RESEARCH ARTICLE

Digitization of the historical Herrenhausen Herbarium at Göttingen (GOET), with special focus on plants collected in Switzerland in 1820

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Abstract Three generations of the Wendland family, Johann Christoph Wendland (1755–1828), Heinrich Ludolph Wendland (1792–1869) and Hermann Wendland (1825–1903), were outstanding court gardeners at the Royal Gardens of Herrenhausen (Hanover, Germany). The "Wendlands" not only enriched the botanical diversity of the gardens through plants obtained in exchange, purchased or collected during their own journeys, but they also achieved a good scientific reputation by publications on diverse botanical themes including the description of new taxa. Moreover, there exists a herbarium of approximately 16,600 plant specimens related to these gardens, the Wendlands and their publications. Numerous papers dealing with the Wendlands and the Royal Gardens of Herrenhausen have been published. The Herrenhausen Herbarium, however, also known as the Wendland Herbarium, which was donated to the University of Göttingen in 1969, was so far neither digitized nor revised. Here, we describe the history and the current digitization of this herbarium, which includes specimens collected between 1780 and 1857. It consists of three major parts: the Herrenhausen Herbarium arranged according to the Linnaean System (13,035 specimens), the palm collection (1069 specimens) and smaller collections (specimens collected by Hermann Wendland in Central America, collections of Carl Hoffmann from Costa Rica and a part of Jakob Friedrich Ehrhart's herbarium, who was a student of Linnaeus; approximately 2500 specimens). The systematic digitization of this historical herbarium as a whole revealed a seemingly unconventional arrangement of the specimens, which we explain here for the correct interpretation of collection data. Furthermore, and despite the meagre information on the herbarium labels, we were able to identify 260 specimens from a trip of Heinrich Ludolph Wendland to Switzerland in 1820. By comparing the specimen labels with entries in his diary and travel report, we were able to retrace detailed information on localities and dates, providing historical biodiversity information. Also, the historical identification of these specimens was revised. A list of collectors represented in the Herrenhausen Herbarium is provided, which includes famous names such as Linnaeus and his students Afzelius, Bergius, Ehrhart, Schreber, and Thunberg.

Keywords Herrenhausen Gardens; historical botanical collection; Jakob Friedrich Ehrhart; specimen metadata; Wendland family

Supporting Information may be found online in the Supporting Information section at the end of the article.

■ INTRODUCTION

The methods for preparing herbarium specimens have not changed significantly throughout the past five centuries (Wagenitz, 2001, 2016). Even though drying ovens significantly reduce the time for drying specimens, the usage of a plant press together with paper is still largely identical to the original methods practiced in Italy in the 16th century (Wagenitz, 2003). The largest difference between a historical and a modern herbarium specimen is clearly the information presented on the label, the *scheda*. Most historical specimens contain very scarce label information. Sometimes only the plant name is mentioned and often only a broad description of the locality and the name of the collector are included. Since historical herbaria have often been assembled as books (Ghorbani & al., 2018), the locality and name of the collector might only be present on the title page, and are lacking on the pages with the specimens. In modern herbaria, a multitude of label information is usually provided, including the plant name, detailed description of the locality (often with GPS coordinates and altitude) and vegetation, the collection date, the name of the collector(s), and a collection number.

Despite the scarce metadata, historical specimens are of great importance in studies of different biological disciplines and processes including taxonomy (e.g., typification; Wagenitz, 2001; Vorontsova & Knapp, 2010; Borges & al., 2018), biogeography and climate change biology (Case & al., 2007; González-Orozco & al., 2016), biodiversity (Nelson & Ellis,

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2018), phenology (Jones & Daehler, 2018; Yost & al., 2019; Pearson & al., 2020), nature conservation (Nualart & al., 2017), invasiveness of species (Crawford & Hoagland, 2009), population genomics (e.g., loss of genetic diversity; Cozzolino & al., 2007), as well as historical sciences, e.g., in studies about botanical collecting practices, biographies of certain botanists and the practice of specimen exchange and acquisition in the past (Groom & al., 2014; Ghorbani & al., 2018). Especially the steady advances in high-throughput sequencing and ancient-DNA extraction protocols increase the applicability of historical specimens in DNA-based studies (Bieker & Martin, 2018).

Digitization of a collection and adding correct metadata for specimens with fragmentary label information are important first steps to make a collection accessible for researchers worldwide and to make them aware of the collection. In this study, we have digitized the "Herrenhausen Herbarium", which is an important historical collection from the Herrenhausen Gardens in Hanover (Germany), one of the largest and most important botanical gardens in central Europe of the 18th and 19th centuries (Wagenitz, 1972; König, 2006). The Herrenhausen Herbarium became part of the Göttingen Herbarium (GOET) in 1969 (Wagenitz, 1972). It can mainly be attributed to three generations of the Wendland family and has been collected between the 1780s and 1850s (this study). The three Wendlands served as court gardeners and botanists, and their herbarium is based on plants cultivated at Herrenhausen Gardens, specimens collected during field-trips, as well as specimens acquired from other botanists and botanical gardens (Wagenitz, 1972). In addition to the Wendlands, Jakob Friedrich Ehrhart (1742–1795) is an important contributor to the Herrenhausen Herbarium. Ehrhart was the "court botanist" at the Herrenhausen Gardens and he was one of the latest students of Linnaeus at Uppsala from 1773 to 1776 (Sokoloff & al., 2002).

The Herrenhausen Herbarium documents how specimen label information changed during the 18th and 19th centuries. The older specimens in the Herrenhausen Herbarium bear nearly no label information, while later specimens usually contain information about the locality and the date. Among other collections, specimens collected during a field trip to Switzerland in 1820 (this study) and specimens collected in Guatemala, El Salvador and Costa Rica in 1856 and 1857 are part of the Herrenhausen Herbarium (Wagenitz, 1972). A travel report has been published about the field trip to Switzerland (Fischer & al., 2015) and it is therefore possible to reconstruct information about the specimens collected during this trip by combining the scarce label information and the detailed information about localities, dates and botanical observations presented in the travel report. The Wendlands were respected botanists and corresponded with many contemporary botanists from other institutions forming a network of experts and specialists (Peters, 2013). They also published many species names, especially in the families Arecaceae, Ericaceae, Fabaceae, and Rutaceae (e.g., J.C. Wendland, 1798–1823, 1805–1819; H.L. Wendland, 1820; H. Wendland, 1858).

The Herrenhausen Herbarium is thus an important collection mainly from a taxonomic and historical point of view. The first goal of our study was to make the collection accessible for botanists and historians, a task that not only included digitization and databasing, but also to describe the very unconventional style, in which the specimens are arranged. The second, more specific goal of the study was to identify specimens collected during Heinrich Ludolph Wendland's excursion to Switzerland in 1820 and to reconstruct a specimen list with exact information about localities and collection dates with the help of the travel report. The third goal was to identify specimens in the Herrenhausen Herbarium that have been collected by other botanists and which demonstrate the connections of the Wendlands and Ehrhart with contemporary botanists and botanical gardens in the 18th and 19th centuries.

■ MATERIALS AND METHODS

The Herrenhausen Herbarium

To appreciate the significance of this herbarium, four major subjects need to be introduced, namely "The Royal Gardens of Herrenhausen", the "Wendland dynasty", "The Royal Garden Library of Herrenhausen" and the "Herrenhausen Herbaria".

The Royal Gardens of Herrenhausen ("Königliche Herrenhäuser Gärten"). — The story of the Herrenhausen Gardens began in 1638, when Georg, Duke of Calenberg, ordered the creation of a kitchen garden in the town of "Höringhusen" for the Hanoverian court (Morawietz, 1963; Palm, 2006). Detailed descriptions and the history of the gardens, including the buildings, fountains and sculptures, and a survey of Hanover's history were published with the contribution of numerous experts by König (2006). Today, the Royal Gardens of Herrenhausen are composed of the "Großer Garten", the "Berggarten" (which is well known for its high botanical diversity and a world-famous orchid collection), the "Georgengarten" and the "Welfengarten" (both landscape gardens) and belong to the municipality of Hanover.

The Wendland dynasty. — Generations of court gardeners worked at Herrenhausen in the design, maintenance and development of the gardens, contributing to their international fame (Rettich & Rohde, 2006; for a definition of court gardeners ["Hofgärtner"] and court botanists, see Peters [2013] and Fischer [2016]). An increasing scientific reputation of Herrenhausen was established by three successive court gardeners of the Wendland family (Knoll, 2005; Peters, 2013): Johann Christoph Wendland (1755–1828), Heinrich Ludolph Wendland (1792–1869), and Hermann Wendland (1825–1903) (hereafter JCW, HLW, and HW respectively). The Wendlands, a "botanical dynasty", were not only outstanding gardeners, but they continuously enriched the botanical diversity mainly of the Berggarten, with plants obtained in exchange, purchased and collected during own journeys (e.g., H. Wendland, 1857; Knoll, 2005; Fischer & al., 2015).

The scientific reputation of the Wendlands is based principally on the numerous publications on botanical themes, including the description of new taxa (Knoll, 2005; Peters, 2013; Rettich, 2016). The Wendlands worked and published on different families of vascular plants from different geographical areas. JCW is well known for his studies on Ericaceae (*Erica* L.), Geraniaceae (*Pelargonium* L'Hér.), and Rutaceae; HLW specialized in Cactaceae, Fabaceae (*Acacia* Mill.), and Rutaceae (Diosmeae), whereas HW mainly published on Arecaceae, and less so on Bromeliacae, Cyclanthaceae, Gesneriaceae, and Pandanaceae (e.g., J.C. Wendland, 1798–1823; H.L. Wendland, 1820; H. Wendland, 1854). A recent study of Australian plants in which one of the three Wendlands is included in the author citation resulted in the identification of about 145 names, with approximately 30 of them being currently accepted names (Dowe & al., 2019). Worldwide, almost 980 plant names have been associated with the Wendlands (Dowe & al., 2019). Numerous detailed studies on the Wendland dynasty have already been published (e.g., Meyer, 1963; Knoll, 2005; Peters, 2013; Wolschke-Bulmahn, 2016; Dowe, 2019).

The Royal Garden Library of Herrenhausen ("Königliche Gartenbibliothek Herrenhausen", KGBH). — At the end of the 18th century, JCW started to acquire botanical books needed for publications on plants from the Berggarten (Schwerin, 2013; Palm, 2016) as well as for identification and cultivation instructions. The administration of Herrenhausen Gardens purchased these books in 1832, and placed them in the Berggartenpavillion (Laube & Hülsmann, 2011; Palm, 2011). This can be considered the basis of the Royal Garden Library of Herrenhausen (Palm, 2011). The library increased continuously, and it contained manuscripts, illustrations and herbaria in addition to books (Palm, 2016).

