

Between Metropole and Province: circulating botany in British museums, 1870–1940

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ABSTRACT: Exchange of duplicate specimens was an important element of the relationship between metropolitan and regional museums in the period 1870–1940. Evidence of transfers of botanical museum objects such as economic botany specimens is explored for the Royal Botanic Gardens, Kew, and six museums outside the capital: Cambridge University Botanical Museum, National Museum Wales, Glasgow Museums, Liverpool World Museum, Manchester Museum and Warrington Museum. Botany became an important element in these museums soon after their foundation, sometimes relying heavily on Kew material as in the case of Glasgow and Warrington, and usually with a strong element of economic botany (except in the case of Cambridge). Patterns of exchange depended on personal connections and rarely took the form of symmetrical relationships. Botanical displays declined in importance at various points between the 1920s and 1960s, and today only Warrington Museum has a botanical gallery open to the public. However, botanical objects are finding new roles in displays on subjects such as local history, history of collections, natural history and migration.

KEYWORDS: economic botany – plant specimens – Royal Botanic Gardens – Kew – Manchester Museum – Cambridge University Botanical Museum – Warrington Museum – World Museum Liverpool – National Museum Wales – Glasgow Museums.

INTRODUCTION

Recent studies of nineteenth-century regional museums have situated those institutions in wider networks of collecting and display, highlighting their connections beyond their immediate communities (Alberti 2002; Hill 2005). Alberti (2002: 291–292) has argued that regional collections were in many ways modelled on metropolitan ones, and often interacted with, and were dependent on, them for specimens; he continues: “[they] nonetheless exhibit particular characteristics, developments and forms, and a distinct range of social groups engaged with them as owners, collectors, curators and audiences.”

Botanical collections and displays, whether as free-standing entities or as galleries within larger museums, occupied a prominent position in museum culture between 1870 and 1940. Quantitatively, in 1887 botanical specimens accounted for an estimated 12% of the total collections held in regional museums, third in place after geology and zoology (Ball *et al.* 1887: 114). We have identified a minimum of 40 museums in the United Kingdom that had significant botanical displays, most of which have now vanished, or in a few cases become incorporated into thematic natural history and local history displays (Nesbitt and Cornish 2016).

The content of such botanical collections typically comprised both a reference element, in the form of pressed plant specimens forming an herbarium and kept in closed cupboards, and a display element of plant parts such as fruits and seeds, and economic botany specimens such as woods, fibres and artefacts. Models, made of plaster, wax, papier mâché or glass, were also a prominent feature. We have argued elsewhere that economic botany collections, particularly those formed in the nineteenth century, were and sometimes still are recognizable by their hybrid or “biocultural nature” (Salick *et al.* 2014; Nesbitt and Cornish 2016). Assemblages of specimens and artefacts, they represent a point of encounter between nature and culture, an alternative way of viewing plants – as raw materials, and a distinctive display aesthetic.

The formation and use of herbaria in British and Irish museums has been relatively well studied, as these collections form the continuing basis of the countries’ botanical inventory and thus attract interest from present-day botanists (Kent and Allen 1984; Penn *et al.* 2018). Such studies often take a national perspective, emphasizing the complex movements and aggregations that have led to the current composition of herbarium collections. The exchange networks by which individual botanists built up collections have also been a focus (Groom *et al.* 2014). In contrast, botanical displays and their varied contents have only been studied at the level of individual collections, as in the case of Kew (Cornish 2015, 2017) or within broader museum histories, as at the Royal Botanic Garden, Edinburgh (Fletcher and Brown 1970).

THE ROLE OF DUPLICATES

With the passing of the Museums Act in 1845, municipal boroughs of over 10,000 inhabitants in the United Kingdom were empowered to build and maintain “Museums of Art and Science”, funded by raising the annual rates one halfpenny in the pound.¹ Although the initial response from boroughs was hesitant (by 1853 only 11 boroughs were making provision for a museum under the act),² by the publication of the British Association for the Advancement of Science’s Report on provincial museums in 1887, there were 55 museums supported by local boroughs, making this the single largest category amongst regional museums in the United Kingdom (Ball *et al.* 1887).

