TRACING PLANT HISTORIES

Linking Botanical Collections, Peoples, and Illustrations in Seventeenth Century Dutch Brazil

Mireia Alcantara Rodriguez

Cover image:

Watercolor in the *Libri Principis* (f. 2) of *Centrosema brasilianum* (L.) Benth. (former *Clitoria brasiliana* L.) created in the colony of Dutch Brazil c. 1640. Unknown author. Jagiellonian library, Krakow, Poland.

Tracing Plant Histories

Linking Botanical Collections, Peoples, and Illustrations in Seventeenth Century Dutch Brazil

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	Dr. A. Geurds
	Dr. V. Stern da Fonseca-Kruel
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A mi madre, Virti

Verde, que te quiero verde

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‘Uma andorinha só não faz verão’ *

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Summary

Plants and peoples' connections intertwine in multiple histories that natural history books, images, and objects often capture within their collections. These can include textual accounts, dried plants, seeds, and illustrations. In the seventeenth century, the material originating from the colonial enterprise of Johan Maurits van Nassau-Siegen in the northeast of Brazil (Dutch Brazil) circulated in Europe and fed the curiosity for the 'exotic' and the commercial purposes of their beneficiaries. This material included the *Historia Naturalis Brasiliae* (Marcgrave & Piso 1648, HNB) – a treatise on flora, fauna, tropical diseases, and ethnology and illustrated with woodcut images– and a collection of Brazilian drawings and paintings, today bound in the *Libri Picturati* and kept in Krakow (Poland).

We analyzed the plant composition, plant uses, and botanical terminology in these collections to respond to the central question of this dissertation 'What does the botanical knowledge in the HNB and the *Libri Picturati* reveal about plant use and names by the different ethnic groups in Dutch Brazil?' We anticipated low knowledge retention due to the erosion of ecological knowledge caused by genocide, industrialization, globalization processes, and habitat loss. Additionally, we expected to find species of African origin shipped across the ocean via the trans-Atlantic slave trade. We predicted tracing most of the species and the vernacular names from these historical sources to northeastern areas in Brazil (such as Recife), where Georg Marcgrave and Willem Piso surveyed plants, animals, and medicines. Furthermore, scholarly research pointed out that these naturalists gathered their collections from the surroundings of their living quarters. Overall, as these botanical representations originated in the same context, we assumed the plant taxa among visual and textual sources would be similar. Likewise, we expected to trace most woodcut images in the HNB to the illustrations and drawings of the *Libri Picturati*, which bear similarities to several woodcuts.

We conducted diachronic comparative research of the plant practices in the 1640s as written in the HNB and the use of these plants by Brazilians as documented in contemporary ethnobotanical literature, including plant market surveys. We identified the flora depicted in the *Libri Picturati* and compared its taxa and images with the specimens Marcgrave collected in Brazil and the paintings on Brazilian flora by the artists in Johan Maurits' entourage (like Albert Eckhout and Frans Post). In addition, we analyzed the correlations between the images, the represented taxa, and their plant names with those documented and displayed as woodcuts in the HNB, the second version of this book (Piso, 1658), and a draft of the botanical section based on Marcgrave's notes in the field (De Laet's manuscript).

Our results reveal the preservation of botanical knowledge over time, which corresponds significantly to the plant practices and terminology of Indigenous Brazilians from the macrolinguistic Tupi family. These historical sources also provide proof of the presence of crops and weeds brought across the Atlantic and used by the enslaved Africans in the alien territory. We studied the origin and current distribution ranges of the species documented in the historical sources and their presence in contemporary Brazilian markets. Furthermore, we indicated some of Brazil's first records of exotic plants, their possible dispersion routes, and the agents who moved them along. In addition, we reviewed the conservation status of the flora depicted, highlighting the species at risk of extinction. Finally, we discussed the methods of visual knowledge-making in the early modern period in connection with the sources used to elaborate the woodcuts. Even though the Western male gaze dominated these processes, we looked at the multiple (plant use) histories of Indigenous Brazilians, enslaved Africans, and European settlers that intermingled and shaped the botanical knowledge embedded in the natural history collections of Dutch Brazil.

Resumo (Portuguese summary)

As conexões entre plantas e povos se entrelaçam em várias histórias, por sua vez capturadas em livros de história natural, e em coleções de imagens e objetos. Tais coleções podem incluir relatos textuais, plantas secas, sementes e ilustrações. No século XVII, o material proveniente do empreendimento colonial de Johan Maurits no nordeste do Brasil (Brasil Holandês) circulou pela Europa e alimentou tanto a curiosidade pelo 'exótico' quanto os objetivos comerciais de seus beneficiários. Esse material incluía a *Historia Naturalis Brasiliae* (Marcgrave & Piso 1648, HNB) – um tratado sobre flora, fauna, doenças tropicais e etnografia – e uma coleção de imagens brasileiras, hoje encadernadas no *Libri Picturati* guardados em Cracóvia (Polônia).

Analisamos a composição vegetal, os usos das plantas e a terminologia botânica nessas coleções para responder à questão central desta dissertação: 'O que o conhecimento botânico no HNB e no *Libri Picturari* revela sobre o uso e os nomes das plantas pelos diferentes grupos étnicos no Brasil Holandês?'. Esperávamos uma baixa retenção do conhecimento botânico devido à erosão do conhecimento ecológico causada pelo genocídio da população nativa, industrialização, processos de globalização e perda de habitat. Da mesma forma, esperávamos encontrar espécies de origem africana enviadas pelo oceano como parte do comércio transatlântico de escravos. Previámos rastrear a maioria das espécies e os nomes vernaculares dessas fontes históricas para áreas do nordeste do Brasil (como Recife), onde Marcgrave e Piso pesquisaram plantas, animais e remédios. Além disso, pesquisas acadêmicas apontavam que os naturalistas reuniram suas coleções vindas dos arredores para seus gabinetes. No geral, como as representações botânicas do HNB e do *Libri Picturati* se originaram no mesmo contexto, assumimos que os táxons vegetais entre as fontes visuais e textuais seriam semelhantes e esperávamos rastrear a maioria das xilogravuras no HNB para as ilustrações dos *Libri Picturati*, que guardam semelhanças com várias xilogravuras.

Realizamos uma pesquisa comparativa diacrônica das práticas botânicas na década de 1640, conforme descritas no HNB e o uso dessas plantas pelos brasileiros, conforme documentado na literatura etnobotânica contemporânea, incluindo pesquisas de mercado de plantas. Identificamos a flora retratada nos *Libri Picturati* e comparamos seus táxons e imagens com os espécimes coletados por Marcgrave no Brasil e as pinturas sobre a flora brasileira dos artistas da comitiva de Johan Maurits (como Eckhout e Post). Além disso, analisamos as correlações entre as imagens, os táxons representados e seus nomes de plantas com aqueles documentados e exibidos como xilogravuras no HNB, a segunda versão deste livro (Piso, 1658), e um rascunho da seção botânica baseado nas notas de campo de Marcgrave (manuscrito de De Laet).

Nossos resultados revelam a preservação do conhecimento botânico ao longo do tempo, o que corresponde significativamente às práticas botânicas e terminológicas dos indígenas brasileiros da família macrolinguística Tupi. Essas fontes históricas também fornecem evidências sobre a presença de culturas agrícolas e ervas trazidas e usadas pelos africanos escravizados no território estrangeiro, a origem e distribuição atual das espécies de plantas documentadas nessas fontes históricas, bem como sua presença nos mercados do Brasil contemporâneo. Além disso, indicamos alguns dos primeiros registros de plantas exóticas no Brasil, suas possíveis rotas de dispersão e os agentes que as movimentaram. Igualmente, mostramos o estado de conservação da flora retratada, destacando as espécies em risco de extinção. Finalmente, discutimos os métodos de produção de conhecimento visual no início do período moderno em conexão com as fontes usadas para elaborar as xilogravuras. Embora o olhar masculino ocidental dominasse esses processos, examinamos as múltiplas histórias (do uso de plantas) de indígenas brasileiros, africanos escravizados e colonos europeus que se misturaram e moldaram o conhecimento botânico incorporado nas coleções de história natural do Brasil holandês.

Samenvatting (Dutch summary)

Planten en mensen zijn met elkaar verweven in meerdere geschiedenissen die natuurhistorische boeken, afbeeldingen en objecten vaak hebben vastgelegd. Dit kunnen tekstuele verslagen, gedroogde planten, zaden en illustraties zijn. In de zeventiende eeuw circuleerde het materiaal afkomstig van de koloniale onderneming van Johan Maurits van Nassau-Siegen in het noordoosten van Brazilië (Nederlands Brazilië) in Europa en voedde de nieuwsgierigheid naar het 'exotische' en de commerciële doeleinden van hun begunstigden. Dit materiaal omvatte de *Historia Naturalis Brasiliae* (Marcgrave & Piso 1648, HNB) - een verhandeling over flora, fauna, tropische ziekten en etnologie - en een verzameling Braziliaanse afbeeldingen, tegenwoordig gebonden in de *Libri Picturati* die in Krakau (Polen) wordt bewaard.

We analyseerden de botanische samenstelling, het plantgebruik en de botanische terminologie in deze collecties om antwoord te geven op de centrale vraag van dit proefschrift :'Wat onthult de botanische kennis in de HNB en de *Libri Picturati* over plantgebruik en lokale plantennamen van de verschillende etnische groepen in Nederlands Brazilië?' We verwachtten een erosie van etnobotanische kennis als gevolg van de genocide op de inheemse bevolking, industrialisatie, globaliseringsprocessen, ontbossing en het verlies van leefgebied. Bovendien verwachtten we soorten van Afrikaanse oorsprong te vinden die via de trans-Atlantische slavenhandel over de oceaan waren verscheept. We voorspelden dat we de meeste soorten en de lokale namen uit deze historische bronnen konden terug getraceren naar noordoostelijke gebieden in Brazilië (zoals Recife), waar Georg Marcgrave en Willem Piso op zoek waren naar planten, dieren en medicijnen. Bovendien wees wetenschappelijk onderzoek uit dat deze natuuronderzoekers hun collecties uit de omgeving naar hun woonvertrekken verzamelden. Aangezien deze botanische representaties in dezelfde context zijn ontstaan, gingen we er over het algemeen van uit dat de plantentaxa van de

visuele en tekstuele bronnen vergelijkbaar zouden zijn. Evenzo verwachtten we de meeste houtsneden in de HNB te herleiden tot de illustraties en tekeningen van de *Libri Picturati*, die overeenkomsten vertonen met verschillende houtsneden.

We voerden diachroon vergelijkend onderzoek uit naar de plantpraktijken in de jaren 1640 zoals beschreven in de HNB en het gebruik van deze planten door Brazilianen zoals gedocumenteerd in de hedendaagse etnobotanische literatuur, inclusief onderzoek op medicinale plantenmarkten. We identificeerden de afgebeelde flora in de *Libri Picturati* en vergeleken de taxa en afbeeldingen met de exemplaren die Marcgrave in Brazilië verzamelde voor zijn herbarium en de schilderijen over de Braziliaanse flora van de kunstenaars in de entourage van Johan Maurits (zoals Albert Eckhout en Frans Post). Daarnaast analyseerden we de correlaties tussen de afbeeldingen, de vertegenwoordigde taxa en hun plantennamen met die gedocumenteerd en weergegeven als houtsneden in de HNB, din e tweede versie van dit boek (Piso, 1658), en een ontwerp van de botanische sectie gebaseerd op op Marcgrave's aantekeningen in het veld (manuscript van De Laet).

Onze resultaten onthullen het behoud van botanische kennis in de loop der tijd, wat significant overeenkomt met het plantgebruik en de terminologie van inheemse Brazilianen uit de macrolinguïstische Tupi-familie. Deze historische bronnen leveren ook bewijs van de aanwezigheid van gewassen en onkruiden die de Atlantische Oceaan zijn overgestoken en gebruikt door de tot slaafgemaakte Afrikanen in dit voor hen vreemde gebied. We hebben de oorsprong en huidige verspreidingsgebieden van de plantensoorten die in deze historische bronnen gedocumenteerd, en hun aanwezigheid in het hedendaagse Braziliaanse markten gerapporteerd. Verder hebben we enkele van de eerste Braziliaanse records van exotische planten aangegeven, hun mogelijke verspreidingsroutes en de personen die ze hebben meegenomen. Daarnaast toonden we de staat van instandhouding van de afgebeelde flora, waarbij we de soorten benadrukten die met uitsterven worden bedreigd. Ten slotte bespraken

we de methoden van visuele kennisvorming in de vroegmoderne tijd, in verband met de bronnen die werden gebruikt om de houtsneden uit te werken. Hoewel de westerse mannelijke blik deze processen domineerde, hebben we gekeken naar de vele (plantgebruik) geschiedenissen van inheemse Brazilianen, tot slaafgemaakte Afrikanen en Europese kolonisten die zich vermengden en vormgaven aan de botanische kennis die is ingebed in de natuurhistorische collecties van Nederlands Brazilië.

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Chapter 1

General Introduction

Plants and peoples' connections intertwine in multiple histories that are often captured in natural history collections. These can include several materials, such as textual accounts, dried plants, seeds, and illustrations. For centuries, these repositories of botanical knowledge circulated among circles of naturalists, merchants, and wealthy collectors. They ultimately ended up in libraries, herbaria, and private collections – which, if we are lucky, we can access today. By the mid-seventeenth century, information on the environment and society in Dutch Brazil was compiled into a large book entitled the *Historia Naturalis Brasiliae*. Herbarium specimens, paintings, and other objects also encapsulated valuable biocultural knowledge from the northeastern region of Brazil, occupied by the Dutch West India Company. Several images portrayed the natural resources encountered in this colony, which later were embedded in the Brazilian collection of the *Libri Picturati*. Studying these collections could bring us closer to understanding how people of different backgrounds interacted with their natural environment and with each other in the colonial context of Dutch Brazil.

1.1 Background

The *Historia Naturalis Brasiliae* (HNB, 1648) is a Western treatise published in 1648 that aimed to portray the natural history of Brazil in the 1640s. At that time, the Dutch occupied the northeastern territories of Brazil (Fig 1.1) under the mandate of count Johan Maurits of Nassau-Siegen (1604-1679) and the management of the West India Company (WIC). While the Dutch colonial rule in Brazil lasted from 1630 to 1654, Johan Maurits was governor between 1636 and 1644 in the captaincy of Pernambuco and other northeastern territories – known as Dutch Brazil. To depict and document Brazilian nature, he commissioned naturalist

George Marcgrave (1610-1643), physician Willem Piso (1611-1678), and painters Albert Eckhout (1610-1665) and Frans Post (1612-1680), among others, who worked in Brazil; and cartographer Johannes de Laet (1581-1649), who edited the HNB in Holland. The HNB is one of the most important outcomes of Johan Maurits' scientific and artistic entourage. It emerged at the turbulent time when the WIC attempted to increase its capital by trading Brazilian goods and exploiting its sugar monopoly. As a result, ships continuously crossed the ocean bringing the popular Brazilwood (*Paubrasilia echinata* (Lam.) Gagnon, H.C.Lima & G.P.Lewis) to the European shores, along with other demanded plant products. At the same time, the sugar cane plantations dominated the Atlantic coast, enterprises sustained by the forced labor of enslaved Africans brought via the WIC or smuggled into the colony by Johan Maurits himself (Monteiro & Odegard, 2020).

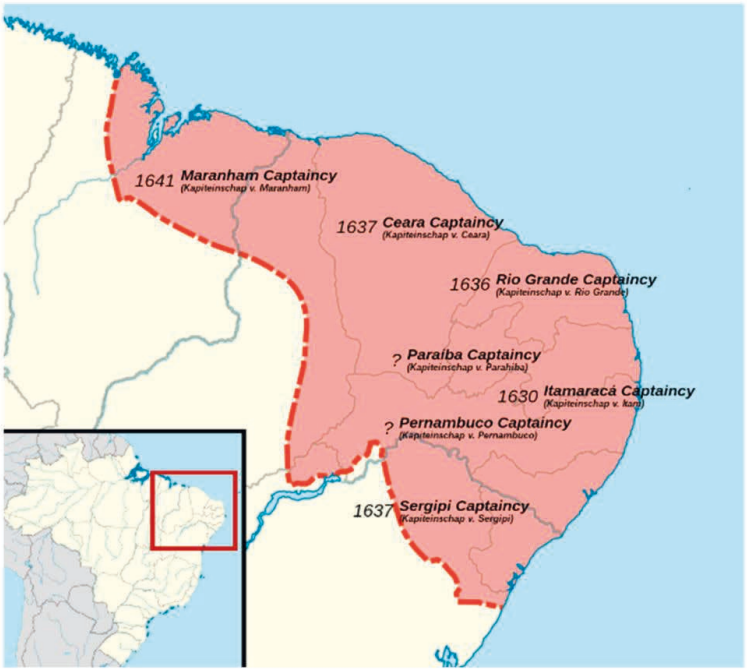


Fig 1.1 **Map of Dutch Brazil from 1630-1654, overlaid on a modern-day map of Brazil.** Source Berrely (2022).

The HNB consists of systematically formatted descriptions and images of the Brazilian flora, fauna, climate, geography, tropical diseases, and the inhabitants coexisting in Dutch Brazil under the European gaze (Fig 1.2a). The knowledge and practices exchanged among the different ethnic groups shaped the environmental knowledge the scholars compiled in the HNB. The population in the colony consisted of diverse Indigenous groups, who spoke different languages, from a myriad of families, being two of the major ones the Macro-linguistic Tupi and Macro-jê families. For the European naturalists, the former branch included the *Tupinambá, Tobajara, and Petiguara* peoples, who inhabit the coastal territories. The latter included the *Tapuiya*, who lived in the interior, like the sertão or hinterland areas in the northeast (Marcgrave, 1648: 268). Under the Eurocentric gaze, *Tapuiya* (or Tapuia) peoples were those who did not fit into the category of Tupi or Tupinambá, and were considered savages and dangerous. However, both Tupi and Tapuia groups included, and still do, more diversity of Indigenous groups than those perceived by the colonizers and spoke more than a thousand languages before the arrival of the Portuguese, decreasing to ci. 160 languages today due to their genocide, exposal to European diseases, and displacement (https://pib.socioambiental.org/en/Languages). The population also consisted of enslaved Africans, mainly brought from West and Central Africa, including the regions currently known as Angola, the Democratic Republic of Congo, and Ghana, but also from other territories (Eltis & Richardson, 2010). The European settlers included the Portuguese, Luso-Brazilians, and Spanish (united to Portugal until the Iberian Crowns' union dissolved in 1640). They lived there for over a century before the Dutch arrived. In addition, Sephardic Jews who escaped the Iberian Inquisition settled in the Dutch colony. Other inhabitants were the English, German, French, and of course, the Dutch (Marcgrave, 1648: 268). The latter failed a previous attempt to create a colony in Salvador da Bahia in 1624 but succeeded in Pernambuco in 1630 and remained there for over 24 years.

Other relevant sources from Dutch Brazil include a modified version of the HNB, authored by Piso and published in 1658 as *De India Utriusque re Naturale et Medica* (IURNM) (Fig 1.2b), Marcgrave's herbarium with 177 dried specimens collected in Brazil (Fig 1.2c), a series of still-life paintings and portraits authored by Eckhout (Fig 1.2d), De Laet's manuscript (a draft of the HNB) (Fig 1.2e), and the set of illustrations and drawings included into the *Libri Picturati* (Fig 1.2).

The *Libri Picturati* is an extensive collection of art kept in the Jagiellonian Library in Krakow (Poland). It contains three distinct collections of Brazilian imagery: the oil-based illustrations of the *Theatrum Rerum Naturalium* (from now on *Theatrum*) (Fig 1.2f), the drawings and sketches of the *Miscellanea Cleyeri* (Fig 1.2g), and the watercolors of the *Libri Principis* (Fig 1.2h). As in the HNB, the three collections display images of flora, fauna, and local people. Initially, the artistic set was given by Johan Maurits to the Elector of Brandenburg, Frederik Wilhelm, as a diplomatic gift. His physician Christian Mentzel organized this material to be part of the Elector's library – today, the Berlin State Library (*Staatsbibliothek zu Berlin*) (Albertin, 1985). The *Theatrum* is the most extensive collection and includes an entire volume made of plant images. Mentzel included 206 blank folios with references to Marcgrave and Piso's chapter on plants (1648, 1658) interleaved between 160 folios with botanical illustrations. Unfortunately, the history of access to this visual material has been inconsistent, as it was interrupted in the 1940s because of World War II when it was still in Berlin. As a result, the *Libri Picturati* remained inaccessible to researchers and the general public for decades until it was found in Krakow by zoologist Peter Whitehead (Whitehead, 1979). Scholars who studied this material before and after its rediscovery noticed its images interconnected with the HNB.

The HNB is a historical repository of (plant) knowledge and human practices, (botanical) terminology, and plant distribution. Likewise, botanical illustrations often reveal information

on the working practices of botanists (Nickelsen, 2006). The iconography of both the HNB and the *Libri Picturati* can therefore be considered historical sources that reflect the methods of plant collection and collaboration amidst different agents in Dutch Brazil.

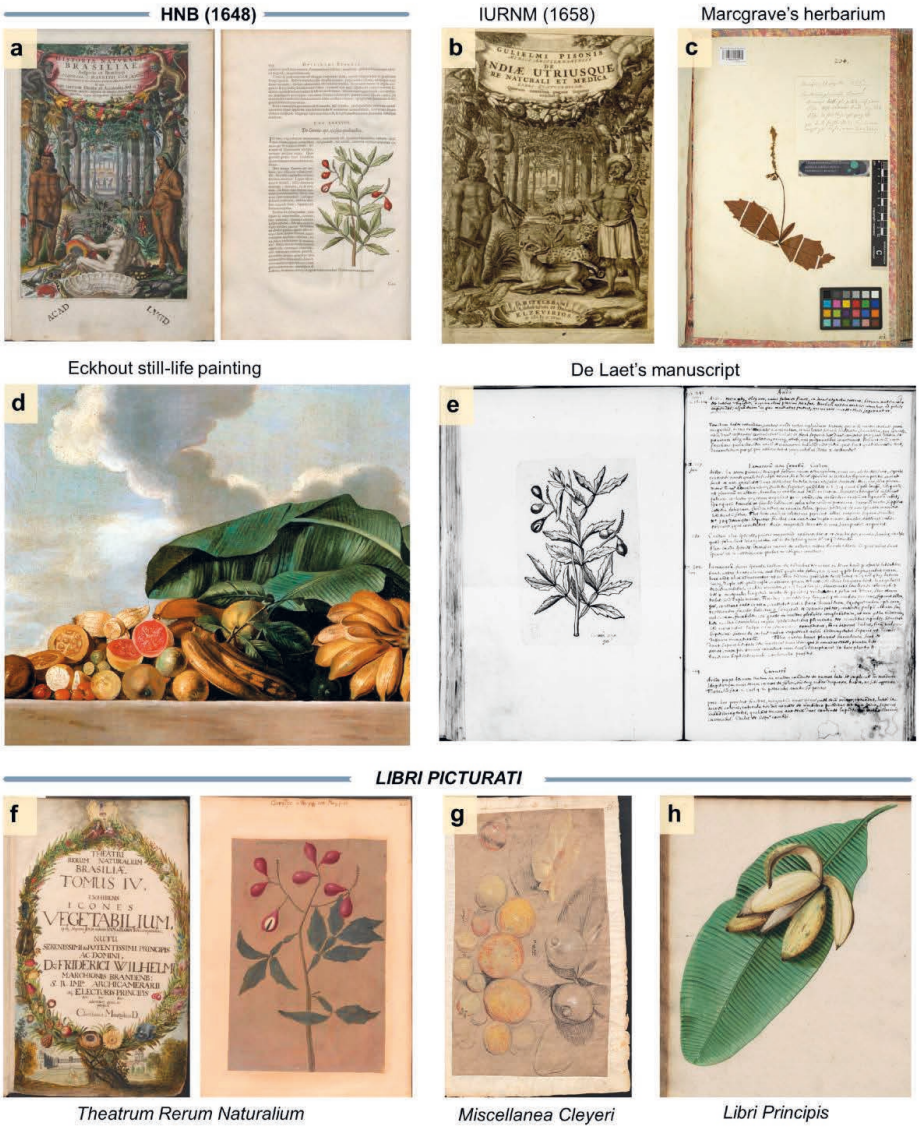


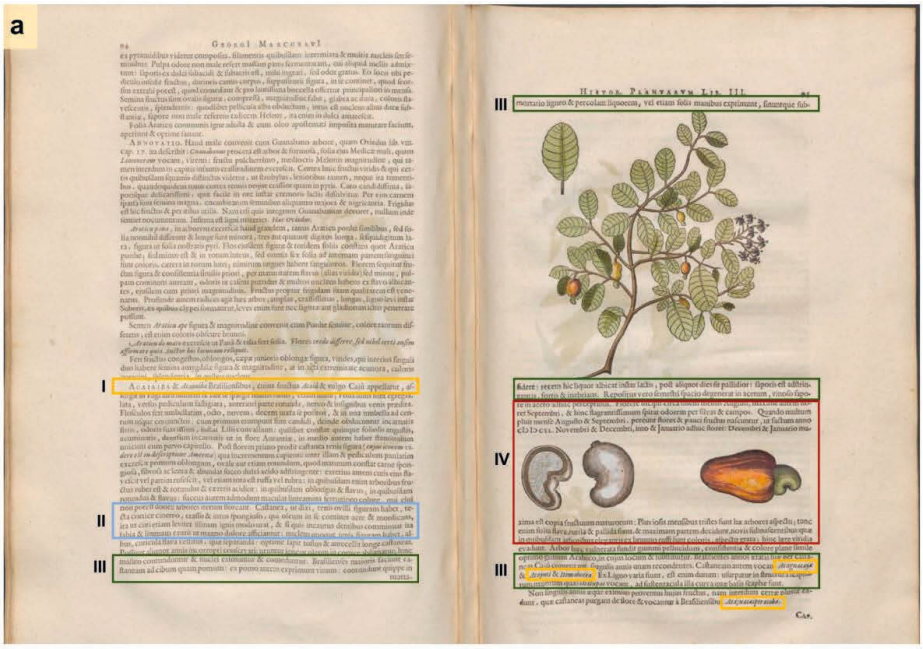
Fig 1.2 **Visual and textual material that originated in Dutch Brazil (**a) Cover page of the HNB (Marcgrave & Piso, 1648) and description and woodcut of *Cururu ape* (Piso, 1648:

114), Leiden University library **(**b) Cover page of the IURNM (Piso, 1658), Missouri Botanical Garden **(**c) Specimen of *Paullinia pinnata* L. in Marcgrave`s herbarium (p. 101), University of Copenhagen (C) **(**d) Still-life with bananas and other fruit by Eckhout, c. 1640, National Museum of Copenhagen **(**e) Proof woodcut of *P. pinnata* in De Laet's manuscript (f. 69v), Sloane MS 1554, British Library **(**f) Cover page of the *Theatrum* (*Icones Vegetabilium*) and oil painting of *P. pinnata* (f. 283) **(**g) Brazilian fruits in the *Miscellanea Cleyeri* (f. 51r) **(**h) Watercolor of banana fruits on a banana leaf in the *Libri Principis* (f. 69 [81]), Jagiellonian library, Krakow.

1.2 Scope and objectives

The primary purpose of this thesis was to study the botanical knowledge documented in the HNB and portrayed in the Brazilian collection of the *Libri Picturati*. To do so, we mainly focused on the plants named and used by the different ethnic groups. For example, several names and uses were retrieved from the Indigenous population and documented for several species, as well as morphologic, organoleptic, and phenological data (e.g., in Fig 1.3). We paid particular attention to the presence of plants shipped from the African coast. These constitute evidence of plant introduction during the trans-Atlantic slave trade and the exchange of botanical knowledge by the enslaved African population, which the HNB sometimes documented. These reports constitute first-hand evidence of observations and experimentations with tropical pharmacopeias and food plants, which highly influenced the development of Western science(s) in the following centuries. Taking as a reference the HNB, we aimed to analyze the (dis)- similarities in plant use with present-day Brazil and check to what extent the flora depicted in the HNB, the *Libri Picturati,* and other related sources were representative of the northeastern ecosystems that shaped the Brazilian coast. Moreover, we studied the visual sources embedded in these natural history treatises and

collections to analyze the methods of knowledge production in the early modern period in Europe, as well as the strategies of plant collection and representation by naturalists and artists in the colony.



b **Vernacular names.** *Acaiaiba* and *Acaiuiba, Acaiû* or *Cajú* (fruit); *Acaguacaya*, *Acajuti*, and *Itimaboera* (chestnut); *Acajucaipiracoba* (tree without flowers after the rainfall).

II. Morphological and organoleptic characteristics. "The chestnut has the shape of a sheep's kidney, covered by a gray husk, thick, spongy inside with acrid, pungent oil that applied lightly to the skin burns like a fire; if someone crushes it with their teeth, tongue and lips will be burned, causing intense pain".

III. Uses and recipes. "Indigenous peoples value the chestnut for food more than the fruit, from which they extract wine. They pound the fruits in a mortar and strain the broth; sometimes they also squeeze it with their hands and let it settle; the broth turns white like milk, becoming paler after a few days; it has a strong and intoxicating astringent taste" […] "They count the years of age with the nuts, keeping one each year" […] "Various things are made from wood, as it is hard; used in the manufacture of larger canoes, called *chalupas*".

IV. Phenology. "The tree begins to flower at the end of August and reaches its peak in September; then it spreads the most delicious aroma through the woods and fields. When it rains abundantly in August and September, the flowers perish and a few fruits are born, as happened in 1640"

Fig 1.3 **(Ethno-) botanical knowledge of the cashew tree (*Anacardium occidentale* L.) as documented in the HNB** (a) Description of *A. occidentale*, and woodcuts of the same

species representing its branch, seed, and fruit (Marcgrave, 1648: 94-95). Original Latin edition, Leiden University Library (b) Translation of the framed sections after the Portuguese edition (Magalhães, 1942) by the author.

1. 3 Research questions and hypothesis

This dissertation is framed around one central question:

- What does the botanical knowledge in the HNB and the *Libri Picturati* reveal about plant use and names by the different ethnic groups in Dutch Brazil?

By looking at the plant composition, plant uses, and botanical terminology embedded in these collections, we posed several sub-questions that aimed to respond to the objectives of this research 1) What are the useful plants documented in the HNB, and are these still used in Brazil today? 2) What are the similarities between the specimens in Marcgrave's herbarium and the useful species in the HNB? 3) What are the species of African origin? 4) What is the species distribution range in the HNB and the *Libri Picturati* after c. 370 years? 5) How many species in the HNB are present in contemporary Brazilian markets, and have they preserved their local names? 6) What are the plant species depicted in the Brazilian collection of the *Libri Picturati*? 7) What are the origins, habits, domestication and conservation status, and plant parts depicted of the *Libri Picturati* flora? 8) What were the sources used to create the plant woodcuts in the HNB and the IURNM? 9) What is the connection between the textual and visual sources from Dutch Brazil? 10) How do the vernacular names of the HNB species relate to those found in the associated visual sources? 11) What does the botany in these collections reveal about the methods of plant collection in the colony?

The HNB represents a repertoire of Indigenous plant knowledge that likely underwent substantial changes over time. The Indigenous population that survived slavery, European

diseases, and genocide has often migrated to other areas and merged with other groups in complex processes of transformation, resistance, and ethnogenesis (Langfur, 2014; Monteiro, 1999; Rodrigues, 1994). Hence, we expected low retention of plant knowledge due to the erosion of ecological knowledge caused by industrialization, globalization processes, and habitat loss (Aguiar, 2018; Brandão et al., 2013; Federici, 2004; Gazzaneo et al., 2005; Sawyer, 2008). On the other hand, we expected to find species of African origin due to the trans-Atlantic slave trade that started in Pernambuco in c. 1560 by the Portuguese (Eltis & Richardson, 2010). As these sources originated in a relatively small territory compared to the vast extension of Brazil, we reckoned that most of the species and their vernacular names were to be found today in the northeast of the country. Therefore, the most remarkable similarities in species and names would occur in northeastern markets (as in Recife). Furthermore, scholarly research has pointed out that the naturalists working in Johan Maurits' court likely gathered from their immediate surroundings the plants that later ended up in the natural history books, herbarium, drawings, and illustrations (Brienen, 2006; Scharf, 2019). Indeed, many species were cultivated in the gardens of Johan Maurits in Recife (Silva & Alcides, 2002). Still, others might come from various places, as Marcgrave, Piso, and their crew conducted expeditions to the interior and regions farther away than Recife (Van den Boogaart & Brienen, 2002). Overall, as these botanical representations originated in the same context, we assumed that the plant taxa among visual and textual sources would be similar. Likewise, the woodcuts in the HNB and IURNM would be traced to the images in the *Libri Picturati*, especially to the oil-based paintings of the *Theatrum*, which bear similarities to several woodcuts (Brienen, 2006; Whitehead & Boeseman, 1989).

1.4 Methodology

The methodology used throughout this research follows a mixed-methods approach by combining (mainly) quantitative and qualitative analyses within ethnobotany. Ethnobotany studies the classification, use, and management of plants by human populations in different cultures and at various times (Martin, 2010). Ethnobotany draws on several disciplines, including botany, anthropology, history, linguistics, and ecology. For this research, we combined those with a strong focus on plant taxonomy by using the scientific identifications of the plant species embedded in these collections. Once we identified the species, we could retrieve the botanical knowledge associated with these taxa, such as contemporary plant use, nomenclature, habitat, distribution range, etc. To trace the sources used for the woodcuts, we studied all the visual sources created in Dutch Brazil, as well as several botanical images that resembled the woodcuts and were published in herbals and natural history accounts before the creation of the HNB. Finding the connections and/or overlap between the botanical content of the Dutch Brazilian sources has been arduous, as Fig 1.2 proves. Some were perceptible at first sight, as was the case for *Paullinia pinnata* (*Cururu ape*) in the HNB (Fig 1.4a), the *Theatrum* (Fig 1.4b), and De Laet's manuscript (Fig 1.4c). At the same time, other images do not bear strong similarities but correspond to the same taxon (Fig 1.4e). Could you identify more overlaps among the botanical taxa in Fig 1.2? Overall, the identifications of the depicted flora allowed us to cross-reference over 600 images and systematize the correlations among the taxa represented by the multiple sources.

Fig 1.4. **Example of overlap in plant species between the HNB and other sources from Dutch Brazil** (based on Fig 1.2) (a) Woodcut of *Paullinia pinnata* (*Cururu ape*) in the HNB (b) Oil painting of the same species in the *Theatrum* (c) Dehiscent fruit of *P. pinnata* and seed in nature (NMNH, CC0 1.0) (d) Proof woodcut of the same species in De Laet's manuscript (e) Fertile voucher of *P. pinnata* in Marcgrave's herbarium (f) photo of this species' branch with dry inflorescence and fruit (NMNH, CC0 1.0).

Several institutions have facilitated access to the biocultural material under study. Several copies of the HNB and the IURNM are scattered worldwide (Alsemgeest & Bos, *in press*; Whitehead & Boeseman, 1989), but fortunately, some are available online. The digitalization of these rare books has made this research possible, together with the access to the Portuguese edition of the HNB and the IURNM – translated by Magalhães (Marcgrave,

1942), Correia (Piso, 1948), and Leal et al. (Piso, 1957). A visit to the botanical garden of Copenhagen (Denmark) to study Marcgrave's herbarium, facilitated by curator Ib Friis in 2014, and the recent digitalization of this collection, allowed us to study the seventeenth century specimens in detail. The Brazilian collection in the *Libri Picturati* is partly digitized. Its curator, Izabela Korczyńska, generously provided us with the scanned images of the *Theatrum*, which allowed us to proceed with the botanical analysis of its iconography. Likewise, the © British Library Board (London, UK) granted us permission to use the scans of De Laet's manuscript's and reproduce the images we used for our research.

1. 5 Relevance

Our study of the natural history collections from Dutch Brazil resulted in 1) an in-depth ethnobotanical analysis of the HNB, 2) a comprehensive scientific study of the flora depicted in the *Libri Picturati*, and 3) a systematic inquiry into the interconnections between textual and visual sources.

Natural history collections are valuable sources for biocultural research (Bartomeus et al., 2019; Lister & CCRG, 2011; Roullier et al., 2013; Shaffer et al., 1998; Stork et al., 2019). By studying them, we can generate data within a broad array of subjects (botany, ecology, art), together with specialists from different disciplines, such as biologists, (art) historians, and museum curators. Several scholars pointed out the relevance of studying the material that originated in Dutch Brazil as a whole to understand better the relationships involved (Boeseman, 1994; Brienen, 2006, 2007; Ferrão & Soares, 1993; Scharf, 2019; Schneider, 1938; Teixeira, 1995; Whitehead & Boeseman, 1989). By adding new insights into this topic that has been debated for a long time, particularly by art historians, we can better understand the complexities in the systems of visual knowledge-making in a colonial setting in the early modern period.

It is pertinent, however, to look into natural history collections critically. The material under study was produced in a colonial context characterized by very complex interactions between its inhabitants since the Portuguese colonization in the sixteenth century (Monteiro, 1999). In Dutch Brazil, these interactions included alliances between Indigenous groups, the Portuguese and Dutch invaders (Cerno & Obermeier, 2013; Meuwese, 2012), and also the Indigenous population's resistance. Other human contacts involved the capture and enslavement of African peoples, and also their escape and settlement in the hinterlands (today known as Quilombos), and their alliances with diverse Indigenous groups (Fausto, 2014; Schwartz, 2003). The multiple connections occurring amidst or being endured by the diverse ethnic groups in Dutch Brazil undoubtedly shaped the plant practices and terminology captured in the HNB and the *Libri Picturati*.

After more than 370 years, studying these natural history collections from an ethnobotanical perspective reveals an essential part of Brazilian (botanical) heritage and questions how it is represented and accessed. Ultimately, with the study of the HNB and the *Libri Picturati*, we can acknowledge the multiple cultural identities and historical contexts they embody and the urgent need to preserve the Brazilian nature they portray.

1.6 Dissertation outline

This dissertation is structured into five main chapters (2 to 6), which respond to the research questions and objectives of this Ph.D. thesis. These chapters include an extensive and detailed historical background related to the topic studied in each chapter, as well as an in-depth analysis of the material used for each project. The chapters have been published in peer-reviewed journals or are under review for publication. They follow a chronological order according to the publication dates but are not exact copies of the published material. Any modifications in these papers do not alter our results but make the narrative more concise and

correct minor errors we had missed. Each chapter can be read independently from the others. They respond to the research questions and hypotheses formulated throughout this research. Chapter 7 discusses the key findings of our study and analyzes in more detail several points generated by those findings. Lastly, we described the challenges we encountered, recommendations to overcome them, suggested future research and wrapped everything up with our conclusion. An abstract of each paper focused on the most relevant outcomes is provided below.

Chapter 2: Plant knowledge in the *Historia Naturalis Brasiliae* (1648): Retentions of seventeenth century plant use in Brazil

We analyzed botanical knowledge retentions in Brazil by comparing the plant uses in the HNB and the practices associated with the same species as reported in modern literature in Brazil. Contrary to the commonly assumed loss of traditional knowledge over time, we found botanical knowledge retention in contemporary Brazil. Indigenous plant medicine used to heal ailments in the seventeenth century influenced the Brazilian pharmacopeia, leaving a noticeable footprint today. However, the practices employed with these plants or the diseases they treated are now more varied and differ in some cases. For example, Brazilians no longer eat some food plants; instead, they use them differently (e.g., ornamental use in urban landscaping). Early modern scientists documented many species used as anti-poison (i.e., to counteract snake venom). These are not reported as such today, despite the recurrent cases of snake poisoning in Brazil (Feitosa et al., 2015). Changes in diet and advances in modern medicine played a role in medicinal and food plant use over time.

Moreover, the current contrast in plant use diversity and the more significant number of plants ascribed per use compared to the past is largely due to the increase in ethnobotanical surveys during the twentieth century (Corrêa, 1926-1978) and especially in the last decades

(Albuquerque et al., 2007; Bieski et al., 2012; Cartaxo et al., 2010; Coelho-Ferreira, 2009; Lorenzi & Matos, 2008). The limitations during the knowledge gathering in the colony and the Eurocentric bias during the knowledge-making certainly influenced our results. Our outcomes would also vary if the species in the HNB were unique to the territories surveyed by Marcgrave and Piso. We retrieved the current distribution range of the HNB species by consulting specialized Brazilian and global plant databases to check whether those plants were now restricted to the northeastern region or had a more extensive distribution range. Most of the useful plants in the HNB are now widely distributed in several biomes and regions of Brazil, apart from a few endemic species unique to the lands surveyed by Marcgrave and Piso in the 1640s.

Chapter 3: Marcgrave and Piso's plants for sale: The presence of plant species and names from the *Historia Naturalis Brasiliae* (1648) in contemporary Brazilian markets.

We studied whether the plants from the HNB and their vernacular names were still in use in contemporary local markets in Brazil. The focus fell on local markets as these constitute great repositories of plant knowledge, reflecting the actual plant use in urban and rural surroundings (Leitão et al., 2009; Parente & da Rosa, 2001; Pochettino et al., 2012; Van Andel et al., 2012). For this diachronic research, we compared the useful species' composition in the HNB with 24 botanical inventories of Brazilian markets, including our research on the Ver-o-Peso market in Belém (Pombo Geertsma, 2019). Although the HNB included flora that was documented in the northeast, the greater overlap in floristic composition and plant names corresponded to the markets in the north. Most of the current plant names that overlap with the historical sources in the HNB are of Tupi-based origin, proving the retention of Indigenous knowledge over time. Most popular species sold at the markets were introduced from Mediterranean regions (e.g., *Rosmarinus officinalis*), and

plants of Asian and African origin were also sold at the stalls. Our results were related to complex migratory movements, in which botanical knowledge moved along with people; environmental changes that occurred since colonialism; globalized and homogenous plant trade based on monocultures; and non-standard market survey methods, which responded to different aims.

Chapter 4: Dancing to the beat: *Ahoay* (*Cascabela thevetia*), stories embedded in a rattle.
This chapter focused on a particular species documented in the HNB: *Cascabela thevetia* (L.) Lippold, locally named *Ahoay*). We described this plant from a biological, etymological, and cultural point of view. We paid attention to how *C. thevetia* was portrayed in literature since its iconography from Brazil appeared in the sixteenth century in Europe. In the seventeenth century, *C. thevetia* was depicted in the HNB and IURNM, which accounts attested how the Indigenous population did not easily surrender their knowledge about *Ahoay* to the inquisitive foreigners. To conclude, we showed an example of how a present-day museum portrays a collection made from *C. thevetia* and how the plant relates to the Wayana peoples in Suriname. By tracing the historical records of plants, studying their contemporary uses, and considering the socio-political context in which these records were created, it is possible to disrupt the colonial narrative discourses that have circulated for centuries.

