

# The Zierikzee Herbarium: An analysis of the contents and origins of an enigmatic herbarium

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## Research Article

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# Abstract

The Municipal Museum of Zierikzee houses a loose-leafed herbarium containing 360 dried plant specimens, of which the provenance, age and maker were until recently unknown. By studying the plant specimens, paper, decorations and labels, an image was conveyed of an early 18th century herbarium that matched the description of a herbarium from the legacy of Jakob Ligtvoet, who was gardener in the Leiden Hortus botanicus from 1703 till his death in 1752. This herbarium is one of the oldest garden herbaria of its kind and contains 306 unique species, of which 201 are currently native to the Netherlands. Exotic species come from the Mediterranean (82 spp.), Europe (24), South Africa (8), the Americas (9) and in tropical Asia (7). Based on our comparison of names on the oldest labels, this collection of dried plants was probably started after publication of the first garden catalogue by the prefect of the Leiden garden and professor of botany Herman Boerhaave (1710), but before the second edition in 1719. This historic herbarium reflects the state-of-the-art of botanical science and the international network of Dutch botanical gardens in the early 18<sup>th</sup> century.

## Introduction

The ongoing digitalization of botanical collections has paved the way for the study of historic herbaria. Where once they were confined to the realm of inaccessible treasure rooms, they can now - in their digital form - be studied without the need to handle the fragile specimens too frequently (Van Andel, 2017). For research on the history of botany, the study of historic herbaria is essential (Van Andel et al., 2012; Pulvirenti et al. 2015; Stefanaki et al., 2019). Historic herbaria can provide us with valuable information about plant occurrences in time and place, the state-of-the-art of botanical science at a specific moment and about the scientific networks of the people who collected the specimens. Herbaria are also a reflection of society as a whole. Dutch herbaria of the late 17th and early 18th century mirror not only the wild and cultivated plants present in the Dutch Republic, but also the flora of the regions where the Dutch East and West India Companies (VOC, WIC) founded their trading posts. 'Factorijen', as they were called, were established in South Africa, Japan, Mocca, Persia, Bengal, Malacca, Siam, Formosa, the Malabar and Coromandel coasts, the Guianas, the Dutch Caribbean, and eventually China, with Batavia on Java as headquarters of the VOC in Asia. Together with silk, plantation goods and spices, there was a steady flow of exotic plants from these places to the Dutch Republic. The purpose of collecting these plants was manifold: the direct need for new medicinal plants for unknown tropical diseases (Scott & Hewett, 2008; Van Andel & Barth, 2018) and the desire by curators of public and private gardens in Holland to obtain exotic species (Scott & Hewett, 2008; Baas, 2002) among others. Grown from seeds and cuttings if possible, collected plants were nurtured and propagated in botanical gardens. Many plants were dried and mounted in herbaria, either in these botanical gardens themselves or sent from exotic places to the Dutch garden owners (Veendorp & Baas Becking, 1938).

All the major cities in the Dutch Republic boasted public botanical gardens, but Leiden and Amsterdam surpassed the other gardens in size and quality of their collections (Wijnands, 1988). Founded in 1590 (Karstens & Kleibrink, 1982), the Hortus botanicus in Leiden had a history of acquisition of plants by

exchange. Its third prefect, Carolus Clusius (1526–1609), was appointed as much on account of his reputation as a botanist as on account of his international contacts. Arnold Syen (1640–1678), prefect from 1670 till his death, was the first to actually receive compensation for corresponding with botanists abroad (Heniger, 1989; Molhuysen, 1913). Around the same time, pharmacist Antoni Gaijmans (1630–1680) made a herbarium with plants from the Leiden garden. This was remarkable because permission to collect plants in this garden was in general rarely granted (Heniger & Sosef, 1989). Paul Hermann (1646–1695), prefect of the Leiden garden from 1678 until his death, had a large collection of dried plants from Sri Lanka, the Malabar coast and Suriname (van Andel & al., 2012; Van Andel & Barth, 2018). There is no evidence that Hermann composed a herbarium with dried plants from the living collections at Leiden, even though he collected many specimens during his time as VOC doctor in Sri Lanka and published a catalogue of the Leiden garden (Hermann, 1687).

The Hortus Botanicus Amsterdam started as a medical garden in 1638, but under the direction of Joan Huydecoper van Maarsseveen (1625–1704) and Jan Commelin (1629–1692) it developed into a fully-fledged botanical garden. Huydecoper was director of the VOC and therefore in an excellent position to acquire plants for the garden. Commelin produced a catalogue with meticulous descriptions and engravings of the rare plants in the living collection, posthumously published by his nephew Caspar (J. Commelin, 1697–1701). A slightly more functional catalogue of medicinal plants was published in the meantime (C. Commelin, 1698). Both Jan Commelin and Huydecoper possessed herbaria. Huydecoper's herbarium is now part of the Sloane Herbarium under the name '*Meerseveen*' (H.S.77–78). The whereabouts of Commelin's herbarium – if it survived at all – are not known. The garden itself may have had one, but as it stands, no herbarium is known to have survived (Heniger, 1986; Wijnands, 1983; Wijnands, 1988).

In the late 17th and early 18th century, the Dutch Republic was the setting of numerous private gardens that equaled or even surpassed the Leiden and Amsterdam botanical gardens in their possession of exotic plants. Most of these have disappeared, but two gardens were immortalized and their collections catalogued and published: the garden of Simon van Beaumont (1641–1726) by Frans Kiggelaar (1690) and the garden belonging to the manor of the Clifford family, the Hartekamp, by Carl Linnaeus (1737). When cataloguing and describing a garden collection a herbarium came in useful when plants withered or disappeared altogether when wintering. Herbaria from both gardens still survive today. Both Linnaeus and Kiggelaar had access to dried specimens from herbaria and to living plants from gardens and greenhouses while cataloguing the respective collections. Kiggelaar's herbarium is now part of the huge Sloane Herbarium (Dandy, 1958), which is stored at the Natural History Museum in London (H.S. 214–227). Half of the volumes contain plants from the Cape of Good Hope. The herbarium of the Hartekamp is also kept at the Natural History Museum, but a small part (less than 1%) is housed at Naturalis Biodiversity Center in Leiden. The Clifford Herbarium has been entirely digitized and studied, unlike the herbarium of Kiggelaar.

Professor of botany in Amsterdam, Frederik Ruysch (1638–1731), mentioned 39 herbaria in his possession in the prologue to the *Thesaurus animalium primus* (1710). A large part of Ruysch's herbaria

was sold after his death in 1731 to Czar Peter the Great, a smaller part ended up in the Sloane Herbarium at the Natural History Museum (H.S.111-112). Professor of botany in Leiden, Herman Boerhaave (1668-1738), presumably possessed herbaria, but no herbaria which can be attributed to him seem to have survived. Given the fact, however, that until recently historic herbaria were difficult to access, it is not surprising that many of them still have to be studied in detail (Thijsse & Veldkamp, 2003; Thijsse, 2012; Bertin, 2016).

In 2017, the Municipal Museum Zierikzee contacted us to identify the dried specimens and determine the origins of a historic, loose-leafed herbarium in their collection. Various cut-out paper garden vases, bows and ribbons were present as ornaments on the sheets, as well as three types of labels from different time periods with contemporary identifications. Previous studies on the Zierikzee Herbarium included an analysis and dating of the paper prior to restoration (De Valk, 2010). Paper and plants had been damaged by water and insects, some specimens had entirely disappeared, and many plants were covered with a white mould. In an attempt to establish the age of the herbarium, De Valk was confronted by conflicting information: the date of paper manufacture was estimated between 1690 and 1700 and one particular ornamental vase was found in a publication by Weinmann (1737–1745) (De Valk, 2010). De Graaf (2016) made a general inventory of the contents and origins of the collection. He dated the herbarium between 1680 and 1705, suggesting that the maker of the herbarium had the initials B.P. and simply copied the Linnean names on the younger labels to identify the species.

