Searching for Copaiba: tracing the quest for a wound-healing oil by early explorers in Brazil

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Tracing the Quest for a Wound-Healing Oil by Early Explorers in Brazil

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Introduction

When Count Johan Maurits of Nassau-Siegen was appointed governor of Dutch Brazil in 1636, he commissioned a group of scientists and artists to document the flora, fauna, and cultures in this new Dutch colony.[2] The count's support of natural history, astronomy, geography, and scientific and ethnographic illustration during his governorship was highly unusual and distinguished him from other colonial administrators and military leaders in the seventeenth century.[3] The *Historia Naturalis Brasiliae* (henceforth HNB), with its beautiful and accurate illustrations of plant and animal life, was one of the first comprehensive publications of South American natural history and had a substantial influence as a reference work among European scholars.[4]

The identification of the plants described in the HNB is difficult due to the crude woodcut illustrations and the early seventeenth-century Latin descriptions,[5] but is greatly facilitated by Marcgraf's herbarium,[6] which is praised as the first to hold dried plant specimens from tropical America.[7] Recent studies on sixteenth-century herbaria, however, have discovered several older Neotropical specimens, grown in European botanical gardens from seeds brought from the Americas around the 1560s.[8] These Renaissance book herbaria, however, only contain a handful of cultivated plants (e.g., tomato and chili pepper), without any notes on geographic origin or uses, while Marcgraf's herbarium contains 145 species of mainly wild Brazilian plants, of which 103 are also described by Marcgraf and Piso in the original HNB and/or by Piso in what became known as the second edition of the treatise.[9]

For many European doctors and pharmacists, the HNB offered a first introduction to various Brazilian medicinal plants and their effect on the human body.[10] Species such as ipecacuanha (*Carapichea ipecacuanha* (Brot.) L. Andersson), used against dysentery; the insect-resistant cabuberiba balm (from *Myroxylon balsamum* (L.) Harms); the laxative seeds of pinhones (*Jatropha curcas* L.); and the wound-healing copaiba balsam

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(*Copaifera* spp.) quickly spread their fame and were shipped to Europe in large quantities toward the end of the seventeenth century.[11] Instead of only copying what was already known from letters and books by previous explorers, missionaries, and colonial authorities, Piso and Marcgraf had the chance to make their own observations. Marcgraf took part in organized expeditions into the Brazilian wilderness and probably used the opportunity to collect specimens, while Piso experimented with medicinal plants on himself or on local inhabitants.[12] The HNB has been repeatedly praised as the most important contribution to the science of natural history since Aristoteles and Pliny.[13] Carl Linnaeus, the godfather of botany, considered the scientific descriptions and illustrations in the HNB of such high quality that he used several of them for the tenth edition of his taxonomic masterpiece *Systema Naturae*.[14]

Marcgraf and Piso, however, were not the first to document Brazilian herbal medicine. Portuguese Jesuit missionaries were engaged in substantial bioprospecting activities since the 1550s, collecting knowledge on local herbal medicine from Indigenous healers to address the health problems of Portuguese settlers in the South American tropics. Although the Jesuits' ethnopharmacological work was passed on to Portuguese physicians, surgeons, pharmacists, and colonial officials, many of these early writings on traditional remedies and their natural ingredients only survive as unpublished manuscripts.[15] Portugal did not send out state-sponsored scientific expeditions to systematically study and record the flora and fauna of their overseas territories until the late eighteenth century.[16]

This chapter focuses on early reports of one important Brazilian medicinal product: copaiba balsam. Although the HNB was applauded for providing the first explicit description and illustration of one of the trees yielding this oily exudate, the exact species of *Copaifera* that yielded this highly valued medicine remained shrouded in mystery long after 1648.[17] Although the plant species in the HNB have been subjected to botanical revision, in which the copaiba tree was identified as *Copaifera officinalis* L., a recent revision of the useful plants described by Marcgraf and Piso indicates that many of these identifications were outdated or inaccurate.[18]

We list the earliest reports on this herbal product in Brazil and trace attempts to describe the plant species that yield the copaiba balsam, its uses, and extraction method. We explain how Marcgraf's unexpected early death led to the erroneous combination of his encrypted information on copaiba with other descriptions and illustrations, leading to a confusion in taxonomy, local names, and interpretations, which lasted for centuries. We show that by studying the original texts and illustrations from diverse sources in the scientific entourage of Count Johan Maurits, of which several only recently became available to scientists,[19] we can finally link the wound-healing oil described in the HNB to two species of *Copaifera*.

Methods

In 2014, we conducted an ethnobotanical research on the useful plants described in the HNB and those in the so-called second edition of this treatise, in fact a somewhat different book published by Willem Piso under the title *De Indiae utriusque Re Naturali et Medica*, both held in the Rare Book Room of the library of Naturalis Biodiversity Center in Leiden, the Netherlands.[20] We consulted the original Latin copies of the two aforementioned tomes and the Portuguese translations of both works.[21] We also studied Marcgraf's original herbarium in the Botanical Museum of the University of Copenhagen and compared its specimens with the earlier revision by Andrade de Lima et al.,[22] the identifications of the plants in the HNB by the Brazilian botanist B.J. Pickel,[23] the online checklist of Brazilian flora,[24] the digital database on Brazilian herbarium specimens SpeciesLink,[25] and the Brazilian herbarium collections in the herbaria of Copenhagen, Missouri Botanical Garden,[26] and Naturalis.[27] For the distribution of the different *Copaifera* species, we consulted the Global Biodiversity Information Facility (GBIF) database.[28] We updated the scientific names by using The Plant List.[29]

For the present paper, we focused on historical attempts to describe the wound-healing copaiba balsam and the search for the tree that produced this valuable product in Brazil. We built on a previous article in Dutch on the confusion around copaiba balsam due to the erroneous combination of plant descriptions and drawings by Johannes de Laet, the editor of the HNB.[30] To verify what knowledge was already available before the HNB was published in 1648, we added information on the earliest reports on Brazilian copaiba balsam (1550–1647) from historical texts mentioning words in Tupi-related Indigenous languages listed by Cunha.[31]

We did not review seventeenth- and eighteenth-century reports on copaiba oil found outside Brazil, such as those from the Guianas or the Caribbean islands, as these likely describe different species of *Copaifera* than the Brazilian sources – or no *Copaifera* at all.[32] To trace when copaiba was first mentioned in Dutch pharmacopoeias or trade documents, we queried the Time Capsule database, an online search engine that links several datasets relating to the early modern history of medicinal plants in the Low Countries between 1550 and 1850.[33]

We also consulted the entries on copaiba or similarly named plant species in a manuscript containing notes by Marcgraf and passed on to De Laet, presently kept at the British Library.[34] Finally, we examined the digital images of several oil paintings of plants that had not been taxonomically identified, made during the 1630s–1640s by artists in the circle of Johan Maurits and currently kept in the *Libri Picturati* collection housed by the Jagiellonian Library in Kraków, Poland.