However, the report criticized many museums for the patchiness of their collections and for the lack of a systematic collecting policy, relying, as was the tendency, on donations. This practice it described as a “desultory method of accumulating a promiscuous mass of objects” (Ball *et al.* 1887: 118). Another issue raised was the accumulation of duplicates in particular museums, and the need was flagged for a “well-understood system of exchange” (1887: 126). Birmingham, Brighton, Nottingham, Salford and Cardiff were cited as sites of institutions where duplicates were distributed to schools or other museums “as fast as they

come in” (1887: 126).; and the Dublin Science and Art Museum was, by this time, establishing a duplicate department for periodic distributions to other Irish museums.

The subject of metropolitan museums supporting their regional colleagues was a recurrent theme in the museum literature of the nineteenth and early twentieth centuries, and, beyond London, museums themselves were also taking initiatives in this regard. An 1876 address given by William Boyd Dawkins (1837–1929), Curator of the Owens College Museum (now Manchester Museum), entitled “The need of museum reform”, acted as a stimulus for many museum stakeholders (Anonymous 1876: 129). So, for example, in January 1877 a conference of mayors and chairmen of regional museum committees met in Birmingham to consolidate their claims to a share of the surplus funds from the Great Exhibition of 1851, and to a share of the duplicates “stored away in Government collections” (Howarth 1877: 276). There also ensued a flurry of correspondence in the pages of *Nature* over the summer of 1877, with discussion centred on the themes of the arrangement and development of collections (Dawkins 1877: 78–79). The rate local authorities could raise to pay for museums was by now one penny, but it was still woefully inadequate for museums tasked with building collections, and the duplicates held by metropolitan museums were one of the means identified to expand regional collections (Lewis 1989: 1–7). James Paton (1843–1921), Superintendent of Glasgow’s City Industrial Museum, of whom we will hear more later, advocated a duplicates exchange programme between all museums and called for the “great institutions” to act “in loco parentis” regarding the dispersal of their duplicates (Paton 1877a: 183).

In 1878, a bill was raised by John Lubbock, Robert Lowe and Spencer Walpole to enable the transfer of the British Museum’s natural history collections to the new British Museum (Natural History) in South Kensington – today the Natural History Museum; Anthony Mundella and Joseph Chamberlain, MPs for Sheffield and Birmingham respectively, proposed the insertion of a clause to the effect that “the Trustees of the British Museum may also give away any duplicate works, objects, or specimens not required for the purposes of the Museum”.³ Though their suggestion was not acted upon, this was nevertheless a signal moment in the increasingly concerted effort to establish a system of duplicates’ redistribution from metropolitan to regional institutions.

THE ROLE OF KEW

In 1838, botanist John Lindley (1799–1865) was appointed by the Government to conduct an inquiry into the future of the Royal Gardens at Kew. In a landmark report, Lindley recommended Kew’s transfer from royal estate to the public purse “for the promotion of Botanical Science throughout the Empire”,⁴ and in 1841 Sir William Jackson Hooker (1785–1865) became the first director of the new, state-funded Kew. Without specific instructions from the Commissioners of Woods and Forests,⁵ Hooker adopted Lindley’s recommendations as Kew’s unofficial charter. Six years later he opened the Museum of Economic Botany at Kew.⁶

In his report, Lindley had proposed that “the Garden should be perfectly adapted to the three branches of instruction, exhibition, and supply.”⁴ “Supply” is perhaps the term which requires some explanation and refers to Kew’s role in circulating plants to other gardens at home and abroad. From the beginning, the Kew Museum addressed directly the issues of instruction and exhibition, but it took a little longer to develop a systematic approach to

supplying other museums. The reasons became clear at the hearings of the Devonshire Commission (1870–1875), when Joseph Dalton Hooker (1817–1911), then the second director of Kew, was asked if the Kew Museum had duplicate objects to supply to other museums:⁷

— I should think very largely. The difficulty is in making application at the right time. Hitherto duplicates have been distributed as fast as possible, because they take up a great deal of room and encourage insects. My plan has hitherto been, whenever I receive a collection, whether from a Government Expedition or from a private source, to have it at once named and catalogued, the first complete set deposited in the herbarium or museum, and the duplicates distributed.

