shipping the individually dried insects "free of flour and stones and other materials."[22] José Antonio de Alzate y Ramírez (1737–1799), author of a 1777 treatise on cochineal cultivation, devoted an entire chapter to the "falsification" of cochineal, warning in particular against the addition of tiny pebbles, globules of chalk or clay, and beans. To detect impurities, he advised dropping samples of the dried cochineal into a glass of warm water or vinegar. So important to Spain was the cochineal trade—and so great a problem was the adulteration of the merchandise perceived to be—that in 1575 the king himself decreed that "nothing should be mixed with the cochineal" shipped from the New World.[23]

Another Spanish concern was the process used to dry the insects, which can affect the overall color derived from them (steaming the insects over a double boiler or oven drying them can turn them black, for example). In 1599 a manuscript was compiled at the request of the viceroy of New Spain to explain native methods of cultivating and drying cochineal. After surveying local cochineal farmers, the author recommended to all of the Spanish *encomenderos* (overseers) of cochineal-producing regions that the best method of drying the insects was to place them on a mat and leave them in the sun. Alzate, in the treatise noted above, further specified that the insects should ideally be harvested only when they had attained the size of "a fat lentil."[24] European dyers eventually became connoisseurs of American cochineal, able to select the finest-quality *grana* (or *granilla*, referring to a smaller