Results

The first Europeans arrived in Brazil in 1500, but permanent settlement began only a few decades later, for instance near São Paulo only in 1532. Somewhere between 1513 and 1521, in one of the first accounts of explorations in South America, the Italian historian Petrus Martyr of Anghiera (1457–1526) wrote in a letter to Pope Leo X about a resin-producing tree named "copei."[35] He was probably the first European to mention copaiba balsam (Table 4.1). On 31 May 1560, the Jesuit priest José de Anchieta (1534–1597) wrote a letter to his Spanish colleague Diego Laynes (1512–1565), in which he mentioned a tree that supplied a sweet balm that was produced by incisions with knives or axes in the bark. It reminded him of a Swedish distillate and cured wounds so quickly that no scars remained. Anchieta had used it himself. This unnamed tree was later connected to a tree described as "cupaigba" by another Jesuit priest, Fernão Cardim, between 1583 and 1601 and a tree named "copaíba" by Soares de Sousa and identified by Hoehne as *Copaifera officinalis* L.[36]

The chronicler Pêro de Magalhães Gândavo (1540–1580) was the first to mention that animals also know the healing properties of copaiba balsam, which was later confirmed by the Jesuit priest Fernão Cardim (1548?–1625). The latter wrote a more detailed account of copaiba during his stay in Pernambuco between 1583 and 1601, which was only published centuries later.[38] Cardim thought that "cupaigba" was a fig tree ("figueira"), but also described the clear, oily exudate that was used for wound healing and added that it was inflammable and could be used as a light source. This is hardly ever the case for the white, non-transparent exudate of *Ficus* trees. Cardim considered the wood to be worthless. Typically, exactly the same description, including the inaccurate identification as a fig tree, was attributed to the Portuguese monk Manoel Tristão of the convent of Bahia, whose account on this oil under the name "cupayba" was published by Samuel Purchas and often considered as the first or second written account on copaiba oil.[39] Ambrósio Fernandes Brandão (1555–1618), sugar mill owner in Paraíba, reported that wounded soldiers were treated with the oil,[40] a use that is not mentioned afterwards anymore (Table 4.1). In his treatise on the country and people of Brazil from 1587, Portuguese farmer, landowner, and scholar Gabriel Soares de Sousa also gave a detailed description of "the most holy oil," but considered the fruits to be inedible.[41]

Around 1594, the Jesuit priest Francisco Soares described the copaiba as a tall and thick tree with very hard wood that yielded a unique, wound-healing oil that had its best quality in summer. When he was on a ship, he cut off his fingertip (which fell overboard) and rubbed his wound with copaiba oil. The injury did not get infected and left only a thin white scar. He tried to convince the ship surgeons to use this oil as well. He mentioned a request to the bishop of Brazil for a license to commercially produce and export the oil. He ends his praise with the suggestion that "there are many things

Table 4.1 Historical accounts that mention copaiba balsam from Brazil, ordered chronologically.[37]

Author (year when copaiba is mentioned)	*Botanical description*	*Image*	*Local name*	*Use description (translated text)*
Petrus Martyr of Anghiera (1513–1521?)	?	no	copei	Resiniferous tree?
Father José de Anchieta (31 May 1560)	"tree"	no	not given	Resin harvested by incisions, sweet scent, wound healing, prevent scars.
Pêro de Magalhães Gândavo (1576)	"tree in Pernambuco"	no	copahíbas	Resin harvested from bark, wound healing, eases pain, wounded animals also use it.
Jean de Léry (1578)	tree, looks like walnut tree?	no	copa-u	Wood used for furniture.
Anonymous Jesuit priest (c. 1580)	?	no	copaíba?	?
Gabriel Soares de Sousa (1587)	large tree, not very hard wood,	no	copaíba	Fruit inedible, oil used in lamps, harvested with axes, runs into bottles, good smell, applied on wounds and burns, prevents scars, for colds, stomach aches, most holy oil, used in households. Wood used to make wooden shields.
Carolus Clusius (1605)	A liquid or gum brought from the West Indies	no	copal-yva	Strongly recommended and I understand that it is very useful for curing fresh wounds.
Father Fernão Cardim (1583–1601)	Common, tall, straight and thick fig tree	no	cupaigba	Contains abundant oil, sometimes more than a quarter. Oil is very bright, olive color. Highly esteemed for wounds, takes away every sign, also used for candles, burns well. Animals rub against the bark. Wood of no value.
Father Francisco Soares, c. 1594	tall and thick tree	no	copajba	Hardwood, wound-healing oil, own experiments, prevents scars, internally as laxative, against swellings.
Father Simão Travaços, c. 1596	trees that give the balm from Ilheos and Espírito Santo, are the best in the world	no	not given	Trees that [when] cut they give much oil from the cup that has great virtues for wounds, and discharges.

(*Continued*)

Table 4.1 Historical accounts that mention copaiba balsam from Brazil, ordered chronologically.[37] (*Continued*)

