



Icones Plantarum Malabaricarum: Early 18th century botanical drawings of medicinal plants from colonial Ceylon



Tinde Van Andel^{a,b,*}, Ariane Scholman^c, Mieke Beumer^d

^a Naturalis Biodiversity Center, PO Box 9517, 2300 RA, Leiden, The Netherlands

^b Clusius chair in History of Botany and Gardens, Leiden University, Leiden, The Netherlands

^c Environmental Biology–Plant Biology, Utrecht University, Utrecht, The Netherlands

^d Artis Library, University of Amsterdam, Amsterdam, The Netherlands

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ABSTRACT

Ethnopharmacological relevance: From 1640–1796, the Dutch East India Company (VOC) occupied the island of Ceylon (now Sri Lanka). Several VOC officers had a keen interest in the medicinal application of the local flora. The Leiden University Library holds a two-piece codex entitled: *Icones Plantarum Malabaricarum, adscriptis nominibus et viribus, Vol. I. & II.* (Illustrations of Plants from the Malabar, assigned names and strength). This manuscript contains 262 watercolour drawings of medicinal plants from Sri Lanka, with handwritten descriptions of local names, habitus, medicinal properties and therapeutic applications. This anonymous document had never been studied previously.

Aim of the study: To identify all depicted plant specimens, decipher the text, trace the author, and analyse the scientific relevance of this manuscript as well as its importance for Sri Lankan ethnobotany.

Materials and methods: We digitised the entire manuscript, transcribed and translated the handwritten Dutch texts and identified the depicted species using historic and modern literature, herbarium vouchers, online databases on Sri Lankan herbal medicine and 41 botanical drawings by the same artist in the Artis library, Amsterdam. We traced the origin of the manuscript by means of watermark analysis and historical literature. We compared the historic Sinhalese and Tamil names in the manuscript to recent plant names in ethnobotanical references from Sri Lanka and southern India. We published the entire manuscript online with translations and identifications.

Results: The watermarks indicate that the paper was made between 1694 and 1718. The handwriting is of a VOC scribe. In total, ca. 252 taxa are depicted, of which we could identify 221 to species level. The drawings represent mainly native species, including Sri Lankan endemics, but also introduced medicinal and ornamental plants. Lamiaceae, Zingiberaceae and Leguminosae were the best-represented families. Frequently mentioned applications were to purify the blood and to treat gastro-intestinal problems, fever and snakebites. Many plants are characterised by their humoral properties, of which ‘warming’ is the most prevalent. Plant species were mostly used for their roots (28%), bark (16%) or leaves (11%). More Tamil names (260) were documented than Sinhalese (208). More than half of the Tamil names and 36% of the Sinhalese names are still used today. The author was probably a VOC surgeon based in northern Sri Lanka, who travelled around the island to document medicinal plant use. Less than half of the species were previously documented from Ceylon by the famous VOC doctor and botanist Paul Hermann in the 1670s. Further archival research is needed to identify the maker of this manuscript.

Conclusions: Although the maker of this early 18th century manuscript remains unknown, the detailed, 300-year-old information on medicinal plant use in the *Icones Plantarum Malabaricarum* represents an important ethnobotanical treasure for Sri Lanka, which offers ample opportunities to study changes and continuation of medicinal plant names and practices over time.

Abbreviations: VOC, Dutch East India Company (Verenigde Oost-Indische Compagnie)

* Corresponding author at: Naturalis Biodiversity Center, PO Box 9517, 2300 RA Leiden, The Netherlands.

E-mail addresses: tinde.vanandel@naturalis.nl (T. Van Andel), arianescholman@gmail.com (A. Scholman), wgmbeumer@planet.nl (M. Beumer).

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1. Introduction

The so-called Golden Age of Dutch colonial botany lasted from ca. 1600 to ca. 1750. In this period, substantial amounts of natural history specimens were brought to the Netherlands from Asia and the Americas collected by employees of the East and West India Company (Baas, 2017; Baas and Veldkamp, 2013; Cook, 2007). Among the pioneers of Asian tropical botany were two staff members of the Dutch East India Company (VOC): Paul Hermann (1646–1695), who was stationed as Chief Medical Officer in Ceylon (modern Sri Lanka) and Hendrik Adriaan Van Reede tot Drakenstein (1636–1691), who occupied a military and administrative position in Malabar (modern Kerala, southern India). Hermann's mission was to explore whether local Sri Lankan medicinal plants could serve as an alternative for European herbal medicine used by the VOC apothecaries and surgeons (Baas, 2017; Gunawardena, 1975). Between 1672 and 1679, Hermann collected hundreds of plant specimens and bound them into several book herbaria, several of which were used by Linnaeus for his publications *Flora Zeylanica* (1747) and *Species Plantarum* (1753), and therefore of great importance for nomenclature and typification (Jarvis, 2007; Trimen, 1886).

Van Reede, in his position of Commander of Malabar, recruited a team of local and European plant collectors, interpreters, Ayurvedic herbalists and artists (Baas, 2017; Cook, 2007; Heniger, 1986), which resulted in the monumental 12-vol *Hortus Malabaricus*, with descriptions, detailed illustrations, vernacular names and uses of 689 plant species (Van Reede, 1678–1692), which was only recently translated into English (Manilal, 2003). In 1691, just before his death, Van Reede gave instructions to VOC staff in Ceylon and southern India to continue collecting plant specimens, seeds and bulbs and documenting their local names and medicinal uses. This resulted in annual shipments of living and dried plant material from Colombo to the Netherlands, where the specimens were received with great interest by botanical gardens in Leiden en Amsterdam and by private collectors (De Silva and Beumer, 1988; Heniger, 1986). While the living material was propagated in these gardens to be described and illustrated (Veldkamp, 2002), the dried specimens were incorporated into book herbaria, such as those of Hermann (Van Andel et al., 2018) or mounted on loose herbarium sheets, such as the Van Royen herbarium (Thijsse, 2012), which are still kept at Naturalis Biodiversity Center in Leiden. These annual shipments of plant material lasted for about hundred years (Cook, 2007). Manuscripts on Asian botany were sent to publishers to be printed, but some were stored in private and institutional libraries and subsequently forgotten.