The purpose of our research was to identify all specimens of the Zierikzee Herbarium and answer the following research questions:

- (1) Do these specimens represent wild or cultivated, native or exotic plants?
- (2) What do the paper, labels and the decorations tell us about the origin of the herbarium?
- (3) What is the source of the specimens in this herbarium?
- (4) Who created this herbarium?
- (5) What is the current scientific significance of this herbarium?

## **Materials And Methods**

### **Paper and images**

Prior to the start of this project, high resolution photographs were taken of each herbarium sheet by the Zierikzee museum. These photos, stored as JPEG- and TIFF-files, were used for the identification of the specimens. By opening the images in Paint, Faststone image viewer and Adobe Photoshop CS 5 (version 12) and CS 6 (version 13 extended), the image was adapted to such an extent that the text underneath the pieces of paper glued on top of the oldest labels was legible. This was nearly always sufficient, except when the author of the youngest label used the piece of paper to write on. We physically examined the

herbarium sheets at the Zierikzee museum on two occasions in 2018, during which we studied the paper, the supporting boards and the way the herbarium was organized in detail. A light-emitting sheet and by default, the torch on a smartphone were used to study the paper. Characteristics of the paper, such as watermarks, chain lines, laid lines and even the composition of the paper pulp came to light. The watermarks were compared with the database of the Bernstein project (<http://memoryofpaper.eu/>, accessed 3 Feb 2020) and surveys of historical watermarks from paper manufactured in the Dutch Republic (Churchill, 1935; Voorn, 1960).

## Species identification

To identify the plant specimens, we used floristic literature from the Netherlands (van der Meijden, 2005; Eggelte, 2007), Germany (Rothmaler, 2017; Flora von Deutschland (<http://www.blumeninschwaben.de/>, accessed 21 May 2018)), the Mediterranean (Blamey & Grey-Wilson, 2008; Thorogood, 2016) and the South African Cape (Manning, 2008). For initial searches, a survey of genera of garden plants was used (Cheers, 2004). We also used herbarium specimens of Naturalis (L), digitally accessed through the Naturalis BioPortal (<https://bioportal.naturalis.nl/> accessed 3 Feb 2020), including those of the 18<sup>th</sup> century D'Oignies Herbarium (Bertin, 2016) and digital images of the Clifford Herbarium, published by the Natural History Museum (Jarvis, 2016) and Naturalis (Ek, 2011). Various botanical experts from Naturalis were consulted to identify some of the specimens. The Plant List (2013) was used to check the currently accepted names for each plant species. To verify areas of distribution and domestication status, we used Wikipedia as a starting point (<https://www.wikipedia.org/>, accessed 3 Feb 2020), and NDFF Verspreidingsatlas (<https://www.verspreidingsatlas.nl/vaatplanten>, accessed 3 Feb 2020) to see whether a species was native to the flora of the Netherlands. For African species the website of the South African National Biodiversity Institute was used (<http://pza.sanbi.org/>, accessed 3 Feb 2020), while the website of Global Biodiversity Information Facility was used for additional information about species occurrences (<https://www.gbif.org/>, accessed 3 Feb 2020).

## Origins of botanical names, decorations and owners

As plant names were subjected to much change in the pre-Linnean period, similarity between names could help us to establish the period during which the herbarium was created. We reviewed the nomenclature in botanical literature of the late 17<sup>th</sup> and early 18<sup>th</sup> century to get an impression of the time period in which the Zierikzee Herbarium was created. The catalogues of Hermann (1687), Jan Commelin (1697–1701), Caspar Commelin (1698) and Boerhaave (1710; 1719) were consulted to determine whether they were used as source for the names written on the oldest labels alongside the Zierikzee specimens. To point out the degree of similarity between the names on the oldest labels of the Zierikzee Herbarium and the most likely sources, in particular the names on the labels of the Clifford Herbarium, the names used in the first catalogue, the *Index Plantarum* (Boerhaave, 1710) as well as the second catalogue, the *Index Alter Plantarum* (Boerhaave, 1719) and the medicinal catalogue from the Amsterdam garden (J. Commelin, 1698), we adopted different levels of similarity. While comparing the texts separately, we counted the words common to both names and divided the outcome by the total

number of unique terms used in both names, following Stefanaki & al. (2019). This comparison is shown in Appendix II. In Appendix III a comparison of the use of source references is made. In Appendix I the following data were made accessible: A) the number of the digital images; B) the number on top of label type A (the oldest label with pre-Linnean names); C) the number at the bottom right corner of the sheets; D) the type of decoration; E) the text of label type A; F) the text of label type B (younger label with Linnean names); G) the text of label type C (youngest label with Engler nomenclature); H) the scientific name; I) the plant family; J) the old Dutch names, as recorded on label type B; K–P) distribution area of the species; Q) domestication status of the species.

To assess the origin of the vases, ribbons and labels, we looked for identical decorations in herbaria of other 18th century botanists, discussed by Wijnands & Heniger (1991), Wijnands (1992) and Thijssse (2018). In order to obtain more information on one of the possible owners of the Zierikzee Herbarium, we consulted the archives of the Municipal Museum Zierikzee and the Zeeland Archives (<https://www.zeeuwsarchief.nl/>, accessed 3 Feb 2020).

## Results

### Botanical content of the Zierikzee Herbarium

The Zierikzee Herbarium comprises 348 loose sheets of paper with mounted specimens and 23 thin boards covered with blue paper as protective supports. All sheets contain a single specimen. One sheet contains an extra specimen, which was added later on a separate piece of paper (Fig. 1). If possible, the inflorescences were shown and sometimes – out of necessity - mounted separately (no. 368). With the exception of 21 sheets, all sheets contain paper decorations, occasionally bows and ribbons, but usually in the form of a paper garden vase. The herbarium sheets are currently stored in thirteen boxes. The digital images of the herbarium are available online (<https://www.stadhuismuseumzierikzee.nl/Herbarium/nl/Herbarium-dutch.html>).

Roughly 70% of the sheets contain whole specimens, the remaining 30% show plant specimens with leaves or inflorescences positioned symmetrically on either side (nos 13, 61, 189 and 243). The way the plants are mounted looks as if they are meant to please visually (nos 166, 172, 266, 269, 301, 310 and 365), but on closer inspection an attention to botanical details comes to the fore. In most specimens (for instance nos 53, 76, 100 and 310) the lighter, abaxial side of the leaves is distinctly displayed. With other specimens (no. 271) the inflorescence is mounted separately. No. 265 reveals a peloric flower and with some specimens (for instance nos 32 and 100) different leaf forms are shown. In one case (no. 2) an identical species was added later on a piece of paper, where, on closer inspection, a watermark ('GR') was revealed that was only used at the end of the 18th century. In total, 331 specimens were identified to species level and 28 to genus level. A total of 306 unique species are present. These species are distributed among 260 genera. In total, 82 families are represented in the herbarium by at least one species. Nearly half of the species in the herbarium belong to eight species-rich families, of which the Compositae are the best represented (39 spp.), followed by the Lamiaceae (38 spp.), Apiaceae (18 spp.),

Leguminosae (16 spp.) and Brassicaceae (15 spp.). All species were listed with their current scientific names, families, domestication status, geographical origin, and transcriptions of historic label data in Appendix I.

Apart from the 14 duplicates according to modern nomenclature, the names on the type A and B labels revealed several other duplicates. According to the nomenclature of label type A only '*Brassica capitata rubra*' contained a duplicate (nos 112 and 137). Following the type B labels (or, if absent, names in identical handwriting on the sheets), there were six duplicate species: *Beta vulgaris* L. (nos 123 and 125), *Brassica oleracea Rubra* L. (nos 112 and 137), *Chamaerops* L. (nos 52 and 79), *Laurus nobilis* L. (nos 339 and 150), *Nicotiana tabacum* L. (nos 240 and 241) and *Scandix odorata* L. (nos 25 and 248). Keeping several specimens of the same species was not uncommon in botanical collections. Linnaeus himself thought it necessary to have multiple specimens of the same plant to define the species (Müller-Wille, 2006), but it was already clear to early Renaissance botanists that a plant could have many forms (Stefanaki et al., 2018). We found no visible evidence in the herbarium that indicated who made the herbarium or owned it.