Chapter 5: Looking into the flora of Dutch Brazil: Botanical identifications of seventeenth century plant illustrations in the *Libri Picturati*.
First, we identified the species depicted in the botanical illustrations, drawings, and sketches included in the Brazilian collection of the *Libri Picturati*. Then, we approached these objects (botanical images) as subjects (living plants) placed in a socio-environmental context. By studying the three bound collections, we noticed how the plants differed with regard to their

origin, habit, domestication status, and composition (depicted by their entire branches or by only their fruits, flowers, etc.). Based on this analysis, we discussed the potential methods of botanical collection by naturalists, artists, and local assistants who collaborated on the three visual collections. We found the first iconographical records of several exotic species in Brazil, such as the sunflower (*Helianthus annuus* L.) and the Ethiopian pepper (*Xylopia aethiopica* (Dunal) A.Rich.), from which we traced their potential dispersion routes by different ethnic groups. By studying the conservation status of the flora depicted, we added new insights into species distribution and dispersion. These botanical illustrations revealed baseline conditions where the environment became altered by large-scale plantations and other high-profit activities conducted by the European colonial powers. Apart from studying the illustrated folios of the *Theatrum*, we identified the species that were meant to occupy the blank folios mixed between the illustrated folios. Hence, we provided an overview of the complete flora repertoire that the second owner of these images, Frederik Wilhelm, would have obtained if he had received the rest of the illustrations from Johan Maurits– as he had expected (Mentzel, 1664). The connections between the published and unpublished images allow for a more in-depth study of this material by scholars interested in the floristic landscape of Dutch Brazil. We further compared the plant species depicted in this collection with the textual sources in the HNB and IURNM. The level of interconnectedness was diverse, depending on the material under study. To what extent these visual plant representations were related is discussed in the next chapter.

Chapter 6: Nature portrayed in images in Dutch Brazil: Tracing the sources of the plant woodcuts in the *Historia Naturalis Brasiliae* (1648).

Here, we compared the plant woodcuts in the books (1648, 1658) with the *Libri Picturati* illustrations. We created a database of more than 1700 images to display these correlations.

This database includes all the images from Dutch Brazil whose plant species overlapped with the species represented with the woodcuts, as well as images in older herbals and botanical treatises that resemble the woodcuts. Additionally, we added modern pictures of the taxa portrayed in the woodcuts, including botanical illustrations and herbarium specimens. In this way, we show how the seventeenth century depicted plants look in real life and how they were represented in collections other than those from Dutch Brazil. This visual database is valuable for academics and everyone attracted to the world of tropical flora and botanical art. Most of the sources used for the woodcuts did not resemble the oil paintings in the *Theatrum*, as was previously thought by Brienen (2006) and Whitehead & Boeseman (1989). The original models were likely a series of drawings made in Brazil that are now lost or misplaced. These would have belonged to Margrave, who prematurely died before returning to the Dutch Republic. The naturalist was assisted by his field workforce, consisting of Indigenous Brazilians, who were familiar with the environment to be surveyed, and enslaved Africans, who accompanied the members of Johan Maurits' crew to conduct various tasks. Soldiers also joined this crew to control the subversive population according to the orders of the WIC and Johan Maurits (Van den Boogaart & Brienen, 2002). Differences in the visual knowledge-making of the HNB and the IURNM existed, in which combining various plant materials and pictorial sources were crucial. Yet, some sources' provenance pointed to regions other than Brazil at different points in time and made by different authors.

Chapter 2

Plant knowledge in the *Historia Naturalis Brasiliae* (1648): Retentions of seventeenth century plant use in Brazil

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Abstract

The *Historia Naturalis Brasiliae* (HNB, 1648) is a systematic treatise on Brazilian flora and fauna created in the seventeenth century. Scientists Marcgrave and Piso depicted hundreds of plants and described uses, vernacular names, and diseases in Dutch Brazil. We aimed to verify whether these plants are still used similarly, using herbarium vouchers and taxonomic literature to identify the species described in the HNB and reviewing historical and modern ethnobotanical literature to analyze whether the HNB documented specific plants and uses for the northeast region. We highlighted species of African origin, as they indicate plant introduction before and during the trans-Atlantic slave trade and exchange of African ethnobotanical knowledge. Of the 378 species found in the HNB, 256 (68%) were useful, mostly used for healing and food in a similar way (80%) both in the seventeenth century and in modern Brazil. Only one species (*Swartzia pickelii* Killip) is endemic to northeast Brazil, while the others are more widely distributed. The HNB includes one of the first reports on African crops in Brazil, such as sesame, okra, and spider plant. This study brings insights into

Indigenous and African plant knowledge retentions since the creation of the HNB and acknowledges its non-European contributors.

2.1 Introduction

The Dutch West India Company (WIC) occupied northeastern Brazil from 1630 to 1654 in search of economic profits from the exploitation of Brazil wood (*Paubrasilia echinata* (Lam.) Gagnon, H.C.Lima & G.P.Lewis) and sugarcane (*Saccharum officinarum* L.) (Mors et al., 2000). The captaincy, the modern-day state of Pernambuco, constituted the central point of the Dutch colony in the seventeenth century and was then the greatest sugar producer worldwide (Santos et al., 2010). Dutch Brazil was governed from 1637 to 1644 by Count Johan Maurits of Nassau-Siegen, who assembled a group of scholars and painters to depict the local geography, biodiversity, Indigenous population, tropical diseases, and traditional medicine. This group included German naturalist and astronomer Georg Marcggrafe, Dutch physician Willem Pies (also known as Marcgrave and Piso), and Dutch painters Frans Post and Albert Eckhout (Souza, 2006), among others whose names are still unknown. Marcgrave explored northeastern Brazil (particularly Pernambuco, Paraíba, and Rio Grande do Norte), where he studied the flora, fauna, geography, meteorology, and astronomy of the territory. At the same time, Piso focused more on medicinal plants and local diseases. Dutch artist Frans Post painted Brazilian landscapes, while Albert Eckhout worked on portraits of people in Dutch Brazil and paintings of the fauna and flora of the region. Marcgrave confided to Nassau some dried plant specimens and several manuscripts about Brazilian natural history before leaving for Luanda (Angola) between 1643 and 1644 (Whitehead, 1979). Johannes de Laet, (geographer and WIC board member) received Margrave's plant specimens and manuscripts and transcribed, edited, and published them in 1648, together with Piso’s writings, in one of the most influential treatises on Brazilian botany, zoology, and medicine:

Historia Naturalis Brasiliae (HNB). Marcgrave and Piso's legacy also comprises a second version of the book published by Piso alone, two Portuguese translations, and Marcgrave's bound herbarium, among other artistic and botanical materials (Whitehead & Boeseman, 1989). The HNB has two sections: the first part, *De Medicina Brasiliensi*, written by Piso and subdivided into four chapters, provides an account of local diseases and Brazilian medicine (Piso, 1648). Medicinal plants used by the inhabitants of seventeenth century Brazil, generally from Pernambuco, are depicted in the last chapter. The second part, *Historia Rerum Naturalium*, is devoted to Marcgrave's natural history studies (Marcgrave, 1648). This part is divided into eight chapters: the first three on plants, the next four chapters on fauna, and the last one on ethnology. In addition, four plant drawings are displayed at the end of the book. The plant chapters present descriptions and numerous woodcut images, separated into three subchapters: herbs, plants with fruits, and shrubs and trees. Johannes de Laet discovered that woodcuts were missing for some plants, so he produced new ones based on the dried specimens collected by Marcgrave or from dried specimens sent to him by his colleagues in Brazil (Gudger, 1912). He published the book with many comments, especially about plants (Françoso, 2010), and also added several annotations from the works of the Spanish monk and apothecary Francisco Ximenez (Hernández, 1615) and the Spanish physician Nicolas Monardes (1574). Ximenez published a treatise about the nature and herbal medicine of Mexico, based on the expeditions by the physician Francisco Hernández in 1570 and his own experience (Piñero & Tomás, 1996), while Monardes studied medicinal plants brought to him from the Spanish colonies in the Americas and cultivated in Seville. De Laet compared the plants described by Marcgrave with the ones described by Ximenez and Monardes and by early modern naturalists, such as Carolus Clusius, Rembert Dodoens, and Garcia da Orta; religious chroniclers, such as Jean de Léry and André Thevet; and explorers, such as Gabriel Soares de Souza (Pickel, 2008). The HNB was the earliest and most extensive intellectual

product of Natural History that came from the Dutch colonies in the Americas, and despite covering a region in the northeast of Brazil, this was interpreted by Europeans as an encyclopedia that represented the flora, fauna, and population of the whole country (Françoso, 2010). Marcgrave's chapters in the HNB were translated for the first time from Latin into Portuguese and edited by José Procópio de Magalhães in 1942 (Marcgrave, 1942). Piso's chapters were translated into Portuguese and edited by Alexandre Correia in 1948 (Piso, 1948). Correia extended Piso's section with a biography of him and Marcgrave and several reviews of their work by Brazilian historian Affonso de E. Taunay. In the original and translated editions of the HNB, specimens of plants and animals are organized in an index by vernacular names. In the Portuguese edition of 1948, Correia included the comments of the Brazilian botanist Alberto J. de Sampaio, who added a scientific classification of the plants reported by Marcgrave with local names (*História Natural do Brasil*, pp. XLVIII–LI). He based this classification mainly on the work of the German botanist Carl Friedrich Philipp von Martius, who studied Marcgrave's herbarium and published, between 1840 and 1906, the *Flora Brasiliensis* (see in Flora brasiliensis, CRIA, accessed 23.10.22). The second version of the HNB, entitled *De Indiae Utriusque Re Naturali et Medica* (IURNM), was published by Piso in 1658. He incorporated Marcgrave's figures and descriptions in his own text but made some botanical mistakes (Andrade-Lima et al., 1977). The 1658 book, organized in three parts and 14 chapters, covers both the Southeast Asian and Northeast Brazilian colonies explored in the seventeenth century by the Dutch. The first part corresponds to Piso's observations and is a review and enlargement of the first version. The second part includes two chapters, which include Marcgrave's annotations on topography and meteorology with his comments about Brazilian customs and languages. The further chapters are taken from the work published in 1642 by Jacob Bontius, a Dutch physician who worked for 4 years in the Dutch colony of Batavia, modern-day Jakarta (Bontius, 1642). Marcgrave's botanical

collections and notes were sent to the Netherlands in 1646, presumably by the Count of Nassau to De Laet, who published the HNB in 1648 but kept the herbarium containing Marcgrave's specimens (Andrade-Lima et al., 1977).The herbarium was of interest to Ole Worm, a Danish antiquarian and physician at the court of king Frederik III of Denmark, and acquaintance of De Laet. Both scholars shared correspondence about plant material and knowledge that circulated in the Netherlands during the Dutch enterprise in Brazil. Through the son of Worm, living in the Netherlands, the herbarium was bound and sent to Denmark in 1653, and eventually acquired by Frederik III after Worm's death in 1654, probably because of their shared interest in natural history collections (Romero-Reverón & Arráez-Aybar, 2015). Finally, Marcgrave's herbarium was transferred to the Botanical Museum of the University of Copenhagen at the end of the eighteenth century. In the late 1970s, botanists identified 137 species out of the 146 taxa preserved in the book herbarium, 90 of which are also described in the HNB (Andrade-Lima et al., 1977). This extensive record of Brazilian flora and medicinal plants greatly impacted the European scientific community, being used as a reference for many scholars, from taxonomists to naturalists or chroniclers working in the tropics (Safier, 2014). The Swedish naturalist Carl Linnaeus based part of his taxonomy on the species described in the HNB because he considered the scientific descriptions and illustrations high quality (Whitehead & Boeseman, 1989). Linnaeus included many species of Piso and especially Marcgrave in the 10th edition of his *Systema Naturae* (Linnaeus, 1758), all validated for scientific purposes with binomial Latin names (Boeseman, 1994). Marcgrave and Piso's work was even considered to be one of the most important contributions to the science of Natural History since Aristotle and Pliny the Elder by Gudger (1912). Moreover, the HNB provided a rich source of plant knowledge of native Brazilians, especially of Indigenous peoples from the Tupi macro linguistic family, which promoted the introduction of useful plants to Europe. Examples are ipecacuanha root (*Carapichea ipecacuahna* (Brot.)

L.Andersson) and copaiba oil (*Copaifera officinalis* L.), which are still used for medicinal purposes in Brazil and Europe (Lorenzi & Matos, 2008). Several botanists have attempted to identify the specimens depicted in the HNB and the IURNM, such as Alberto José de Sampaio (Piso, 1948), and especially Bento José Pickel (2008), but these identifications are often incomplete or outdated according to the new nomenclature system. Medeiros and Albuquerque (2014) compared the seventeenth century food plants in the HNB with present-day uses. However, no detailed overview exists of all the documented useful plants in the HNB. In this paper, we present new identifications of all useful plant species described in the original Latin HNB and IURNM, as well as the specimens in Marcgrave's herbarium. We compared the seventeenth century plant uses with modern Brazilian uses from recent ethnobotanical literature. We further compare the historical uses (compiled in northeastern Brazil) to plant uses in the rest of the country to analyze whether the HNB included plants and uses specific for the northeast region or represented a more general Brazilian plant use in the 1640s. Since colonization, the natural environment in Brazil has changed due to sugarcane monocultures, deforestation, industrialization, and urbanization (Freyre, 1989; Rogers, 2010). Indigenous peoples who survived slavery, European diseases, and genocide, have often migrated to other areas and merged with other groups in complex processes of transformation, resistance, and ethnogenesis (Langfur, 2014; Monteiro, 1999; Rodrigues, 1994). Therefore, we expect that many plant uses may have changed. Likewise, we anticipate substantial changes in plant use over time because perceptions about health and diseases, plant-based diet, and recipes in the seventeenth century were likely much different from today. We also expect to find species of African origin in the HNB, as a result of the trans-Atlantic slave trade that started in Pernambuco from circa 1560 by the Portuguese (Eltis & Richardson, 2010). To test these hypotheses, we addressed the following questions: Which useful plants are listed in the *Historia Naturalis Brasiliae* and in *De India Utriusque Re*

Naturali et Medica? Are these plants used in a similar way in recent ethnobotanical literature? Which species described in the HNB are of African origin? Through this study, we bring insights on the retentions of Indigenous and African plant knowledge since colonial Dutch Brazil.

2.2 Materials and Methods

2.2.1 Source material

We used several types of source material to identify the useful plant species described by Marcgrave and Piso (Table 2.1).

Table 2.1. Source material consulted to identify plants and their uses reported in Dutch Brazil by Marcgrave and Piso.

Title	*Authors and date*	*Source Material*	*Location*
Historia Naturalis Brasiliae [HNB]	George Marcgrave & Willem Piso, 1648	Original Latin book. Digital copy	Naturalis Library, Leiden https://archive.org/details/marcgrave
De Indiae Utriusque re Naturali et Medica [P.2]	Willem Piso, 1658	Digital copy of Latin book	Library Nederlands Tijdschrift voor Geneeskunde, Amsterdam https://archive.org/details/mobot31753002909064
Historia Rerum Naturalium	José Procópio de Magalhães, 1942	Portuguese translation of Marcgrave's chapters (1648)	Naturalis Library, Leiden
De Medicina Brasiliensi	Alexandre Correia, 1948	Portuguese translation of Piso's chapters 1648	Naturalis Library, Leiden

Title	*Authors and date*	*Source Material*	*Location*
Marcgrave's Herbarium	Georg Marcgrave, collected 1638 to 1643	Original bound herbarium and digital images	Botanical Garden of the University of Copenhagen, Denmark
Flora do Nordeste do Brasil segundo Piso e Marcgrave no século XVII	D. Bento José Pickel, 1937-1949	Commemorative edition by Vasconcellos de Almeida (Pickel, 2008)	http://www.ufrpe.br/download.php?endArquivo=noticias/4543_florafinal.pdf
Marcgrave's Brazilian Herbarium, collected 1638-44	Andrade-Lima et al. 1977	Article published in Botanisk Tidsskrift	Botanical library Naturalis, Leiden

We consulted the original Latin edition of the HNB (Marcgrave & Piso, 1648) to check the watercolor woodcuts and the original Latin edition of IURNM (Piso, 1658a) to check for illustrations that do not appear in the 1648 edition but correspond to plant species described in this first book. We also consulted the Portuguese editions of HNB (Marcgrave, 1942; Piso, 1948) to study the plant descriptions. We identified all useful plant specimens by verifying Pickel's 1949 identifications (edited by Almeida in 2008) with Brazilian and other South American collections at the herbarium of Naturalis Biodiversity Center (L) in Leiden, the Netherlands, botanical literature (Lorenzi, 1998; Lorenzi & Matos, 2008), and the online checklist Flora do Brasil 2020 (http://floradobrasil.jbrj.gov.br/) for species distributions and vegetation types. We asked several botanists at the Naturalis herbarium to verify our identifications. We checked the latest taxonomic status of each species by using The Plant List (http://www.theplantlist.org/). We identified all specimens in Marcgrave's bound herbarium collections using the South American collections in the herbarium of Copenhagen (C) and the floristic literature. We made digital images of all Marcgrave's original collections and deposited them with the curator, Prof. Dr. Ib Friis. In addition, we studied the plants

depicted in the paintings of Albert Eckhout and Frans Post in the National Museum of Denmark in Copenhagen and at the Rijksmuseum in Amsterdam.

2.2.2 Data analysis

We organized our data with information on the author and date of the consulted source, page number, taxonomical identification of the plant (genus, species, and family), vernacular names (in original spelling), geographic distribution, cultivation state, vegetation type, biomes, and seventeenth century uses (Electronic Supplementary Material – ESM 1). Subsequently, we searched for modern plant uses for these species in the extensive work of Pio Corrêa (1926–1978), Mors et al. (2000), Schoof (2012), and Lorenzi (1998), Lorenzi and Matos (2008) and additional queries in Google Scholar on specific plant use in Brazil. We did not limit this study to northeast Brazil, where Marcgrave and Piso worked, because the landscape, flora, and inhabitants have changed drastically since the seventeenth century. Many species have disappeared from Pernambuco due to deforestation and land conversion to agriculture, but these plants live in other parts of their distribution range. More importantly, most species in the HNB are commonly found in regions outside the northeast, such as weeds throughout Brazil, or are widely cultivated by people of different ethnic origins.

We searched for the distribution data of the useful species described in the HNB and their vegetation type in the online Flora do Brasil 2020 (http://floradobrasil.jbrj.gov.br/) unless there were obvious errors or misinterpretations in these data. In this case, we used the Bioportal Naturalis (https://bioportal.naturalis.nl/), Catalogue of Life: 2008 Annual Checklist (https://www.catalogueoflife.org/annual-checklist/2008/search.php), Tropicos (https://www.tropicos.org/), Species Link (https://specieslink.net/), and CNC Flora (http://cncflora.jbrj.gov.br/portal) to look for distribution patterns of herbarium specimens.

We categorized traditional and modern uses in food (including spices and drinks), medicine (including cosmetics), construction, technology (including fibers, ink, paper, illumination, fish poisoning, tanning, and insecticides), and others (e.g., ornamental, fuel, living fences, shadow plants, erosion control, fodder, and rituals) (Prance et al., 1987). Based on the plant uses in the HNB, we divided medicinal uses into 11 frequently occurring categories. These corresponded to plants that act as antidotes, febrifuges, diuretics, emmenagogues (i.e., to stimulate the menstrual flow), antiparasitic, purgatives and emetics; and plants used to heal: sexually transmitted diseases (STDs), diarrhea, wounds, skin affections and dropsy (i.e., edema or accumulation of liquid in the body). After extracting the matching uses from the literature, we added the historical and modern plant use data into an MS Word file (ESM 2).

2.3 Results

2.3.1 Comparing HNB uses to modern plant uses in Brazil

We encountered 391 plant entries in Marcgrave and Piso's books (1648, 1658) and Margrave's herbarium. We identified 378 different species, as some species were described several times. Plant entries often included local names and descriptions of plant use but not always illustrations. A total of 267 plant entries corresponded to plants used by the native population, enslaved Africans, or European colonizers in seventeenth century Brazil, while 124 included plants with no use, according to the HNB. The 267 entries of useful species sometimes had plants cited twice or more times. They referred to a total of 256 unique, useful species validated by the Plant List and the Flora do Brasil 2020 (ESM 1), representing 68% of the total number of species in Marcgrave and Piso's books (1648, 1658). The most species-rich families were Fabaceae (43 species), followed by Arecaceae, Solanaceae, and Myrtaceae (each 11 spp.), and Malvaceae, Asteraceae, Annonaceae, and Cucurbitaceae (each

eight spp.). When comparing the historic uses with modern plant uses, we found that 204 species (80% of the total useful species) had similar uses in the recent literature to those reported by Marcgrave and Piso in the seventeenth century (ESM 2). We could not find any uses in modern-day Brazil for 15 of the 256 useful plant species in the HNB: *Aniseia cernua* Moric., *Campomanesia dichotoma* (O.Berg) Mattos, *Clidemia biserrata* DC., *C. octona* (Bonpl.) L.O. Williams, *Dioclea marginata* Benth., *Gnaphalium* cf. *polycaulon* Pers., *Lundia virginalis* DC., *Matelea ganglinosa* (Vell.) Rapini, *Ouratea caudata* Engl., *Piper phytolaccifolium* Opiz, *Rhizophora racemosa* G.Mey., *Scleria gaertneri* Raddi, *Tanaecium cyrtanthum* (Mart. ex DC.) Bureau & K.Schum., *T. pyramidatum* (Rich.) L.G.Lohmann, and *Vitex rufescens* A.Juss. The number of useful plant reports per use category in modern Brazil is higher than in the seventeenth century. We observed more species in medicine, construction, technology, and others. On the contrary, we detected a slight decline in the food category, where 12 species listed as edible in the HNB are no longer used for nutritional purposes (Fig 2.1).

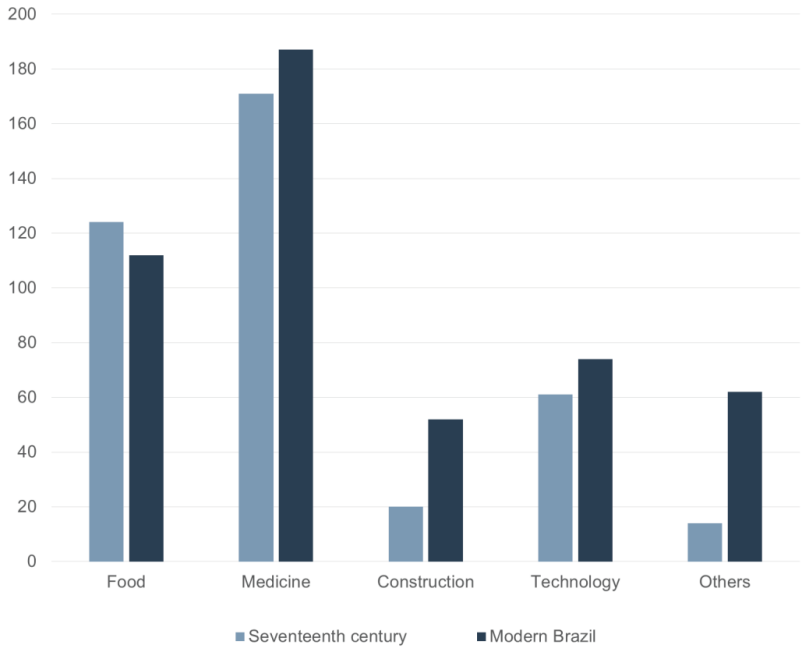

Fig 2.1 **Number of species listed by Marcgrave and Piso (1648, 1658) per use category and current uses for these species in Brazil.**

Of the 256 useful species, most plants were used as medicine in the seventeenth century (171 species, 67%) and in modern Brazil (187 spp., 73%). However, 22 medicinal species documented in 1648 seem to have lost their therapeutic use. For example, we did not find any medicinal use for *Albizia saman* (Jacq.) Merr. modern literature, although Piso described it as an 'astringent and diuretic plant, which root is used to treat kidney and bladder affections, gonorrhea, syphilis, and dropsy…to treat eye inflammation' (Piso, 1648: 80). On the other hand, the HNB did not document the medicinal use of 44 species which are now used therapeutically. For instance, Marcgrave mentioned that the fruit of *Chrysobalanus icaco* L. was edible (Marcgrave, 1648: 77) without reporting any other use, while this plant was used

in the 1980s as an astringent agent to combat diarrhea, gonorrhea, and leucorrhea (Corrêa, 1931). Notably, 84 medicinal species documented by Marcgrave and Piso had at least one specific therapeutic application in common with the twentieth or twenty-first century; however, how plants are used has changed substantially over time (Fig 2.2).

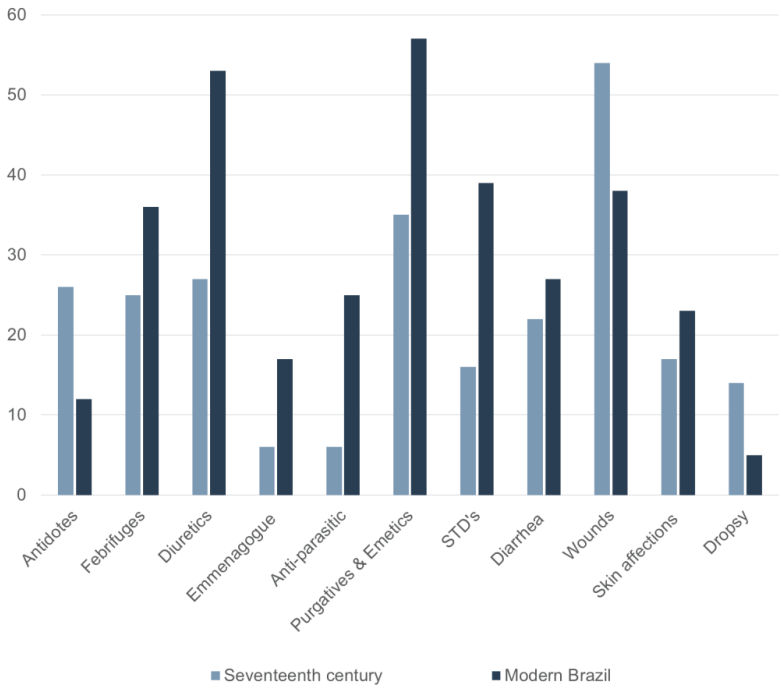

Fig 2.2 **Number of plant species in medicinal use categories in the seventeenth century and modern Brazil.**

In the seventeenth century, most medicinal species were used to heal ulcers, wounds, and abscesses. Modern Brazilians, however, use most of these species as purgative or emetic agents. Other common modern use is diuretics, treatments against STDs, and aphrodisiacs, which were less prevalent in the past. Purgatives, emetics, emmenagogues, and plants to treat fever, intestinal worms, and skin infections are also more reported today than in the past.

However, using plants as anti poisons or against dropsy is less common at present. In addition to our medicinal use categories (Fig 2.2), several other affections, such as stomachache, bladder and kidney obstructions, and rheumatism, were mentioned in the HNB. Margrave and Piso described 228 combinations of plant species and health affections, while we recorded 413 of such combinations for modern Brazil for the same species. Several useful plants we identified in the HNB are now used to treat other ailments, such as jaundice, arthritis, or neuralgia.

2.3.2 Marcgrave's herbarium

Botanical specialists incorporated glued identification slips on some of the pages in Marcgrave's herbarium. For example, John J. Wurdack, curator of botany at the Smithsonian Institution, identified *Clidemia biserrata* in 1969 (p. 25). Other specimens, like *Vismia guianensis* (Aubl.) Pers. (p. 157) have labels or notes with an identification, the page number corresponding to the HNB (Marcgrave, 1648: 96), and the local name (*Caa-opia*), but the authors of these labels are missing or unreadable. The bound herbarium contains 173 pages with 177 plant specimens (Fig 2.3).

Fig 2.3 **Marcgrave's herbarium**. The author shows the specimen of *Crescentia cujete* L. on page 50 (C, Copenhagen, July 2014. Photo by T. Van Andel).

Four pages contain mixed collections, such as page 18 with a specimen of *Zollernia latifolia* Benth. with the epiphytic orchid *Trigonidium acuminatum* Bateman ex Lindl. On page 61, fruits of *Physalis pubescens* L. are combined with a twig of *Rivina humilis* L. In total, 32 species were collected more than once (e.g., *Eichhornia paniculata* (Spreng.) Solms: 26 and 27). We identified 146 taxa, 141 at the species level, and five at the genus level (ESM 3). In addition, we encountered 37 species that were not mentioned in the published works (e.g., *Abrus precatorius* L.). We found 11 species of African origin and 114 species in the herbarium that correlated with Marcgrave and Piso's published work (1648, 1658), of which 76 (52%) were reported as useful. Although only names and no plant uses are written on the

herbarium sheets, most of the herbarium specimens described in the HNB are medicinal (76%), edible (41%), or used for technology (28%), such as *Jatropha curcas* L., or *Ricinus communis* L. The seed oil of the latter was used as a lamp fuel by Portuguese and Dutch settlers and as a medicinal oil by Indigenous peoples.

2.3.3 Useful species of African origin in the HNB

The HNB also provides several examples of plant knowledge exchange between Europeans, Indigenous peoples, and the enslaved Africans brought to Pernambuco at the beginning of the 1560s as forced labor in the sugar fields (Fausto, 2014). When Piso attended to the diseases of the enslaved and the native population and European colonists, he noticed useful herbs that had been introduced from Africa (Voeks, 2013). Both Marcgrave and Piso cited African vernacular plant names, medicinal practices, and weeds and crops that were part of the diet of African peoples. Indigenous peoples, Portuguese, and Dutch settlers used some of these plant species within the complex exchange in plant knowledge that occurred in the colonial context.

Marcgrave and Piso (1648, 1658) reported twenty-nine species of African origin (see ESM 2). Examples are sesame (*Sesamum indicum* L.), named Gangila by the 'Congo people' (the term used in the HNB is 'congensibus') and, according to Marcgrave (1648: 21), introduced from Africa by Portuguese colonizers. Other examples are the African eggplant, *Solanum macrocarpon* L., (which can also be *S. aethiopicum* L.) named Macumba by Congolese and Tongu by the 'Angolese' (Marcgrave 1648: 24) and okra (*Abelmoschus esculentus* (L.) Moench), known as Quillobo (Marcgrave 1648: 31). Some of the plants introduced from Africa were edible weeds, such as the spider plant (*Cleome gynandra* L.), while others were crops brought by the European settlers from Africa and planted in Brazil's similar tropical

environment, such as banana and plantain (*Musa* spp.), which were initially introduced from Asia to Africa centuries before the slave trade (Kury et al., 2013).

2.3.4 Paintings of Dutch Brazil

Some species that figure in the paintings by Albert Eckhout and Frans Post, such as the African weed *Abrus precatorius*, are missing in the HNB but present in Marcgrave's herbarium. Therefore, we consider them representative of the seventeenth century flora of NE Brazil. Other useful species that figure in the paintings are native crops such as cassava (*Manihot esculenta* Crantz) and *Casabanana* (*Sicana odorifera* (Vell.) Naudin) and plants that were brought from Africa like the coconut (*Cocos nucifera* L.) and banana (*Musa* sp.). In addition, European species introduced by the Portuguese, such as kale (*Brassica oleracea* L.) and turnip (*Brassica napus* L.), also appear in these paintings.

2.3.5 Phytogeographical distribution of the HNB species

Only one species (*Swartzia pickelii* Ducke) occurs exclusively in northeastern Brazil (Pernambuco) according to the literature (Ferreira et al., 2016) and the consulted virtual databases (CNC Flora and Flora do Brasil 2020). Five species (*Dioclea marginata*, *Encholirium spectabile* Mart. ex Schult. & Schult.f., *Eugenia luschnathiana* (O.Berg) Klotzsch ex B.D.Jacks., *Moquilea tomentosa* Benth., and *Pouteria grandiflora* (A.DC.) Baehni) were indicated as endemic to the northeast by some sources but had wider distribution ranges according to others (ESM 1). According to the online flora of Brazil, *D. marginata* is indicated as endemic to northeast Brazil, although it is also found in Paraná, south of Brazil (http://www.splink.org.br/index?lang=en). The seeds of other *Dioclea* species are used elsewhere in Brazil to obtain flour to prepare arepas (Maxwell, 2011), a flat bread

usually made of maize, originating in Venezuela and Colombia but also eaten in Brazil. Although Marcgrave reported *D. marginata* as an edible plant 'prepared like cassava' (they probably ground the seeds to make flour), we are not sure which species of *Dioclea* are ground into flour in Brazil today. *E. spectabile* is mentioned as endemic to northeast Brazil by the online flora, but it is also found in Minas Gerais (southeast) (http://www.tropicos.org/Specimen/3003066). *E. luschnathiana* used to be endemic to northeast Brazil, but it has been recently introduced and naturalized in Florida (Lucena et al. 2014). Ferreira et al. (2019) indicated that *L. tomentosa* is endemic to northeast Brazil. Still, this species is found in other regions of the country according to the online flora and the Species Link online database. *P. grandiflora* was listed by the online flora as endemic to the northeast. In Tropicos, botanists collected most specimens in Bahia and Sergipe (northeast), but some in Espírito Santo (southeast) and the Darien gap in Panamá. *Swartzia pickelii* is the only useful species described in the HNB that is considered endemic to northeast Brazil by all consulted sources. Piso reported its fruit pulp as edible when cooked (ESM 1). Today, people use the wood of this tree in Pernambuco for fuel and construction and the stem to make brooms (Silva, 2009), although the fruit is no longer consumed.

2.4 Discussion

2.4.1 *Historia Naturalis Septentrionalis* or *Brasiliae*?

Although compiled in northeast Brazil, the HNB was presented as an encyclopedia of Natural History of the entire country and also perceived as such by European scholars of the Early Modern period. But to what extent does the HNB represent the specific situation in the country's northeastern part? Our ethnobotanical analysis shows that concerning useful plants, the HNB is far more representative of the entire country than one might expect. From all the

useful species described in the HNB, only *Swartzia pickelii* is endemic to the Caatinga or Atlantic Rainforest biomes where Marcgrave and Piso conducted their expeditions (Gardner, 1846). Most of the plants are much more widespread, encompassing the diverse biomes of Brazil. Many species of useful plants documented in the HNB (e.g., cashew, cassava, *Bixa orellana* L., *Xanthosoma sagittifolium* (L.) Schott) were, and are used similarly by many Indigenous groups throughout Brazil (Corrêa 1926–1975; Schoof, 2012). In addition, there is evidence of great migration patterns of the Tupi-speaking peoples before and increasingly after the Dutch colonization of Brazil (Monteiro, 1999; Neves et al., 2011). Over time, the plant knowledge recorded in the HNB could have been preserved in different locations by the descendants of Indigenous peoples who migrated out of northeast Brazil in the past centuries. The origin and transmission of ethnobotanical knowledge across the regions of Brazil have not been studied extensively. Unlike Leonti (2011), who traced the transmission of ancient Greek and Roman herbals in modern Europe, we cannot trace back the direct influence of the HNB in local Brazilian pharmacopeias. Back then, this book was only accessible to the European elite (including doctors, scholars, and religious people). It became widely available in Brazil in the twentieth century when it was translated into Portuguese. Hence, it is very dubious that it ever influenced the Indigenous Tupi-speakers and African descendants, even though they were the main actors of the ecological knowledge in the HNB. The oral transmission of plant selection and botanical knowledge between ethnic groups likely influenced Brazilian pharmacopeias over time rather than the HNB. In any case, plant uses described in the HNB are now representative of larger territories in Brazil.

2.4.2 Retention of seventeenth century plant use in modern Brazil

Most useful flora reported in the two versions of the HNB were employed for medicine and food. Medicinal species were the largest category in both the seventeenth century and today,

increasing in importance over time. On the other hand, food was the second largest category in 1648, but the number of reported edible species is reduced today. We still found more edible species than Medeiros and Albuquerque (2014). They missed 32 edible species documented by Marcgrave (1648) (e.g., *Cereus fernambucensis* Lem., *Ficus gomelleira* Kunth & C.D.Bouché) and another 16 food species from Piso (1658), such as *Lagenaria siceraria* (Molina) Standl. and *Macoubea guianensis* Aubl. Marcgrave's original herbarium proved very relevant in identifying several species described in the HNB. For 22 food species, we obtained different taxonomical identifications than Medeiros and Albuquerque (2014), of which at least four edible species (*Cecropia pachystachya* Trécul, *Spondias mombin* L., *Physalis pubescens*, and *Clidemia biserrata*) were included in Marcgrave's herbarium. We also encountered 24 more plant species in the herbarium that correlated with the work of Marcgrave and Piso (1648, 1658) than Andrade-Lima et al. (1977), who reported only 90 overlapping species. There was a slight difference in the percentage of edible species between the HNB and modern Brazil (48 vs. 44%), in which 28 of the 124 edible species from the HNB are no longer consumed in Brazil today (according to scientific literature), such as *Copernicia prunifera* (Mill.) H.E.Moore and *Ficus gomelleira*. On the other hand, some species Macgrave and Piso described as medicinal in the past are now part of the Brazilian diet, such as *Piper marginatum* Jacq. or *Senna occidentalis* (L.) Link. Over time, the decrease in edible plants can be related to changes in perceptions about food and recipes since the seventeenth century and to demographic changes in the population who consumed these food resources, mostly Tupi-speaking Indigenous peoples. As Indigenous peoples migrated to other areas, they must have adjusted their plant-based diet to the new environment. According to Medeiros and Albuquerque (2014), the number of food plants in seventeenth century Brazil was higher than today due to modern cultural taboos that consider these ancient food resources as a sign of poverty. However, there are some exceptions.

Neither Marcgrave nor Piso reported *Senna occidentalis* as an edible plant. Still, its seeds are roasted as coffee by Brazilians in the northeastern region of Ceará (Lombardo et al., 2009) and other parts of Brazil (Lorenzi & Matos, 2008). *Montrichardia* cf. *arborescens* (L.) Schott (which could also be *Montrichardia linifera* (Arruda) Schott) was an 'edible fruit in case of need' (Marcgrave, 1648: 106), and its fruits are still sporadically eaten today (Schoof, 2012). This trend was also reported for eighteenth century food plants in Suriname, where the enslaved runaway population consumed *M. arborescens* without other food sources. However, Surinamese only used it as fish bait today (Van Andel et al., 2012). The species *Ananas comosus* (L.) Merr., *Bixa orellana*, *Canna glauca* L., *Carica papaya* L., *Syagrus coronata* (Mart.) Becc., and *Xylopia frutescens* Aubl. were not categorized as food in modern Brazil (M. F. T. Medeiros & Albuquerque, 2014). Nevertheless, they are still commonly consumed (*A. comosus*, *B. orellana*, and *C. papaya*) or occasionally eaten in Brazil (*C. glauca*, *S. coronata*, and *X. frutescens*) (Mors et al., 2000). On one hand, our comparison shows the continuation, to some extent, of vegetable food resources over time. On the other hand, some commonly eaten plants in the past, such as *Spondias tuberosa* Arruda and *Amaranthus viridis* L. had already turned into 'emergency food' in the 1920s (Corrêa, 1926), as was also reported for eighteenth century food plants in Suriname (Van Andel et al., 2012).

2.4.3 Transformations in medicinal plant use over time

The input of knowledge acquired from native Brazilians strongly influenced European colonial pharmacopeia (Carneiro, 2011). Food plants and several medicinal species were incorporated into European Materia Medica, such as *Anacardium occidentale* L. (Albuquerque et al., 2007) and *Passiflora edulis* Sims (Cartaxo et al., 2010). Indigenous peoples had a good reputation as healers through the use of wild and cultivated plants (Mors et al., 2000). However, many more species are recorded in Brazil today for their therapeutic

properties than the 171 medicinal species documented in the HNB. In Brazil, medicinal plants have been traded between Europeans since the Portuguese Jesuits started exchanging them in the sixteenth century (Walker, 2013), promoting the diffusion of botanical knowledge not only towards Portugal but also to diverse regions of the country and the Portuguese Empire. Nowadays, a wide variety of medicinal plants is used in Brazil in urban and rural areas (Rates, 2001). Taking into account that our literature review covered a larger region than the territories explored by Marcgrave and Piso, the higher number of medicinal plants could be related to the increase in the last decades in ethnobotanical studies (Albuquerque et al., 2007; Bieski et al., 2012; Cartaxo et al., 2010; Coelho-Ferreira, 2009; Lorenzi, 1998; Lorenzi & Matos, 2008) or the recent phytomedicinal development promoted by Brazil's great floristic diversity and potential for natural drug production (Calixto, 2005). On the other hand, local pharmacopeias have changed, and synthetic products have replaced some traditional medicines while other uses may have been forgotten. Most plant species documented by Marcgrave and Piso kept their function, and their use was often extended to different categories. *Cascabela thevetia* (L.) Lippold was 'powdered and mixed with tobacco or food to produce its highly toxic effects' (Piso, 1648: 49), while in the twentieth century, it was still considered a paralyzing poison but mainly planted as an ornamental (Corrêa, 1978b). Other medicinal plants from the HNB treat different ailments today than in the past. The resin and oil squeezed from *Schinus terebinthifolia* Raddi were used as a poultice for cold affections: 'The tree's astringent and warm leaves are used in baths, both to heal the body and to obtain pleasure' (Piso, 1648: 64). Piso based his terminology on the hot-cold Hippocratic humoral theory, prescribing warm plants to heal cold diseases and vice versa. *S. terebinthifolia* oil was later indicated for corneal diseases and tumors arising from arthritis or syphilis, while leaves were used against rheum, ulcers, and wounds (Corrêa, 1978b). Plants that were once used to heal skin ulcers and wounds have now been replaced by antibiotics

and antiseptic creams. Brazilians also use fewer plants as anti-poison today, despite the high occurrence of snakebites, a severe public health issue, especially in rural areas (Feitosa et al., 2015). The observed transformations in medicinal use can result from changes in health perception and illness since the development of modern medicine and the introduction of new terms for diseases (Van Andel et al., 2012). Still, some ideas on human health and diseases have persisted over time. In the nineteenth century, naturalists and physicians Piotr Czerniewicz, George Gardner, and Auguste de Saint-Hilaire depicted several plants to heal human ailments based on their expeditions to Brazil (Chernoviz, 1897; Gardner, 1846; Saint-Hilaire, 1824). The analysis of their manuscripts showed that diuretic, purgative, and febrifuge plants were, two centuries later, the most common ones in Brazil (Brandão et al., 2012; Fagg et al., 2015; Ricardo et al., 2017). More recently, purgative and diuretic plants have become very popular among modern Brazilians, acting as blood purifiers and intestinal cleansings (Bieski et al., 2012; Coelho-Ferreira, 2009). The retention of these particular uses may be related to attempts to achieve modern beauty standards and weight loss with purgatives, a common practice among young Brazilians (Kakeshita et al., 2013; Nunes et al., 2003).