The Special Collection department of Leiden University Library holds a two-piece codex entitled: *Icones Plantarum Malabaricarum, adscriptis nominibus et viribus, Vol. I. & II* (Catalogue number BPL 126D). The manuscript contains watercolour drawings of plants and handwritten descriptive notes in Dutch about these plants. In the cover of Volume 1, a small note has been inserted, written by the Leiden botanist A.J.G.H. Kostermans (1906–1994). The handwritten memo is dated on the 22nd of March 1977 and states that the title of this codex should be *Icones Plantarum Zeylanicum*, as the text “clearly indicates that these plants originate from Ceylon” (<https://digitalcollections.universiteitleiden.nl/view/item/937962>). According to Kostermans, the author must have had a copy of Van Reede's *Hortus Malabaricus*, from which he copied the Malabar names after comparing his specimens. Kostermans concludes in his 14-line note that the drawings must have been made between 1670 and 1700. Apart from Kostermans' quick scan, this anonymous, undated codex has never been subjected to scientific study. None of the depicted plants are indicated with scientific names. The Artis Library of the University of Amsterdam, however, holds 41 watercolour drawings that bear great resemblance to the Leiden collection (Beumer, 2018).

The aim of this study was to identify all depicted plant specimens, transcribe and translate the handwritten Dutch texts, trace the artist

and/or author, and analyse the scientific and societal relevance of this manuscript. We have posed the following research questions: 1) Which plants are depicted in the *Icones Plantarum Malabaricarum*?; 2) What medicinal properties and uses are mentioned for the plants in the manuscript?; 3) What is the origin of the manuscript?; 4) What are the similarities between the manuscript and the 41 plant illustrations kept in the Artis Library?; 5) Are the historic vernacular plant names still used in Sri Lanka today?

We hope that the online publication and scientific analysis of this manuscript will contribute to the scientific study of historic medicinal plant practices and to the valorisation of Sri Lankan traditional knowledge on herbal medicine.

2. Materials and methods

We requested the digitization of the entire two-volume manuscript from the Special Collections of the Leiden University Library. We used the high-resolution photographs to identify the plant specimens. Since none of the pages of the manuscript contained scientific names, we used the Tamil and Sinhalese plant names as a lead when the plant family was not distinguishable at first glance. The vernacular names were checked with an online database of Sri Lankan herbal medicine (Jayatissa et al., 2013, <http://www.instituteofayurveda.org/plants>) and the Encyclopaedia on Indian Medicinal Plants (Ved et al., 2017, <http://envis.frlht.org/implad>). When we had a clue of the plant family, we identified the specimens by comparing them with herbarium vouchers from south and southeast Asia in the herbarium of Naturalis Biodiversity Center (L), publications on medicinal plants of Sri Lanka (Gunawardena, 1975; Jayaweera, 1982) and floristic literature on this region (Dassanayake et al., 1980–2006; Fernando, 1980; Fernando and Fernando, 1979; Kottegoda, 1994; De Vlas and De Vlas-De Jong, 2008, 2014; Worthington, 1959). Scientific names were updated by using the Plant List (2013) (www.plantlist.org). Distribution of species in Sri Lanka were checked by searching for observation data and herbarium specimens on <https://www.gbif.org> and consulting the Flora of Ceylon (Dassanayake et al., 1980–2006).

We checked all pages of the manuscript for watermarks, and photographed them with a small digital camera while shining a light through the pages. To trace the date and location where the paper was made, we used the Bernstein database (<http://www.memoryofpaper.eu>) and literature on Dutch watermarks (Churchill, 1935; Voorn, 1960; Sonneveld and Hooijberg, 2015) and on watermarks in the 17th and 18th century (Heawood, 1969). To trace the origin of the manuscript, we consulted 18th century literature on the Leiden libraries (Boerhaave, 1739; Senguerdius et al., 1741).

For our comparison between historic and current vernacular names, we searched the online databases and literature on Sri Lankan botany and medicinal plants mentioned above for plant names that were similar spelled or showed great similarity in sound and structure to the ones listed in the manuscript. To quantify the percentage of name retention, we scored matching names with 1 and partly matching names with 0.5. For a complete overview of all local Sri Lankan names currently used for the depicted plant species in Sri Lanka, see Scholman (2017). We compared the drawings and the texts in the Leiden manuscript to similar-looking watercolour illustrations and associated handwritten texts kept at the Artis library, University of Amsterdam (Beumer, 2013). To analyse the early 18th century descriptive texts, we used the Dutch dictionary (Van Dale, 2017), 17th century literature on medicinal plants (Munting, 1696; Snelders, 2012) to clarify terms for tropical illnesses and their symptoms in the period of the Dutch East India Company. To analyse the overlap in species described in the manuscript and the specimens collected by the contemporary botanist Paul Hermann in Ceylon, we checked our identifications with those of Hermann's book herbaria in London (<http://www.nhm.ac.uk/research-curation/scientific-resources/collections/botanical-collections/hermann-herbarium/>), Leiden (Barth, 2015), Paris (Lourteig, 1966) and

Erfurt, Germany (Rauschert, 1970). To trace the types of herbal medicines traded between Ceylon and the Netherlands during the late 17th and early 18th century, we queried the website of the Time Capsule project (<http://timecapsule.science.uu.nl/timecapsule/> - /login), which links historic documents on drug components with historic trade routes and botanical databases.

3. Results

3.1. Library information

All pages of the two-volume codex *Icones Plantarum Malabaricarum* have been published online with the transcriptions and translation of the original Dutch text, current scientific names of the depicted plants, modern and historic names in Tamil and Sinhalese on the website: <https://digitalcollections.universiteitleiden.nl/IconesPlantarumMalabaricarum>.