### Geographic origins of the specimens

Of the 306 unique species identified, 201 species are currently native to the Netherlands, part of which originally comes from the Eastern, Northern, mountainous or coastal regions of Europe (24 spp.) and the Mediterranean (82 spp.). Other species come from the Americas (9 spp.), tropical Asia (7 spp.) and the Cape of Good Hope (8 spp.).

Four of the 28 specimens of which only the genus could be established, belonged to genera that had a distinct distribution area. The remaining 24 specimens belonged to genera with a global distribution area or one covering an entire hemisphere. A survey of the geographical distribution of the Zierikzee specimens is presented in fig.2.

Present in both the Zierikzee Herbarium (Fig. 3a) *Arctotheca calendula* (L.) Levyns was one of the many exotic plants that were introduced in the Republic from the Cape of Good Hope at the end of the 17<sup>th</sup> century. In Boerhaave's catalogue (1719, I: 100) the species was described as an African 'anemonospermos' – a genus name devised by Hermann (1698: App.3) – with the leaves and the appearance of a hairy dandelion. The abbreviation H.R.D. is missing from the description of this species, but present in the descriptions of the other five 'anemonospermoi'. H.R.D. (in hibernaculis servandas ramis depactis propagandas) tells us it wintered in a greenhouse and was propagated from cuttings. Boerhaave didn't refer to Commelin (C. Commelin, 1706: 36), who described the plant extensively. Commelin refers to the dark red disc florets in his description of the plant. He writes '*Finally, the short stem is divided in six pedicels, which end in scaly flower heads, whose petals consist of ray flowers, sulphurous yellow as in the preceding flower, but smaller. The flowers of which the disc is composed, are red, even approaching black*' (Fig. 3b). The latter characteristic is visible on all available specimens. In the herbarium of George Clifford the species is also present (BM000647146). Another specimen is preserved

in the Bergius Herbarium. On the back of the sheet is written *ex horto Leydensi. Burmester* (Norlindh, 1967). Johan Henrik Burmester (1720–1770), a professor from Lund, visited the Leiden botanical garden between 1746 and 1749 and collected approximately 400 plant specimens, which he subsequently dried. They are now kept in the Bergius herbarium at the botanic garden in Stockholm. If the description by Boerhaave is indeed of *A. calendula* (L.) Levyns, it is on a par with Boerhaave's claim that all the species described in his catalogue were present in the Leiden garden. *A. calendula* was probably present in the garden of Hieronymus Beverningk according to Jakob Breyne (1679; 1688) and the Leiden garden under the prefecture of Paul Hermann (1687). The presence of another species of the same genus in the d'Oignies Herbarium, *Arctotheca populifolia* (P.J.Bergius) Norlindh shows the complimentary character of the two herbaria. *A. populifolia* from the Bergius Herbarium was also collected from the botanical garden in Leiden by Burmester.

In a botanical garden, plants were usually grown from seeds. Most of the exotic species must have come from plants or seeds obtained by exchange (Heniger, 1971; Wesseling, 2019). The ultimate place of origin therefore, can be deduced by studying the correspondence the prefects of the garden were obliged to undertake.

Seeds of *A. calendula* could have been sent to Leiden by the brother of gardener Willem Hertog, Jan Hertog, who worked as a master gardener in the company gardens at the Cape from 1687 till 1715 (Karsten, 1951) or by one of his successors.

When we assume that the Zierikzee Herbarium contained plants from a (botanical) garden, the vast majority of the specimens will have been cultivated, with the exception of some dried specimens sent from overseas, that couldn't be cultivated here. A minority of the specimens (5%) belong to domesticated species, such as the European crops beetroot, parsley and broad bean, while tobacco and maize were already well-known domesticates from South America.

## **Paper and watermark**

The sheets of the herbarium are made of thick, grainy paper. De Valk (2010) qualified the paper as 'cartridge' paper, 'kardoespapier' in Dutch, which is in essence a rather coarse paper that originally served the purpose of wrapping gunpowder. An uneven, 'cloudy' distribution of the pulp and small dark-colored spots, possibly caused by metal particles derived from clothing or papermaking equipment, were visible in the paper. The paper sheets measure 48.5 cm x 30.5 cm, and in most cases show deckle-edges on three sides. On the left side the paper had been cut, suggesting the original size of the sheets was 61 cm x 48.5 cm. This implies that the herbarium has always been loose-leafed. If it started its life as a book herbarium, the papers would have been bound in quires and punctures would have been visible. The presence and position of double chain lines appeared to be typical of this paper. Normally, laid handmade paper shows only single chain lines, originating from the chain wires of the papermaking mould that run over the wooden ribs of the mould frame. In this paper, however, extra, faintly visible chain lines appear to run alongside the first, sometimes parallel but often slightly slanted. The existence of these extra lines is not well documented and therefore rarely studied. We observed them in heavy sorts of paper from the

Dutch 'Zaanstreek' papermaking region. Extra chain lines have been noticed in thick writing paper of music manuscripts, for instance those of Johann Sebastian Bach, paper that had to be very strong to endure frequent handling (K.T.Weiss, 1962; W.Weiss, 1985). A garden herbarium made of strong paper would certainly be practical.

A watermark is infrequently present in the herbarium paper: a ligature of three letters: 'P', 'V' and 'L', which stands for 'Pieter Van der Ley' (Fig. 4). Unfortunately, the watermark offers insufficient support to determine the date of paper production of this herbarium with certainty, because of the long period that the PVL monogram was used - from the 17<sup>th</sup> until well into the first half of the 19<sup>th</sup> century - and the lack of 'readability' due to the unevenness and thickness of the paper. Therefore, the estimation (1690–1700) mentioned earlier in the introduction, cannot be confirmed.

The paper of the Zierikzee Herbarium is very similar to that of the D'Oignies Herbarium. In both we find the Van der Ley watermark (PVL) as well as the anomalous 'extra' chain lines. Together with other paper characteristics, this suggests that the paper of both herbaria was not only made in the same paper mill, but also in the same period. In fact, it is likely that the paper of the Zierikzee and the D'Oignies herbaria came from the same ream of paper. A standard ream at the time comprised 480–500 sheets. Cut in half, this would provide the customer with approximately 1000 sheets of paper. The actual number of sheets in both herbaria (892) roughly coincides with the number of sheets from one ream, cut in half.

## Labels

The Zierikzee Herbarium contains three types of labels of different ages. Labels of type A have an ornamental frame with supporting putti and naturalistic elements such as leaves and shells. Primitive garden vases grace the top of the label (Fig.5). This style was popular at the end of the 17th century and the beginning of the 18th century (Yvonne Bleyerveld, pers. comm.). There are 175 numbered type A labels, which have been covered with pieces of blank paper (Fig.6). In only one case (no. 37) this particular piece of paper was missing and the text on the label was legible without resorting to digital applications. On 20 labels this piece of paper was used to write the name on according to the Engler system (Engler & Prantl 1887–1915). Underneath this piece of paper, pre-Linnean plant names were legible with references to the *Historia Rariorum* (Clusius, 1601), the *Pinax Theatri Botanici* (C. Bauhin, 1671), the *Historia Plantarum Universalis* (J. Bauhin, 1650), the *Historia Plantarum* (Morison, 1680-1699), the *Stirpium* (Dodoens, 1583) and the *Institutiones Rei Herbariae* (1700) by Joseph Pitton de Tournefort. If the plant was considered indigenous this was indicated by an 'I' at the end. Occasionally an 'A' or a 'B' was added to indicate that the plant was annual or biennial. The labels were numbered from 1 to 183. There were three double numbers, eleven numbers missing, most of them probably linked to 8 sheets from which label type A was visibly removed, with traces of glue testifying to its former presence. Five sheets contained only label type A and no later labels. The succession of numbers coincided with the alphabetical order. This was not unusual: the garden catalogue by Paul Hermann (1687) was also alphabetically ordered.

