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Journal of Ethnobiology and Ethnomedicine (2024) 20:87
https://doi.org/10.1186/s13002-024-00727-3

Journal of Ethnobiology and Ethnomedicine

RESEARCH

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Plants of the USA: recordings on native North American useful species by Alexander von Humboldt

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Abstract

Background The German naturalist Alexander von Humboldt conducted an expedition through the American continent, alongside Aimé Bonpland, from 1799 to 1804. Before finally returning to Europe, they decided to take a side trip to the USA between May 20 and July 7, 1804. Humboldt's most detailed account of his time in the USA consists of a manuscript entitled "Plantae des États-Unis" (1804), containing information on useful plants and timber of the country. The aim of this paper is to retrieve, for the first time, ethnobotanical information regarding North American plants and their uses inside this Humboldt's manuscript as well as to highlight the erasure and invisibilization of North American Indigenous knowledge within historical documents and bibliography, mainly during the nineteenth century.

Methods "Plantae des États-Unis" (digitized version and its transcription) was carefully analyzed, and information on plant species mentioned in the manuscript (including botanical and vernacular names, traditional uses, and general observations) was retrieved. Traditional uses were correlated with ethnobotanical data from the Native American Ethnobotany Database and encyclopedic literature on North American plants from the nineteenth and early twentieth centuries, as well as recent pharmacological studies searched in scientific papers.

Results In the manuscript are mentioned 28 species distributed in 15 botanical families, with Fagaceae (9 *Quercus* species) being the most representative. All species are USA natives, except for one undetermined species (only the genus was mentioned, *Corylus*). Four species were directly mentioned as medicinal (*Toxicodendron radicans*, *Liriodendron tulipifera*, *Actaea racemosa*, and *Gillenia stipulata*), while other four were described as tanning agents (astringent) (*Cornus florida*, *Diospyros virginiana*, *Quercus rubra*, and *Quercus velutina*). Two species were described as bitter (*Xanthorhiza simplicissima* and *A. racemosa*). Nine *Quercus* species were described, but five were reported as the most useful oaks for cultivation in Europe (*Quercus bicolor*, *Quercus castanea*, *Quercus virginiana*, *Quercus michauxii*, and *Quercus alba*); three of them were used for ship construction (*Q. virginiana*, *Q. michauxii*, and *Q. alba*), two as astringent (*Q. rubra* and *Q. stellata*), and one had wood of poor quality (*Quercus phellos*). One species was described as a yellow dye (*Hydrastis canadensis*), and the other was mentioned as toxic (*Aesculus pavia*). Ten species did not have any useful applications listed.

Conclusions Although "Plantae des États-Unis" is a brief collection of annotations, these data reveal a historical scenario of outstanding plants with social and economic interest in the USA at the beginning of the nineteenth century. The data highlight a clear process of suppression of the traditional knowledge of Native North American Indigenous

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peoples in past historical records and literature, due to the lack of acknowledgment by white European settlers and American-born explorers. This ethnobotanical inventory may help us understand the relationship between plants and Native North American Indigenous peoples, as well as European naturalists and settlers, and USA-born people in the past, and reflect on the importance of Indigenous traditional knowledge, bioeconomy, sustainable management, and conservation of biodiversity in the present and future.

Keywords Alexander von Humboldt, Historical ethnobotany, Natural history, North American Flora, Indigenous peoples, Decolonization

Background

In June 1799, Alexander von Humboldt (Fig. 1) and Aimé Bonpland set sail from La Coruña, Spain, embarking on a five-year voyage (Fig. 2) that would have a lasting impact on the cultural and scientific history of the Atlantic world. A month later, they arrived in Cumaná, the capital of New Andalusia, a province within the General Captaincy of Venezuela (present-day Venezuela). By November 1799, the two naturalists started an extensive expedition across the American continent. Their journey took them from Caracas through the Orinoco, Rio Negro and Casiquiare rivers, and back to Cumaná. Following this, they explored the modern-day states of Cuba, Colombia, Ecuador, and the Peruvian territories. They traversed the Andes, scaling volcanoes like Chimborazo, and high peaks such as Quindío (3650 m). They subsequently spent a year in Mexico (then the Viceroyalty of New Spain) and completed their stay in the American possessions of the Spanish Empire with a second, six-week visit to the island of Cuba. Before finally returning to Europe in August 1804, Humboldt, Bonpland, and their traveling companion, Carlos Montúfar, a young neo-Granadian aristocrat, decided to take a side trip to the USA [1–7]. During the five-year expedition, Humboldt and Bonpland collected, described, and illustrated several thousand plants, comprising approximately 6000 specimens [8, 9].

Fig. 1 "Alexander von Humboldt." Charles W. Peale, oil on canvas (Philadelphia, 1804). Mütter Museum, The College of Physicians of Philadelphia. PD-US

The American Consul in Havana, Vincent Gray, had convinced Humboldt to divert his route to stop in Philadelphia and Washington to meet some North American authorities such as President Thomas Jefferson. In return, Gray informed Secretary of State James Madison about Humboldt's upcoming visit, alluding to his expertise on the geography of New Spain and the little known territories southwest of the Rocky Mountains, vital knowledge for the young Republic after the Louisiana Purchase only a year before. Humboldt, Bonpland, and Montúfar spent seven weeks in the USA, from May 20 to July 7, 1804 [10, 11].

The travelers disembarked in Philadelphia, then the intellectual center of the country, on May 23, 1804. Here, they met, among others, Charles Willson Peale, founder of the Philadelphia Museum, Caspar Wistar, a medical doctor and Vice President of the American Philosophical Society, and the botanist Benjamin Smith Barton. On May 29, Humboldt, Bonpland, and Montúfar traveled to Washington D.C., accompanied by Peale, English physician Anthony Fothergill, and the Lutheran minister and inventor Nicholas Collin. In Washington, Humboldt had several conversations with Thomas Jefferson. From his student days in Hamburg, he was familiar with Jefferson's "Notes on the State of Virginia," first published in 1785, which would prove influential in writing the account of his American journey [12]. On their way back to Philadelphia, Humboldt, Bonpland, and Montúfar made a detour to Lancaster, Pennsylvania, to meet with botanist Gotthilf Heinrich Ernst (Henry Ernest) Muhlenberg and Andrew Ellicott, a surveyor who had just published his journal of a boundary survey he had conducted for the US government [13]. The complete day-by-day itinerary of Humboldt, Bonpland, and Montúfar during their stay in the USA (1804) is shown in Table 1.

While the visit to the USA served to expand Humboldt's transatlantic network of scholars and friends, it

Fig. 2 Map of Alexander von Humboldt's and Aimé Bonpland's five-year American journey: departure from La Coruña, Spain, in 1799 and arrival at Bordeaux, France, in 1804. Author: Alexrk translated by Cäsium137 (T.). https://commonswikimedia.org/wiki/File:Map_Alexander_von_Humboldt_expedition-en.svg

can be also assumed that he did not regard this rather incidental short trip as part of his scientific research journey [14]. The stay is not recorded in the American travel journal that Humboldt had bound in nine volumes at the end of his life [15]. Likewise, Bonpland made the final entries in his botanical field book in Havana before both explorers left for Philadelphia. However, Humboldt's manuscript collection ("Nachlass") contains very few notes taken in the USA, which show that Humboldt and Bonpland did not lose sight of their natural history research even on this "journey after the journey." For example, Humboldt recorded information from a conversation with Caspar Wistar about the contagiousness and symptoms of yellow fever, a topic that had preoccupied Humboldt in Mexico and Cuba during the months prior [16, fol. 3v]. Also in the USA, he excerpted from Andrew Ellicott's field journal [16, fol. 1-3r], as well as from a manuscript on the geography of plants of the USA by Benjamin Smith Barton [17, fol. 13].

Humboldt's most detailed account of his time in the USA consists of a manuscript composed of two large folios, each folded lengthwise. Humboldt wrote on only four of the eight pages, most likely in June 1804, after the return from Lancaster to Philadelphia. Entitled "Plantae des États-Unis" (Fig. 3), these pages primarily contain information on useful plants and timber of the USA [18]. Humboldt was following up a research topic that had engaged him throughout the entire journey: the description of medicinal or otherwise useful plants appears in both his and Bonpland's journals [19]. Additionally, the manuscript includes a list of 18 North American botanists and gardeners, details on prices for accommodation, provisions, transportation, and clothing in Philadelphia and Washington, accounts of conversations with Thomas Jefferson and G.H.E. Muhlenberg, and observations on geological formations in the region around Lancaster [18].