The complete Latin title of the codex, *Icones Plantarum Malabaricarum, adscriptis nominibus et viribus* can be translated as ‘Illustrations of Plants from the Malabar, assigned names and strength’. The name ‘Malabar’ currently refers to the long, narrow coastline on the southwestern tip of India. In the 18th century however, the Dutch and Portuguese traders used the term ‘Malabar’ also for Tamil-speaking people and the Tamil language in southern India and northern Sri Lanka (Yule, 1903).

This manuscript contains 262 watercolour drawings of medicinal plants, 131 in each volume, with handwritten descriptions on their habitus, medicinal properties and therapeutic applications. Local names are given in the Tamil (‘Malabar’) and Sinhalese languages, phonetically converted to Roman script. Each plant is drawn on the cover of a double folio sheet, while the inside of each sheet has a Dutch descriptive text on the plant written in a neat, easily legible handwriting. The writer used a horizontal dash when he could fill out the lines of the paper, so no one could add more words afterwards without this being noticed (see Fig. 1). This dash was quite commonly used in official VOC documents, which suggests the writer was a clerk. The VOC employed many scribes, who were often ordered to copy valuable scientific manuscripts before these were sent to the Netherlands (Buijze, 2006).

The text ‘Ms. Lat. Bibl. Publ. XVII. F. 126, D. emt. Ex Libris Boerhavii’, written on the inside of the cover of both Volume I and II (<https://digitalcollections.universiteitleiden.nl/view/item/938235>), refers to

the library of Herman Boerhaave (1668–1738), a Dutch botanist, physician and chemist who held three professorships at the medicinal faculty of the Leiden University. From 1709–1730, he was director of the Leiden Botanical Garden (Knoeff, 2002). In the catalogue of his library, published after his death, Boerhaave : 27) (1739) listed the codex under the manuscripts and illustrations as ‘*Icones vivis coloribus pictae venustissimae Plantarum Malabaricum cum adscriptis Nominibus & Viribus, 2 voll.*’, referring to the graceful depiction and vivid colours of the drawings. After Boerhaave’s death, the codex was acquired by Leiden University, as it appears in the catalogue of the University Library that lists accessions in the period 1716–1741 (Senguerdius et al., 1741).

More than hundred years later, the Leiden library catalogue listed the manuscript as ‘*Icones mediocriter delineatae et coloribus pictae Plantarum malabaricarum, cum descriptione hollandica virium earundem*’ (Geel, 1852), translated as ‘Mediocre coloured illustrations of Malabar plants, with Dutch descriptions of their strength’. The only scientific publication that mentions the existence of this manuscript is the work on Van Reede tot Drakenstein by Heniger : 77) (1986): “During the administration of Pijl or Van Rhee probably the two-volume codex of water-colours of Ceylon plants with short descriptions was also composed, which later came into the hands of the Leiden professor of Botany Hermann Boerhaave and which is now in the University Library in Leiden”.

3.2. Dating the paper

The paper used for the *Icones Plantarum Malabaricarum* contains various watermarks, each with its own countermark consisting of the initials of its manufacturer. The two volumes contain paper with five different watermarks (Supplementary File 1): three are used for the drawings and two are only used for the binding of the book. The most commonly used paper (230 of the 262 drawings) contains a watermark depicting the coat of arms of Amsterdam and as countermark the initials ‘IVP’. The watermark bears resemblance to one that was dated in 1720 by Voorn (1960), but with a different countermark. The paper of the remaining drawings also has a watermark of the Amsterdam coat of arms, but in another style and with countermark of the initials DP, which stand for Dirck Pieters de Jong, owner of the paper mill ‘De Visser’ in Zaandijk. The combination of the watermark with the countermark was dated between 1694 and 1722 (Voorn, 1960). A third watermark is found in only one drawing and depicts a different coat of arms of



Fig. 1. Example of a typical entry in the manuscript: Volume II, nr. 141. A. Drawing of *Hygrophila auriculata* (Schumach.) Heine (Acanthaceae) (<https://digitalcollections.universiteitleiden.nl/view/item/938081>) B. Handwritten description of this herb, known as ‘Niermoelli’ in Tamil and ‘Ickiri’ in Sinhalese, and its use against dropsy. (<https://digitalcollections.universiteitleiden.nl/view/item/938190>).

Amsterdam and a contramark with the initials IV, which refer to French paper that was imitated in the Netherlands. The combination of watermark and contramark was dated at 1716 (Voorn, 1960). Two watermarks are found in the binding of the manuscript: a variation on the Amsterdam coat of arms and a Dutch freedom mark (Supplementary File 1) that has a contramark with the initials LVG. These stand for Lubertus van Gerrevink, a Dutch paper manufacturer who used these marks until 1718 (Voorn, 1960). As the binding of the manuscript was done after the drawings were made, we estimate that the *Icones Plantarum Malabaricarum* must have been produced between 1694 and 1718.

3.3. Plant identification

The 262 drawings in the two volumes of the manuscript represent ca. 252 species from at least 75 families. All drawings are listed with their scientific names, families, historic and current vernacular names in Supplementary File 2. Eight species were depicted twice: *Zaleya decandra* (L.) Burm.f., *Clitoria ternatea* L., *Alpinia cf. galanga* (L.) Willd., *Ipomoea asarifolia* (Desr.) Roem. & Schult., *Tephrosia purpurea* (L.) Pers., *Sida rhombifolia* L., *Datura metel* L. and *Cleome gynandra* L. The author was probably not aware of this, as the drawings are not identical and associated with different (combinations of) vernacular names or spelled in dissimilar ways. The root of *Curcuma* sp. (Fig. 2 A and B), for example, was listed under the Tamil names ‘Colawinda manzel’ (nr. 36; Fig. 2 B) and ‘Koelawindamansel’ (nr. 225) and under the Sinhalese names ‘Karanga’ (nr. 36; Fig. 2 B) and ‘Haranga’ (nr. 225). The two entries also had slightly different recipes (Supplementary File 2), but appear to be the same species, even though the morphological characters necessary for taxonomic identification (flowers, fruits) are lacking.