Author (year when copaiba is mentioned)	*Botanical description*	*Image*	*Local name*	*Use description (translated text)*
Ambrósio Fernandes Brandão (1618)	"plants found in the southern provinces"	no	copaúba	Wounded soldiers are readily healed with native copaúba, a balsam confected from plants.
Manoel Tristão (1625)	a fig tree, commonly very high, straight and big		cupayba	It has much oil; to get it they cut the tree in the middle, where it comes out in great abundance, sometimes more than a quarter; very clear colored oil; much used for wounds, takes away all the scars. Also for lights and burns well. Animals rub themselves to the trunk. Wood not used.
Johannes De Laet (1625, 1640)	Very common tree, similar to fig tree, high, big and straight		cupayba, copal-yua	Contains much oil, obtained by cutting the bark, heals wounds, prevents scars, also as lamp oil. Wood is not useful.
Amsterdam Pharmacopeia (1643)	no	no	balsam Copa-ivae	No
Adriaen van der Dussen (1637)	"famous tree"	no	copaiba	Sweet-scented balsam though incision in bark, miraculous wound and scar healing, used by animals bitten by snakes.
Georg Marcgraf (1648)	detailed description of leaves, flowers, fruits.	yes, fruit only	Copaiba Brasiliensi bus	Detailed description of oil properties, harvest methods, medicinal recipes and application: wounds, nerves, diarrhea, dysentery, fruit pulp edible.
Willem Pies (1648 and 1658)	Detailed description of wood, leaves, bark, fruits, fruiting period, distribution	yes, but forged image	Copaiba, Copaliba	Detailed description of harvest methods, recipes, properties and application of oil: against "espinela", severe diarrhea, dysentery, gonorrhea, wounds, ulcers, nerves, breast disorders, abdominal colic, menstruation, flatulence, mosquito and snake bites. Fruit eaten by monkeys and humans; wood used for boards.

that could be written [about the oil that it could be] a book." Soares' manuscript, however, was only published three centuries after his death.[42]

Even the Dutch had written about copaiba before the HNB was published. Adriaen van der Dussen, employee of the West India Company (WIC), noted in 1637: "Among their most famous trees is copaíba, of which the sweet-smelling balsam comes from an incision in the bark, healing wounds and removing scars with a miraculous force. The tree can be recognized by the damage done on the bark by wild forest animals, which know by natural instinct to rub their skin against its bark when they are bitten by snakes." His account was published as part of historian Caspar Barlaeus' *Rerum per Octennium…* in 1647.[43]

Almost 20 years before the HNB was published, copaiba oil was apparently already shipped to Europe in such quantities that it was mentioned in the Amsterdam Pharmacopeia of 1630.[44] This name was also used in the Amsterdam Pharmacopeia of 1643 as "balsam Copa-ivae." This name was later changed into balsamus capivi or copaiba.[45]

Johannes de Laet, one of the founding directors of the WIC, had already written a description of the "New" World in 1625, which was first published in Dutch, then in Latin, and finally in French, with new additions in each edition.[46] In De Laet's reference to copaiba oil, he cited the work of the French botanist Carolus Clusius, who had translated the book *Tractado de las Drogas y Medicinas de la Indias Orientales* by the Portuguese doctor Cristóbal Acosta.[47] Acosta had received several bottles of copaiba oil from his overseas friends. De Laet's description of copaiba balsam, however, echoes the earlier descriptions of the Jesuits rather than Clusius' description (Table 4.1).

To inform Johan Maurits on the situation in Dutch Brazil, De Laet compiled a handwritten guide for the new colony,[48] in which he gave a detailed account of the geography of the area, as well as suggestions where and how to attack the Portuguese and what goods could be obtained from the local inhabitants in specific areas. De Laet described that in "Marannon," the Indigenous people were willing to trade cotton, food, dyes, silver, and "a balsam oil that they call uwijraca-andugh, growing on the copaíba tree."[49] Typically, this Indigenous name does not appear anymore in the HNB, in which only the Tupi name copaíba is given.[50] It is likely that Marcgraf and Piso used De Laet's early work to compile a "wish list" of useful Brazilian plants that needed professional scientific descriptions.

Marcgraf's Description: Scarlet Wood with a Turpentine-Like Oil

On pages 130 and 131 of the HNB, Marcgraf described "Copaiba Brasiliensibus" as a tree with mostly deep scarlet wood, hard as beech wood, which was sawed into wide planks for diverse applications (Figure 4.1).

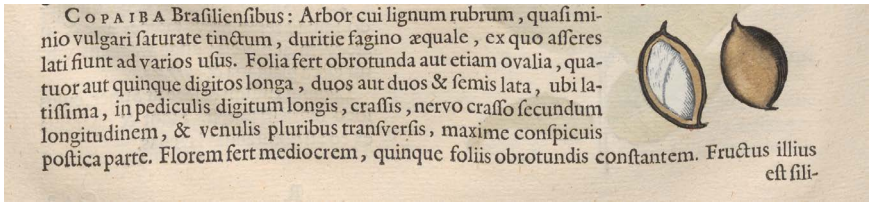
COPAIBA Braſilienſibus: Arbor cui lignum rubrum, quaſi minio vulgari ſaturate tinctum, duritie fagino æquale, ex quo aſſeres lati fiunt ad varios uſus. Folia fert obrotunda aut etiam ovalia, quatuor aut quinque digitos longa, duos aut duos & ſemis lata, ubi latiſſima, in pediculis digitum longis, craſſis, nervo craſſo ſecundum longitudinem, & venulis pluribus tranſverſis, maxime conſpicuis poſtica parte. Florem fert mediocrem, quinque foliis obrotundis conſtantem. Fructus illius eſt ſili-

Figure 4.1 Description of "Copaiba Brasiliensibus" by Marcgraf with the woodcut image of the opened and closed fruit of *Copaifera* in *Historia Naturalis Brasiliae* (Piso and Marcgraf, 1648: part II, 130). Leiden University Libraries (copy 1407 B 3).

The leaves of the tree were round or oval, four or five fingers long, and two to two-and-a-half fingers wide, on a stalk of a finger long, with thick secondary longitudinal veins and many transverse veins, the most strikingly visible on the back. The tree had small flowers with five roundish petals. The fruits were small, brown, and round pods, the size of a finger, and easy to open by hand. They contained a seed the size and shape of a hazelnut, covered with a black, membrane-like skin embedded in a little yellow pulp, with a scent of crushed peas. This soft, tough pulp had an unclear, watery taste, but was nevertheless eaten. Ripe pods all fell from the branches at the same time. The tree produced a remarkable oil or balm with a resinous odor and drops that resembled turpentine oil in taste and consistency. The oil was harvested by drilling a hole at the base of the trunk into the sapwood and placing a small container under it. About four cups of oil could be harvested within an hour. Because the oil continued to flow, the gap was often closed from dawn to dusk, which undoubtedly pointed to the importance of the oil. A small amount of heated oil was applied on fresh wounds, after which they stopped bleeding and healed quickly. Three or four drops of oil were mixed with a fresh egg and taken two or three times on one morning against nerves. The oil helped to cure dysentery and other forms of diarrhea. The oil was considered warm and dry in the second degree. Unfortunately, the first and only illustration of the copaiba included in the HNB is a woodcut image of an opened and a closed fruit. Marcgraf probably picked them up from the forest floor, as he wrote that the ripe pods fell massively from the trees. Although he had seen the leaves and flowers of the copaiba tree, they are missing from his herbarium.