The aim of this paper is to retrieve, for the first time, ethnobotanical information regarding North American plants and their uses from Humboldt's "Plantae des États-Unis" manuscript, updating the botanical names and collecting data about the current importance of these species. Furthermore, we aim to highlight the erasure and invisibilization of North American Indigenous

Table 1 Chronological itinerary of Alexander von Humboldt's stay in the USA (1804) [10, 11]

Date (1804)	Alexander von Humboldt in the USA
May 23	Humboldt, Bonpland, and Montúfar disembark the ship "Concepción" in Philadelphia, on which they had sailed from Havana on April 29
May 23 to 28	Stay in Philadelphia: The travelers make the acquaintance of Charles Willson Peale and other members of the American Philosophical Society
May 29	Humboldt, Bonpland, and Montúfar travel to Washington by stagecoach. They are accompanied by Peale, Nicholas Collin and Anthony Fothergill (itinerary: Chester, Wilmington, Charlestown, Havre de Grace, Baltimore)
May 30 to June 1	Stopover in Baltimore and visit of the harbor
June 1	Arrival in Washington (stay until June 13)
June 2	Humboldt's first meeting with US President Thomas Jefferson
June 4	Tour of the Navy Yard and the Capitol building. This is followed by a dinner with President Jefferson
June 5	Humboldt spends a good part of the day with Thomas Jefferson in the President's house. They will meet frequently during the following days until Humboldt's departure from Washington
June 6	One-day excursion to Mount Vernon in the company of Collin, Fothergill, Peale and James Woodhouse
June 13	Humboldt, Bonpland, and Montúfar leave Washington by stagecoach for Lancaster/Pennsylvania
June 16 to 18	Stay in Lancaster and conversations with Andrew Ellicott and G.H.E. Muhlenberg
June 18	Return to Philadelphia. Humboldt and his companions are guests at an honorary dinner in Peale's Museum. They also take part in one of the famous "Wistar Parties," a scientific and social event organized by Dr. Caspar Wistar
July 7	The French frigate "Favorite" leaves Philadelphia with Humboldt, Bonpland, and Montúfar on board (arrival in Bordeaux on August 3, 1804)

knowledge within historical documents and bibliography, mainly during the nineteenth century.

Methods

The Humboldt's manuscript "Plantae des États-Unis" was consulted digitized in the Staatsbibliothek zu Berlin [20, fols. 11–13] and its transcription in edition humboldt digital [21]. In this survey, we retrieved information on plant species mentioned in the manuscript, such as botanical and vernacular names, traditional uses, and general information, according to the methodology applied in other recent works by our research group [22–24]. All of these data, described in Tables 2 and 3, were originally written in French by Humboldt. Current botanical names were checked and updated according to Plants of the World online [25] as well as species origin. Plants were quantified into botanical family distributions and categories of use (medicinal, tanning agent, bitter plant, timber, dye, and toxic plant). Ethnobotanical data were surveyed mainly in the Native American Ethnobotany Database [26] and encyclopedic literature on North American native medicinal and other useful plants from the nineteenth and early twentieth centuries in the Biodiversity Heritage Library database [27]. Regarding the medicinal information on plants noted by Humboldt, recent pharmacological studies related to those historical medical uses were searched in the PubMed, ScienceDirect, and Google Scholar databases, using scientific names (updated and synonyms) and medical terms as keywords.

Results and discussion

In the "Plantae des États-Unis" manuscript are mentioned 28 species distributed in 15 botanical families, being Fagaceae (9 species) the most representative, followed by Ranunculaceae (3 species), Magnoliaceae, Salicaceae and Sapindaceae (2 species), and Anacardiaceae, Betulaceae, Bromeliaceae, Cornaceae, Cupressaceae, Ebenaceae, Juglandaceae, Lauraceae, Poaceae, and Rosaceae (1 species). All species are USA natives, except for one undetermined species (only the genus was mentioned, *Corylus*).

Four species are directly mentioned as medicinal (*Toxicodendron radicans* (L.) Kuntze, *Liriodendron tulipifera* L., *Actaea racemosa* L., and *Gillenia stipulata* (Muhl. ex Willd.) Nutt.), while other 4 are described as tanning agents (astringent) (*Cornus florida* L., *Diospyros virginiana* L., *Quercus rubra* L., and *Quercus velutina* Lam.), a property related to tannins, which can be used for medical purposes too. Two species are described as bitter (*Xanthorhiza simplicissima* Marshall and *A. racemosa*), which can be correlated to tonic properties. Nine *Quercus* species are described, but 5 were reported as the most useful oaks for cultivation in Europe (*Quercus bicolor* Willd., *Quercus castanea*, *Quercus virginiana* Mill., *Quercus michauxii* Nutt., and *Quercus alba* L.). Three of them are used for ship construction (*Q. virginiana*, *Q. michauxii*, and *Q. alba*), 2 as astringent (*Q. rubra* and *Q. stellata*), and 1 highlighted as having wood of poor quality (*Quercus phellos* L.). One species is described as a yellow dye (*Hydrastis canadensis* L.), and the other is mentioned as toxic (*Aesculus pavia* L.). Thirteen species

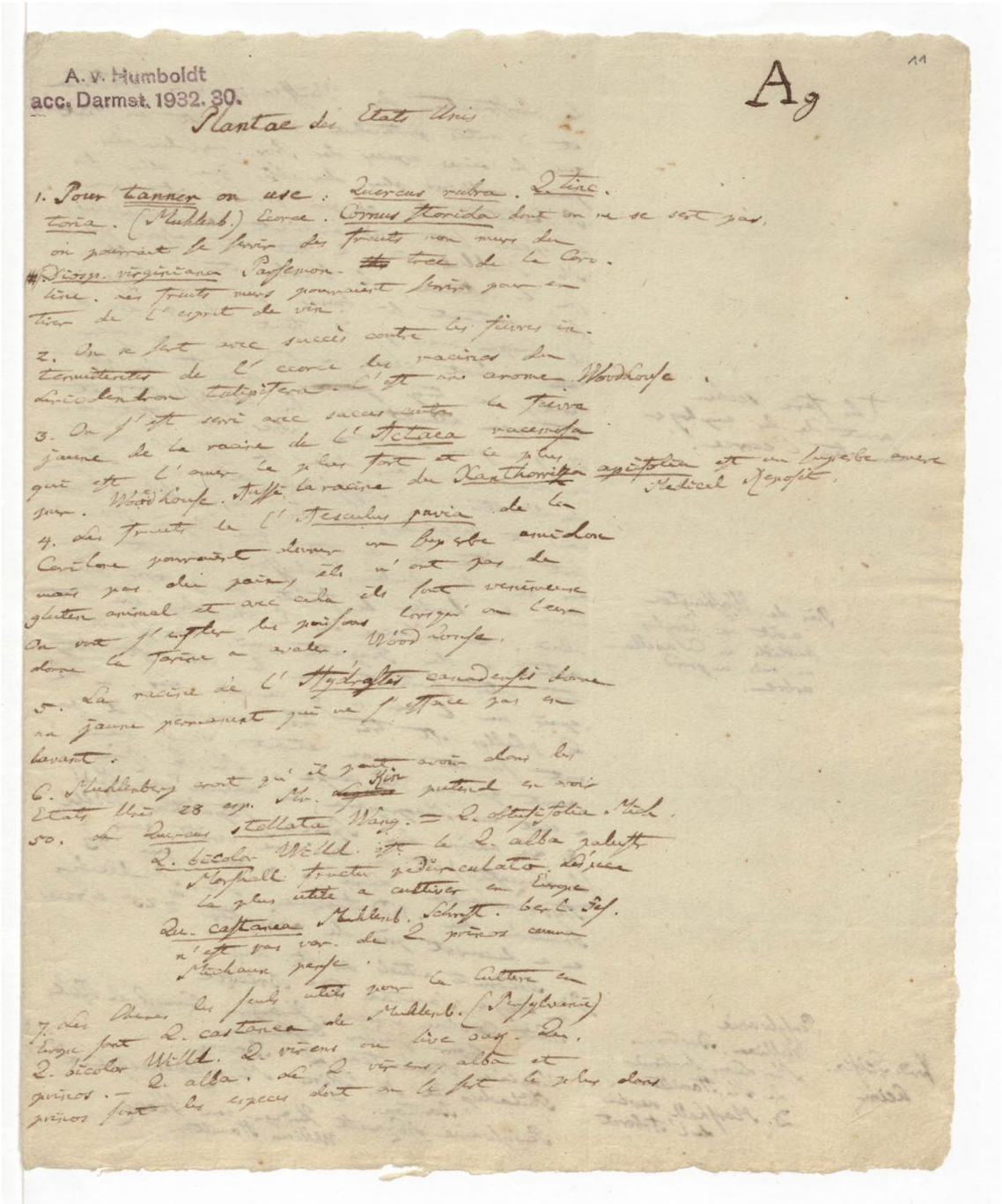

Fig. 3 Front page of Humboldt's manuscript "Plantae des États-Unis" (1804). Staatsbibliothek zu Berlin – Preußischer Kulturbesitz. http://resolver.staatsbibliothek-berlin.de/SBB00019F4D00000019. Public Domain Mark 1.0

did not have any useful applications listed. The entire inventory of "Plantae des États-Unis" is described in Tables 2 and 3.

The results of this work bring to light knowledge that had been hidden within an unanalyzed document in the field of Historical Ethnobotany. This branch of science emerges as a prominent discipline, focusing on the study of historical human–plant relationships, primarily through the analysis of written historical documents such as publications, manuscripts, official records, prescriptions, as well as iconographic sources and voucher specimens in herbaria [38–40].