It was, therefore, only a matter of time before the Kew Museum assumed the role of botanical duplicates supplier to the museum community, and the opportunity eventually came with the closure of the India Museum in 1879. Kew took delivery of the India Museum's vast botanical and economic-botanical collections, and to enable Kew staff to sort and distribute them, the India Office also provided a building – a shed known as the “iron house”. The exercise took a year to complete, but at the end Kew retained the iron house and a reserve collection of Indian specimens and artefacts, to be used “for the supply of future applicants”, providing the basis for future, more systematic, distributions of museum objects (Hooker 1880: 59–60). With this came new administrative practices, notably the introduction of the “exit” or “Specimens Distributed” books to record such transactions (Cornish and Driver 2019).

SOURCES AND METHODOLOGY

The facility with which botanical specimens, economic and otherwise, were transferred between collections, owed much to the practice of field collectors of gathering multiple specimens, specifically for exchange with private and institutional collectors. The distribution of duplicate specimens was essential both to the development of botanical displays in regional museums, and to the function of the Royal Botanic Gardens, Kew. This was a distinctive function for Kew; the British Museum (Natural History) in London restricted its distribution activities to the exchange of herbarium specimens (Anonymous 1931: 55). We have excluded herbarium specimens from this study, both because they are already better researched, and because they did not form the main display component in museums, being generally kept in cupboards except when required for teaching or research. Our focus is therefore on the essentially three-dimensional specimens of plant parts, economic botany and models that made up the displays most often encountered by museum visitors.

At Kew, distribution of this type of material was handled by the Museum of Economic Botany, founded in 1847 and today rehoused in a modern store and known as the Economic Botany Collection. The Museum's documentation is exceptionally complete and includes Museum Entry books (1847 to present day), Museum Distribution books (1881 to the end of duplicate distribution in 1990),⁸ correspondence in Kew's central archive, and an irregular series of annual reports. Analysis of these shows that between 1847 and 1914, the Kew Museum distributed an estimated 59,000 objects to over 1,100 institutions (and some individuals), of which 690 were schools. From 1881, the Exit Books usually give a brief description for each item sent from Kew; for dates before this, such as the large distribution to Glasgow's City Industrial Museum in 1879, we use data held at recipient museums. It was possible for the Kew Museum to distribute so many objects because it often requested and received them in multiples, retaining one at Kew, or because they could be subsampled by

removing portions, for example from specimens of fibre, dye or paper. Museum exits are summarized in the supplementary online data, as are objects received at Kew from the case study museums. For regional museum histories, we draw on the local knowledge of curators – this study would have been impossible as a purely library-based project – and on minute books, annual reports, guidebooks and museum histories, mostly unavailable outside the relevant institution.

CASE STUDIES

Our sample of museums represents a range of geographies, of institutional types, and of partnerships with Kew.

There are institutions notable for having received large numbers of objects (City Industrial Museum, now Glasgow Museums); for the frequency or longevity of their interactions with Kew (Manchester Museum and Cambridge University Botanical Museum); as an early example of a municipal museum (Glasgow and Warrington (roughly halfway between Liverpool and Manchester)); or because they had, and in some cases, still have, economic botany collections (Manchester Museum, Liverpool Museum, now World Museum, National Museums Liverpool, and Amgueddfa Cymru – National Museum Wales).

Below, accounts of these six museums are arranged in chronological sequence, according to when they first received material from Kew.