Piso's Description: An Oil with Remarkable Uses

Piso mentioned copaiba several times in his work. In his chapters of the HNB, bundled together and called *De Medicina Brasiliensi*, there is a lengthy description of the copaiba tree. Piso wrote that the "province of Brazil" produced various balms, of which copaiba is the most important. Copaiba was the name of the tree from which it came: a tall tree with gray

bark that grew in the wild. The leaves were half a foot long and consisted of larger and smaller leaves that faced each other, with fine veins and a pointed tip. Young leaves were rusty brown. At the end of the branches, among the leaves, the flower clusters were found. These were followed by fruits with the size and shape of bay berries, first green, then black after ripening, with little, slightly sweet-tasting flesh. The fruits contain an oval, hard seed, thicker than that of the wild plum, covered with black skin that was easy to remove and containing a white core with a floury taste, but not edible. The fruit ripened in April and was eaten by the Brazilians, who consumed the juice and spat out the black skin. Monkeys also enjoyed the fruits very much. Piso recalled that "in the month of June I collected fruits that were already half germinated, and I ordered the earth to increase the yield."[51]

Earlier in the HNB, Piso had already mentioned several medicinal applications of copaiba oil. To heal "espinela" (a pain near the solar plexus),[52] some drops of copaiba oil were dissolved in a generous amount of wine and taken internally, and for an external poultice on the stomach, the oil was mixed with the exudate of icicariba (*Protium heptaphyllum* (Aubl.) Marchand), caboreiba balsam (*Myroxylon balsamum* (L.) Harms), egg yolk, and saffron.[53] Apart from the vomiting-inducing ipecacuanha roots (*Carapichea ipecacuanha*) and the strongly laxative seeds of pinhones (*Jatropha curcas*), Piso recommended for severe diarrhea and dysentery the oral intake of some drops of copaiba oil, dissolved in sugar and beaten egg. The rectal administration of this mixture was also prescribed to comfort inflammation of the anus.[54]

For "the virulent gonorrhea," Piso mentioned that once the disease was defeated, most experts limited themselves to prescribe astringents, consolidating and drying agents.[55] He recommended copaiba balsam, dissolved in sugar or olive oil, as the best medicine, either taken orally or injected in the penis. Wounds and ulcers were healed with the scented balsams caboreiba (*Myroxylon balsamum*) and copaiba: they did not only stop the bleeding, but, applied internally and externally, also fortified the nerves. The two balsams were considered to have the same quality.[56] He also described that the brave men who travel the backwoods or dense forests of Brazil, where the sea breezes barely arrived, anointed their naked members with the balsams of copaiba and caboreiba.[57]

Piso also provided a description of the harvesting practices of copaiba oil: "the tree is rich in fragrant liquid. One makes cuts in the bark of this huge tree, preferably in the period up to the full moon, so that a large amount of oil droplets come out. In three hours, 12 libras flow out without difficulty. If no oil flows out, close the hole in the bark with clay or wax. After two weeks the yield will be enough to compensate for the delay. This tree is not so much found in the Pernambuco prefecture but especially on the island of Maranhon. An abundance of [copaiba] balm is growing here, which is why we can afford the supply of this balm."[58]

About the medicinal use of the oil, Piso stated: "not only does the oil have an amazing cleansing and stabilizing capacity, it is primarily used to heal wounds, mosquito and snake bites, and to remove scars. Not only the locals, I myself have also noticed the remarkable usefulness of this oil. He is not as sweet-smelling as required by Maffeus. [The oil is] warm in the second degree, thick, very greasy and resinous. In drops administered orally, it relieves breast disorders, abdominal diseases and cold colic. The oil provides vital strength, it stops women's periods, flatulence, and gonorrhea. A similar success against this evil can be achieved by means of a syringe in the anus or in the penis with [copaiba drops] dissolved in [an extract of] plantain water (an extract of *Plantago major* L.) or rose oil."

Piso did not add a drawing of the copaiba tree. It was probably also difficult for him to get the leaves because the tree, as he wrote it himself, did not occur in the neighborhood of Mauritsstad, but in the Maranhão area. At one moment in June, however, he obtained germinating seeds and probably planted them in the garden of Vrijburg, the walled garden of Johan Maurits where many plant species were grown and wild animals were kept in cages for further study.[59] We do not know whether the copaiba seedlings grew successfully.

Secrecy and Distrust in Dutch Brazil

Around 1644, Marcgraf travelled to Angola to map the Dutch possessions for the WIC, but he died from yellow fever shortly after arriving in Central Africa.[60] Since he had not yet published anything when he left Brazil, Marcgraf had entrusted his botanical collections, manuscripts, and drawings of plants and animals to Johan Maurits before he left. He had written his notes in a secret code, probably out of fear of plagiarism by Piso. Although they initially worked closely together, their relationship was later characterized by jealousy and distrust.[61]

Johannes de Laet managed to decipher the secret code and edited Marcgraf's manuscripts together with Piso's notes on indigenous diseases and medicinal plants and published them together in the HNB.[62] The entry on copaiba in De Laet's British Library manuscript does not differ substantially from the final version in the HNB.[63] There is no woodcut proof attached to the opposite page, as is the case on other pages of the manuscript, and no reference is made to an image elsewhere (Figure 4.2).