Table 2 Useful North American plant species reported by Alexander von Humboldt in "Plantae des États-Unis" during his passage in the USA in 1804

Original botanical nomenclature given by Humboldt	Updated species and family	Vernacular names*	Part used	Category of use	Uses and properties according to Humboldt's notes [original French report]	North American traditional uses corroborating with Humboldt's notes
Actaea racemosa	*Actaea racemosa* L., RANUNCULACEAE	*ulidástĭ útana* (Cherokee, "it deceives, large") [28], Black Bugbane [26], black snake root or black cohosh [27]	Root	Medicinal	The root is used against yellow fever; the strongest and purest bitter [*On s'est servi avec succès contre la fièvre jaune; l'amer le plus fort et le plus pur*]	To treat fevers mixed to other plants (Cherokee people) [28]; used by natives to treat plague and fevers, acting as sudorific, and even cure yellow fever [29]
Aesculus pavia	*Aesculus pavia* L., SAPINDACEAE	Red Buckeye [26]	Fruit	Food; toxic	The fruits could yield a superb starch, but not for making bread, because they do not have gluten and are poisonous. Fish swell when they receive the fruit flour to swallow [*pourraient devenir un superbe amidon, mais pas du pain, ils n'ont pas de gluten animal et avec cela ils sont venimeux. On voit s'enfler les poissons lorsqu'on leur donne la farine à avaler]*	–
Cornus florida	*Cornus florida* L., CORNACEAE	*kănûsĭ´tă* (Cherokee, opaque name) [28], flowering dogwood [26]	Bark, root bark [26]	Tanning	Barks could be used for tanning (astringent) [*Pour tanner*]	Astringent (Cherokee people) [26, 29–32]
Diospyros virginiana	*Diospyros virginiana* L., EBENACEAE	*salĭ´* (Cherokee, opaque name) [28], Persimmon ("Parsemon")*; Tree de la Caroline*; Common persimmon [26]; Date plum [29]	Fruit	Tanning; beverages preparation	Unripe fruits could be used for tanning (astringent); ripe fruits could be used for extraction of wine spirit (alcohol) [*Pour tanner; pour en tirer de l'esprit de vin*]	Astringent (Cherokee people) [26, 29, 32]; fruits rolled in corn meal, brewed in water, drained, baked, and mixed with hot water to make a beer (Rappahannock people) [26]; preparation of wine or beer [29]
Hydrastis canadensis	*Hydrastis canadensis* L., RANUNCULACEAE	Goldenseal [26]	Root	Dyeing	The root yields a permanent yellow dye that does not fade in the wash [*donne un jaune permanent qui ne s'efface en lavant*]	Used to make a dye (Cherokee people) [26]
Liriodendron tulipifera	*Liriodendron tulipifera* L., MAGNOLIACEAE	*tsiyu* (Cherokee, opaque name) [28], Tuliptree [26], poplar [27,28?]	Root barks	Medicinal	Aromatic; root barks are used successfully against intermittent fevers [*on se sert avec succès contre les fièvres intermittentes*]	Infusion of root bark taken for fevers (Cherokee people) [26]; febrifuge [29, 31]

Table 2 (continued)

Original botanical nomenclature given by Humboldt	Updated species and family	Vernacular names*	Part used	Category of use	Uses and properties according to Humboldt's notes [original French report]	North American traditional uses corroborating with Humboldt's notes
Quercus alba	*Quercus alba* L., FAGACEAE	tă'lû' (Cherokee, opaque name) [28], Chêne*, White oak [26]	Wood	Naval construction	One of the most useful oaks for cultivation in Europe; the most species used for ship construction [*les seuls utils* [sic] *pour la culture en Europe; sont les espèces dont on se sert le plus dans la construction des Vaisseaux*]	–
Quercus phellos	*Quercus phellos* L., FAGACEAE	Willow oak [26]	Wood	Naval construction	Very bad wood, sometimes it rots even green (immature), before it is cut. The US Navy has frigates that rot quickly, especially when the wood is thick and the air does not circulate properly [*très mauvais, il pourrit souvent encore étant verd [sic], même avant qu'on le coupe*]	–
Quercus prinos [sic] (Humboldt meant *Quercus prinus*)	*Quercus michauxii* Nutt., FAGACEAE	*tsisátugwûléga* (Cherokee, opaque name) [28], Chêne*, Chestnut Oak [26]	Wood	Naval construction	One of the most useful oaks for cultivation in Europe; the most species used for ship construction [*les seuls utils* [sic] *pour la culture en Europe; sont les espèces dont on se sert le plus dans la construction des Vaisseaux*]	–
Quercus rubra	*Quercus rubra* L., FAGACEAE	*tsugwû'nstătsâ'lĭ* (Cherokee, "'the leaves taper") [28], Northern Red Oak [26]	Bark, acorns	Tanning	Barks are used for tanning (astringent) [*Pour tanner*]	Astringent (Cherokee people); bark used in tanning and coloring (Ojibwa people); acorns freed from tannic acid by boiling with wood ashes and used for food (Omaha and Potawatomi peoples) [26]
Quercus tinctoria	*Quercus velutina* Lam., FAGACEAE	*dagû´nageĭ* (Cherokee, "they are black" or "blackwood") [28], Black oak [26]	Barks, acorns	Tanning	Barks are used for tanning (astringent) [*Pour tanner*]	Astringent (Cherokee people); acorns, with tannic acid extracted, equally as good as other acorns (Ojibwa people) [26]

Table 2 (continued)

Original botanical nomenclature given by Humboldt	Updated species and family	Vernacular names*	Part used	Category of use	Uses and properties according to Humboldt's notes [original French report]	North American traditional uses corroborating with Humboldt's notes
Quercus virens	*Quercus virginiana* Mill., FAGACEAE	Chêne*; live oak*[26]	Wood	Naval construction	One of the most useful oaks for cultivation in Europe; the most species used for ship construction [*les seuls utils* [sic] *pour la culture en Europe; sont les espèces dont on se sert le plus dans la construction des Vaisseaux*]	–
Rhus radicans	*Toxicodendron radicans* (L.) Kuntze, ANACARDIACEAE	*ulû´ta* (Cherokee, "it has climbed") [28], Eastern poison ivy [26]	Leaves	Medicinal	It is successfully applied for diseases like scabies or some other skin rash (according to Muhlenberg) [*Muhl. assure qu'on inoccule* [sic] *avec succès* (…) *dans les maladies dont le cours s'interrompe* [sic] *avec la gâle ou quelque autre éruption cutanée*]	It is used for running or non-healing sores; whole or broken leaves rubbed over boils or skin eruptions (Kiowa people) [26]; treatment of furuncles, herpetic eruptions and also for other eruptive skin diseases [30, 33, 34]
Spirea stipulata Willd [sic] (Humboldt meant *Spiraea stipulata*)	*Gillenia stipulata* (Muhl. ex Willd.) Nutt., ROSACEAE	American ipecac [35]	Root	Medicinal	The root has the same properties as the "ipecacuanha" [*la même vertu que l'Hypecacuanha*]	Emetic properties [32, 36]
Xanthorriza apiifolia [sic] (Humboldt meant *Zanthorhiza apiifolia*)	*Xanthorhiza simplicissima* Marshall, RANUNCULACEAE	*dalâni amayułtehi*, *dalânige unastetsi* (Cherokee, "yellow, water edge growing," "yellow roots") [28], *ītī wiyę*^{n}, *wį'ti nusę'* (Catawba, "root yellow") [37], Yellowroot [26]	Root	Medicinal	The root has superb bitterness [*un superbe amere* (sic)]	Taken as a tonic (Cherokee people) [26]

* Vernacular names exactly as given by Humboldt

Table 3 Other North American plant species without specification of uses reported by Alexander von Humboldt in "Plantae des États-Unis" (1804)

Original botanical nomenclature given by Humboldt	Updated species and family	Vernacular names*	Humboldt's notes [original French report]
Acer negundo	*Acer negundo* L., SAPINDACEAE	Boxelder [26]	–
Arundo gigantea	*Arundinaria gigantea* (Walter) Muhl., POACEAE	*ſ ˙ya* (Cherokee, "rivercane") [28], Giant cane, Switchcane [26]	It forms a tall impenetrable forest [(…) *forme une forêt impénétrable*]
Corylus	*Corylus* sp., BETULACEAE	Hazelnut [35]	Similar to the European *Corylus avellana*, but as a big tree [*Près de Washington croît un* Corylus *semblable au* C. avellana, *mais en grand arbre*]
Cupressus disticha	*Taxodium distichum* (L.) Rich., CUPRESSACEAE	Baldcypress [26]	–
Juglans rubra Gaertner = *Juglans illinoinensis* or *Juglans pacan* [sic] (Humboldt meant *Juglans pecan*)	*Carya illinoinensis* (Wangenh.) K. Koch, JUGLANDACEAE	Pecan [26]	Fruits similar to *Corylus avellana* L. [*à fruit* [sic] *du* Corylus avellana]
Laurus borbonia	*Tamala borbonia* (L.) Raf., LAURACEAE	Redbay [35]	–
Magnolia grandiflora	*Magnolia grandiflora* L., MAGNOLIACEAE	Southern Magnolia [26]	–
Populus deltoides Marshall	*Populus deltoides* W. Bartram ex Marshall, SALICACEAE	Cotton-wood*, Eastern Cottonwood [26]	Very similar to the Italian *Populus nigra* f. *italica* (Münchh.) A.Andersen (= *P. italica* (Münchh.) Moench) [*très ressemblant au* Pop. italica *en pyramide*]
Quercus bicolor Willd. = *Quercus alba* [var.] *palustris* Marshall	*Quercus bicolor* Willd., FAGACEAE	*gasotegwalega* (Cherokee, "small abdomen") [28], Chêne*, Swamp white oak [26]	The most useful oak for cultivation in Europe [*L'espèce la plus utile à cultiver en Europe*]
Quercus castanea Muhlenb.	*Quercus muehlenbergii* Engelm., FAGACEAE	Chêne*, Chinkapin Oak [26]	One of the most useful oaks for cultivation in Europe [*les seuls utils* [sic] *pour la culture en Europe*]
Quercus stellata Wang. = *Quercus obtusiloba* Mich.	*Quercus stellata* Wangenh., FAGACEAE	*tsuskă´* (Cherokee, "heads") [28], Post oak [26]	–
Salix nigra	*Salix nigra* Marshall, SALICACEAE	Black Willow [26]	–
Tillandsia usneoides	*Tillandsia usneoides* (L.) L., BROMELIACEAE	Spanish moss [26]	It was observed covering *Taxodium distichum* [Cupressus disticha (…) *couvert de* Tillandsiausneoides]

* Vernacular names exactly as given by Humboldt

In recent years our research group has investigated the historical and ethnobotanical legacies of many naturalists and propagandists regarding South American biodiversity [23, 24], especially Humboldt's travel journals, manuscripts, and books [22]. Our findings confirm that this manuscript "Plantae des États-Unis," written by Humboldt, is a valuable source of information on North American plant species of the nineteenth century.