The best-represented family was the Leguminosae with 29 different species, followed by the Euphorbiaceae with 15 spp., Lamiaceae (13 spp.) and Convolvulaceae (12 spp.). The illustrated plant species include common weeds (e.g., *Achyranthes aspera* L. and *Abrus precatorius* L.), cultivated ornamentals (e.g., *Hibiscus rosa-sinensis* L., *Nerium oleander* L.), large forest trees (e.g., *Pterocarpus marsupium* Roxb.) and Sri Lankan endemics, such as *Biophytum hermanni* Veldk. and *Salacia reticulata* Wight. Several species were depicted as seedlings without clear morphological characters, which made identification difficult. The artist did not always have access to flowering or fruiting material, and although it is likely that the plants were sketched in the field, some of his drawings depict only a loose leaf, which must have been collected

from the ground or brought to him by another person. The position of the leaves (alternate or opposite) is not always consistent, and in some cases no clear distinction is made between compound and simple leaves, which also complicated botanical identification. The artist has paid much more attention to the accurate drawing of the roots, which are often disproportionately large compared to the rest of the plant, which further challenges proper identification. Still, we identified 221 drawings (88%) to species level, 24 to genus level and seven to family level. We could not assign any taxon name to one drawing (nr. 185).

3.4. Floristic environment

For almost all illustrated plants, the author mentioned whether the plant was common on the island (‘Zij vallen op t’ eijland Ceijlon overal’) or restricted to some areas (‘Zij vallen hier op een seekere plaats’). Mostly the locations are vague (‘they grow everywhere here’), from which it is not clear what area is meant with ‘here’. In one occasion, he wrote: ‘They grow here little, but are abundant near Negombo’, while in other cases he wrote ‘they grow here in Negombo, and on the side of Jaffanapatnam’ or ‘here in Colombo’. The home base of the author therefore remains unclear, but he cites several places in Dutch colonial Ceylon (see Fig. 3), of which Jaffanapatnam (modern Jaffna) is mentioned most frequently (11x), followed by Colombo and Negombo (each 10x), Mannaer (modern Mannar, 7x), ‘s’ Koninx land’ (the Kings land Kandy, 3x), Wannij (Wanni, 2x) and Calpentijn (now Kalpitiya, south of Mannar, 1x). He also mentions six times Tutucorijn (Thoothukudi, southern India). The many growth locations indicate that the author was able to travel around and even outside Sri Lanka to observe medicinal plants in their natural habitat. Another possibility is that he had informants from all over the country, bringing him plants and supplying him with information on growth form, abundance and collection localities. This, however, is not consistent with the varying meaning of ‘here’ and the fact that the plants are depicted as if they look fresh and not dried or wilted due to being transported over large distances.

The author hardly mentioned any specific ecosystems or habitats, like forest, swamp or grasslands. He neither made a distinction between wild and cultivated plants. Several domesticated crops are depicted in the manuscript, such as lime, pomegranate, pigeon pea and onion, but only their medicinal uses have been reported. Nothing was said about gardens or agricultural fields. Even in his description of onion (*Allium cepa* L.), the author omitted a reference to its cultivation or use as food, but wrote instead: ‘they strengthen the stomach, expel slime and stimulate the urine production. They grow plentiful on Ceylon’ (nr. 262,



Fig. 2. A. Drawing of *Curcuma* sp. ‘Colawinda manzel’ (Volume I, nr. 36) (<https://digitalcollections.universiteitleiden.nl/view/item/937932>), B. The associated recipe on the following page. (<https://digitalcollections.universiteitleiden.nl/view/item/937778>).



Fig. 3. Map with the territories of the VOC in Ceylon before (green) and after (striped) the treaty of 1766. Made by Armand Hay from Wagenaar (2016).

Supplementary File 2).

When we compared the species in the manuscript with specimens collected by Hermann around Colombo in the 1670s, we found 119 matching species with Hermann's London collections, 53 with the Paris, 44 with the Leiden and 26 with the Erfurt collections (Supplementary File 2). The greater correspondence with Hermann's collections in London is explained by the fact that most of Hermann's collections are stored here (550 specimens), while the collections in Leiden (183 specimens), Paris (171 specimens) and Erfurt (92 specimens) are much smaller. In total, 88 species in the manuscript were different from those collected by Hermann in Ceylon, while for another 32 drawings the taxonomic identifications in the Hermann collections and / or the manuscript are too uncertain to make a comparison on species level.

The geographic origin of the plant species depicted in the

manuscript does not give a clear indication on the residence of the author. Only recently collected herbarium specimens from Sri Lanka are accurately geo-referenced, so their distribution can be viewed through www.gbif.org and checked with the occurrence mentioned in the manuscript. Moreover, much of the original forests of Sri Lanka have disappeared between 1700 and today. For example, the endemic shrub *Salacia reticulata* (nr. 34) is now only known from the Central Highlands (Creuwels, 2017; Wadhwa, 1996) and the Wilpattu National Park in the northwestern part of the country (Telenius and Shah, 2016), while in the 16th century the species was apparently 'very common on Ceylon'. The limited overlap with Hermann's collections (47%) can partly be attributed by the fact that the author of the manuscript travelled around the island, while Hermann collected only around Colombo. The spiny shrub *Azima tetraacantha* Lam. (nr. 224), for example is only known from

recent herbarium collections from granite outcrops in southern Sri Lanka, in Wilpattu National Park and along the eastern coast (Capers, 2014; Harriman, 1991), quite far from Colombo. However, many other species not collected by Hermann but present in the manuscript are common tropical weeds (e.g. *Ipomoea asarifolia* (Desr.) Roem. & Schult. and *Senna occidentalis* (L.) Link) or cultivated plants such as hemp (*Cannabis indica* L.) and pomegranate (*Punica granatum* L.).

3.5. The Amsterdam collections

The Artis Library, part of the Special Collections of the University of Amsterdam, holds 41 botanical drawings by the same artist (Catalogue nr. AB Legkast 343). The illustrations are made in the same style and have the same green pigment that is equally affected by copper oxide corrosion (Beumer, 2018), so that brown shadows of the images are showing through on adjoining pages (Fig. 2). The drawings are sometimes supplemented by handwritten Dutch texts on loose slips of paper, in a different handwriting than the Leiden manuscript, and often just a local name or a short text. Some paper slips are glued to the margin of the second page, others inserted between the double folio leaves.