Glasgow

The City Industrial Museum, situated in Kelvingrove House, Kelvingrove, opened to the public in 1870 to collect and display examples of engineering and manufacturing in the local area. In 1877, James Paton produced the first *Sketch Guide to the City Industrial Museum of Glasgow*, with floor plans showing the location of displays entitled “Economic Vegetable & Mineral Products” and “Textile Manufactures & Food Collection” (Paton 1877b). As described in the museum’s annual report for 1902 (Anonymous 1903), plant specimens were primarily displayed as part of the Technological Collections under the categories of “Raw Products of Commerce” and “Manufacturing Processes and Products”. There is no record of the contents of the Museum’s herbarium, but it was kept in closed cases in the gallery.⁹ Diary entries between 1891 and 1894 record “showing herbarium” as an activity assigned to a member of staff two or three times per year.¹⁰

In 1902, the collections were transferred to the new Kelvingrove Art Gallery and Museum. Economic botany specimens remained in the technical section, while examples of objects manufactured from plant materials were exhibited as ethnography (now World Cultures), archaeology and local history. A pencilled note of 1921, added to an 1880 registration entry for Kew material, records that “many specimens of this collection decayed beyond recognition and destroyed”. The surviving objects from Kew are now in the World Cultures collection and are described in more detail later. The practice of displaying plant material in relation to human activity was not unique in Glasgow to Kelvingrove. It was also adopted at Tollcross House (opened 1905), a children’s museum which housed a display of “the uses mankind makes of materials” (Eggleton 1936).

Glasgow Museums’ botany collection is today primarily a research collection, and displays, where they have occurred, have almost always utilized living plants or models. From the mid-1940s until the time of the appointment of the Museums’ first botany curator, Gwyneth



Figure 1. Annual display of local wild plants in Kelvingrove Museum, Glasgow, 1949. © CSG CIC Glasgow Museums Collection. Glasgow Museums Collection CC BY-NC 4.0.

Jones in 1976,¹¹ plants were represented solely in the summer display of wild flowers (Figure 1).¹² This annual exhibition was introduced by William Rennie, an amateur enthusiast, and subsequently maintained by members of the Andersonian Natural History Society.¹³ “Habitat cases” were introduced in the 1980s in which models were used to represent plants; and in the 1990s the “Green Area” was an initiative at Kelvingrove to create interactive displays on environmental conservation. Living plants have featured strongly in various displays concerning, for example, the growth of trees, and plants used as dyes.¹⁴ In the World Cultures collection, existing and more recently-acquired ethnobotanical specimens have been included in the “Charms and Healing”, “Ancient Tea Horse Road” and “Life in the Rainforest” displays at Kelvingrove. Indeed, it is in these displays that Natural History and World Cultures once again come together. There are also botanical specimens in Kelvingrove’s Environment Discovery Centre and the “Wild about Glasgow” displays which feature sections on taxonomic groups, food chains and seed dispersal.¹⁵

Glasgow and Kew

Glasgow City Industrial Museum was not only the first of the museums in our sample to receive items from the Kew Museum; it also led the way in terms of the volume of objects received, amounting to an estimated total of 5,200 plant specimens, plant products and plant-based artefacts between 1877 and 1881. Paton, as we have seen, was a vocal believer in

the duty of national museums to help the regionals, and an eloquent advocate of a “permanent union among museum officers” (Paton 1877a: 183).

Transactions began in 1877 when Kew sent quantities of unspecified “vegetable products”, repeated in 1878. Further transfers occurred with the redistribution from Kew of the India Museum’s botanical collections, alluded to earlier (Desmond 1982: 169). Glasgow City Council was among the first claimants.¹⁶ Thiselton-Dyer invited Paton to the Indian Galleries at the South Kensington Museum (where the collections had been housed since 1875), to make a selection before the collections were transferred to Kew. Paton’s objects were despatched in December 1879 and consisted of 14 cases containing products such as dyes, drugs, tea, coffee, cereals and cotton; one carved Blackwood sideboard; and 19 packages containing stands for swing cases. Shortly thereafter, in January 1880, a box, containing ten cases of specimens to mount on the stands, was also received.¹⁷

Of all the objects sent from Kew, only 51 survive. Geographically they represent Asia, Oceania and Europe. Chronologically they stretch from the first millennium BC to the late nineteenth century, from Egyptian “mummy cloth” to contemporaneous commercial samples of cotton and paper, and artefacts such as an Indian fan made of Vetiver root (*Andropogon muricatus*). Bark-cloth accounts for over one fifth of the “Kew” items, including historically significant specimens of tapa from the Pacific region, collected by Prince Alfred (1844–1900) in Tahiti in 1869 (see also “Warrington” below). Papers, made from various plants, account for a similar proportion. In the epistemology of economic botany, they all served as examples of the practical uses of plants.