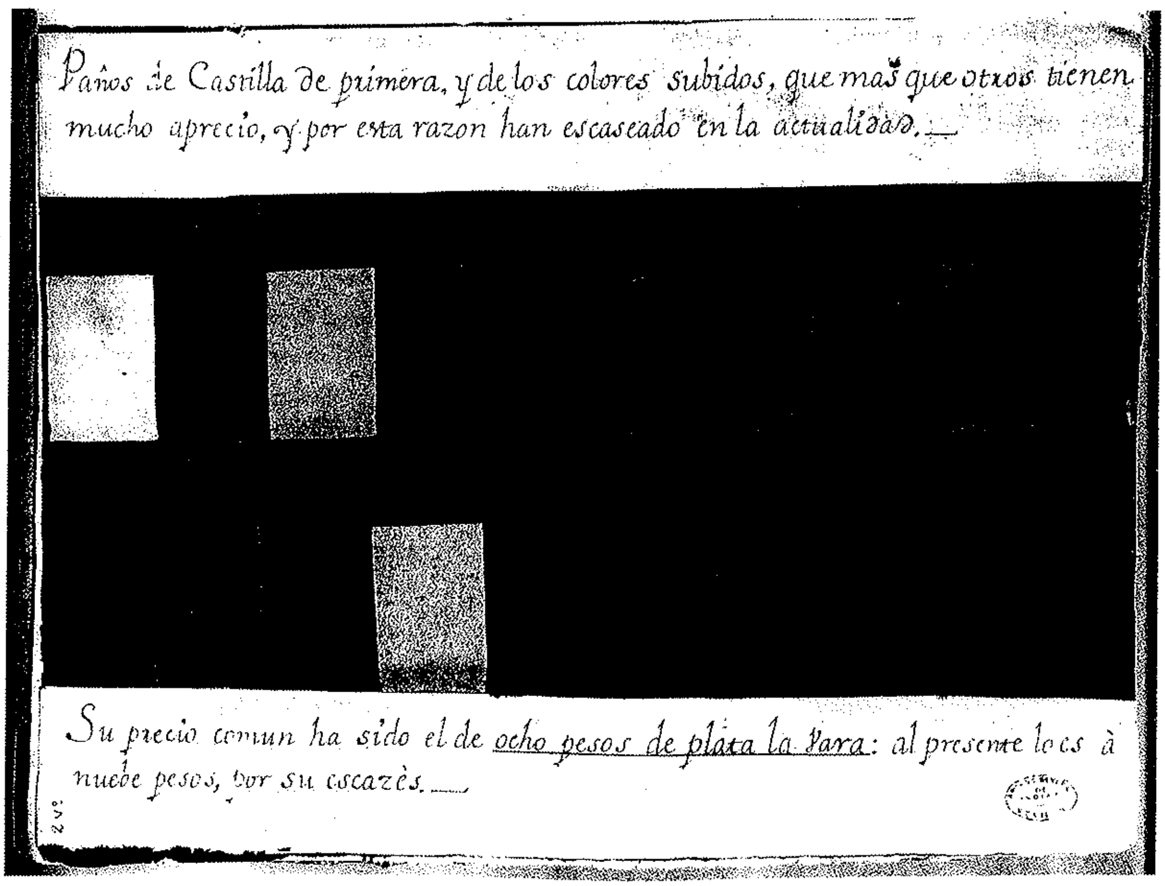


Fig. 110
Terra Brasilis (detail showi
gathering brazilwood). Fro
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Fig. 111
Samples of high-quality Sp
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Spain, before 1780. From
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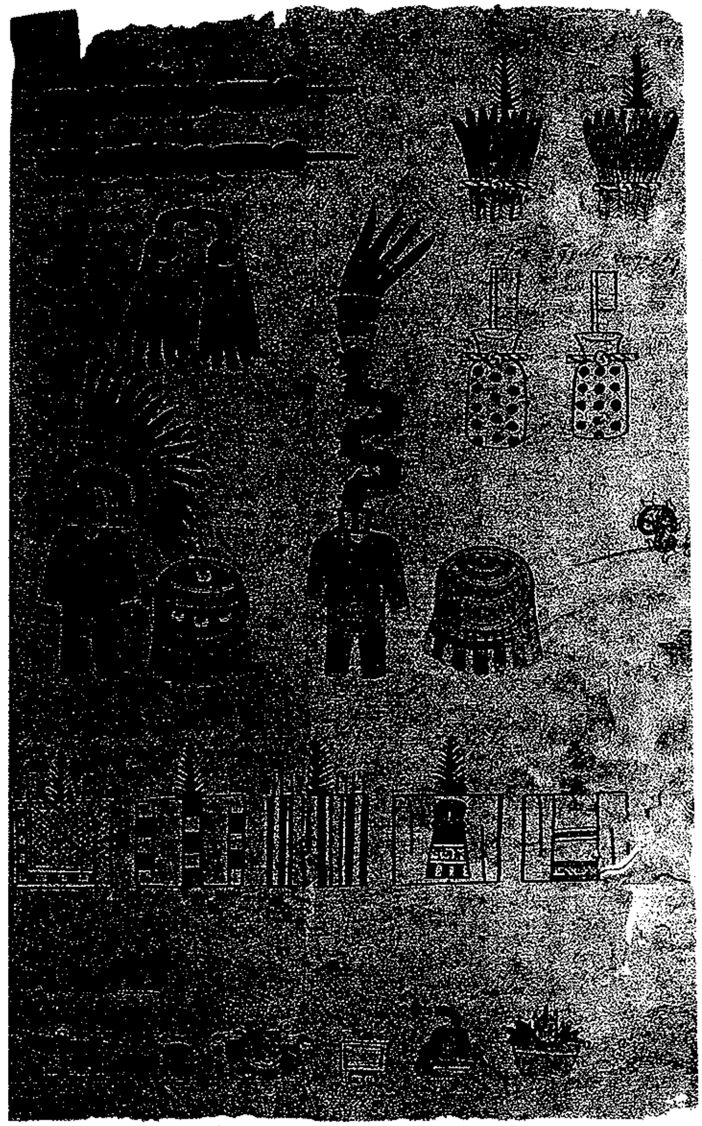
specimen of lesser quality) and to discern wild from cultivated insects and region of origin. A 1716 recipe for "French Scarlett" (a particularly popular shade of red) noted that "3 pounds of *campechiane* [cochineal from Campeche, Mexico] could be substituted [for] by only 1 pound of *mestique*,"[25] referring to a district in the state of Oaxaca considered the source of the finest-quality cochineal. In *The Art of Dying Wool, Silk, and Cotton* (1789), Jean Hellot, a French dyer, called specifically for *mestique* or *texcali*, likely referring to Tlaxcala, a town in the Puebla region, which was another important cochineal-producing area in Mexico in the seventeenth and eighteenth centuries.[26]

After being dried following the prescripts of the Spanish authorities, Mexican and Peruvian cochineal was normally shipped to Europe in leather sacks called *zurrónes*. Remarkably, a number of *zurrónes* aboard the *Nuevo Constante* survived for some two hundred years submerged in the sea, even as the thousands of pounds of cochineal they contained did not. So valuable was cochineal in the seventeenth century that it was often salvaged from such wrecks and remained an expensive commodity even when damaged.[27] Dried, it enjoyed a remarkably long shelf life, as noted by Hellot after he obtained a sample of dried Mexican cochineal from a Dutch supplier. Although the sample was "undoubtedly 130 years old," Hellot marveled that it was "entirely perfect" and still viable as a dye.[28] By the same token he cautioned against the sometimes unscrupulous practices of the merchants who dealt in damaged dyegoods and recommended scrutinizing dyestuff from shipwrecks, even if available at a cheaper price.[29] An additional problem faced by shippers of cochineal was the compounding of tariffs, as the dyestuff passed through numerous hands on its way to markets around the world. Sometimes it even made a return trip to the Americas, as lamented by Asa Ellis, an eighteenth-century dyer from Philadelphia. Cochineal, he wrote in his 1798 *Country Dyer's Assistant*, "is shipped to Spain, from Spàin to England, whence we obtain it at a high price on the account of accumulated and heavy duties."[30]