After The House of Welf ("Welfen") reclaimed their confiscated property in Herrenhausen in 1934, they sold the Berggarten and the Großer Garten to the city of Hanover in 1936 (Palm, 2011). The Royal Garden Library remained property of the Duchy of Brunswick and Lüneburg and was stored at Marienburg Castle, about 30 km south of Hanover, during World War II. The library remained inaccessible during the next decades (Palm, 2011, 2016).

In 2005, the Royal Garden Library of Herrenhausen was purchased by the auction house Reiss & Sohn (Königstein im Taunus, near Frankfurt), who planned to sell it by public auction (Dugall & al., 2008). The auction catalogue lists 742 items, of which 51 are unique (manuscripts, drawings, herbaria, etc.) and 691 are printed works (Reiss & Sohn, 2005). In order not to disperse this inimitable and valuable collection, the library was included in the Register of National Cultural Property and the auction was cancelled in the very last moment (Dugall & al., 2008; Hausinger, 2011). The library's estimated value of 3.3 million euro was collected through the engagement of the Ministries of Lower Saxony, Hesse and Thuringia, as well as different institutions, libraries, etc. (Dugall & al., 2008; Schwerin, 2011). The complete collection was then distributed among three libraries: the Johann Christian Senckenberg University Library in Frankfurt (http://publikationen.ub.uni-frankfurt.de/frontdoor/index/index/docId/188, accessed 18 Aug 2021; Hausinger, 2011), the Duchess Anna Amalia Library in Weimar (https://haab-digital.klassik-stiftung.de/viewer/gartenbibliothek_herrenhausen/ accessed 18 Aug 2021; Lorentz, 2011; Mangei, 2011) and the Gottfried Wilhelm Leibniz Bibliothek (GWLB) in Hanover (https://digitale-sammlungen.gwlb.de/sammlungen sub "Königliche Gartenbibliothek Herrenhausen", accessed 18 Aug 2021; Laube & Hülsmann, 2011). It is planned to virtually reunite the objects of the Royal Garden Library of Herrenhausen as part of the web-based project "Books and gardens in Hannover" (http://www.buecherundgaerten.de/index.php?id=227, accessed 18 Aug 2021) (Mangei, 2011).

Herrenhausen Herbaria ("Königliche Gartenbibliothek Herrenhausen – Herbarien"). — There is only scarce information about the history of the Herrenhausen Herbaria (Wagenitz, 1972, 2001, 2016; Peters, 2013). While the oldest specimens in the herbarium are from the 1780s, HLW purchased a herbarium cabinet only in 1819 (Knoll, 2005). In 1818, HLW began writing a catalogue of the herbarium (Reiss & Sohn, 2005: KGBH-45; suppl. Appendix S1), and it was probably in this context, that he decided to buy the cabinet. Von Malortie (1804–1887) was appointed director of the gardens in 1852 and formally established a herbarium (H. Wendland, 1852; Peters, 2013). Two new herbarium cabinets were purchased in that year. HW did not continue the herbarium of his father, but started his own collection in a larger format. During World War II, the herbaria were deposited in Marienburg Castle, together with other handwritings and the books of the Royal Garden Library. At present, the Herrenhausen Herbaria are stored almost exclusively in two locations: the GWLB in Hanover and GOET. Single or few specimens are found in other herbaria.

The GWLB acquired four herbaria from the Royal Garden Library Herrenhausen in 2007 (Reiss & Sohn, 2005; Palm, 2016; Wagenitz, 2016). These collections, comprising in total approximately 656 specimens, have already been digitized and are available online. They are: KGBH-11, "100 Engadiner-Pflanzen", 100 plants collected by J.L. Krättli (1812–1903) in Engadin, Switzerland, around 1870 (Kulturerbe Niedersachsen, GWLB – Niedersächsische Landesbibliothek: http://digitale-sammlungen.gwlb.de/resolve?id=00052285). KGBH-12, "Herrenhäuser Herbarium", 465 plants that can be considered a remnant of the larger Herrenhausen Herbarium, which is now at GOET. This collection comprises 65–70 bryophytes, collected probably by HW in the surroundings of Göttingen in 1846, and 398 specimens from the Herrenhausen Gardens probably collected by HW between 1841 and 1844 (Kulturerbe Niedersachsen, GWLB – Niedersächsische Landesbibliothek: http://digitale-sammlungen.gwlb.de/resolve?id=00052286). KGBH-13, "Flora der alten Welfenburg (Veitsburg bei Ravensburg)", approximately 50 plants collected near Ravensburg, Germany (Kulturerbe Niedersachsen, GWLB – Niedersächsische Landesbibliothek: http://digitale-sammlungen.gwlb.de/resolve?id=00052287). KGBH-14, "Flora alpina du Lac des quatre Cantons primitifs de la Suisse": See comments below under HLW's journey to Switzerland in 1820.

By far the largest herbarium of the Royal Gardens of Herrenhausen was donated to the University of Göttingen by Prince Ernest August of Hanover (1914–1987) in December 1969 (Wagenitz, 1972, 2016). It includes the largest collection of specimens from the Wendlands and is also known as the "Wendland Herbarium". This collection of about 16,600 plant specimens consists of three parts: the Herrenhausen Herbarium ordered according to the Linnaean System (13,035 specimens), the palm collection (1069 specimens) as well as smaller collections (2500 specimens). Since the donation of this herbarium to GOET, numerous specimens have been identified as type material and have been transferred to the "Type Herbarium" mainly by the late Prof. G. Wagenitz. Together with all other specimens in the Type Herbarium, these specimens have already been digitized in the framework of the Global Plants Project, funded by "The Andrew W. Mellon Foundation" and can be searched online at JSTOR-Global Plants (https://plants.jstor.org/). Recent publications including specimens from this herbarium are, e.g., Steudel & Appelhans (2016; e.g., GOET013902, type of *Maxillaria atrata* Rchb.f.), Dowe & al. (2019; e.g., GOET004971, type of *Acacia dolabriformis* H.L.Wendl.). In addition to the Herrenhausen Herbarium obtained in 1969, the Göttingen herbarium contains numerous specimens originally from the Herrenhausen Gardens, the Wendlands as well as Ehrhart. These specimens were probably obtained as gift, exchange or loan to botanists in Göttingen. The Herrenhausen Herbarium has not been merged with the general collection at GOET and is kept as a separate collection in its original condition.

Specimens from the Herrenhausen Gardens and Wendland collections are also found scattered in other herbaria, worldwide. The largest number of specimens that are not at GOET or the GWLB in Hanover are probably in the former herbarium of Hanover University (HAN). HAN was transferred to Hamburg (HBG) in 2000, but is not accessible at present (M. Schultz, curator HBG, pers. comm. 2019). HLW corresponded with Carl Ludwig Willdenow (1765–1812) in Berlin, and numerous Wendland specimens can therefore be found in the Willdenow Herbarium at B. Photographs of Wendland specimens are in the Field Museum in Chicago (F, Project Berlin Negatives) and they were most likely taken from B specimens that were destroyed in World War II (Grimé & Plowman, 1986). A search (18 Sep 2020) at the JSTOR-Global Plants online portal (https://plants.jstor.org/) with "Wendland" as collector and excluding the GOET specimens identified 162 specimens in 17 herbaria worldwide (AMES, B, BM, BR, C, F, G, K, L, M, MEL, MPU, NY, P, S, SI, US).

Digitization of the Herrenhausen Herbarium in Göttingen (GOET)

Before the digitization, all palm specimens were mounted on new sheets. The original sequence of specimens was kept for the palm collection and all other parts of the herbarium. The digitization is based on the standards established for the Global Plants Project (JSTOR, 2021a). Additionally, a label with the following text was added to each specimen so that they can be clearly identified as being part of the collection: "Herbarium Göttingen – Aus dem Herbar der ehem. Königl. Gärten zu Herrenhausen b. Hannover – Geschenkt durch Prinz Ernst August von Hannover im Dezember 1969" (Herbarium Göttingen – from the Herbarium of the former Royal Gardens Herrenhausen near Hanover – Donated by Prince Ernest Augustus of Hanover in December 1969). Type specimens were digitized with HerbScan Equipment (JSTOR, 2021b). All other specimens were photographed using a Canon EOS 5 DS R camera and a HerbScan Lightbox. The folder for each specimen was placed below the specimens, so that the information written on the folder could be included. In case that no plant was found in the folders or on sheets, the folder/sheet was also digitized including the note "No specimen on sheet", in order to maintain the original order as well as the metadata of the missing specimen.

Specimen collection data was databased using the Diversity Workbench (Diversity Workbench, 2021). Information about the collector(s) and the collection number, the country of origin, the exact location and date were included in case that information was present on the label. Country names were added in case they were missing and the locality information allowed the determination of the country. Taxonomic names were linked to the Catalogue of Life (https://www.catalogueoflife.org/, all online resources accessed 2020–2021). Other databases consulted include Tropicos (https://tropicos.org/), IPNI (http://www.ipni.org), The Plant List (http://www.theplantlist.org/) and GeoNames (https://www.geonames.org/). New identifications of specimens were only undertaken for Ehrhart's specimens (suppl. Table S1) and for the specimens from HLW's journey to Switzerland in 1820 (suppl. Table S2). For the plants from Switzerland, we used the *Flora Alpina* (Aeschimann & al., 2004) as taxonomic and nomenclatural standard as this regional standard work provided the best old synonymy for the flora of the region. These names can provide a link to extant global databases and specialized taxonomic literature. For identifications of species, we further used keys and descriptions in Hess & al. (1967–1972). Specimens without locality information were registered as "No locality on sheet". Most of them were probably collected at Herrenhausen Gardens, but this cannot be confirmed. Images and metadata will be available through the Sammlungsportal Göttingen (https://sammlungen.uni-goettingen.de) and the Global Biodiversity Information Facility (https://www.gbif.org/).

■ RESULTS AND DISCUSSION

The Herrenhausen Herbarium at GOET

The Herrenhausen Herbarium ordered according to the Linnaean System. — This herbarium consists of 13,035 specimens arranged in 125 fascicles, which are organized according to the Linnaean Sexual System for plants (Linnaeus, 1735). Most specimens are vascular plants, but four fascicles

(numbers 122–125) with bryophytes, algae and fungi are also included, and the last fascicle contains three animal specimens: one bryozoan (*Flustra foliacea* L., GOET037133) and two hydrozoans (*Sertularia cupressina* L., GOET037134; *S. operculata* L., GOET037135). Based on the Herbarium Catalogue by HLW (Reiss & Sohn, 2005: KGBH-45; suppl. Appendix S1), we could clarify that the Herbarium ordered in the Linnaean System is based on *Systema vegetabilium* by Roemer & Schultes (1817–1830) and *Species plantarum* by Willdenow (1797–1830). Volume 1 of the catalogue cites the specimens from fascicles 1 to 19 of the herbarium and Volume 2 the fascicles 20 to 125. The herbarium contains approximately 3800 specimens more than cited in the catalogue. These were likely added to the herbarium after December 1833, as the catalogue was not continued after that date.