The most sensitive issue is that the information reported by Humboldt was provided by prominent North American naturalists, as annotated in the manuscript. However, it did not come directly from sources reporting the original inhabitants of America—hundreds of North American indigenous tribes—nor did these naturalists acknowledge the traditional knowledge of Indigenous peoples regarding biodiversity.

It is important to clarify that North American biodiversity has been systematically studied by naturalists from the perspective of European settlers since the sixteenth century, and later under the sight of white American-born explorers, but not from the Indigenous peoples' point of view, even though they had interacted with nature for millennia and had a deep understanding of the medicinal, edible, and other uses of plant species, as well as the locations for collecting them and the methods for cultivating certain species.

The first book on North American plants was very well illustrated by the Frenchman Jacques Philippe Cornut (1606–1651). Other naturalists arrived earlier on the new continent, such as the Britishmen Thomas Hariot (1560–1621) and the artist John White (died around 1593), sent by Sir Walter Raleigh, and John Lawson (circa 1650–1711) in the USA; the Frenchmen Michel Sarrazin (1659–1734) and Jean-François Gaultier (1708–1756) in Canada; the French Pierre-François-Xavier de Charlevoix (1682–1761), the British Mark Catesby (1682–1749) and

the Swedish Pehr Kalm (1716–1779) in USA [41]; French father and son, André Michaux (1746–1803), and François André Michaux (1770–1855); Englishman Thomas Nuttall (1786–1859); the Scottish John Leigh Bradbury (1768–1823); the Turkish-born Constantine Samuel Rafinesque (1783–1840) [42], among many others.

The first well-documented expedition sponsored by the USA government was that conducted by Meriwether Lewis (1774–1809) and William Clark (1770–1838). After the Louisiana Purchase in 1803, President Thomas Jefferson, a very enthusiastic man in science that had been planning such a trip since 1783, gathered efforts in Congress to finance an expedition to make reports on the geography, soils, plants, and animals [42]. Other important American expeditions were conducted by USA-born naturalists such as John Bartram (1699–1777) and his son William Bartram (1739–1823) [43]; Thomas Freeman (died in 1821) and Peter Custis (1781–1842) in 1806, and Zebulon Montgomery Pike (1779–1813) in 1805 and then 1807 [42].

Unfortunately, indigenous peoples have been eclipsed in the historiography of the production and circulation of knowledge and technologies since the beginning of Natural History expeditions [44]. The indigenous erasure was motivated by a desire to remove indigenous peoples in order for the settlers to access resources and land. American Indians were not only removed geographically through reservations by forced treaties defined by white men and biologically through genocide, but also culturally and politically, and they were classified by settlers in a way to further erase and eliminate their existence [45].

Settler colonialism destroys to replace [46]. This is evident in this work where vernacular names are all written in English or French in Humboldt's manuscript, with no indigenous references to traditional uses. As Wolfe [46] argues, renaming indigenous names is a way of cultural erasure and it means the imposition of settler colonialism. Another example refers to generalization: when we analyze encyclopedic literature on North American useful plants between the eighteenth and nineteenth centuries, authors mention indigenous peoples simply as "Indians" or "Natives," without discriminating between specific tribes or nations. Wolfe [46] comments with an example on black people, which were racialized as "slaves," and slavery constituted their blackness. Correspondingly, Indigenous North Americans were not killed, driven away, romanticized, assimilated, fenced in, bred White, and otherwise eliminated as the "original owners of the land" but simply as "Indians" [46].

In a different manner than the naturalists who preceded and even succeeded them, Humboldt and Bonpland described medicinal and useful plants in field journals during their voyage through South America, Mexico, and Cuba, often giving the Spanish and/or indigenous names, describing the preparation and use of the plants and sometimes giving tips on how to cultivate that plants and how to obtain advantages through plant breeding [22]. They obtained this knowledge directly from the indigenous population and other locals during longer sojourns in settlements such as missions and plantations. During his few weeks in the USA, however, Humboldt moved exclusively in the circle of scholars and the upper society. His information about useful and medicinal plants was therefore filtered through conversations with and publications by European Americans. Indigenous names of the plants are missing, as is information on the use of the plants by Native Americans.

Good examples are the properties of the plants *Liriodendron tulipifera*, *Actaea racemosa*, and *Zanthorhiza apiifolia* (*Xantorhiza simplicissima*) that Humboldt wrote down on top of the first page of his notes. He obtained this knowledge from an essay by chemist James Woodhouse, with whom he also met in Washington [47]. Woodhouse describes, in particular, the numerous experiments carried out with *Xanthorhiza*, which certainly also stirred the interest of the plant physiologist Humboldt. Through this form of presentation, Woodhouse gives the impression that he had discovered the properties of this plant as a dye and medicinal agent. The author ignores the already established use of the plant by Native peoples, such as the Cherokee in the Appalachians as well as European settlers [37]. Subsequently, this information is missing in Humboldt' notes.

Analyzing and comparing the ethnobotanical information collected in "Plantae des États-Unis" with North American ethnobotany databases, it is possible to observe that much of this knowledge is similar to what Humboldt recorded, clearly showing a systematic suppression of Native peoples' knowledge from historical records and medicinal plant literature. When historical literature does not acknowledge the original owners of this knowledge, it becomes evident as cultural appropriation. As stated by Colenbaugh and Hagan [37], settlers perceived Indigenous cultural institutions as inferior, systematically substituting native cultural traditions—such as hairstyles, attire, dances, and languages—by forcibly "educating" them in Euro-American subjects. However, the settlers consistently adopted Indigenous cultural precedents, particularly the uses of native resources for their own survival and livelihood, including medicinal, edible, woody, and many other useful plants [37]. The settlers translated and altered the natural environments they observed, simplifying them to fit colonial needs, concerns, and economic interests. In so doing, plants became material resources and objects of knowledge that

continue to be used to produce Western herbalism as a predominantly white settler modality of medicine [48].

Besides Woodhouse, Humboldt also obtained information from the botanist Muhlenberg in Lancaster. In his diary, Muhlenberg mentions Humboldt's visit on June 16, 1804, and particularly points out their exchange on oak trees [49]. However, the most distinguished authority was President Thomas Jefferson himself. In his "Notes on the State of Virginia," Jefferson lists many North American native species, categorizing them as medicinal, edible, ornamental, and useful for fabrication, in his own words, "those which would principally attract notice." Some of these species mentioned by Humboldt in "Plantae des États-Unis" include *Aesculus pavia*, *Cornus florida*, *Liriodendron tulipifera*, and *Tillandsia usneoides* as ornamental; *Carya illinoensis* and *Diospyros virginiana* as edible; *Actaea racemosa* as medicinal; and *Quercus alba*, *Q. michauxii*, *Q. phellos*, *Q. rubra*, *Q. velutina*, *Q. virginiana*, *Salix nigra*, and *Taxodium distichum* as useful for fabrication. Jefferson also cited many other species belonging to these same genera of species in Tables 2 and 3, such as *Acer*, *Arundo*/*Arundinaria*, *Magnolia*, *Populus*, *Quercus*, *Rhus*/*Toxicodendron*, and *Salix*, showcasing the diversity of useful species in the USA and the importance of these plants for the country [14, 50, 51]. The mention of these much-discussed native plants by Jefferson and Humboldt alike echoes their conversations on the local flora in June 1804.

Consulting the Native American Ethnobotany Database [26] and encyclopedic literature on medicinal plants from the USA in the nineteenth and early twentieth centuries, we will discuss the historical uses and context of these species from "Plantae des États-Unis," focusing on the medicinal properties of these plants, complementing current scientific information about them.

Actaea racemosa, known as black snake root or black cohosh, was used by Indigenous peoples to treat plague and fevers, acting as sudorific, and even cure yellow fever [29], this last one the same indication of Humboldt. The febrifuge activity was evidenced by Wang et al. [52], when rhizome extract and the isolated compound cimicifugamide showed antipyretic and sudorific activities, acting both as agonists on beta-adrenergic receptors.