Labels of type B are rectangular labels with a Linnean name written on it, usually followed by pre-Linnean references, the name in Dutch and concluding with the Linnean class the plant belonged to (Fig. 7). The presence of pre-Linnean references presupposes a source of information no longer available. Though Linnaeus had already published several works with descriptions of plants, his *Species Plantarum* from 1753 was the first publication in which he applied his binomial system, confining the names of a plant species to a generic and a specific name. Therefore, it is safe to assume that whoever wrote and glued the labels of type B on 332 sheets of the Zierikzee Herbarium, did so after 1753. Fig. 8 shows the mutual relation of the labels and their position on the sheets. On all sheets the plant names were written directly on the sheet and later erased, using a pencil, probably as a reminder to apply the correct label afterwards. In four cases labels were switched: For instance, a specimen of *Aristolochia rotunda* L. (no. 331) was adorned with a label reading *Aristolochia sempervirens* L. and vice versa. The design of label type B and the fragments of a watermark that are visible in the paper, suggest a date of production of the label in the early decades of the 19<sup>th</sup> century.

Label type C (Fig. 9) only occurs twice and dates from the late 19th century, judging by the use of a botanical system, that was published after 1887 (Engler & Prantl 1887–1915). There are 20 such descriptions on the pieces of paper covering label type A in a handwriting, that matches the handwriting on the two labels.

### Correlation with Boerhaave's catalogues

Being the oldest, label type A was important for dating the Zierikzee Herbarium. The pre-Linnean names and the sources quoted on the type A labels suggested an author well-versed in the field of botany. Even though the size of the label limited the length of the description, these appeared to be select quotations, rather than random plant names. The next step was to determine where these names came from. The label on sheet no. 37 (*Glechoma hederacea* L., ground ivy) reads: '*Hedera Terrestris vulgaris chamaecissus* C.B.P.306 J.B. in app. 855. I.' The references are indeed correct: '*Hedera Terrestris vulgaris*' was described on p. 306 in the 1671 edition of the *Pinax* of Caspar Bauhin and '*chamaecissus*' came from p. 855 in the appendix of the third part of *Historia plantarum* by Jean Bauhin (1650), even though in this particular description the volume number of the latter was missing. The abbreviation C.B.P. always referred to 'Caspar Bauhin Pinax', instead of to the initials of the maker of the Zierikzee Herbarium, as suggested earlier by De Graaf (2010). Compared with the two editions of Boerhaave's garden catalogue, the author seemed to go along with the first edition (Boerhaave, 1710) in calling the plant *Hedera terrestris*, but added the reference found in the second edition of the catalogue from the third part of Jean Bauhin's *Historia* (1650), '*Chamaecissus, J.B.App.855*'. Striking was the presence of a capital 'I' on this and several other labels. In both editions of his catalogue, Boerhaave marked plants that were native with a cross (✚) at the end of the descriptions. In the legends of both editions, the cross was explained as '*Indigenam in Belgio*' (Boerhaave, 1710) or '*Significat indigenam Bataviae Stirpem*' (Boerhaave, 1719). The author of the Zierikzee labels choose to use an 'I' for 'Indigena' instead of the cross. Boerhaave also indicated whether plants were annual or bi-annual, hence the 'A' and the 'B' at the end.

Another peculiarity was the consistent use of 'p.' on the Zierikzee labels after the abbreviation for Dodoens (Dod.). Boerhaave used the phrase 'Dod.p.' in both his catalogues (1710 and 1719), whereas authors of other reference works were simply represented with the abbreviation of their names without the 'p.'. The label of greater celandine (*Chelidonium majus* L., no. 278) for instance, reads '*Chelidonium Majus C.B.P.144 Dod.p.48 l.*', which is identical to the text in both Boerhaave's catalogues. In concordance with 1719 however, the author added the reference from Dodoens. In the case of *Glechoma hederacea* L., however, Boerhaave eventually decided to change the name of this genus in his second edition from *Hedera* to *Chamaeclema*, a name used by the German botanist Valerius Cordus (1515–1544). The text on the Zierikzee label does not coincide entirely with any of Boerhaave's catalogues, but combines names from both editions, '*Hedera Terrestris vulgaris chamaecissus C.B.P.306 J.B. in app. 855. l.*'. Almost all names on type A labels could be retraced to an entry in the first and the second catalogue (Boerhaave, 1710 and 1719), but the author of the Zierikzee labels seems to have been cherry-picking from either an annotated version of the first edition or the draft of the second edition (Boerhaave, 1719). Of the 175 names on the type A labels, 125 coincided for over 50% with those in Boerhaave's 1710 catalogue (Fig. 10). The 1719 edition was extended with a few new names and many others from multiple published sources, so the overall correspondence with the Zierikzee labels turned out to be slightly lower. Apart from the similarity between label names and the entries in the catalogues, correspondence was also observed in the references. The sources cited in the text of the type A labels were Bauhin (1671), Morison (1680), Dodoens (1583), Bauhin (1650) and Clusius (1601). 19% of the type A labels had identical references to the first catalogue of Boerhaave (1710), 23% made use of different references, 13% cited less references and 33% added references. Label type A used less sources than the catalogue of 1719, but when the references differed, label type A showed a decisive (8 vs. 11) preference for Dodoens (1583). The joint references of Boerhaave (1710) and the type A labels were all present in Boerhaave (1719), as is shown in Appendix III.

The six names on label type A that were not found in any of Boerhaave's catalogues could be traced back to other sources. *Acmella chrysanthemum* (no. 205) may have come from Ray's *Historia III*, 226 (1704). *Spica celtica* (no. 105), *Spica nardi* (no. 77), *Cuscuta major* (no. 22) and *Epithymum cuscuta* (no. 24) were listed in Bauhin (1671). *Folium Malabatum* (no. 205) was mentioned in Commelin (C. Commelin, 1698), but also in Ray (1704). The names *Calamintha* (no. 148), *Illecebra* (nos 164 and 359) and *Cauda equina* (no. 160) were connected with plant names found in Boerhaave's catalogues, by virtue of their accompanying descriptions, but also found in Bauhin (1650 and 1671), Gerard's *Herball* (1597) and Dodoens's *Stirpium* (1583). In addition, *Spica celtica*, *Spica nardi*, *Folium Malabatum*, *Calamintha* and *Illecebra* were also listed in contemporary pharmacopoeias, such as the Amsterdam pharmacopoeia from 1683 (Timecapsule).

### **Correlation with the Clifford Herbarium**

The Zierikzee Herbarium in general resembles the Clifford Herbarium closely in composition and content (Fig. 11). The specimens are mounted with the same attention to detail, with in general one specimen per page, cut-out paper garden vases and decorative labels with names that referred to both Boerhaave's

catalogues (1710; 1719). The author of the Clifford labels however, adhered more faithfully to Boerhaave's text than the author of the oldest Zierikzee labels. For example, the Clifford label for *Glechoma hederacea* contains the literal text of Boerhaave's first catalogue of 1710, '*Hedera Terrestris vulgaris C.B.P.306 Calamintha humilior folio rotundiore. T 194*', with two later additions, '*Chamaeclema*' from the catalogue of 1719 and '*Glechoma hederacea*', the Linnean name published in the *Hortus Cliffortianus* (Linnaeus, 1737). Since the specimens in the Clifford Herbarium had been identified, it was possible to establish that 264 (86%) out of 306 unique species in the Zierikzee Herbarium were also present in the Clifford Herbarium (Ek, 2011; Jarvis, 2016).