The intensified production of cochineal that followed upon the worldwide upsurge in consumption quickly became a source of social unrest in the New World. Just thirty years after the Conquest, for example, Oaxaca experienced such a severe case of "cochineal fever" that local officials complained that the town's residents were not producing enough food and other staples, as they devoted all of their time to the insect, leaving agricultural fields fallow. The town council further admonished local producers of cochineal for indulging in "bad habits," including drunkenness and ostentatious displays of wealth. According to records of the Tlaxcalan town council (*cabildo*) from March 3, 1553, "Many sins were committed there and it is all because of cochineal."[31]

Other European countries soon sought to circumvent Spain's monopoly on the lucrative cochineal trade and its strict prohibition of the export of live insects from the Americas. These efforts included attempts to cultivate the cochineal insect abroad. In 1777 Nicolas-Joseph Thiéry de

Menonville (1739–1780), a French naturalist, collected live cochineal insects in Oaxaca and managed to slip his precious illicit cargo past the authorities as far as Saint-Domingue. Published accounts of his exploits detail how de Menonville evaded customs guards at the port of Veracruz by hiding the insects in his luggage, but he eventually succumbed to fever before his labors bore fruit.[32] The Spanish themselves brought cochineal and its host cactus to the Canary Islands, both of which successfully took to the island's rocky environment and thrive there to this day.[33] The English East India Company, betting that India would be a prime place to cultivate cochineal, smuggled in plant cuttings and insects acquired by a Captain Neilson in Brazil in 1794–95. Although the cactus died and the insects initially did not thrive, the project eventually succeeded, and by 1797 more than 36,000 pounds of "Madras cochineal" were being shipped to England.[34] In the nineteenth century Dutch traders cultivated cochineal on government plantations in Java and produced more than 80,000 pounds of it, primarily for the Chinese market,[35] while the French attempted to raise the insect in Algeria. The cochineal trade continued briskly until the late nineteenth century, when synthetic dyes supplanted the insect in the worldwide marketplace.[36]



INDIGO BLUES

Although blue color for cloth was derived from many natural sources, in terms of global and historical impact the most important of these, arguably, were a select few of the hundreds of species and subspecies of the *Indigofera* genus of plants, whose leaves are the primary source of a compound (indican) that can be chemically transformed to yield "indigo" blue (fig. 115).[37] The various species of indigo native to Africa, India, and the Americas all contain relatively high concentrations of

Above:
Fig. 113
Folio 23 from *Matrícula de Tı* showing the annual tribute ov the towns of the Coaixtlahuac region of northern Oaxaca. M early 16th century. Pigment or native paper. Biblioteca Nacio Antropología e Historia, Mexi City (Codex 35-52)

Fig. 114
Bernadino de Sahagún (Spanish, 1590). *Sellers of Cakes (Tortill Cochineal.* From *Historia gene las cosas de Nueva España*, Me ca. 1540–85. Ink on paper. Bil teca Medicea Laurenziana, Flo (Mediceo Palatino 220, fol. 36

Fig. 115
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Fig. 116
me Martínez Campañón
737–1797). Indigo vats.
'lo del Perú, 1782–86.
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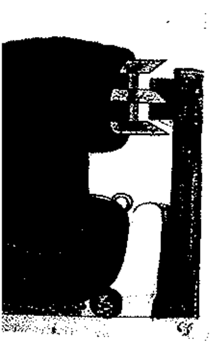
indican. In Europe, however, the local source of the indigo compound used since prehistory was woad (*Isatis tinctoria*), a short, low-growing plant that contains comparatively smaller quantities of the dye. Color from woad was extracted through a slow process that involved fermenting balls of its macerated leaves. In this form, the woad leaves were difficult to transport because they required consistent levels of moisture and temperature. Woad was eventually displaced as the primary source of blue color in Europe because it could not compete with Indian indigo, with its greater quantities of colorant, which began arriving in Europe in the early sixteenth century via Portuguese traders and by midcentury through the Dutch.