Roots of *A. racemosa* were also used by Native Indigenous peoples (Cherokee, Delaware, Iroquois, Micmac, and Penobscot) in the form of decoctions against snake bites and to treat acute and chronic rheumatism, in gargle for sore throat and treatment of smallpox and for digestive disorders as tonic, fevers, tuberculosis, and bronchitis [30, 32, 53]. Cherokee used root infusion for rheumatism, coughs, and colds [54], as well as analgesic, diuretic, and laxative [26]. Delaware people used it as tonic; Iroquois people used infusion of roots to "promote the flow of milk in women" and as blood purifier; Micmac and Penobscot used roots for kidney trouble [26].

In the past, *A. racemosa* was used for the treatment of menstruation disorders like amenorrhea and dysmenorrhea, and as a substitute of ergot during parturition favoring labor and after delivery relieved the after-pains (antispasmodic), puerperal mania and convulsions. By another way, large doses could be toxic causing sedation, vertigo, dilatation of pupils, and even abortion during pregnancy [30, 32]. Cherokee used the root to stimulate menstruation [54]. Curiously, nowadays *A. racemosa* is one of the most studied and prescribed plants for treatment of symptoms during menopause [55, 56].

Liriodendron tulipifera, known as the tulip tree or poplar, had the root and trunk barks as well as green seeds used as a febrifuge, with a similar effect to *Cinchona* (Peruvian bark or quina) for intermittent fevers by the native Osage and Cherokee peoples [26, 29, 31]. It used to be associated with *Cornus florida* to treat intermittent fevers [32]. The antimalarial and febrifuge activities were evidenced by Graziose et al. [57], who isolated aporphine alkaloids and sesquiterpene lactones from barks and leaves, respectively, with antiplasmodial activity in vitro. Furthermore, the alkamide tulipiferamide A isolated from barks inhibits NF-κB activation, resulting in the suppression of inflammatory mediators, including iNOS, COX-2, IL-1β, TNFα, and IL-6 [58].

Moreover, the bitter barks (roots and trunk) of *L. tulipifera* were used as tonic, stimulant, and diaphoretic and for the treatment of intermittent and chronic rheumatism as well as digestive disorders [30–32]. Vermifuge properties of the bark were well known by the Cherokee and the Osage [26, 29, 31]. Cherokee knew the medical properties of barks for dispepsy, dysentery, pinworms, cholera, coughs, rheumatism, wounds and boils, snakebite, hysterics (sedative), and weakness (tonic stimulant) [26, 54]. Wood was employed as lumber, to make long canoes and cradles, and as pulpwood by Cherokee. Rappahannock chewed the green bark as a stimulant [26].

In the USA, a full teacup with a strong infusion of *Toxicodendron radicans* aerial parts was used to be administered as a stomach stimulant, sudorific, and diuretic, and also for pulmonary conditions [33]. In England, the species was introduced in 1640, but the first medicinal use was reported in 1798 for the treatment of herpetic eruptions and also for other eruptive diseases, paralysis, rheumatism, and amaurosis [30, 33]. Regarding medical use reported by Humboldt, fresh parts (leaves, stems, and roots) of *Toxicodendron* spp. were used to prepare ointments and lotions by North American Indigenous peoples to treat skin diseases. Leaves of *T. radicans* are traditionally employed for the treatment of furuncles and skin eruptions [34]. Kiowa people used the plant for

running or non-healing sores, rubbing the leaves over boils or skin eruptions, while Houma nation employed decoction of leaves as a tonic and "rejuvenator," and Cherokee as emetic [26].

Some species of *Toxicodendron*, such as poison ivy (*T. radicans*), are considered to be toxic due to the presence of urushiols and derivatives, compounds that cause hypersensitivity reactions. Symptoms of dermatitis include acute eczematous eruptions characterized by streaks of intensely pruritic and erythematous papules and vesicles [59]. Navajo tribe considered the plant toxic, using it to poison arrows, while Thompson avoided it because it caused skin irritations and temporary blindness [26]. Furthermore, the latex is used as indelible ink for making linen and as an ingredient in liquid dressings and varnishes for finishing boots and shoes [30, 33].

Humboldt recorded *Gillenia stipulata* as having the same properties of roots of ipecacuanha (*Carapichea ipecacuanha* (Brot.) L. Andersson), a very important and traded South American medicinal plant in the eighteenth and nineteenth centuries due to its emetic and amebicide actions [36]. Johnson [32] reported the same observation, highlighting the vomiting effect of *G. stipulata* was less intense than ipecacuanha; in small doses it would act like stomach tonic.

The four species discussed above were included in the first edition of the United States Pharmacopoeia (USP) published in 1820. Although not recorded by Humboldt as medicinal, other species (*C. florida*, *D. virginiana*, *Q. alba*, *Q. velutina*, *X. apiifolia*, and *Magnolia* sp.) were also included in USP and had medical properties known at that time [60].

Known as dogwood, *C. florida* root barks were described as astringent, tonic, antiseptic (for ulcers, erysipelas, and anthrax), anti-periodic, stimulant, and febrifuge, and when it was used fresh, as emetic. The powdered bark was used as a substitute to *Cinchona*, indicated for the treatment of intermittent fevers, typhus, and febrile disorders. Twigs used to be chewed to prevent fevers [29–32]. Cherokee used to chew the barks of *C. florida* for headache and drink the decoction made of barks for fevers and body aches, and bark poultice was used on sores/ulcers [54], as well as anthelmintic, antidiarrheal, and for hoarseness. Roots were used by Delaware people as tonic, while Rappahannock used the root barks as antidiarrheal, tonic, and to purify the blood; Houma people used barks and roots as febrifuge and antimalarial; decoction of stems and roots were taken for blood chills by Iroquois people [26].

It is reported to *Cornus* spp. high levels of tannins, mainly in leaves [61], corroborating to astringent property [62]. Millspaugh [30] observed the economic interest for the valuable wood, susceptible to polish, and the use of the young branches without barks as dentifrice, by rubbing them on the teeth, turning them incredibly white; moreover, root barks furnished a red pigment for Native American Indigenous peoples.

Unripe fruits of *Diospyros virginiana*, known as common or American persimmon, were recorded as astringent by Humboldt, and alongside the barks, were used as styptic, tonic, and antiseptic [29], for internal hemorrhages, anthelmintic [63], and for chronic and subacute catarrhal affections [32]. Cherokee used the plant for its astringent properties, mainly barks infusion for venereal diseases, sore throat and mouth, toothache; treatment of hemorrhoids; syrup for oral thrush, bloody discharge from bowels; the bark was chewed for heartburn [26, 29, 54]. Rappahannock tribe prepared an infusion of the bark to treat trash and sore throat [26]. Rafinesque [29] still indicates the inner barks to treat intermittent fevers. Cherokee, Comanche, and Seminole used the fruit for food [26]. Rappahannock used to prepare a kind of beer, rolling the fruits in corn meal, brewed in water, drained, baked, and mixed with hot water [26]. Rafinesque [29] mentioned that dried fruits preserved in the form of a paste are used to prepare an alcoholic liquor ("beer or wine"), which alcohol has been attempted to be extracted. Unripe fruits of *Diospyros* sp. are very astringent because they accumulate large amounts of condensed tannins (proanthocyanidins), acting as defense compounds against herbivory [64]. Humboldt reported the use of ripe fruits to extract alcohol from wine; in comparison, tannins from unripe fruits of *Diospyros kaki* Thunb., an Asiatic species, are used nowadays in brewing sake [65].

Bark from *Quercus alba* (white oak) was included in USP as a powerful astringent used in the form of decoction as antiseptic, febrifuge, for diarrhea, hemorrhages, and externally to prevent bed sores [29, 31, 32, 53], which medical properties were known by the Cherokee [54], Meskwaki, and Delaware peoples [26]. Other tribes such as Mohegan used the bark as analgesic, while the Iroquois used it for tuberculosis and the Houma for rheumatism. Delaware still used the barks for sore throat and mouth, coughs, and as a douche in gynecological problems. Non-medicinal indigenous uses referred to wood for lumber, furniture, and basketry (Cherokee); a pie prepared with acorns after boiling, simmering to remove lye, grinding, and sifting (Menominee, Meskwaki) or mush with bear oil seasoning (Menominee); the ground and scorched acorns made into a drink similar to coffee (Meskwaki) [26].

Species of *Quercus* are tannin-rich, such as the barks of *Q. rubra*, which is a potential source of tannins with antioxidant, antimicrobial (mainly Gram-positive bacteria, e.g., *Staphylococcus aureus*), antifungal (*Candida krusei* and *C. parapsilosis*), and antienzyme (tyrosinase and

alpha-glucosidase) activities [66]. Top [67] observed that leaves of *Q. rubra* produce more tannins under stressful climate conditions (dry and warm environment), mainly condensed tannins.

Humboldt reported 9 North American *Quercus* species. These species had enormous economic importance at that time, mainly due to their uses as timber for constructions. In the same way, Humboldt and Bonpland described at least 16 oak species when they were in Mexico and Colombia, prior to the USA stay [22]. Due to scarcity of wood in Europe, naturalists were interested in finding timber sources in the other continents to supply internal necessities. *Quercus* spp. were used preferentially, because of their better mechanical properties for construction, barrels, tannin extraction, and even production of seeds for pig forage [68].

Regarding records on bad quality of the timber of *Q. phellos*, Humboldt and his traveling party had visited the Navy Yard in Washington on June 4, 1804, where they found "a number of frigates out of repair, although none of them have been built many years [sic]" [69]. Humboldt most likely mentioned this in his conversation with Jefferson the following day.