The watermark and contramark in 31 of the 41 Amsterdam drawings by the same artist correspond with watermark V and the initials “IV”, found in only one drawing of the Leiden collection and dated in 1716 (Supplementary File 1). Watermark I with the contramark “IVP” was found in five drawings, and once with the contramark “IV” and twice with the contramark “PSH”. One drawing (folio 49) contains the same Freedom mark (IV) and initials “LVG” as the binding of the Leiden collection and folio 36 contains watermark III, also found in the Leiden binding, but then with the initials “DP”, referring to Dirk Pieters de Jong. This indicates that, with one exception, the Amsterdam drawings were not made on exactly the same stack of paper as the Leiden drawings. They were, however, made in roughly the same period and by the same person. The archives of the Artis library provide no clue on the provenance of these drawings (Beumer, 2018).

The Amsterdam drawings form part of a set of 69 watercolour drawings of Sri Lankan plants on double-folio leaves, but sheets numbered 1–27 are clearly made by another, much more professional artist (Beumer, 2013). Their accompanying texts are mostly in German, written on separate slips of paper, although in three cases a separate Dutch text is added (Beumer, 2018). The hand of a third artist is recognized in the drawing on folio 66, the only sheet where the Dutch text is written right below the depicted plant.

When we compare the Leiden *Icones Plantarum Malabaricarum* with the Amsterdam drawings made by the same artist (nr. 28–65, 67–69), we find 21 overlapping species (See Supplementary File 2). Examples are *Croton tiglium* L., *Nerium oleander* L., *Cassia fistula* L., *Caesalpinia pulcherrima* (L.) Sw. and *Jatropha curcas* L. (Fig. 4 A and B). We did not, however, find exact duplicates of either texts or drawings. The few texts associated with the Amsterdam drawings mostly only mention a Tamil name (often spelled in a more phonetically ‘Dutch’ way than in the Leiden manuscript). In a few cases, a longer text on the appearance and uses of the plant is provided, which is mostly a shortened draft of the final text of the Leiden manuscript. However, for *Punica granatum* and *Phyllanthus emblica* L., the original text on the Amsterdam drawings mentions the use of the plants against gonorrhoea (‘druppert’ in 18th century Dutch), which is left out in the final text. This does not seem a case of censorship, as in the Leiden manuscript three other species (*Tribulus terrestris* L., *Gmelina asiatica* L. and *Ficus racemosa* L.) are listed as medicine against gonorrhoea, although the Dutch spelling of the disease is slightly different (‘druijppaerts’, ‘d Druppel’ or ‘druijpert’), all of which can be translated as ‘the dripper’. In one case, the Amsterdam texts provide an explanation of uncertain terms in the Leiden manuscript. The ‘hairworms’ treated with the exudate of *Nerium oleander* L. are specified as ‘small worms that grow in ulcers’ in the Amsterdam text belonging to the same species. This probably refers to botfly larvae (*Dermatobia hominis*), a common skin parasite in the tropics.

Our comparison indicates that the *Icones Plantarum Malabaricarum* was used on its own and did not serve as a duplicate or supplement for another collection. The Amsterdam drawings were probably left out of the final manuscript because of redundancy or insufficient information on names and uses of the plants, as the associated text with names and uses are often lacking. The other, more professional artist (drawings nr. 1–27) of the Artis library depicted 14 overlapping species, including the Sri Lankan endemics *Biophytum hermanni* and *Salacia reticulata*. His texts are more extensive and in German (Beumer, 2013).

3.6. Vernacular names

The manuscript mentions 260 unique Tamil names and 208 unique Sinhalese names. There is only one plant depicted (*Pogostemon* cf. *reflexus* Benth., nr. 29) for which no Tamil name is given, while for 53 plants, the Sinhalese name is lacking. This indicates that the author mainly worked with Tamil informants. For 17 plants, the author reported that the Tamil and Sinhalese names were the same. A few Dutch and Portuguese names are given as well, mostly for cultivated exotics (e.g., lime, mustard, Cannabis and pomegranate) or for well-known Asian spices like cinnamon and turmeric. As the vernacular names are written in an early 18th century phonetic Dutch spelling, linking them with modern Tamil and Sinhalese names was difficult. When we compared the vernacular names in the manuscript with current Tamil and Sinhala names for the same species reported in recent literature and online sources, we could find a matching modern equivalent for 134 (51%) the Tamil names. For another 43 (17%) historic Tamil names, the current name is partly similar. For the historic Sinhalese names, we found lower retention percentages, as 75 (36%) of the names were identical to a currently used name, and 29 (28%) of the names survived only partly. Due to the differences between the Dutch spelling around 1700 and the modern Sri Lankan spelling, we must have missed several matching names. Moreover, historic Sinhalese plant names for which the word “gas” (tree) or “heen” (small) was either added or left out in the modern variant were counted as partly similar. Individual scores for each historic plant name are listed in Supplementary File 2. As probably not all current Sinhalese or Tamil plant names have been documented, and since we were not able to identify all plant drawings to species level, we estimate that the actual overlap between historic and modern names is higher. For most of the species depicted in the manuscript, many more (partly) different local names are documented in the past decennia (Scholman, 2017).