Marcgraf's lack of confidence in Piso's integrity, however, proved to be correct. In 1658, after De Laet's death, Piso published *De Indiae utri-usque…* as sole author, in which he incorporated Marcgraf's figures and descriptions into his own text, without mentioning him as an author, for which Linnaeus accused him of plagiarism.[64] Linking his own collected information about medicinal plants to Marcgraf's botanical descriptions, Piso made a number of mistakes in the transcription of the text, the retouching of illustrations, and the identification of species. This plagiarism, and

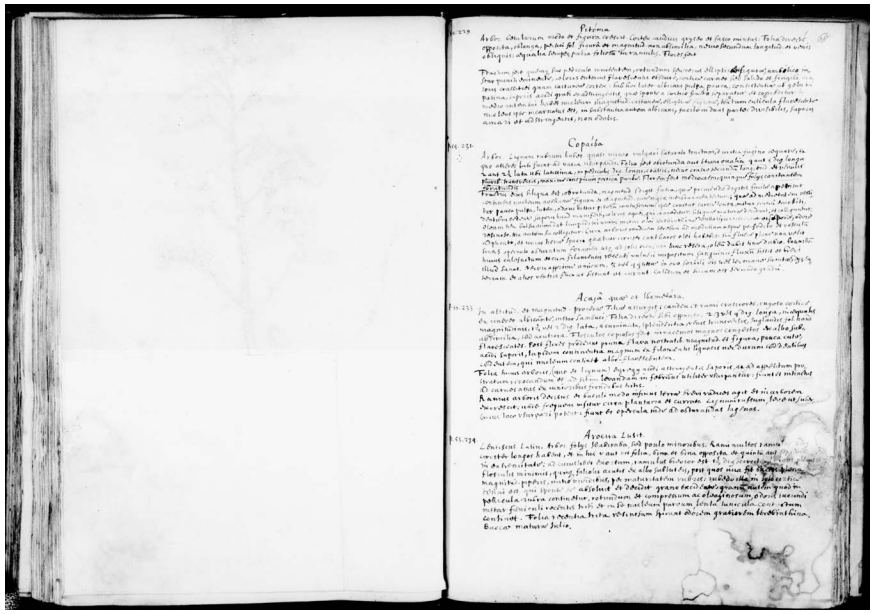

Figure 4.2 Entry on "Copaiba" from Johannes De Laet's manuscript (De Laet, n.d.: f. 68). © The British Library Board (Sloane Ms. 1554).

the consequent confusion, has caused major headaches to (ethno-) botanists in their interpretation of the historic descriptions of plants and their uses in seventeenth-century Brazil.[65]

Copaifera spp. (Leguminosae) versus *Clusia nemorosa* (Clusiaceae)

In his 1658 "version" of the HNB, Piso again devoted a paragraph to the copaiba: "most Americans call all scented resins and gums copal, although there are various species with different names. Therefore, all resin-bearing trees in Brazil are simply called copaliba or copaíba. In the dense forests of the interior this often happens [with trees] whose wood is red as vermilion and so hard that it is used to make wide boards." Piso continued with a description of the copaiba. This time, however, he did not mention compound leaves but suddenly described a flower with five rounded petals. The description of the dark pod with the watery, edible flesh and the extraction of the richly scented oil is the same as in earlier versions of his own text and that of Marcgraf. For the medicinal uses, Piso added that the healing power of the oil was proven again during Jewish circumcisions: "after treatment with copaíba oil, the blood flows very limitedly from this cruel wound. Previously it was difficult to effectively heal wounds, now this oil works without any problems."[66]

Piso's description is accompanied by a woodcut image of the copaiba tree, but this time the image contains leaves and flowers (Figure 4.3). The leaves are not compound, as is usually the case with members of the Leguminosae family and always the case in the genus *Copaifera*. The flower strongly resembles that of *Clusia nemorosa*, a species described and depicted by Marcgraf under the local name "coapoiba" or "pao gamelo" in Portuguese "of which several species exist, two of which will be described here."[67] Marcgraf mentioned that the leaves of the first species of "coapoiba" had almost invisible veins and produced a white exudate when they were cut off. The flowers were

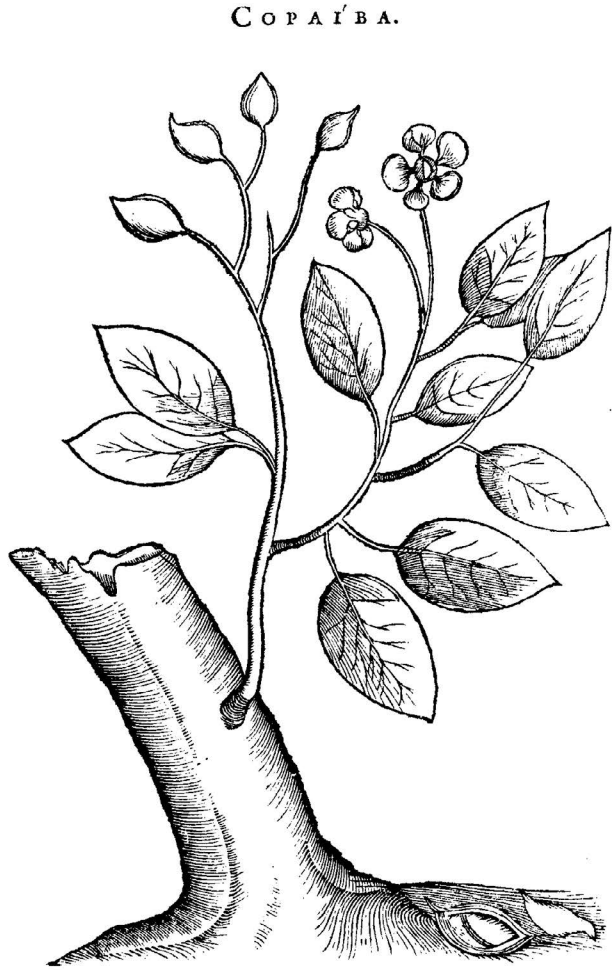

Figure 4.3 Woodcut image from Piso's *De Indiae utriusque* (Piso, 1658: 118). A combination of the flowers of *Clusia nemorosa* (branch on the right side) and the fruits of *Copaifera* (branch on the left side) and leaves of an unknown origin. Republished by Elsevier B.V. 2013.

as large as roses, the petals white with "soft pink like toenails and a navel in the middle, in the shape of a sticky yellow bulb." The fruit contained a yellow exudate split open lengthwise and rows of seeds in a red pulp. The bark and the marrow could be easily separated from the wood. In the seventeenth century, the term "gamelo" referred to a wooden bowl, used as a container, which was probably made from the wood of this species.[68]

Marcgraf's entry on "coapoiba" is a very adequate description for a species of the genus *Clusia*, which is depicted in Marcgraf's woodcut image on page 131, directly after his description of *Copaifera*, and represented with two specimens in his herbarium that were identified by us as *Clusia nemorosa* G. Meyer (Figure 4.4A–C). Marcgraf finally noted that the fruit of "coapoiba" was dry with no pronounced taste. Although he heard that some people ate it, he found it worthless. He did not mention any medicinal use.