Despite the observed trends in plant use over time, Marcgrave and Piso may not have adequately documented all plant species and local diseases in Dutch Brazil. In addition, access to specific areas was undoubtedly challenging for these two scholars, not exempt from hostile encounters, water supply limitations, and other difficulties in the tropical territory (Van den Boogaart & Brienen, 2002). Moreover, Western scholars probably did not consider or value Indigenous peoples' cosmologies and cosmovisions. Finally, the personal bias of Marcgrave and Piso likely influenced their work, as the background of both authors and their editor (Johannes de Laet) developed within a particular European context, highly influenced by the dominant political and religious scene at the time (Furtado, 2007).

During his inquiries, Piso explicitly expressed both rejection and praise of Indigenous practices that did not fall into the medical mainstream: ‘How among such crass barbarism many gross or corrupt practices, unworthy of Hippocratic art, are encountered, so that not a few very useful ones, which smell of antiquity, can be observed, and that foreign doctors who are well versed in art submit to discipline’ (Piso, 1648: 15).

In Early Modern Europe, it was common to eliminate evidence of abortive and ritual plant uses documented by European scholars due to religious beliefs, gender attitudes, and social constraints in Western society (Schiebinger, 2009). Although European scientists incorporated a significant corpus of Indigenous knowledge to create the HNB, they must have missed or deliberately omitted specific plant uses. In addition, native peoples or enslaved Africans who were compelled, to a greater or lesser degree, to give complete information on their plant resources to European colonists could have been reluctant to do so and therefore have chosen to conceal information.

Overall, the great number of useful plants encountered in our modern literature survey is a result of the large percentage of Brazil that is now covered by ethnobotanical research, compared to the small northeastern region that was explored in the seventeenth century by Marcgrave and Piso. Therefore, further ethnobotanical field research in Brazil in cooperation with Tupi-speaking Indigenous peoples and other ethnic groups would be valuable. This way, we could jointly bring new insights into plant knowledge retention over time and co-produce data, ideas, and methods that will benefit all the stakeholders.

2.5 Conclusions

Marcgrave and Piso depicted the rich flora and its many uses by the different ethnic groups who coexisted in northeastern Brazil in 1648 in their influential work of early modern science, the *Historia Naturalis Brasiliae*. According to the Western scholars, the Indigenous

population, European settlers, and enslaved Africans used most species documented in the HNB (68%). In comparison, Brazilians use 80% of these useful species similarly as they did in the seventeenth century (or as Marcgrave and Piso documented in the HNB). A substantial number of African plants, introduced during the trans-Atlantic slave trade, were used by enslaved Africans, Indigenous peoples, and Europeans. The HNB provides evidence for early plant dispersal by the Portuguese and the Dutch via the Middle Passage and the exchange of African ethnobotanical knowledge with other inhabitants in seventeenth century Brazil. Contemporary literature shows higher numbers of Brazilian medicinal plant uses, used for a broader spectrum of diseases, than the HNB. This trend is probably due to the development of ethnobotanical surveys in the country in the past century, compared to the small northeastern region Marcgrave and Piso surveyed in the seventeenth century. Our analysis shows that only a few useful plants documented in the HNB are endemic to the northeast. Most species occur in other regions of the country, and the uses described in the HNB represent larger parts of Brazil. We found fewer edible plants in modern sources than in 1648, which could result from changes in diet and health perceptions over time. These differences could also result from the editing process and the research methodology used by the authors of the HNB. By comparing the *Historia Naturalis Brasiliae* with current plant uses in Brazil, we reveal the preservation of Indigenous and African plant knowledge over time. This local knowledge influenced the works of scholars over the past 370 years. Now, however, is time to critically look into its content and enhance awareness of the crucial role of its non-European contributors.

Chapter 3

Marcgrave and Piso's plants for sale: The presence of plant species and names from the *Historia Naturalis Brasiliae* (1648) in contemporary Brazilian markets

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Abstract

Parallelisms between current and historical medicinal practices, as described in the seventeenth century treatise *Historia Naturalis Brasiliae* (HNB), provide us with an overview of traditional plant knowledge transformations. Local markets reflect plant use in urban and rural surroundings, allowing us to trace cross-century similarities of ethnobotanical knowledge. We aim to verify how far the HNB, created in seventeenth century northeastern Brazil, correlates with contemporary plant use in the country by comparing the plant knowledge therein with recent plant market surveys at a national level. We conducted a literature review on ethnobotanical market surveys in Brazil. We used the retrieved data on plant composition and vernacular names, together with our fieldwork from the Ver-o-Peso market in Belém, to compare each market repertoire with the useful species in the HNB. We analyzed similarities among markets and the HNB with a Detrended Correspondence Analysis and by creating Venn diagrams. We analyzed the methods of the different markets to check whether they influenced our results. Out of the 24 markets reviewed, the greatest

similarities with the HNB occurred in northern Brazilian markets, both in plant composition and vernacular names, followed by the northeast. We found lesser overlap with markets in the central west and Rio de Janeiro. Most of the shared vernacular names with the HNB belonged to languages of the Tupi linguistic family. The similarity patterns in floristic composition among Brazilian markets and the HNB indicate the wider distribution and trade of the species that Marcgrave and Piso described in 1648 in the northeast. Migration of Indigenous groups, environmental changes, globalized and homogenous plant trade, and different market survey methods played a role in these results. The HNB is a reference point in time that captures a moment of colonial cultural transformations.

3.1 Introduction

Boosted by the Dutch colonial enterprise, an influential scientific account of Brazil's natural history was created from a relatively small but highly biodiverse territory. The Dutch West India Company (WIC) occupied the present-day state of Pernambuco in northeast Brazil between 1630 and 1654. They appointed count Johan Maurits van Nassau-Siegen governor-general of the colony between 1637 and 1644. He commissioned a group of naturalists, artists, and physicians to describe and illustrate the local diseases, flora, and fauna of Dutch Brazil, generating one of the most comprehensive treatises of tropical natural history of the early modern period: the *Historia Naturalis Brasiliae* (HNB). The HNB was authored by the German naturalist George Marcgrave and the Dutch physician Willem Piso and edited by the geographer and director of the WIC, Johannes de Laet, who published it in 1648. With great detail, De Laet systematized local knowledge about plants and animals, as reported by Piso and Marcgrave. He also added several illustrations, combining art and science in an encyclopedic format (Whitehead & Boeseman, 1989). He followed the work of other naturalists, explorers, and religious chroniclers who traveled to the Americas. This is

reflected in the many comparisons he wrote throughout the text, especially for plants (Françoso, 2010). Ten years later, after Marcgrave and De Laet died, Piso published the *De Indiae Utriusque Re Naturali et Medica* (IURNM), adding Marcgrave's notes on flora and fauna under his name. For those reasons, he was accused of plagiarism by scholars such as Linnaeus (Ossenbach, 2017; Whitehead & Boeseman, 1989). Other contributors, not acknowledged but essential to creating this book, were the diverse Tupi-speaking Indigenous peoples, enslaved Africans and their descendants, and Portuguese and Dutch settlers in the colony, whose ecological knowledge was documented in the HNB (Alcantara-Rodriguez et al., 2019; Furtado, 2007). To what extent this knowledge is still present in Brazil was the subject of two recent historical revisions of the HNB (Alcantara-Rodriguez et al., 2019; Medeiros & Albuquerque, 2014). Although this treatise was based on studies of flora and fauna of the northeast of Brazil, most plant species and uses described here are widespread in the different regions and biomes of the country (Alcantara-Rodriguez et al., 2019).

To what extent these distributions result from pre-colonial, colonial, or post-colonial exchanges in ethnobotanical knowledge and plant trade in Brazil – or a combination of these – is still uncertain. In the pre-Columbian era, plant exchange and trade existed among diverse Indigenous groups, and in Brazil, these movements were associated with Tupi-Guarani migrations and settlements across the country (Noelli, 2008). Indigenous groups modified the Brazilian landscape to acquire plant and animal resources long before colonization, creating a corpus of ecological knowledge over millennia (Heckenberger et al., 2007; Levis et al., 2018). The local populations spread this dynamic and adaptative knowledge over the Brazilian regions, interacting in contact zones with the Portuguese and other European colonists since 1500 and the enslaved Africans since the 1560s along the northeast coast (Fausto, 2014).

Our previous study of the plant uses documented in the HNB (Alcantara-Rodriguez et al., 2019) was mainly based on the research of Brazilian botanist Pio Corrêa (1874–1934), whose work was published in six extensive volumes of useful native and exotic plants of Brazil (Corrêa, 1926–1978). The information on plant uses and names compiled by Corrêa stems from the beginning of the twentieth century or even earlier. This knowledge may have been transformed, disrupted, or disappeared in Brazil given the large-scale deforestation and land degradation by agribusiness and cattle industry (Gazzaneo et al., 2005; Sawyer, 2008), the 'interculturalization' of plant practices (Tareau, 2019), and processes of industrialization and globalization (Aguiar, 2018; Brandão et al., 2013). Here we use a more up-to-date approach by comparing ethnobotanical information in the HNB to surveys of local plant markets in Brazil in the period 1984–2018 to analyze whether the plant species and their vernacular names, as documented by Piso and Marcgrave in the 1640s, are still present in Brazil today. Local markets constitute places of acquisition and dissemination of natural resources, such as plants or plant-derived products, and the information about them between producers, vendors, and consumers, which promote the resilience of this dynamic knowledge over time (Freitas et al., 2012). Local markets play a socio-economic role as they provide an essential source of income for people in vulnerable sectors of the population, such as low-resource, migrants, and women under forced or non-equal conditions (Lima et al., 2014; Macía et al., 2005; Van Andel et al., 2012). Medicinal plant markets offer alternative sources of health care that have earned their users' confidence in healing efficacy and are less expensive than conventional treatments (Nóbrega-Alves et al., 2008).

Market surveys reveal the pluricultural and intercultural context in which several pharmacopeias, botanical knowledge, and beliefs co-exist (Pochettino et al., 2012) and intermingle (Tareau, 2019). They also inform about the plant diversity, species in highest demand, the most frequent diseases treated with herbal medicine, and the relevance of

medicinal plant use in a particular location (Leitão et al., 2009; Parente & Rosa, 2001; Pochettino et al., 2012; Van Andel et al., 2012). Markets also reflect socio-environmental activities, as vendors or intermediaries often gather their products from the wild, in the forest, or disturbed areas (Pinto et al., 2013). They also cultivate them in their yards or gardens (Alves, 2007). In both cases, they influence the nearby landscape to a greater or lesser extent through the need for plant-based products (Oliveira et al., 2014). Markets give us an overview of the most valuable native plants (Bitu et al., 2015; Pinto et al., 2013) but also introduced plants, reflecting human migration, trade between regions, and globalization (Cajaiba et al., 2016; Luz, 2001; Maioli-Azevedo & Fonseca-Kruel, 2007; Tareau, 2019). Most published market surveys in Brazil represent descriptive inventories of medicinal and ritual plants (Stalcup, 2000; Van den Berg, 1984), qualitative studies on socioeconomic aspects (Bitencourt et al., 2014; Santos et al., 2018), and quantitative research on medicinal properties and species richness (Almeida & Albuquerque, 2002; Carvalho, 2004; Lima et al., 2011). Only two studies in Brazil investigated parallelisms between current and historical medicinal practices. Silva et al. (2004) compared animal-based products sold on medicinal markets in Recife with the animals used for healing described in the HNB. Pombo Geertsma (2019) compared useful plants from the Ver-o-Peso market in Belém with those described in the HNB. Here we present a comparison between plant knowledge from seventeenth century Dutch Brazil, as registered in the HNB, and recent ethnobotanical market surveys in the country. Surveys of local plant markets can be helpful in tracing cross-century change and retention of ethnobotanical knowledge, as they reflect the actual plant use in urban areas and their rural surroundings. By comparing useful plant species and vernacular Indigenous and African names described by Marcgrave and Piso with recent data from local Brazilian markets, we can verify which areas show the greatest similarities with the traditional plant knowledge that was documented in 1648 in the northeast.

We posed the following research questions (1): Which plants are sold at local markets in several regions of Brazil (2)? What are the similarities in species composition between these markets and the HNB (3)? To which extent and where do we find similarities in Tupi plant names as documented in the HNB? We expected to find the most remarkable overlap in plant species composition and plant names in the northeast of Brazil. In particular in Pernambuco, because the HNB was compiled there. Through this research, we analyzed to which extent the botany of the HNB correlates with contemporary plant use and names in Brazil.

3.2 Materials and Methods

3.2.1 Data collection

We retrieved literature sources from Google Scholar in English, Portuguese and Spanish, using the following key words: *(urban) (local) markets, plants, ethnobotany, Brazil, Brasil, mercados, feiras, etnobotânica, plantas, comercializadas, medicinais,* and *comestíveis.* We completed this review with the data from our survey at the Ver-o-Peso market in Belém (Amazon) in August 2018 (Pombo Geertsma, 2019). During our fieldwork, we made voucher specimens and identified most of them at the herbarium of the Museu Paraense Emilio Goeldi (MG) in Belém. We labeled all vouchers with information on their taxonomical identification, vernacular name, location, perishable morphological characteristics, habit, and plant parts sold and deposited them at the MG (Pombo Geertsma, 2019). For doubtful identifications or unknown plants, we compared the photographs of the specimens to the South American collections at the herbarium of Naturalis Biodiversity Center (L) in Leiden and consulted expert botanists at Naturalis. We also checked the Global Biodiversity Information Facility database-GBIF (www.gbif.org/), Flora do Brasil 2020 (www. floradobrasil.jbrj.gov.br/), Tropicos (www.tropicos.org/), and literature on medicinal plants in

Brazil (Lorenzi, 2002; Lorenzi & Matos, 2008) and Surinam (Van Andel & Ruysschaert, 2011).

We organized all plant species reported in the market inventories in an Excel table, updated their scientific nomenclature using The Plant List (www.theplantlist.org/), and then compared them with the useful species identified in the HNB by Alcántara-Rodriguez et al. (2019). These identifications were based on the plants described and often depicted in the fourth chapter of Piso on medicinal plants (*De Medicina Brasiliense*, 1648) and the three first chapters of Marcgrave (*Historia Rerum Naturalium*, 1648) on herbs, shrubs, and trees. We also considered the IURNM (Piso, 1658). Still, as Piso copied most of the species from the HNB, we mainly refer to the HNB as the primary reference unless some plants appear only in the IURNM. We followed a conservative approach, as we excluded plants from our analysis identified to family or genus level. However, we have considered the total number of species collected per market survey to calculate the species richness. To see whether (dis-) similarities among markets were caused by methodological differences in the surveys, we conducted an in-depth analysis of the methods in the reviewed literature. We checked whether the authors collected and identified vouchers, conducted free-listing or interviews with vendors, did their own observations and verified the domestication status of plants.

3.2.2 Data analysis

We used descriptive statistics by simple tabulations after grouping all market species. First, we calculated for every market the number and percentage of species in common with the HNB. Then, we obtain the most commonly sold species on all surveyed Brazilian markets (present in ≥10 locations). We also indicated whether the market plants were present in the HNB or not and added information on domestication status, habit, and distribution (biomes)

in Brazil according to the online Flora do Brazil 2020, Species link (www.splink.org.br/) and the Pl@nt Use (www.uses.plantnet-project.org/).

Of all species that overlapped with the HNB, we calculated for every market the proportion of vernacular names in Portuguese, African, Tupi-related, or other languages shared with the HNB. We considered vernacular names 'similar' when they showed a strong resemblance in structure, sound, or meaning (Van Andel et al., 2014), for example: 'passion fruit' for *Passiflora edulis* Sims in Albuquerque et al. (2007) and 'flor de paixão' in the HNB (Marcgrave, 1648: 71). We considered Tupi-related names those that originated from the macrolinguistic Tupi family, even the Portuguese language 'borrowed' them by time: e.g., *João-barandí* for *Piper anisum* (Spreng.) Angely (Azevedo & Silva, 2006) and *Jaborandi* (Marcgrave, 1648: 69) for the same species.

We grouped market locations per geographic region (north, northeast, central west, and southeast) and by biome (Amazon, Atlantic Rainforest, Atlantic Coast, Caatinga, and Cerrado or Central Savannah), according to the Flora do Brazil 2020 (www.floradobrasil.jbrj.gov.br/). To assess similarities in species composition among markets and the HNB, we entered all plant species present at the markets. Then, we listed them in the HNB in a presence-absence data matrix in Excel. We did a preliminary analysis of the data to test if the species response to markets showed a unimodal distribution using vegan:decorana in R version 3.6.2, in which axis lengths should be greater than 4 (Oksanen et al., 2018). A unimodal distribution means that most species occurred only in subsets of markets, and few are present uniformly. To minimize the effect of rare species, we opted for a Detrended Correspondence Analysis (DCA) in R. Finally, for each region, we calculated the overlap in species with the HNB using Venn Diagrams made with FUNRICH open access software (Pathan et al., 2015: http://funrich.org/). Within the shared species, we counted the number of vernacular plant names in common with the HNB and the origin of their language.

3.3 Results

3.3.1 Plant diversity and similarity in Brazilian markets

Our literature review yielded 23 Brazilian market surveys, which, combined with our fieldwork (Pombo Geertsma, 2019), resulted in 24 surveys (Table 3.1). Most were carried out in the north of the country (9 surveys), followed by the northeast (6), southeast (5), and central west (4) (Fig 3.1). While the HNB listed 256 useful species, a total of 652 taxa identified to species level were recorded in these 24 surveys: most in the north (438 species), followed by the southeast (279), the northeast (203), and the central west (153) (Supplementary Table S1).

Table 3.1 Overlap in species and vernacular plant names between the HNB and the 24 Brazilian markets.

Region (Biome)	*Municipality, State*	*Total nr species*	*Shared spp. with HNB**	*Shared names with HNB***	*Origin of shared name (language)****	*References*
North (Amazon)	Belém, Pará	172	42 (24%)	34 (81%)	15 Tu, 2 Ar, 11 Po, 6 A	Pombo-Geertsma, 2019 (1)
North (Amazon)	Boa Vista, Roraima	105	30 (29%)	24 (80%)	9 Tu, 2 Ar, 10 Po, 5 A	Luz, 2001(8)
North (Amazon)	Belém, Pará	158	30 (30%)	23 (77%)	11 Tu, 1 Ar, 6 Po, 5 A	Van den Berg, 1984 (2)
Northeast (Atlantic Coast)	São José, Recife, Pernambuco	107	26 (24%)	23 (88%)	7 Tu, 1 Ar, 9 Po, 2 A, 4 O	Albuquerque et al., 2007 (10)
Southeast (Atlantic Rainforest)	Tijuca, Rio de Janeiro	145	24 (17%)	15 (63%)	6 Tu, 1 Ar, 6 Po, 2 A	Stalcup, 2000 (24)

Region (Biome)	*Municipality, State*	*Total nr species*	*Shared spp. with HNB**	*Shared names with HNB***	*Origin of shared name (language)****	*References*
North (Amazon)	Região Metropolitana de Belém (RMB), Pará	129	23 (18%)	16 (70%)	7 Tu, 1 Ar, 4 P, 4 A	Santos et al., 2018 [4]
Northeast (Atlantic-Caatinga)	Caruaru, Pernambuco	74	21 (28%)	17 (81%)	8 Tu, 6 P, 3 A	Almeida & Albuquerque, 2002 [11]
Southeast (Atlantic Rainforest)	West, Rio de Janeiro	117	21 (18%)	12 (57%)	5 Tu, 5 P, 2 A	Azevedo & Silva, 2006 [22]
Northeast (Caatinga)	Crajubar Triangle-Cariri, Ceará	89	18 (20%)	15 (83%)	8 Tu, 4 P, 4 A	Bitu et al., 2015 [14]
Southeast (Atlantic Rainforest)	North / South, Rio de Janeiro	102	15 (15%)	12 (80%)	6 Tu, 4 P, 2 A	Maioli-Azevedo & Fonseca-Kruel, 2007 [21]
Central west (Cerrado)	Cuiabá, Mato Grosso	108	15 (14%)	8 (53%)	4 Tu, 2 P, 2 A	Pinto et al., 2013 [16]
North (Amazon)	Guamá, Belém, Pará	125	14 (11%)	9 (64%)	2 Tu, 6 P, 1 A	Bitencourt et al., 2014 [3]
North (Amazon)	Boa Vista, Roraima	85	12 (14%)	9 (75%)	6 Tu, 2 P, 1 A	Costa-Pinto & Maduro, 2003 [9]
North (Amazon)	Uruará, Pará	56	10 (18%)	10 (100%)	3 Tu, 6 P, 1 A	Cajaiba et al., 2016 [7]
Northeast (Cerrado-Amazonia)	Bacabal, Maranhão	31	9 (29%)	7 (78%)	3 Tu, 2 P, 2 A	Araújo, 2015 [15]

Region (Biome)	*Municipality, State*	*Total nr species*	*Shared spp. with HNB**	*Shared names with HNB***	*Origin of shared name (language)****	*References*
Southeast (Atlantic Rainforest)	Petrópolis / Nova Friburgo, Rio de Janeiro	92	9 (10%)	7 (78%)	1 Tu, 5 P, 1 A	Leitão et al., 2009 [20]
Northeast (Atlantic Coast)	Recife, Pernambuco	47	7 (15%)	5 (71%)	1 Tu, 3 P, 1 A	Albuquerque, 1997 [12]
Southeast (Atlantic Rainforest)	Barra do Piraí, Rio de Janeiro	66	7 (11%)	4 (57%)	3 Tu, 1 P	Parente & Rosa, 2001 [23]
Northeast (Caatinga)	Campina Grande, Paraíba	23	6 (27%)	4 (67%)	3 Tu, 1 P	Alves, 2007 [13]
Central west (Cerrado)	Anápolis, Goiás	37	4 (11%)	3 (75%)	2 Tu, 1 P	Carvalho, 2004 [18]
Central west (Cerrado)	Campo Grande, Mato Grosso do Sul	27	4 (15%)	3 (75%)	3 Tu	Nunes et al., 2003 [17]
North (Amazon)	Distrito Florestal Sustentável (DFS), Pará	32	3 (9%)	2 (67%)	2 Tu	Lima et al., 2011 [5]
North (Amazon)	Itaituba, Pará	14	2 (14%)	1 (50%)	1 Tu	Lima et al., 2014 [6]
Central west (Cerrado)	Goiânia, Goiás	24	0 (0%)	0 (0%)		Tresvenzol et al., 2006 [19]

* Percentage of the total number of identified species on that specific market.

** Percentage of overlapping vernacular names for plant species in common with the HNB.

*** Indigenous: Tu (Tupi-related); Ar (Arawak-related); P (Portuguese); A (African / Arabic); O (Others).

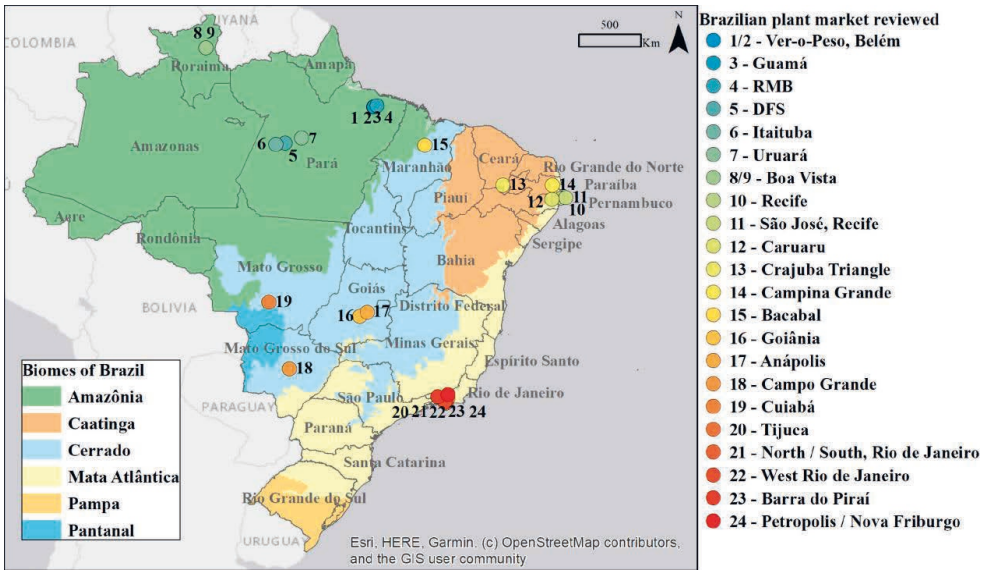

Fig 3.1 **Map depicting the 24 market survey locations and biomes**. Numbers refer to references in Table 3.1 (Map by M. Lumbierres).

Of the 25 most commonly sold species (recorded in ≥10 surveys), less than a quarter (20%) are native plants. In contrast, the majority (80%) were introduced from Europe (mainly from the Mediterranean region), Asia, or Africa, during the colonial trade started by the Portuguese in the sixteenth century (Walker, 2013), and from other areas of the continent (Table 3.2). Of these most frequently sold species, 20% are also in the HNB. Most introduced species (55%) are domesticated, and the others (45%) are either cultivated or wild, as they have become naturalized over time. While few native plants are exclusively domesticated or gathered from the wild (each 20%), 60% are cultivated and wild. Of those species in common with the HNB, more than half (60%) were introduced from Eurasia or Africa, and the rest (40%) are native Brazilian (Table 3.2). Most of these common market plants are herbs (52%), followed by trees (24%), shrubs (16%), and lianas (8%). Most of the shared species with the HNB are herbs, followed by trees and shrubs.

Table 3.2 Most frequently sold species in the 24 Brazilian markets, their distribution, biomes, domestication status, and presence in the HNB.

Species (Family)	*Nr of markets (%)*	*Region*	*Domestication status*	*Distribution (biome)*	*Habit*	*Present in the HNB*
Petiveria alliaceae L. (Phytolaccaceae)	16 (67%)	All regions	Introduced (cultivated, wild)	Tropics worldwide	Herb	No
Dysphania ambrosioides (L.) Mosyakin & Clemants (Amaranthaceae)	15 (63%)	All regions	Introduced (cultivated, wild)	All biomes except Pampa and Pantanal	Shrub	No
Punica granatum L. (Lythraceae)	14 (58%)	All regions	Introduced (domesticated)	Tropics worldwide	Tree	No
Ruta graveolens L. (Rutaceae)	14 (58%)	All regions	Introduced (domesticated)	Worldwide	Herb	No
Cymbopogon citratus (DC.) Stapf (Poaceae)	13 (54%)	All regions	Introduced (domesticated)	Tropics worldwide	Herb	No
Lippia alba (Mill.) N.E.Br. ex Britton & P.Wilson	13 (52%)	All regions	Native (cultivated, wild)	All biomes except Pampa and Pantanal	Herb	Yes
Luffa operculata (L.) Cogn. (Cucurbitaceae)	13 (54%)	All regions	Introduced (domesticated)	Amazon, Cerrado, Atlantic Rainforest	Liana	No

Species (Family)	*Nr of markets (%)*	*Region*	*Domestication status*	*Distribution (biome)*	*Habit*	*Present in the HNB*
Ocimum gratissimum L. (Lamiaceae)	13 (52%)	All regions	Introduced (cultivated, wild	Tropics worldwide	Herb	No
Rosmarinus officinalis L. (Lamiaceae)	13 (54%)	All regions	Introduced (domesticated)	Worldwide	Shrub	No
Zingiber officinale Roscoe (Zingiberaceae)	13 (54%)	All regions	Introduced (domesticated)	Tropics worldwide	Herb	Yes
Anacardium occidentale L. (Anacardiaceae)	12 (50%)	All regions	Native (domesticated)	All biomes	Tree	Yes
Momordica charantia L. (Cucurbitaceae)	12 (50%)	All regions	Introduced (cultivated, wild)	Tropics worldwide	Vine	No
Alpinia zerumbet (Pers.) B.L.Burtt & R.M.Sm. (Zingiberaceae)	11 (46%)	All regions	Introduced (domesticated)	All biomes except Pampa and Pantanal	Herb	No
Amburana cearensis (Allemao) A.C.Sm. (Fabaceae)	11 (46%)	N, NE, CW, SE	Native (cultivated, wild)	Caatinga, Cerrado, Atlantic Rainforest, Pantanal	Tree	No
Carapa guianensis Aubl. (Meliaceae)	11 (46%)	N, NE, SE	Native (wild)	Amazon	Tree	No
Cinnamomum verum J.Presl (Lauraceae)	11 (46%)	N, NE, CW, SE	Introduced (domesticated)	Tropics worldwide	Tree	No

Species (Family)	*Nr of markets (%)*	*Region*	*Domestication status*	*Distribution (biome)*	*Habit*	*Present in the HNB*
Helianthus annuus L. (Asteraceae)	11 (46%)	All regions	Introduced (domesticated)	Cerrado, Atlantic Coast / Rainforest, Caatinga	Herb	No
Aloe vera (L.) Burm.f. (Xanthorrhoeaceae)	10 (42%)	All regions	Introduced (domesticated)	Tropics worldwide	Herb	Yes
Bidens pilosa L. (Asteraceae)	10 (42%)	All regions	Introduced (cultivated, wild)	All biomes	Herb	No
Bryophyllum pinnatum (Lam.) Oken (Crassulaceae)	10 (42%)	All regions	Introduced (cultivated, wild)	Tropics worldwide	Herb	No
Caesalpinia ferrea C.Mart. (Fabaceae)	10 (42%)	All regions	Native (cultivated, wild)	Caatinga	Tree	No
Jatropha gossypiifolia L. (Euphorbiaceae)	10 (42%)	All regions	Introduced (cultivated, wild)	Tropics worldwide	Shrub	No
Ocimum basilicum L. (Lamiaceae)	10 (42%)	All regions	Introduced (domesticated)	worldwide	Herb	No
Ricinus communis L. (Euphorbiaceae)	10 (42%)	All regions	Introduced (cultivated, wild)	All biomes and regions	Shrub	Yes
Matricaria chamomila L. (Asteraceae)	9 (38%)	All regions	Introduced (cultivated, wild)	Worldwide	Herb	No

The most commonly sold species in the Brazilian markets are widespread weeds, such as *Dysphania ambrosioides* (L.) Mosyakin & Clemants and *Petiveria alliaceae* L. They grow in the wild, although people also cultivate them because of their medicinal value and high demand. Cultivated trees are very popular, such as *Punica granatum* L. or the native *Amburana cearensis* (Allemao) A.C.Sm., which also grows wild. Cosmopolitan shrubs and herbs that are widely traded are *Ruta graveolens* L., *Cymbopogon citratus* (DC.) Stapf, *Luffa operculata* (L.) Cogn., *Rosmarinus officinalis* L., and *Zingiber officinale* Roscoe (Table 3.2).

3.3.2 Similarity in species between Brazilian markets and the HNB

Out of 256 useful species described in the HNB, 160 (63%) species were not recorded by any recent market surveys in Brazil, while we found 96 (37%) in at least one market. The most remarkable overlap in commercialized species with the HNB was found in northern Brazil in the surveys of the Ver-o-Peso market in Belém by Pombo Geertsma (2019) and Van den Berg (1984) and the market in Boa Vista, Roraima (Luz, 2001). On the other hand, we found less overlap with the markets in Pernambuco and Ceará, even though the HNB was produced in the northeast (Table 3.1). Typically, the most negligible overlap (0 species in common) was surprisingly not found near Rio de Janeiro, located the furthest away from the northeast and having very different vegetation, but in Goiás in the central west region (Tresvenzol, 2006).

Species response to markets showed unimodal distributions. To visualize the results of the DCA, we plotted it on the two axes that caused the data distribution. The results (Fig 3.2) show how close in species composition the different markets are from the HNB and each other. The HNB has a much higher number of species than any plant market; hence, many HNB species are not present in any of them. In any case, the HNB shows the most similarity in species composition with markets situated in the north of Brazil and the least similarity

with those located in the central west. The clustering of the Rio de Janeiro markets suggests that in this region, there are more species in common per market than among markets in the north, northeast, and central west.

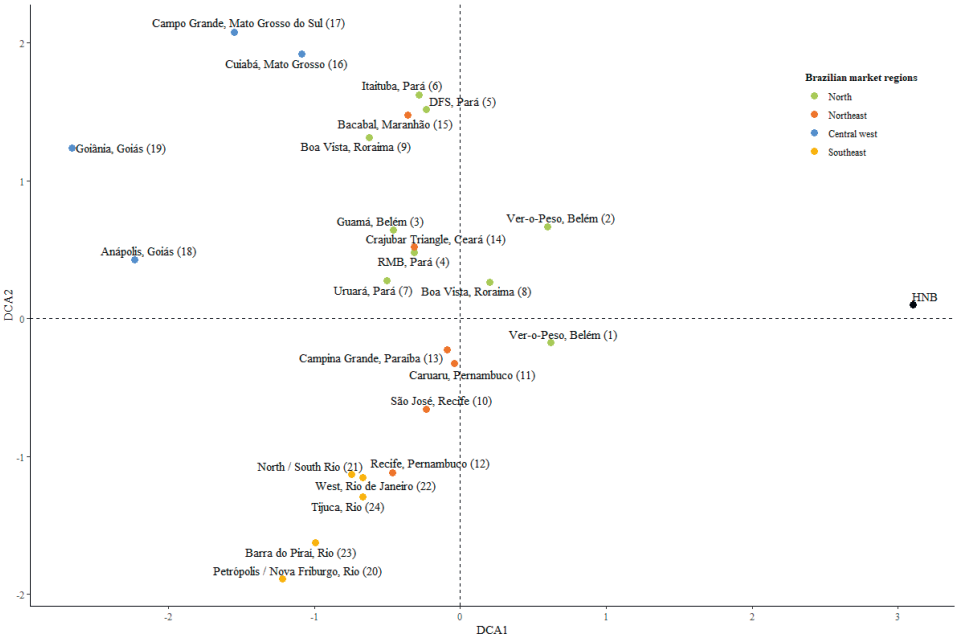

Fig 3.2 **DCA ordination diagram of 24 Brazilian markets and the HNB (black dot) based on presence-absence species matrix.** Each dot represents a market: the closer dots are to each other, the more species they share. Axes do not represent variables but standard deviations and serve to visualize variation and similarity in plant composition. Numbers refer to references in Table 3.1.

On the other hand, the high overlap in shared plant species between the markets in the north and the HNB is based on absolute numbers of shared species (Fig 3.3). Regarding percentages, the greatest overlap occurs between the northeast and the HNB, followed by the north (Fig 3.3). The larger number of plant species reported in northern markets (Table 3.1)

could explain the overlap in the number of shared plant species. However, these differences do not necessarily justify the results. Markets in Rio, with higher numbers of species than in the northeast, shared fewer species with the HNB than the northeastern markets (Fig 3.3).

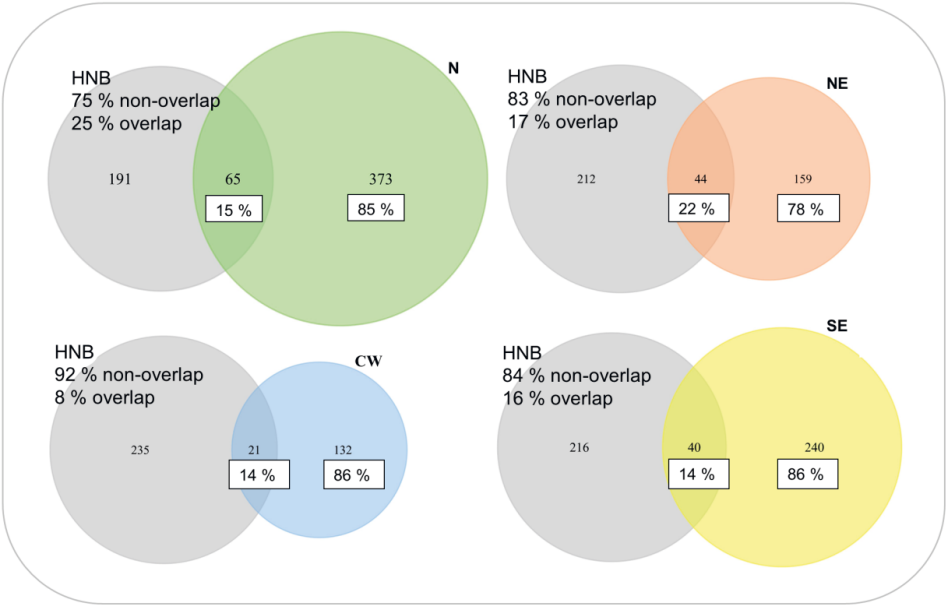

Fig 3.3 **Overlap in plant species (absolute numbers and percentages) between markets in the different geographic regions of Brazil and the HNB.** N: north; NE: northeast; CW: central west; SE: southeast.

3.3.3 Similarity in local names between Brazilian markets and the HNB

Regarding vernacular names, we found the most remarkable correlation with the HNB in the recent survey in Belém (Pombo Geertsma, 2019), with 34 plant names similar to those documented in the HNB, followed by the Boa Vista market (Luz, 2001). In contrast, Albuquerque et al. (2007) listed fewer vernacular names in Recife, although this was once the

capital of Dutch Brazil. The greatest percentage overlap occurs in the Uruará (Pará) market, where all ten species had the same vernacular name as in the HNB. However, the absolute number of vernacular names was much smaller (Table 3.1).

The most significant percentage overlap in vernacular names for the species in common among the HNB and the markets pooled per Brazilian region was found in the northeast, followed by the north (Fig 3.4). For all regions, the highest percentage (56%) of overlapping vernacular names was found for Indigenous plant names, mostly belonging to the macro-linguistic Tupi family, except for three that belonged to the Arawakan languages. Portuguese names were shared among 34% of the species in common, and African or Arabic names for 15%. The remaining (6%) were names that did not share a common origin but overlapped with the HNB names in meaning (Supplementary Table S2).

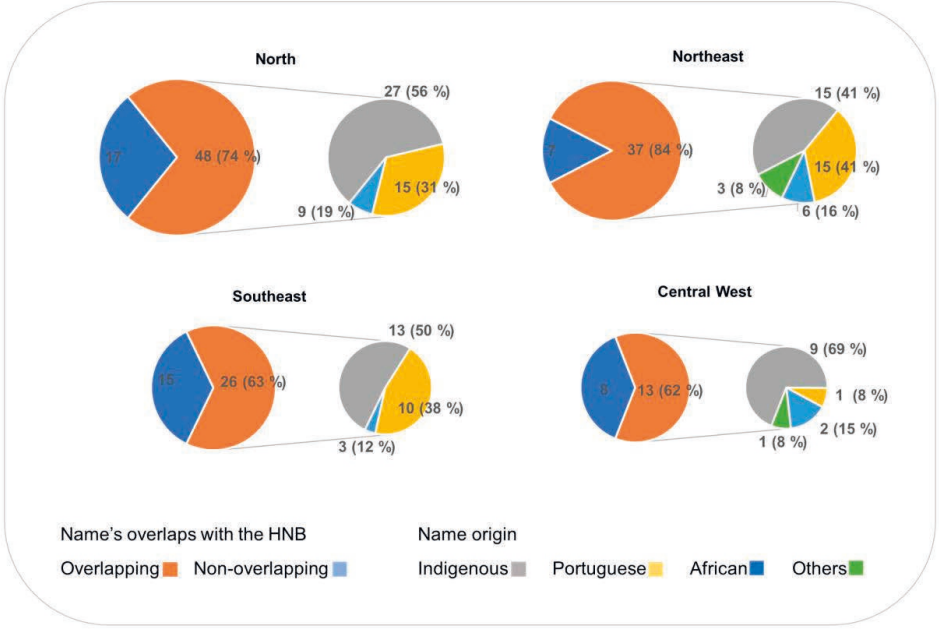

Fig 3.4 **Overlap in vernacular names between Brazilian markets and the HNB**. Absolute and relative numbers between the plant names documented during market surveys in the different regions and the HNB expressed as language origins.

The HNB and the market surveys included several plant species with more than one vernacular name, and sometimes names were compounded in different languages. We found 73 vernacular names made out of two or more languages in the 25 market surveys, which correspond to 68 plant species, of which the names overlap with those in the HNB (Supplementary Table S2).

In the north, most overlapping plant names are Indigenous, mostly Tupi-related (90%), while 10% are from the Arawakan linguistic family. An example of an Arawakan name is *Batata* for the sweet potato (*Ipomoea batatas* (L.) Lam.). A compound name is *Batata de purga* (*Operculina hamiltonii* (G. Don) D.F. Austin & Staples), made from an Arawakan word and the Portuguese term for 'purge,' probably after its purgative properties (Piso, 1648: 93). Four of the African names are of Central African origin, such as *Inhame* (*Dioscorea alata* L.), and *Quiabo* (*Abelmoschus esculentus* (L.) Moench), which are Kimbundu names from Angola. The others are derived from Arabic words, such as *Tamarindo* (*Tamarindus indica* L.) and *Alcaçuz* (*Periandra mediterranea* (Vell.) Taub.) (Barros, 2012; Burkill, 1997).

In the northeast, the percentage of overlapping plant names is more prominent, while the proportion of Indigenous and Portuguese names is the same (Fig 3.4). Most Indigenous names are Tupi-related, and only *Guava* (*Psidium guajava* L.) has Arawakan roots (Góis & Martins, 2019). Half of the names with African roots are Afroasiatic, mostly of Arabic origin. Generally, name retentions occurred with one simple plant name per species and, therefore, in a unique language. Only a few species kept two of the names reported in the HNB. *Cereus jamacaru* DC., a cactus characteristic of the Caatinga-Cerrado biome, has kept its Tupi name, written in the HNB as *Iamacaru*, and is currently known with a slight modification as *Mandacaru*. Still, it has retained the Portuguese name reported by Marcgrave (*Cardon* or *Cardo*), now *Cardeiro*.

In the central west, the relative proportion of Indigenous names is the greatest; all are Tupi-related. *Mirabilis jalapa* L. was categorized as 'others' because it was reported in the HNB by the Latin term *Mirabilis Peruana* and known today as *Cipó Maravilha* in the market at Goiás (Carvalho, 2004), which in Portuguese means 'wonder', retaining its original meaning. In the southeast, the proportion of Indigenous and Portuguese names is similar, while African names remain a minority, like in all regions. Plant cognates are sometimes compound names. For example, the Tupi term *Ambaiba* in the HNB for *Cecropia hololeuca* Miq., now known as *Embaúba Branca* in Rio de Janeiro (Maioli-Azevedo & Fonseca-Kruel, 2007), probably because of its leaves that are white below.