3.7. Plant parts used

The manuscript reported many different plant parts as ingredient in the medicinal preparations (Fig. 5), but roots were most frequently mentioned (79 cases). They were used fresh, soaked in alcohol, dried and ground to powder, boiled in water, eaten or drunk as tea (Supplementary File 2). The fact that roots were the main ingredients in ca. 30% of the recipes could explain the disproportionately large size of the roots on many of the depicted plants (Fig. 4). This would facilitate the identification of roots by doctors and traders in herbal medicine. The author often used the Latin term ‘radix’ when describing medicinal roots. For *Merremia* cf. *tuberosa* (nr. 17), for example, he wrote: ‘Radix appaijkilangoe, named by the Malabars, [...] is a branched liana. The root is mixed [...] with other soothing ingredients [...] against bites of malicious animals’ (<https://digitalcollections.universiteitleiden.nl/view/item/937916>). It is unlikely that the local population used Latin terms for their herbal medicine, but this combination of pharmacological and local names reflects the author’s attempt to make his work look more scientific. He probably anticipated that the medicinal roots he documented were likely to be commercialized in the future (after his manuscript was published) and thus needed pharmacological trade names. Small herbs were mostly incorporated entirely (27% of the recipes). Leaves (16% of the recipes) and bark (11%) were often



Fig. 4. A. Illustration of *Jatropa curcas* from the Leiden collection (Vol. I, nr. 32). 4 B. Drawing of the same species by the same artist in the Amsterdam library (folio 50). In both cases, the plant is drawn out of proportion: the leaves and fruits are depicted too close to the root and a stem is lacking.

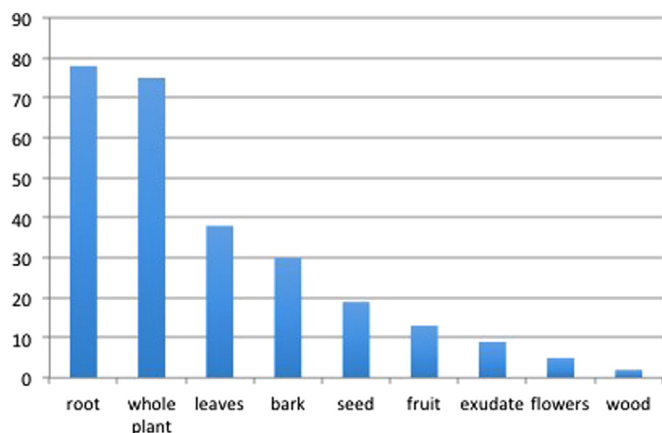


Fig. 5. Number of times a medicinal plant part was mentioned in the 262 text fragments associated to the drawings.

harvested from trees. In some cases, the plant part used was not specified.

3.8. Medicinal properties and applications

The plant descriptions, of which both transcriptions and translations are provided in [Supplementary File 2](#), revealed a variety of ailments, therapeutic uses and pharmacological properties. The most cited medicinal application was the use of plants to purify the blood (55 cases), followed by gastro-intestinal problems (stomach pain, heartburn, excess of bile, poisoning) and fever (Fig. 6). Many plants were said to expel or resolve slime from the stomach, although the reason why this property was so important remains unclear. Remedies to cure the bites of snakes and ‘other malicious animals’ were also frequently mentioned. Translating the terms for diseases around 1700 to a modern equivalent was somewhat problematic. Fever appeared often in the manuscript, as this was seen as a disease and not as a symptom at that time (Snelders,

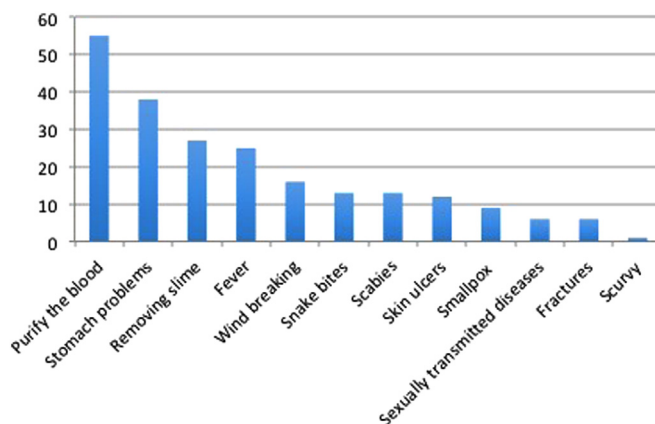


Fig. 6. Citation frequency of the 12 most frequently mentioned medicinal applications in the text accompanying the 262 drawings.

2012), although it may be related to infectious diseases such as malaria or typhoid. Sexually Transmitted Diseases, quite prevalent at the time of the VOC (Snelders, 2012), were mentioned occasionally in terms like ‘Venus pox’, which could not directly be translated to syphilis or gonorrhoea. For some diseases, we could not find any definition, such as ‘hajrworm’ (hairworm?), ‘bloedpijn’ (blood pain?), and ‘persie’ (pleurisy? pneumonia?). A few plants have multiple medicinal applications, for example *Indigofera aspalathoides* DC. (nr. 8) and *Cinnamomum verum* J.Presl (nr. 33).

Besides the various medicinal recipes, the author has paid special attention to report the pharmacological properties of the plant species. More than 20 plants were said to have removing (‘afdrijvend’ in Dutch), expelling (‘verdrijvend’ in Dutch) or opening (‘openend’ in Dutch) properties. It is not clear whether the author meant diuretic, laxative or purgative effects with these terms. The species that were listed for their ripening properties (‘rijpmakend’) referred to their treatment for skin swellings and abscesses. At least 58 species were described to have

warming ('verwarmende kracht' in Dutch) or hot-making powers ('heetmakende kracht'), while only 12 species were classified as cold, eight as dry and none as wet. Some plant parts, such as the root of *Gloriosa superba* L. (nr. 248), were even considered 'hot in the second and third grade'. The total number of therapeutic uses reported in the manuscript was about 35, but distinction of all these into clear ailments was not possible.

Although he did not mention this explicitly, the author must have interviewed both local traditional healers and lay people. For *Phyllanthus* cf. *reticulatus* Poir. (nr. 69), he reported: 'this bark is employed by many indigenous healers and combined with other remedies for a variety of illnesses', while for *Gloriosa superba*, he mentioned that 'when someone uses it too much, he will die, so this medicine should be used by an experienced healer'. Local patients are often described as 'Blacks', with no distinction between 'Malabaaren' (Tamils) or 'Cingaleesen' (Sinhalese). For *Hygrophila auriculata* (Schumach.) Heine (Fig. 1), he mentioned that this herb was burnt and the ashes mixed in water were 'given to the Blacks who suffer from dropsy, as it is a strong diuretic'. The fruit peel of *Terminalia bellirica* (Gaertn.) Roxb. (nr. 72) 'can be considered as one of the most important blood purifying remedies among the Blacks'. The author does not specify anywhere in the manuscript between plant uses specific to either Tamils or Sinhalese.