What Went Wrong with Copaiba?

Piso, who scornfully wrote that "Americans confused all trees with fragrant resin," seemed to be making the same mistake himself. Why were two very different species forged together in one woodcut image? Did he think that such an economically important tree as *Copaifera* deserved a complete illustration? Piso's description of copaiba is placed in his fourth chapter in the HNB, after sugar (chapter 1), cassava (chapter 2), and wild honey (chapter 3). Copaiba balsam must have been of great economic importance because of its multiple medicinal properties, widespread use, and trade. Although there are major differences in flowers and fruits, the local names copaíba and coapoiba are indeed quite similar, and both trees produce exudate, although the sticky, pale yellow or white latex excreted by *Clusia* species differs substantially from the colorless oil of *Copaifera* trees. The origin of the name copaíba is found in the Indigenous Tupi language, in which it means "deposit tree," referring to the amount of oil it produces.[69]

According to the Brazilian botanist Pickel, the woodcut of copaiba in Piso was a "fantasy" and a "bluff."[70] The faulty woodcut could also have been made by De Laet, who produced several missing illustrations based on Marcgraf's herbarium to include in the HNB. It is often unclear which descriptions the illustrations belong to, possibly because of De Laet's limited botanical knowledge or his problems with deciphering Marcgraf's secret code.

The exact species of *Copaifera* that was described and depicted by Marcgraf and Piso is difficult to trace from the published texts of the HNB. When the French botanist Von Jacquin found a flowering *Copaifera* tree on Martinique in 1760, he considered it to be identical to the species described by Marcgraf and named it *Copaiva officinalis* Jacq., literally "medicinal copaiba," even though the tree had four instead of five petals.[71] Linnaeus based his description of the species *Copaifera officinalis* (Jacq.) L. (literally "medicinal copaiba-bearing [tree]") on the specimen collected by Jacquin

Figure 4.4 (A) Marcgraf's woodcut image of "Coapoiba" (*Clusia nemorosa*) in *Historia Naturalis Brasiliae* (Piso and Marcgraf, 1648: part II, 131). Leiden University libraries (copy 1407 b 3). (B) and (C) Marcgraf's herbarium Collections of *C. nemorosa* that were used as models for this illustration (The Marcgrave Herbarium, 1638–1644: 32, 48). Image published with permission from Herbarium C, Natural History Museum of Denmark.

but confirmed that Marcgraf's copaíba and Piso's coapoiba belonged to the same species.[72] This erroneous identification was later copied by the French botanist Aublet in his influential work on the flora of French Guiana.[73] In a later edition of the *Species Plantarum*, the reference to Piso's description was corrected to the copaiba in the original edition of the HNB.[74] In 1949, Pickel identified the copaiba tree described in the HNB as *C. officinalis*, but the Brazilian physician and parasitologist Pirajá da Silva identified the species in the HNB as *C. langsdorffii* Desf,[75] although it is unclear on what morphological characters they based their decisions.

Theatri Rerum Naturalium Brasiliae

In 1652, Johan Maurits gifted hundreds of unbound oil paintings and drawings of Brazilian plants and animals to Friedrich Wilhelm, Elector of Brandenburg, which were later reorganized and bound by the Elector's physician, Christian Mentzel, into four volumes: the *Theatri Rerum Naturalium Brasiliae*, or *Libri Picturati* A 32–35.[76] This collection, currently housed by the Jagiellonian Library in Kraków, has not been examined by botanists for centuries, but has recently been digitized. Some of these illustrations served as the basis for the woodcut illustrations in the two editions of the HNB.[77] In the fourth volume (A 35), dated 1662 and containing 171 illustrations of plants glued on sheets of paper, several pages are left blank. Folio 77 was intended to contain a painting of "Copaiba P. p. 118. Coapoiba. Marg. p. 130" (Figure 4.5). Did Mentzel have to wait for the missing drawings because they were left at the publishers? Or was he confused about the similarity of the local names and did not know which image to include: Marcgraf's *Copaifera* fruits (Figure 4.1), the forged image (Figure 4.3), or the image of *Clusia nemorosa* (Figure 4.4A)?

Mysterious Paintings Identified

Mentzel's *Theatri Rerum Naturalium Brasiliae* vol. 4 also contains several pages with botanically unidentified oil paintings, which do not contain any written text, except the word "Anonyma" or a local name. As Marcgraf had already died and Mentzel was not a botanist, the latter probably did not know where to include these unnamed drawings. To the disappointment of twentieth-century scholars Whitehead and Boeseman, Mentzel did not indicate the name(s) of the person(s) that made these illustrations, but they assume that the artist(s) must have worked closely with Marcgraf.[78] In a letter, Johan Maurits claimed to have six painters in Brazil, but according to Brienen the oil paintings of the *Libri Picturati* were made by either Marcgraf himself or Albert Eckhout (c. 1607-c. 1666), painter of Brazilian still lifes and portraits of inhabitants of Dutch Brazil.[79] After studying the

Figure 4.5 (A) Blank page of Mentzel's *Theatri Rerum Naturalium Brasiliae*, vol. 4, reserved for copaiba and coapoiba (*Libri Picturati* A. 35: f. 77). Jagiellonian Library. (B) Detail of this page.

digital images of these unidentified paintings, we discovered that two of them are probably *Copaifera* species (Figures 4.6A and 4.7A).

The fruiting branch depicted in Figure 4.6A is unmistakably a *Copaifera* species, with the laterally compressed pods and the compound leaves, although they are imparipinnate, while *Copaifera* leaves are paripinnate. The number of leaflets in the painting is rather small, but leaves tend to drop off from dried specimens, as can be seen in the herbarium voucher in Figure 4.6B.