In addition to its higher levels of indican, Indian indigo, which is formed into concentrated cakes for market, was also more convenient to ship than woad. During the last quarter of the seventeenth century alone the East India Company exported 1,241,967 pounds of the blue dye from Bombay and Surat to England.[38] The high demand for Indian indigo wreaked havoc with the long-established woad industry in Europe, sparking numerous political campaigns and legislation as local woad producers, facing the long-term collapse of their livelihood, protested the importation of what was referred to in Germany and England as the "devil's dye."[39]

The discovery in the sixteenth century of a species of indigo native to the Americas (*Indigofera suffruticosa*) greatly added to worldwide supply (fig. 116). Guatemalan indigo, especially prized, was exported primarily to Spain but was also traded within the Americas via Spanish merchants, who shipped it to the *obrajes* of Cuzco, thousands of miles south in Peru (fig. 117).[40] Central American indigo was also shipped to the North American colonies via England until the introduction of indigo cultivation in the late seventeenth and early eighteenth centuries in the southern United States, notably South Carolina, where it was a primary export to England before the American Civil War (indeed, the South Carolina indigo crop had contributed 35 percent of the total value of American annual exports to England by the time of the Revolution).[41] The French and British likewise introduced indigo cultivation to their colonies in the Caribbean, including Jamaica, Saint-Domingue, and Guadelupe (fig. 118). In 1771 exports of indigo from the French West Indies exceeded 1,800 tons.[42]

Concomitant with the intensive cultivation practices necessary to sustain such large quantities of indigo exports was a long history of abusive labor practices, resulting in periods of widespread social unrest involving both growers and merchants. Indigo was also intimately connected to the growth of slavery, which, as noted above, supplied much of the labor force needed to grow the crop, especially in the Americas. In the last quarter of the eighteenth century Bengali farmers in India were compelled by contracts with the English East India Company, which virtually governed the region, to grow indigo in most of their fertile ground, thus supplanting the rice crops needed to sustain the local population. The resulting famine and widespread resentment under the oppressive British plantation system led directly to the Indigo Revolt of 1859–60, which was resolved only when a charter was enacted stating that cultivators could not be forced to grow indigo against their will.[43]



DYEWOODS: RED, BLUE, PURPLE, AND BLACK

A number of tropical trees contain coloring compounds used to make dyes, from reds and blues to purples. Loaded onto ships, where they were often used as ballast, billets of hewn dyewood logs traversed the ocean, ultimately transforming the palette and color sensibilities of Europe while simultaneously fostering new trends in global fashion (fig. 108). Among the earliest traded dyewood species

Fig. 11?
Detail of 17th-century
tapestry with indigo-b
The indigo dye was lik
from Guatemala. The
Museum of Art, New
chase, Morris Loeb Be
(56.163)

is what we now refer to as sappanwood (*Caesalpinia sappan*), a tree native to India and Southeast Asia but known to Europe and the West by the eleventh century through imports from Ceylon and Sumatra.[44] African species of red dyewoods, such as camwood and barwood from Nigeria, Sierra Leone, and other regions, were traded to Europe after the Portuguese opened the sea route around the continent's southern tip, and they, too, eventually became part of the European and British dye palette, used, for example, to make the red and brown dyes for Scottish tartans.[45] The most sought-after dyewoods, however, came from the Americas, especially logwood from the Yucatán in Mexico and brazilwood from Amazonian Brazil, key species that, beginning in the sixteenth century, were exported to Spain, Portugal, France, Italy, and the Netherlands, where they became integral components of textile and tapestry production.

The tree known as brazilwood (*Caesalpinia echinata*) seeps an orange-red liquid when cut, hence its name, which derives from the Portuguese term *brasa*, referring to the color of burning coals. Somewhat confusingly, "brazilwood" was originally used to refer to the related Asian species sappanwood, noted above, which has similar characteristics. The modern country of Brazil, the wood's primary source, was in fact named after the dyewood; the Portuguese changed the country's name from Terra de Santa Cruz, or Land of the Holy Cross, giving rise to complaints that they "preferred a block of wood to the Holy cross and a red dye to the true blood of Christ."[46] The Portuguese began logging brazilwood in the northern Bahia region in the early 1500s, soon after explorer Pedro Álvares Cabral (ca. 1467/68–ca. 1520) loaded his ship with the precious wood and took the first logs back to Lisbon. To cut and haul the heavy brazilwood logs, the Portuguese traders who followed Cabral relied on the region's native Tupinambá people. The French soon established their own colony in Bahia and began logging there as well, and they, too, exploited the labor of the Tupinambá people living along the coast (see detail p. 120; fig. 110).