A striking aspect of the recipes is that the author tried out many plants himself. He described *Coriandrum sativum* L. as 'sweet-scented' which 'gives a lovely bitter-like taste on the tongue', while he experienced the herb *Pentanema indicum* (L.) Ling as 'very bitter on the tongue'. The pharmacological and humoral properties of the plants (hot, cold, dry, bitter, sweet, etc.) were apparently often established by self-testing.

4. Discussion

4.1. Tracing the maker of the manuscript

Based on the paper used for the drawings and the binding of the Leiden manuscript and the work by the same artist in the Artis library, we can conclude that the illustrations must have been made between 1694 and 1718. This is somewhat in line with Kostermans' estimation (between 1670 and 1700). This means that the plants could have been drawn during the administrations of Thomas van Rhee (1634–1701), governor and director of the Dutch colony of Ceylon from 1693 to 1695 (Heniger, 1986; Anthonisz, 1915) or his successors Gerrit de Heere (1657–1702), who died on duty in Colombo, or Cornelis Joan Simons (ca. 1660–1727), who ordered the translation of the traditional Tamil laws of Jaffnapatnam and started a Leper hospital in the western Gampaha district (Bartholomeusz, 1943). Around 1700, several Dutch surgeons were active throughout Sri Lanka, collecting and documenting medicinal plants and sharing these with Botanical gardens, interested scientists and private collectors in the Netherlands (Wijnands, 1983; Heniger, 1986; De Silva and Beumer, 1988). The Kings of Kandy, an area in the central highlands where the traditional Sri Lankan rulers had retreated to remain independent from the Dutch (Wagenaar, 2016, see Fig. 3), often requested and received medical aid from the Dutch doctors in Colombo, but there are no records that 'any effort was made by the Dutch to teach the science of medicine systematically to the natives' (Bartholomeusz, 1943: 133). The *Icones Plantarum Malabaricarum*, however, shows that the Dutch doctors were actively documenting the traditional 'science of medicine' from the native population. From 1699 to 1779, the surgeons of Colombo arranged annual shipments of on average 150 plant species (Heniger, 1986). The seeds and cuttings were grown in the botanical gardens in Amsterdam and Leiden, scientifically described (e.g., Commelin et al., 1697) and depicted when in full bloom (Wijnands, 1983), while the dried specimens ended up in herbaria and were studied by generations of botanists (Heniger, 1986; Jarvis, 2007).

There was also interest from the side of apothecaries for Ceylonese

herbal medicine. Our query on the Time Capsule database resulted in cargo records of a few dozens ships departing from Ceylon between 1712 and 1757 that carried 'spiritus acmella', an alcohol-based extract of *Acemella paniculata* (Wall. ex DC.) R.K. Jansen, described under the Sinhalese name 'Hackmalla' in the *Icones Plantarum Malabaricarum* (nr. 182) and used by local people as a diuretic. According to the Leiden apothecary Schröder (1741), seeds of 'Acemella' or 'Bidens ceylanensis antinephritica' were already sent from Colombo to the Netherlands in 1650, and grown in the Amsterdam botanic garden in 1652, in order to test out its famous diuretic properties and abilities to treat kidney stones. The species is also listed in the Leiden Pharmacopoeia of 1732 (Anonymous, 1732). Our research points out, however, that substantial ethnobotanical information sent from colonial Ceylon could also remain unstudied for centuries.

The author of the manuscript recorded more Tamil plant names than Sinhalese and often mentioned Jaffnapatnam, the historic name for Jaffna, the capital of the northern province of Sri Lanka. Tamils make up only 18% of the population of Sri Lanka and mainly live in the northern part of the country, while 75% of the people are Sinhalese. Therefore, he may have been based in the northern parts of the island (Beumer, 2018). The Tamil names in the manuscript differ substantially from the vernacular names documented in the *Hortus Malabaricus* (1678–1692), so Kostermans' remark that the author had copied the Malabar names from Van Reede is proved to be incorrect.

It is likely that the author was one of the many doctors who were employed by the VOC to provide health care to its personnel and carry out bioprospecting activities in the meantime. He was Dutch, as both the final manuscript as the draft texts are written in the Dutch language. The manuscript was produced in a rich tradition of the documentation of traditional knowledge, brought to a high level by his predecessors Van Reede in southern India (Heniger, 1986) and Georg Eberhard Rumphius in the Moluccas (Arens, 2017; Beekman, 2011; Veldkamp, 2002). It does not become clear from the manuscript text whether the author was based in a VOC hospital, as suggested by Beumer (2018). The author does not refer to the VOC or the spice trade, in spite of the hundreds of ships with cinnamon bark leaving Colombo during the period that the manuscript was made. Although the Dutch name for cinnamon ('Caneel') is given for *Cinnamomum verum*, the use of its bark for spice is not even mentioned. The plant is just described as having a hot nature and removing properties.

It remains a mystery why the manuscript was never published. The illustrations were described as 'mediocre' (Geel, 1852), but that happened more than hundred years after they were made. The inferiority of the drawings probably referred to the deteriorating ink and the lack of detail. Plant illustrations with exaggeratedly sized roots and flowers and fruits drawn out of proportions to show the details in one individual were not uncommon in the 17th century. A similar style of depicting useful plants can be observed in the *Historia Naturalis Brasiliae*, the first and influential natural history description of Dutch Brazil (Piso and Markgraf, 1648; Alcántara Rodríguez, 2015). A possible explanation for the fact that the drawings remained unpublished could be that the author died before finding sufficient funds for publishing.