The plants from this herbarium are from various sources, but most specimens were probably acquired by the Herrenhausen garden staff. The majority of the specimens were collected by HLW, but also many specimens collected by JCW are present. Numerous plants from the herbarium were collected directly from the Herrenhausen Gardens, mostly from the Berggarten, at which the plants arrived in many ways from all over the world. There was a continuous plant and seed exchange mainly with the botanical gardens in Berlin, Bonn, Göttingen, Kew, and Vienna (Wagenitz, 1972; Knoll, 2005). Living plants and herbarium specimens were also actively collected, especially in field trips by Ehrhart and HLW, and from trading nurseries like Lee & Kennedy's Nursery at Hammersmith, London, and Loddiges Nursery at Hackney, London. Plants were also obtained by purchase, exchange or gift to the Royal Garden Library (Knoll, 2005; Wagenitz, 2016). It is often not possible to recognize whether the plants were obtained as dried herbarium plants, or as seeds, bulbs and/or cuttings for cultivation at Herrenhausen Gardens, of which herbarium specimens were prepared at a later stage. Numerous specimens bear no information about the collection dates, but they have probably been collected between 1780 and 1835.

The specimens are arranged in fascicles of about 25 × 35 cm. Each fascicle contains an original label written by HLW (for handwriting samples, see Wagenitz, 1972) indicating the number, class and order in the Linnaean System. These labels are often broken or illegible and new labels, with the same information, have been added after the collection was moved to Göttingen. New labels that contain information about the barcodes included in the fascicle were added during the digitization. In each of the fascicles, specimens belonging to one genus are placed together in a blue folder. Within these "genera folders", specimens of each species are placed in a yellowish/greenish "species folder". In addition to the species names, information on the locality, collectors and dates are often written on the species folders. Additional information is often written on paper slips that are directly attached to the specimens or are loosely placed next to them. The specimens are generally not mounted. The arrangement of specimens of the same species is very unconventional and needs to be explained in some detail because it is crucial for future studies that deal with typifications involving specimens from this collection. The sheets on which specimens are placed cannot be regarded as an underlay for the specimens, but it represents a cover. The label information for the first specimen in a species folder is thus displayed on the outside of the species folder and on the paper slips next to the specimen, while the information on the sheet on which the specimen is placed belongs to the next specimen in the species folder. Since our goal was to keep the original layout, specimens were digitized in a way that the label information of the next specimen is shown (Fig. 1).

The development of this arrangement is interpreted as follows: the first collection of a particular taxon was included in a species folder and data was written on the outer cover of the folder. When a new collection of the same taxon was added to the herbarium, it was placed in the same species folder and a sheet of paper with information on the new collection was positioned between the two collections in order to separate the newly added collection from the first specimen.

To explain the unconventional style in which the specimens are arranged, a disclaimer was included for each Herrenhausen Herbarium specimen in the database Diversity Workbench (Fig. 2).

Very little is known about the history of the herbarium, and the Wendlands did not document how they organized the herbarium regarding the species folder. Also the herbarium catalogue (suppl. Appendix S1) has no information concerning this matter. The understanding of the data and its relation to the specimens is based on the careful observation of labels, data, position of plants, as carried out during the digitization of the collection. Therefore, in order to preserve the herbarium in its original state, the specimens were digitized strictly maintaining the original sequence.

The palm collection. — The palm collection comprises 35 fascicles with herbarium sheets and one box with seeds. Within this collection there are numerous handwritings by HW, including descriptions, letters, illustrations and plates (e.g., GOET025041; see also Palm, 2011: 61–62). The handwritings are scattered among the collection, but most of them are in the last fascicle. The specimens were mounted on new herbarium sheets for conservation purposes before digitization, and the original sequence of the specimens was kept. Due to the large size and number of the plant parts, many single specimens are distributed on more than one sheet (up to 23 sheets). We used a single barcode per specimen and the additional sheets have been numbered with suffixes (e.g., GOET025005, GOET025005_a, GOET025005_b). In total, the palm collection consists of 1069 specimens. Summing up the multiple sheets for many specimens, the handwritings, several plates as well as the seeds, the collection comprises 2280 items.

The palm collection mainly includes specimens prepared from palms cultivated at Herrenhausen and obtained from other botanical gardens. In the introduction of "Index Palmarum", HW cited more than 30 botanical gardens and trading nurseries, from which he received living specimens (H. Wendland, 1854). There are also numerous collections

Fig. 1. An example of a species folder with more than one specimen in the Herrenhausen Herbarium ordered according to the Linnaean System. **A**, Pictogram showing the relation of label information with the specimens included in the folder; **B**, Blue genus folder "*Verbascum*" with the species folder "*Verbascum lychnitis*" and three collections included in it. For the digitization (**C**–**E**), specimens were positioned over the genus and species folders, in a way so that the information on these folders was visible. **C**, GOET026406: "*Verbascum*" (genus folder), "*Verbascum lychnitis*" (species folder), "Legit in Helvetia 1820" (written on sheet, bottom left); **D**, GOET026407: "*Verbascum*" (genus folder), "*Verbascum lychnitis*" (species folder), "Dr. Bartling" (written on sheet, bottom left), "p. Vevay" (written on loose label); **E**, GOET026408: "*Verbascum*" (genus folder), "*Verbascum lychnitis*" (species folder), "*Verbascum Lychnitis* flor. lutea pr. Allendorf Dr. Bartling" (written on loose label). Collection data for the specimens are: GOET026406: no locality and collector on sheet; GOET026407: Legit in Helvetia 1820, prope Vevay, HLW; GOET026408: prope Allendorf, Bartling.

obtained as herbarium sheets (e.g., "Herb. Delessert", "Herb. Lugd. Batav.", "From The Herbarium of the Royal Gardens, Kew", "Herb. Hort. Bot. Calcuttensis", "Ex Museo botanico Berolinensi", "Herb. Boissier"). In addition, 50 specimens collected by HW during his travel to Central America in 1856–1857 are part of the palm collection.

The famous palm house "Großes Palmenhaus" in the Herrenhausen Gardens, completed in 1880, was the tallest glasshouse worldwide then and it contained the world's largest palm collection of the 19th century (Dowe & Schlumpberger, 2019). The significance and contributions of HW's studies on Arecaceae were treated in detail by Dowe (2019). During the present study, we identified approximately 70 collectors in the palm collection (included in Appendix 1), which reflects the fruitful collaboration of HW with other botanists, as pointed out by Dowe (2019) (Fig. 3).

Smaller collections (HW in Central America, Hoffmann in Costa Rica, Ehrhart). — About 2500 specimens in the Herrenhausen Herbarium belong to separate, smaller collections. These include seven fascicles of specimens collected by HW in Central America (Guatemala, El Salvador, Costa Rica) in 1856–1857, 51 specimens collected by Carl Hoffmann in Costa Rica in 1854–1857, three fascicles of Ehrhart's herbarium, and several fascicles of an additional herbarium containing plants cultivated at Herrenhausen. The latter has not been digitized in this project because the specimens of this collection do not bear any label information and only a label on the outside of each fascicle states that they belong to the Herrenhausen Herbarium.

The Central American collection consists of 415 specimens and all of them had already been mounted on standard GOET sheets before the project started. An additional 138 specimens collected by HW in Central America had already been identified as type material and had been digitized in the framework of the Global Plants Initiative project (https://plants.jstor.org/; Ryan, 2013; Smith & Figueiredo, 2014). As mentioned above, 50 palm specimens can be attributed to HW's journey to Central America as well. In addition to these specimens, four bryophytes, two *Equisetum* L. and three lycopods that are known from our general collection, can be attributed to this journey. The *Equisetum* and lycopod specimens contain the label that was added after the donation of the Herrenhausen Herbaria to Göttingen, so that they clearly do not belong to an exchange of specimens between the Wendlands and contemporary botanists at Göttingen, but to the donation of specimens in 1969. Only about 5% of all GOET specimens have been digitized at the time of writing this article and the only families that have been completely digitized are Equisetaceae, Isoetaceae and Lycopodiaceae. It is likely that G. Wagenitz inserted these specimens to the general herbarium, and a complete digitization of GOET, which has recently been recommended by Borsch & al. (2020) for all German herbaria, will probably identify additional specimens collected by HW in Central America.

In total, 612 Central American specimens collected by HW are known at GOET. In contrast to the herbarium in the Linnaean system collected mainly by HLW, HW's specimens contain more detailed label information. In most cases, HW added a plant name, locality information, the date of collecting and a collection number to his specimens (Fig. 4). Almost all specimens contain a date and the specimens have been collected between 17 Dec 1856 and 12 Aug 1857. This collection was in part revised by Heinrich Gustav Reichenbach (1824–1889) for Orchidaceae (Reichenbach, 1867), Heinrich Wilhelm Schott (1794–1865) for Araceae (Schott, 1858) and Johannes Ludwig Emil Robert von Hanstein (1822–1880) for Gesneriaceae (Hanstein, 1865). Recently, Steudel & Appelhans (2016) identified additional type material from the collection.

Carl (Karl) Hoffmann (1823–1859) travelled to Costa Rica in 1853, together with Dr. Alexander v. Frantzius (1821–1877), principally to gain new geographical and meteorological knowledge (Seemann, 1853). Hoffmann was also interested in botany and collected plants in Costa Rica during 1853–1859 (C. Hoffmann, 1856, 1858; Schott, 1858; HUH, 2021). One fascicle of Hoffmann specimens consisting of 51 specimens mounted on 53 sheets is part of the Herrenhausen Herbarium. Like HW's Central American collection, these specimens had already been mounted on standard GOET sheets. The specimens have been collected between July 1854 and December 1857 and they bear collection numbers ranging in between 8 and 556. Except for two ferns and one lycophyte, all specimens represent angiosperm taxa, but most of them have not been determined to the species or genus level. One of Hoffmann's

FOR A CORRECT INTERPRETATION OF COLLECTION DATA IN THE HERRENHAUSEN HERBARIUM: THE NUMBER OF COLLECTIONS IN EACH "SPECIES FOLDER" MUST BE CONSIDERED

! If more than one collection per species folder: the collections are separated by sheets with collection data, on which the collections are placed loosely instead of being mounted. The collection data written on the folder or the individual sheets applies to the plant collection below (= next barcode) and thus serves as a cover of the collection instead of a base on which the collection is placed. All collections in a folder must therefore, be considered for the correct interpretation of the collection data.