### Correlation with the Amsterdam garden catalogues

The names on the type A labels of the Zierikzee Herbarium also showed a strong relationship with the Amsterdam catalogue of medicinal plants (Commelin, 1698): 111 names present on the type A labels were highly similar (>50%). This is not surprising, as medicinal plants were natural components of botanical gardens, in Amsterdam as well as in Leiden. Commelin's catalogue could be regarded as an annotated pharmacopoeia, because he did not only list medicinal plants and their applications, but also added the names, that were found in the *Pinax* (Bauhin, 1671). This meant that names from the medicinal catalogue corresponded to a high degree with the names on the type A labels, which in general came from the same *Pinax*. Although Commelin added 'officin.' to each and every plant name, there were only nine type A labels that contained the description 'officinarum'. The fact that 28 plant names from the Zierikzee Herbarium were absent in Commelin's medicinal catalogue suggested that these two texts were similar, but by no means identical.

In the Amsterdam catalogue of rare plants (J.Commelin, 1697–1701) no plants with names corresponding to those of label type A were found. Six species, *Nerium oleander* L., *Hermannia althaeifolia* L., *Arctotheca populifolia* (P.J.Bergius) Norl., *Clutia pulchella* L., *Arctotis aspera* L., and *Senecio inaequidens* DC, all identified by Wijnands (1983), were present in the Zierikzee Herbarium, but did not have an A label. *C. pulchella* had a type B label with a pre-Linnean reference to Commelin's catalogue, namely 'Frutex Aetiopicus'.

While the plants in the catalogue of rare plants by Commelin (J.Commelin, 1697–1701) have been identified by Wijnands (1983) with the aid of the watercolours in the Moninckx Atlas (1686–1709) and the engravings in the catalogue itself, the catalogues of medicinal plants by Commelin (C.Commelin, 1698) and those of Boerhaave (1710, 1719) have never been updated with modern scientific names. Therefore, we could not compare the actual species grown in the gardens of Leiden and Amsterdam with the Zierikzee Herbarium, as it was not always certain what species were described in their catalogue. We assume, however, a larger correspondence in species between the Zierikzee Herbarium with the Leiden garden, even though the overlap in names between the oldest Zierikzee labels and Boerhaave (1710) is only marginally greater than the overlap with Commelin (C.Commelin, 1698). The six names for the Zierikzee specimens that were absent from Boerhaave's text suggests that they were not present in the

Leiden garden. As 49% of the Zierikzee sheets do not contain a label type A, the final correspondence with Boerhaave's catalogues (and the garden collection) may be even higher (see Appendix II).

## Decorations

From the mid-seventeenth century onwards, the Dutch paper industry flourished and especially in Leiden, print trade was booming (Hoftijzer, 1999; Pettigree & Der Weduwen, 2019). The fame of Daniel Marot (1660-1752), for instance, a leading designer at the turn of the century, was partly due to the distribution of his designs in print (Ek, 2011). Ornamental garden vases and their paper counterparts became fashionable at the end of the 17th century, as is seen in the *Hortus Regius Honselaerdicensis* by Stephanus Cosijn (1688) and stimulated by the publication of *Lusthofcieraaden* (Schijnvoet, 1697), which contained designs inspired by Marot, and they continued to be popular in the first half of the 18th century (Fock, 1973; Wijnands & Heniger, 1991; Thijsse, 2018). The designs for garden vases were also used for the decoration of herbaria (Fock, 1973). The other word for herbarium, 'hortus siccus', a dry garden, may have suggested the use of these paper garden vases.

The Zierikzee Herbarium stands out on account of its decorative labels, cut-out vases, bows and ribbons. All five types of vases, the bows and the ribbons in the Zierikzee Herbarium are also present in the D'Oignies Herbarium (Fig. 12). Vase C is not found in any other herbarium, but the design and the details are almost identical to vase B. The popularity of vase B may have been the reason why it ended up in a publication as late as the *Phythanthoza iconographia* (Weinmann, 1737–1745). Two vases, A and E, also occur in the herbarium of Adriaan van Royen (1704–1779) and two, B and D, are present in the herbarium of David de Gorter (1727–1799) (De Vries, 2015).

Proof of the manufacture of garden vases designed in Leiden is found in the archives of the De la Court family, where it appears that Pieter de la Court van der Voort (1664–1739), a successful wool-merchant and author of a publication on manorial gardens (1737), owned metal garden vases, designed by Hieronymus van der Mij (1687–1761) and cast by his father Filips van der Mij (Fock, 1973). Hieronymus also designed garden vases in cooperation with print-artist Johannes van der Spijk, active in Leiden from 1716 till 1761 (Waller, 1938), who turned Van der Mij's designs into etchings. Van der Mij set up business in 1710, and Van der Spijk started out in 1716. Therefore, their cooperation could have started as early as 1716. The Naturalis archive holds several printed pages of decorative vases and ribbons produced by Van der Mij and Van der Spijk that have never been cut out (Thijsse, 2018), but none of these vases are present in the Zierikzee Herbarium. They are, however, present in the D'Oignies Herbarium, adorn some specimens of the Linnean collections (Linnean herbarium; Linnean herbarium (S-LINN)) and appear in adapted forms in the Clifford Herbarium. While we cannot prove that the decorations in the Zierikzee Herbarium were made by Leiden crafts men, they certainly can be dated within the period when paper vases on herbarium vouchers were fashionable. Starting in the first quarter of the 18<sup>th</sup> century, Clifford (1685–1760), Linnaeus (1707–1779), Van Royen (1704–1779), De Gorter (1717–1783) as well as Meerburgh, successor of Jakob Ligtoet as head gardener (1734–1814) used paper garden vases to

decorate their herbarium vouchers (Thijssse, 2018). A survey of the correspondence of paper ornaments between these 18<sup>th</sup> century herbaria is shown in Fig.12.

## Discussion

### Boerhaave's classification

The Zierikzee Herbarium has all the ingredients of a garden herbarium with native, mostly medicinal plants rubbing shoulders with exotic plants from Dutch colonies or areas where the Dutch had trade contacts. Native plants were collected in the vicinity of the garden (De la Court van der Voort, 1737) and although occasionally a living specimen survived the arduous journey across sea, most exotic species were cultivated from seeds that were obtained by exchange. Prefects like Boerhaave spent considerable time and effort in corresponding with other botanists worldwide, contributing to a barter trade that led to an explosive distribution of plants in a relatively short time (Heniger, 1971; Wesseling, 2019). The botanical system that Boerhaave applied in his catalogues was only used in the Leiden garden from 1710 till 1737, after which Boerhaave's successor, Adriaan Van Royen rearranged the garden, assisted by Linnaeus. The Clifford Herbarium was also arranged according to Boerhaave's system, using, as does our herbarium, both the first and the second edition of the catalogue. In the Utrecht botanical garden, Boerhaave's system was applied until 1747, when Von Wachendorff (1703–1758), professor of botany, replaced it with a system according to his own design (Heijnen, 2014). No other institutions or gardens are known that used Boerhaave's catalogue to organize their botanical collection.

### The Leiden gardener Jakobus Ligtvoet (1684–1752)

Since the anonymous botanist who wrote the oldest labels was acquainted with contemporary botanical nomenclature and the texts on his labels were strongly linked to the first edition of Boerhaave's catalogue (1710), but also to the second edition (1719), he must have had, at the very least, an annotated copy of the first catalogue or a draft version of the second at his disposal.

At the end of October 1752, a public auction took place in Leiden, during which the library of the deceased gardener, Jakobus Ligtvoet, was sold (Haak, 1752). One of the more interesting objects in this library was a herbarium, arranged in 13 bundles. At the time of his death in 1752, Ligtvoet was head gardener of the Leiden botanical garden. Born in 1684, he started working in 1703 under the supervision of head gardener Willem Hertog. When Hertog suddenly died in 1723, Boerhaave recommended Ligtvoet for the position of head gardener. This appointment was an opportunity to tighten the rules: on top of the existing regulations from 1692 (no trading of bulbs, roots, plants or even parts of plants was allowed), keeping chickens, lodging students or anything else without the express consent of the professor of botany was no longer permitted (Molhuysen, 1913). On the whole, it seems that Boerhaave was duly pleased with Ligtvoet; with his then 20 years of experience in the garden he was a worthy successor of Hertog (Hoftijzer, 2009).