The ethnobotanical descriptions and illustrations by Van Reede (1678–1692) and Rumphius (1741–1755) are of better scientific quality, but the *Icones Plantarum Malabaricarum* contains much more details on Ceylonese medicinal plant use and also includes many different species than Paul Hermann incorporated in his herbaria (Barth, 2015) and publications (Sherard, 1717; Gunawardena, 1975). While Hermann earned eternal fame for his Ceylonese collections (Baas, 2017), the anonymous author of the *Icones Plantarum Malabaricarum* received hardly any scientific recognition.

4.2. Humoral medicine

The many references to plants with a 'hot nature' in the *Icones Plantarum Malabaricarum* refer to the humoralist system of medicine.

Until the introduction of modern medicine in 19th century, humoralism was the most used medicine in Europe. It was based on the concept that the body consisted of four bodily fluids (blood, yellow bile, black bile and phlegm), which should be in balance (Jackson, 2001). An excess or deficiency of one of these humors would lead to illnesses, and treatment was based on the principle of opposites (Geck et al., 2017; Snelders, 2012). Herbal remedies with a hot and dry nature could help against cold and wet ailments, such as slow pulse, indigestion, a poor appetite and inertia, while plants with cold properties were prescribed against fevers, headache and burning pains (Jackson, 2001). Humoral qualities are now often considered as abstract concepts, mainly applied *post hoc* to validate therapy, but recent pharmacological and ethnobotanical studies have shown that the key predictors of drugs' therapeutic uses are their humoral qualities (e.g., bitterness, astringency, aromatic properties), which can be detected by taste and smell (Geck et al., 2017). In the *Icones Plantarum Malabaricarum*, the description of the humoral qualities of each species probably served as a tool to detect medicinal properties if no local uses were known or to provide additional scientific evidence for traditional uses.

The practice of self-testing unknown medicinal plants by early bioprospectors to describe their (potential) healing properties was common, as was shown by Rumphius (1741-1755) in the Moluccas and Daniel Rolander (ca. 1755) in Suriname (Van Andel et al., 2012). Herbal medicine traders in 18th century Amsterdam also categorized their medicinal plants as cooling, drying or warming, without detailed recipes, as doctors would know how to use these plants once their humoral qualities were established (Swart, 2017). Moreover, humoral concepts also play a significant role in traditional Ayurveda medicine in southern India and Sri Lanka, although they differ somewhat from the European concepts (Foster, 1994). It is likely that the author, apart from self-testing, also documented the humoral qualities of the plants claimed by the local population. The *Icones Plantarum Malabaricarum* offers interesting opportunities to study the concepts of health and illness prevalent around 1700 and the exchange of knowledge between local people and early modern scientists in a colonial setting.

4.3. Scientific importance and societal relevance

The local plant knowledge documented by VOC employees represents a largely untapped source of ethnomedicinal information with potential application in health care, new drug development and intellectual property protection (Scott and Hewett, 2008). Historical ethnobotanical studies, supplemented by pharmacological review and validation by modern science, could directly benefit the descendants of the original intellectual property holders in former colonies and serve as stepping stones to (re-) integrate lost medicinal plant uses in both local and wider evidence-based contexts (Soelberg et al., 2016). Such historic documents are also interesting sources to study the exchange in knowledge between local people and early modern scientists. The *Icones Plantarum Malabaricarum* contains detailed, 300 years old information on medicinal plant use in Ceylon. The manuscript is therefore of huge cultural importance to Sri Lankan citizens, who greatly value herbal medicine and traditional Ayurveda practices (Jayatissa et al., 2013). Especially for the Tamil population, this manuscript represents an important ancestral legacy, as it is one of the oldest documents on their ethnomedicinal knowledge documented by Western scientists. The manuscript also offers great opportunities for scientific studies on changes in plant names and uses over time. The descriptions in the manuscript could be compared with published ethnobotanical and linguistic studies from the same region or discussed with Sri Lankan traditional healers to assess the scale of loss and preservation of local medicinal plant knowledge. Further archival research is needed to obtain more information on the history of the manuscript, in particular in documents on the library of Herman Boerhaave and the VOC archives, especially the letters, diaries and reports from governors in northern Sri Lanka in the period 1694–1718.

It is possible that the author of the *Icones Plantarum Malabaricarum* made herbarium vouchers in Ceylon to be used as a basis for his illustrations. However, besides the historical Hermann herbarium from the 1670s, Naturalis has no other historical collections from Ceylon around 1700. A few specimens collected between 1720 and 1721 by Boerhaave's pupil Pieter Hertog (1695–1728) on Ceylon are incorporated in the Van Royen herbarium, but the manuscript was bound just before Hertog arrived on the island. Future studies in historic herbaria from Ceylon kept in other European herbaria may yield specimens that resemble the drawings in the manuscript, which could lead us to the identity of the author.

5. Conclusions

The *Icones Plantarum Malabaricarum*, made between 1694 and 1718, represents a rich source of ethnobotanical knowledge from colonial Ceylon. The 262 drawings represent 252 plant species, varying from introduced ornamentals and common weeds to forest trees and Sri Lankan endemics. The medicinal plants were mostly used for their roots and often cited to have 'warming properties' and employed to 'purify the blood'. Although we were not able to trace the name of the artist and/or author, he was probably a Dutch surgeon employed by the VOC. He was possibly based in Jaffapatnam (northern Sri Lanka), but he was able to travel around the island to document local knowledge and illustrate medicinal plants. Only 47% of the depicted species overlap with those collected by Paul Hermann around Colombo in the 1670s. A set of 41 drawings in the Artis library were made by the same person, but either served as drafts or were left out from the main manuscript as they had too little descriptive information. More historic Tamil plant names survived than Sinhalese ones, although the majority of late 17th century vernacular names have at least partly been retained. The *Icones Plantarum Malabaricarum* should be recognized as an important cultural treasure for Sri Lanka, which offers ample opportunities to study changes and continuation of medicinal plant names and practices over time, as well as historic concepts of health and illness and the exchange of traditional knowledge with early modern scientists in the colonial period.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.jep.2018.04.033>.

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