For more details see: Reiner-Drehwald, Hörandl & Appelhans (2022)

Fig. 2. Disclaimer included in each Herrenhausen Herbarium specimen in the database (Diversity Workbench).

specimens collected in 1857 (No. 545) was used for the description of *Drymonia ovata* Hanst. Hanstein's (1865) description is based on a specimen deposited at B that was destroyed in WWII. A duplicate (isotype) is present at GOET and it has already been digitized and can be found online (https://plants.jstor.org, GOET003888).

Hoffmann's and HW's travel reports (Seemann, 1853; C. Hoffmann, 1856, 1858; H. Wendland, 1857) do not contain direct proof that they went on excursions together in Central America. However, they knew each other and also exchanged information on their collections. Hoffmann commented that HW ascended the Barba volcano in May 1857, that HW also found an interesting *Balanophora* J.R.Forst. & G.Forst. and mentioned a splendid plant that was identified as *Gunnera* L. by HW (C. Hoffmann, 1858). On the other hand, HW narrated his visit to Hoffmann in San José, Costa Rica, in March 1857, to whom he gave a letter of recommendation (H. Wendland, 1857: 361). HW also mentioned that Hoffmann was interested in natural sciences, that he had already collected numerous plants and that he had told him about good localities for collecting. The presence of Hoffmann specimens in the Herrenhausen Herbarium is a clear evidence that HW and Hoffmann exchanged specimens during their time in Costa Rica.

Fig. 3. Example from the palm collection. *Bactris confluens* Linden & H.Wendl., coll. Funck & Schlim, San Cristóbal, Colombia. Type, rev. R. Bernal 1988. Taxon name accepted by Dowe (2019). GOET025071, 5 sheets, including one illustration.

The three fascicles of the Ehrhart Herbarium contain a total of 707 barcode numbers. In many cases either more than one specimen, species or label was included in a single specimen folder and we assigned a barcode in case it was evident that the different plants or labels consisted of different gatherings. In three cases, a specimen folder was completely empty, but we still assigned a barcode to them because the folders contained a specimen number.

After Ehrhart's death, his herbarium was purchased by the Hanoverian government in 1795, who gave it in custody of Georg Franz Hoffmann (1760–1826), who was the director of the Botanical Garden in Göttingen then. After many years in Göttingen, Hoffmann accepted an appointment at Moscow University in 1804. Hoffmann took the largest part of Ehrhart's herbarium with him, and it is now kept in the Moscow State University (MW). A detailed study of Ehrhart's specimens in MW was published by Sokoloff & al. (2002). The remaining Ehrhart collections at GOET can be grouped as follows: (1) the three fascicles (707 barcodes) discussed here; (2) numerous specimens included in the Herrenhausen Herbarium ordered according to the Linnaean System; (3) numerous specimens and exsiccatae in the general and type herbaria at GOET.

Fig. 4. Specimen collected by Hermann Wendland in Central America. *Phaseolus speciosus* Kunth, Guatemala, "In barranca de Hacienda de Naranjo", HW 97, 6 Jan 1857 (≡ *Vigna speciosa* (Kunth) Verdc.; WFO, 2021); GOET037367.

The specimens in the three fascicles are numbered in the same way as the main Ehrhart collection at Moscow. Hoffmann (G.F. Hoffmann, 1824) published a catalogue of the Ehrhart Herbarium, which he took from Göttingen to Moscow; the numbering in the catalogue is consecutive and ranges from 1 to 8228. The Ehrhart set at Moscow is not complete, and among the 707 barcodes at GOET, 94 contain numbers that are lacking in Hoffmann's (1824) catalogue (see suppl. Table S1). Most of the specimens represent angiosperm taxa (637), and there are 11 gymnosperms, 6 ferns and lycopods, 29 bryophytes, 22 lichens, plus 1 alga and fungus each. Most Ehrhart specimens contain a collecting locality and most specimens are from Germany (mainly Lower Saxony; e.g., H.Hh. = Hortus Herrenhusianus, H = Hanover, H.pr. = hortus proprius Ehrharti) or Sweden (H.U. = Hortus Upsaliensis, U = Uppsala), and few specimens are from other countries, e.g., the Netherlands (Delft, Leiden, Noordwijk, Hortus Ultrajectinus [Utrecht]), Switzerland and Lithuania (Nida; then part of East Prussia). The plants from Uppsala cannot represent original material for typification of Linnaean names, but they are nevertheless an important historical and botanical resource and can also be useful for the purpose of neotypification (Sokoloff & al., 2002: 142). Ehrhart did not collect all specimens himself, but also obtained specimens from other collectors (Appendix 2).

Heinrich Ludolph Wendland's journey to Switzerland in 1820

The relevance of the court gardeners' historical travels and travel reports was summarized by Fischer & al. (2015), who also included a transcription of HLW's travel report of the journey to Switzerland in 1820. From May to October 1820, HLW travelled by coach, boat and on foot through what is now Germany, France, Switzerland, Austria and the Czech Republic (Fischer & al., 2015). In his travel diary, HLW not only described the journey itself with lists of observed or collected plants, but he also included personal comments on the botanical gardens he visited, their gardeners, nurseries, plant collectors and friends. This valuable information lets us take a glance at HLW's huge personal network, that was also discussed by Fischer (2016). The focus on wild-plant collecting activities was in Switzerland. Outside Switzerland, approximately 300 plants are cited in the travel report, mostly as lists of plants observed in botanical gardens and nurseries.

Among the 13,035 specimens from the Herrenhausen Herbarium ordered according to the Linnaean System, we detected 260 herbarium specimens with the text "Legit in Helvetia 1820" written mostly on the species folders in HLW's handwriting. The results of our investigation are summarized in suppl. Table S2, including for each collection: the barcode, the original plant identification, a revised identification indicating correctness, synonymy or misidentification, family, locality as on the label/folder, date (based on locality in combination with information traced in the travel report), page number in the travel report where the taxon was mentioned and notes. A detailed itinerary is presented in suppl. Table S3 and most localities are shown in Fig. 5.

The specimen labels bear no exact dates and the locality information is very scarce. In most cases, the label information consists of the species name and the note "Legit in Helvetia, 1820" on the species folder, and a small paper slip with sparse information about the locality, e.g., "Rigi", "Grimsel" or "p. Vevay" written on it (Fig. 1D). Approximately 30 different localities could be identified (see suppl. Table S3). All these localities are mentioned in HLW's travel report (Fischer & al., 2015), so that it was possible to add a precise locality and an exact date (a range of two days in some cases) for the specimens. For 42 specimens, no indication of locality was found. The travel report contains 163 names of collected or observed plants during the journey to Switzerland between 9 July and 5 August 1820. Out of these, we were able to locate approximately 65% as specimens in the Herrenhausen Herbarium (included in suppl. Table S2). From the 260 specimens collected by HLW in Switzerland, we could find 252 taxa cited in the Herrenhausen catalogue (KGBH-45; suppl. Appendix S1). The missing taxa in the catalogue are plants only identified at genus level or with a questionable name (*Alchemilla* cf. *fissa*, *Dianthus* sp., *Silene* sp., 3× *Rosa* sp., *Stachys* sp., *Bryum zierii*). There is no collecting information, like collector, locality or date, for taxa cited in the catalogue. It is therefore not possible to search in the catalogue for particular specimens, for example for plants obtained from a specific botanical garden or from a travel.

The 260 specimens belong to 51 families. Five bryophytes, two lycophytes, seven ferns, and two gymnosperms are among the specimens, and the vast majority (244 specimens) are angiosperms. With 41 specimens, Asteraceae is most frequently represented, followed by Rosaceae (21), Caryophyllaceae (19), Lamiaceae (16), and Fabaceae (15). Most of the species are common alpine plants and, applying modern IUCN standards (IUCN Standards and Petitions Committee, 2019), only 17 species are categorized as Near Threatened (NT), 8 as Vulnerable (VU), and 1 – *Xeranthemum inapertum* (L.) Willd. (Asteraceae) – as Critically Endangered (CR) in Switzerland (Moser & al., 2002). We checked the identification for all specimens using the *Flora Alpina* (Aeschimann & al., 2004). In 131 cases, the species identifications from 1820 were congruent with our determinations and the species names were identical. In 90 cases, the species names from 1820 are nowadays regarded as synonyms and we updated the names. The identifications of these 90 specimens were thus correct, and reflect the changes in the taxonomy in the past 200 years. Six specimens were only identified at the genus level and determinations at the species level are added here. In eight cases, the species could not be determined with certainty because the specimens were insufficient, and in four of these cases, the original determination was likely correct. Eight specimens consisted of plants belonging to two different species (mixed collection), although only one species was listed on the label. Finally, we labelled 22 specimens as misidentified. Not all of these can be regarded as mistakes, since eight of the

"misidentified" species had not been described yet in 1820, and another two species have been described between 1800 and 1820 and might not have been included in the literature that HLW used to determine his specimens. Some mixed or confused samples might be also due to a bad taxonomic circumscription and knowledge of species at that time (e.g., in *Salix* L., see Buser, 1940).

Wendland (HLW) often included specific observations about single species or specimens, e.g., on 31 July, he noted "[…], den Nachmitag ging es nach den Unter Aar Gletscher unter wegens fanden wir *Pinguicula major*, *Lycopodium alpinum* und dichte am Gletscher *Ranunculus glacialis* von einer ungemeinen Höhe, […]" (In the afternoon, we passed by the Unteraargletscher [Lower Aare-Glacier] and found *Pinguicula major*, *Lycopodium alpinum* and very close to the glacier we found *Ranunculus glacialis* of a tremendous size). In the case of *Ranunculus glacialis*, the only herbarium specimen from this species in the Herrenhausen Herbarium (GOET031330) is in fact relatively large, and the determination is correct. In addition to the date (31 July 1820) we were able to render the location more precisely to "Switzerland, Canton of Bern, Bernese Oberland, near Lower Aare-Glacier, near Grimsel Hospiz", whereas the original label only specifies "Legit in Helvetia 1820". The collection sites were most likely at the glacier's forefield, which is nowadays, under consideration of the glacier retreat (GLAMOS, 2021), the area covered by the dammed lake Grimsel See (built in 1932). The Herrenhausen Herbarium is thus a good example for a collection with fragmentary label information that can be complemented with information from a well-documented and detailed travel report. This example also demonstrates that such collections can serve as historical documents for changes of landscapes and vegetation.