Rafinesque [29] described some uses of *Quercus* in the nineteenth century: *Quercus rubra* and *Q. alba* for tanning; *Q. velutina* (=*Q. tinctoria*) and *Q. castanea* as source of quercitron (bark yellow dye); *Q. virginiana* (=*Q. virens*), wood heavy as guaiac, cannot split, nails driven in cannot be taken off, resistant, durable, the best timber; *Q. alba*, *Q. stellata* (=*Q. obtusiloba*), and *Q. michauxii* (=*Q. prinus*) good timber too; *Q. alba*, brown dye, contains much tannin. The use of *Quercus* spp. as wood source remains today, but nowadays with forest management approach [68]. The Native American Ethnobotany Database [26] gathered North American Indigenous knowledge from many different ethnic groups on the uses of various *Quercus* species, including for medicinal purposes and wood.

Humboldt wrote that "Muhlenberg believed the occurrence of 28 oak species in the USA, while Mr. Kin said 50." It is known North America has the largest number of oak species, with 161 species in Mexico [70] and 90 in the USA [71]. Thomas Jefferson said to Humboldt that oaks from the South were better and more durable than the North ones. Muhlenberg denied this fact and ensured that *Q. castanea*, *Q. bicolor*, and *Q. alba* were as good as the European oaks, but they should be cut in closed places in order to not pick up green young trunks. They emphasized that local people were not careful in selecting the trees, since there were very few adult species with more than 18 to 20 inches, once Indian hunters used to burn the oak forests to see clearer at long distances before European colonization.

Xanthorhiza simplicissima (yellow root) and *Hydrastis canadensis* (goldenseal) are sources of protoberberine alkaloids such as berberine [72]. As pointed out by Humboldt, both species furnish a yellow dye, a Cherokee knowledge [26]. In the early nineteenth century, the yellowroot dye, mixed to the black oak bark, was used by the Cherokee to color ceremonial feathers, turning them "a most brilliant yellow" [28]. The Cherokee had described a series of diseases associated with yellow bile, some of which were treated with the yellow rhizomes of *X. simplicissima* [37]. This yellow color is derived from berberine and is used until today for woolen fabrics and silk [73–75].

Rhizome and roots of *X. simplicissima* [32, 73] and *H. canadensis* [29] were used due to bitter tonic properties for the stomach and liver disorders. *H. canadensis* roots were described by Barton [73] as having a strong and narcotic smell when dried.

Native Indigenous peoples knew the tonic properties of *H. canadensis* and also the uses for sore eyes and skin ulcerations, anti-inflammatory, and sedative as well as dye for clothes and implements of warfare [30, 53, 54, 73]. The plant was used as body pigment and insect repellent when mixed with grease and smeared upon the skin by Indigenous peoples [53]. Cherokee people used it as a stimulant, to improve the appetite, for cancer [26] (questioned by some authors, like Barton [73] and Johnson [32]) and even to treat gonorrhea [53]. Iroquois people used the roots for whooping cough and diarrhea, sour stomach, liver and heart trouble, earaches, sore eyes, fevers, pneumonia and tuberculosis, and as carminative and emetic; Micmac applied the roots in chapped or cut lips [26]. It was also used in catarrhal affections, leucorrhea, hemorrhoids, prolapsus ani, chronic coryza, and had laxative effect in some cases [32].

X. simplicissima roots were used by Cherokee for cramps, hemorrhoids, sore eyes, sore throat, and mouth and as tonic and sedative [26, 54]; Catawba people used them for stomach ulcers, colds, and jaundice [26].

No reference was found regarding toxic and ichthyotoxic properties of *Aesculus pavia*. However, their nuts were considered medicinal by Cherokee people who used them against tumors and infections [54].

The durable and flexible cane *Arundinaria gigantea* was used by Cherokee for woven materials, such as baskets, walls for houses, and floor mats, as well as for candles, musical instruments, furniture, tools, and weapons [26, 28]. Choctaw, Houma, and Seminole tribes used the plant as raw material for the same purposes as Cherokee, but also the roots as medicinal for kidney trouble, breast pain, and as cathartic [26].

Species like *Acer negundo*, *Magnolia grandiflora*, *Salix nigra*, *Taxodium distichum*, and *Tillandsia usneoides* did

not have any descriptions by Humboldt but were considered medicinal or useful by other authors. Species of *Magnolia*, such as *M. grandiflora*, were used by Native Indigenous peoples to treat rheumatism and fevers. Dried bark is tonic, stimulant, diaphoretic, and stomachic; the bark used to be switched with that of *Liriodendron*, which has a weaker effect [29].

Acer negundo (maple tree) was used by Indigenous peoples to prepare syrup and sugar. In "Travels to the West of the Alleghany Mountains: In the States of Ohio, Kentucky, and Tennessea, and Back to Charleston, by the Upper Carolines" (1805) [76], François André Michaux described that inhabitants of Pennsylvania used to extract sugar from other maple species—the silver-, white-, or sugar-maple (*Acer saccharinum* L.)—for their own use but did not sell it, because the sugar was very coarse and was not refined due to the great waste occasioned by the operation. Actually, the sap of *A. saccharinum* was processed by the Iroquois and Cherokee to be used as sweetener [28].

Tillandsia usneoides (Spanish moss) was used as winter food for cattle; when rotted in water, a very elastic fiber remains, which was used to stuff mattresses, saddles, and chairs, and to make ropes and cables. It was also used in sudorific baths and as an expectorant to treat catarrh and asthma [29]. Houma people used the decoction for chills and fever; dried fibers twisted and used for cordage and to make floor mats. Seminole used to remove scum in cooking and for tanning [26].

Salix nigra, for its part, had a very bitter root, whose decoction was used as a depurative and to treat intermittent fevers [77], the same uses (among many others) done by Cherokee, Houma, and Koasati [26].

Taxodium distichum was used for its very resistant and durable timber in constructions [77]. Barks were used by the Choctaw to make cordage [26]. Humboldt saw many of these trees in the ancient gardens of the Emperor of Mexico [77].

It is interesting to note that some medicinal uses of these species have been proven in recent pharmacological studies, such as the febrifuge activity of *A. racemosa* and the antimalarial activity of *L. tulipifera*. Conversely, the emetic effect of *G. stipulata*, bitter tonic properties of *X. simplicissima*, and the potential of *T. radicans* to treat skin diseases remain to be investigated.

Furthermore, most of these species have not been properly researched scientifically and represent a significant potential field for conducting pharmacological investigations. When we find a medicinal plant that was used to treat diseases centuries ago in historical documents and this property has not yet been pharmacologically investigated, it presents a tremendous opportunity to direct research toward testing these properties and potentially developing new drugs. The other uses of some of these species could help reinforce the necessity of conservation and biodiversity preservation, always considering that their use must be sustainable. Useful plants represent a biodiversity treasure, and cultural heritage, which are also tied to the bioeconomy. Recognizing the potential of plants and studying them is a way to acknowledge the knowledge of Native Indigenous peoples and create conditions to preserve nature.

Conclusion

This work systematizes ethnobotanical information regarding 28 North American plants reported by Humboldt during his short stay in the USA in 1804. Although "Plantae des États-Unis" is a brief collection of annotations, these data reveal a historical scenario of outstanding plants with social and economic interest in the USA at the beginning of the nineteenth century. Therefore, these data are more than simple plant names; they are symbols of interest to one of the most prominent naturalists of all time. Through Humboldt's journey in 1804, we can glimpse a small, yet economically and socially important, portion of the biodiversity of the USA. On the other hand, the analysis of our data showed that much of this knowledge came from Native North American Indigenous peoples, although they were not acknowledged in past historical records and literature. This demonstrates a clear process of invisibilization by white European settlers and American-born explorers. In this work, we have used the limited literature and databases available to acknowledge the original owners of the knowledge regarding the plant species mentioned in the manuscript. This ethnobotanical inventory may help us understand the relationship between plants and Native North American Indigenous peoples, as well as European naturalists and settlers, and USA-born people in the past, and reflect on the importance of Indigenous traditional knowledge, bioeconomy, sustainable management, and conservation of biodiversity in the present and future.

Abbreviations

BBAW	Berlin-Brandenburgische Akademie der Wissenschaften
COX-2	Cyclooxygenase-2
IL-1β	Interleukin-1-beta
IL-6	Interleukin-6
iNOS	Inducible nitric oxide synthase
NF-κB	Nuclear factor kappa-light-chain-enhancer of activated B cells
TNFα	Tumor necrosis factor alpha
UFRJ	Universidade Federal do Rio de Janeiro
USA	United States of America
USP	United States Pharmacopoeia

Author contributions

L.C. Baratto collected and interpreted the data, discussed the results, and wrote the manuscript; U. Päßler researched the historical contextualization for the Background and Results and Discussion sections, and revised the final text.

Funding
This research did not receive any specific grant from funding agencies of the public, commercial, or not-for-profit sectors.

Availability of data and materials
All data generated or analyzed during this study are included in this published article

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no conflict of interests.