Manchester

Manchester Museum opened its doors to the public in 1887 as a purpose-built museum to house the collections of the Manchester Natural History Society. The Society had been dissolved in 1869 and the collections transferred to Owens College, the forerunner of the University of Manchester (Alberti 2009). The Society’s collection was diverse, containing natural history specimens, archaeological objects and curios, but very little botany.¹⁸ The development of the botanical collections was driven by this new link with the academic institution (Alberti 2009).

Acquisition of economic botany objects was varied. Some specimens were derived from the large donations of James Cosmo Melvill, Charles Bailey and Leopold Hartley Grindon (King 2007, 2009), others were transferred from fellow museums – including Kew – and some were donated by merchants, manufacturers and travellers.¹⁹ The surviving plant-derived raw and partly-processed materials such as fibres, oils and resins are now to be found in the herbarium collection. Fully-worked items such as baskets, jewellery and carved wood, however, are considered as cultural artefacts and are now in the Living Cultures collection.

Inspired by a visit to Kew, Assistant Keeper of Botany Harold Murray (1878–c.1966) wished to appeal to the commercially-minded – a logical approach to engaging the public in the world’s arguably first industrialized city. One of Manchester Museum’s founding principles was to be a public museum open to all, free of charge,²⁰ and in this respect, it was fundamentally different from Cambridge (see below). However, particularly during the early years, there were tensions between the curators and the overseeing academic staff (Alberti 2009). Botany Professor Frederick Ernest Weiss (1865–1953), for example, was an advocate of the museum as a teaching resource for students, believing economic botany would be better pursued in technical institutions (Weiss 1892), and it is pertinent to note here that the 1899 guide to the natural history galleries gives details of botany displays explaining plant

systematics and adaptations. It seems that the growing economic botany collections largely remained in the stores for interested enquirers, with only one case of edible fruits on show to the public (Hoyle 1899).

In more recent times, however, these economic collections have regained a place in the gallery displays. The Museum's vision is one of engaging visitors with two contemporary key issues: building understanding between cultures, and developing a sustainable world. The "Manchester Gallery" (2009–2018) explored the relationship between the collections, the city and its people. It featured stories of journeys and connections, linking objects with collectors and the wider historical contexts of empire, trade and migration. Examples include the cotton magnate Jesse Haworth (1835–1921) funding his passion for Egyptology and presenting his collection to the Museum, and the Manchester Ship Canal, linking Salford and British Columbia through the timber trade. Economic botany specimens were a natural way to explore these stories. In 2011 and 2013, two natural history galleries were redeveloped along taxonomic and sustainable lines: "Living Worlds" explores the relationship between people and nature, while "Nature's Library" celebrates the breadth and diversity of the natural history collections. Economic botany objects have been re-presented to depict nature as an essential resource.

Manchester and Kew

Dispersals from Kew to Manchester fall into two categories: donations to the Museum, where the number of objects ranged from ten to a hundred; and responses to enquiries from academic botanists, usually involving single specimens. Plant parts and products formed the majority of the objects sent to the Museum, including what became a standard element of nineteenth-century botanical collections, the fruit of the Coco de Mer (*Lodoicea maldivica*).