Ligtvoet's herbarium was described in the auction catalogue as "*consisting of thirteen large-size bundles [...] plants, that are found in it have been dried in a truly magnificent way and expertly glued on a large sheet of paper. With some plants the very author who described the plant is commended.*" The plants were also said to have come from various regions, but most of them had been cultivated in the garden long since. Moreover, the auction document mentioned that "*the plants had been ordered according to the system of the famous Boerhaave*" (Fig. 13).

The auction catalogue (Haak, 1752) also mentioned, amongst several other botanical publications, a copy of Boerhaave's first catalogue, the *Index Plantarum* (1710) and an annotated copy of a 1729 reprint of Boerhaave's second catalogue, the *Index Alter Plantarum* (Hoftijzer, 2009). The last book was described as being 'in good order and with comments from the deceased'.

We assume that the Zierikzee collection is the very herbarium that was described as being part of Ligtvoet's library and auctioned off after his death in 1752. Ligtvoet was in a position where he had access to the plants and was probably asked to collect specimens in order to create a garden herbarium, part of which ended up in his possession. The larger part with comparatively more exotic plants probably ended up in the possession of Boerhaave and was sold after his death (Luchtman, 1739), as preliminary research on the D'Oignies Herbarium suggests. Ligtvoet was in frequent contact with Boerhaave and owned (annotated) copies of his catalogues. The fact that the oldest Zierikzee labels contain the literal text of Boerhaave's first catalogue (1710) and show elements from the second edition (Boerhaave, 1719), suggests that whoever wrote those labels was in the process of renaming the plants from the first edition. While creating a garden herbarium, Ligtvoet co-authored the second edition of Boerhaave's catalogue. In between the first and second edition of Boerhaave's catalogue, Ligtvoet was still assistant gardener. A large part of the plants with label type A was indigenous and Ligtvoet, according to the instruction, drawn up under Hermann, would have been assigned the collation and care of indigenous plants. The instruction reads "*that the gardeners, and especially the assistant gardeners will collect all the [...] indigenous plants that are missing in the said garden, while looking for the seeds or fruits at the proper time of the year in order to plant them according to the order [of the catalogue].*" (Molhuysen, 1913). This would put him in a perfect position to occupy himself actively with the method according to which the plants were arranged.

The fact that the head gardener possessed a copy of the first catalogue by Boerhaave and an annotated copy of the second one (1719) suggests that, apart from having the responsibility of looking after a large botanical garden and the plants in it, he was contributing to the academic discussion on the systematic ordering of plants. The text on the earliest labels indicates that the herbarium was started between 1710 and 1720, when Ligtvoet was still working as assistant (Fig. 14).

It is possible that the Zierikzee Herbarium was arranged in 13 bundles: assuming a bundle had supporting boards at the front and at the back, a total of 26 boards would have been present. Later, these boards were used to re-arrange the plants according to the 23 Linnean classes present in the herbarium. The three remaining boards presumably lost their function and consequently vanished.

It is not known who bought the Ligtovoet herbarium in 1752, but the Zierikzee Herbarium turns up in the legacy of Helena Diederika Schutter (1774–1838), who lived in Utrecht, unmarried, yet financially independent due to a bequest of one of her aunts. She was also a competent botanical illustrator (Fig.15) and made a financial contribution to the memorial book of the University, the then 'Hogeschool' of Utrecht, with which she was apparently affiliated in some way (Van den Bergh, 1837; Van de Zande-Vleugels Schutter, 2001; <https://hetutrechtsarchief.nl/>). If label type B was indeed produced in the early decades of the 19<sup>th</sup> century, she may well have been the one who renamed all the plants according to the Linnean system. After Diederika's death, the herbarium went to her brothers in Oosterland, Zeeland. It remained in the possession of the family for 170 years. Thanks to the foresight of its then owner it survived the North Sea Flood of 1953. By then it was in dire need of restoration. In 2008 Mrs. A. van der Zande-Vleugels Schutter donated the herbarium to the Municipal Museum Zierikzee.

### **Scientific significance of the herbarium**

A critical approach to classifying plants is only conceivable by using loose-leafed herbaria. In order to classify thousands of plants it is necessary to be able to arrange and re-arrange the plant specimens according to the system used. At the basis of the *Pinax Theatri Botanici* by Caspar Bauhin (1560–1624) and the *Institutiones Rei Herbariae* by Joseph Pitton de Tournefort (1656–1708), two major, influential botanical works, lie two large, loose-leafed herbaria with 3352 and approximately 7000 specimens respectively. In his catalogues Boerhaave made use of a system with genera that were largely those of Tournefort, but the description of those genera was based on his own observations and displayed, as Sprague (1937) writes *an insight, unusual for his time, into comparative morphology of the flower, fruit and seed*. This shows that Boerhaave was a botanist, who reflected critically on plants and arranged the plants from his garden according to his system. This would have been inconceivable without a loose-leafed herbarium and without the gardeners, that worked under his supervision.

In his *Philosophica Botanica* (1755) Linnaeus argued that a herbarium was necessary for every botanist to be able to collate and identify plant species. A herbarium was primarily required to consist of loose leaves and to contain only a single whole plant specimen per sheet. Looking at the Zierikzee Herbarium it is difficult not to imagine Linnaeus learning the tools of the trade in Leiden and the Hartekamp. Here, the combination of large, diversified plant collections, a critical approach in an academic setting and the technical knowledge that was required to make herbarium specimens gave him the means to become the world's best known botanist.

### **Role of gardeners**

Gardeners like Hertog and Ligtovoet were well-informed, capable men, who, while not academically educated, played a vital role in the upkeep of the gardens under their supervision but evidently also in the science of botany. As intermediaries of medical and scientific knowledge, gardeners were part of the scientific and educational venture of the institution (Hickman, 2019). Their contribution was nearly always appropriated by someone higher in hierarchy. To paraphrase Steven Shabin in his article on

invisible technicians, 'In the case of horticultural practice, the price of gardeners' continued invisibility is an impoverished understanding of the science of botany' (1989).

## Conclusions

Based on the pre-Linnean plant names, the plant species, the corresponding description of the herbarium sold in 1752 and to a lesser extent the decorations, we conclude that the Zierikzee Herbarium was created in the Leiden botanical garden. The collection and annotation of this garden herbarium probably started in the years between the first (1710) and the last draft of the second edition in 1718, probably by Jacob Ligtvoet, assistant gardener in the Leiden Hortus Botanicus under the direction of Herman Boerhaave, as witnessed by the description of his herbarium in the auction catalogue of Haak (1752). Most specimens were derived from plants grown in the Leiden garden, while some were received from overseas through contacts of Boerhaave or the gardeners. As we have no direct evidence that the Zierikzee specimens were made by Ligtvoet in the Leiden gardens, further research is needed on other 18<sup>th</sup> century herbaria, such as the D'Oignies and Van Royen herbaria at Naturalis and Dutch herbaria in the Natural History Museum in London, and the archives and seed catalogues of Hermann Boerhaave. The online publication of the Zierikzee Herbarium and our full analysis of its contents will contribute to a better insight in this crucial period in the history of botany.

## Declarations

### AUTHOR CONTRIBUTIONS

TvA designed and supervised the research, OP identified part of the specimens, EdH identified the largest part of the specimens and wrote a MSc internship on this research, HP and AK did research on the paper of the herbarium, RE contributed information concerning the use and the meaning of the decorative vases, AO revised all specimens, made the comparisons with historic literature and herbaria and wrote the paper. All authors commented on the final manuscript.

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## A STATEMENT REGARDING POTENTIAL CONFLICTS OF INTEREST OR LACK THEREOF

In the text of this article there are no potential conflicts of interest.