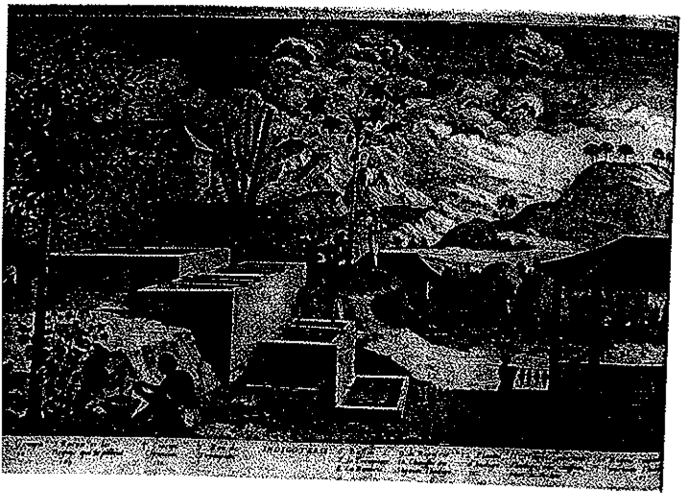


Fig. 118
…ocessing in the Antilles, …oire générale des Antilles …ar les Français. Jean-Bap…ertre (French, 1610–1687), …mas Iolly, publisher. Paris, 1667. Archive of …rican Images, The John …wn Library, Brown Uni…vidence, Rhode Island

From the 1620s to the 1630s the Dutch established a short-lived claim to a stretch of Brazilian coast near Recife and through the Dutch West India Company shipped tons of brazilwood back to the Netherlands.[47] To prepare the dyestuff, specialized workshops in Flanders and Bruges known as *tailleurs de brésil* cut and rasped the wood into chips.[48] Similar workshops existed in Italy, although the redwood imported through the port of Venice was primarily the Asian species. Called *verzino* in Italian, brazilwood was sold in Florence as both heartwood and "peelings" (*mondiglia di verzino*).[49]

Brazilwood dye was classified as fugitive, or false (*faux teinte*), by Jean-Baptiste Colbert (1619–1683), the French minister of culture under Louis XIV who in 1661 established dye regulations for the royal workshops. Used in Europe to impart color to silk and wool, brazilwood dye was understood not to have the same lightfast qualities of "true dyes" such as cochineal and madder.[50] Jean Hellot described the red derived from brazilwood as "an extractive dye in great abundance and tolerably beautiful, though evidently inferior to the cochineal." He further noted, however, that brazilwood red was "infinitely cheaper [and] consequently very much used."[51]

Equally fugitive is the dark bluish purple obtained from logwood (*Haematoxylum campechianum*), a large tree that grows in the boggy coastal wetlands of tropical Central America, in particular around the Yucatán Peninsula in a region that encompasses Mexico's Bay of Campeche (hence the Latin name of the species), Honduras, Belize, and Guatemala. In 1581 the British prohibited its use in textile dyeing, "forasmuch as the Colours made with the said Stuff called Logwood, alias Blockwood, is false and deceitful . . . Logwood shall be forfeited, openly burnd and no Cloth or Wool shall be dyed therewith."[52] When combined with a yellow dye and in some cases with a mordant (discussed below), logwood blue becomes black, a difficult color to achieve with natural dyes. Indeed, before logwood was available, producing black generally required multiple dyebaths and combinations of expensive dyes such as indigo and madder. After European dyers in the seventeenth and eighteenth centuries managed to stabilize logwood black, it became the most important component of black dye.[53] The combination of the vast quantities of logwood discovered in the Americas and the development of a method utilizing it to render true black had a tremendous impact on European silk and woolen production, notably supporting the ever-growing fashion for black garments spurred in part by the Protestant Reformation.

Logwood is so dense that it does not float. Large trees were thus cut into sections and shipped in pieces, which loggers either dragged to landing areas or ferried in small loads on canoes from the swampy regions of Mexico and Central America to the open seas. As English explorer William Dampier (1651–1715) observed, "when a [logwood] Tree is so thick that after it is logged, it remains still too great a Burthen for one Man, we blow it up with Gunpowder."[54] In the late seventeenth century Spanish vessels loaded with cut lengths of logwood were subject to frequent raids by English pirates. It was the English, in fact, beginning with acts of piracy—and in spite of their early prohibition of the dye—who eventually established the dominant North Atlantic trade in logwood via Jamaica, an English colony, where logwood was introduced and grown in the eighteenth century. From there it was taken to New England (especially Boston, one of the main ports for the logwood trade) as an intermediary stop before being shipped to England and to other parts of Europe.[55]

YELLOWS

One of the yellow dyestuffs often mixed with logwood to make black was "old fustic," a brilliant, strong yellow dye obtained from a tropical tree called "dyer's mulberry" (*Maclura tinctoria*), native to Central and South America and the Caribbean islands. Along with logwood, fustic was shipped north to Boston and thence to Europe, where it was used to make greens and khaki colors; it was even used to dye military uniforms during World War I.[56] Another highly regarded source of yellow, especially in England and France, was quercitron, a dye derived from the eastern black oak (*Quercus velutina*) of North America. The dye was developed by Edward Bancroft (1744–1821), a prominent American physician notable for being a double agent during the American Revolution. Bancroft, whose 1794 *Experimental Researches Concerning the Philosophy of Permanent Colours* addressed the history and science of dyeing, held exclusive rights to the import of quercitron into Europe in the late eighteenth century.[57]