Cambridge

Whilst the first botanical museum at the University of Cambridge was established by John Stevens Henslow (1796–1861) in 1827, it was in effect re-established in 1885 by "two youngsters", Walter Gardiner (1859–1941), then Demonstrator of Botany, and Michael Cressé Potter (1859–1948), Assistant Curator of the Herbarium (Gardiner 1904: 6). They were acting within a new botanical paradigm at Cambridge, where, since the appointment of Sydney Vines (1849–1934) as botany lecturer in 1876, plant science had taken a more physiological or "whole-plant" turn, inspired by the "new botany" from Germany (Grubb *et al.* 2004). Gardiner and Potter were convinced of the need for a teaching collection which was adjacent to the classrooms. The University Museum of Zoology and Comparative Anatomy, established in 1865 in the same building as the botany department, and at this point "still in vigorous growth" (Gardiner 1904: 5), acted as a model. Gardiner was also aware of the "truly magnificent" Museum of Economic Botany at Kew through his scientific associate, Thiselton-Dyer. Gardiner and Potter's first task was to find the remains of Henslow's original museum collection, of which only the dried specimens proved to be in serviceable condition. It should be emphasized here that, unlike Manchester (see "Manchester" above), the Cambridge museum was not conceived of as a public facility: "from its first commencement we have aimed at collecting only such specimens as are definitely required for teaching purposes, and have resolutely excluded all other objects which, from this standpoint, would possess merely a fancy value" (Gardiner 1904: 13). In 1891, management of the Museum passed to Deputy Professor of Botany Francis Darwin (1848–1925). In 1904, under Professor Harry Marshall Ward (1854–1906), the Botany School moved across the road to a new building on the



Figure 2. Cambridge Botanical Museum, 1904. © Cambridge University Herbarium.

Downing site. The Botanical Museum, today used as the first-year teaching lab (Figure 2) was situated on the ground floor in a large, purpose-designed room.

Exchanges between Kew and Cambridge (and between Cambridge and others) continued in the inter-war period. After the Second World War, between 1949 and 1953, the Museum was disbanded and the collections “thinned out”; the herbarium was moved into the space formerly occupied by the Museum; and the library was enlarged and relocated to the former herbarium room. Remaining exhibition cases were transferred to the corridor on the first floor (Grubb *et al.* 2004: 9) or to the Museum of Archaeology and Anthropology. The record is patchy at this stage, but the move was most likely part of a broader trend away from collections-based teaching in the second half of the twentieth century and the subsequent disposal of many teaching collections (Arnold-Foster 2000; Tirrell 2010). As at many other universities in the United Kingdom, the Botany School was renamed the Department of Plant Sciences. As for the unwanted specimens, some were transferred to the University’s botanic garden (part of Plant Sciences), including some of those originally from Kew or incorporated into other collections at Cambridge and elsewhere.²¹

A three-dimensional specimen of stems of the so-called “rice-paper plant”, *Aralia papyrifera*, sent to Henslow by William Hooker in 1857 (Figure 3), and mounted on a wooden block for exhibition, raises the question of modes of display at the Cambridge Botanical Museum. Initially the spirit specimens were kept on open shelves, with the herbarium and carpological specimens in wall-cases. Acquisitions reflected the species featured in students’ textbooks. As the collections grew, the Museum expanded into a second room, and in 1889 the



Figure 3. Specimens of *Aralia papyrifera* Hook. sent to J. S. Henslow by William Hooker in 1855 and now in the Cambridge University Herbarium and Cory Library. © Cambridge University Herbarium.

two rooms were re-arranged according to monocotyledons and dicotyledons, as at Kew. Other elements of display were also redolent of Kew and with good reason: many of the framed botanical wall charts at Cambridge, for example, were donated by the Kew Museum (Gardiner 1904: 13). As Gardiner (1904: 17) said of wall charts, “they do much to decorate and enliven the whole collection, which might otherwise stand in some danger of being deadened and overweighted by the presence of many dried specimens.” In 1888, teaching demonstrations also began to take place in the Museum, further marking it as a space of pedagogy.