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## Figures



Figure 1

Example of two specimens of the same species on one sheet : *Calendula officinalis* L. (no.2)

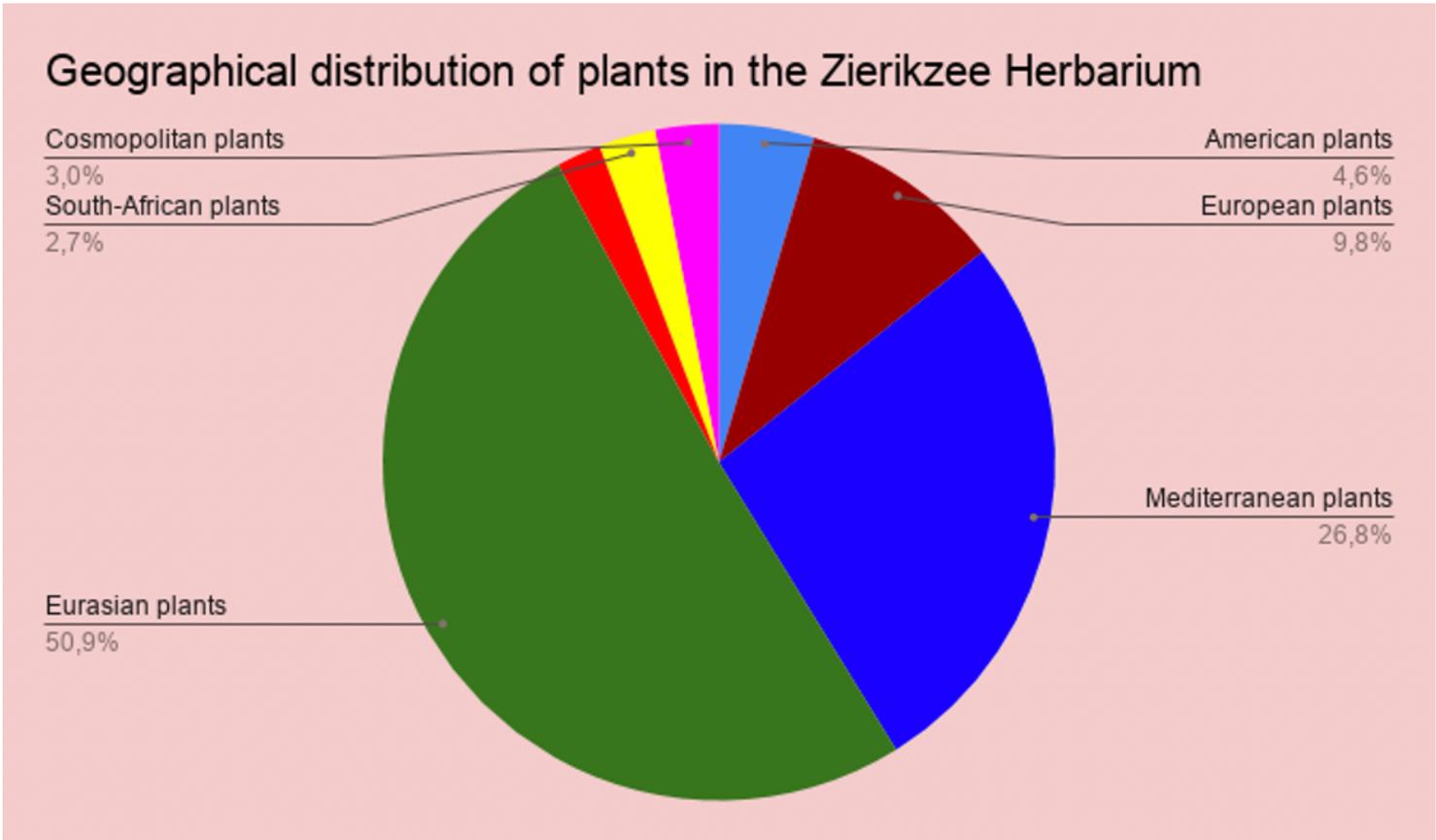


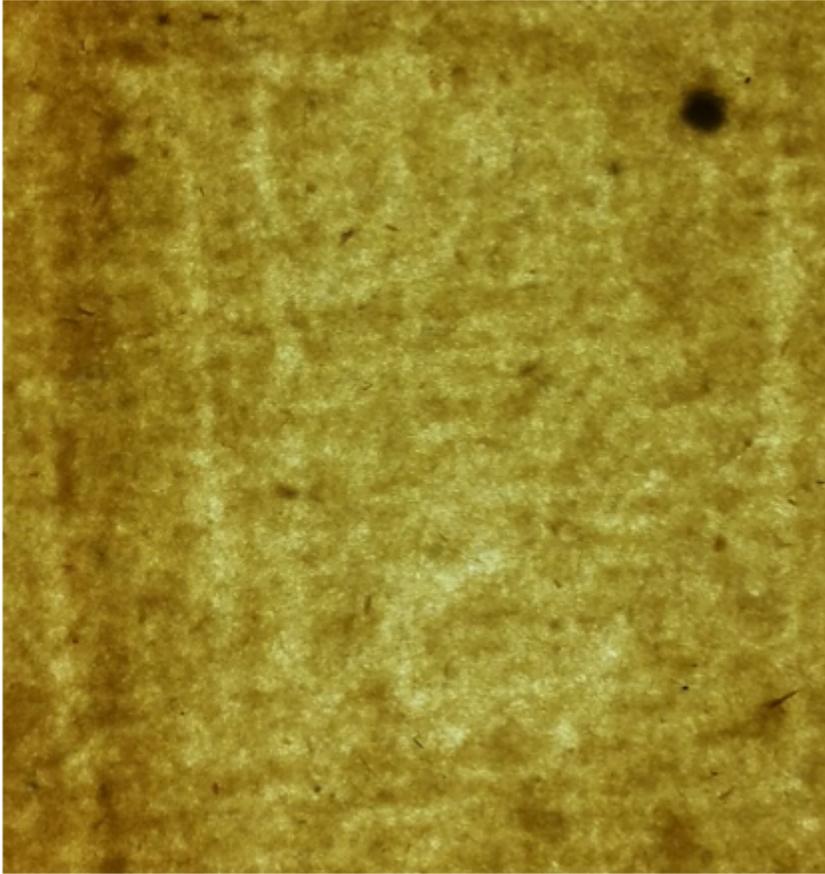
Figure 2

Geographical distribution of plant species in the Zierikzee Herbarium



Figure 3

A. *Arctotheca calendula* (L.) Levyns in the Zierikzee Herbarium (no. 326) B. Detail from *Arctotheca calendula* (L.) Levyns with dark-red disc



**Figure 4**

Watermark in paper Zierikzee Herbarium



Figure 5

Label type A



Figure 6

A. Label type A uncovered; B. traces of glue from label type A; C. Label type A covered and label type B attached; D. Label type A covered with late 19th century names on it

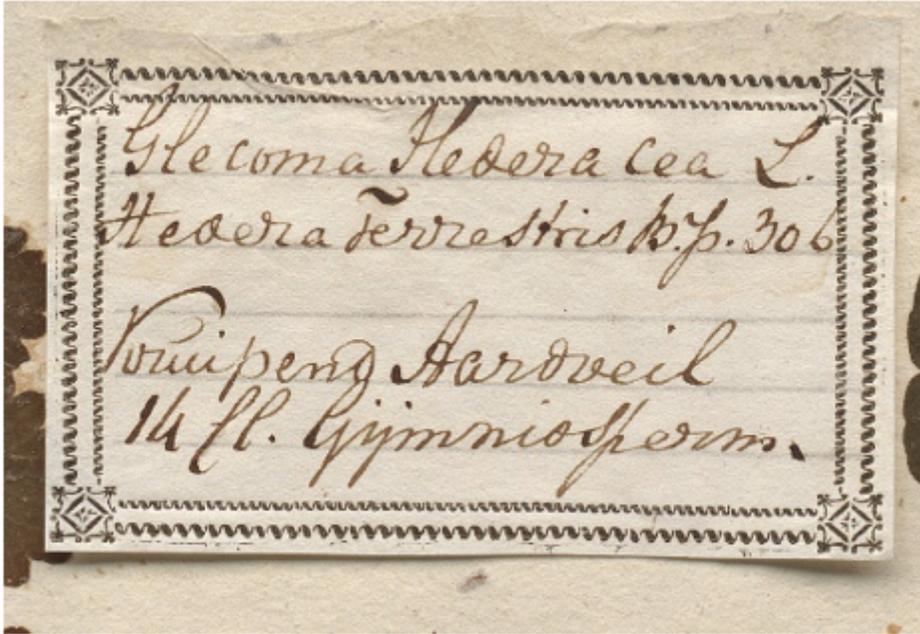


Figure 7

Label type B

## Figure 8

Two types of labels in the Zierikzee herbarium: Label type A is covered by a blank piece of paper under which the pre-Linnaean name is written. On the upper edge of the label a number is written to indicate the position in the alphabetical order. Label type B is glued on the lower edge of label type A and contains the Linnaean name, a pre-Linnaean name from the Pinax by C. Bauhin, an old Dutch name and the Linnaean class the plant belongs to.