3.3.4 Differences in market survey methodologies

There was a considerable variation in the methods among the 24 market papers. While five surveys also included edible and handicraft plants (Leitão et al., 2009; Pombo Geertsma, 2019; Santos et al., 2018; Stalcup, 2000; Van den Berg, 1984), 19 studies surveyed only medicinal and ritual plants (Table 3.3). Tresvenzol et al. (2006) focused on the most cited plants, while Lima et al. (2011) paid more attention to plants gathered in extractive reserves. Only 15 of the 24 studies consulted botanists and/or collected herbarium vouchers, which made their identifications more reliable (Table 3.3). The identification methods of the nine other studies were unclear. Researchers who only interviewed vendors, asking them to free-list the specimens they sold (instead of surveying the stalls by themselves), probably ended up with fewer species. Although the methods of each survey may have been accurate to the author's specific aims, for our study, these possible underestimations of species richness resulted in less overlap with the HNB, which does not necessarily reflect the actual situation.

Table 3.3 Methodologies of the 24 Brazilian plant market surveys reviewed.

Market Location (Ref.) *	*Identified taxa-species level (Total)*	*Fieldwork duration*	*Survey methods*	*ID* **	*Uses*	*Plant origins and Market dynamics*
Ver-o-Peso, Belém, Pará, N (1)	172 (204)	18 days (August 2018)	Free-listing, interviews, vouchers, observation	Herbarium vouchers, photos, plant databases, plant names, taxonomic literature, botanists	Medicine, food, handicraft	Backyards of small producers, many in Outeiro/Mosqueiro (Belém)
Ver-o-Peso, Belém, Pará, N (2)	158 (179)	18 years (1965-1983)	Observation (unclear)	Herbarium vouchers, botanists, literature	Medicine, food, ritual, handicraft, ornamental	N, NE, SE, but 50% fewer species since 1965, fewer vendors over time. Japanese migrants
Guamá, Belém, Pará, N (3)	125 (180)	Nine months (Sept 2013-May 2014)	Interviews (informed consent)	Herbarium vouchers, walk in the woods, photos, ID guides, names	Medicine, magic-religious	Ver-o-Peso (intermediaries), cultivated in gardens, backyards, or wild (gathered in Pará/other states)
RMB, Pará, N (4)	129 (166)	Ten months (January-October 2014)	Free-listing, interviews, buying plants (fertile plants)	Herbarium vouchers, macro-wood analysis, plant names, literature, photos	Medicine, food, ritual-religious	Ver-o-Peso or from cooperative, 2 % cultivated, 2 % collected. Migrants invigorate the local pharmacopeia

Market Location (Ref.) *	*Identified taxa-species level (Total)*	*Fieldwork duration*	*Survey methods*	*ID ** *	*Uses*	*Plant origins and Market dynamics*
DFS, Pará N (5)	32 (46)	Nov. 2008-Sept. 2009	Free-listing (unclear), interviews	Botanical literature, macro-analysis, photos	Medicine	Via intermediaries, extractivism, imported (NE)
Itaituba, Pará, N (6)	14 (23)	Nov.2008 May 2009	Free-listing, interviews	Botanical literature, plant names	Medicine	Agriculture, extractivism. Migrations replace/add plants
Uruará, Pará, N (7)	56 (63)	Nov. 2014-March 2015	Free-listing, interviews	Photos, herbarium vouchers, botanists, literature	Medicine	Cultivation, extractivism, imported (NE, SE). Migrants brought their knowledge
Boa Vista, Roraima, N (8)	105 (113)	January 1995-April 1997	Interviews	Botanical literature, herbarium vouchers	Medicine	Gathered in the interior, cultivated. Migrants (NE) introduced plants. Indigenous migrants brought native plants to the city. Diverse population (NE, SE, Amazon)
Boa Vista, Roraima, N (9)	85 (99)	May-July 2001	Interviews (questionnaire)	Herbarium vouchers? (unclear)	Medicine	From other states, especially NE: established trade, most vendors are migrants
São José, Pernambuco, NE (10)	107 (164)	1993-1995 2001-2002	Free-listing, interviews, observation	Herbarium vouchers, literature, wood analysis	Medicine, magic-religious	Cultivated, gathered (Caatinga, Cerrado). Strong Afro-Brazilian influence

Market Location (Ref.) *	*Identified taxa-species level (Total)*	*Fieldwork duration*	*Survey methods*	*ID* **	*Uses*	*Plant origins and Market dynamics*
Caruaru, Pernambuco, NE (11)	74 (116)	Not specified	Free-listing, interviews	Herbarium vouchers, literature, botanists	Medicine	Extractivism. Cultural selection of the sold plants
Recife, Pernambuco, NE (12)	47 (47)	Not specified	Interviews	Not specified	Medicine, magic-religious	Gathered by intermediaries in Mata, Agreste, few from Sertão/Serra. Knowledge often by intermediaries
Campina Grande, Paraíba, NE (13)	23 (25)	July 2004-February 2005	Free-listing, interviews	Vernacular names, literature, botanists	Medicine	Cultivation, intermediaries
Crajubar Triangle, Ceará, NE (14)	89 (90)	March 2012-June 2014	Interviews	Photos, herbarium vouchers	Medicine	Extractivism (trees) Many are native from the Cerrado (high local plant knowledge), exotics (38 %)
Bacabal, Maranhão NE (15)	31 (31)	December 2013-January 2014	Free-listing, interviews	Not specified	Medicine	Bought from Ceará, Piauí, and Bahia (many exotic species), very few cultivated
Cuiabá, Mato Grosso, CW (16)	108 (119)	September-October 2013	Interviews, observation	Not specified	Medicine	Preference for native species (54 %), mostly trees from Cerrado: high local flora knowledge

Market Location (Ref.) *	*Identified taxa-species level (Total)*	*Fieldwork duration*	*Survey methods*	*ID* **	*Uses*	*Plant origins and Market dynamics*
Campo Grande, Mato Grosso do Sul, CW [17]	27 (39)	1992, 2002	Free-listing, interviews	Herbarium vouchers, literature	Medicine	Not documented
Anápolis, Goiás, CW [18]	37 (44)	June-November 2001	Interviews, observation	Not specified	Medicine	Other regions (intermediaries), few are cultivated. Plant knowledge: via vendors, family, indigenous peoples, clients, TV, books
Goiânia, Goiás, CW [19]	24 (28)	Not specified	Selecting the most cited plants out of 235	Botanists (not specified)	Medicine	Intermediaries, some come from other regions (Bahia). Deforestation obstructed plant collection nearby
PetrópolisNova Friburgo, Rio de Janeiro, SE [20]	92 (113)	Not specified	Free-listing, interviews, observation, buying plants	Literature, voucher herbarium, botanists	Medicine, food, ritual, ornamental	Cultivated, wild plant (50 %)
North and South, Rio de Janeiro SE [21]	102 (106)	May 2003-June 2004	Free-listing, interviews, observation	Literature, voucher herbarium, botanists	Medicine, ritual	Most are bought in big markets, some from the wild, 70% plants from Europe/Africa. Many ritual plants. Knowledge: media, oral stories

Market Location (Ref.) *	*Identified taxa-species level (Total)*	*Fieldwork duration*	*Survey methods*	*ID* **	*Uses*	*Plant origins and Market dynamics*
West markets, Rio de Janeiro SE (22)	117 (127)	January-December 1999	Free-listing, walk-in-the-woods, interviews, conversation, participant observation	Botanical vouchers, analytic keys, botanists	Medicine, religious	Bought, cultivated, wild (Atlantic Forest). Many Afro-Brazilian ritual plants
Barra do Piraí, Rio SE (23)	66 (94)	Not specified	Walk-in-the-woods, interviews	Literature, voucher herbarium, botanists	Medicine	Most cultivated. Many Afro-Brazilian ritual plants
Tijuca, Rio, SE (24)	145 (158)	August 1998-August 1999	Interviews	Literature, voucher herbarium, botanists	Medicine, magic-religious, food	Bought, cultivated, wild. Urban people looking for 'natural' medicine. Afro-ritual plants (18 %). Knowledge: written and oral sources

* Numbers refer to references in Table 3.1

**Tools and resources used to identify the species in the Brazilian markets

3.4 Discussion

3.4.1 Moving plants and people

We expected to find the greatest species similarities in the northeastern markets, as the HNB was based on plant knowledge gathered during expeditions in Pernambuco, Paraíba, Rio Grande do Norte, and Ceará (Van den Boogaart & Brienen, 2002). Plants were also collected in other northeastern areas, such as Alagoas, Sergipe, Bahia, and Maranhão, around the Itapicurú river (Sampaio, 1942; Von Martius et al., 1840). In addition, plants were cultivated in the gardens of Johan Maurits in Recife (Silva & Alcides, 2002). Nevertheless, we reject our initial hypothesis because we found the greatest overlap in plant species and vernacular names in the north, on the Amazonian markets of Belém and Boa Vista. Most matching plant names belong to the macro-linguistic Tupi family. These plant names, despite borrowings and exchanges with other ethnic groups, have remained practically unchanged over centuries – or even millennia, as those names associated with biocultural practices in the Amazon by contemporary Tupi-Guarani societies (Balée, 2000). The migrations of Tupi-speaking peoples from the northeast towards the Amazon after 1500 (Métraux, 1927; Monteiro, 1999; Neves et al., 2011) likely played an essential role in these retentions, promoting a cultural continuity in plant knowledge through the maintenance of collective memory, not exempt of transformations, as occurs with cultural traits in contact zones with different populations by time (LaRocque, 2011; Tareau, 2019).

Similarly, European and Brazilian-born colonists had been learning about plant uses and plant names from the Indigenous population since the sixteenth century. The transmissions of this corpus of plant knowledge do not necessarily reflect a northeastern origin. For example, Tupi-Guarani groups cultivated cassava (*Manihot esculenta* Crantz) more than a thousand years ago. They diversified this crop to the northeast through pre-Columbian migrations

(Gibbons, 1990; Nassar, 2002). Later, in the 1640s, Western scholars Marcgrave (1648: 65) and Piso (1648: 52) documented the cassava in the HNB. Hence, population expansions and demographic changes enabled the incorporation of Indigenous, African, and European plant knowledge, shaping the coastal part of Brazil as a multicultural place from the sixteenth century onwards and promoting the dissemination of floristic knowledge throughout the country.

The market surveys conducted in the Amazon commonly mentioned the high number of migrants from the northeast, bringing plants and associated knowledge with them (Bitencourt et al., 2014; Medeiros et al., 2012; Santos et al., 2018; Van den Berg, 1984). These movements of people and plants may be the underlying cause for the similarities in plant composition and local names with the HNB. Some species characteristic of the Caatinga, where Marcgrave and Piso worked, and the Central Brazilian Savannah, such as the cactus *Cereus jamacaru*, were found by Santos et al. (2018) on the markets around Belém. *C. jamacaru* could have been shifted from northeastern regions, where it is sold in the markets, although it also occurs in the wild in Pará (www.splink.org.br/). The introduction of new plants by migrants was also highlighted in Itaituba (Pará) by Lima et al. (2014). Indeed, human movements have influenced the flora of several regions, especially concerning plants sold as medicine, food, or as rituals in markets (Oliveira, 2008; Pochettino et al., 2012; Van Andel et al., 2014). Markets act here as places of botanical exchange and reflect the intercultural mix caused by several populations in contact with different pharmacopeias (Tareau, 2019).

The markets in Rio de Janeiro showed considerable similarities in species composition with the HNB, compared with some markets in the north and northeast. However, many of these shared species are exotics of European, African, or Asian origin, currently cultivated for Afro-Brazilian rituals (Azevedo & Silva, 2006; Maioli-Azevedo & Fonseca-Kruel, 2007;

Parente & da Rosa, 2001; Stalcup, 2000). Marcgrave and Piso (1648, 1658) described several of these Afro-Asian plants, which the Portuguese and the Dutch introduced via the trans-Atlantic slave trade. Examples are *Aloe vera*, *Cajanus cajan* (L.) Millsp., *Musa* × *paradisiaca* L., *Ricinus communis* L., *Zingiber officinale*.

3.4.2 Different methods and resources

Even if the markets from the same region mostly shared the same biomes or environmental factors, the different methods used in the botanical surveys (Table 3) or the fact that researchers carried them out in different states probably influenced the diversity of species composition (Fig 3.2). Markets often share commercialized plants due to their geographical proximity (Lima et al., 2011). However, other factors, such as connections with other markets and common commercial routes, influence floristic composition (Santos et al., 2018). The species richness is a factor to consider. The small number of plants and names documented in Pernambuco markets and its surroundings resulted in greater relative percentages of overlapping plant species and vernaculars with the HNB than in the north. Still, the north (with a higher species richness) had more species and names in common. Scholars often considered ethnobotanical market surveys as 'short lists' of a broader range of species that may be part of the market's repertoire (Cunningham, 2014). If more funding were dedicated to detailed market surveys, the overlap in species composition with the HNB would probably increase for the northeast (as species richness would be higher too). The same applies to all ethnobotanical research in Brazil to obtain more complete plant market repertoires.

3.4.3 Changing landscapes

Environmental factors have played a crucial role in our results. Market sellers can not rely anymore on some species because of over-exploitation or loss of natural habitats due to

deforestation or soil degradation (Shanley et al., 2002). The Caatinga, Cerrado, and Atlantic Rainforest ecosystems (characteristic of the northeast) suffered from high rates of deforestation and land degradation since colonialism (Gazzaneo et al., 2005; Myers et al., 2000; Rogers, 2010; Sawyer, 2008). Vendors or intermediaries collected many plants in those ecosystems (Table 3.3). Hence, this negative environmental impact might have affected the species overlap between the northeastern markets and the HNB. For example, *Schinus terebinthifolia* Raddi, also known as Brazilian pepper or *Aroeira*, and *Bowdichia virgilioides* Kunth (*Sucupira*) are characteristic of the Caatinga and Atlantic Rainforest (www.splink.org.br/). We found derived products from these trees in Belém and Itaituba markets, brought by migrants or local intermediaries from the northeastern regions, as they hardly occur naturally in the north (www.floradobrasil.jbrj.gov.br). On the other hand, the HNB included some rainforest trees (e.g., *Caraipa densifolia* Mart., *Copaifera* sp., *Mauritia flexuosa* L.f., and *Spondias mombin* L.) that nowadays occur in the markets in the north, but not in the northeast. The HNB documented the tree *S. mombin* as *Ibametara*, *Acaia*, and *Acaja* (Fig 3.5a) and the IRUNM and Marcgrave's herbarium as *Açaia* (Figs 3.5b, c). Although *S. mombin* has a wide distribution range, including the Atlantic coast (www. floradobrasil.jbrj.gov.br), we did not find its fruit or medicinal bark in the market surveys from Pernambuco, Ceará, Paraíba, and Maranhão. *S. mombin* was, however, found in Belém with the names *Taperebá* and *Cajá* (Fig 3.5d).

Fig 3.5 **Presence of *Spondias mombin* L. in the seventeenth century sources in Dutch Brazil and contemporary Brazilian markets** (a) colored woodcut in the HNB (Margrave, 1648: 129) (b) woodcut in the IURNM (Piso, 1658: 239) (c) specimen in Marcgrave's herbarium (1638-44: 53), Botanical Garden Copenhagen, July 2014 (Photo by T. Van Andel) (d) seeds sold at the Ver-o-Peso market in Belém, August 2018 (Photo by I. Pombo Geertsma).

The loss of biodiversity due to habitat destruction in the northeast may also explain why the Brazilian market surveys do not report more than half of the useful plants documented in the HNB. For example, several useful species characteristics of the Caatinga/Atlantic biome (Giulietti et al., 2004) described in the HNB were absent from the markets of northeastern regions and any of the other markets. These plants are *Abarema cochliocarpos* (Gomes) Barneby & J.W.Grimes, *Andira fraxinifolia* Benth., *Chloroleucon dumosum* (Benth.) G.P.Lewis, *C. foliolosum* (Benth.) G.P.Lewis, *Copernicia prunifera* (Mill.) H.E.Moore, *Dioclea marginata* Benth., *Encholirium spectabile* Mart. ex Schult. & Schult.f., *Geoffroea spinosa* Jacq., *Indigofera microcarpa* Desv., *Manihot cartaginensis* subs. *glaziovii* (Müll.Arg.) Allem, and *Spondias tuberosa* Arruda). Likewise, some species now predominantly found in the Amazon (Balée, 1993), were reported in the HNB but not found in any of the Brazilian market surveys (e.g., *Astrocaryum vulgare* Mart., *Jacaratia spinosa* (Aubl.) A.DC.).

3.4.4 Mega biodiverse country in a globalized world

The lack of many HNB species in the markets and the popularity of widely traded non-native species (Table 3.2) are likely related to the globalized plant trade. Although local markets reflect local demand, global economies based on agri-business highly influenced this demand (Chaddad & Jank, 2006). This industrial model favors the homogeneity of global plant trade, decreasing plant crop diversity and increasing land grabbing to introduce monocultures (Altieri & Nicholls, 2012; Clements & Fernandes, 2013). However, local communities could use HNB species not present in trade for subsistence. Further research in these communities will add more insights into the presence of plant practices and knowledge as described by Marcgrave and Piso in the seventeenth century.

3.5 Conclusion

The *Historia Naturalis Brasiliae* reflects the flora used in the northeastern Atlantic Coast in the seventeenth century, under the mandate of the Dutch WIC and influenced by the Portuguese, enslaved Africans, and many Indigenous groups living in the region. The HNB also carries the knowledge of all the naturalists, explorers, and religious chroniclers that influenced De Laet's work when he assembled the floristic and zoological knowledge to create this treatise. Our research shows that the HNB not only represents the typical flora of northeast Brazil but reflects ethnobotanical knowledge and practices with a much greater distribution range. The similarity patterns of plant composition among Brazilian markets and the HNB indicate the wider distribution and trade in the species that Marcgrave and Piso described in 1648.

Movements of Indigenous peoples from the Amazon into the northeast since pre-Columbian times might have influenced the knowledge documented in the HNB. The methodological limitations in the published market surveys could explain the lack of most of ‘Marcgrave and Piso's plants' in current northeastern Brazilian markets. The absence of these plants could also result from the destruction of natural habitats due to economic interests and lack of proper social and environmental policies, the globalized and homogenous plant trade, and the complex movements and displacements of Brazilian Indigenous groups since colonialism. The displacement and decrease of Indigenous peoples are perpetuated in the present with right-wing governmental policies (Casarões & Flemes, 2019; Cunha & Almeida, 2000). This fact, together with the destruction of the environment to fulfill economic purposes, does not favor the conservation of traditional plant knowledge among the Tupi or other Indigenous groups and local communities.

Despite all odds, Indigenous knowledge persists, as our study has shown with the retention of plant names derived from Tupi-linguistic family languages. The multi-ethnic Brazilian

colonial society incorporated the indigenous repertoire of plant knowledge and names, which expanded this knowledge in their migrations throughout the country and normalized these names into current Brazilian Portuguese vocabulary, as shown in the HNB and the market surveys. In one way or another, the HNB is a reference point in time that captures a moment of colonial cultural transformations. This body of plant knowledge, embedded in the intersection of art and science in the seventeenth century Dutch Brazil, partly remains for sale in contemporary Brazilian markets.

Chapter 4

Dancing to the beat: *Ahoay* (*Cascabela thevetia*), stories embedded in a rattle

A shorter version of this text was published as Alcantara-Rodriguez, M. (2020) Geheimen van een rammelaar ('The secrets of the rattle'), In *Wonderkamer: Magazine voor Wetenschapsgeschiedenis,* Wetenschap & de Koloniën, 1: 75-76.

4.1 The botany of the rattle seeds

'*Rammelaar'* (rattle) is how a bracelet made of hanging shells tied with cotton strings is often labeled at museums in the Netherlands. For example, the Volkenkunde Museum in Leiden (the National Museum of Ethnology) displays this object together with maracas, musical instruments made of calabashes (*Crescentia cujete* L.), and wooden flutes ornamented with colorful patterns and feathers. These shells belong to the species *Cascabela thevetia* (L.) Lippold., formerly known as *Thevetia peruviana* (Pers.) K.Schum. *C. thevetia* are small trees with thin leaves spirally arranged and bright yellowish funnel-shaped flowers, often planted in tropical cities as ornamentals (Figs 4.1a, b). The green fruits have a waxy pericarp (Fig 4.1c), and the fleshy mesocarp becomes black on ripening. After drying, a bony endocarp or shell is exposed (Fig 4.1d), which contains the kernel, the main part of the seed (Sahoo et al., 2009). The whole plant contains milky and poisonous latex with cardiac glycosides, especially the kernels (Bandara et al., 2010).

Fig 4.1 **Botany of *Cascabela thevetia* (L.) Lippold.** (a) Habit (b) Flowers of the same species (c) unripe and hanging fruit (By *Scamperdale*, Flickr - CC BY-NC 2.0) (d) Dried pericarp of the fruit, which contains inside the bony shell (endocarp) that surrounds the seed (kernel). (https://natureshalfacre.wordpress.com/plants/1412-2/).

This species is native to tropical America and became widely cultivated in other tropical and sub-tropical areas around the world, such as India and Africa (https://powo.science.kew.org/, accessed 23.06.22). The plant belongs to the Dogbane family (Apocynaceae), which includes various poisonous species, such as the closely related *Thevetia ahouai* (L.) Vahl (also used to make rattles). The seeds of these plants are weaved into rattles to make music and accompany songs and dances by Indigenous groups and people of African origin in Brazil, Guyana, Suriname, French Guiana, and other tropical regions (Lévi-Strauss, 1952; Van Andel &

Ruysschaert, 2011). Brazilians used the seed extract in the 1970s as a heart stimulant, purgative, and abortifacient, as well as to heal wounds, treat toothache, and perform enemas (Corrêa, 1978b). This plant is mainly used now as ornamental, although the seeds are often sold as a dietary supplement for weight loss, which is potentially fatal after ingestion (González-Stuart & Rivera, 2019). This misuse has a significant impact, mostly on women, pressured by the normative standards of body image, as seen in Gurupi (Tocantins) in northern Brazil (Teixeira et al., 2013). The Ver-o-Peso market in Belém (Pará) had bags of these seeds for sale at the medicinal plant stalls, called *Castanha da India* (Indian chestnut) or *Chapéu de Napoleão* (Napoleon's hat) (Figs 4.2a,b) – both appellatives referring to the shape of the shells (Pombo Geertsma et al., 2021).

Fig 4.2 **Medicinal plant stall at Ver-o-Peso market** (a) Plant market stall with seeds, dry and fresh plants (b) Close-up of a bag with shells of *C. thevetia*. Belém, Pará, Brazil, August 2018 (Photo by I. Pombo Geertsma).

4.2 Historical accounts of *Ahoay*

As a scientist, my thoughts were initially drawn to the (ethno-) botany of *Cascabela thevetia*. But what is the history behind the rattle made with the poisonous seeds of this plant? Chroniclers and naturalists who traveled to the colonies in South America did not overlook the deadly effects of *C. thevetia*. The first images depicting Indigenous peoples in Brazil wearing these rattles were provided in the sixteenth century by French Franciscan priest André Thevet (1516-1590) in *Les singularitez de la France antarctique autrement nommee Amerique, & de plusieurs terres et isles decouvertes de nostre temps* (Thevet, 1558) (Fig 4.3). He based his narratives on his expeditions in *La France Antartique* – currently Rio de Janeiro – in the Guanabara Bay, where he spent ten weeks. Thevet cited a tree named *Ahouaï* with very poisonous seeds. According to the priest, the Indigenous Tupinambá used these seeds [shells] to make ankle bracelets and wore them during their dances (Fig 4.3). He referred to an Indigenous group related to a much wider diversity of Tupi-speaking peoples living along the coast of Brazil during the first century of colonization (Fausto, 2014).

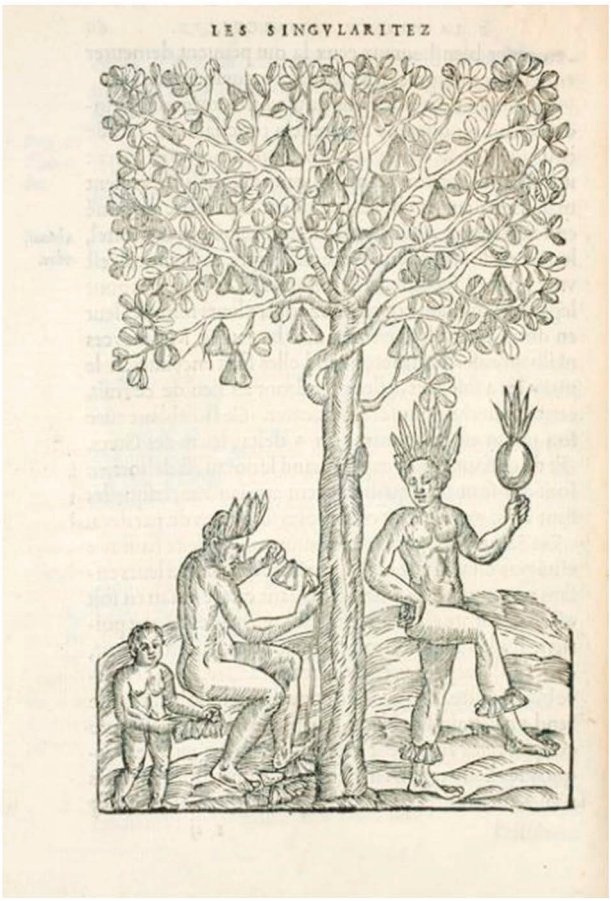

Fig 4.3 **First visual account in Europe of *Cascabela thevetia*.** Woodcut of a tree with the fruits of *C. thevetia* and Tupinambá peoples weaving the shells to make the ankle ornaments (Thevet, 1558: 66v).

Furthermore, Thevet (1558: 66r) cited the Indigenous Brazilians as 'those bad people who have gone astray from the righteous path, and he explained their use of *Ahouaï* to 'communicate with the spirits of hell.' The priest also highlighted the poisonous nature of the seeds: 'the men being angry with their wives will poison them, and likewise the women their husbands' (Thevet, 1558: 66r). He further mentioned, 'if these unfortunate women are

angered by their men, and they are pregnant, they will eat not this fruit, but certain herbs to abort' (Thevet, 1558: 66). It is uncertain how these herbs related to *Ahouaï* but, according to Schiebinger (2004), publishing on abortive plants was not common in Europe under the patriarchal structure of society that prohibited women to cease pregnancy, which nonetheless did not deter them from doing so.

Over two decades after Thevet's publication, the French chroniquer and Calvinist Jean De Léry (1534-1611) released his *Histoire d'un voyage fait en la terre de Brésil, autrement dite Amerique* (1578). De Léry spent over ten months in Guanabara Bay, where he lived among the Tupinambá. He also portrayed the rattle made of *C. thevetia* shells, among other scenes of Indigenous peoples and plants (Fig 4.4). Like Thevet, he associated the rattle with the local inhabitants' dances and the sound the seeds [shells] made when they moved. However, in contrast to Thevet – with whom he disagreed to a great extent – he praised the lives of the Tupinambá peoples, particularly their bravery in warfare, while at the same time criticized their lack of 'true' religion and their nudity (Juall, 2008; De Léry, 1578).

Fig 4.4 **Depicting the rattle and the Tupinambá peoples' dances** (a) Woodcut illustration of *Du Danseur & du Sonneur de Maraca* (The Dancer and the Maraca Rattler) (De Léry, 1578: 275) (b) Close-up of the ankle bracelets made with *Cascabela thevetia* shells.

4.3 *Ahoay* in the *Historia Naturalis Brasiliae* (HNB, 1648)

In the mid-seventeenth century, Piso cited a plant named *Ahoay* in his chapter on venoms and antidotes in the HNB. The physician stated, 'the barbarians always refuse to show the fruit, with fear of suffering the consequences, as they did not discover poison more active than the nucleus [kernel] of this fruit. They think they must guard this secret to perform their diabolic benefits safely. So they prepare with skillful art the nucleus reduced to powder, and secretly mix it with food or tobacco, to sooner or later produce an effect […] a specific remedy has not yet been discovered, so it kills rapidly […] The husks of this fruit are tough and noisy, so these are used as rattles in dances, surrounding arms, and feet around the heels, as ornaments' (Piso, 1648: 49).

Ten years later, in his modified version of the HNB, Piso (1658: 308) added to this description a figure of the *Ahoay* tree with hanging seeds of *Cascabela thevetia* – similar to the image depicted by Thevet (1658: 66v) (Fig 4.5). He also incorporated a woodcut of the bracelet (Fig 4.5) he copied from the *Exoticorum Libri Decem* (1605: 232) by Carolus Clusius (1526-1609) (Chapter 6: Alcantara-Rodriguez et al., *under review*).

Fig 4.5 **Woodcut of *Ahoay* published by Piso.** Image of the *Ahoay* tree with hanging fruits and bracelet made with *Cascabela thevetia* shells as shown in the IURNM (Piso, 1658: 308).

A century later, this plant did not go unnoticed by the Swedish taxonomist Carolus Linnaeus (1707-1778), who formalized the scientific binomial nomenclature. He named this species *Cerbera thevetia* L. in *Species Plantarum* in honor of André Thevet– who portrayed this plant for the first time in Europe – and after the fierce multi-headed dog in Greek mythology

(Linnaeus, 1753: 209). The genus was changed in 1838 to *Cascabela* Raf. by French polymath Constantine Samuel Rafinesque, named after the characteristic rattle sound of the shells clanging together (Rafinesque, 1838: 162).

4.4 From Brazil to Suriname

The rattle of *Cascabela* shells displayed in the Volkenkunde Museum (inventory number RV-5900-23) was collected in 1998 and labeled as belonging to the Wayana indigenous group from Suriname (https://hdl.handle.net/20.500.11840/842824) (Fig 4.6). The Wayana speak a Cariban language and live on the border between Suriname and French Guiana, near northern Brazil (Pará). They called this rattle *Kawai* and used it in their dances, as the Tupinambá, tied below their knees (Duin, 2009).

Fig 4.6 **Ankle bracelet made with seeds of *Cascabela thevetia* and cotton strings, belonging to the Wayana in Suriname**. Museum Volkenkunde, Leiden, October 2020 (Photo and editing by M. Nienart and L. Mens).

The Dutch obtained colonial power over Suriname shortly after losing their colonies in Brazil. From 1667, they expanded the sugar plantations in their new settlement based on a similar trade economy as in the former Brazilian territories. The plantations, as in Dutch Brazil, were sustained mainly by the forced labor of enslaved Africans. The earliest account of *C. thevetia* in Suriname was written by the Swedish naturalist Daniel Rolander (c. 1723-1793) in his *Diarium Surinamicum*, written during his expeditions to Suriname from 1754 to 1756. Rolander stated that *C. thevetia* was used for its poisonous sap by enslaved Africans to fight other black people or to kill their white masters (Van Andel et al., 2012).

4.5 Plant collections contain multiple stories

Fueled by colonial enterprise, treatises on the tropical world rapidly emerged in the early modern age. The European intellectual elite, merchants and collectors of naturalia greatly appreciated knowledge and objects. Often, these texts aimed to serve as survival guides to expand further the settlements (Schiebinger & Swan, 2007). At the same time, naturalists enlarged curiosity cabinets and private or institutional herbaria with their collections to earn a salary and build academic position and prestige (Fleischer, 2020). However, collecting and systematizing the natural world was not achieved without a cost for the people whose land was seized. Thevet demonized Indigenous peoples connecting the poisonous nature of the seeds with their 'devil practices.' De Léry seemed to sympathize with Indigenous Brazilians, yet he harshly judged their religious practices, or the lack thereof according to his Calvinist beliefs. Rolander was assisted by enslaved Africans when gathering botanical knowledge in Suriname (Andel et al., 2012), as was the case with many scientists who worked with tropical flora in the colonies (Kean, 2019; Polcha, 2019). Piso was cautious about the toxicity of the *Ahoay* seeds, trying to turn safeguarded secrets into stories that later circulated in Europe.

Stories in which he positioned himself as superior to the native people, similar to other chroniclers and naturalists. These stories embedded into text and images strengthen the narrative of the potentially exploitable lands and their people (Monteiro, 2019).

From the Netherlands to Brazil, Suriname, and back, the first European accounts of this rattle revealed its colonial history. By focusing on the images and descriptions of the objects currently kept in natural history collections in (Western) institutions, we can disentangle the interactions rooted in the unequal power dynamics these witnessed. We can trace multiple histories with the help of historical literature and botanical identifications. Certainly, the rattle depicted here includes many more uses than those observed at first sight in the museums (rattle and musical instrument), but also a medicinal plant, ornamental tree, and a source of poison. The toxicity of *C. thevetia* should not be a reason to approach this plant negatively. Education about the toxicity of *C. thevetia* takes place in Codó (Maranhão), as in other Brazilian schools, where children learn about recognizing and avoiding the ingestion of these and other poisonous plants (Conceição et al., 2018).

Beyond its toxicity or the utilitarian value of *Ahoay*, other meanings may come to mind for the Wayana and other Indigenous peoples connected to their heritage items by their personal and collective identity. These meaningful connections might go beyond the visible and tangible nature of the objects portrayed at museums. These historical accounts do not solely witness the dubious practices and beliefs of those who conducted first-hand observations in foreign lands. Just like the objects brought along the way, these written and visual sources also contain multiple histories. *Ahoay* is not only a rattle or a menacing plant: it embodies the defiance of the Tupinambá, the Wayana, and other Indigenous and Afro-descendent peoples, whose botanical knowledge was feared by the colonizers. To this day, *Cascabela thevetia* encapsulates the histories of those who kept weaving its seeds and dancing to the beat, and it is undoubtedly time for them to tell their own stories, if they wish to do so.

Chapter 5

Looking into the flora of Dutch Brazil: botanical identifications of seventeenth century plant illustrations in the *Libri Picturati*

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Abstract

The *Libri Picturati* includes a collection of plant illustrations from seventeenth century Dutch Brazil kept in the Jagiellonian Library in Krakow since World War II. While many studies focused on these images' artistic details and history, we identified the flora depicted and checked their geographic origins. Using contemporary textual sources (e.g., *Historia Naturalis Brasiliae*), monographs, and taxonomist assessments, we obtained 198 taxa. These mainly were wild and native rainforest trees and 35 introduced species. In addition, we retrieved the life forms, domestication and conservation status, and the represented plant parts of these species. Fertile branches are the most represented, although some loose dry fruits and sterile material were also painted, which sheds light on the collection methods by naturalists in Dutch Brazil. Since colonialism, several species are no longer abundant or have become invasive due to anthropogenic influences. Through this botanical iconography, we traced the first records of the sunflower and the Ethiopian pepper in Brazil and the dispersion and assimilation of the flora encountered in the colony by Indigenous, African and European peoples. We emphasized the relevance of combining visual and textual sources when

studying natural history collections, and we highlighted how digitalization makes these artistic and scientific collections more accessible.

5.1 Introduction

> 'We are also told that the nature of the foreign was understood through its natural objects. What this nature was, we are often left to wonder' (Pugliano, 2009: 324).

In 1977, in the Jagiellonian library of Krakow (Poland), zoologist Peter Whitehead found a treasure that most scholars had already considered lost: a collection of Brazilian illustrations in the *Libri Picturati* (Whitehead & Boeseman, 1989). The *Libri Picturati* consists of thousands of drawings and paintings of flora, fauna, and people from several ethnical backgrounds, which were bound together in the nineteenth century (Albertin, 1985). It contains—inter alia—sixteenth century plant watercolors attributed to the circle of correspondents around Carolus Clusius and Charles de Saint-Omer (Egmond, 2008) and a collection of Brazilian Natural History illustrations made during the Dutch occupation of northeast Brazil. The latter was created under the patronage of count Johan Maurits of Nassau-Siegen (governor-general of Dutch Brazil from 1636 to 1644) by artists and naturalists who aimed to represent the natural elements that surrounded them in the colony. The Brazilian collection includes the oil paintings known as the *Theatrum Rerum Naturalium Brasiliae* (from now on *Theatrum*), the watercolor drawings known as Handbooks, *Manuais* or the *Libri Principis* (LP), and the crayon/pencil sketches and oil paintings bound in the *Miscellanea Cleyeri* (MC) (Albertin, 1985).

Other contemporary materials to these visual sources of Brazilian nature include an account of Johan Maurits' endeavors in Brazil written by polymath Caspar Barlaeus (1647); the encyclopedia *Historia Naturalis Brasiliae* (from now on HNB) authored by the naturalist

Marcgrave and the physician Piso and published by Johannes de Laet in 1648; and the *India Utriesque re Naturali et Medica* (IURNM), a modified and doubtful version of the HNB (Piso, 1658). Both the HNB and IURNM contained descriptions and woodcut images of animals, plants, people, and tropical diseases of Dutch Brazil. These textual sources were published in the Netherlands and circulated widely among European naturalists and other inquiring minds interested in the 'exotic' nature of the Americas, while the Brazilian images were exchanged as diplomatic gifs (Whitehead & Boeseman, 1989). In 1652, Johan Maurits sent these images to Frederick William, Elector of Brandenburg (1620-1680), who passed them to his court physician Christian Mentzel (Albertin, 1985). Also interested in the natural world, Mentzel devoted himself to assembling all the illustrations from 1660 to 1664. His work resulted in a fairly organized art collection of Brazilian nature that was kept in the Elector's library (presently part of the *Staatsbibliothek zu Berlin*), available for study to humanists and intellectuals alike. Almost 300 years later, this collection was evacuated during World War II to protect it from the bombings. The *Libri Picturati* went through several transfers, and ultimately, the Brazilian iconography was found in Poland, which opened new possibilities for research (Albertin, 1985; Whitehead & Boeseman, 1989).

5.1.1 Previous research and our role

When the paintings were still in Berlin, Lichtenstein (1819, 1961) studied the fish and other animals depicted, while Schneider (1938) identified the birds and matched them with the HNB woodcuts. Martius (1853) used the *Theatrum* to compare its plant images to the HNB and IURNM and elaborated further on Brazilian botany in his commentaries on Marcgrave's plants. However, he previously described this endeavor as 'such a laborious task' (Martius, 1843: XI). Albertin (1985) focused on the content of the *Theatrum* from an art historical perspective with a special focus on the authorship of the images. Whitehead and Boeseman

(1989) provided a thorough overview of the visual and textual sources produced in or about Dutch Brazil, considering the *Theatrum* images as the basis for the HNB woodcuts. Brienen (2006, 2007) focused on the relationship between visual information and scientific enterprise in the early modern period and advanced hypotheses about the authorship of the images. Ferrão and Soares (1993, 1995) historically contextualized and reproduced the images of the *Libri Picturati* while commenting on some of the illustrations. Recently, Scharf (2019) analyzed the different pictorial techniques behind the composition of the LP. The images were made by different artists using various techniques, but the authorship is still uncertain. Scholars have attributed them to Dutch painters Albert Eckhout (Brienen, 2006; Teixeira, 1992, 1995) or Frans Post (Schneider, 1938). Others suggested that they were made by Marcgrave, who had taken artistic training and produced several drawings that served as the basis for some of the woodcuts depicted in the HNB (Whitehead & Boeseman, 1989). Scharf (2019) suggested that count Johan Maurits was the artistic hand behind some watercolors. Hence, these illustrations have been mainly studied from an (art) historical approach. We chose to identify the species depicted in the paintings, thereby revealing their domestication status, geographic origin, and the natural vegetation type in which they occur, to suggest where they were made and how close naturalists and artists collaborated in Dutch Brazil.

A team of art historians and botanists that studied the sixteenth century illustrations of the *Libri Picturati* have identified the plants depicted (Koning et al., 2008), but this has not been the case for the Brazilian collection. In the *Theatrum*, some taxonomic notes are written above the plant illustrations—of dubious authorship, which Albertin (1985) attributed to Lichtenstein. Nevertheless, these are often incomplete, outdated, or erroneous. The recent digitization of all plant illustrations by the Jagiellonian library has enormously facilitated research on these valuable historical images. Here we present the first botanical revision and systematic identifications of the plants depicted in the Brazilian collection of the *Libri*

Picturati: the *Theatrum Rerum Naturalium Brasiliae*, the *Libri Principis,* and the *Miscellanea Cleyeri*. We posed the following research questions: (1) What plant taxa are illustrated in the *Libri Picturati*? (2) What taxa were intended to be added to the original collection by Mentzel but lack illustrations in this collection? (3) What insights can we infer from the illustrations on the methods of plant collection and collaboration between naturalists and artists in the colony? (4) What are the differences and similarities in botanical content between visual and written sources?

Brienen (2006) and Ferrão and Soares (1993) attested that the flora represented in the *Libri Picturati* mainly came from the surroundings of Recife, the colony's capital. Due to Marcgrave's multiple expeditions to the interior of Brazil (Van den Boogaart & Brienen, 2002), we expected to find plant species from a wide variety of ecosystems in northeastern Brazil: the semi-arid *sertão* or *caatinga* and the Atlantic rainforest, which includes savannas, mangroves, and dry shrub land (Martinelli & Moraes, 2013: 1070). Following Whitehead and Boeseman (1989) and Teixeira (1992), we expected to find similar plant taxa in the *Libri Picturati* as in Marcgrave and Piso's natural history treatises because both visual and textual representations were made in the same area around the same time in Dutch Brazil.