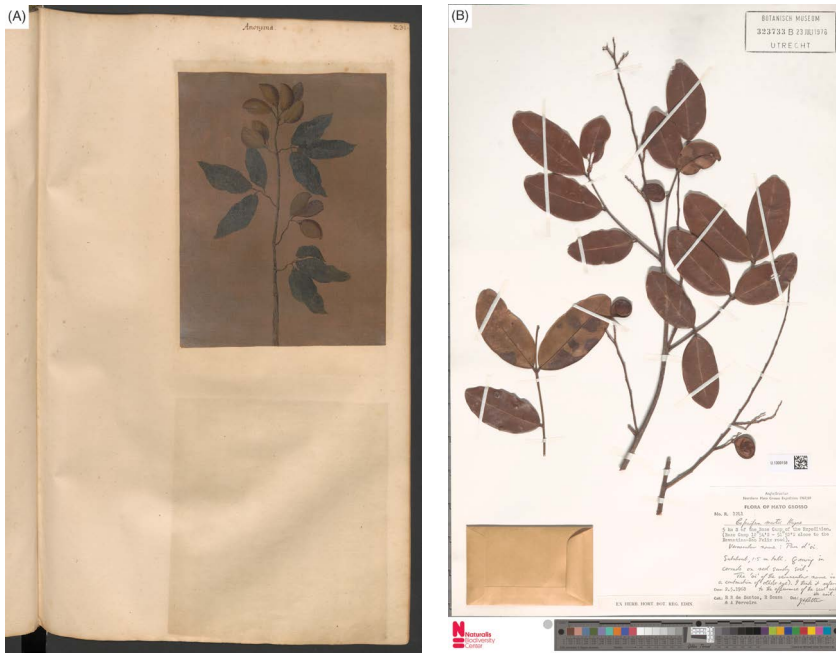

Figure 4.6 (A) Unidentified oil painting in Mentzel's *Theatri Rerum Naturalium Brasiliae*, vol. 4, showing resemblance to *Copaifera martii* (*Libri Picturati* A 35: f. 231). Jagiellonian Library. (B) Herbarium voucher of *C. martii* Hayne from Mato Grosso. Naturalis Biodiversity Center (U.1300158).

In the first detailed revision of Neotropical *Copaifera* species, Dwyer suggests that the species described by Marcgraf is *C. martii* Hayne, "especially as the leaflets are 'obrotunda aut etiam ovalia quattuor aut quinque digitos longa' (about 8–9 cm long), 'duos aut duos et semis lata' (about 3.6–5 cm wide); other characters suggestive of *C. martii* are the yellow arillus of the seed and the red bark."[80] In dry areas, *C. martii* takes the form of a shrub, as is mentioned on the label of Figure 4.6B, but in the forest it can grow as a tree up to 40 m high.[81] The species is widely distributed in Maranhão and northeastern Brazil.[82] In contrast, *C. officinalis* has more and larger leaflets, a white aril, and occurs mostly in the northern and central Amazon, Venezuela, and Colombia.[83]

The label on the specimen of *C. martii* depicted in Figure 4.6B indicates the local name of this species as "pau d'oi." The collector thinks that this vernacular name is a contraction of *olho* (eye) and probably refers to the appearance of the seed with its aril. It is more likely, however, that the local name is misspelled: pau-de-óleo is a common Brazilian name for *Copaifera* species.[84] Laboratory research has indicated that copaiba oil obtained from *C. martii*, collected in the state of Acre, exhibited good antibacterial activity against Gram-positive bacteria, including MRSA.[85]

Figure 4.7 (A) Unidentified oil painting in Mentzel's *Theatri Rerum Naturalium Brasiliae*, vol. 4, showing resemblance to *Copaifera langsdorfii* Desf. (*Libri Picturati* A 35: f. 353). Jagiellonian Library. (B) Herbarium collection of *C. langsdorfii* from Minas Gerais. Naturalis Biodiversity Center (WAG.1639777).

The sterile branch depicted in Figure 4.7A is likely a member of the Leguminosae family, as has been written in pencil on the drawing by an unknown botanist, but due to the absence of fruits it is difficult to prove that it is a *Copaifera*. However, the leaves have long petioles, are sometimes paripinnate and have alternate leaflets with an obtuse apex. *Copaifera langsdorfii* can have up to 6 pairs of alternate or subopposite leaflets, petioles up to 9 cm, leaflets of up to 8 × 4 cm.[86] The brownish-green fruits are produced in large quantities and have one black seed with a yellow aril. The brown-red wood is used for construction.[87] The tree occurs from the Amazon to São Paulo, in different vegetation types, but is most commonly found in northeast Brazil.[88]

Initially, *C. officinalis* was thought to be the only species within the genus to produce the valuable oil.[89] Nowadays, more than 20 species of *Copaifera* yield copaiba oil in Brazil, but the most common supplier of the medicinal oil in Maranhão is probably *C. langsdorffii*.[90] The German botanist and explorer Carl Friedrich Philipp von Martius (1794–1868) was the first to give detailed descriptions and illustrations of *C. martii*

Figure 4.8 Illustration of *C. martii* and *C. langsdorfii* by Carl von Martius (1870, vol. XV, part II, fasc. 50: plate 63). Digitized by CRIA 2005.

and *C. langsdorfii* (Figure 4.8), based on extensive fieldwork and herbarium vouchers, collected during his travels in the Amazon and northeast Brazil.[91]

The Fig Tree "Quapoiba"

In his entry on "coapoiba" or "pao gamelo," Marcgraf mentioned that this name referred to several species.[92] After his description of *Clusia nemorosa*, he mentioned "another species," that went under these

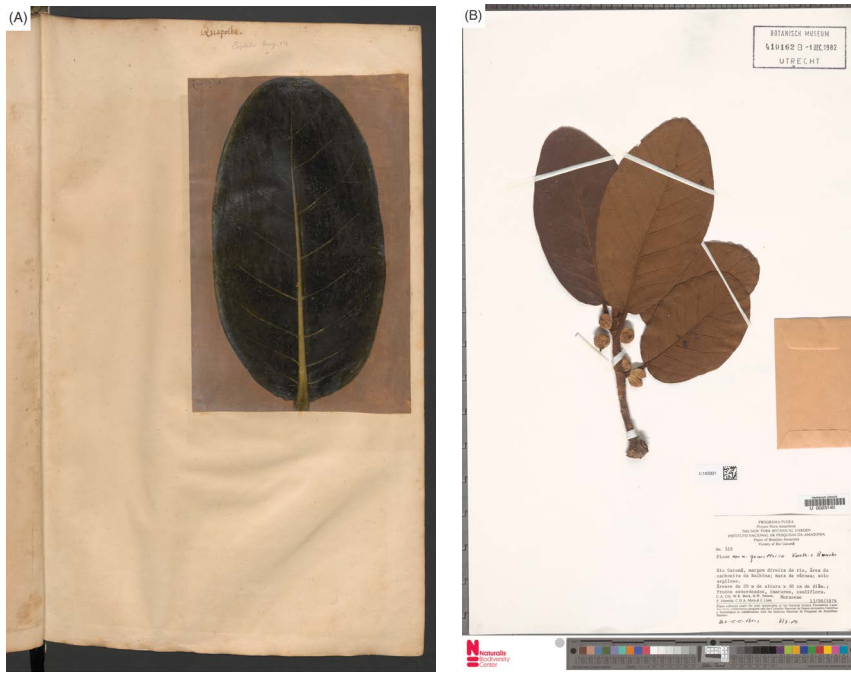

Figure 4.9 (A) Unidentified oil painting in Mentzel's *Theatri Rerum Naturalium Brasiliae*, vol. 4, showing resemblance to *Ficus gomelleira* (*Libri Picturati* A 35: f. 157). Jagiellonian Library. B) Specimen of *F. gomelleira* collected in the Brazilian Amazon. Naturalis Biodiversity Center (U.1425821).