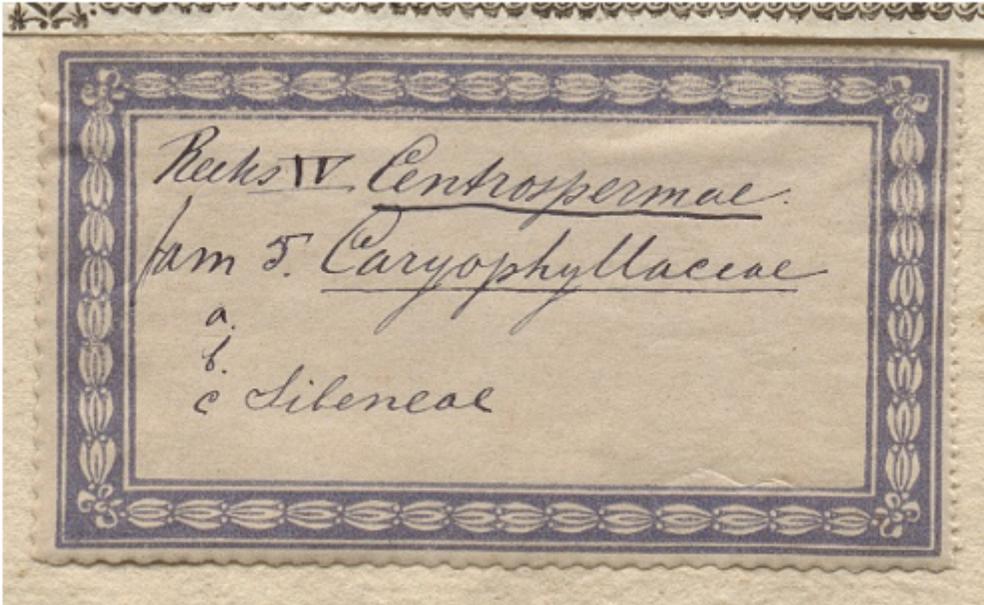


Figure 9

Label type C

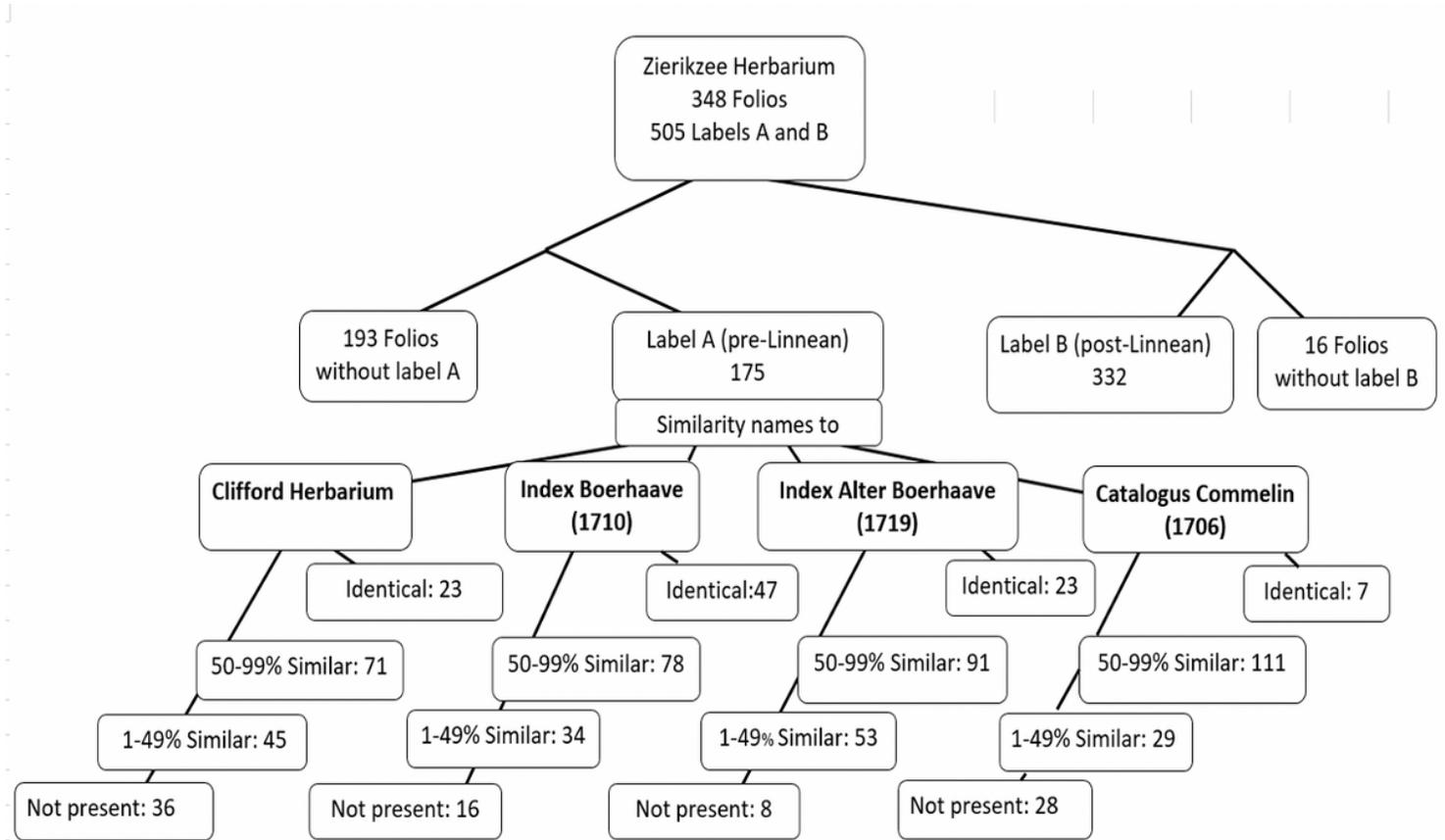


Figure 10

Similarity of names between the text of the oldest label (type A) and four botanical works from the beginning of the 18th century



**Figure 11**

Specimen of *Potentilla erecta* (L.) Raeusch in the Zierikzee Herbarium (left) and the Clifford Herbarium (right). In both cases the plant is mounted very carefully and the botanical details come to the fore.



## Figure 12

The different types of decorations present in the Zierikzee Herbarium, represented by the capitals A-G with a survey showing their corresponding presence in 18th century herbaria



**Figure 13**

A. Cover of the catalogue from the auction of Jacob Ligetvoet's library; B. Description of the herbarium in the catalogue (Haak, 1752)

	1670	1680	1690	1700	1710	1720	1730	1740	1750	1760		
Willem Hertog (1665-1723)				1699: Head gardener Leiden botanical garden								

**Figure 14**

Time schedule of the persons and objects relevant to the creation of the Zierikzee Herbarium.



## Figure 15

Drawing by Diederica Schutter, aged 17 (courtesy of F. Teng-Van der Zande)

## Supplementary Files

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