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Received: 16 July 2024 Accepted: 9 September 2024
Published online: 17 September 2024

References

1. Sprague TA. Humboldt and Bonpland's Mexican Itinerary. Bull Misc Inf. 1924. https://doi.org/10.2307/4113500.
2. Sandwith NY. Humboldt and Bonpland's Itinerary in Venezuela. Bull Misc Inf. 1925. https://doi.org/10.2307/4107508.
3. Sandwith NY. Humboldt and Bonpland's Itinerary in Ecuador and Peru. Bull Misc Inf. 1926. https://doi.org/10.2307/4118688.
4. Sprague TA. Humboldt and Bonpland's in Colombia. Bull Misc Inf. 1926. https://doi.org/10.2307/4114319.
5. Andrä H. Alexander von Humboldt e as suas relações com o Brasil. Revista de História. 1962. https://doi.org/10.11606/issn.2316-9141.rh.1962.121720.
6. Kohlhepp G. Scientific findings of Alexander von Humboldt's expedition into the Spanish-American Tropics (1799–1804) from a geographical point of view. Ann Braz Acad Sci. 2005. https://doi.org/10.1590/S0001-37652005000200010.
7. Egerton FN. A history of the ecological sciences, part 32: Humboldt, nature's geographer. Bull Ecol Soc Am. 2009. https://doi.org/10.1890/0012-9623-90.3.253.
8. Lack HW. Alexander von Humboldt and the botanical exploration of the Americas. Munich: Prestel; 2009.
9. Tkach N, Heuchert B, Krüger C, Heklau H, Marx D, Braun U, Röser M. Type material in the herbarium of the Martin Luther University Halle-Wittenberg of species based on collections from Alexander von Humboldt's American expedition between 1799 and 1804 in its historical context. Schlechtendalia. 2016. https://doi.org/10.25673/90144.
10. Harvey EJ. Alexander von Humboldt and the United States: art nature and culture. Princeton: Princeton University Press; 2020.
11. Friis HR. Alexander von Humboldts Besuch in den Vereinigten Staaten von Amerika vom 20. Mai bis zum 30. Juni 1804. In: Schultze JH, editor. Alexander von Humboldt: Studien zu seiner universalen Geisteshaltung. Berlin: De Gruyter; 1959. p. 142–95.
12. Schwarz I. Alexander von Humboldt's Visit to Washington and Philadelphia, His Friendship with Jefferson, and His Fascination with the United States. Northeast Nat. 2001;8:43–56.
13. Ellicott A. The journal of Andrew Ellicott, late commissioner on behalf of the United States during part of the year 1796, the years 1797, 1798, 1799, and part of the year 1800: for determining the boundary between the United States and the possessions of His Catholic Majesty in America, containing occasional remarks on the situation, soil, rivers, natural productions, and diseases of the different countries on the Ohio, Mississippi, and Gulf of Mexico, with six maps. Philadelphia: Thomas Dobson; 1803. https://hdl.handle.net/2027/nyp.33433113800183. Accessed 09 Jul 2024
14. Rebok S. Humboldt and Jefferson: a transatlantic friendship of the enlightenment. Charlottesville: University of Virginia Press; 2014.
15. Götz C. Die (Un-)Ordnung des Schreibens. Der *Index général* und die *Amerikanischen Reisetagebücher*. Humboldt im Netz. 2023. https://doi.org/10.18443/361.
16. Humboldt A von. Extrait de "Journal of Andrew Ellicott". Nachl. Alexander von Humboldt, gr. Kasten 5, Nr 42. Staatsbibliothek zu Berlin - Preußischer Kulturbesitz; 1804. http://resolver.staatsbibliothek-berlin.de/SBB00019E2200000000. Accessed 05 Jul 2024.
17. Humboldt A von. Notizen und Excerpte zur Pflanzengeographie. Nachl. Alexander von Humboldt, gr. Kasten 6, Nr. 71a. Staatsbibliothek zu Berlin - Preußischer Kulturbesitz; 1804. http://resolver.staatsbibliothek-berlin.de/SBB00019F1C00000000. Accessed: 05 Jul 2024.
18. Päßler U. Plantae des États-Unis – Rediscovered Pages from Alexander von Humboldt's United States Diary. HiN - Alexander Von Humboldt Im Netz. 2017; https://doi.org/10.18443/265
19. Götz C. Linnés Normen, Willdenows Lehren und Bonplands Feldtagebuch. Die Pflanzenbeschreibungen in Alexander von Humboldts erstem Amerikanischen Reisetagebuch. edition humboldt digital, Berlin-Brandenburgische Akademie der Wissenschaften. 2024. https://edition-humboldt.de/v10/H0016429. Accessed 05 Jul 2024.
20. Humboldt A von. Botanische Manuskripte und Aufzeichnungen, u. a. "Plantae des États-Unis". Nachl. Alexander von Humboldt, gr. Kasten 6, Nr. 81a. Staatsbibliothek zu Berlin - Preußischer Kulturbesitz; 1804. http://resolver.staatsbibliothek-berlin.de/SBB00019F4D00000000. Accessed 05 Jul 2024.
21. Humboldt A von. Ag – Plantae des États-Unis. edition humboldt digital, Berlin-Brandenburgische Akademie der Wissenschaften. 2024. https://edition-humboldt.de/v10/H0006939. Accessed 02 Jul 2024.
22. Baratto LC. Useful plants described in the Plantes Équinoxiales (1805–1817) by Alexander von Humboldt and Aimé Bonpland. Bot Lett. 2022. https://doi.org/10.1080/23818107.2022.2135021.
23. Mariath F, Baratto LC. Female naturalists and the patterns of suppression of women scientists in history: the example of Maria Sibylla Merian and her contributions about useful plants. J Ethnobiol Ethnomed. 2023. https://doi.org/10.1186/s13002-023-00589-1.
24. Silva LNR, Oliveira ECP, Baratto LC. Amazonian useful plants described in the book "Le Pays des Amazones" (1885) of the Brazilian propagandist Baron de Santa-Anna Nery: a historical and ethnobotanical perspective. J Ethnobiol Ethnomed. 2024. https://doi.org/10.1186/s13002-024-00663-2.
25. POWO. Plants of the World Online. Royal Botanic Gardens, Kew. https://powo.science.kew.org/. Accessed 15 Jul 2024.
26. Native American Ethnobotany. A Database of Foods, Drugs, Dyes and Fibers of Native American Peoples, Derived from Plants. 2024. http://naeb.brit.org/. Accessed 23 Sept 2024.
27. Biodiversity Heritage Library. Smithsonian Libraries and Archives. 2024. https://www.biodiversitylibrary.org/. Accessed 28 May 2024.
28. Cozzo DN. Ethnobotanical classification system and medical ethnobotany of the Eastern Band of the Cherokee Indians. Ph.D. dissertation. Athens, Georgia: University of Georgia; 2004. https://esploro.libs.uga.edu/esploro/outputs/9949334466702959.
29. Rafinesque CS. Medical flora, or, Manual of the medical botany of the United States of North America. Philadelphia: Atkinson & Alexander; 1828. https://doi.org/10.5962/bhl.title.524.
30. Millspaugh CF. Medicinal plants: an illustrated and descriptive guide to plants indigenous to and naturalized in the United States which are used in medicine. Philadelphia: J.C. Yorston; 1892. https://doi.org/10.5962/bhl.title.6467.
31. Henkel A. American medicinal barks. Washington: Govt. Print. Off.; 1909. https://doi.org/10.5962/bhl.title.65100.
32. Johnson L. A manual of the medical botany of North America. New York: William Wood & Company; 1884. https://doi.org/10.5962/bhl.title.60987.
33. Bigelow J. American medical botany: being a collection of the native medicinal plants of the United States, containing their botanical history and chemical analysis, and properties and uses in medicine, diet and the arts /by Jacob Bigelow. Boston: Cummings and Hilliard; 1817. https://doi.org/10.5962/bhl.title.3693.