5.2 Methods

Due to Covid-19 travel restrictions, we could not study the original material in Poland. Jagiellonian library curator Izabela Korczyńska provided the scanned images of the *Theatrum*, while the LP (https://jbc.bj.uj.edu.pl/dlibra/publication/193892/edition/183824/content) and MC (https://jbc.bj.uj.edu.pl/dlibra/doccontent?id= 197455) were retrieved from the Jagiellonian Digital Library. We systematized all information on the botanical images in a spreadsheet organized by page number, vernacular plant names, and reference annotations to the HNB

and IURNM on the folios. Next, we included our taxonomical identifications (to species level whenever possible) and indicated whether these taxa were present in Marcgrave and Piso's books (1648, 1658) or Marcgrave's herbarium (1638-1643/4) (available at https://samlinger.snm.ku.dk/en/dry-and-wet-collections/botany/general-herbarium/ the-marcgrave-herbarium/). We identified the illustrated plant taxa by using our previous identifications of the species present in the HNB, the IURNM, and Marcgrave's herbarium (Alcantara-Rodriguez et al., 2019), and prior research of the Brazilian botanists Pickel (2008) on the species described in Marcgrave and Piso's textual sources and Andrade-Lima et al. (1977) on Marcgrave's herbarium. We compared the illustrations with related seventeenth century Brazilian images (Wagener, c.1641, in Teixeira, 1997). In addition, we used literature on the Brazilian flora (Lorenzi, 2002; Lorenzi & Matos, 2008), monographs (e.g., García-Mendoza, 2001; Johnson & Murray, 2018; Taylor, 1980), online herbarium databases, such as the Global Biodiversity Information Facility (https://gbif.org/), Tropicos (https://tropicos.org/), Naturalis Biodiversity Center (https://bioportal.naturalis.nl/). We also consulted expert taxonomists in Brazil, the Netherlands, Mexico, and the United States. Information on the native or introduced status and life form of the depicted taxa was retrieved from the online Flora do Brazil 2020 (http://floradobrasil.jbrj.gov.br/). We checked the exotic species' origin using the database Pl@ntUse (https://uses.plantnet-project.org/en/Main_Page). We also reviewed other sources on introducing specific taxa to Brazil (e.g., Burle et al., 2010; Lentz et al., 2008; Maia et al., 2015; Roullier et al., 2013). We noted the plant parts represented in the illustration, as these give an idea of the collection methods in the mid-seventeenth century. We verified the domestication status of each depicted taxon from the descriptions by Marcgrave and Piso (1648, 1658), who sometimes alluded to cultivation methods or plant provenance. We also reviewed archaeobotanical and historical studies on pre-Columbian plant domesticates (Clement, 1999; Levis et al., 2017, 2018). Lastly, we

looked into the research on Johan Maurits' palace gardens in Recife (Silva & Alcides, 2002) based on Barlaeus (1647). Although the varying degrees in the level of domestication of certain species fit better in a continuum (Clement, 1999), for this paper, we distinguish three categories: wild, cultivated, and domesticated. Following Levis et al. (2017), we considered domesticated species that show substantial morphological and genetic changes and depend on human management for long-term survival. We included as cultivated species those that are managed to some extent by humans, albeit they can survive and reproduce in the wild without them (Levis et al., 2017: 6). We retrieved the conservation and endemic status from the Brazilian database on Flora Conservation (CNC-Flora: https://cncflora.jbrj.gov.br/portal/) and the IUCN Red List (https://iucnredlist. org/). We also referred to the CITES list to check which species are currently protected to avoid over-exploitation by international trade (https://cites.org/). To reconstruct the floristic content of the *Theatrum* if Mentzel had been able to add all plant illustrations he aimed, we verified reference annotations (vernacular names and page numbers) on the empty folios to Marcgrave and Piso's books (1648, 1658) and identified the taxa that were meant to be represented on those folios. To update the taxonomical nomenclature, we used the Flora do Brazil 2020 (https://floradobrasil.jbrj.gov.br/) and the Plants of the World Online (https://plantsofheworldonline.org/).

5.3 Results

5.3.1 Botanical content of the *Libri Picturati* Brazilian collection

We listed our identifications of all plant illustrations with their vernacular names, page numbers, and associated information on growth form, geographical origin, conservation, and domestication status in Supplementary Dataset S1. From the entire collection of Brazilian

plant illustrations in the *Libri Picturati*, we identified 198 taxa organized in the *Theatrum*, LP, and MC, as indicated in Supplementary Table S1. Between folios 729 and 731 of the *Theatrum*, an illustration of a tea plant (*Camellia sinensis* (L.) Kuntze) is glued, which was sent by Cleyer from Batavia (currently Jakarta, Indonesia), the headquarters of the Dutch East Indian Company (VOC). As it was inserted later in the *Theatrum* and not depicted in Brazil, we did not include it in our analysis. A few plants remained unidentified due to a lack of morphological characters, the limited quality of the drawing, and/or the lack of references to written sources by Marcgrave or Piso (1648, 1658).

Among the LP botanical watercolors, we identified 34 vascular plant species (38 images), with the Passifloraceae as the most represented family (five species, six images), followed by the Fabaceae (five species, five images). Among the MC plant drawings, we identified 26 vascular plant species (34 images), and the most represented families were the Cucurbitaceae (three species, seven images) and the Myrtaceae (three species, three images). Among the illustrated content of the *Theatrum*, we identified 162 vascular plant species (175 images) and one basidiomycete fungus (*Copelandia cyanescens* (Sacc.) Singer, Bolbitiaceae). Fungi were commonly placed within the plant kingdom until the mid-twentieth century. The most represented families among the illustrated content are the Fabaceae (22 species, 22 images), followed by the Solanaceae (10 species, 11 images), Lamiaceae (six species, six images), and Myrtaceae (six species, eight images). The Fabaceae is the most diverse plant family in the world (Gomes et al., 2018), while the Myrtaceae is one of the most rich-species woody plant families in the Atlantic Forest in Brazil (Giaretta et al., 2015).

5.3.2 Mentzel's unfinished task: the intended botanical content of the *Theatrum*

The *Theatrum* also includes 206 empty folios, interleaved between 160 folios with plant illustrations (see example in Fig 5.1). On most folios, vernacular names and references to the pages of the HNB and IURNM are written on the top center, often relating to one taxon but sometimes referring to two taxa.

The blank folios occur predominantly at the end of the collection, as if the maker had little space and somehow had to squeeze them in. Among these unillustrated folios, the vernacular plant names and references to Marcgrave and Piso's sources allowed us to identify 196 vascular plant species (218 records), including five ferns from the families Drypteriaceae (one species), Polypodiaceae (one species) and Pteridaceae (three species); one algae (*Sargassum tenuissimum* (Endlicher & Diesling) Grunow, Phaeophyceae) and a marine sponge (*Clathria* cf. *nicoleae* Vieira de Barros, Santos & Pinheiro, Microcioniadae) (Supplementary Dataset S1). Since the study of spongiology (Porifera) did not develop until the mid-nineteenth century, these animal colonies must have been considered aquatic plants because of the tree-like shape and the fact of living attached to the seabed. The most represented family that would correspond to the blank folios was the Fabaceae (29 unillustrated species, 33 records), followed by the Arecaceae (nine species, ten records), Solanaceae (nine species, nine records), and Asteraceae (seven species, seven records). Estimates of the intended botanical content (i.e., empty folios with references and illustrated folios) are shown in Table 5.1.

Table 5.1 Estimations of the botanical content of the *Theatrum Rerum Naturalium*, including empty and illustrated folios.

Theatrum	*Unfinished plant content*	*Illustrated plant content*	*Total (intended) botanical content*
Folios	206	160	366
Illustrations	0	172	172
Vernaculars/plants	220	176	396
Taxa	205	163	335
Species	197	150	313
Genera	5	8	13
Unidentified taxa	3	5	8
Families	74	68	95

* The sums of taxa, species, and families exclude the repeated records in both empty and illustrated folios.

On f. 139 of the *Theatrum*, the vernacular name *Ambaibuna* is written on an empty page without reference to Marcgrave's or Piso's books (Fig 5.1a). Moreover, the page with *Ambaibuna* is located between *Ambaiba*, which corresponds to the illustration of *Cecropia pachystachya* Trécul (Fig 5.1b), and a blank page with only the vernacular name *Ambaitinga*, which corresponds to *C. hololeuca* Miq. (Fig 5.1c). The Brazilian *Cecropia* species are known in Tupi-related languages as *Ambauba*, *Ambauva,* or *Umbaúba* (https://dataplamt.org.br/). These terms are phonetically and morphologically similar to *Ambaibuna*. For those reasons, we initially assumed that *Ambaibuna* referred to a *Cecropia* species. Still, the same name *Ambaibuna* is later repeated with the name Iito (Fig 5.1d) next to an illustration representing a completely different tree species: *Guarea guidonia* (L.)

Sleumer. Furthermore, *Ambaibuna* is written above the illustration of a grapevine, Vitis vinifera L., unrelated to *Cecropia* (Fig 5.1e).

Fig 5.1 **Similar vernacular names for different taxa in the *Theatrum* collection** (a) Empty folio, except for the vernacular name written above (f. 139) (b) oil painting of *Cecropia pachystachya* Trécul in f. 137 (b) (c) empty folio that would correspond to *Cecropia hololeuca* Miq. according to the reference to the IURNM (d) illustration of *Guarea guidonia* (L.) Sleumer in f. 227 (e) illustration of *Vitis vinifera* L.

Whether *Ambaibuna* was a generic name to designate several non-related species or represents a mistake by the author who wrote the names on the illustrations remains

unknown. On the other hand, neither Marcgrave nor Piso mentioned *Ambaibuna* in their descriptions of the Brazilian flora. Aside from Marcgrave and Piso's books (1648, 1658), it is yet to be determined which source(s) Mentzel relied on when arranging the botanical content of the *Theatrum*. It is nonetheless clear that he must have been confused by the similarity of some of the Tupi-related plant names. Unfortunately, Marcgrave was no longer present to help him match the illustrations, names, and descriptions because he died about 16 years before Mentzel started organizing the Brazilian plant illustrations.

5.3.3 Origin of the exotic species in the *Libri Picturati*

Predominantly, the *Libri Picturati* collection depicts native Brazilian plants. Most of the species represented in the *Theatrum* are native to Brazil. Still, the proportion of native species is much lower in the MC and lowest in the LP, in which almost half of the illustrations represent introduced species (Fig 5.2).

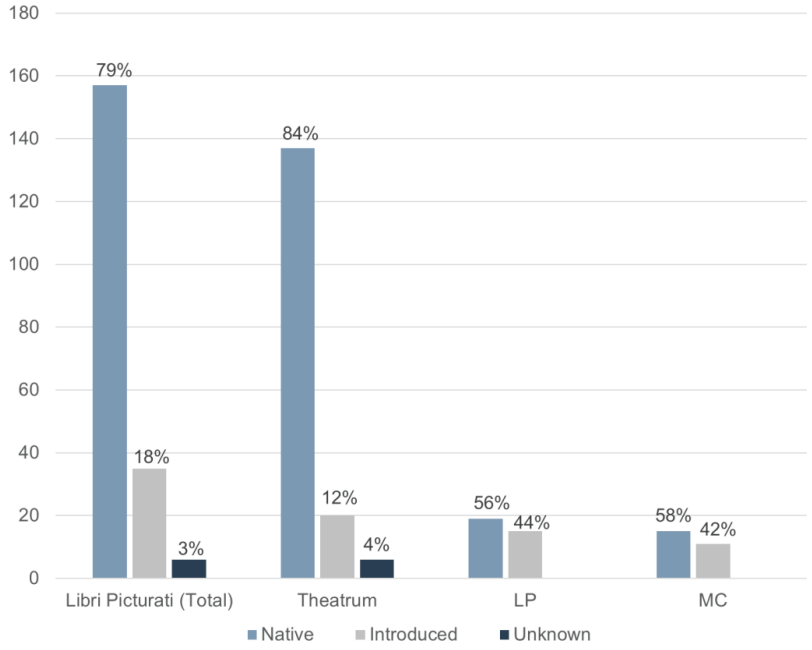

Fig 5.2 **Proportion of native and introduced species in the Brazilian collection of the *Libri Picturati*.** Percentages and numbers correspond to the ratio of native/introduced plant species depicted in the whole collection and the three separate works: *Theatrum Rerum Naturalium* (Theatrum), *Libri Principis* (LP), and *Miscellanea Cleyeri* (MC).

There are 35 species of exotic origin in the complete Brazilian collection of the *Libri Picturati* (Supplementary Table S2). These introduced species now occur in (sub-) tropical areas worldwide. Most of the exotic plants originally came from other parts of the Americas, especially Mexico, the Caribbean, and the Andes region (14 species), followed by those that originated in the African continent (10 species) and tropical Asia (nine species) (Supplementary Table S2). Long before the European colonization, Indigenous groups domesticated, traded, and introduced to Brazil most of the exotic American plants we found

in these collections. Examples are the papaya (*Carica papaya* L.), cotton (*Gossypium barbadense* L.), sweet potato (*Ipomoea batatas* (L.) Lam.), beans (*Phaseolus vulgaris* L.), guava (*Psidium guajava* L.) and maize (*Zea mays* L.) (Clement, 1999). Most of the species of Asiatic origin were already naturalized or cultivated in Africa and introduced to Brazil through the Trans-Atlantic slave trade before the Dutch arrived. Examples are yams (*Dioscorea alata* L.), plantains (*Musa* × *paradisiaca* L.), and weeds like *Abrus precatorius* L. and *Plumbago zeylanica* L. (Carney & Rosomof, 2009; Voeks, 2013). Others were introduced from Europe by merchants and settlers, such as the Portuguese Jesuits, who incorporated them as remedies into their *boticas* (Jesuit pharmacies in the colonies). For instance, *Citrus* and pomegranate fruits were planted as fruits but also used medicinally. Lemons expelled roundworms, and pomegranates could combat cold fevers (Leite, 2013: 88). Portuguese and Dutch must have been familiar with some African plants before their arrival to Brazil, such as *Aloe vera* (L.) Burm.f., *Ricinus communis* L. and *Tamarindus indica* L. These useful plants were already known in Europe through Arabic and Greek medical texts, whose knowledge was boosted by their translations into Latin during the High Renaissance (Leite, 2013; Reeds, 1976). *Punica granatum* L. was introduced into the Iberian Peninsula via ancient merchant routes in the Mediterranean (Chandra et al., 2010) and brought to Brazil by the Portuguese (Leite, 2013). Portuguese started cultivating grapes (*Vitis vinifera* L.) in Pernambuco around 1542 (Sousa, 1969). Along the Atlantic coast, lemons, pomegranates, and grape vines adapted to the new environmental conditions and thrived in the vicinities of Johan Maurits' residence, as evidenced by the illustrations in the *Theatrum* and textual accounts (Marcgrave & Piso, 1648; Piso, 1658a; Silva & Alcides, 2002).

These globally commodified plants are common today in Brazil as in many regions worldwide. Other species seem to have lost their popularity over time. The so-called Ethiopian, Guinean, or Negro pepper, *Xylopia aethiopica* (Dunal) A.Rich., was present

around the 1640s in northeast Brazil, as evidenced in the *Libri Picturati* by a painting with a fruiting branch with leaves named *Piperis aethiopici spés* (Fig 5.3a). The first iconography of this aromatic tree in Europe is found in Matthioli's commentaries on Dioscorides under the name of *Piper aethiopicum* (Matthioli, 1565: 575), and its fruits were previously cited by the Persian polymath Avicenna (980–1037) (Johnson & Murray, 2018). This African pepper was commonly used in Europe until southeast Asian spices gained popularity in the sixteenth century (Halikowski Smith, 2008). In the plantation societies of tropical America, *X. aethiopica* constituted a food crop for enslaved Africans in the early colonial period (Carney & Rosomof, 2009: 135). Today, its fruits are used in aphrodisiac tonics (Volpato et al., 2009) and special dishes prepared for African deities (Orishas) in Cuba (Carney & Rosomof, 2009: 90). Still, it is unclear whether the species grows in Brazil. Its current distribution range encompasses west, central, and southern Africa (https://gbif.org/occurrence/map?taxon_key=3157151). The dry fruits are used in tropical Africa as a condiment, in rituals, and as medicine to treat cough, bronchitis, rheumatism, malaria, amenorrhea, and uterine fibroids (Burkill, 1985; Erhirhie & Moke, 2014; Kofie et al., 2016). There is an herbarium record in Brazil made by photographer and anthropologist Pierre Verger. The label on the specimen mentions 'Brazil' and 'Plantas de Candomblé' and it indicates that the voucher was deposited at the Herbarium Alexandre Real Costa (ALCB, according to *Index Herbariorum*: http://sweetgum.nybg.org/science/ih/, accessed 23 August 2021) in Bahia (Verger s/n, ALCB012478, available at ALCB, via Species Link: https://specieslink.net/search/, accessed 23 August 2021). Verger presumably collected this specimen in Bahia in 1967 while researching ritual and medicinal plants used in Candomblé (http://inct.florabrasil.net/alcb-resgate/, accessed 2 June 2021) (Verger, 1995). However, it seems to be a mixed collection, as the leaves are oppositely arranged and with long petioles, which is uncommon for Annonaceae (Johnson & Murray, 2018). In Brazil, the fruits of the Brazilian relative *Xylopia*

aromatica (Lam.) Mart. have probably served as a good substitute for *X. aethiopica*, as they have a similar peppery taste and stomachic properties (Dias, 1988: 3), and are more easily gathered from the *cerrado* savannahs or the Amazon rainforest. Voeks (1990) documented *X. aethiopica* seed powder as used in Candomblé rituals by Yoruba practitioners in Bahia. Nevertheless, there is no clear information on whether *X. aethiopica* is cultivated in the Neotropics or imported; thus, the origin of the fruits, seeds, or powder in Brazil remains uncertain.

Fig 5.3 **Exotic species in Dutch Brazil depicted in the *Theatrum*** (a) illustration of the African spice-producing tree *Xylopia aethiopica* (Dunal) A.Rich. in f. 321 (b) oil painting of the first record of the sunflower (*Helianthus annuus* L.) in Brazil (f. 555).

The first reference to the sunflower (*Helianthus annuus* L.) in Brazil dates to the twentieth century when European immigrants introduced it due to its economic value as an oil-producing crop (Feoli & Ingaramo, 2015). Sunflowers are of North American and/or Mexican origin (Janick, 2020; Salgado, 2009) and were introduced to Europe in the sixteenth century by the Spanish as part of the Columbian exchange (Crosby, 2003). Merchants observed how native Americans benefited from this plant and exported the sunflower to Europe, where it was primarily valued as ornamental and later as a food crop, propelled by genetic improvement by the Russians in the 1800s (Salgado, 2009). Before the sunflower became a popular and well-established crop in the twentieth century, this plant was already encountered in northeast Brazil, as evidenced by the illustration in the *Theatrum* (Fig 5.3b). Portuguese sailors may have played a role in its introduction to Brazilian territories, or it could have been intentionally brought by merchants or Jesuits, although the latter paid more attention to medicinal plants (Leite, 2013; Walker, 2013). We may also consider the Dutch as active agents in its introduction to their colonies in the northeast. Egmond (1016) indicated that a relevant female agent in disseminating the sunflower in the Netherlands was Christine Bertolf (1525-1590), who was acquainted with the Spanish court and keened on the rare plants that thrived in the Royal Botanical Garden in Madrid. She spread textual and visual information about the sunflower and possibly its seeds among her network of naturalists and collectors, including the Flemish botanists Dodoens and Clusius (Egmond, 2016). After Dodoens (1568: 295) depicted the first European sunflower in his herbal in 1568, images and descriptions of this species began to circulate in manuscripts of other naturalists and physicians in Europe (e.g., Matthioli, 1568: preface, Fragoso, 1572: title page, Monardes, 1574: 109v, and Clusius, 1590: 14-15). Thus, by the seventeenth century, Dutch scholars and collectors of exotic naturalia were familiar with sunflowers, which possibly promoted their cultivation at Johan Maurits' gardens for ornamental purposes.

Interestingly, the sunflower is referenced as *Camará-guaçú,* an Indigenous term from the macrolinguistic Tupi family. *Camará*, *Kamará* or *Cambará* is a generic name given to several unrelated species, such as *Lantana camara* L. (Verbenaceae) and *Ageratum conyzoides* L. (Asteraceae) (http://www.dataplamt.org.br/, accessed 2 June 2021), both found in the *Theatrum* (p. 341 and 343 respectively). According to Tibiriçá (1984), Tupi *caa* means plant, and *mbaraá* means illness, and according to Cherini (2007), *Cambará* means 'leaf of rough bark.' Hence, *Camara* also refers to medicinal plants with rough leaves in general. *Guaçú* means big and *miri* small (Navarro, 2015), which matches with the larger inflorescence of *H. annuus* in contrast to the African weed *Sida rhombifolia* L. (Malvaceae), documented as *Camara-miri* in the HNB and 'used by black people as a broom to sweep the houses of their masters' (Piso, 1648: 110). According to the Tupi-based nomenclature associated with *H. annuus* in the *Theatrum*, Tupi Indigenous groups were already familiar with the sunflower in Brazil around the 1640s.

5.3.4 Life forms and domestication status of the *Libri Picturati* plants

Most of the species in the *Theatrum* are tropical trees, followed by shrubs, herbs, and lianas (Fig 5.4). Several consisted of rainforest trees, such as *Andira fraxinifolia* Benth., *Garcinia brasiliensis* Mart. and *Syagrus coronata* (Mart.) Becc. The same trend was observed for the illustrations in the MC, with trees as the most often represented life forms, followed by shrubs, lianas, and herbs. Typically, the LP contains much fewer trees but more small herbs, shrubs, and vines that were probably found in and around Mauritsstad (i.e., the former capital of Dutch Brazil, currently a part of the Brazilian city of Recife). Examples are *Commelina erecta* L. and *Turnera subulata* Sm., which commonly grow in disturbed landscapes.

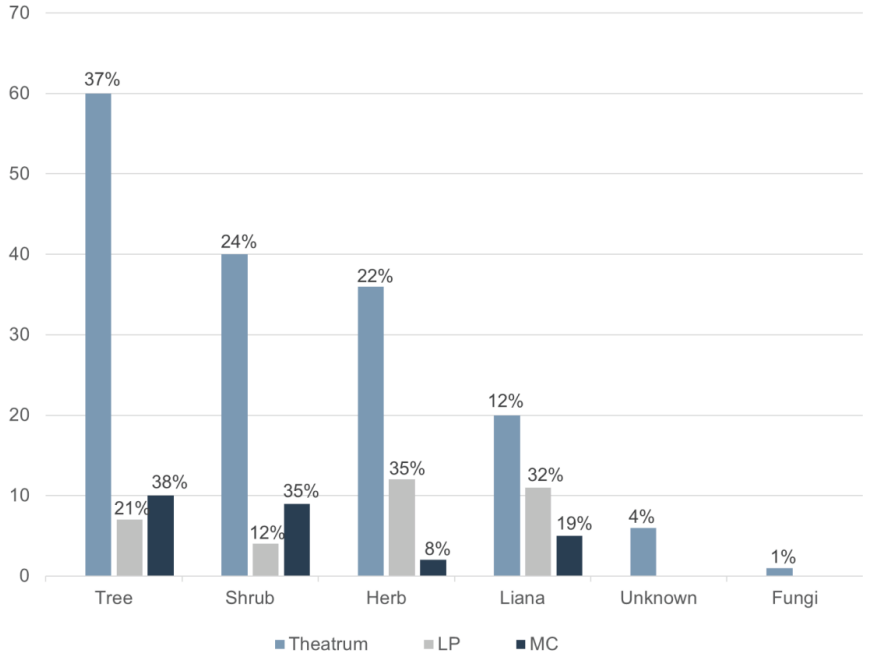

Fig 5.4 **Proportion and number of life forms of the species depicted in the *Libri Picturati***.

Although the majority of the species depicted in the *Theatrum* and the MC are wild forest trees, some species are found both in the wild and cultivated, such as *Psidium guineense* Sw., which was part of the pre-Columbian anthropogenic forests or 'Indigenous landscape' in Brazil (Balée, 1994; Clement, 1999; Levis et al., 2017). Some trees were planted in or around Recife. *Hancornia speciosa* Gomes, known by its Tupi-based name *Mangabiba* or *Mangaiba* [*Mangabeira*] (Marcgrave, 1648: 121), was cultivated in Mauritsstad (Barlaeus, 1647: 242; Silva & Alcides, 2002). The fruit of *H. speciosa* (*Mangaba*) was harvested in large amounts as it was a highly appreciated food (Marcgrave, 1648: 122). Seeds were collected to plant the tree, and Marcgrave gave details about the specific locations of varieties in different northeastern locations (Salvador, Sergipe, and Olinda). *H. speciosa* was already selected and

managed by Indigenous groups before colonization (Clement, 1999), yet wild populations of this tree exist today in the Brazilian rainforest and savannah (http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB15558, accessed 4 June 2021). Domesticated plants are represented in higher proportions within the LP and the MC (Fig 5.5), mainly accounting for introduced fruit species (Supplementary Dataset S1). Examples are *Citrus* spp., *Musa* x *paradisiaca,* and *Cocos nucifera* L. cultivated in Maurits' gardens in Recife (Silva & Alcides, 2002). The influence of the European colonization of Brazil is also visible in the presence of weeds from Asia and Africa among the illustrations in the *Theatrum* and the LP, such as *Abrus precatorius* L., *Argemone mexicana* L., *Boerhavia coccinea* Mill. and *Plumbago zeylanica* L. Some plants were introduced from Africa via slave ships, while others may have dispersed naturally (Voeks, 2013). *Guilandina bonduc* L., an African scrambling shrub depicted as *Inimboi* in the *Theatrum,* was described by Piso (1648: 95) as 'growing in abundance in sandy and dry forests of the coasts.' We categorized *G. bonduc* as a wild plant: its round seeds could have been brought by oceanic currents from West African shores and germinated in the coastal vegetation of Pernambuco and other South American areas (Murray, 1986). However, *G. bonduc* may have reached Brazil during the Trans-Atlantic slave trade, as the hard, grey seeds are used in the African game *Oware* and bead ornaments (Heilbron, 2012).

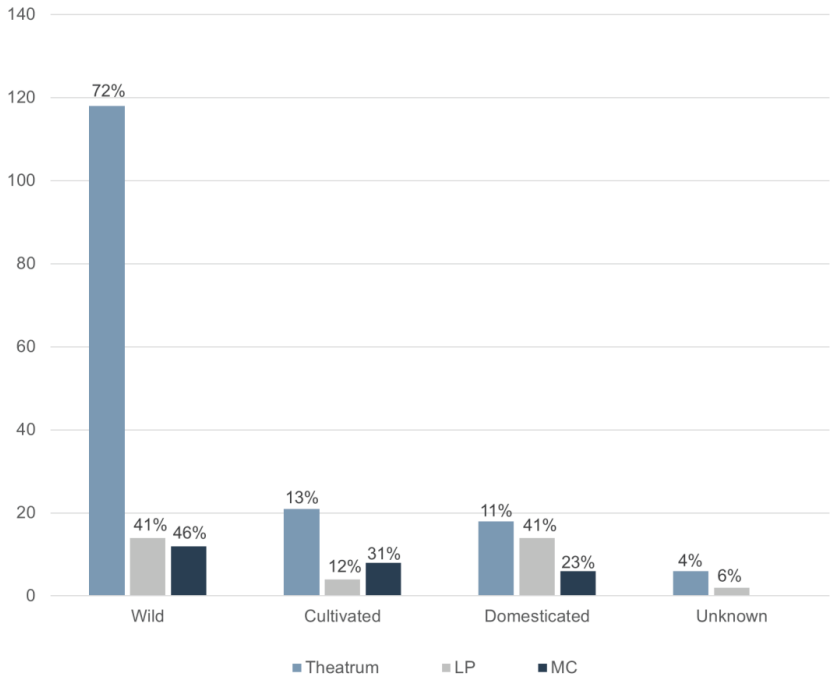

Fig 5.5 **Domestication status of the species in the Brazilian collection of the *Libri Picturati*.**

5.3.5 Plant parts represented in the *Libri Picturati*

The way plants are depicted in the *Libri Picturati* provides information about the artists' level of botanical skills and how closely they worked together with the naturalists in the Dutch colony. For instance, some plants are represented by only loose parts or depicted as sterile, while others show us different organs and reproductive stages, which greatly facilitated their taxonomic identification (Table 5.2).

Table 5.2 Plant parts represented in the botanical illustrations of the *Libri Picturati*.

Plant parts represented	*N° of plants in the Theatrum*	*N° of plants in the LP*	*N° of plants in the MC*
Stem [(a)] + (Leaves) + Fruits + (Seeds)	73 (41%)	6 (16%)	10 (29%)
Stem + (Leaves) + Flowers + Fruits + (Seeds) + (Underground organs) [(b)]	38 (22%)	4 (11%)	2 (6%)
Stem + (Leaves) + Flowers	33 (19%)	16 (42%)	6 (18%)
Fruit + (Seeds) only	12 (7%)	7 (18%)	8 (23%)
Flowers only	4 (2%)	3 (8%)	3 (9%)
Sterile branches/leaves/underground organs only	15 (9%)	2 (5%)	5 (15%)

[(a)] Stems, including branches and trunks.

[(b)] Including roots, rhizomes, tubers, and bulbs.

Most illustrations depict fertile plant species with flowers and fruits, often cut in half to show the seeds, which reveals a high level of botanical knowledge. Fertile plants are more common in the *Theatrum*, on a few occasions also showing their tubers, such as *Spondias tuberosa* Arruda, known as *Umbi* [*Iva Umbu*], of which the prominent tuber in the bottom front captures the attention of the observer (Fig 5.6a). Likely associated with a scientific purpose, drawing some plant parts out of proportion corresponds to a visual style also observed in other iconographies. This selective painting method is also the case in the *Icones Plantarum Malabaricarum*, which depicts plants from Ceylon (modern Sri Lanka) in the eighteenth century and often accentuates valuable fruits, flowers, or roots (Van Andel et al., 2018).

Fig 5.6 **Examples of plant parts represented in the *Libri Picturati*** (a) tuber of *Spondias tuberosa* Arruda painted in the front and branch with leaves, tiny white flowers, and fruits in the back (*Theatrum* f. 261) (b) Infertile individual of *Hippeastrum psittacinum* (Ker Gawl.) Herb. (*Theatrum* f. 389) (c) leaf of *Ficus gomelleira* Kunth & C.D.Bouché (*Theatrum* f. 157) (d) Flowering vine of *Centrosema brasilianum* (L.) Benth. (*Libri Principis* f. 2) (e) dry open fruit without seeds of *Amphilophium crucigerum* (L.) L.G.Lohmann (*Theatrum* f. 387).

Piso (1648: 78) indicated that roots [tubers] of *S. tuberosa* deserved special attention because of the way they developed underground and their use as a refreshment [water reservoir] for feverish patients and exhausted travelers, as he experimented by himself. He and Marcgrave

(1648: 108) also described how the local population valued its fruits as food. This example provides textual and visual evidence of these naturalists' field trips to the interior and their first-hand experiments. Furthermore, it adds insights into the connectedness between artistic and scientific practices in seventeenth century Dutch Brazil. Currently, *S. tuberosa*, known as *Umbu* or *Umbuzeiro* (https://dataplamt.org.br/), is an essential economic and subsistence food resource for rural communities in semiarid regions of northeast Brazil (Cavalcanti et al., 2000; Neto et al., 2010). Its specialized root system (xylopodia) bears tubers that store liquids, sugars, and other nutrients and allow the tree's survival during the dry seasons of the *caatinga* and central Brazilian savanna, where this species is endemic (Cavalcanti & Resende, 2006). The water or sweet juice of the xylopodia is still used as an emergency thirst quencher in extremely arid areas of the Brazilian sertão (Batista et al., 2015); also see https://www.youtube.com/watch?v=NyGNl rljAww, accessed 25 August 2012].

In the *Theatrum*, a small proportion of plants are illustrated in their sterile stage, such as *Hippeastrum psittacinum* (Ker Gawl.) Herb. (Fig 5.6b) or *Ficus gomelleira* Kunth & C.D.Bouché (Fig 5.6c). As noticed by Pickel (2008: 59), Marcgrave must not have seen the impressive flower of *H. psittacinum* as any description of the fertile parts is lacking in his observations (Marcgrave, 1648: 32). The *Theatrum* painting was likely made in the wet season in the interior of Pernambuco when Marcgrave and the painter(s) encountered the lily with only leaves, which occurs before the leaves fall off and the mesmerizing flower appear (Pickel, 2008: 59). *Ficus gomelleira*, depicted by a single oblong leaf with its characteristic pinnate venation (Fig 5.6c), is a large tree, up to 40 m tall (https://portal.cybertaxonomy.org/flora-guianas/node/3041, accessed 4 June 2021). It can be challenging to collect a branch, so the painter(s) or local assistants may have picked a leaf from the ground.

The LP contains mainly flowering plants (e.g., *Ruellia* cf. *elegans* Poir.), tendrillate vines (e.g., *Centrosema brasilianum* (L.) Benth. in Fig 5.6d) and cultivated crops, such as peanuts (*Arachis hypogaea* L.), pumpkins (*Cucurbita pepo* L.) or guava (*Psidium guajava* L.) (Supplementary Dataset S1). Compared to the MC and the LP, a smaller proportion of the illustrations display only flowers or fruits in the *Theatrum*. Yet, these deserve special attention as the reasons for only painting the reproductive organs in the three collections may differ. While in the MC and LP, flowers or fruits represent domesticated species or are more likely to be found in urban areas, such as *Capsicum baccatum* L. or *Hancornia speciosa*, the *Theatrum* contains more loose parts of native plants found in the rainforest. *Amphilophium crucigerum* (L.) L.G.Lohmann is a liana referenced by the Tupi-related name *Iaruparicuraba* and today known in Brazil as *pente-de-macaco* (https://dataplamt.org.br/), meaning monkey's comb. This term refers to its sizeable dehiscent fruit (c.17 cm long) that opens in two valves covered with soft spines (Fig 5.6e). Its winged seeds are not present in the drawing, possibly one empty valve was gathered from the ground, and the wind already dispersed the seeds.
In the MC, we also find some drawings of infertile structures, but these mostly belonged to species depicted on several folios. When assembling those folios, we observed the whole plant represented in its fertile stage: the watermelon (*Citrullus lanatus* (Tunb.) Matsum. & Nakai) is depicted with its leaves and fruit on folio 63 (verso) and its leaves on folio 64 (recto). In the case of *Furcraea foetida* (L.) Haw., whoever bounded the drawings in the MC collection, did not realize that three of its folios formed together one entire plant (Fig 5.7).

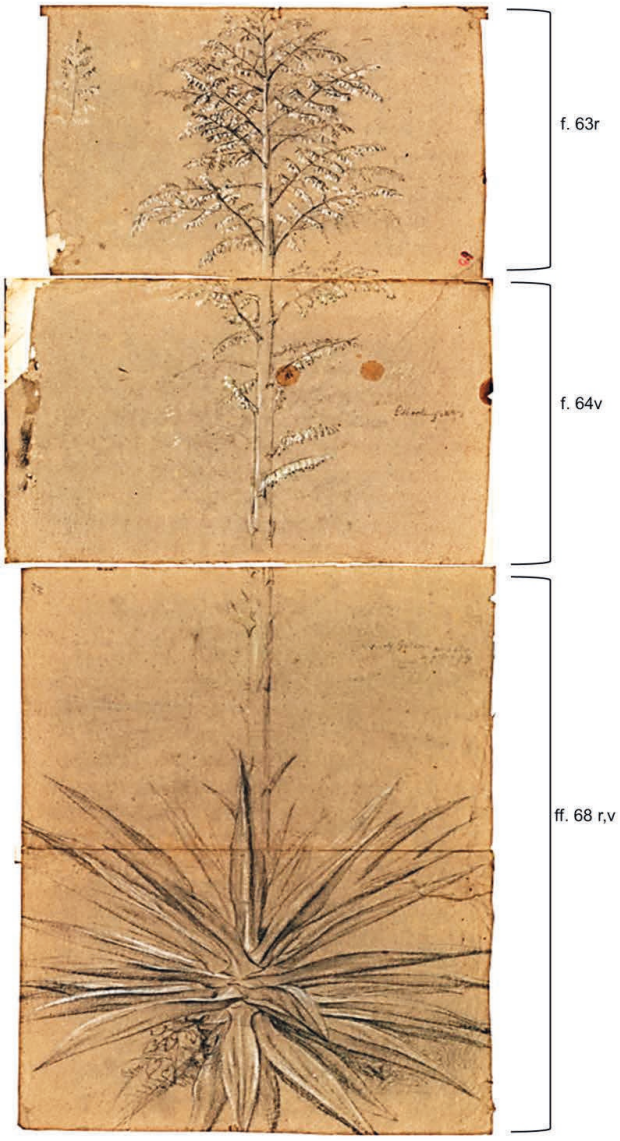

Fig 5.7 **Seventeenth century botanical puzzle.** *Miscellanea Cleyeri*'s folios 63 (recto), 64 (verso), and 68 (double folio) assembled to reveal the flowering *Furcraea foetida* (L.) Haw.

On other occasions, the painters focused on painting the plant parts that were valuable to humans. Several rainforest trees were highly valued for their edible fruits or seeds, such as *Hymenaea courbaril* L. (Marcgrave & Piso, 1648: 101) or *Lecythis pisonis* L., of which 'the seeds (also called chestnuts) were eaten raw or roasted' (Marcgrave & Piso, 1648: 128) and 'were considered aphrodisiacs' (Marcgrave & Piso, 1648: 65). The fruit of *Macoubea guianensis* Aubl. was 'appreciated for its sweetness by the Indigenous peoples to eat during their travels, while Europeans used it to treat chest affections' (Piso, 1658: 242). The fruit of *Swartzia pickelii* Killip ex Ducke was 'not eaten unless it was cooked, from which the inhabitants made a wholesome delicacy for the stomach called Manipoy' (Piso, 1658: 165). The same applies to the tomato-like fruits of the African eggplant *Solanum aethiopicum* L. These fruits were 'eaten cooked, after seasoning with oil and pepper; they have lemon taste' (Marcgrave & Piso, 1648: 24). While these plants are represented in the *Theatrum* only by their fruits (Supplementary Dataset S1), the tree branches or the whole plant are depicted in the written sources. Marcgrave most likely made the drawings displayed in the books, as he aimed to describe and show as many plant parts as possible, although compromising in aesthetic aspects. On the other hand, the painters focused on the edible parts without sacrificing their aesthetics. Nonetheless, the *Theatrum* illustrations and the woodcuts and descriptions of the written sources (HNB, IURNM) often complemented each other and thus facilitated our identifications.

5.3.6 Current conservation status of the Brazilian species in the *Libri Picturati*

In the past centuries, the Atlantic Forest and savannah regions of northeast Brazil have been severely affected by habitat loss and degradation due to the expansion of urbanization, intensive agriculture, farming, and logging (Rogers, 2010; Silva & Casteleti, 2003). As a

result, several plant species that were abundant enough to be noted by European artists around 1640 are not common anymore today. According to the IUCN Red List, eight species in the *Libri Picturati*, seven in the *Theatrum,* and one in the LP are currently experiencing population decline or are at risk of extinction (Supplementary Table S3). The illustrations show several endemic plants from the northeast Atlantic rainforest and caatinga biomes. Four species in the *Libri Picturati* are currently CITES-listed and restricted to trade: the cacti *Brasiliopuntia brasiliensis* (Willd.) A.Berger, *Cereus fernambucensis* Lem., *Epiphyllum phyllanthus* (L.) Haw. and *Melocactus violaceus* subsp. *margaritaceus* N.P.Taylor. The latter is an endemic cactus of the coastal dunes in the Atlantic rainforest known as *restinga*, an ecoregion severely threatened by agricultural expansion and urbanization (Hughes, 2017). Some endemic species are classified as Least Concern by the IUCN or the CNC Flora (12 species), while others (13 species) have not been evaluated yet (Supplementary Dataset S1). The MC does not contain threatened species but includes two endemic trees: *Attalea compta* Mart. and *Eugenia* cf. *brasiliensis* Lam., which are only found in the biodiversity hotspots of the Atlantic rainforest and the *cerrado*, both greatly affected by habitat loss (Martinelli & Moraes, 2013). The mangrove vegetation along the Brazilian coast has been severely affected by urbanization, pollution by industrial and domestic waste, and climate change (Magris & Barreto, 2010; Pelage et al., 2019), threatening the populations of the mangrove trees *Avicennia schaueriana* Stapf & Leechm. ex Moldenke and *Laguncularia racemosa* (L.) C.F.Gaertn. The occurrence of anthropogenic impacts and the lack of available data call for the implementation of more in-depth and continuous studies on the conservation status of these vulnerable populations.

5.3.7 Linking the plant illustrations to the published works and Marcgrave's herbarium

A total of 357 different plant species are described in the HNB and IURNM (Supplementary Dataset S2). Because the *Theatrum* includes more illustrations, we found more taxa from the books and the herbarium represented in this source (102 out of 163 taxa, 63%). However, the largest overlap occurred between the HNB and the MC (21 out of 26, 81%). A smaller overlap exists between the LP and the HNB/IURNM (18 out of 34, 53%). We counted 143 taxa at the species level in Marcgrave's herbarium (Supplementary Dataset S3), and we observed some of these preserved species in all three pictorial works, with the greatest percentage of taxa in common with the MC (seven out of 26, 27%), probably because of its smaller number of images. Strikingly, a third of the species illustrated in the whole Brazilian collection of the *Libri Picturati* could not be ascribed to the species described by Marcgrave or Piso (61 out of 180, 34%).

5.4 Discussion

Mentzel intended to include much more botanical illustrations in the *Theatrum*, as is shown by the empty folios with the Tupi vernaculars and the references to plants described by Marcgrave and Piso. The combination of the plant illustrations in the *Libri Picturati* and the written sources provide a complete overview of the flora as perceived by naturalists and painters in the Dutch colony than the published works alone. In addition, the links provided between the published and unpublished images allow for more in-depth studies by (art) historians, botanists, and other scholars interested in the floristic landscape of Dutch Brazil. As Whitehead and Boeseman (1989) highlighted, studying these plant images allows us to trace humans' introduction of exotic species. These human groups were highly diverse:

Portuguese or Dutch colonists growing popular fruits or ornamentals, Jesuits bringing their plant-based remedies from Europe, enslaved Africans planting crops from their homeland, Indigenous groups trading and domesticating several species before and during colonization, etc. The iconographic identifications provide evidence for the first records of some introduced species in Brazil. For example, the presence of *Xylopia aethiopica* in the *Libri Picturati* reveals its existence for the first time in the Neotropics, adding new insights into the corpus of literature on plant exchange related to the African diaspora in the Americas and the preservation of its botanical legacy by African descendants (Carney & Rosomof, 2009; Ferrão, 2013; Van Andel et al., 2014; Voeks, 2013). The sunflower in the *Theatrum* proves that it was introduced to Brazil at least 300 years earlier than previously thought (Feoli & Ingaramo, 2015). The Tupi-related names for this exotic plant show how Indigenous peoples incorporated the foreign flora and revealed the role the Dutch played in introducing plants to Brazil, sometimes promoted by the early plant exchange between Spain and the Netherlands. The differences in plant habit, domestication status, and plant parts represented between the *Theatrum*, LP, and MC reveal the selection and collection methods by the naturalists and artists that collaborated in the three visual collections. The MC shares characteristics with the *Theatrum* (many wild trees with fruiting branches) and the LP (multiple small weeds and loose fruits of domesticated crops). Most of these plant parts also figure in the artworks that were possibly made after them, such as Eckhout's still-life paintings and the series of tapestries of the Old Indies (Brienen, 2006; Thomsen, 1938; Whitehead & Boeseman, 1989). The plants represented in these paintings could have been found in Recife's surroundings and close to the court painters in Mauritsstad (Brienen, 2006; Teixeira, 1992). The same may apply to the makers of the LP illustrations, who probably stayed in open, anthropogenic vegetation, as evidenced by the many herbs and weeds depicted. The large number of rainforest trees in the *Theatrum* show that the artist(s) either accompanied Marcgrave during

his botanical expeditions, went into the hinterland themselves, or obtained the plant material from locals.