Annatto is a yellow dyestuff derived from the seeds of achiote trees (*Bixa orellana*). Contained within a spiny pod, the seeds yield a bright orange or yellow used to dye foodstuffs and, in the tropical regions of the Yucatán and the Amazon, as a body paint (fig. 119). Like indigo, annatto was formed into cakes for shipping, and the more than five thousand pounds of annatto aboard the wreck of the *Nuevo Constante* were remarkably well preserved even after some two hundred years in the sea. French silk dyers made a paste from annatto seeds called *roucou*, which was not only a source of yellow but also a colorant used to "correct" the bright red of cochineal into an orange-red hue considered more fashionable in the eighteenth century.[58]

Turmeric (*Curcuma longa*), a rhizomatous member of the ginger family native to India and Southeast Asia, was imported to Europe as a spice but was also a key source of yellow color. Prior to the arrival of the Spanish and Portuguese in Southeast Asia, turmeric was one of the most important and widely traded colorants. Although in Europe turmeric's value as a food spice likely overshadowed its merits as a dyestuff, it was nonetheless understood as an important raw material in the global trade because Indian dyers used it to make their prized dye-painted cottons (fig. 121). In the traditional Indian dyeing process, turmeric was generally the last in a sequence of dyes and was often applied by hand over areas already dyed blue with indigo in order to create specific color details, such as the green of foliage. Georges Roques, an agent for the French Compagnie des Indes Orientales, recorded in a 1678–80 report on Indian dye-painted cloth production that final payments from the company to local dyers were made only after this turmeric-based green had been added.[59] Although the orange-yellow derived from turmeric is rather fugitive (like brazilwood, turmeric was classified as false in Europe), it nonetheless became a standard component of the French silk-dyeing industry, primarily as a modifier to scarlet reds. By the eighteenth century turmeric was mostly supplanted in Europe by annatto from the Americas, which served a similar purpose.

Fig. 119
Francisco Hernández (Span
1514–1587). Achiote (ann
From *Rerum medicarum N*
Hispaniae thesaurus, Rome
Special Collections, The Ge
Research Institute, Los Ang
California (93-B9305)

DYEING PROCESSES AND TECHNIQUES

Mastery of traditional dyeing techniques demanded a varied body of knowledge, from botany and chemistry to aesthetic principles. In addition to an intimate understanding of the special characteristics of dyes and their potential color ranges, the dyer had to know how to make colors fast, or permanent, rather than just stains or tints that would fade in sunlight or wash away in water over time. Creating specific shades and hues, moreover, often entailed sequential dyeing or overdyeing (dyeing on top of existing colors) rather than simply mixing powders, as we do today. The affinities of certain dyes for certain fibers—not every dye is suitable for every type of cloth—was another important consideration.

Unlike the pigments used in painting, which are composed of ground earths and minerals that in their natural rock or powder form can be used as colorants, the dye compounds in plants and animals generally require processing in order to be efficacious. The coloring materials first had to be extracted from a source (leaves, roots, or glands, for example) and then often immersed in hot or boiling water along with a mordant: an agent, such as mineral salts or certain metals, including aluminum, copper, and iron, that chemically enables the natural dye to bond securely to a fiber.[60] One of the most widely used mordants was alum, a mineral salt. In regions where deposits of alum did not occur naturally, plants whose leaves are rich in alum were burned to ash and then the ashes placed in water to leach out the salts. Soils rich in dissolved irons and tannins from decaying leaves were another early source of mordants. Iron could also be obtained from shavings of rust or scrap metal soaked in vinegar (or another type of "sour," meaning a natural acidic source), a technique used in India for part of the dye-painting process.[61]

A few dyes, including indigo and shellfish purple, do not require mordants and instead rely on different types of chemical transformations to impart their colors, which then bond permanently with the fiber or cloth.[62] Generally speaking, the first step in using indigo is to extract the colorant from the plant by crushing its leaves in water, which yields an almost colorless or yellow-green liquid containing the indican compound. As the indican comes into contact with oxygen through agitation of the dye bath or just being exposed to air, it turns blue and precipitates out of solution as the insoluble compound indigotin, which was often then shaped into cakes or blocks and dried. At this stage the indigo is actually a pigment. In order to be used as a dye, the insoluable indigotin must be returned to its soluable form in a second stage, known as vat dyeing, in which it is dissolved and reduced back to its yellow-green state; only then can it be absorbed into cloth or fibers. Many cultures around the world developed their own methods of bringing about this seemingly alchemical transformation in which the colorless liquid is absorbed into the fibers and oxidized, turning it the brilliant blue that is also extremely lightfast. Some methods relied on fermentation, for example, in which microbes assist the color change; others added stale urine or other strongly alkaline materials to the vat.