Another interesting comment in the travel report is "[…] wo die Straßen von Lausanne und Moudon zusamen treffen ein *Solanum Dulcamara* ich vermuthete sogleich daß es vieleicht das *Solanum littorale* welches am Genfer See wachsen soll, seien könnte, ich nahm es mit zur fernern Untersuchung, […]" (where the roads from Lausanne and Moudon meet, one

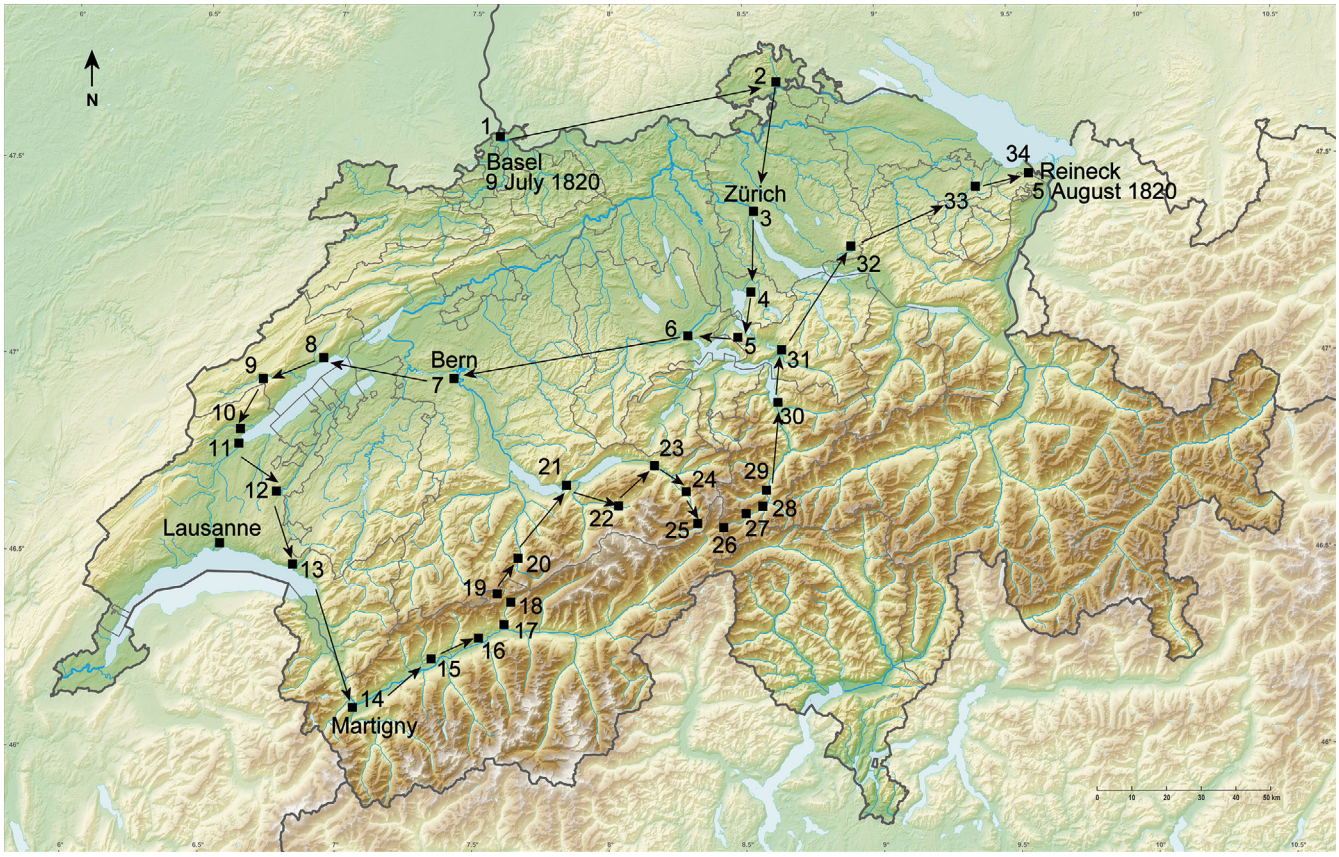

Fig. 5. Itinerary of Heinrich Ludolph Wendland's journey to Switzerland in 1820 (arrows indicate direction of journey, for details see suppl. Table S3). 1: Basel (9 July 1820), 2: Schaffhausen, 3: Zürich (on Lake Zürich), 4: Zug (on Lake Zug), 5: Mount Rigi, 6: Lucerne (on Lake Lucerne = Vierwaldstättersee), 7: Bern, 8: Neuchâtel (= Neuenburg, on Lake Neuchâtel = Neuenburgersee), 9: Creux du Van, 10: Grandson, 11: Yverdon-les-Bains, 12: Moudon, 13: Vevey (on Lac Léman = Lake Geneva), 14: Martigny, 15: Sion (= Sitten), 16: Sierre (= Siders), 17: Leuk, 18: Leukerbad, 19: Gemmi Pass, 20: Kandersteg, 21: Interlaken, 22: Grindelwald, 23: Meiringen, 24: Guttannen, 25: Hotel Grimsel Hospiz/Grimsel, 26: Furka Pass, 27: Realp, 28: Hospental, 29: Devil's Bridge (= Teufelsbrücke), 30: Altdorf, 31: Schwyz, 32: Lichtensteig, 33: St. Gallen, 34: Rheineck (5 August 1820, South of Lake Constance). [Creator: Tschubby - Eigenes Werk, CC BY-SA 3.0, https://de.wikipedia.org/wiki/Datei:Reliefkarte_Schweiz3.png; https://commons.wikimedia.org/wiki/Commons:GNU_Free_Documentation_License,_version_1.2. The original relief map (download 21 April 2021) was supplemented with names and localities.]

Solanum dulcamara, I supposed it could be the *Solanum littorale*, known to grow at Lac Léman, and I collected it for later revision) (Fig. 5, Nr. 13; Fischer & al., 2015: 51–52 in the travel report). The mentioned specimen is part of the Herrenhausen Herbarium with the following information: on the species folder "*Solanum littorale* Rab. Legit in Helvet. 1820" and on a loose label "Am Genfer See nicht weit von Vevey gesammelt 1820" (collected on Lac Léman not far from Vevey) (Fig. 6, GOET026506). The specimen matches *Solanum dulcamara* L. according to Aeschimann & al. (2004), and the monographer Knapp (2013) treated *S. littorale* as a synonym of *S. dulcamara*. The comments by HLW on this specimen demonstrate the up-to-date knowledge on botanical issues and his extensive botanical network, as *Solanum littorale* Raab was published only one year before HLW's journey, based on a specimen collected by Raab at Lac Léman in this area ("inter Vidy et Pully, prope Ouchy et Champlande", https://tropicos.org/name/29604640). Since the type material of *S. littorale* is unknown (Knapp, 2013), the HLW specimen could be a candidate for neotypification.

According to Wagenitz (2016) there is no indication of collectors or dates in the herbarium "Flora alpina du Lac des

Fig. 6. Specimen collected by Heinrich Ludolph Wendland in Switzerland. *Solanum littorale* Raab (synonym of *Solanum dulcamara* L.) near Vevey, Lac Léman (= Lake Geneva), 23 July 1820; GOET026506.

quatre Cantons primitifs de la Suisse" (Kulturerbe Niedersachsen, GWLB – Niedersächsische Landesbibliothek: http://digitale-sammlungen.gwlb.de/resolve?id=00052289). But he considered that the herbarium might be related to HLW's journey to Switzerland in 1820. Fischer & al. (2015) even considered this herbarium from the surroundings of Lake Lucerne to be a first output of HLW's journey to Switzerland, as he also collected plants in this region. However, we cannot confirm with certainty that the plants from this herbarium are part of HLW's collections from Switzerland in 1820 due to following reasons: Although some localities from the herbarium "Flora alpina du Lac […]" are also found in the Herrenhausen Herbarium (Rigi, Furka), most of the localities are not found there (Titlis, Lopper, Buchserhorn, Pilatus, Engelberg, Mendrisio) and are not cited in HLW's travel report (Fischer & al., 2015 [geographical index]). Two specimens from this herbarium are from Mendrisio (Tessin, Switzerland), a district more than 150 km south of the Furka Pass (probably the nearest locality to Mendrisio in HLW's journey) and this locality is not mentioned in HLW's travel report. Out of the 40(–41) species in the "Flora alpina du Lac des quatre Cantons primitifs de la Suisse", 19 were also found in the Herrenhausen Herbarium and 7 are cited in the travel report, but often from different localities. It is possible that some plants in this herbarium were collected by HLW in 1820, but it seems more likely that they are plants obtained as gift, exchange, etc. from other botanists or collectors.

Collectors and origin of herbarium specimens

The lists of collectors presented here, are based mainly on the study of the plant specimens, of the Herrenhausen Herbarium. Additional information can probably be obtained by studying documents and handwritings from the Royal Garden Library Herrenhausen. The sale and exchange of plants from the Herrenhausen Gardens (including the register of buyers, botanical gardens, trading nurseries and private collections) were documented in account books that are deposited in the GWLB. Also letters related to the library and herbarium, travels and the organization of the gardens and a catalogue of the trading nursery Loddiges can probably help to complete the list of collectors of the Herrenhausen Herbarium (Reiss & Sohn, 2005: KGBH-16 to 19, 21, 46, 384; Palm, 2011).

Collectors. — Wagenitz (1972), based on a first survey, mentioned 10 collectors that contributed to the Herrenhausen Herbarium. We identified 154 collectors for the complete Herrenhausen Herbarium at GOET (Appendices 1, 2). These lists are probably not 100 percent complete because some labels do not contain a collector's name or the name is illegible.

The high number of collectors documents that the Wendlands, Ehrhart and the Herrenhausen Gardens were in correspondence with important contemporary botanists and institutions and it proves their active role in specimen exchange and acquisition. Thirteen of the 154 contributing collectors had direct connections to the Herrenhausen Gardens or the nearby Göttingen University (i.e., studied or worked there) or lived in one of these towns (e.g., Bartling, Fischer, Hahn, Meyer, Schrader). It is likely, that the Wendlands and/or Ehrhart were in contact with these collectors and directly exchanged or purchased specimens with or from them. Specimens collected by Karl Boriwoj Presl (1794–1852; Prague), Joseph Sadler (1791–1849; Pest [Budapest]), Heinrich Wilhelm Schott (1794–1865; Vienna) and Carl Ludwig Willdenow (1765–1812; Berlin) vouch for the network that Herrenhausen botanists established with botanists from other important European universities. Numerous collectors are represented in the palm collection, due to the extensive network of HW.

Arguably, the most important collectors contributed to the three fascicles of the Ehrhart Herbarium and we therefore present a separate list of collectors for this part of the Herrenhausen collection (Appendix 2). Biographical information about Ehrhart can be found in Wagenitz (1982, 2001, 2016) and Sokoloff & al. (2002). Born in Switzerland, he made his studies and training as pharmacist in Germany (Nuremberg, Erlangen, Hanover) and then went to Uppsala, where he was one of the last students of Carl Linnaeus. Ehrhart returned to Germany and was designated court botanist in Herrenhausen in 1787.