34. Hu X, Wang M, Cai F, Liu L, Cheng Z, Zhao J, Zhang Q, Long C. A comprehensive review of medicinal *Toxicodendron* (Anacardiaceae): Botany, traditional uses, phytochemistry and pharmacology. J Ethnopharmacol. 2024. https://doi.org/10.1016/j.jep.2023.116829.
35. USDA. United States Department of Agriculture. Natural Resources Conservation Service. https://plants.usda.gov/home. Accessed 02 Sept 2024.
36. Gänger S. World trade in medicinal plants from Spanish America, 1717–1815. Med Hist. 2015. https://doi.org/10.1017/mdh.2014.70.
37. Colenbaugh C, Hagan DL. Natural and cultural history of *Xanthorhiza simplicissima*. Castanea. 2022. https://doi.org/10.2179/0008-7475.86.2.151.
38. Albuquerque UP, Hanazaki N. As pesquisas etnodirigidas na descoberta de novos fármacos de interesse médico e farmacêutico: fragilidades e perspectivas. Rev Bras Farmacogn. 2006. https://doi.org/10.1590/S0102-695X2006000500015.
39. Silva TC, Medeiros PM, Balcazár AL, Araújo TAS, Pirondo A, Medeiros MFT. Historical ethnobotany: an overview of selected studies. Ethnobiol Conserv. 2014. https://doi.org/10.15451/ec2014-6-3.4-1-12.
40. Odonne G, Tareau MA, van Andel T. Geopolitics of bitterness: Deciphering the history and cultural biogeography of *Quassia amara* L. J Ethnopharmacol. 2021. https://doi.org/10.1016/j.jep.2020.113546.
41. Egerton FN. A history of the ecological sciences, part 22: Early European naturalists in Eastern North America. Bull Ecol Soc Am. 2006. https://doi.org/10.1890/0012-9623(2006)87[341:AHOTES]2.0.CO;2.
42. Egerton FN. History of the ecological sciences, part 33: naturalists explore North America, mid-1780s–mid-1820s. Bull Ecol Soc Am. 2009. https://doi.org/10.1890/0012-9623-90.4.434.
43. Egerton FN. A history of the ecological sciences, part 25. American naturalists explore Eastern North America: John and William Bartram. Bull Ecol Soc Am. 2007. https://doi.org/10.1890/0012-9623(2007)88[253:AHOTES]2.0.CO;2.
44. Sanjad N, Pataca E, Santos RRN. Knowledge and circulation of plants: unveiling the participation of Amazonian indigenous peoples in the construction of eighteenth and nineteenth century Botany. J Hist Sci Technol. 2021. https://doi.org/10.2478/host-2021-0002.
45. Orr R, Sharratt K, Iqbal M. American Indian erasure and the logic of elimination: an experimental study of depiction and support for resources and rights for tribes. J Ethn Migr Stud. 2018. https://doi.org/10.1080/1369183X.2017.1421061.
46. Wolfe P. Settler colonialism and the elimination of the native. J Genocide Res. 2006. https://doi.org/10.1080/14623520601056240.
47. Woodhouse J. An account of a new, pleasant, and strong bitter, and yellow dye, prepared from the stem and root of the *Xanthorhiza* Tinctoria, or Shrub yellow root; with a chemical analysis of this vegetable. Med Repos. 1802;5:169–164.
48. Flood M, Myhal N. White pine in time and place: Anishinaabe history, western herbalism, and the settler dynamics of appropriation. Hist Pharm Pharm. 2022. https://doi.org/10.3368/hopp.63.2.302.
49. Muhlenberg GHE. Fortsetzung meines Journals von Botanic und der Naturhistorie, 1799–1807. American Philosophical Society Library, Muhlenberg Family Papers, 1769–1866, Mss.B.M891. 1799–1807.
50. Jefferson T. Notes on the State of Virginia. Philadelphia: R.T. Rawler; 1801. p. 72–76. https://english.hku.hk/staff/kjohnson/PDF/JeffersonThomasNOTESONTHESTATEOFVIRGINIA1801.pdf. Accessed 10 Jun 2024.
51. Cornett P. Jefferson's botanical catalog in notes on the state of Virginia. Twinleaf. 2009. http://www.monticello.org/sites/default/files/inline-pdfs/notesonVA.pdf. Accessed 06 Jun 2024.
52. Wang Z, Wang Q, Zhang M, Hu X, Ding G, Jiang M, Bai G. Cimicifugamide from *Cimicifuga* rhizomes functions as a nonselective β-AR agonist for cardiac and sudorific effects. Biomed Pharmacother. 2017. https://doi.org/10.1016/j.biopha.2017.03.058.
53. Lloyd JU. History of the vegetable drugs of the Pharmacopeia of the United States. Ohio: J.U. & C.G. Lloyd; 1911. https://doi.org/10.5962/bhl.title.52411.
54. Setzer WN. The phytochemistry of Cherokee aromatic medicinal plants. Medicines. 2018. https://doi.org/10.3390/medicines5040121.
55. Mohapatra S, Iqubal A, Ansari MJ, Jan B, Zahiruddin S, Mirza MA, Ahmad S, Iqbal Z. Benefits of black cohosh (*Cimicifuga racemosa*) for women health: an up-close and in-depth review. Pharmaceuticals (Basel). 2022. https://doi.org/10.3390/ph15030278.
56. Sadahiro R, Matsuoka LN, Zeng BS, Chen KH, Zeng BY, Wang HY, Chu CS, Stubbs B, Su KP, Tu YK, Wu YC, Lin PY, Chen TY, Chen YW, Suen MW, Hopwood M, Yang WC, Sun CK, Cheng YS, Shiue YL, Hung CM, Matsuoka YJ, Tseng PT. Black cohosh extracts in women with menopausal symptoms: an updated pairwise meta-analysis. Menopause. 2023. https://doi.org/10.1097/GME.0000000000002196.
57. Graziose R, Rathinasabapathy T, Lategan C, Poulev A, Smith PJ, Grace M, Lila MA, Raskin I. Antiplasmodial activity of aporphine alkaloids and sesquiterpene lactones from *Liriodendron tulipifera* L. J Ethnopharmacol. 2011. https://doi.org/10.1016/j.jep.2010.08.059.
58. Park I, Byun HS, Hur GM, Na M. Tulipiferamide A, an alkamide from *Liriodendron tulipifera*, exhibits an anti-inflammatory effect via targeting IKKβ phosphorylation. J Nat Prod. 2021. https://doi.org/10.1021/acs.jnatprod.1c00146.
59. Hunt MJ, Elston DM. Botanical briefs: *Toxicodendron* dermatitis. Cutis. 2022. https://doi.org/10.12788/cutis.0649.
60. USP. The Pharmacopoeia of the United States of America. Boston: Wells and Lilly; 1820. http://resource.nlm.nih.gov/2567001R. Accessed 28 May 2024.
61. De La Pascua DR, Smith-Winterscheidt C, Dowell JA, Goolsby EW, Mason CM. Evolutionary trade-offs in the chemical defense of floral and fruit tissues across genus *Cornus*. Am J Bot. 2020. https://doi.org/10.1002/ajb2.1540.
62. Monteiro JMM, Albuquerque UP, Araujo EL, Amorim ELC. Taninos: Uma abordagem da química à ecologia. Quim Nova. 2005. https://doi.org/10.1590/S0100-40422005000500029.
63. Pamel LH. A manual of poisonous plants, chiefly of eastern North America, with brief notes on economic and medicinal plants, and numerous illustrations. Iowa: The Torch Press; 1911. https://doi.org/10.5962/bhl.title.55543.
64. Akagi T, Katayama-Ikegami A, Yonemori K. Proanthocyanidin biosynthesis of persimmon (*Diospyros kaki* Thunb.) fruit. Sci Hortic. 2011. https://doi.org/10.1016/j.scienta.2011.07.021.
65. Singh S, Joshi H. *Diospyros kaki* (Ebenaceae): a Review. Asian J Res Pharm Sci. 2011;1:55–8.
66. Tanase C, Nicolescu A, Nisca A, Ştefănescu R, Babotă M, Mare AD, Ciurea CN, Man A. Biological activity of bark extracts from northern red oak (*Quercus rubra* L.): an antioxidant, antimicrobial and enzymatic inhibitory evaluation. Plants (Basel). 2022. https://doi.org/10.3390/plants11182357.
67. Top SM, Preston CM, Dukes JS, Tharayil N. Climate influences the content and chemical composition of foliar tannins in green and senesced tissues of *Quercus rubra*. Front Plant Sci. 2017. https://doi.org/10.3389/fpls.2017.00423.
68. Feiss T, Robin V, Aran D, Levillain J, Paul T, Dupouey JL. Are western European oak forests man-made constructs? The pedoanthracological perspective. For Ecol Manage. 2024. https://doi.org/10.1016/j.foreco.2023.121588.
69. Peale CW. The selected papers of Charles Willson Peale and his family. In: Miller LB, editor. Vol. 2. Pt. 2. New Haven, London: Yale University Press; 1988. p. 691.
70. Valencia AS. Diversidad del género *Quercus* (Fagaceae) en México. Boletín de la Sociedad Botánica de México. 2004;75:33–53.
71. Döring M. *Quercus* L. English Wikipedia - Species Pages. Wikimedia Foundation. 2022. https://doi.org/10.15468/c3kkgh. Accessed: 03 Jun 2024.
72. Cicero AF, Baggioni A. Berberine and Its role in chronic disease. Adv Exp Med Biol. 2016. https://doi.org/10.1007/978-3-319-41334-1_2.
73. Barton WPC. Vegetable materia medica of the United States; or, Medical botany: containing a botanical, general, and medical history of medicinal plants indigenous to the United States. Philadelphia: H.C. Carey & I. Lea; 1818. https://doi.org/10.5962/bhl.title.114849.
74. Ahn C, Yoo HJ, Li L. Dyeing behaviors of berberine, palmatine, and dye extracted from *Phellodendron* bark on silk fabric. J Korean Soc Cloth Text. 2012. https://doi.org/10.5850/JKSCT.2012.36.12.1257.
75. Luo Y, Zhang X. Effects of yellow natural dyes on handmade Daqian paper. Herit Sci. 2021. https://doi.org/10.1186/s40494-021-00560-x.
76. Michaux FA. Travels to the west of the Alleghany mountains: In the States of Ohio, Kentucky, and Tennessea, and Back to Charleston, by the Upper Carolines. London: D.N. Shury, 1805. https://openlibrary.org/works/OL7662342W/Travels_to_the_west_of_the_Alleghany_Mountains?edition=key%3A%2Fbooks%2FOL13489475M#overview.

77. Michaux FA. Histoire des arbres forestiers de l'Amérique septentrionale, considérés principalement sous les rapports de leur usage dans les arts et de leur introduction dans le commerce, ainsi que d'après les avantages qu'ils peuvent offrir aux gouvernemens en Europe et aux personnes qui veulent former de grandes plantations, volume 3. Paris: De l'Imprimerie de L. Haussmann; 1813. https://doi.org/10.5962/t.173720. Accessed: 10 Jun 2024.

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