Cambridge and Kew

Of the museums reviewed in this paper, the Cambridge Botanical Museum had the most sustained association with the Kew Museum, extending from the 1870s to the 1930s, and it was also the only museum in our sample which had an explicit exchange relationship with Kew. Over this period, several actors were instrumental in Kew–Cambridge relations. The most intense period of activity, from 1886 to 1894, occurred during Gardiner’s time as demonstrator and, from 1888, as botany lecturer. Of the Kew donations, woods, cones, seeds and other plant parts made up the larger part; plant products were in a minority consisting in the main of fibres and exudates. There were no cultural objects. Otherwise, the emphasis was on systematically and morphologically interpretative material: 160 botanical wall charts by Zippel and Bollmann, Leopold Kny, Arnold and Carolina Dodel-Port and Daniel Oliver; cabinets and cases; and 139 glass jars described as “old museum stock”, between 1889 and 1890 alone.²²

Many of the specimens sent were de rigueur items for the emergent category of botanical display: a range of specimens in spirit, including that Victorian sensation, the *Welwitschia*; the carnivorous pitcher plant *Nepenthes*; and, as at Manchester, fruits of *Coco de Mer*.

Albert Charles Seward (1863–1941) succeeded Gardiner in 1906. His correspondence and the specimens sent to him from Kew reflect his research interests,²³ but curiously, in 1930, he wrote to Kew, requesting specimens of tea, coffee and so forth for “an Economic Museum”.²⁴ Thirty-three assorted economic plants and products were sent in response. What became of them, and of the idea of an economic museum at Cambridge, is as yet unknown.

Another key actor was Augustine Henry (1857–1930). Henry, who had trained as a doctor, worked as an official in the employ of the Chinese Imperial Customs Service from 1881 to 1900 and collected plants both as a personal interest and as part of his customs work (Pim 1984). Over the course of his life he sent over 15,000 dry specimens and seeds, 500 plant samples and 123 museum objects to Kew (Nelson 2000: 309–324). He returned to the United Kingdom on his retirement in 1900 and spent the next eight years furthering his knowledge of forestry at Kew and at Nancy. His working relationship with botanist Henry John Elwes (1846–1922) contributed to the establishment of a readership in forestry at Cambridge University, and Henry became the first title holder in 1907 (Forbes 1930). He acted as a middleman between the Kew and Cambridge museums and brokered the donation of various specimens to the Botanical Museum.²⁵

Warrington

Founded in 1848, Warrington Museum, like Manchester, has its origins in a private museum, in this instance founded by the Warrington Natural History Society in 1842. Bryologist William Wilson (1799–1871) was a prominent member and later president of the Society, corresponding with contemporary botanists Henslow, Thomas Taylor (1786–1848) and William Jackson Hooker. In 1847, under the Museums Act (1845), the council took over the Society’s collections and library, amalgamating it with a local antiquarian collection to form one of the first municipal museums in the UK.

Opening on 1 November 1848, the Warrington Municipal Museum was so successful that by 1854 *The Warrington Guardian* reported “it is so crowded on all public occasions, as to defy a proper inspection of its contents” (Anonymous 1854). Consequently, a public subscription was instigated and raised enough funds for a new building which opened 20 September 1855. Mayor William Beaumont (1797–1889) laid the foundation stone, declaring: “let the people of Warrington feel that the Museum is theirs” (Anonymous 1855).

The concept of a “people’s museum” of entertainment and instruction guided the Museum for much of its existence. In 1873, the Museum committee invited botanist James Robinson (1838–84) to carry out a “collections review” of the herbarium, and his findings were highly critical. Botany had moved on since 1848, and whilst the herbarium was still impressive in scope, it was poorly arranged by modern standards. Robinson suggested several remedies, noting at the end that “by application to Dr. [J. D.] Hooker at Kew a representative collection of Indian and other plants could be secured”.