In total, we identified 28 names of botanists in addition to Ehrhart in the three fascicles, and five names that could not be deciphered or interpreted might represent additional collectors (Appendix 2). The specimens are generally not mounted but placed loosely in the specimen folders. One specimen, however, is mounted on a sheet and the number "5" is written at the base of the sheet (Fig. 7). The label is in Ehrhart's hand and contains the species name *Holcus odoratus* (currently used names: *Anthoxanthum nitens* (Weber) Y.Schouten & Veldkamp and *Hierocloe odorata* (L.) P.Beauv.) and the abbreviation "h.L.", which stands for "herbarium Linnaeus" in Ehrhart's herbarium (G.F. Hoffmann, 1824). The Ehrhart collection at Moscow contains 31 specimens that are linked to Linnaeus (Sokoloff & al., 2002) and the style of the mounted specimen at GOET is identical to these. The number "5" corresponds to the numbering used by Linnaeus in *Species plantarum* (Linnaeus, 1753), in which *H. odoratus* is the fifth species in the genus *Holcus*. A comparison with the handwriting on the labels of the Linnaean specimens at MW (Sokoloff & al., 2002) and additional specimens at the Linnean Society revealed that the number on the sheet was very likely written by Linnaeus himself and the specimen is very likely from Linnaeus's herbarium (own observation MSA; confirmed by Isabelle Charmantier and Mark Spencer of the Linnean Society). In addition, the Ehrhart collection at GOET contains specimens of other famous botanists including the Linnaean students Adam Afzelius (1750–1837), Johann Christian von Schreber (1739–1810) and Peter Jonas Bergius (1730–1790).

Hoffmann (G.F. Hoffmann, 1824) lists 67 names of collectors for the Ehrhart Herbarium, and closer examination of the Ehrhart collection at Moscow by Mikhail Nikolaevich Karavaev enlarged the list to about 80 (Sokoloff & al., 2002). Given that the specimens at GOET comprise less than

10% of the species/specimens of Ehrhart's collection, 28 names of collectors are a comparatively large number. The discovery of a Linnaean specimen and the identification of 94 numbers that are not represented in the Ehrhart Herbarium at MW and Hoffmann's (1824) catalog makes it clear that the Ehrhart specimens at GOET are more than just a fragmentary set of duplicates or appendix of Ehrhart's herbarium. Instead, they represent an important component to the Ehrhart collection at MW.

In addition to the specimens collected by Linnaeus and the Linnaean students mentioned above, the Herrenhausen Herbarium contains specimens from another important Swedish collector and student of Linnaeus: Carl Peter Thunberg (1743–1828). Much has been written about the life and accomplishments of Thunberg (e.g., Svedelius, 1944; Rietbergen, 2004; Kijewski, 2014), and it is not repeated here. There are no Thunberg specimens in the three fascicles of Ehrhart specimens, but Thunberg specimens exist in the larger Herrenhausen Herbarium in the Linnaean system. The Thunberg specimens obviously came to the Herrenhausen Herbarium via Ehrhart, who continued to correspond with Thunberg after he had left Uppsala (Manitz, 1976). It is

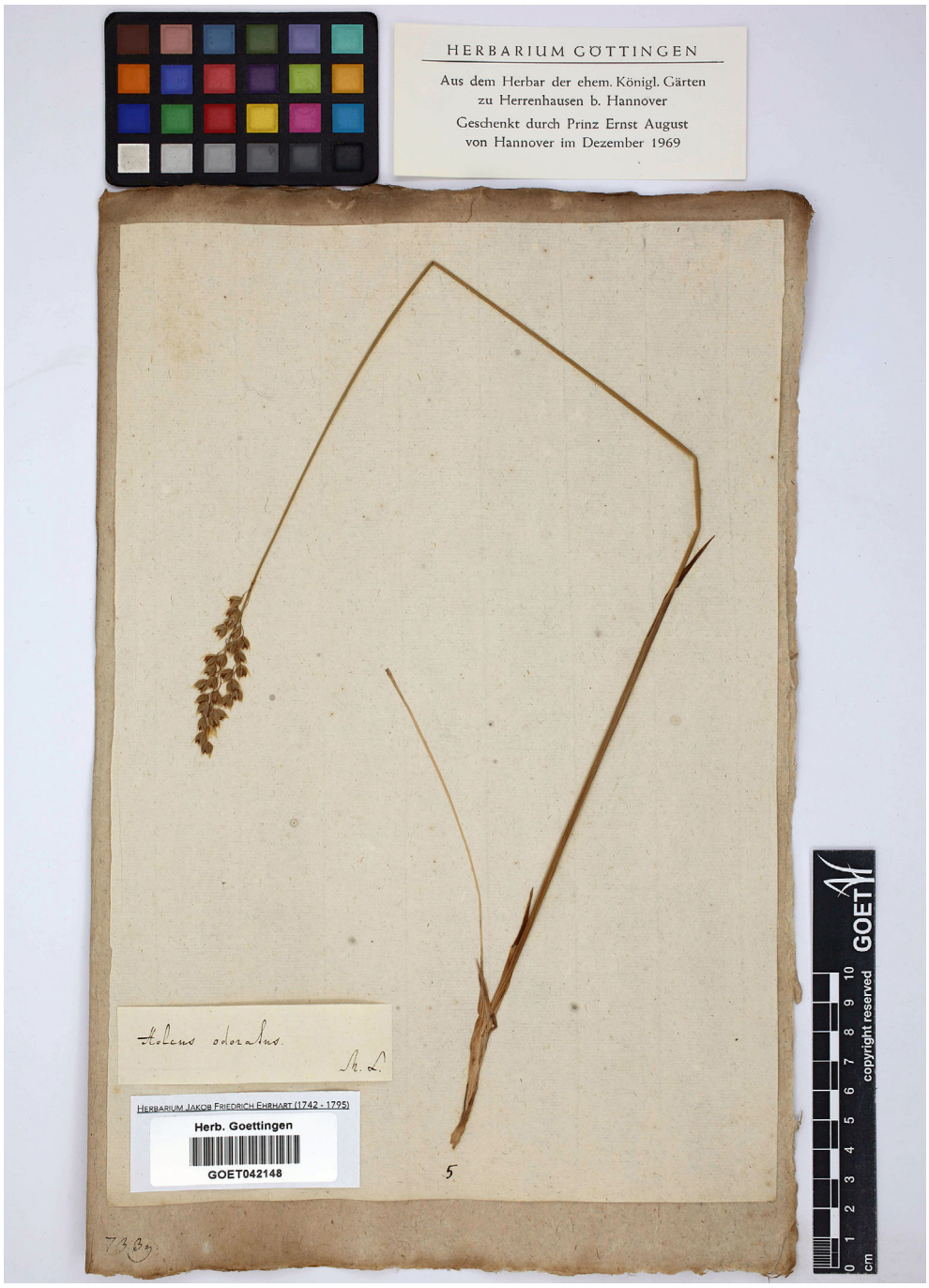

Fig. 7. Specimen from Ehrhart's herbarium that Ehrhart probably obtained from Linnaeus. The label is written in Ehrhart's hand: "*Holcus odoratus* h.L" (h.L. = herbarium Linnaeus). The number "5" written directly on the sheet corresponds to the numbering used by Linnaeus (1753) in *Species plantarum* and was very likely written by Linnaeus himself; GOET042148.

somewhat surprising that there are no Thunberg specimens in the three fascicles of Ehrhart specimens. Hoffmann (1824) lists Thunberg as a contributor to the Ehrhart Herbarium, and the lack of Thunberg specimens in the Ehrhart Herbarium at GOET might be due to its small size compared to the larger Ehrhart collection at MW.

With the exception of HW, the Wendlands and also Ehrhart have never been overseas. Yet the herbarium contains numerous specimens from other continents and countries, especially from South Africa and Australia. Apart from HW's specimens collected in Central America (see above "Smaller collections"), American specimens have been collected by 35 botanists. Among these, Jean Baptiste Christophe Fusée Aublet (1720–1778), is particularly interesting because his specimens predate all other collections of the Herrenhausen Herbarium with a collecting date. Aublet studied the flora of the Guianas and described 208 new genera in his *Histoire des plantes de la Guiane Françoise* in 1775 (Zarucchi, 1984). He collected plants in French Guiana from 1762 to 1764 (Zarucchi, 1984), so that the Aublet specimens in the Herrenhausen Herbarium are at least 16 years older than any other specimen with a collecting date.

At least ten collectors have contributed South African specimens in the Herrenhausen Herbarium (Appendix 1). In addition to Thunberg, "the father of Cape botany" (Glen & Germishuizen, 2010), Johann Franz Drège (1794–1881), Christian Friedrich Ecklon (1795–1868) and Carl Ludwig Philipp Zeyher (1799–1858) may be regarded as the most important South African collectors in the Herrenhausen Herbarium, and they rank among the most productive South African collectors in the 19th century. They all arrived in South Africa in the 1820s and were professional natural history collectors, whose specimens were acquired by many herbaria, museums and private collectors. While Drège, who has collected about 200,000 specimens in his life, returned to Europe in 1834, Ecklon and Zeyher spent most of their lives in South Africa and died in Cape Town in 1868 and 1858, respectively (Glen & Germishuizen, 2010).

Australian plants have been important in the horticultural and scientific work of the Wendlands (Dowe & al., 2019). Most specimens of Australian species in the Herrenhausen Herbarium have been prepared from plants cultivated at the Herrenhausen Gardens, and the original collector of seeds, bulbs or cuttings often remains unknown. At least eight collectors of plants in Australia are represented in the Herrenhausen Herbarium, namely James Anderson (1797–1842), Hermann Beckler (1828–1914), C.F. Eduard Dämel (1821?–1900), John Dallachy (1820–1871), Peter Good (?–1803), B.T. Gulliver (1851–1938), Ferdinand Jacob Heinrich von Müller (1825–1896) and Johann August Ludwig Preiss (1811–1883).

Finally, two additional collectors, namely Friedrich Gottlieb Bartling (1798–1875) and Franz Conrad Ernst Wendland, need to be mentioned. Bartling was a professor at Göttingen University and founded the herbarium. There are specimens in the Herrenhausen Herbarium that were supposedly collected by Bartling in Egypt, Hispaniola, Martinique, Mexico, Norway, South Africa, Spain and Sweden. These were probably obtained as gift or exchange from other collectors since we could not find any information about travels undertaken by Bartling himself to those countries (Ziegenspeck, 1953; Wagenitz, 1982). In some specimens, the name "Bartling" was probably added to the label (e.g., name of the taxon and locality) later on and not by Bartling himself, which is obvious from the different handwriting. The citation of specimens collected by Bartling in South Africa (e.g., GOET024418: Bartling, c.b.sp. Tafelberg; Tropicos: http://legacy.tropicos.org/Person/379; Gunn & Codd, 1981) is therefore presumably erroneous. Plants from Egypt are probably from F.W. Sieber (1789–1844).