Many of the *Theatrum* illustrations not only represent species described and/or depicted in the HNB and IURNM, but they resemble, sometimes almost identical, the woodcuts in Marcgrave and Piso's published sources. Whitehead and Boeseman (1989) and Brienen (2006) discussed the potential function of the *Theatrum* illustrations as sources for the engravings. Still, the reasons for leaving out some of these botanical images in the written sources have been overlooked. Editor De Laet must have had difficulties linking some of these images to the descriptions, as parts of Marcgrave's notes were presumably missing, and his sudden and mysterious death prevented him from discussing the arrangement of the HNB content with De Laet. Marcgrave was a skilled botanist who aimed for full descriptions of plants, capturing the morphology, life stages, phenology, and other characters as much as possible. He likely excluded some of the specimens known only by loose parts, such as the fruits of *Amphilophium crucigerum* or the flower of *Neomarica* cf. *northiana* (Schneev.) Sprague (Supplementary Dataset S1). These loose flowers and fruits were either found by him during his expeditions or brought to him by local people or artists but never observed in situ by himself in their complete form. Hence, he did not include them in his descriptions, as Marcgrave himself stated: 'I will not write anything down that I have not seen or observed myself' (Marcgrave & Piso, 1648: 139). Unsurprisingly, most of the MC plants are found in the HNB and IURNM, as the MC mainly consisted of plants that grew in Maurits' palace gardens or surroundings and also figured in Eckhout's paintings; these paintings aimed to represent the territory in the colony as seen by the European settlers (Brienen, 2006). The LP contains many common weeds from roadsides and gardens, likely admired by the artist who depicted them for the beauty of their flowers or fruits, which fulfilled its contemplative purposes (Ferrão & Soares, 1995) but probably dismissed by scientists like Marcgrave and

Piso. In our forthcoming paper, we will use the correlations between the *Libri Picturati* and Marcgrave and Piso's books and herbarium to shed light on the origin of the woodcuts and the multiple connections between visual and textual sources as scientific and artistic entities in the early modern period.

The joint study of all associated materials has facilitated our identifications of the flora represented in both visual and textual sources. In the MC, *Citrus* x *aurantiifolia* (Christm.) Swingle, of Asian origin, was first mistaken for a native Brazilian fruit due to the lack of coloration and other key characters. We found a plant drawing in Wagener (Teixeira, 1997: 5) that bears a remarkable resemblance to the sketch in the MC. This *Citrus* is colored dark green and includes a brief description and the vernacular name *Sweet lemon*, which dissipated doubts about this taxon. Attempts to reveal the species behind the three separate folios that depict *Furcraea foetida* were made before, but the pieces were not assembled correctly, or the plant was mistakenly considered a Bromeliad (Teixeira, 1995). In the seventeenth century, *F. foetida* was already familiar to the Spaniards. They encountered it in their colonies in the Caribbean and presumably brought it in 1648 from Spain to the Netherlands (Trelease, 1910). However, as the MC painting reveals, the Dutch already knew about this plant around 1640 and cultivated it in northeast Brazil to obtain its fibers (García-Mendoza, 2001). *Furcraea* species have been used as fiber sources by multiple Indigenous groups, a traditional use appropriated by Europeans and now in disuse in the Western world (Barbosa, 2017). However, the ecological footprint of its introduction is still present, as *F. foetida* is today an invasive species along the Atlantic Brazilian coast (Barbosa, 2017). These new botanical findings provide new insights into vegetation distribution and dispersion and reveal baseline conditions where the environment was altered by intensive Western agriculture and other high-profit enterprises of early capitalist societies. These plant illustrations act as a repository of historical distributional data that allows us to trace the origins of ecological

disturbance (Shaffer et al., 1998), in this case, in northeastern Brazil since the seventeenth century. Moreover, with these findings, we add valuable information to the existing literature on these taxa (e.g., for *Furcraea* spp.: Barbosa, 2011; Drummond, 1907; García-Mendoza, 2001).

One of the most relevant new fields in ethnobotany is plants & art research (Pieroni, 2020). The digitalization of the Brazilian collection of the *Libri Picturati* enabled us to take this innovative approach and perform an in-depth botanical study of its beautiful plant images. Through this study, we draw attention to the relevance of digitizing and studying historical collections and facilitating their access to a more extensive and diverse community (Soltis et al., 2018). Furthermore, as proven throughout this paper, these valuable but sometimes forgotten collections are excellent data sources for cultural and biodiversity research (Stork et al., 2019).

In summary, through access to these digital natural history collections and their scientific study, we disclosed a valuable data source that we can research from several perspectives. By identifying the depicted plants, we revealed their various habits, geographical origin, and domestication status. By analyzing the plant parts illustrated and comparing all visual and textual sources, we discussed the methods of collection and collaboration between botanists and artists in Dutch Brazil. Finally, we detected plants no longer abundant in northeast Brazil due to deforestation, urbanization, and large-scale agriculture and drew attention to their urgent conservation needs. We hope that the *Libri Picturati*—as a botanical and cultural treasure—will reach the inhabitants of the country where these illustrations were made and that the Brazilian vegetation will continue to reflect the beauty and rich diversity captured by artists and naturalists almost 380 years ago.

Chapter 6

Nature portrayed in images in Dutch Brazil: Tracing the sources of the plant woodcuts in the *Historia Naturalis Brasiliae* (1648)

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Abstract

By the mid-seventeenth century, images of natural elements that originated in Dutch Brazil circulated in Europe. These were often included in art collections (the *Libri Picturati*) and natural history treatises (the *Historia Naturalis Brasiliae* and the *India Utriesque re Naturale et Medica*, 1658). The plant woodcut images in these books constituted (icono) type specimens and played a significant role in the transmission of scientific botanical knowledge. We present a systematic analysis of their origins by cross-referencing the visual and textual sources related to Dutch Brazil. To do so, we used our previous botanical identifications of the portrayed plants, published sources, and digital archival material. The plant woodcuts accounted for 529 images, which corresponded to 426 taxa. We created a PDF booklet to visualize the correlations of the woodcuts with the *Libri Picturati* and other visual sources. Substantial differences in the visual-making methodology exist between the two treatises (1648, 1658). In the first book, most of the images were available from Dutch Brazil and carved into the woodcuts, while most of these woodcuts were reused in the second one. The Indigenous Tupi-based plant names that accompanied the images were crucial when arranging the sources, as well as portraying as much botanical information as possible.

Freshly picked, living plants, dried branches, fruits, and seeds were used to represent the megadiverse Brazilian flora, even when these belonged to species originating from other regions. Despite not being recognized for their contribution, Indigenous Brazilians and enslaved Africans were essential in the visual knowledge-making processes that later resulted in these natural history collections. As several sources remain lost and many histories yet untold, further archival studies and collaborative projects are pertinent to reveal the missing pieces of this conundrum.

6.1 Introduction

6.1.1 Nature portrayed in the early modern period: Dutch Brazil

By the mid-seventeenth century, images of natural elements that originated in Dutch Brazil circulated in Europe, often included in art collections and natural history treatises. The term 'Dutch Brazil' corresponds to the northeastern part of Brazil colonized by the Dutch West Indian Company (WIC) between 1630 and 1654 after they overtook it from the Portuguese. Appointed by the WIC, count Johan Maurits of Nassau-Siegen was the governor-general in Dutch Brazil from 1636 to 1644. He commissioned naturalist George Marcgrave, physician Willem Piso, and painters Albert Eckhout and Frans Post, among others, to portray and document the environment encountered in the seized land. With the support of the WIC, the count commanded a military guard to accompany Marcgrave when collecting fauna and flora (Van den Boogaart & Brienen, 2002). At the same time, local people (often Indigenous Brazilians, but also enslaved Africans and Portuguese) brought the specimens to him while he resided in Maurits' court. The same applied to Piso, who, like the other members of Johan Maurits' entourage, was entitled to an assistant for himself. The outcomes of the team assembled by Johan Maurits included, among others, the treatises *Historia Naturalis*

Brasiliae (HNB) (Marcgrave & Piso, 1648) and *India Utriesque re Naturale et Medica* (IURNM) (Piso, 1658a)), botanical specimens in Marcgrave's herbarium, and a set of plant illustrations, drawings, and sketches divided into three collections: *Theatrum Rerum Naturalium Brasiliae* (*Theatrum*), *Miscellanea Cleyeri* (*Misc. Cleyeri*), and the *Libri Principis* (also known as *Handbooks* or *Manuais*). The botanical imagery of these sources is the object of this study.

6.1.2 Background to the visual and textual repertoire of Dutch Brazil

The origin, arrangement, and destination of all these materials are varied. The HNB was commissioned by Johan Maurits after his return from Brazil when he handed over the field notes of Piso and Marcgrave and several drawings on plants and animals to Johannes de Laet, WIC director, cartographer, and ultimately editor of the HNB. De Laet organized these drawings and ordered a few woodcut images based on Marcgrave's herbarium, as becomes evident by his commentaries (Marcgrave, 1648). The HNB was published in 1648 by Elzevier in Amsterdam and Hackium in Leiden, becoming an authoritative work on Brazilian and tropical flora and fauna for the upcoming centuries (Almeida, 2016; Whitehead & Boeseman, 1989). It contains references to classical naturalists, such as Dioscorides and Theophrastus, and to Renaissance and contemporary scholars (e.g., Francisco Hernández, Nicolas Monardes, and Carolus Clusius), whose manuscripts and early images of American flora influenced the work of Marcgrave and Piso (Almeida, 2016; Pickel, 2008).

Based on the field notes, De Laet produced a preliminary draft of the HNB (Sloane MS 1554), which included 15 plant drawings, 11 proof-woodcuts, and 366 plant descriptions – often with the word *Icon* next to them (Whitehead & Boeseman, 1989). This manuscript could be De Laet's first attempt to arrange Marcgrave's species. The word *Icon* could correspond to field drawings, watercolors, and oil paintings from the expedition (Andrade-

Lima et al., 1977) or to living plants collected in Brazil (Whitehead & Boeseman, 1989). The manuscript was later purchased by the slaveholder, physician, and collector Hans Sloane (1660-1753), and it is now part of the Sloane manuscript collection at the British Library. Most of Marcgrave's specimens ended up in Copenhagen in 1653 and are now kept at the University Herbarium (C).

In 1644, Johan Maurits, Piso, Ekckout, Post, and other members of the count's crew returned to the Low Countries, but Marcgrave never did. Instead, in 1643, he was sent to Angola, where he died shortly after his arrival (Zuidervaart & Matsuura, 2022). De Laet passed away in 1649, a year after the publication of the HNB. Piso, discontent with the arrangement of the HNB, edited its content and published a modified version in 1658 (Piso, 1658a).

The Brazilian imagery had another destiny. In 1652, Johan Maurits sent several oil-based illustrations and drawings of flora, fauna, and Indigenous and African peoples from Dutch Brazil as a diplomatic gift to Frederick William, Elector of Brandenburg, from 1640 to 1688. He passed them to his court physician Christian Mentzel, who organized the oil paintings in a bound collection (the *Theatrum*). Mentzel included Johan Maurits's words in the preface of the *Theatrum*, emphasizing that 'these images aimed to reproduce Brazilian nature as perfectly as possible' (Mentzel, 1664). The elector also received two bound volumes of watercolors (the *Libri Principis*), and a few sketches and oil paintings, which were bound in 1757 (the *Misc. Cleyeri*) (Whitehead & Boeseman, 1989). In the nineteenth century, these Brazilian collections were incorporated into a larger collection known as the *Libri Picturati*, which was housed in the Preussische Staatsbibliothek (the present-day *Staatsbibliothek* in Berlin, Germany) until this library was evacuated during World War II (Albertin, 1985). The *Libri Picturati* were considered lost until zoologist Peter Whitehead located them at the Jagiellonian Library in Krakow, Poland (Whitehead, 1976; Whitehead & Boeseman, 1989).

6.1.3 Behind the images: Previous and present research

Due to its undeniable historical value, several studies on the Brazilian images in the *Libri Picturati* have been conducted, focusing on its content, composition, and authorship (Albertin, 1985; Boeseman, 1994; Brienen, 2006; Lichtenstein, 1819, 1961; Mentzel, 1993; Scharf, 2019; Teixeira, 1995, 1997; Thomsen, 1938; Whitehead, 1979; Whitehead & Boeseman, 1989). Scholars have argued that the *Libri Picturati* images served as models for the woodcuts of the HNB (Albertin, 1985; Boeseman et al., 1990; Brienen, 2006, 2007; Joppien, 1979; Mentzel, 1993; Teixeira, 1995, 1997; Whitehead, 1979, 1973, 1976; Whitehead & Boeseman, 1989). Correlations between the *Theatrum* illustrations and the woodcuts were established for the birds (Schneider, 1938) and the animals in general – including the *Libri Principis* (Boeseman et al., 1990; Scharf, 2019). A few woodcuts seem to be based on Post's drawings (Joost, 1983). Brazilian botanists Pickel (2008) and Almeida (2016) suggested the borrowing of images from published treatises, such as those by Clusius or De Laet. Some woodcuts were made in the Dutch Republic after the specimens collected by Marcgrave (Andrade-Lima et al., 1977). Additionally, several woodcuts were based on Marcgrave's drawings, as De Laet and Piso indicated in the preface of the HNB (Marcgrave & Piso, 1648) and the IURNM (Piso, 1658a). In 1640, Marcgrave wrote to De Laet from Brazil that he had made 350 pencil drawings of plants and several more of animals (Brienen, 2001). The few pencil sketches found in De Laet's manuscript could be part of those (Andrade-Lima et al., 1977; Joppien, 1979; Whitehead & Boeseman, 1989), but most of Marcgrave's original drawings do not exist anymore or have not been located yet.

Beyond doubt, the study of the woodcuts embedded in these natural history books is of great relevance, as they play a significant role in the transmission of scientific botanical knowledge (Gesteira, 2008). Moreover, the woodcuts constituted (icono) type specimens because they accompanied the first descriptions of individual species against which all later individuals

were compared (Whitehead & Boeseman, 1989). As the intriguing question of which plant images were used as the basis for the woodcuts remained unanswered, we present a systematic analysis of their origins. We focused on the botanical images included in the HNB, the IURNM, the *Libri Picturati* Brazilian collection, De Laet's manuscript, and Marcgrave's herbarium specimens to 1) analyze the correlations between the woodcuts and the other visual sources from Dutch Brazil, and 2) trace back the remaining sources that were used to create the woodcuts. By applying our botanical image analysis to these historical collections, we provide an overview of how the visual material was used in the composition of seventeenth century natural history treatises on Brazil. In doing so, we add insights into the processes of visual knowledge-making and botanical practices in the early modern period.

6.2 Materials and Methods

To analyze the correlations among the historical visual sources, we built a database in FileMaker Pro with all woodcuts and illustrations organized by species and created a spreadsheet with the background information. Our database contained all digital woodcut images in Marcgrave's and Piso's books (Marcgrave & Piso, 1648; Piso, 1658a), their correspondent images for the same species in Marcgrave's herbarium (collected between 1638 and 1643), the *Libri Picturati,* and other visual sources. We used a digital-colored copy of the HNB located in Leiden University (the Netherlands) (HNB Leiden University library) (Fig 6.1) and the digital images of Marcgrave's herbarium in C (Marcgrave's herbarium). For the IURNM, we used the copy kept at the Missouri Botanical Garden (IURNM copy Missouri). The Jagiellonian library provided the *Libri Picturati* illustrations as digital images, of which the *Miscellanea Cleyeri* (Misc. Cleyeri) and the *Libri Principis* (Libri Principis) are publicly available.

Fig 6.1 **Frontispiece of the *Historia Naturalis Brasiliae* (Marcgrave & Piso, 1648).** This colored copy is kept at the Library of Leiden University (the Netherlands). Available at https://digitalcollections.universiteitleiden.nl/view/item/1535938#page/25/mode/1up.

To trace the origins of the woodcut images in the HNB and the IURNM, we also compared the woodcuts with the drawings included in De Laet's manuscript in the Sloane collection (Sloane MS 1554). In addition, we associated the plant descriptions with the term 'Icon' to their corresponding species in the HNB and the *Libri Picturati* to analyze potential correlations between their accompanying vernacular plant names. The Manuscript Department of the British Library provided the digitized scans of De Laet's manuscript.

To compare woodcuts, vouchers, and plant illustrations, we cross-referenced all textual and visual sources for each plant species using our recent botanical identifications for the HNB, the IURNM, and the *Libri Picturati* (Alcantara-Rodriguez et al., 2019, 2021). Then, we assembled the images from multiple sources belonging to the same species to visualize their (dis-)similarities using FileMaker Pro. Due to the more extensive number of woodcuts in Marcgrave's chapters on plants (Marcgrave, 1648) than in Piso's work (Piso, 1648, 1658a) and the many duplicates in the latter, we started our analysis with Marcgrave. We systematized the information with database entries on the page numbers of the woodcuts in the HNB and IURNM, vernacular name(s), botanical identifications, and the origin of these woodcuts. We first identified the woodcuts that correlated at the species level with Marcgrave's herbarium and the *Libri Picturati*. For the latter, we analyzed the degree of similarity among the images based on the level of detail matching between the *Libri Picturati*'s images and the woodcuts. We distinguished four categories: 1) very similar (woodcut and illustration share [almost] the same features), 2) moderately similar (they bear a remarkable resemblance but do not share exactly the same features), 3) slightly similar (they are different in most features yet some details, such as the inflorescence, the fruits, a few leaves, etc., look-alike), and 4) different (not enough similar features between images to assume any correlation). The more similar a woodcut and its corresponding species in the *Libri Picturati* were, the more probably the woodcut was made after the image, or they both

originated from the same source. For the woodcut images that did not resemble the visual sources mentioned above, we checked the works of Renaissance and early modern scholars that included engravings similar to the plant images in the HNB and IURNM. To navigate this vast corpus of literature, we first checked the HNB and IURNM for references to scholars who worked with tropical flora, such as Hernández (1651), Monardes (1574), or Clusius (1601, 1605, 1611). We narrowed this search by consulting Almeida (2016), who systematized those citations per plant species. For Clusius, we searched for corresponding images in Ubrizsy and Heniger (1983), who listed the American plants portrayed by this botanist. For the woodcuts whose sources were still unknown, we searched for their species name on Plantillustrations.org (plantillustrations.org). This open-access site offers a large digital collection of HD botanical illustrations through time. We retrieved some of these flora illustrations for our database.

Finally, we checked phenological and other botanical characters in modern photos (including herbarium vouchers) and added them to the database to show how these plants appear in nature. We retrieved all plant images from Creative Commons (creativecommons.org), Flickr (flickr.com), Plants of the World Online (powo.science.kew.org), Flora do Brasil 2020 (floradobrasil.jbrj.gov.br), Species Link (specieslink.net), and the Global Biodiversity Information Facility (gbif.org).

6.3 Results

6.3.1 Origin of the *Historia Naturalis Brasiliae* (1648) woodcuts

There are 301 plant woodcuts in the HNB (Marcgrave & Piso, 1648). We listed the background information of all woodcut images (species, family, sources, page numbers, author, etc.) in Supporting Information S1. We provided in Supplementary Information S2 an

overview of all the visual sources arranged by their correlated species, taking as the reference the woodcuts in the HNB. Fig 6.2 shows how we linked a woodcut in the HNB to several other visual sources.

Fig 6.2 **Linking a woodcut in the HNB to other visual sources from Dutch Brazil.** (a) Woodcut of the common medicinal plant against intestinal worms, *Spighelia anthelmia* L. (Marcgrave, 1648: 35) (b) Specimen of the same species in Marcgrave's herbarium (f. 55) (c) *S. anthelmia* depicted as an oil painting in the *Theatrum* (f. 323).

Several woodcuts in Marcgrave's chapters on plants are repeated in Piso's (1648) chapter because De Laet re-used them for the species mentioned by both authors (Fig 6.3). In the HNB, nine species are represented by two different woodcuts, and two species are depicted by three different ones. For six woodcuts, we could not identify the species depicted (Fig 6.3). We traced approximately one-third (84 woodcuts) of the 243 unique woodcuts in the HNB (Marcgrave's woodcuts plus Piso's unique ones) to the *Libri Picturati*, Marcgrave's herbarium, or other known sources (Fig 6.3). However, over two-thirds (159 woodcuts) of the plant images did not correspond to these visual sources.

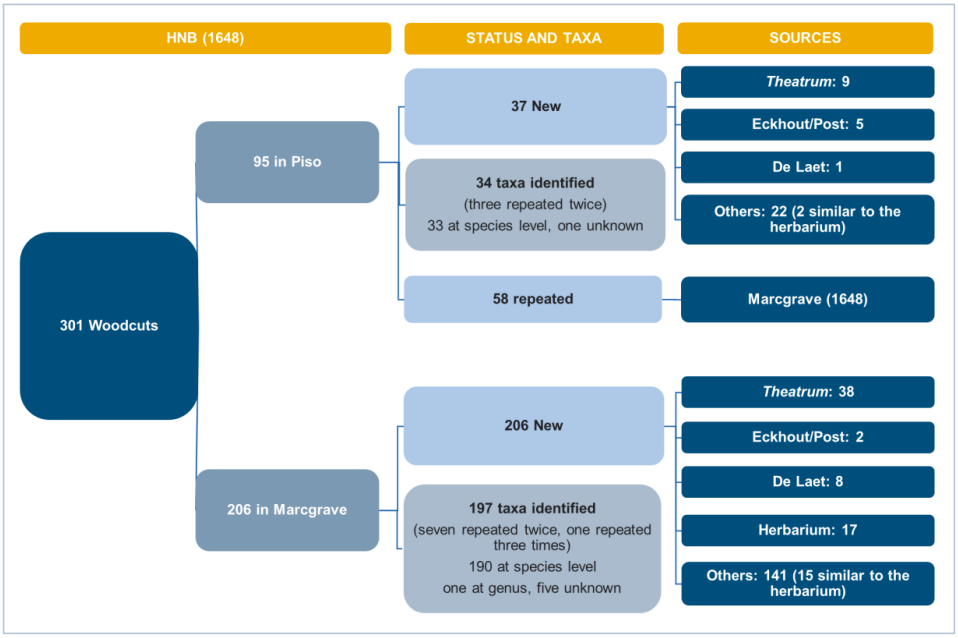

Fig 6.3 **Tracing the sources of the plant woodcuts in the HNB.** Flowchart showing the organization of the woodcut images in the HNB, the number of plant taxa, and the sources used to create the woodcuts.

6.3.1.1 *Theatrum Rerum Naturalium*

From the entire Brazilian collection of the *Libri Picturari*, the HNB plant woodcuts mostly match the *Theatrum* illustrations. One exception is the woodcut that represents *Canna indica* L., which is very similar to the one in *Misc. Cleyeri* (in reversed format). Most of the plant woodcuts in the HNB, however, represent species not included in the *Theatrum* (Fig 6.3), even though over half of the species in common with the *Theatrum* (78 species in Marcgrave and 15 spp. in Piso) bear resemblance in different degrees to the plant illustrations, while the other half are different (Figs 6.4 and 6.5). In addition, a small proportion (15%, seven spp.) of the overlapping images between the HNB and the *Libri Picturati* (47 spp.) are reversed (example in Fig 6.5b).

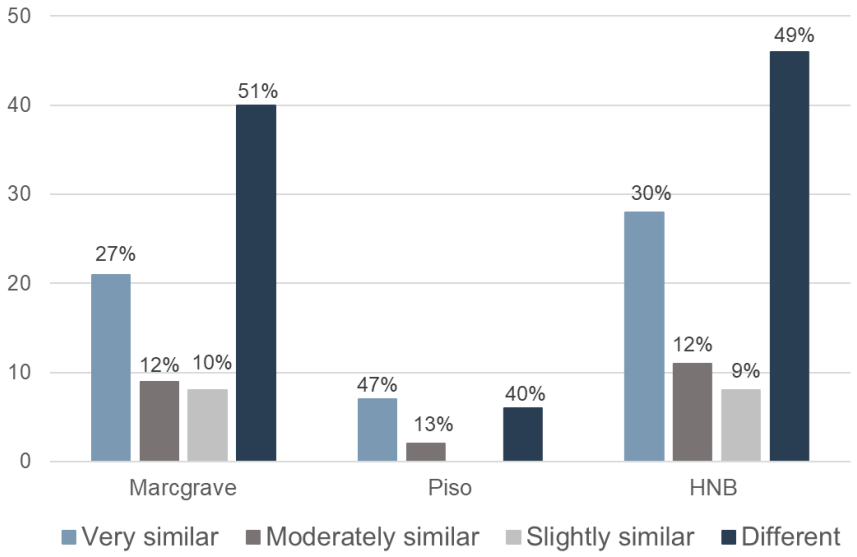

Fig 6.4 **Comparing the plant images portrayed in the HNB and the *Theatrum* for the same species.** Similarities between the botanical illustrations in the *Theatrum* and the woodcuts depicted in Marcgrave's chapters on plants, Piso's chapter on medicinal plants, and the whole repertoire of botanical woodcuts in the HNB (Marcgrave & Piso, 1648).

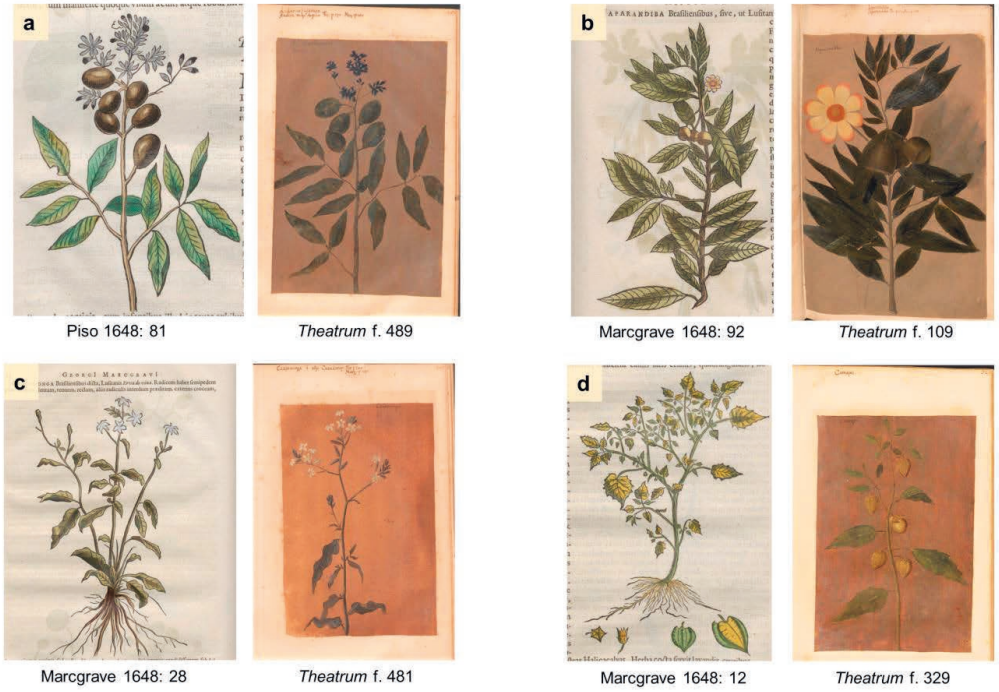

Fig 6.5 **Examples of similarity degrees between the woodcuts in the HNB and the *Theatrum* illustrations.** (a) Very similar: *Andira fraxinifolia* Benth. (b) Moderately similar: *Gustavia augusta* L. (c) Slightly similar: *Plumbago zeylanica* L. (d) Different: *Physalis pubescens* L.

6.3.1.2 Marcgrave's herbarium

Of the 143 species preserved in Marcgrave's herbarium, 92 (64%) are described in Marcgrave and Piso's books, but only 74 are represented by a woodcut image in the HNB. According to Andrade-Lima et al. (1977), 17 woodcuts for the HNB were produced using Marcgrave's herbarium vouchers (Fig 6.3, S1). De Laet explicitly mentioned in the HNB that 15 woodcuts were made after these specimens (Marcgrave, 1648). In addition, *Galphimia brasiliensis* (L.) A.Juss. and *Spondias mombin* L. were also made after Marcgrave's

exsiccates (S2: 303, 449), although De Laet did not indicate this in the HNB (Andrade-Lima et al., 1977). By comparing the taxa shared between the HNB and the herbarium, we found that the woodcuts of 25 species bear no resemblance to the vouchers; hence these were probably made after other sources. For 17 species in the herbarium, we cannot infer whether the specimens were used to design the woodcuts because they are poorly preserved or consist of a few plant parts (a single leaf or sterile branches). Nevertheless, 17 specimens share similarities to the woodcut images (Fig 6.3). These herbarium vouchers could have been used as models to make the drawings later carved onto the woodblocks (Fig 6.6).

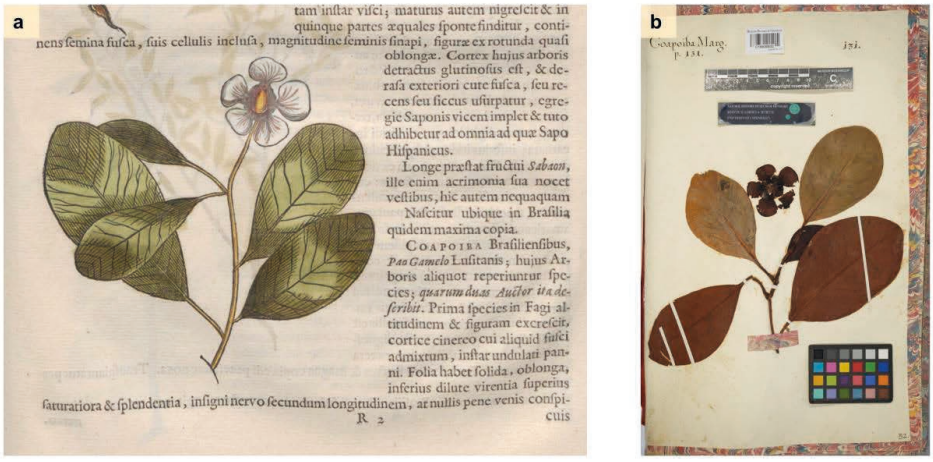

Fig 6.6 **Correlation between a woodcut in the HNB and the specimen collected by Marcgrave.** (a) Woodcut of *Clusia nemorosa* G.Mey. in the HNB (Marcgrave, 1648: 131) (b) Specimen of *C. nemorosa* in Marcgrave's herbarium (f. 32).

6.3.1.3 Other traceable visual sources

De Laet tried to find ways to provide images of the plants described in the HNB when these were lacking – as occurred with the vouchers collected by Marcgrave. For example, he received a pod of *Mimosa pigra* L. from his friends in Brazil. De Laet commissioned to have

it designed at natural size, even though 'the painter hardly represented its elegance' (Marcgrave, 1648: 74). While editing the HNB, he also obtained seeds from Brazil of a plant called *Micambe Angolensibus*. He planted them and observed how the plant grew and flowered in the summer of 1646 but saw it die in October (Marcgrave, 1648). The seeds belonged to *Cleome gynandra* L., an African weed introduced to Brazil via the trans-Atlantic slave trade and eaten by enslaved Africans as a leafy vegetable (Marcgrave, 1648:10). De Laet tried to obtain a drawing from the living plant in the Dutch Republic. Yet, he did not manage to do so, as the tropical plant perished during the winter frost.

We found that eight woodcuts were based on images previously published by De Laet in his books on the colonized territories of the Americas (De Laet, 1633, 1640). For instance, De Laet mentioned that the woodcut of *Bromelia karatas* L. depicted on p. 111 in Piso's (1648) chapter on medicinal plants was drawn at its natural scale after he received the fruit from Brazil (De Laet, 1633: 614). In turn, De Laet (re)used three of the woodcuts from his books, which he copied after images of related flora published by Clusius (1605, 1611) (S2). He often cited Clusius, Monardes, and other Renaissance authors to compare the Brazilian plants to known European or American species.

The artists that joined Johan Maurits's crew in Brazil also played a role in the making of the images. Three woodcuts included in Piso (1648) depict how sugarcane (*Saccharum officinarum* L.) and cassava (*Manihot esculenta* Crantz) were processed in the mills and ovens of the colony by enslaved African labor. Some scholars attributed these images to Frans Post (Joost, 1983; Whitehead & Boeseman, 1989). We found similar scenes in Barlaeus' 1647 publication about Johan Maurits' endeavors in the colony, which Post indeed designed and appeared embedded in the maps Marcgrave drew in Brazil (S2: 1-5). The woodcut of *Cereus jamacaru* DC. also closely resembles the cactus portrayed by Post in 'View of the Rio São Francisco Brazil with Fort Maurits and Capibara' (S2: 437).

Post's contemporary Albert Eckhout included at least three plants in his still-life paintings and portraits similar to the woodcuts in the HNB (S1, S2). One example is *Ipomoea pes-caprae* (L.) R. Br, of which the woodcut in Marcgrave's chapter in the HNB does not match any of the known sources (Fig 6.7a), but the same species in Piso (Fig 6.7b) strongly resembles the creeping plant in Eckhout's portrait known as 'African man' (Figs 6.7c, 6.7d). There is a crayon sketch of the same species in the *Misc. Cleyeri* (Fig 6.7e), but it neither resembles the woodcut (Fig 6.7b) nor the vine in the painting (Fig 6.7d) – as is often the case with the sketches in the *Misc. Cleyeri* and Eckhout's paintings (Brienen, 2006; Thomsen, 1938).

Fig 6.7 **Similarities between the HNB and Eckhout's paintings.** (a) Woodcut of *Ipomoea pes-caprae* (Marcgrave, 1648: 51) (b) *I. pes-caprae* in Piso (1648: 103) (c) the same species

on the left bottom corner in Eckhout's painting (National Museum of Denmark) (d) close-up of *I. pes-caprae* in Eckhout's painting (e) Sketch of the same species in the *Misc. Cleyeri* (f. 12v).

6.3.1.4 Remaining sources of the HNB woodcuts

Most of the HNB woodcut images (67%, 163 woodcuts) did not originate after the *Libri Picturati*, Marcgrave's herbarium, Eckhout and Post's paintings, or De Laet. The question is whether Marcgrave himself made the original drawings. Interestingly, considerable mistakes are present in several of these woodcuts. For example, on page 137, the banana bunch (*Musa* × *paradisiaca* L.) emerges from the middle part of the trunk instead of the center (Marcgrave, 1648). The *Anda* tree (*Joannesia princeps* Vell.) on page 110 bears large, bell-shaped flowers compared to the smaller and compound inflorescences characteristic of the Euphorbiaceae family (S2: 377-378). As Pickel (2008) noticed, it is unlikely that a trained botanist like Marcgrave would have approved these morphological errors in his botanical drawings.
In Marcgrave's chapter on trees, De Laet indicated for *Jetaiba* (*Hymenaea* cf. *courbaril* L.) that 'more details about this tree were to be found in Piso, to whom we owe this figure' (Marcgrave, 1648: 101). De Laet referred to the woodcut in Piso (1648: 60), which is the same as in Marcgrave's chapter. It is unclear whether Piso made some of the plant drawings since he was not trained in botany and art like his naturalist colleague. We know that some woodcuts were borrowed from Marcgrave's sketches during their expeditions (Piso, 1658a: 107, 1957: 249), while others were made *ad vivum* (after life) by a painter traveling with him in the *sertão*, the dry hinterland of northeastern Brazil (preface in Piso, 1658a: 2, 1957: 8).

6.3.2 Origin of the woodcuts in the *India Utriusque re Naturale et Medica* (1658)

We listed the background information of all woodcut images (species, family, sources, page numbers, author, etc.) in Supporting Information S3 and displayed their associated images in Supporting Information S4. Piso reused many woodcuts from the HNB, which we showed in S2. Hence, to avoid repetitions, we only added in S4 those different plant woodcuts. In most cases, the woodcuts from Marcgrave's chapters on plant species he did not describe as used by humans are lacking in the IURNM.

6.3.1.1 New and reused woodcut images

In the IURNM, there are 228 woodcuts, eight of which are depicted twice (Fig 6.8). Hence, Piso used 220 woodblocks to complete the botanical part of his *solo* work. He distributed the images in chapter IV (equivalent to Marcgrave's chapters on flora and Piso's chapter on medicinal plants in the HNB (Piso, 1658b) and chapter V (equivalent to his chapter on venoms and antidotes in the HNB (Piso, 1658c).

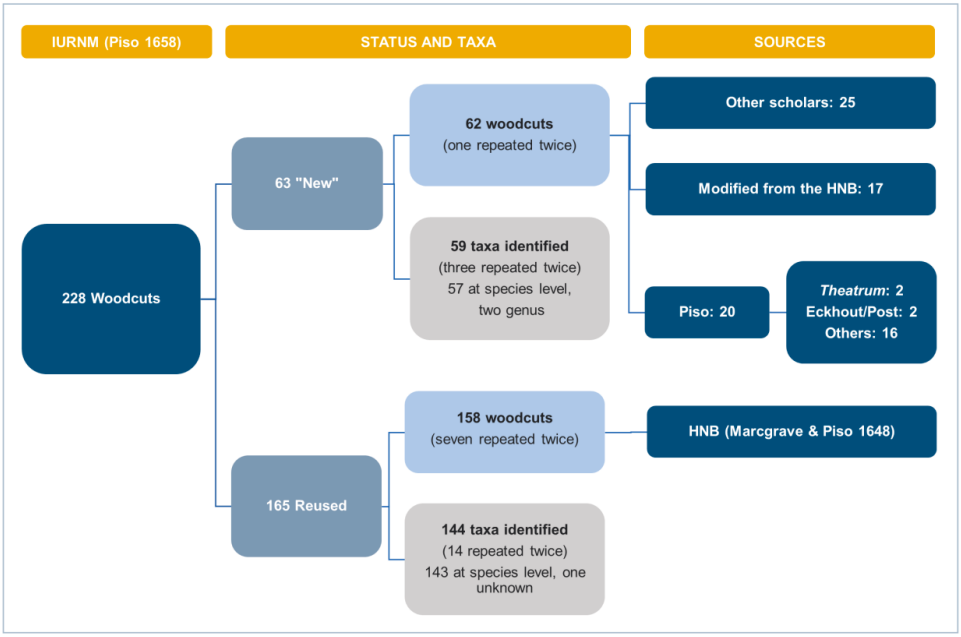

Fig 6.8 **Tracing the sources of the plant woodcuts in the IURNM.** Flowchart showing the organization of the woodcut images in the IURNM, the number of plant taxa, and the sources used to create these woodcuts.

Within the 59 identified taxa (Fig 6.8), we found a mushroom, a sponge, and a coral, which do not belong to the plant kingdom but were classified as such by seventeenth century scholars. Most of the woodcuts (72%) look exactly like those printed before in the HNB, suggesting these were made with the same woodblocks De Laet had used ten years earlier, which were kept by the Elzevier publishing house after his death (Whitehead & Boeseman, 1989). The remaining woodcuts (28%) were 'new' illustrations Piso included in the IURNM. The physician copied most of those images (40%) after Renaissance and Early Modern botanists and physicians' herbals, such as those written by Brunfels (1530), Fuchs (1542), Matthioli (1563), and Monardes (1580, 1574) (S3, S4). He also 'borrowed' several images from the works of Dodoens (1553, 1583), De l' Obel (1591, 1571), and Clusius (1601, 1605,

1611). Sometimes, Piso did not depict plants collected or observed in Brazil, like *Gossypium barbadense* L. and *Astrocaryum vulgare* Mart. Instead, he copied the African cotton (*Gossypium arboreum* L.) and the date palm (*Phoenix dactylifera* L.) from the work of Prospero Alpini (1592, 1640) – a Venetian physician who depicted the flora he encountered during his expedition in Egypt.

Several of those new woodcuts (28%) are modified copies made after the images in the HNB related to the same plant. Most of these modifications consisted of attaching the branch depicted in the HNB to a trunk – a style often encountered in late Renaissance herbals, likely to portray the tree habit of the plant while still showing enough detail of the fertile branch. Occasionally, some new images were created by combining parts of different plant species, something that Pickel (2008: 23) defined as 'fantasy woodcuts' (S3, S4: 29, 85, 87, 103). A few times, the modified plant parts in the woodcut were those that had nutritional or medicinal value. For example, two woodcuts represent *Cissampelos glaberrima* St. Hil. (*Caapeba*) in the IURNM (Fig 6.9a). One is the same as in the HNB (Fig 6.9b) and was made after one of the woodblocks that remained with Elzevier's publishers. The other woodcut is new, albeit slightly similar to the first one, but with larger roots that split in two (Fig 6.9a). Piso (1658b: 261) directed the reader to these different roots by citing this figure, specifying that one of them became larger as it grew older. In addition, he experimented with the leaves and roots of *C. glaberrima* and documented its medicinal properties (Piso, 1658b).

Three years before the publication of the IURNM, Danish physician and historian Ole Worm published an image of *C. glaberrima* root in his book *Museum Wormiamum*. Worm (1655) obtained this root from Brazil (Fig 6.9c), perhaps as part of the plant material exchanged between De Laet and him. He also added the woodcut from Marcgrave using the same woodblock De Laet applied in the HNB (Fig 6.9d), owned by their common publisher: Elzevier (Andrade-Lima et al., 1977; Whitehead & Boeseman, 1989). Just like Worm, Piso

was aware of the medical relevance of *C. glaberrima* and emphasized its roots in his new image.

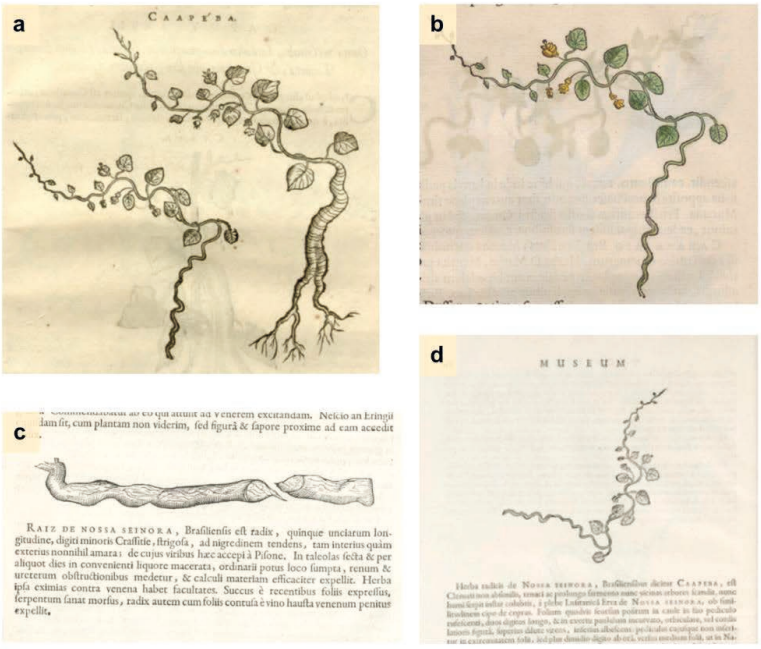

Fig 6.9 **New image used by Piso (1658) and its connection to previously published woodcuts.** (a) Woodcuts of *Cissampelos glaberrima* St. Hil. In the IURNM (page 261) (b) The same species in the HNB, documented by Marcgrave (p. 26) (c) Root of *C. glaberrima* shipped from Brazil as portrayed by Worm (1655: 157) (d) The same species made after the same woodblock (Worm, 1655: 158).