names, which was a large tree with gray bark and wide branches, and leaves that were oblong, keeled, and glabrous. Its fruits were the size of small balls, full of tiny grains, like a fig: dry and tasteless. They were eaten by some people, although not much appreciated. This species was identified by Pickel as *Ficus doliaria* (Miq.) Mart.,[93] which is now a synonym of *Ficus gomelleira* Kunth & C.D. Bouché, a tree that is still known in Brazil as gameleira branca,[94] but also as copaibuçu or copaíba grande.[95]

In the collection of oil paintings in the *Libri Picturati*, there is also an unidentified illustration of a single leaf, with the local name "Quapoiba" written on it (Figure 4.9A), which bears a close resemblance to *Ficus gomelleira* (Figure 4.9B).

The fact that both *Clusia nemorosa* and *Ficus gomelleira* have large leathery leaves and sticky white exudate may have led to their shared local names, although the fruits and flowers of the two species are clearly different. According to Veiga Junior and Pinto, *F. gomelleira* has a similar crown as *Copaifera martii* when growing in open areas and therefore is named copaíba grande.[96] This confusing allocation of the names copaíba,

coapoiba and gameleira also explains why around 1600 the Jesuit priest Cardim made a reference to a fig tree when he described the oil-producing "cupaigba" (Table 4.1), which was later copied by Manoel Tristão and De Laet.[97]

There is a small pencil note written on the drawing that says "Copiiba, Marcg. 121," which refers to the description of copiiba (*Tapirira guianensis* Aubl.) by Marcgraf.[98] Apart from the similar local name, the two species are unrelated and do not look alike, as *T. guianensis* has compound leaves with small leaflets and small, edible black fruits.

Conclusion

While the HNB may be the earliest published account of the Brazilian flora and fauna written by what could presently be understood as "trained scientists,"[99] our review indicates that the HNB was certainly not the first to report on medicinal plants from that area. The pioneering work of the Portuguese Jesuits remained largely unpublished, while the achievement of the HNB surpassed the Portuguese manuscripts with regard to detail, clarity, and scientific method.[100] Given the existing early reports on valuable natural resources that could be obtained from Brazil, Marcgraf and Piso probably had a wish list of useful plants to search for in the surroundings of Recife, which they were expected to describe and depict in more scientific detail. Partly due to the financial problems of Johan Maurits and his entourage, the large collection of natural history objects, descriptions, and illustrations produced in Dutch Brazil was later scattered across Europe.[101] Marcgraf's early death also hindered the botanical verification of unannotated botanical illustrations and their association with the Latin descriptions.

Some decades ago, Whitehead already suggested that the botanical study of the rest of the *Libri Picturati* would facilitate the identification of the flora and fauna described in the HNB.[102] The recent digitization of these paintings will make this feasible without having to examine the physical collections for a prolonged period. Plant species described in the HNB that currently lack taxonomic names can probably be identified by using these illustrations.

The HNB has long served as a naturalist's vade mecum for Brazil and other Neotropical regions. The Dutch, expelled from Brazil in 1654, started to explore the riches in the Guianas, using the HNB as a handbook to identify useful plants, as can be seen from the Brazilian local names used in their reports.[103] From their fortified trading posts, the Dutch exchanged knives, beads, alcohol, and plant products such as copaiba balsam with local Indigenous peoples.[104] The first botanist in Suriname, the enigmatic Hendrik Meyer, tried to collect a specimen of "Copayva" but did not know how the tree looked, so he ended up with a branch of *Neea constricta* Spruce ex J.A. Schmidt instead.[105]

The lack of clear descriptions on the botanical origin of copaiba balsam certainly did not hinder the trade in this precious medicinal product. From at least the seventeenth century, the balsam was widely exported to Portuguese trading posts in Asia (Goa and Macau), North America, and Europe, where it was sold in pharmacies.[106] A total of 21 pounds of "bals: copaiv." was transported on the Dutch ship *Wolphaartsdijk* from Cape of Good Hope to Batavia (Jakarta, Indonesia) and arrived there on 11 January 1729.[107] In his manuscript on the materia medica traded in Amsterdam around 1800, an anonymous Dutch merchant wrote that "Copaivae-Balsamum (*Copaifera officinalis*) comes from Brazil, from a tree growing on the island Maranhon and on the Antillean islands, which they call Copaiva-tree, from which this balsam flows. When it is of good quality it should dissolve entirely in Tri-Tartar."[108] This trade information indicates that copaiba balsam in Europe came from various sources and was probably of mixed origin at the time it entered the pharmacies.

Nowadays, Brazil remains the main exporter of copaiba balsam in the world, and the oil is used industrially for soap, lacquer, varnish, natural fragrances, and perfume.[109] Modern pharmacological studies have shown that it has anti-inflammatory, antibacterial, and analgesic properties that make scars heal faster and repel insects.[110] Many of these studies, however, have been conducted with commercially available copaiba oil, of which the botanical origin was unclear. Significant differences exist in the chemical composition of the more than 20 species of *Copaifera* that are tapped for their medicinal oil and even between individuals of the same species.[111] Further research is needed into the differences in composition and pharmacological properties of the oil of the *Copaifera* species in various Brazilian regions, but detailed descriptions and botanical illustrations are not yet available for every species. The work of Marcgraf and Piso is therefore far from finished.

Acknowledgment

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Notes

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40 Fernandes Brandão, *Dialogues*, 107–113; see Walker in this volume.
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