Some specimens in the Herrenhausen Herbarium bear the name "E. Wendland" as the collector; e.g., GOET023625 ("Do. E. Wendland legit p. Carlsruh.") and GOET023685 ("Legit E. Wendl. prop. Rhein"). This might refer to Franz Conrad *Ernst* Wendland (1803–?), the youngest stepbrother of HLW (Peters, 2013). Ernst Wendland did not publish any botanical works, and apparently emigrated to the U.S.A. in 1838 (Peters, 2013). HLW mentioned his stepbrother Ernst in a handwritten life story, but he doubted his emigration to the U.S.A. (H.L. Wendland, 1868/1869, http://digitale-sammlungen.gwlb.de/resolve?id=00055889, see pages 1 and 73 for data on Ernst Wendland).

Botanical gardens. — As a proof of the extensive connections of the Wendlands and Ehrhart to other institutions, many specimens in the Herrenhausen Herbarium have been prepared from cultivated specimens in other botanical gardens. These include for Germany: Berlin (Hortus Regius Botanicus Berolinensis), Bonn, Göttingen (Hortus Botanicus Gottingensis, e.g., "Dr. Bartling Hort. Goett. 1822"), Hamburg (Flottbeck, e.g., "Flottb. 1833"; Hortus Botanicus Hamburgensis, e.g., "e. Hort. Hamburg Do. Ohlendorf 1833"), Karlsruhe (Hortus Carlsruhanus, e.g., "e. H. Carlsruh.") and Schwetzingen (Hortus Schwetzingen, e.g., "Ex H. Swezingen"). For Sweden, there are specimens from the botanical garden in Uppsala (Hortus Upsaliensis) and they are obviously connected to Ehrhart. Dutch specimens are from Leiden (Hortus Botanicus Leiden) and Utrecht (Hortus Ultrajectinus) and Ehrhart collected probably most of them during his journey to the Netherlands in 1782 (Ehrhart, 1788). Additional botanical gardens include those in Vienna (Hortus Botanicus Vindobonensis, e.g., "e. Hort: Vindob. 1835"; Hortus Caesareus Schoenbrunnensis) for Austria, and Copenhagen (Hortus Regius Botanicus Hafniensis, e.g., "e. H. Hafnien. 25") for Denmark. Botanical Gardens from the United Kingdom are abbreviated as "Hort. Angl." or "H. Anglorum", and it is not clear which garden this abbreviation refers to. The connections between the Herrenhausen Gardens and the nurseries of Loddiges, as well as Lee and Kennedy, suggest that the specimens might be from there, but there are also specimens from the Kew Gardens (Peters, 2013).

Trading nurseries. — Numerous plants and seeds for the Herrenhausen Gardens were obtained from the famous trading nurseries "Loddiges" (The Botanical Garden of Mr. Loddiges, Hackney, near London) and "Lee and Kennedy" (The Vineyard Nursery in Hammersmith, west of London) (H. Wendland,

1854; Peters, 2013; Fischer & al., 2015). Numerous specimens from these nurseries are found in the Herrenhausen Herbarium and some of them have been used by the Wendlands for the description of new taxa (e.g., GOET027613: "*Acacia longissima* mihi Lee", lectotype of *Acacia longissima* H.L.Wendl., see Dowe & al., 2019). Also collections from the famous "James Veitch & Sons, Royal Exotic Nurseries, King's Road, Chelsea" are represented in the Herrenhausen Herbarium. In the palm collection, we identified numerous specimens from collectors that worked for the Veitch Nurseries, for example plants collected by Guillermo Kalbreyer (1847–1912) in Colombia (e.g., GOET025246).

■ CONCLUSION

This is a detailed analysis of the complete Herrenhausen Herbarium donated to GOET in 1969, after a first survey provided by Wagenitz (1972). The major findings of our study are that the Herrenhausen Herbarium is a valuable collection that contains specimens collected by important botanists such as Linnaeus and five of his students (Afzelius, Bergius, Ehrhart, Schreber, Thunberg), and that it is possible to complement the scarce specimen label information with literature and travel reports, so that a detailed list of specimens of a collecting journey can be obtained and label information can be substantiated. We demonstrated that a complete inventory and digitization of a collection is a prerequisite for such a study. Botanists have long been calling for more funds for digitization of whole herbarium collections, but funding sources for basic work at collections are scarce in many countries (e.g., Borsch & al., 2020). The Herrenhausen Herbarium is important for typification of the numerous taxa described by the three Wendlands. We describe here for the Herrenhausen Herbarium ordered according to the Linnaean System that the herbarium sheets serve as a cover for the specimens, instead of the underlay, and that the information on the sheets on which specimens are placed therefore belong to the subsequent specimen. In this context, the description of the unusual arrangement of specimens in the Herrenhausen Herbarium in the Linnaean System is essential so that the correct specimen will be selected for lectotypification.

■ AUTHOR CONTRIBUTIONS

All three authors conceived the project. MER-D conducted the digitization, with contributions from MSA. EH and MSA determined the specimens. MER-D wrote an initial manuscript with contributions from MSA, and all authors contributed to the final version. — MER-D, https://orcid.org/0000-0001-6820-2029; EH, https://orcid.org/0000-0002-7600-1128; MSA, https://orcid.org/0000-0003-4864-5003

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Appendix 1. Collectors represented in the Herrenhausen Herbarium at GOET. Biographical information on these collectors was obtained mainly from: Australian Botanist's Companion (George, 2009), Australian Plant Collectors and Illustrators (CHAH, 2017), Deutsche Biographie (2021), Fischer & al. (2015), Harvard University Herbaria & Libraries (HUH, 2021), Index Collectorum of the Göttingen Herbarium (Wagenitz, 1982; Index Collectorum, 2021), JSTOR-Global Plants Plant Collectors (JSTOR, 2021c) and Tropicos Person Search (Tropicos, 2021).

Family name	First name(s)	Birth-death dates	Country (origin of Herrenhausen herbarium specimens)	Comment
Anderson	James	1797–1842	Australia	
Aublet	Jean Baptiste Christophe Fusée	1720–1778	Guyana (Essequibo)	Specimen from Herb. Lammersdorf. See under "Collectors"
Balfour	Isaac Bayley (Sir)	1853–1922	Mauritius (Rodrigues), Réunion (Bourbon)	
Baron	Richard	1847–1907	Madagascar	
Barter	Charles	?–1859	Nigeria	
Bartling	Friedrich Gottlieb Theophil	1798–1875	Austria, Croatia, Germany, Hungary, Italy	See under "Collectors". Not confirmed: Egypt, Hispaniola, Martinique, Mexico, Norway, South Africa, Spain, Sweden
Beckler	Hermann	1828–1914	Australia	
Beier	?	?	Germany (Botanical Garden in Karlsruhe, Baden-Württemberg, cultivated)	No biographical information found
Berlandier	Jean Louis	1805–1851	Mexico	
Bieberstein	Friedrich August Marschall von	1768–1826	Russia (Gorenki Botanical Garden, near Moscow; Horto Gorenkiensi)	

(Continues)

Appendix 1. Continued.

Family name	First name(s)	Birth-death dates	Country (origin of Herrenhausen herbarium specimens)	Comment
Bischoff	? G.G.	? (fl. 1852)	cf. U.S.A. (Carolina)	Possibly G.G. Bischoff (https://www.tropicos.org/person/100075350)
Boivin	Louis Hyacinthe	1808–1852	Madagascar	
Brunner	Carl Emmanuel	1796–1869	France, Italy, Switzerland	Fischer & al. (2015). It is possible that some specimens were collected by Samuel Brunner (1790–1844), brother of C.E. Brunner
Crüger	Hermann	1818–1864	Trinidad	
Cuming	Hugh	1791–1865	Philippines	
Curtiss	Allen Hiram	1845–1907	U.S.A. (Florida)	On label "A.B.Curtiss"
Dallachy	John	1820–1871	Australia	
Dämel	C.F. Eduard	1821?–1900	Australia	
Dammer	Carl Lebrecht Udo	1860–1920	?	
De Vriese	Wilhelm Hendrik	1806–1862	Indonesia	
Dieffenbach	Joseph	1796–1863	Austria	
Drège	Johann Franz	1794–1881	South Africa	From Herbarium W. Sonder
Duchassaing de Fontbressin	Edouard Placide	1818–1873	Guadeloupe	
Ecklon	Christian Frederik	1795–1868	South Africa	Ecklon collected (p.p.) with Zeyher, C.L.P. Specimens in Herrenhausen from Herbarium W. Sonder
Eggers	Heinrich Franz Alexander von	1844–1903	Puerto Rico	
Ehrhart	Jakob Friedrich	1742–1795	Germany, Netherlands, Sweden, Switzerland	See under "Smaller collections" and "Collectors"
Engel	Franz	1834–1920	New Granada (Colombia, Venezuela)	
Falconer	Hugh	1808–1865	India	
Fendler	August	1813–1883	America	
Fischer	Christian Abraham	1785–1836	Germany	
Funck	Nic(h)olas	1816–1896	New Granada (Colombia, Ecuador, Venezuela)	Collected with Schlim, L.J.
Galeotti	Henri Guillaume	1814–1858	Mexico	
Gaudichaud-Beaupré	Charles	1789–1854	Philippines	Voyage de la Bonite, ex. Herb. Delessert
Gay	Jacques Étienne	1786–1864	France	
Ghiesbreght	Auguste Boniface	1810–1893	Mexico	
Good	Peter	?–1803	Australia	
Griffith	William	1810–1845	Afghanistan, India, Malaysia	
Gulliver	Benjamin Thomas	1851–1938	Australia	
Hahn	? Leonhard Ernst Gottlob	1807–1887	Germany	Not confirmed: collector in Spain (Tenerife), Index Collectorum (2021). Also possibly Hahn, Ludwig (1836–1881), see Urban (1902: 54–55)
Hart	John Hinckley	1847–1911	Jamaica	
Hegewisch	Ernst Friedrich Adolph	?	Mexico	
Helfer	Johann Wilhelm	1810–1840	India (Khasi Hills)	

(Continues)

Appendix 1. Continued.