Piso did not copy the remaining new woodcuts (32%) after the HNB or images from other treatises. Four resemble the illustrations in the *Theatrum* (S3, S4: pp. 23, 57) and the flora depicted by Eckhout or Post in their paintings (S3, S4: 1, 39). Most of them (15 woodcuts), we could not trace to any existent source. Piso could have had sketches and seeds of the plants on those images, but their exact origin or provenance remains uncertain. Sometimes,

the plant drawings did not make it. For instance, the physician did not provide the woodcut of *Cuipouna* (*Cestrum schlechtendalii* G.Don,) because its picture 'had been damaged by the action of time' (Piso, 1658b: 178). He lost the drawing of *Tapirapecu* (*Elephantopus mollis* Kunth) due to the 'eventualities of the journey' (Piso, 1658b: 182). These circumstances may refer to expeditions in Brazil or events happening during his return to the Low Countries or after it.

Of the 143 species preserved in Marcgrave's herbarium, 55 are represented by a woodcut image in the IURNM. However, only seven species from the herbarium appear in the newly made woodcuts and not in the HNB. There is no resemblance between Marcgrave's herbarium vouchers and their corresponding species in the new IURNM woodcuts.

6.3.3 Early modern 'Photoshop'

6.3.3.1 Combining multiple sources

Grouping images from various sources was a technique that allowed portraying a plant as completely as possible, especially when it was challenging to capture at once the different parts of the plant or when some details were missing. A woodcut in the HNB represents the medicinal shrub *Jatropha curcas* L. (Fig 6.10a), with lesser quality and scientific detail than its homolog in the *Theatrum* (Fig 6.10b). Despite the poor quality, De Laet included this image instead of making a new woodcut after the *Theatrum* oil painting. He either did not see this painting or deliberately chose the drawing of lesser quality to avoid making a new woodcut design, thus saving time and money. The HNB woodcut was presumably created after a drawing by Marcgrave (Pickel, 2008: 129). Ten years later, Piso published a different image in which the internodal scars on the stem are visible (Fig 6.10c). This new image is slightly similar to the one in the *Theatrum*, although the ring-like scars on the stem are not visible in the oil painting. Marcgrave documented this feature on p. 96 and compared it to a

fig tree, which might explain why Piso added it to the image. Additionally, the seeds of *J. curcas* are displayed in both the HNB and the IURNM (Figs 6.10c, 6.10d). This image was made 'au naturel' after the seeds that De Laet (1640: 137) received from Brazil and used in his treatise on the Americas (Fig 6.10e).

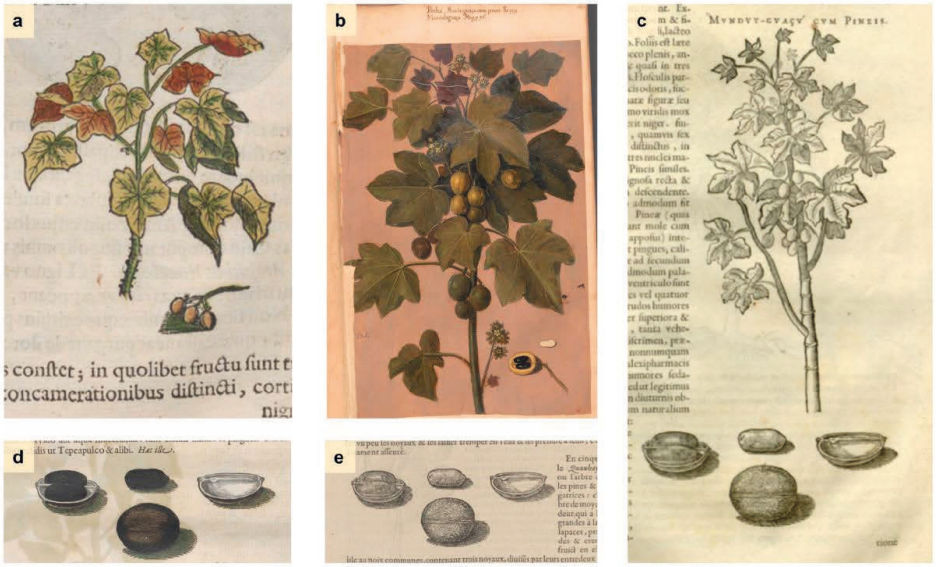

Fig 6.10 **Combining multiple sources to create the woodcuts for the natural history books.** (a) Woodcut of *Jatropha curcas* L. in the HNB (Marcgrave, 1648: 96) (b) Oil painting of the same species in the *Theatrum* (f. 199) (c) Woodcut of this plant and its seeds in Piso (1658: 179) (d) Woodcut of *J. curcas* seeds in the HNB (Marcgrave, 1648: 97) (e) Original woodcut of the seeds (De Laet, 1640: 136).

Another example of using multiple sources occurs with *Bixa orellana* L., known today as *Achiote*, *Annatto*, or *Urucu(m)* in Brazil – among others (Dataplamt, accessed 23.09.22). The woodcut in the HNB shows a flowering branch with four terminal fruits and small fruits on a lateral branch (Fig 6.11a). In contrast, the *Theatrum* illustration lacks flowers, but it displays a couple of open fruits full of red seeds (Fig 6.11b). These seeds were one of the earliest trade

goods exchanged between Indigenous peoples and Europeans in South America and were exported to Europe in the mid-sixteenth century and used as a dye, colorant, and cosmetic (Donkin, 1977; Norton, 2006). The two images differ significantly, and although the fruits of *B. orellana* were of great economic relevance, De Laet included the woodcut with the less showy and accurate image of them, possibly made after a drawing by Marcgrave. In the IURNM, Piso combined the HNB woodcut with a new woodcut of *B. orellana* fruits (Fig 6.11c). To make this add-on, he copied the image of a fruiting branch from *Exoticorum Libri Decem* by Clusius (1605: 74) (Fig 6.11d) and added an open fruit with seeds (Fig 6.11c). Curiously, it seems this fruit was 'removed' from Clusius' leftmost part of the branch, opened in half, and laid under the figure (Figs 6.11c, 6.11d). Clusius obtained the original branch from the aristocrat and naturalia collector Pieter Garet (c.1552/5-1631), who wrote to the botanist that Brazilian Indigenous peoples used the seeds to color their bodies red (Egmond, 2009).

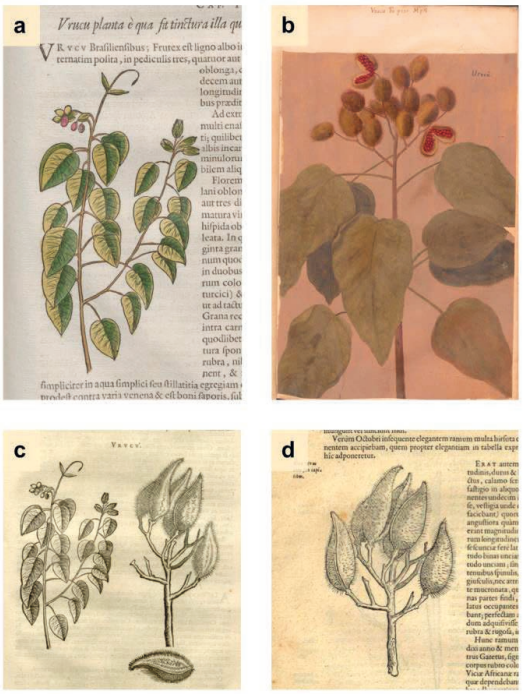

Fig 6.11 **Using multiple sources to create the plant woodcuts by De Laet and Piso**. (a) Woodcut of *Bixa orellana* L. in the HNB (Marcgrave, 1648: 61) (b) Oil-based illustration of *B. orellana* in the *Theatrum* (f. 95) (c) Woodcuts of the same species in the IURNM (Piso, 1658: 133) (d) *B. orellan*a branch in Clusius' treatise (1605: 74).

6.3.3.2 Combining different stages of plant life

Several woodcuts show flowering and fruiting stages depicted together. For example, in the HNB, the woodcut of *Crateva tapia* L. bears a fruiting branch, including an open fruit full of seeds (Fig 6.12a). In the same woodcut, we also see the inflorescence and the tiny (immature) fruits, characteristic of the Capparaceae species (Fig. 6.12a). However, *C. tapia* in the *Theatrum* is represented by two illustrations glued in the same folio, each depicting a fruiting and a flowering branch (including the fruit buds) (Fig 6.12b).

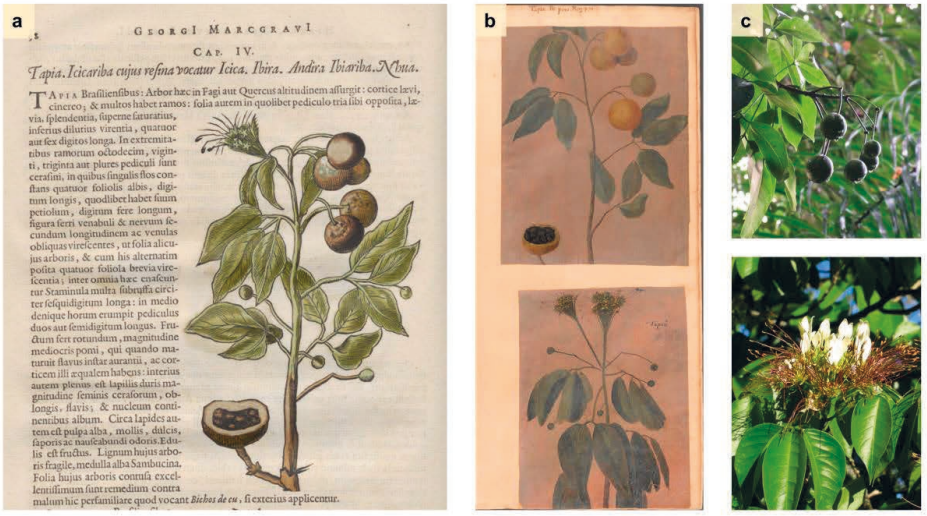

Fig 6.12 **Combining different stages of plant life in one image**. (a) Woodcut of *Crateva tapia* L. in the HNB (Marcgrave, 1648: 98) (b) Fruiting branch of the same species in the *Theatrum* (above) and flowering branch (below) (f. 113) (c) Fruiting branch of *C. tapia* (above), and flowering one (down) (by T. Leão and A.S. Farias-Castro, in: www.flickr.com).

Flowering and fruiting stages of *C. tapia* can overlap in nature (Soares Neto et al. 2014) (example in Species Link: HUEFS 134255, identified and collected by Lyra-Lemos R.P. Alagoas, Brazil), but this is not always the case (Fig 6.12c). However, the oil paintings show the different fertile structures separately, which must belong to branches with different reproductive stages or to the same species collected at different times. Either way, the woodcut in the HNB – similar to those two separate illustrations – conveyed more botanical information in one image and saved money during printing. After all, preparing and including images in treatises was an expensive endeavor in the early modern period (Margócsy, 2014; Nickelsen, 2006), as it is today.

Several images merged flowering and fruiting stages, both in the *Theatrum* and the HNB, such as *Annona montana* Macfad. and *Byrsonima cydoniifolia* A. Juss (S2: 331, 411), of which the reproductive stages can appear simultaneously in nature (https://specieslink.net/search/). Hence, we cannot infer whether these images were based on separate flowering and fruiting individuals– as was the case for *C. tapia*. We noticed, though, these species were drawn with more leaves in the *Theatrum* than in the HNB. In contrast, other images are represented the other way around: *Paullinia pinnata* L. in the *Theatrum* (f. 283), whose infructescence and open fruit resemble the woodcut in the HNB (Piso, 1648: 114), shows many more (and slightly different) leaves (S2: 61).

6.3.4 Connections between De Laet's manuscript and the woodcuts

We listed the database connecting the images and descriptions in the manuscript to their species and woodcuts in the HNB in Supporting Information S5. In total, we counted 388 plant descriptions and 165 plant entries with the word *Icon* next to the entry (S5). Out of these entries, 20 have written 'in lib. [x number]' (*in lib* meaning 'in the book'. The entry on *Mureci* (*Byrsonima cydoniifolia* A.Juss.) lacks the word *Icon*, but it has 'in lib. 93' written next to it; thus, it was likely associated with a specific drawing kept in a notebook and numbered 93. Out of these 166 entries (*Icon* ones plus the entry on *Mureci*), we identified 164 species; two of them remained unidentified as we could not match them to the descriptions in the HNB (S5). There are 149 *Icon* entries (including *Mureci*) whose plant descriptions include a woodcut in the HNB. Surprisingly, we found 15 entries containing the word *Icon*, but the species described in those entries are not depicted by a woodcut in the HNB. The drawings could have existed, but De Laet did not have access to them. For instance, *Tapyracoaynana* (*Cassia grandis* L.f.) in De Laet's manuscript bears the word *Icon in lib. 13* (S5), but there is no image in the HNB for this species. In the HNB, De Laet added

the vernacular name and description of *C. grandis* next to the description and the woodcut of *Byrsonima sericea* DC., which was made after Marcgrave's herbarium voucher (Marcgrave, 1648: 134). In the IURNM, confused by this arrangement, Piso matched the woodcut of *B. sericea* with the description of *C. grandis* under the name *Tapyracoaynana*, but he also added the woodcut of a pod, presumably belonging to *C. grandis* (Piso, 1658b: 158). It is uncertain whether he created this new image after someone else's treatises or after a different species (as he usually did when he did not use the HNB woodblocks) (S4: 43-44). Ultimately, he could have had access to the image De Laet referred to in his manuscript.

Noteworthy are the plant entries of this manuscript and their correlation to the *Theatrum* (S5). Most species (109 spp., 66%) tagged with *Icon* (thus mostly have a woodcut in the HNB) are absent in the *Theatrum*. The remaining (57 spp., 34%) have a correspondent species within the oil paintings, and around half of their woodcuts (27 spp.) are similar to the *Theatrum* (S2), with a few of them (8 spp.) with 'in lib. [x number]' written (S5). We also found this addition in 13 of the *Icon* entries, but the corresponding woodcuts are not similar to the *Theatrum* images. One of the entries reads *Icon* […] *p. 172* and corresponds to *Furcraea hexapetala* (Jacq.) Urb. In the HNB, De Laet reused the woodcut from his treatise on the Americas (S2: 321-322), although number 172 does not match the page number for the same image in the editions we reviewed (De Laet, 1633: 666, 1640: 608; S2: 321-322).

By studying how the images in De Laet's manuscript are arranged, we observed that nine drawings in the *verso* folios do not bear the word *Icon* in their descriptions in the *recto*, but they have similar names. Eight of these figures are represented with an identical woodcut in the HNB (Andrade-Lima et al., 1977; Whitehead & Boeseman, 1989), of which five are only in Piso (1648). This arrangement is strange, as De Laet presumably used this text to elaborate on Marcgrave's chapters on plants. Eight drawings (four pencil-based and four proof woodcuts) resemble the *Theatrum* illustrations (non-reversed). Hence, it seems the drawings

were glued to the *verso* folios in De Laet's manuscript after the completion of the manuscript (perhaps by another person) by matching the vernacular names written in the recto with the plant descriptions. An exception is *Lecythis pisonis* L., whose lead drawing lacks a name and is placed elsewhere (S5).

6.3.5 Connections between the images and their vernacular names

All the HNB woodcuts that look similar to their correspondent taxa in the *Theatrum* share the same or similar (cognates) vernacular names (S1). All the entries with the remark *Icon in Lib x* in the manuscript (n=8) are associated with plant taxa that bear similar images and names in both sources (S5). There are some peculiarities to it: *Camara uuba* in De Laet's manuscript bears *Icon in lib. 69* next to it (Fig 6.13a). Therefore, we would assume that the described plant included a woodcut in the HNB copied from a notebook numbered 69. While the description corresponds to *Calea elongata* Baker (Pickel, 2008), the woodcut in the HNB is very similar (in reversed format) to the *Theatrum* illustration for *Lantana camara* L. (Fig 6.13b). The oil painting bears the name *Camaràuna* (Fig 6.13c), presumably written by the artist in question (Fig 6.13d). De Laet warned the reader in the HNB, 'the image we give here [with *C. elongata* description], even though we found it under the name *Camara uuba*, seems to be from another *Camara*, which the author [Marcgrave] mentioned before' (Marcgrave, 1648: 6) (Fig 6.13e).

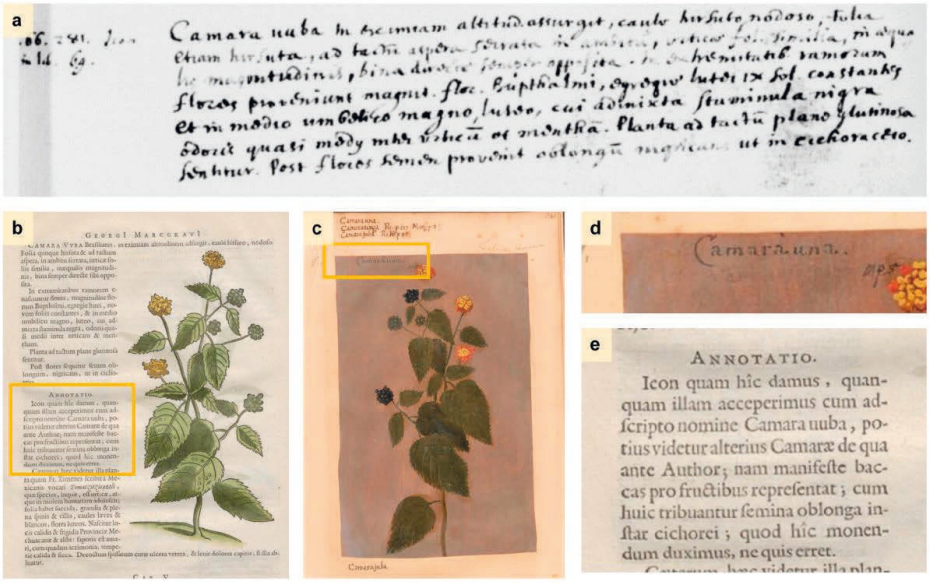

Fig 6.13 **Linking the woodcuts in the HNB with De Laet's manuscript and the *Theatrum*.** (a) Description of *Calea elongata* Baker next to *Icon in lib. 69* in De Laet's manuscript (f. 5r) (b) Woodcut of *Lantana camara* L. in the HNB (Marcgrave, 1648: 6) (c) Oil painting of *L. camara* in the *Theatrum* (f. 341) (d) Vernacular name written on the illustration (e) De Laet's annotation on the use of this image (Marcgrave, 1648: 6).

Most of the taxa with different vernacular names in the HNB and the *Theatrum* are also illustrated differently, except for three species. The woodcuts and illustrations of *Spighelia anthelmia* and *Dorstenia brasiliensis* Lam. look alike but do not bear any name in the oil paintings. These were likely cut-out, as we observed for several oil paintings before being glued into the bound collection (Albertin, 1985: 275). *Samanea saman* (Jacq.) Merr. is named *Guaibí pocaca biba* in the HNB (Marcgrave, 1648: 111) and *Nhuatiunana* in the *Theatrum* (f. 399). Since their images are only slightly similar, with similar inflorescences but different

leaves and spatial composition, this weakens the possibility that they originated from the same source.

Another species with different local names in the HNB and the *Theatrum*, represented with a different image, is *Schinus terebinthifolia* Raddi. A fruiting branch in the HNB (Fig. 6.14a) accompanies the description of this species under the names *Aroeira* and *Lentiscus.* The woodcut, however, belongs to another taxon. De Laet reused the figure (Fig 6.14b) from his book on the Americas, in which he described a Peruvian tree (De Laet, 1640: 327). He copied this image after the treatise *Curae Posteriores* (Clusius, 1611: 94), in which Clusius commented on the work of the Spanish physician Monardes on American plants (Monardes, 1580: 39). This woodcut represents *Schinus molle* L. (not a Brazilian species) which plant material and knowledge were circulating in Clusius' network of physicians and naturalia collectors since the beginning of the seventeenth century (Pardo-Tomás, 2007).

Fig 6.14 **Different vernacular plant names for the same species resulted in mismatching images and descriptions**. (a) Woodcut of *Schinus molle* L. (*Aroeira*) in the HNB with a description of *S. terebinthifolia* Raddi. (Marcgrave, 1648: 90) (b) the same woodcut of *S. molle* in Clusius (1611: 94) (c) a similar woodcut of *S. molle* in Piso (1658: 132) (d) Illustration of *S. terebinthifolia* in the *Theatrum* (f. 295) (e) Close-up of the annotation in the

Theatrum (f. 295) which includes the name *Cambuí* and the misleading reference to Piso (1658: 178).

Ten years later, the woodblock must have been damaged or disappeared, as Piso (1658a) used a slightly different image based again on De Laet's and Clusius' woodcuts (Figs 6.14b, 6.14c), instead of the legitimate species, as the one present in the *Theatrum* (Fig 6.14d). This oil painting includes the name *Cambuí* (Fig 6.14d), which we found in the HNB, but for a different species: *Eugenia involucrata* DC. (Piso, 1648: 82). Whoever wrote the reference above the illustration of *S. terebinthifolia* in the *Theatrum* was pointing out the woodcut of *E. involucrata*, although they noticed the discrepancy between the image and the description (Fig 6.14d). The names *Cambuí* and *Aroeira* were used for *S. terebinthifolia* in seventeenth century Dutch Brazil and are used for the same plant today (Dataplamt, accessed 23.09.22). *Cambuí/i* is currently used for several species within the Anacardiaceae, Myrtaceae, and Fabaceae families (Dataplamt, accessed 23.09.22).

Overall, if the names differ for the same species, most images do not bear strong resemblances. Nevertheless, the same or similar names can be associated with different images for the same taxa, such as *Bixa orellana*, named *Urucu* in both the HNB and the oil painting (Fig 6.11). Interestingly, most of the vernaculars in the oil paintings are written in a Tupi-based language, and just a few originated from an African language. This trend contrasts with the HNB, which, apart from the Tupi-based names, often provides Portuguese and, to a lesser extent, Dutch, Spanish, and Latin plant names (Alcantara-Rodriguez, 2015).

6.4 Discussion

6.4.1 ‘Call me by your name:’ organizing the Brazilian flora by their Tupi names

Arranging the visual and textual material to create the natural history treatises was an arduous task. As the systematic binomial nomenclature had not yet been established, De Laet, Mentzel, and other scholars who used the HNB as a reference for tropical plants, such as C.F.P. von Martius, struggled to organize the megadiverse Brazilian flora by their vernacular names (Martius, 1843). They cross-referenced the different sources that were available to them, just as we did in this study – although we used the scientific names first.

The difficulties of associating the visual material with the right vernaculars and their corresponding descriptions must have contributed to the development of taxonomy in combination with the flow of exotic plants (either dried, alive, or illustrated) to botanical gardens and private collectors (Schiebinger & Swan, 2007; Wijnands, 1987). Linnaeus used the descriptions of Marcgrave and Piso in his *Systema Naturae* (Linnaeus, 1758), and he often used the Tupi Indigenous names as generics or specific epithets (Boeseman, 1994) – like for *Crateva tapia*, in which *tapia* is a Tupi-based vernacular reported by Marcgrave.

That most of the images are labeled with Tupi-based and a few African plant names imply that artists, naturalists, and Indigenous and enslaved Africans had worked in close connection with each other, as it occurred for the creation of the textual sources in the HNB (Alcantara-Rodriguez et al., 2019). Piso stated in his preface that he ‘submitted to the examination and practice everything that out of the vast theater of nature [he] observed or received by the Indigenous veterans’ (Piso, 1658a: 6, 1957: 8). Moreover, the painter traveling with Piso into the interior could have been an enslaved African. All members of Johan Maurits’s retinue were entitled to personal assistants, as is stated in a document from the WIC at the National

Archives in Den Haag (NL-HaNA, n.d.). To what extent those contributions were forced upon the local inhabitants is not explicitly mentioned in the archives or natural history books. Nevertheless, such connections were certainly uneven – and likely unjust – due to the structural violence that prevailed in the colony. The military activities of the WIC, which ensured the company and their stakeholder's economic profitability overseas, were sometimes combined with scientific expeditions (Van den Boogaart & Brienen, 2002). Slavery and armed operatives to subjugate local peoples who did not ally with the WIC were part of these activities (Klooster, 2016; Monteiro, 2019). Our database with all species and vernacular names listed in the HNB and the IURNM, Marcgrave's herbarium, and the *Libri Picturati* (S1, S2, S3, S4), provides a good ground to analyze Western and non-Western plant nomenclature systems and their preservation over time, as well as to review the role of Indigenous and African knowledge embedded in these natural history collections.

6.4.2 Visual knowledge-making processes in the HNB and the IURNM

By analyzing the plant woodcuts, we can observe that a variety of models were used to represent the different plant species: freshly picked plants, living individuals, dried fruits, seeds, branches, or herbs, sometimes preserved as herbarium vouchers. Not all images originated in the immediate surroundings of Johan Maurits' palace (Brienen, 2006, 2007), as plants were gathered in various places and by different people, on several occasions by the Indigenous Brazilians. To portray all fertile stages of a plant was important, but sometimes this aim failed due to inconveniences during the expeditions or the journey back to Europe, or because seeds failed to germinate or grow into plants in Holland. Exsiccates were crucial in the production of botanical books as they allowed authors to compare the specimens with the engravings (Fleischer, 2020). However, only a fraction of the woodcuts in the HNB were

based on the vouchers collected by Marcgrave (C). Unlike the Renaissance authors of popular herbals such as Fuchs or Gessner (1516-1565), who remained in control of publications and could correct botanical mistakes (Kusukawa, 2010, 2011), Marcgrave could not intervene to review his draft chapters or his published work because of his premature death. Instead, De Laet, who had never crossed the Atlantic and did not have botanical training, took the lead in assembling the notes and images given to him by Johan Maurits to create the HNB.

This material originated from diverse people who specialized in different subjects but whose skills were connected. Marcgrave was trained as a botanist and astronomer, but he also made drawings and retrieved medicinal plant knowledge from the native population, just as Piso did. Marcgrave, however, was not only interested in the utilitarian value of the flora. Hence, some of his woodcuts belong to species he did not report as useful in the HNB. These images were not represented in the IURNM (S4) because the physician aimed to create a more pragmatic field guide. Piso stated that he made his book 'with engravings copied after nature [*iconibus ad vivum depictis*], not only for the delight and admiration of the reader but, above all, to serve the doctors and the sick' (Piso, 1658a: 47). This statement is partly true: his images were not original *sensu strictu* because he chiefly reused the same woodblocks used for the HNB. Still, most of them originated from the floristic studies in Brazil by his colleague Marcgrave.

To create the HNB, when plant drawings, sketches, or illustrations from Brazil were available, De Laet commissioned figures carved onto the woodblocks. To organize the correct plant images with their description, he often looked at the vernacular names that accompanied those sources, as we observed for the *Theatrum*, in which the overlapping images with the HNB shared the same plant names. However, several accurate botanical representations in the oil paintings, whose names matched those in the HNB, were not carved onto the woodblocks. Other images, such as drawings from Brazil of lesser artistic quality,

must have been already available and ended up being the basis for the woodcuts. De Laet would match the plant names documented in the field (as seen in De Laet's manuscript) with other sources (i.e., Marcgrave's herbarium, *Theatrum*, herbal treatises, etc.) only if these images were lacking. Then, he would order the design of a plant drawing to be transferred into a woodblock. This strategy allowed for economizing time and money as the editor of the HNB did not have to create a new figure. When producing the IURNM, even though Piso reused most of the HNB woodcuts, he also added several modifications, especially for the trees, so he altered the woodblocks or made new ones based on the HNB images.

Following Chen (2020), we argue that the HNB created a new visual language by including many images never seen before. Those images constituted a legitimate visual repertoire later borrowed by others, such as Worm (1655) or Piso (1658a), whose treatise resulted in an accumulation, rather than an innovation, of visual knowledge by replicating the images published in the HNB a decade before. Piso also copied the woodcuts from other authors, especially those used by the Plantin publisher's house in the sixteenth and seventeenth centuries (S4), even though these plant images were often based on different locations. He sometimes even used images of Mediterranean, Asian, and African species that did not occur in Brazil then or were not reported in the HNB.

6.4.3 Provenance of sources for the plant woodcuts

We answered the question Whitehead and Boeseman (1989) posed on what extent the *Libri Picturati* images served as models to elaborate the woodcuts of the HNB. The *Libri Principi*'s plant images were not used as the basis for any woodcut in Marcgrave and Piso's treatises. This fact contrasts with the animal woodcuts in the HNB, which strongly resemble the watercolors in the *Libri Principis* (Boeseman, 1994; Scharf, 2019; Whitehead, 1976). The *Theatrum* had some influence but did not constitute the primary basis for the plant woodcuts

(Brienen, 2006; Whitehead & Boeseman, 1989), as only one-third resemble the oil paintings. Most of the woodcuts were based on other sources, most likely on the drawings made by Marcgrave in Brazil. Therefore, the plant woodcut's authorship in the HNB would considerably fall on the naturalist instead of Eckhout (Scharf, 2019). Unfortunately, despite a few drawings in De Laet's manuscript, whose authorship was attributed to Marcgrave (Albertin, 1985; Whitehead & Boeseman, 1989), there are no other records of the naturalist's original drawings made in Brazil. Even so, this authorship cannot be entirely attributed to Marcgrave because some woodcuts resemble the *Theatrum*'s illustrations. Hence, if Eckhout made the oil paintings, the agents behind most of the woodcuts would be Marcgrave and, to a lesser extent, Eckhout, as indicated by Brienen (2006). There are 163 botanical woodcuts in the HNB (from Piso and Marcgrave's chapters on plants) that cannot be traced to the *Libri Picturati*, Marcgrave's herbarium vouchers used by De Laet, or other scholars' works. This number represents nearly half (47%) of the drawings that Marcgrave mentioned he had made in his letter to De Laet in 1640 (Brienen, 2001). Considering that the naturalist kept working in Brazil until 1643, we would expect a more signicant number of drawings, several of which were lost or never ended up in De Laet's hands. Another possibility is that Marcgrave was the author of the models used to elaborate the oil paintings, or at least some of them. Apart from some of the drawings glued in the *verso*, several entries (27 species) in De Laet's manuscript with the word *Icon* correspond to the oil paintings images. These could refer to previous drawings of the oil paintings included in a numbered notebook created in Brazil. Some plant woodcuts show greater details than their corresponding images in the *Theatrum*, as observed between the animal woodcuts and the *Libri Principis* (Scharf, 2019). Others, though, display a less crowded image (e.g., by reducing the number of leaves) than their overlapping images in the *Theatrum*. The existence of plant studies previous to the oil paintings, which were later used as models to create the *Theatrum* ones (Scharf, 2019), is reasonable. The increased

value of the Brazilian imagery lies in the fact that many illustrations and drawings were produced *in situ* (Brienen, 2006). Nevertheless, the oil paintings could have been made in the Dutch Republic, as similarly hypothesized by Johann Horkel (1763-1846) for the watercolors of the *Libri Principis* (Boeseman et al., 1990). After all, Johan Maurits did not give this iconographic material to the Elector of Brandenburg until 1652, eight years after his return to the Low Countries.

6.4.4 Future research and recommendations

Further studies of the fauna woodcuts in the HNB and IURM and their correlations with the animal illustrations in the *Libri Picturari* are crucial to complement existing studies (Almeida, 2016; Boeseman et al., 1990; Boeseman, 1994; Lichtenstein, 1819, 1961; Mentzel, 1993; Schneider, 1938; Teixeira, 1995, 1997; Whitehead & Boeseman, 1989) to compare our research outcomes and shed more light into the sources used for the woodcuts. Yet, the location of many sources is unknown or even lost. To solve these mysteries, archival research should be conducted alongside the study of herbaria, libraries, and private collections linked to material originating from Dutch Brazil. Digitizing the known sources is essential to facilitate their analysis without touching the fragile material. Publication of the high-resolution images in an online open format would increase its access to a larger academic community. However, this does not guarantee its dissemination to the wider public. It is pertinent to work towards collaborative projects between Indigenous and Afro-Brazilian communities, researchers, and representatives of the Western institutions that hold this biocultural material. Recently, various historical Brazilian materials have been used in successful cross-cultural projects that generated valuable outcomes for the Indigenous communities involved (Cabalzar et al., 2017; Kruel et al., 2018; Martins et al., 2021).

6.5 Conclusions

The repertoire of drawings used to elaborate the HNB and IURNM is incomplete. Creating these treatises can be compared to doing a puzzle with several pieces lacking and the impossibility of coming back to gather them. Nevertheless, our systematic analysis reveals new insights about the sources of the woodcuts in these books. The images embedded in these natural history books reflect an intentional effort toward portraying as much botanical information as possible. This goal was achieved by using local people's knowledge of the environment to provide the plant material later captured in images and perhaps to assist further with the artistic process. Moreover, Tupi-based plant names played a crucial role in arranging textual and visual sources, which were sometimes confusing for Western scholars. Mof the drawings carved onto the woodblocks arrived from Brazil, sometimes combined with existing images of different provenance and a few new ones made in the Dutch Republic. Overall, the process of visual knowledge-making differs between the two books: the HNB mostly relied on primary visual sources to depict the flora, while the IURNM relied on secondary ones. Yet, the human agency behind such sources requires further attention. Archival studies and collaborative projects with Indigenous and Afro-Brazilian communities and researchers, art historians, and artists could shed light on the missing pieces of this conundrum and the multiple (hidden) histories related to these collections. There is certainly far more than botanical imagery behind the nature portrayed in Dutch Brazil, but to be able to see it, different eyes have to look at it.

Chapter 7

General Discussion

7.1 Key findings

The key findings of this dissertation pertain to the following topics:

- Plant knowledge retentions in Brazil, taking as a historical reference the HNB and considering the phytogeographical range of the documented useful species.

- The presence of these species in contemporary Brazilian markets and the preservation of their vernacular names.

- The depiction of a specific plant (*Cascabela thevetia– Ahoay*) in Late-Renaissance and Early Modern treatises (including the HNB**)** and its representation in museums today.

- The floristic composition of the *Libri Picturati*, its connection with the printed works (Macgrave & Piso, 1648; Piso, 1658), and Marcgrave's herbarium.

- The sources used to elaborate the plant woodcuts in the HNB and IURNM and the methods of plant collection employed by naturalists and artists in the colony.

Regarding botanical knowledge and plant distribution, we found substantial retentions of plant practices between contemporary and seventeenth century (Dutch) Brazil. These practices, although in majority associated with Indigenous Brazilians, reflect a mix of cultures and ethnical backgrounds that resulted from pre-Columbian migrations and plant trade between Indigenous groups, as well as their (forced) contact with the Europeans. The HNB reported crops and weeds of African origin due to the numerous shipments of plants and people during the trans-Atlantic slave trade. Botanical adaptation strategies and the resilience of the enslaved population in the unknown land facilitated the persistence of these plants in tropical America. Although the territory of Dutch Brazil was relatively small compared to the vast extension of the country, its flora encompassed a broad distribution

range. Hence, the HNB was partly representative of the whole country (as was advertised at the time) and fulfilled the purposes of naturalists, physicians, and traders who wanted to study or commodify the tropical flora.

Regarding our study of Brazilian plant markets, we concluded that the large geographical range of the HNB species, migrations, and the diversity in market survey methods, explained that most of the HNB plants are being sold in northern markets instead of Recife, where the HNB originated. Regarding vernacular names, we also found the greatest correlation with the HNB in northern markets (Bélem and Boa Vista). Most of the overlapping names were Indigenous plant names, mostly belonging to the macro-linguistic Tupi family, except for a few that belonged to the Arawakan languages. However, we recommend conducting more market surveys because the percentages of overlapping plant names were higher in Recife (with fewer species in common with the HNB but more overlaps among them). During our market survey in Belém (Ver-o-Peso), several introduced species were found on the stalls and constituted the most popular commodified plants. A plant also present in Ver-o-Peso, was *Cascabela thevetia*, known as *Ahoay* in the HNB. This species' toxicity and use as an ornament in dances attracted the attention of European chroniclers and scholars who tried to retrieve its secrets from the native population. But the Indigenous peoples, well aware of this, often resisted the invaders, who never found the antidote to its poisonous seeds.

As proved by our botanical analysis of the *Libri Picturati*, not only information about plant uses was taken from the local population, images often captured relevant botanical knowledge. Substantial differences exist among the three collections in the *Libri Picturati*, made by different people for various purposes and representing plants that were collected in different ways. For example, the drawings in the *Libri Principis* are not that scientifically accurate. The plants were probably gathered in the surroundings of Johan Maurits' palace to fulfill contemplative purposes. At the same time, the illustrations in the *Theatrum* include

several wild species from the Atlantic Forest and the Caatinga biomes. They are represented mainly by flowering and fruiting branches, which portray more botanical information than sterile branches or loose fruits. These plants were collected either during the scientific-military expeditions (joined by Marcgrave, Piso, enslaved Africans, and Indigenous peoples) or brought to the painters by local people. Several folios in the *Theatrum* contain no illustrations but references to the flora depicted in the HNB and IURNM. Cross-referencing these sources, we retrieved the species that were meant to occupy the unillustrated folios. Finally, regarding the sources for the plant woodcuts, we found that several designs in the *Theatrum* – or their previous drafts – were copied into the HNB in a woodcut format. Possibly the editor of the HNB, Johannes de Laet, matched the vernacular plant names from his notes with the names in the paintings, mainly belonging to the Tupi macro linguistic family. Nevertheless, roughly a third of the Krakow illustrations ended in the textbooks, while other sources to elaborate the woodcuts were borrowed from already published natural history books or made after the plant specimens collected by Marcgrave in Brazil (and later bound in a book herbarium). The rich diversity of vernacular Tupi names and plants in visual and textual sources often confused the scholars, who did not know how to connect them – which we solved by using our scientific identifications. On the other hand, the most extensive corpus of images included in the HNB were those presumably made by Marcgrave in the field, likely assisted by Indigenous and enslaved people. Unfortunately, they seem to have been lost, unless they are hidden somewhere in other collections.

7.2 Analysis of the key findings

Related to the key findings, we reflected about three relevant issues: we discussed the reasons behind the production of the HNB and the *Libri Picturati*, elaborated on the complexities of

plant pathways and botanical practices, and argued about the collaborative work behind the creation of natural history collections from Dutch Brazil.

7.2.1 Depicting plants and designing plans

Marcgrave and Piso (1648, 1658) documented mainly medicinal and food plants. Many of these medicines kept their function, and a considerable percentage of plant-based food persisted over time. Other interesting plant practices were sometimes cited, such as building roofs of houses ('choupanas') with the leaves of *Copernicia prunifera* (Mill.) H.E.Moore or extract oil from the seeds of *Jatropha curcas* L. for lamps. However, the number of citations of these technology or domestic uses was much lower. The Dutch were chiefly interested in the flora that surgeons and physicians could employ in the colony. This course of action was characterized by the bioprospecting for new drugs in the alien land (Schiebinger, 2007), similar to what Jesuit priests implemented with their *boticas* in other parts of Brazil (Leite, 2013; Walker, 2013). The Dutch intention to investigate Brazilian natural resources was tied to imperialistic interests from the beginning, resulting in Johan Maurits' scientific and artistic team surveying the colony during his mandate.

In contrast, the Jesuit's eagerness to learn about tropical pharmacopeia was secondary to the evangelization of the native population (Křížová, 2020). During the military-scientific expeditions conducted by Marcgrave and Piso, Brazilian fruits that could be eaten (*Hancornia speciosa* Gomes) or drank in the form of beverages (*Anacardium occidentale* L.), as well as tubers that alleviated thirst (*Spondias tuberosa* Arruda) were appreciated. Hence, Marcgrave and Piso documented them in the natural history treatises (Marcgrave & Piso, 1648; Piso, 1658). Although the highly diverse flora in the northeast of Brazil certainly had a broader array of meanings for the native population, the scholars gathered specific uses that fulfilled their purposes and aimed to provide a (field)guide for potential newcomers to the

colony. This utilitarian value, often indicated by researchers (Ferrão & Soares, 1995; Françoso, 2010; Teixeira, 1995, 1997; Whitehead & Boeseman, 1989), was noticeable in the great proportion of useful plants documented in the HNB and IURNM, and in Marcgrave's herbarium, which specimens we correlated with the treatises.

On the other hand, the botanical iconography of the *Libri Picturati*, especially the oil paintings of the *Theatrum*, do not correspond entirely to the species described in the HNB or the IURNM. Over half of those images represent flora collected into herbarium vouchers or described in the natural history treatises. Marcgrave and Piso did not report the remaining species portrayed in the *Theatrum,* or their annotations were dismissed, lost in the field, or during the return trip across the Atlantic. Thus, although not all botanical illustrations were included in the textual treatises, they played a role in the colonial venture.

In the early modern period, images that accompanied print works on flora, fauna, and other natural phenomena (such as the HNB) acted as catalogs to attract naturalists, merchants, and patronages, advertising the natural products that could become or were already commodified (Cook, 2007; Kinukawa, 2012; Margócsy, 2014). Hence, images constituted powerful tools to stimulate political endeavors and increase social status (Egmond, 2010; Marcaida, 2014). Johan Maurits was aware of this advantage when he exchanged them as diplomatic gifts with the Prussian and other European rulers (Françoso, 2010; Monteiro, 2019). Moreover, he added an extra value when he categorized them as *Ad vivum* (after life) creations that originated in his former domains under his patronage (Brienen, 2006), which was not necessarily the case for all of them (Chapter 6).