The chemistry of the dyeing process plays an important role in how colors bond with different fibers. Cotton and linen are difficult fibers to dye owing to the lack of affinity between the alkaline nature of plant fibers and the acidic nature of most natural dyes, which inhibits the formation of permanent bonds. (Animal fibers such as wool and silk do not have this problem and can be dyed comparatively easily with the majority of natural dyes.) Historically, most cultures that had indigenous cotton production, including those in Africa and the Americas, were able to dye it only with indigo blue or a variety of brown tannins. An exception was India, whose dyers found ways to produce a wider color range of dyed cottons, from reds and purples to yellows.

From the European perspective, the fine, colorfully designed and dyed cotton cloth from India, which had been produced there by at least the thirteenth century (but likely much earlier), was one of the marvels of the Indian Ocean trade in the early sixteenth and seventeenth centuries. These multicolored textiles were known as "chints," or chintz, ultimately from the Sanskrit term *chitra*, meaning speckled, variegated, or spotted cloth (*pintados*, another term for them, derives from the Portuguese word for "painted").[63] To achieve this varied coloration, Indian dyers relied on an elaborate process

Opposite:
Fig. 120
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so that the dyer can see
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Fig. 121
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that required weeks or even months to complete and used a number of different materials to override the inherent chemical hostility between cotton and natural dyes. First, the cotton was subjected to a repeated sequence of treatments with various oils and fats, described by European dyers as "animalizing" the cloth. These treatments were alternated with applications of astringents and mordants (animal dung and ash from alum-containing plants) followed by soaking in milk and washing and drying; between treatments the cotton was bleached in the sun. All of this was done even before any dyebath was involved. In 1734 French naval officer Antoine Georges N. H. de Beaulieu (1699–1764) observed a demonstration of Indian dyeing in Pondicherry, on the Coromandel Coast—center of the chintz trade—and cut samples of cloth at each of these stages (figs. 120, 121).[64] Once the cotton was ready to be dyed, each color was applied in a separate step. Sometimes color was achieved by immersing the whole cloth into the dyebath. Alternatively, either thickened color or a mordant could be applied directly to the cloth's surface with either carved wood blocks or a brush. Wax was also applied as a dye resist, reserving specific areas of the design (such as a white background) and maintaining the color of others (red flowers, for example). After dyeing was complete, the wax—which had to be applied to both sides of the cloth to ensure no dye penetrated it—was removed in hot water.[65]

Although the sequence of steps was crucial in enabling the dyes to bond with the cotton fabric, Indian dyers also discovered how to achieve a variety of colors within a single dyebath immersion by applying different mordants (such as alum or iron), each thickened with gum, directly to various areas of the design. Areas treated with different mordants would come out as different colors or shades. In a dyebath of chay root, for example (the Indian form of madder red color used to create shades of red, pink, and purple), areas where an alum mordant was applied would turn red, those where iron had been applied would turn purple, and areas with no mordant would remain undyed, all within a red liquid dyebath.[66] To create blue was more cumbersome, as indigo will dye cotton even without a mordant. Where the color was not desired, Indian dyers covered the entire area with wax before immersing the cloth into the dye vat (fig. 120). The final dye application was turmeric yellow, which as noted above was used not only for its yellow color but as an overdye to the blue in order to create green.

The novel designs and nuanced polychrome palette of Indian chinztes proved irresistible to the European and American markets. The same was true of the lightweight cotton fabric itself, since the cotton plant did not grow in Europe (native linen and hemp made a much heavier and coarser cloth compared with fine handspun Indian yarns). Not surprisingly, shortly after the importation of these colorful fabrics to Europe began in earnest in the seventeenth century, European textile producers, seeking to achieve similar results—and profits, no doubt—investigated the Indian dyeing methods and how to reproduce them at home. Their initial approach was to gather

reconnaissance from travelers and agents of the East India companies, such as the detailed reports of Roques and Beaulieu.[67] European writers synthesized the crucial intelligence gleaned from these reports in various publications, among them *L'art de faire les indiennes* (1786),[68] which focused especially on helping the emerging cotton-printing industries of England, France, and Germany, among other countries, re-create bright madder-dyed red cotton, which was not produced in Europe until that time. Originally an Indian technique, this complex process resulted in a red cotton that became known as Turkey Red or Adrianopolis Red after dyers from Turkey and Greece were brought to Europe to help establish its industrial applications.[69]