Family name	First name(s)	Birth-death dates	Country (origin of Herrenhausen herbarium specimens)	Comment
Hesse	Christian Heinrich Friedrich	1772–1832	South Africa	
Hildebrandt	Johann Maria	1847–1881	Madagascar	
Hillebrand	Wilhelm (William)	1821–1886	Hawaii (Sandwich Islands)	
Hoffmann	Carl (Karl)	1823–1859	Costa Rica	See under "Smaller collections" and "Collectors"
Hoffmannsegg?	Johann Centurius von	1766–1849	Aleutian Islands (Unalaska)	Collector uncertain. Specimens collected by Chamisso, L.A. von (1781–1838) in Unalaska are known
Hohenacker	Rudolph Friedrich	1798–1874	Algeria, India	Collector or editor of exsiccates
Hooker	Joseph Dalton	1817–1911	India	
Hübener	Johann Wilhelm Peter	1807–1847	Lapland (Finland, Norway, Sweden, Russia)	
Jenkins	Francis (Colonel)	1793–1866	India	
Jenman	George Samuel	1845–1902	Guyana (Demerara)	
Jürgensen	C.	fl. 1843–1845	Mexico	First date collected: 1840 (HUH, 2021)
Kalbreyer	Wilhelm (Guillermo)	1847–1912	Colombia	Collector for Veitch Nurseries
Karsten	Gustav Carl Wilhelm Hermann	1817–1908	Colombia	
Kegel	Hermann Aribert Heinrich	1819–1856	Surinam	
Korthals	Pieter Willem	1807–1892	Borneo (Brunei, Indonesia, Malaysia)	
Koschny	Theodor Franz (Teodoro Francisco)	?–1913	Costa Rica	
Lammersdorf	Johann Anton	1758–1822	cf. France (Hort. Paris, cultivated)	See also under Aublet
Láng	Franz Adolf (Adolf Ferenc)	1795–1863	Hungary	
Lauterbach	Carl (Karl) Adolf Georg	1864–1937	Papua New Guinea	
Lee				See under "Trading nurseries"
Leprieur	François Mathias René	1799–1869	French Guiana	Ex herb. Delessert
Lichtenstein	Martin Hinrich Carl	1780–1857	South Africa	
Liebmann	Frederik Michael	1813–1856	Mexico	
Linden	Jean Jules	1817–1898	New Granada (Colombia, Venezuela)	
Lobb	Thomas	1820–1894	Singapore, India, Borneo	Collector for Veitch Nurseries
Loddiges	Conrad (1738–1826) & George (son, 1784–1846)			See under "Trading nurseries"
Ludwig	Carl Ferdinand Heinrich	1784–1847	South Africa	From Herbarium W. Sonder
Mann	Gustav	1836–1916	Equatorial Guinea (Bioko), Gabon, India	
Masters	John White	c. 1792–1873	India	
Mathews	Andrew	1801–1841	Peru	
Mélinon	Eugène M.	1818–1879?	French Guiana	
Mertens	Karl (Carl) Heinrich	1796–1830	Federated States of Micronesia (Üalan. Ins. Carolin.), Guam (Guahan)	
Meyer	? Ernst Heinrich Friedrich	1791–1858	Germany	
Micholitz	Wilhelm	1854–1932	Congo Republic (Loango), Philippines	
Moritz	Johann Wilhelm Karl	1797–1866	Probably Venezuela (Colombia is written on label)	
Müller	Ferdinand Jacob Heinrich von	1825–1896	Australia	

(Continues)

Appendix 1. Continued.

Family name	First name(s)	Birth-death dates	Country (origin of Herrenhausen herbarium specimens)	Comment
Müller	Franz August	1798–1871	Italy	
Neitner		1854–?	Sri Lanka	
Niven	(David) James	1774–1826	South Africa	From Herbarium W. Sonder
Ohlendorff	Johann Heinrich	1788–1857	Germany (Botanical Garden Hamburg)	
Otto	Carlos Federico Eduardo (Karl Friedrich Eduard)	1812–1885	Venezuela, Cuba	
Otto	Christoph Friedrich	1783–1856	Germany	Plants probably sent by Otto, C.F. from the Botanical Garden in Schoeneberg, near Berlin, to the Wendlands
Pearce	Richard William	?–1863	South America	Collector for Veitch Nurseries (HUH, 2021)
Poiteau	Pierre Antoine	1766–1854	French Guiana	Ex herb. Delessert
Preiss (Preiß)	Johann August Ludwig	1811–1883	Australia	
Presl	Karl Boriwoj	1794–1852	Austria, Czech Republic, Italy, Switzerland	
Reichenbach	Heinrich Gottlieb Ludwig	1793–1879	Germany (Hort. Frege, Schloss Abtnaundorf, near Leipzig)	
Retzius	Anders Jahan	1742–1821	South Africa	Herb. Retz. Probably not collector (not cited in Gunn & Codd, 1981)
Roemer	Johann Jacob	1763–1819	Switzerland	
Sadler	Joseph	1791–1849	Hungary	
Sanderson	John	1820–1881	South Africa	From Herbarium W. Sonder
Schiede	Christian Julius Wilhelm	1798–1836	Mexico	
Schlim	Louis Joseph	1819–1863	New Granada (Colombia, Ecuador, Venezuela)	Collected with Funck, N.
Schmalz	Edward (Eduard)	1801–1871	Germany	
Schott	Heinrich Wilhelm	1794–1865	Austria, (cf. Brazil)	
Schrader	Heinrich Adolph	1767–1836	Germany (p.p. cultivated)	
Seemann	Berthold Carl	1825–1871	Republic of Fiji, Venezuela	
Sieber	Franz Wilhelm	1789–1844	South Africa, Egypt	From Herbarium W. Sonder
Simons	Charles J.	?	India	Collecting dates: 1820–1851 https://plants.jstor.org/stable/10.5555/al.ap.person.bm000334684
Thunberg	Carl Pehr (Peter)	1743–1828	South Africa	
Timm	Joachim Christian	1734–1805	cf. Germany, cultivated	E.g., GOET023796: label Ehrhart "1792 H. Timm"
Traunfellner	Aloys	1782–1840	Austria, Croatia, Italy, Slovenia	
Triana	Jose Jeronimo	1834–1890	Colombia	
Vahl	Martin (Henrichsen)	1749–1804	?	
Veitch	(cf.) John Gould	1839–1870	?	"E. hort. Veitch", Veitch Nurseries. See under "Trading nurseries"
Waitz	Friedrich August Carl	1798–1882	Indonesia (Java)	
Wallis	Gustav	1830–1878	Philippines (Manila)	Collector for Linden and (later) Veitch
Warburg	Otto	1859–1938	Indonesia (Aru Islands)	
Warszewicz	Josef Ritter von Rawicz	1812–1866	Central America (Panama or Costa Rica)	

(Continues)

Appendix 1. Continued.

Family name	First name(s)	Birth-death dates	Country (origin of Herrenhausen herbarium specimens)	Comment
Weihe	Carl Ernst August	1779–1834	Czech Republic, Germany	
Wendland	Franz Conrad Ernst	1803–?	Germany	See under "Collectors"
Wendland	Heinrich Ludolph	1792–1869	Austria, Czech Republic, Germany, Poland, Switzerland, United Kingdom	
Wendland	Johann Bernhard Daniel Hermann	1825–1903	Costa Rica, Germany, Guatemala, El Salvador	
Wendland	Johann Christoph	1755–1828	Germany	
Wight	Robert	1796–1872	India	
Willdenow	Carl Ludwig	1765–1812	Germany, Switzerland	
Wright	Charles (Carlos)	1811–1885	Cuba	
Wright	William Greenwood	1831–1912	U.S.A. (California)	
Wullschlaegel	Heinrich Rudolph	1805–1864	Antigua and Barbuda (Antigua), Surinam	
Zeyher	Carl Ludwig Philipp	1799–1858	South Africa	Collected (p.p.) with Ecklon; specimens from Herbarium W. Sonder
Zeyher	Johann Michael	1770–1843	Germany (Botanical Garden in Schwetzingen, Baden-Württemberg)	
Ziz (Zyz, Zis)	Johann Baptist	1779–1829	Germany	
Zollinger	Heinrich	1818–1859	Indonesia	

Appendix 2. Collectors represented in the Ehrhart Herbarium at GOET. For some collectors, the first name(s) and dates of birth/death could not be determined.

Family name	First name(s)	Birth–death dates	Abbreviation used by Ehrhart	Comment
Afzelius	Adam	1750–1837	Afz.	
Andreae	Johann Gerhard Reinhard	1724–1793	A.	
Bergius	Peter Jonas	1730–1790	Berg.	
Brakel	Zacharias	ca. 1729–1806	Brak. (H. Ultr. Brak.)	See Ehrhart (1788)
Buek	Johann Nikolaus	1736–1812	Buek	
Ehrhart	Jakob Friedrich	1742–1795	–	
Gärtner	Joseph	1732–1791	Gaertn.	
Girtanner	Christoph	1760–1800	Girt.	
Haller	Albrecht, fil.	1755–1821	Hall.	Ehrhart used the same abbreviation for Albrecht von Haller pat., but given the date of acquisition, this probably refers to the son. The handwriting is not that of Albrecht von Haller pat.
Hedwig	Johann	1730–1799	Hedw.	
Hellwig [Helwing]	Johann Christian Ludwig	1743–1831	Helw./Hellw.	
Hoppe			Hopp.	Either David Heinrich Hoppe (1760–1846) or Johann Conrad Hoppe (1728–1783)
Jordan	Johann Ludwig	1771–1853	J.	
Lammersdorf	Johann Anton	1758–1822	Lam.	
Linnaeus	Carl	1707–1778	L.	
Lundmark	Johan Daniel	1755–1792	Lundm.	
Neuenhahn	Carl Christian Adolph	1745–1807	Nh.	Questionable because Hoffmann lists abbreviation as Neuenh.

(Continues)

Appendix 2. Continued.

Family name	First name(s)	Birth–death dates	Abbreviation used by Ehrhart	Comment
Pflug	J.P.G.	1741–1789	Pflug, Pfl.	Praef. Hort. Bot. Copenhagensis (G.F. Hoffmann, 1824)
Reichard	Johann Jacob	1743–1782	Reich.	
Schaper			Schap.	Botan. (G.F. Hoffmann, 1824)
Scholler	Friedrich Adam	1718–1795	Scholl.	
Schreber, von	Johann Christian Daniel	1739–1810	Schreb.	
Sieveking	Georg Heinrich	1751–1799	Sievek.	
Starke			Stark.	Preco et Bot. Siles. (G.F. Hoffmann, 1824)
Voigt			Voigt	(D.), Botan. (G.F. Hoffmann, 1824)
Weber [Weberd]	Georg Heinrich	1752–1828	Web.	
Wiborg			Wib.	
Wyttenbach	Jakob Samuel	1748–1830	Wytt.	
Zier	John	?–1793	Zier	
Unclear:				
Name				Comment
Bruct., Bruck. or Bruch.				
h. Kohl or h. Rohl				Pohl is listed in G.F. Hoffmann (1824), but the letter is most likely not a "P". It could stand for Daniel Rolander (1723–1793), but Ehrhart used the abbreviation "Rol." for him
H.H.B.				
H.H.W.				Either Hortus Hannoveranus Wendland or Hortus Hannoveranus Wedemajeri
h.hej.				