7.2.2 The meaningful connections in plant pathways

People move, pushed by circumstances to a greater or lesser degree, and plants, as well as the associated botanical knowledge, move along with them. The distribution of the HNB plants

beyond northeast Brazil, together with the movements over time of people who traded and used these plants and adapted their plant knowledge to the new environments (Medeiros et al., 2012), partly explains the presence of the HNB plants in the northern Brazilian markets in the recent decades. Plant pathways are hard to trace, but recent archaeological, linguistic, genetic, and ethnobotanical research is bringing new insights into this topic (Heckenberger et al., 2007; Levis et al., 2018; Neves et al., 2011; Noelli, 2008). Sometimes, we combined information from these studies and historical accounts (HNB) to trace the potential dispersion routes of plants and the human agency involved. Based on the Amazonian domestication of cassava (*Manihot esculenta* Crantz) more than a thousand years ago, Tupi-Guarani peoples brought this plant from the north to the northeast of Brazil (Gibbons, 1990; Nassar, 2002). However, *M. esculenta* has multiple cultivars that require different preparation methods for its consumption. Did all the botanical knowledge associated with cassava originate in the same place? The HNB provides many vernacular names related to the different cultivars, such as *Mandiibabuara, Mandiibparati, Aipi,* and *Tacetima* (Piso, 1648: 52), its processing methods and the various end products obtained from it. 'Once the soft cassava is dried - the *Carima*-, the enslaved Africans from Angola prepared some bread with it that they called *Musa*, *Angu* or *Enfonde*' (Piso, 1648: 54). To name just a few of these food products, Piso cited *Mandiopeba* (grated cassava mixed with butter or lard and sugar), *Tipioca* and *Carima:* beverages in the form of syrups mixed with orange flower water and a bit of sugar (Piso, 1648: 54). Piso also documented that 'the Indigenous Brazilians, the enslaved peoples and not a few of our people, appreciated the leaves, which crushed, cooked and well-prepared, we use as food and, in the form of lettuce and reduced to a mass, the Indigenous peoples called it *Manicoba*' (Piso, 1648: 54). In 2018, we encountered *Maniçoba* in the Ver-o-Peso market in Belém. This dish was made out of bitter cassava leaves, which differ from sweet cassava. Bitter cassava is initially toxic due to hydrogen cyanide compounds (Santos,

2017). Hence, to prepare this Amazonian dish, the leaves are boiled for nine [or at least seven] days to remove the hydrogen cyanide, according to the market vendors. The resultant green mass is mixed with pork, dried (smoked) meats, prawns, and other ingredients and tastes delicious – as we had the pleasure to attest. This dish is today widespread in Belém, where the Portuguese influence is noticeable in adding smoked meats (Macêdo, 2016). This dish is also relevant in Bahia, particularly in the city of Cachoeira and in Salvador, where the legacy of the *Maniçoba* is tied to the Afro-Brazilian population and culture (Brandão, 1967; Macêdo, 2016; Santos, 2017). *Maniçoba* is part of a hybrid cuisine (*cozinha mestiçada*) that characterizes several Brazilian dishes (Macêdo, 2016). Even if the Amazonian Tupi-Guaranis traded the cassava plants with northeastern communities, the recipe of *Maniçoba* could have emerged in the northeast or had two centers of origin. Plant pathways are linked to the cultural practices that emerged in specific socio-environmental conditions and places and may be as diverse as such contexts. Essentially, *Maniçoba* is a reflection of Brazilian intercultural identity embedded in a dish.

Other commodified plants have moved far from their places of origin and are now part of Brazilian cuisine and (natural) medicine. To a great extent, these movements correspond to the globalization of plant trade based on agri-business (Chaddad & Jank, 2006). However, the original routes of several introduced plants sold at the market stalls, as portrayed in the Dutch Brazilian sources, began by the Portuguese during their long-distance trade journeys (Kury et al., 2013). Via the slave ships, many seeds, weeds, and crops traveled from the Western African coast to the American shores. Merchants, scientists, and enslaved Africans contributed to dispersing plants across the continents, such as *Abrus precatorius* L., *Guilandina bonduc* L., and *Dioscorea alata* L. (yam). The latter was often brought as food for the enslaved people during the voyage, and was cultivated in the American continent by them as means of survival and spiritual connection to their homeland (Carney & Rosomof,

2009; Voeks, 2013). Several of these plants are nowadays found both in the wild (naturalized) and cultivated in yards or gardens, such as rue (*Ruta graveolen*s L.) and lemongrass (*Cymbopogon citratus* (DC.) Stapf). Others, like bananas, plantain, and coconuts, were domesticated in Southeast Asia, cultivated in Africa, and later brought to Brazil by the Portuguese and the Dutch via their trading ports in West Africa (Leite, 2013).

By studying the HNB and the *Libri Picturati*, we can capture the botanical knowledge present at a specific period and visualize the different histories that intersect and shape these practices and plant movements. Nevertheless, as the relationships between plants and people may differ in the places they connect, we must pay attention to multiple sources and oral stories. The history behind plant-based products and practices can contain relevant nuances, especially when local communities are connected to them. After all, what is essential beyond the origin or the utilitarian value of plants *per se*, is the cultural and spiritual meaning to the people who perpetuated them through time and space.

7.2.3 'Collaborations' during the knowledge-making process

The work of Marcgrave, Piso, and De Laet, commissioned by Johan Maurits, encapsulated a part of the Brazilian (plant) heritage that naturalists, travelers, and scientists used as a reference work in the tropics for many centuries after its release (Gudger, 1912; Whitehead & Boeseman, 1989). Whether these scholars and chroniclers considered the multiple agents behind the knowledge production process is questionable. There seems to be a pattern related to recognizing local people's knowledge in other colonial natural history books of the early modern period. Over two decades after the publication of the HNB, Van Rheede tot Drakenstein (1636-1691) worked as governor for the VOC in Cochin (present-day Kochi, on the Malabar coast of India). While reporting on medicinal plants for his future treatise, he thanked the local experts (high-rank physicians) by their names. This acknowledgment is

noticeable in his first book in the series *Hortus Indicus Malabaricus* (1678) (Gehrke, 2021: 309; for a comparison of this book with the HNB, see Singh & Francozo, *in press*). However, botanist Jan Commelin (1629–1692) erased all credit to the native population when he took over the publication of the *Hortus Malabaricus* (Gehrke, 2021). Physician Jacob Bontius (1592–1631), another VOC employee, worked in Batavia (today Jakarta, Indonesia). Like Van Rheede, he cited local peoples and their botanical knowledge in his work. However, Piso censured all credit to the inhabitants' plant expertise when he published Bontius' work in the IURNM (Cook, 2007; Gehrke, 2021). Maria Sibylla Merian (1647–1717), one of the many naturalists who used the HNB as a guide on tropical flora, cited Marcgrave and Piso in her work on butterflies and their links to specific plants in Suriname (Merian, 1705: 1). Just like Marcgrave and Piso, she relied on Indigenous and enslaved peoples (*myneen Indiaan* and *myne slaven* – as she called them) to bring her plants when she was unable to obtain them by herself (Merian, 1705: 36) and also stated that she retrieved the vernacular names from the native population (Merian, 1705: preface). Merian addressed how Dutch settlers abused enslaved Africans and Indigenous women to such an extent that they often interrupted their pregnancy with the *Flos Pavonis* (*Caesalpinia pulcherrima* (L.) Sw.) to avoid their children being born into slavery (Merian, 1705: 45). However, as noticed by Polcha (2019), the violence perpetrated in the Dutch colony against women was sidestepped by the scientific character of Merian's work, in which her local contributors were relegated to the background. As a female entrepreneur, she may have broken conventions by traveling overseas to pursue a scientific career; yet, as owner of enslaved people she was embracing others, backed up by her class and white privilege.

Piso and Marcgrave often associated specific plant practices with different ethnic groups, which indicates from whom they learned about these plants: mainly the native population but also the enslaved Africans, Spanish and Portuguese. However, they used pejorative

terminology to refer to Indigenous Brazilians and peoples of African descent (especially Piso) and despised their plant practices but also used it for their convenience (Piso, 1648: 15, Chapter 2: Alcantara-Rodriguez et al., 2019).

Simultaneously, there were frictions between Piso and Marcgrave based on a relationship of servitude by the naturalist towards the physician (Whitehead & Boeseman, 1989), or the other way around, as Linnaeus (critical of Piso) had put it (Scarano, 2008: based on Linnaeus' letters to Vandelli in 1765). One way or another, both sat at the count's table in the luxurious palace (NL-HaNA, n.d.), holding a position of power despite animosities. Piso later discredited Marcgrave when he published the naturalist's work under his name in the IURNM, alluding to Marcgrave's position as his field assistant and hence, his entitlement to use the naturalist's work freely (Piso, 1658: 107). However, Marcgrave's position as field assistant only lasted briefly at the beginning of the naturalist's studies in Recife. Later, Marcgrave was granted by Johan Maurits an entire observatory to do astronomical studies (Matsuura & Zuidervaart, 2014) and his own space to germinate plants, which he called his 'museum' (Marcgrave, 1648: 29, 41). Ultimately, the decision to send Marcgrave to Luanda (Angola), where he died soon after, while the rest of Johan Maurits' crew returned to Holland and became successful, seems obscure and requires further investigation.

These rivalries between the credited authors of the HNB are incomparable to the asymmetric relationships between Europeans and the Indigenous and African peoples because the hegemonic power fell into Dutch (or Portuguese) rule. On the one hand, Indigenous Brazilians and enslaved Africans participated in the knowledge-making process of natural history collections by providing plant material and knowledge, although not explicitly acknowledged. On the other hand, those 'collaborations' took place in occupied land in a climate of social instability that resulted from the previous invasion by the Portuguese and the current Dutch occupation with the help of armed forces (Klooster, 2016). Johan Maurits, with

the support of the WIC, commanded a military guard to accompany Marcgrave when he collected fauna and flora (Van den Boogaart & Brienen, 2002), and local people brought the specimens to him while he safely resided in Maurits' court. The same applied to Piso, who, like the other members of Johan Maurits' entourage, was entitled to an assistant for himself – probably an enslaved person. We should not forget that the whole colony existed in a continuous war zone (Klooster, 2016; Odegard, 2018).

It is also noticeable that women were barely cited throughout the text (Pombo Geertsma, 2019), even though they must have held a remarkable corpus of botanical knowledge and supplied information about plants, such as emmenagogues (Chapter 1). Moreover, if they are mentioned, it is under the male gaze, like when the physician explained how women used the fruit of *Bromelia karatas* to provoke abortions so 'they can prostitute to men safely by committing a criminal infanticide' (Piso, 1648: 123).

The lack of attribution to local plant experts and the contempt towards them is often labeled as a matter of convention within elitist academic circles in early modern Europe (Gehrke, 2021). It is pertinent, however, to move beyond arguments based on 'conventionalisms' or 'circumstantial events' – which, although sometimes unconsciously, might justify injustice and systemic violence. Instead, 'critical scholarship' aims to take responsibility and raise awareness to challenge the *status quo* and the normative orientation that research follows in academia. It does so by challenging power hierarchies, including those related to knowledge-making (Eschle & Maiguashca, 2006). Furthermore, increasing critical research is emerging to avoid undermining the social and environmental damage behind historical processes, including those where plants and peoples intertwine. Hence, research should tackle the complex socio-political factors that underly bioprospecting practices in the colonial world and question how non-Western plant knowledge has been presented to the European audience by their counterparts (Geniusz, 2009; Schiebinger, 2004, 2007; Tuhiwai Smith, 2021).

7.3 Revisiting the ethnobotanical approach to natural history collections

Undeniably, relationships between plants and people can be highly diverse. Therefore, ethnobotany constitutes a transdisciplinary field of study that includes social and natural sciences. It has acquired a more humanistic approach over the last decades, with a strong focus on conservation in Brazil (Oliveira et al., 2009; Ritter et al., 2015). This shift in ethnobotany is directed toward recognizing Indigenous Peoples and Local Communities (IPLC) as active agents in policy-making decisions (Joseph et al., 2022; Reyes-García et al., 2022). Therefore, we performed an in-depth ethnobotanical analysis of these natural history collections, acknowledging the connections between the different ethnic groups and the inequality that these entailed.

By studying historical collections that include or are based on Indigenous and African (plant) knowledge, like the HNB and IURNM, we can bring attention to the relevance and resilience of this corpus of knowledge. This ecological knowledge has persisted, embodied by a collective resistance, despite cultural repression or assimilation policies, genocide and European diseases, and misplacement of the Indigenous population, enslaved Africans, and Afro-Descendant peoples since colonialism. Furthermore, we acknowledge the appropriation of a large part of their heritage by Western institutions. This recognition could lead these institutions to achieve more ethical and fairer practices, such as repatriating the biocultural collections taken from IPLC in the past, a much-debated topic (BBC, 2022). Other options include facilitating access of these materials to IPLC and contextualizing their artifacts with their histories (Martins et al., 2021) or co-creating collaborative projects with the communities that have been affected by colonialism (Cabalzar et al., 2017; Kruel et al., 2018). The so-called ‘post-colonial’ practices prioritize economic profit over human rights and do not belong to the past but are perpetuated in the present, embedded in fascist, racist,

and sexist policies in Brazil and worldwide (Brito, 2022; Coombes et al., 2013; Cunha, 2021; Porto & Rocha, 2022). Due to this continuity of unjust actions impacting present-day societies and the natural environment, and fueled by critical scholarship and IPLCs movements, the so-called decolonization projects are emerging in several institutions, like museums and universities. For example, the Emílio Goeldi Museum in Pará (Brazil) facilitates cultural strengthening projects between several Indigenous groups and ethnographic museums in Europe that hold parts of their heritage in their collections (Augustat & Kapfhammer, 2017; Cabalzar et al., 2017; López et al., 2017).

7. 4 Limitations of this research and further study

We experienced several methodological and socio-political challenges during the overall research process. The methodological limitations are related to virtual taxonomic tools, phytogeographical borders, plant categories, and ethnobotanical literature. The socio-political constraint pertains to the co-creation of projects with the Brazilian IPLC.

7.4.1 Taxonomic tools

We based a significant part of our plant identifications on our revision of the work of eminent Brazilian botanists Pickel (2008 [1949]) and Andrade-Lima et al. (1977), who previously identified the species in the HNB, IURNM, and Marcgrave's herbarium. During this revision, we had to change taxonomic tools on several occasions. The database we used at the beginning, ThePlantList (http://theplantlist.org/), became outdated and replaced by Plants of the World Online (https://powo.science.kew.org/). We have mainly worked with Brazilian flora, so we used Reflora – Flora e Funga do Brasil (https://reflora.jbrj.gov.br/). The last two collaborated by sharing taxonomical data via the Royal Botanic Gardens Kew and the Rio de Janeiro Botanical Gardens and by offering the latest published taxonomy, but these are not

exempt from limitations (https://powo.science.kew.org/about). Botanical names change continuously because of advances in taxonomical studies and developments in molecular research and follow the International Code of Nomenclature for algae, fungi, and plants (ICN) (Cook & Schultze-Kraft, 2015). Due to the lack of standardization at a global scale of binomial plant nomenclature, we sometimes found different scientific names for the same plant. We often used non-legitimate names (synonyms) in our searches to avoid missing old papers that used outdated nomenclature. We also had to update our databases regularly, so the first published datasets show slightly different names than our last plant lists, which does not alter our results significantly. As taxonomy changes are ongoing and lists of names are dynamic, we encourage anyone who uses our plant datasets to check the latest updates for consistency and precision, yet keeping the synonyms in mind to perform a complete search in various sources.

7.4.2 Phytogeographical borders

Besides using different plant names, botanical search engines can also provide different plant distributions. To improve accuracy when analyzing the distribution range of the plants in the HNB, we combined several online databases: SpeciesLink, GBIF, Tropicos, CNC-Flora, Reflora, etc. We used the geopolitical divisions in Brazil (north, northeast, central west, southeast, and south) and combined them with the biomes (Amazon, Atlantic Rainforest, Caatinga, Central Brazilian Savanna or Cerrado, Pampa, and Pantanal). However, as we mainly considered the geopolitical divisions when identifying endemic species in Chapter 2, we might have missed species that do not respond to these limits but occur under specific climatic and geologic conditions. We recommend that future scholars extend our search to check for species currently endemic to the regions surveyed by Marcgrave and Piso, including the phytogeographic range within the Atlantic Rainforest (*Mata Atlântica*), the

Caatinga, and the transition with the Cerrado biomes in Maranhão, Ceará, and Bahia. For instance, *Spondias tuberosa* is not unique to the northeast (as a geopolitical region). Still, it is endemic to the semi-arid Central Brazilian Savanna and Caatinga (Cavalcanti & Resende, 2006), which correspond to the characteristic vegetation domains where Marcgrave did his plant collection. We overlapped the geopolitical regions with the biomes in our comparative study of the HNB and the Brazilian plant markets (Chapter 3). In our analysis of the flora depicted in the *Libri Picturati* (Chapter 5), we accounted as endemic those species unique to the Brazilian biomes. Based on these ecological ranges, we should standardize the current distribution of all the species documented in the seventeenth century in Dutch Brazil. We can create past-present distribution maps by overlapping the species in the HNB whose locations are cited in the book, as provided by Almeida (2016: 30-38) and the diary of Marcgrave (Van den Boogaart & Brienen, 2002), with their present phytogeographic ranges. These studies can bring us valuable insights from an ecological point of view, taking into account that past vegetation may have occupied a more extensive coverage yet based on climatologic and geological factors rather than geopolitical constructs. Plants, unlike humans, do not respond to those.

7.4.3 Plant categories

Other constructs to review include any fixed categorization assigned to living and dynamic organisms and systems. These would include (among others) the categories assigned to understand plant uses (Chapter 2) and domestication status (Chapter 5).Three methodological issues, which might conflict with each other, concern us.

First, we compared plant uses based on plant descriptions written in Latin by German and Dutch scholars from the seventeenth century with modern medicinal uses. Sometimes use categories overlap, but the names for diseases used in the HNB differ from those used today,

like the term ‘dropsy,’ now known as edema. To refine our diachronic analysis, we can conduct a more in-depth review of the original Latin medical terminology in the HNB, partly based on Hippocratic and Galen’s classical Greek medicine (Wulff, 2004). In addition, plants that healed specific ailments might have had properties and uses that we did not consider within our categorizations. According to these, *Crateva tapia* L. is a febrifuge whose leaves ‘calm the excessive fevers and alleviate the horrible pain in the anus called [by the Spanish] *bicho do culo*’ (butt bug) (Piso, 1648: 78). *C. tapia* is still used to alleviate fevers (Agra et al., 2008), which reflects the continuity of this species’ use as a febrifuge. However, to understand the extent to which this species, or any other, covers the spectrum of symptoms of any given disease, we must first understand the health condition. For example, *Bicho do culo* – also named *Maculo* by European chroniclers – seems to be related to the proliferation of intestinal roundworms (*Trichuris trichiura* L.) as found in post-colonial Brazilian mummies (Bianucci et al., 2015). By analyzing the ailment in more detail (not solely the plant species), we can look at recent pharmacological research to determine whether *C. tapia* has any course of action against the parasite or only tackles the fever.

Second, we combined plants that heal different ailments under general categories. For instance, we placed *Bromelia karatas* L. into emmenagogues: plants that regulate or induce menstruation. Piso described *B. karatas* as an abortifacient, technically an emmenagogue. Still, this involves a distinctive and essential function. We recommend splitting some categories into specific ones to avoid lumping medicinal practices for plants with several properties. Creating more specific fields also applies to other groups: placing the beverages apart from the food category or dividing plants whose leaves are used to build houses from those that provide wood to build dwellings or canoes.

Third, assigning categories to classify how humans use and manage plants can be problematic due to the complexity of such relationships. Often, the labels we used correspond to

continuous processes, such as the domestication levels of plants (Clement, 1999). Some of the plants we classified as wild, like *Guilandina bonduc* L., could have been cultivated in the seventeenth century and vice versa, or in an intermediate state between wild and cultivated, as Lévi-Strauss (1952: 252) observed when he was studying the use of wild plants in South America. Placing them as growing spontaneously instead of being managed by people can undermine the agency behind the complex ecological and social practices involved in their cultivation, as is the case with the 'Pristine Myth' in pre-Columbian American landscapes (Denevan, 1992). According to oral accounts by Afro-Caribbean peoples in Jamaica, the seeds of *Guilandina bonduc* L. were brought to the Americas by their African ancestors, and their seeds are still used in the game called *Warri* (pers. comm. by Benjies, Jamaica, June 2022). Even if the oceanic currents frequently transport the drifting seeds of this species around the globe (Murray, 1986), the seeds of *G. bonduc* likely also came with slave ships as body ornaments and as counters in the game known as *Oware* in Ghana or *Warri* in several countries of West Africa and the Caribbean (Heilbron, 2012; Stoffle & Baro, 2016). *G. bonduc* is a meaningful cultural plant, managed in the past by enslaved Africans and connected in the present to both Africans and their descendants in many parts of the Americas. A more careful approach should be taken when using these domestication categories to avoid leaving out the full potential of botanical knowledge and the people behind it.

Assigning plant categories is a challenging task. We can make them more specific and broaden our literature search. However, when studying plant knowledge, we are linking it to a sociocultural context, where people have coexisted and still do. Plants are living organisms that undergo dynamic processes and interact with their environment in many different ways. Likewise, people interact with them and the environment, shaping it with their practices. So how do we categorize knowledge while knowing that the people who created, used, and

transmitted it cannot be categorized (unless we want to fall into colonial practices)? Not to forget, we use a Western categorization system to study botanical knowledge retrieved mostly from Indigenous Brazilians. To tackle these methodological and ethical concerns, we recommend having an in-depth look into the reification of epistemology (i.e., approaching knowledge as an object) and the study of knowledge as a process instead (Bolisani et al., 2012).

7.4.4. Ethnobotanical literature

Academic written sources do not incorporate the whole spectrum of plant uses and practices in Brazil, let alone in the rest of the world, although this would have helped to trace introduced plants. The importance of gathering previously unrecorded ethnobotanical data from oral accounts is well established, especially during fieldwork or *in situ* projects, as a remarkable corpus of botanical knowledge is transmitted orally (Martin, 2010). By listening to oral stories, we can share valuable knowledge, which sometimes adds to the written record – like the relevance of the *Oware*/*Warri* game in Afro-Caribbean communities. There is no documentation in the HNB about this African game in the seventeenth century, neither for *Guilandina bonduc*, nor for other species of beans. This absence could be related to the subversive character of this practice, in which the enslaved population achieved their agency (Stoffle & Baro, 2016), or due to the lack of interest of the Western naturalists, who mainly gathered information about plants they could use themselves. However, there are written sources about the game played with the seeds of *G. bonduc* in Brazil today– also known as *Ouri* or *Aiú* (Guerra, 2009; Pereira, 2016; Ramos, 2007; Silva, 2016: 62-66). Likewise, many valuable oral sources are recorded and streamed online, sometimes using other species of seeds or marbles (https://www.youtube.com/watch?v=qtBMwZcUf7M&t=272s), and

emphasizing the relevance of this game's African heritage for the present generations (e.g., https://www.youtube.com/watch?v=pjFt91qAOEs&t=6012s).

Nowadays, many plant stories are shared virtually via several web hosting services, both in written format (blogs, online magazines, social platform profiles) and audio (visual) form (vlogs, streaming channels, podcasts). Impacted by the Covid-19 pandemic, with the accessibility of this technology and the awareness to preserve IPLC heritage, these virtual communication methods have become widely used. We included blog and visual streaming content a few times as specific plant practices were found in these media. By sharing these plant stories, we also aimed to support and amplify their author's claims about preserving their biocultural heritage. We recommend following these complementary methods for future projects, as long as we are critical of the sources behind the information – just as we are with academic ones.

7.4.5 Co-creation of projects with Brazilian Indigenous and local peoples

When feasible, conducting ethnobotanical research *in situ* can provide valuable outcomes for the involved parties, and the knowledge generated can complement any written and virtual oral records. In these projects, Indigenous and non-indigenous actors have to be able to work together based on a relationship of trust, in which all stakeholders' needs and expectations must align in all phases of research (Kruel et al., 2018: 216-217). Moreover, to avoid misappropriations of traditional knowledge and ensure the safeguarding of IPLC and the biodiversity of their lands, these projects must align with the Law on Access to Genetic Heritage and Associated Traditional Knowledge (Law 13,123 of May 20, 2015 - https://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13123.htm). Using the HNB (and associated material), we aimed to follow a collaborative project between

ethnobotanists, anthropologists, and Tupi-speaking peoples within the framework of cultural revitalization and the reemergence of Indigenous heritage at present.

To do so, in August 2018, we participated in a dialogue with Ka'apor representatives during the Conference of Ethnobiology *Belém+30* in Belém (Pará). The Ka'apor speak the Ka'apor language (also known as Urubú or Urubú-Ka'apor), which belongs to the macro linguistic family Tupi-Guarani (https://pib.socioambiental.org/pt/Povo:Ka'apor, accessed 22.11.2022). They live in the Terra Indígena Alto Turiaçu, between the Gurupi and Turiaçu rivers, in the north of Maranhão, where the Amazon forest transitions into the savannahs of the Cerrado (https://www.rainforest-rescue.org/donate/310/brazil-help-the-indigenous-kaapor-defend-the-amazon-rainforest, accessed 22.11.2022). Collaborative projects between Ka'apor representatives, the Emilio Goeli Museum in Belém (Pará, Brazil), and the Volkenkunde Museum in Leiden began in 2012. They resulted in an exhibition at the Goeldi Museum in 2014: *A Festa do Caium* (López et al., 2017). The project, curated by anthropologist Claudia López, celebrated cultural and social elements of the Ka'apor ceremony from their perspective while making visible the ongoing struggles they undergo due to the constant human rights violations in their ancestral lands. Following the collaboration initiated a decade ago between the Ka'apor and the Goeldi Museum, we aimed to gather ideas for a potential joint project by looking at the plants and the botanical terminology in the HNB and the botany of the Ka'apor at present.

For example, we could perform an in-depth linguistic study of the plant names of the HNB and the *Libri Picturati* and look at the botanical terminology used by the Ka'apor today. However, the Ka'apor are experts in their own plant use, and we do not assume that they share a continuum related to their languages, genetics, and culture with the Indigenous groups encountered by the Dutch in the seventeenth century. We are also aware that the HNB incorporated Indigenous (plant) knowledge within Western epistemologies and should be

interpreted with caution when concerning Indigenous groups in the present day. Nevertheless, as biocultural collections, the HNB, *Libri Picturati*, Marcgrave's herbarium, etc., can serve as powerful tools to connect IPLC with part of the heritage and knowledge that was appropriated within colonized objects. As in previous collaborations, our potential project sought to offer a platform to the Ka'apor to claim their (historical and present) narrative and bring international attention to the struggle they currently face due to continuous acts of violence in their lands and livelihoods since colonialism.

In the end, due to several political and public health circumstances, including the increased threat to the livelihoods of Indigenous Peoples in Brazil and the Covid-19 pandemic (Maracá | Emergência Indígena (apiboficial.org), we were unable to carry out the planned collaboration with the Ka'apor and the Emilio Goeldi Museum. Cultural revitalization projects have proven to be a valuable experience for their participants (Augustat & Kapfhammer, 2017; Cabalzar et al., 2017; Kruel et al., 2018; Martins et al., 2021). Yet, these were inadequate in our case because the community needed to enforce respect for the existing legal recognition of their lands, threatened by extractive activities (such as illegal logging). These intrusive activities affect the territories of IPLC, despite recognizing their tenure rights in article 68 of the Constitution of 1988 in Brazil (Conservation Matters, 2021; Cunha, 2018). More recently, the United Nations (UN) adopted *The Declaration on the Rights of Indigenous Peoples* to protect their rights (UNDRIP, 2007), while local communities, such as Quilombos, sometimes have special provisions (CERD, 2011; ILO, 1989; UN, 2001). The strong movements led by Indigenous Peoples and Afro-Descendants led them to obtain more tenure land in Brazil, as well as in the Caribbean and other countries of South America (RRI, 2020: 15). However, even if IPLC territories are recognized under statutory law, these correspond to a lesser extension than what they hold by historical or customary rights (RRI, 2020). The neoliberal policies of the former government of Jair Bolsonaro (2019–2022)

obstructed the land tenures by allowing profit-driven companies to conduct their extractive activities in IPLC territories (agribusiness, hydroelectric plants, mining, wood-logging, etc.) (Casarões & Flemes, 2019; Porto & Rocha, 2022), as it is the case with the Ka'apor. The consequences for the environment and the IPLC affected are catastrophic (Cunha, 2021; Porto & Rocha, 2022; Vasconcellos et al., 2021). Moreover, IPLCs lands are strategic for safeguarding life on earth, and an increasing number of researchers urge to ensure IPLCs rights and their active role in biodiversity policy (Hill et al., 2020; Lima et al., 2020; Reyes-García et al., 2022).

Hence, a relevant collaborative project with IPLC would be embedded within the framework of the demarcation of Indigenous land and the monitoring of the already demarcated ones (https://pib.socioambiental.org.br/es/Demarcaciones, accessed 14.07.22).

At the same time, identity and cultural recognition are central aspects of enforcing respect for land rights. Cultural heritage projects between museum institutions and IPLC can strengthen their culture by recognizing their traditional knowledge and language, which contributes to strengthening their political claims (Françozo & Vander Velden, 2020; Osorio Sunnucks et al., 2022). Likewise, cultural and linguistic recognition can provide knowledge and skills for young and future generations of Indigenous peoples to fight for their rights.

Ultimately, this dissertation includes the whole repository of botanical knowledge we studied, analyzed, and created from the HNB and the *Libri Picturati*. All our outcomes regarding Brazilian flora in the 1640s in the northeast of Brazil that can be (hopefully) useful for collaborative projects include: parallelisms on plant use documented in the HNB with modern plant uses for the same species, seventeenth century plant uses and modern ones, vernacular plant names, voucher specimens, phytogeographical range, market inventories, plant domestication and conservation status, as well as their habit and geographical origin, and all plant woodcuts in the HNB and IURNM and their corresponding images from Dutch Brazil,

or from other sources, with additional pictures of the plants in nature. These data are available in MS word files, spreadsheet (Excel), and pdf format and accessible through the links for Supplementary Materials in the Appendices. Alternatively, data can be accessed via the links provided for every open-access published paper by the journals or by request to the main author – who is happy to provide any dataset and any necessary information related to the research process.

7.5 Concluding remarks

By studying the botanical knowledge, the species composition, and the vernacular plant names documented in the HNB, the *Libri Pîcturati*, and associated materials, we also look into the Brazilian Indigenous, African, and European medicines, diets, plant-based technology, and botanical nomenclature in northeast Brazil around 1640. The plant knowledge that resulted from the interconnections between the various ethnic groups in Dutch Brazil has prevailed – to a certain extent – in present-day Brazil, despite genocide, habitat loss, and the degradation of the natural environment due to capital-based ventures. Even though the biogeography of the HNB species was more extensive than expected, their range must have been broader before colonialism. Today, some species that once were abundant in the Atlantic rainforest and Caatinga unique ecosystems in Brazil are in decline or endangered. The HNB included plants that also occurred in other tropical regions, which was handy for the physicians, naturalists and merchants who used this treatise as a field guide, either for bioprospecting, survival, intellectual or commercial purposes.

The plant identifications and our correlations among all the visual material from Dutch Brazil add new insights into the corpus of visual knowledge on natural history images (including botanical illustrations), recently compiled in virtual libraries. Our botanical identifications also serve to find multiple (plant) stories and critically review the historical discourse created

around them. Natural history collections often captured local peoples' and enslaved Africans' botanical knowledge without crediting them. Hence, we often retrieved this information from botanical practices and vernacular plant names, which belonged to Indigenous Tupi-based languages, and on a few occasions, Portuguese and African languages. Future research would involve collaborating with linguists and IPLC to look into the etymology of plant names and the ethnic groups associated with these plants and to recognize their biocultural heritage and ecological knowledge at present. Furthermore, archival and herbaria research could provide more clues to the missing links or (plant) materials that originated in Dutch Brazil, as well as to the methods of plant collection and the multiple and diverse identities of the people involved in the knowledge-making processes.

The *Historia Naturalis Brasiliae* and the *Libri Picturati* are valuable repositories of botanical knowledge. The interconnections of the scientific and artistic material from Dutch Brazil bring us closer to the botany of the past, which often witnessed the asymmetric power relationships that shaped this discipline – and the colonial world at large. We strongly hope we can unpack more meaningful plant stories by tracing the plant species in natural history collections and recognize the entangled, although often concealed, histories of people and their botanical heritage.

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Appendices

Supplementary Material

Chapter 2

The supplementary material of this chapter is available at https://doi.org/10.1007/s12231-019-09469-w.

ESM 1 Identifications of Marcgrave and Piso plant species, vernacular names, uses in the seventeenth century northeast Brazil; and current origin, cultivation state, phytogeographical distribution, and vegetation type in Brazil.

ESM 2 Retentions of seventeenth century plant use in modern Brazil.

ESM 3 Identifications of Marcgrave Herbarium, collected from 1638 to 1643, and correlations with the HNB and the IURNM.

Chapter 3

The supplementary data of this chapter is available at https://doi.org/10.1016/j.jep.2020.112911.

Supplementary Table S1 Plant species composition in the Brazilian markets analyzed and overlap with the useful species of the HNB. Specie's presence is marked as 1.

Supplementary Table S2 Overlap in vernacular names for the species in common between the HNB and the Brazilian markets and their language origin.

Supplementary Table S1 Content and plant taxa identified in the *Libri Picturati's* Brazilian plant collection.

Theatrum Rerum Naturalium

735 folios numbered (1-735), verso always blank

1-731 folios with illustrations, vernacular names, references and blank folios

733-735 folios with Index *Plantarum Brasiliae*

366 folios (recto) plus one glued folio between 729 and 731

15 folios completely blank

One folio with only a vernacular name (Ambaibuna) (Fig 1)

190 folios without illustrations but with 220 vernacular names and references

30 folios with two vernacular names (from two taxa) per folio

205 taxa with 18 vernacular names that occur twice

197 taxa identified to species level, five to genus level and three unidentified

160 folios with Brazilian plant illustrations

172 Brazilian plant illustrations that correspond to 176 plant images

12 folios with two figures per folio, one folio with three taxa (f. 37), two folios with two taxa (f. 341, 541)

11 taxa depicted twice and one taxon depicted three times

163 taxa identified: 150 identified to species level, eight to genus level, five unidentified

Libri Principis

34 folios with plant illustrations that correspond to 38 plant images

Four folios with two taxa per folio

35 plant names: 17 Latin names (13 unique) and 18 vernacular names (16 unique)

32 plant images identified to species level and six plants identified to genus level

Four species depicted twice

34 taxa identified: 29 taxa identified to species level and five taxa identified to genus level

Miscellanea Cleyeri

28 folios with plant illustrations that correspond to 34 plant images

One folio with two figures per folio (f. 55), four folios with one taxon

Two folios with two taxa depicted, one folio with three taxa depicted (f. 57)

35 plant names: 17 Latin names (13 unique), 18 vernacular names (16 unique)

32 plants identified to species level and two plants identified to genus level

Three species depicted twice, one species depicted three times, one species depicted four times

26 taxa identified: 24 identified to species level and two taxa identified to genus level

Supplementary Table S2 Origin of the introduced species that were present in Dutch Brazil c. 1640 and depicted in the *Libri Picturati*.

Origin	Plant Species
Tropical Asia - Pacific	*Abrus precatorius* L.
	Citrus x aurantiifolia (Christm.) Swingle
	Citrus x aurantium L.
	Citrus x *limon* (L.) Osbeck
	Cocos nucifera L.
	Dioscorea cf. *alata* L.
	Musa × *paradisiaca* L.
	Plumbago zeylanica L.
	Cf. *Plumeria* sp.
Tropical Africa	*Abelmoschus moschatus* Medik.
	Citrullus lanatus (Thunb.) Matsum. & Nakai
	Guilandina bonduc L.
	Lagenaria siceraria (Molina) Standl.
	Ricinus communis L.
	Solanum aethiopicum L.
	Tamarindus indica L.
	Xylopia aethiopica (Dunal) A.Rich.
South Africa	*Zantedeschia aethiopica* (L.) Spreng.
Middle East, South Africa	*Aloe vera* (L.) Burm.f.
S-Europe (Mediterranean basin)	*Punica granatum* L.
	Vitis vinifera L.

Origin	Plant Species
US, Mexico	*Cucurbita pepo* L.
	Helianthus annus L.
US, N-South America	*Boerhavia coccinea* Mill.
Peru (Andes)	*Gossypium barbadense* L.
Central America, Caribbean	*Argemone mexicana* L.
	Carica papaya L.
	Ipomoea quamoclit L.
	Psidium guajava L.
	Tagetes cf. *erecta* L.
	Zea mays L.
Central America, Andes-N- South America	*Furcraea foetida* (L.) Haw.
	Ipomoea batatas (L.) Lam.
	Phaseolus vulgaris L.
	Phaseolus sp.

Supplementary Table S3 Conservation status of plant species from the *Libri Picturati* currently categorized as threatened by anthropogenic disturbance.

Plant species	Conservation status	Endemic Region	Threats[a]
Aechmea muricata	Endangered	Atlantic Rainforest	Urbanization
Hippeastrum psittacinum	Endangered	Atlantic Rainforest	Mining, harvesting (ornamental, medicinal)
Pilocarpus jaborandi	Endangered	Atlantic Rainforest, Caatinga	Fragmented population, deforestation, harvesting (medicine)
Melocactus violaceus subsp. margaritaceus	Vulnerable: Decreasing / CITES-listed	Atlantic Rainforest	Urbanization, road construction, agro-industry
Bowdichia virgilioides	Near Threatened		Logging, ornamental trade
Avicennia schaueriana	Least Concern: Decreasing		Urbanization, pollution, agri- /aquaculture, logging
Brasiliopuntia brasiliensis	Least Concern: Decreasing / CITES-listed		Urbanization, agriculture, mining, logging

Plant species	Conservation status	Endemic Region	Threats[a]
Laguncularia racemosa	Least Concern: Decreasing		Urbanization, industries, agriculture, aquaculture, logging, pollution

[a] Threats retrieved from http://cncflora.jbrj.gov.br/ and https://www.iucnredlist.org/.

The remaining supplementary information of this chapter is available at https://doi.org/10.1038/s41598-021-99226-8.

Supplementary Information 1 – Dataset S1 Taxonomical identifications of the plant illustrations and empty folios in the *Theatrum Naturalium Brasiliae* with references to Marcgrave and Piso (1648, 1658).

Supplementary Information 2 – **Dataset S2** Taxa at species level present in the HNB (Marcgrave and Piso, 1648) and IURNM (Piso 1658).

Supplementary Information 3 – Dataset S3 Taxa at species level present in Marcgrave's herbarium (collected during 1638-1643/4).

Chapter 6

The supplementary material of this chapter is available at DANS Easy repository in three deposits. The first one includes an excel table, a PDF and a Filemaker file and is available at https://doi.org/10.17026/dans-zk4-ercv.

Supplementary Dataset S1 Origin of the plant woodcuts of the *Historia Naturalis Brasiliae* (HNB, Marcgrave and Piso 1648).

Supplementary PDF S2 – **Appendix (S2)** Sources of the plant woodcuts in the *Historia Naturalis Brasiliae* (1648) Database [Data also available in Filemaker format].

The second one includes an excel table, a PDF and a Filemaker file and is available at https://doi.org/10.17026/dans-xm2-bnhw.

Supplementary Dataset S3 Sources of the plant woodcuts in the *India Utriusque re Naturali et Medica* (IURNM, Piso 1658).

Supplementary PDF S4 – **Appendix (S4)** Sources of the plant woodcuts in the *India Utriusque re Naturali et Medica* (1658) Database [Data also available in Filemaker format].

The third one includes an excel table and is available at https://doi.org/10.17026/dans-2ct-j737.

Supplementary Dataset S5 Correlations between the plant woodcuts in the HNB and the botanical annotations in De Laet's manuscript.

Glossary of Acronyms and Abbreviations

HNB – *Historia Naturalis Brasiliae*

IURNM – *India Utriusque re Naturale et Medica*

L – Herbarium of Naturalis Biodiversity Center, Leiden

C – Herbarium of the University of Copenhagen and Botanical Garden

MG – Herbarium of the Museum Paraense Emilio Goeldi, Belém

Theatrum – *Theatrum Rerum Naturalium*

IPLC – Indigenous Peoples and Local Communities

MC – *Miscellanea Cleyeri* (also abbreviated as *Misc. Cleyeri*)

LP – *Libri Principis*

ESM – Electronic Supplementary Material

GBIF – Global Biodiversity Information Facility database

Curriculum Vitae

Mireia Alcantara Rodriguez

Ph.D. Ethnobotany

Transdisciplinary scientist and gardener. Passionate about plants as part of our biocultural heritage and environment

CONTACT

+31 6687738281

m.alcantara.rodriguez@gmail.com

EDUCATION

Ph.D. Ethnobotany – Heritage & Society
Leiden University, Netherlands (2018-2023)
ERC Horizon 2020 Research & Innovation

MSc. Environmental Biology
Ecology & Natural Resource Management
Utrecht University, Netherlands (2013-2016)

BSc. Biology
University of Valencia, Spain (2005-2009)

Relevant courses: **green survival, ecological gardening, storytelling, tropical plants, open interview & qualitative data analysis**

WORK EXPERIENCE

Researcher – **Colonial Botany** (2018-2023)
Faculty of Archaeology, Leiden (FAL)

- Cross-century study of (Indigenous) plant use knowledge in Brazil
- Analysis of botanical illustrations
- Database management and presentations

MSc. Supervisor (April 2018-Jan. 2019) (FAL)

- Guidance (collaborative approach) on medicinal and ritual plants in Brazil
- Market survey, plant gathering, herbarium collection, peer-reviewed publication

Researcher – Ethnobotany & Climate Change
(2016-2017) Naturalis Biodiversity Center
Andes Mountains, Colombia

- Plant gathering, interviewing, co-creating workshops with local communities
- Qualitative and quantitative data analysis

University Lecturer (once a year: 2016-2022)
Wageningen University - Ethnobotany Course

WRITTEN WORK

Alcantara-Rodriguez M., Francozo M. & Van Andel T. (2021), Looking into the flora of Dutch Brazil: botanical identifications of seventeenth century plant illustrations in the Libri Picturati, *Sci Rep*. 11.

Alcantara-Rodriguez M., Angueyra A., Cleef A. M. & Van Andel T. (2018), Ethnobotany of the Sierra Nevada del Cocuy-Güicán: climate change and conservation strategies in the Colombian Andes, *J Ethnobiol Ethnomed*. 14(1): 34.

More in RG Mireia-Alcantara-Rodriguez (LEI)

QUALIFICATIONS

Creative, resilient and flexible – Independent and eager to find solution-based approaches
Cooperative (teamwork) and socially aware – aiming for inclusivity and intersectionality
Strong focus on building bridges between academia and society (First-Gen)

Plants and peoples' connections intertwine in multiple histories, often captured in textual accounts and illustrations, such as the *Historia Naturalis Brasiliae* (1648) and the *Libri Picturati* (c. 1640). These materials originated in the colonial context of Dutch Brazil and circulated among naturalists, physicians, merchants, and wealthy collectors for centuries. Today, we looked at these collections to identify the documented flora. With an ethnobotanical approach, we analyzed whether these plants are still used the same way in Brazil, their origins, and how they were collected. This study pays attention to the Indigenous and enslaved peoples living in the colony, whose rich corpus of botanical knowledge was appropriated within Western epistemologies and used in the colonial enterprise in Brazil, and beyond.