This quest to understand and reproduce Indian polychrome cotton dyeing focused on developing new textile-printing techniques, not necessarily the use of Indian dyes themselves. Many materials essential to Indian dyeing, such as chay root, myrobalans (the dried fruit of the *Terminalia* genus of trees, which contributes to both the mordanting and tannin dyeing processes), buffalo milk, and sesame oil were not highly sought after since substitutes from local European plant sources were readily available. There were exceptions, however, notably indigo, whose efficacy and superiority to native woad were well established. In addition, some two thousand pounds of sandalwood salvaged from the Swedish East India Company's ship *Sveciai*, which sank in 1740 off the Orkney Islands on the return trip from Bengal, provides evidence of the importance of this redwood dye from Southeast Asia.[70] Christophe-Philippe Oberkampf (1738–1815), a German-born French printer and innovator in the European printing industry, is notable for having found inspiration in both the techniques and materials of Indian cottons, particularly in his famous copperplate-printed cottons and linens with scenic designs known as toiles de Jouy, after the town where his factory was located. A recent scientific study of the 1789 Oberkampf cotton print *Louis XVI, Restaurateur de la Liberté* was found to have been printed with chay root (fig. 122).[71] Edward Bancroft, the chemist responsible for the widespread adoption of the yellow dye quercitron, mentions in his *Experimental Researches* that the French East India Company imported a substantial amount of the root to France and that trials with chay root took place in England possibly in the 1780s.[72]

Fig. 122
XVI, Restaurateur de la
(detail). Oberkampf Manu-
, France, 1789. Copperplate-
cotton (toile de Jouy). The
used to print this cotton has
ntified as Indian chay root.
rth Art Gallery, The Univer-
lanchester, United Kingdom
)

Procedures for officially testing dyes had been established throughout Europe by dyers' guilds and textile organizations as early as medieval times, and these trials became part of a scientific process of assessing and regulating the growing textile industry in Europe in the seventeenth and eighteenth centuries.[73] Such experiments also served as a means of soliciting recipes for industrial use of new dyeing techniques, with organizations like the Royal Society of Arts, London, sometimes offering incentives in the form of annual prizes. John Wilson, a Manchester-based manufacturer of cotton velvets, submitted samples of his red madder-dyed cotton yarns to the society's Chemistry Committee on February 12, 1761, and won the prize offered that year.[74] Similarly, in 1811 Napoleon offered a prize of 20,000 livres "to the person who will find how to give wool by means of madder a solid vivid color as the most beautiful Turkey red and which most closely resembles cochineal scarlet."[75]

Although the global search for and cultivation of dyestuffs were first and foremost matters of commerce and profit, they also represented a quest for scientific knowledge, part of the gathering and "ordering" of the natural world that characterized the Age of Enlightenment. The travelers and naturalists who traversed the oceans from the sixteenth to the eighteenth century in search of such knowledge returned with plants and seeds that in some instances are still preserved in European botanical collections and gardens.[76] A specimen of the Asian pagoda tree (*Sophora japonica*), for example, whose seedpods are the source of a brilliant yellow dye used historically in China and Japan, was planted in the Jardin des Plantes, Paris, by French naturalist Bernard de Jussieu (1699–1777). Propagated from seeds sent home by a Jesuit priest in China, the tree, which is said to have flowered for the first time in 1779, still grows in the royal gardens today.[77] In many cases the collecting of plant specimens may have been motivated as much by their potential medicinal applications as their utility as dyestuffs, since many of the botanical sources of dyes were also used to treat illness.

By the late seventeenth and early eighteenth centuries, the spirit of scientific discovery and the advent of laboratory experimentation in Europe had greatly expanded the understanding of the chemical nature of color. Concoctions of metals and acids were invented that could produce brilliant hues such as Prussian and China blues.[78] Additionally, the discovery of essential dyeing aids such as industrial soaps and chlorine bleaches enabled the textile industry to color fabrics that previously had seemed impervious to dyeing.[79] These developments fostered an exponential expansion in European textile production, particularly in the dyeing and printing industries, much of which was in response to the abundance of raw materials available through the international trade and the high demand for Indian dyed and printed fabrics.

In the end, the history of dyes and colors from the sixteenth to the eighteenth century intersected with the evolution of global exchange on many levels. More than just commodities to be traded on an economic front, colorants were sources of cultural knowledge and identity as well as inspiration for creativity and ingenuity. The quest for these precious raw materials in turn spurred long-distance interactions, social transformations, scientific development, and artistic achievements whose profound implications are still being unraveled and understood today.