In 1887, Museum curator Charles Madeley (1849–1920) received the first Kew material. A librarian by background, Madeley later became an important figure in UK museums as a founding member and President of the Museums Association. Madeley believed passionately that the ideal museum should be a microcosm of the universe, and that learning from specimens was paramount. Developing economic as well as scientific collections was central to this, because he felt technology and commerce would one day “meet with adequate recognition in



Figure 4. Botany Gallery, Warrington Museum. Photograph by Mark Nesbitt. Reproduced courtesy of Warrington Museum and Art Gallery (Culture Warrington).

the museum” (Madeley 1914). Madeley expanded the botanical collections in Warrington, transforming a reference collection into the basis of an educational museum display; central to this concept was the expansion of the economic botany collections.

From 1905 onwards, Madeley was supported by Assistant Curator Gavin Alfred Dunlop (1869–1933), who continued Madeley’s work after the latter’s death in 1920. A botanist by background, Dunlop introduced the annual “wildflower table”, where local people were invited to contribute plant specimens; these were often later added to the herbarium collection. By focusing on local plants and plant materials that people encountered in their personal and working lives, Dunlop hoped to bring botany to a wider audience. In fact, Dunlop was tapping into the burgeoning field of nature study, an influential movement in the USA in the late nineteenth century, which caught on in the UK in the early twentieth century. In 1902, the first exhibition and conference on the subject were held in the Royal Botanic Society’s gardens in Regent’s Park. Interestingly, a Warrington school, the Training College, won a prize there (Anonymous 1902). Dunlop may, therefore, have become aware of the movement through local or museum press.

Dunlop’s appointment as curator in 1905 coincides with the first mention of the Botany Gallery in the Museum accounts, and even today it remains a rare early twentieth-century survival, still laid out much as Dunlop designed it in the 1920s and 1930s (Figure 4). Roughly half of the gallery is dedicated to the scientific classification of botany, and the remainder to the economic uses of plants in industry, medicine and cooking. Many original Kew specimens remain on display with much of the remainder made up of traditional botanical specimens and donations from local (and not so local) early twentieth-century manufacturers.



Figure 5. Barkcloth *tiputa* from Tahiti, collected by Prince Alfred in 1869 and now at Warrington Museum. Photograph by Mark Nesbitt. Reproduced by permission of Warrington Museum and Art Gallery (Culture Warrington).

Warrington and Kew

The profile of dispersals from Kew to Warrington indicates a relatively long-term, continuous donor-recipient relationship, extending from 1887 to 1932, and spanning the lives of the two curators, Madeley and Dunlop. Both approached Kew with specific requests.²⁶ In the midst of the First World War, Madeley requested specimens of maize and rice “in the ear, with the leaves complete”, for an exhibit of bread substitutes as part of a food economy exhibition.²⁷ Food economy was an active movement in Britain in the early twentieth century, aimed at combatting “undernutrition” amongst the working classes, and at lessening Britain’s dependence on imports. The “most interesting and instructive” Food Economy Exhibition to which Madeley referred was mounted to coincide with a cookery demonstration in Warrington by the “Pudding Lady”, Florence Petty, which was organized by the National War Savings Committee and attracted an audience of 1,000 (Anonymous 1917: 4).

On arrival, Kew acquisitions were split between the botany and ethnology collections. For example, a tiputa or poncho made of bright yellow bark-cloth in the ethnographic collections at Warrington is one of 82 garments given to Prince Alfred in Tahiti in 1869 whilst he was captaining HMS *Galatea* on a world tour from 1867 to 1871 (Figure 5). The collection Alfred formed on tour was displayed at the South Kensington Museum in 1872. Following the exhibition, the entirety of Alfred’s bark-cloth collection was given to Kew’s Museum of Economic Botany, and, over the ensuing years, pieces considered to be duplicates were dispersed to other museum collections, including the Warrington example.

Dunlop’s letters to Kew display all the confidence of a botanist communing with fellow botanists, but they also give us a window into the sort of practices he was adopting at Warrington. The range of seeds he requested in October 1906 was required “to illustrate seed dispersion”; in March the following year he was requesting fresh plant material for drying, making sections and skeletonizing leaves; and from 1918 he began to send his own specimens to Kew for naming.²⁸ Naming at Kew was an herbarium task, so the specimens were duly forwarded to the Kew Herbarium and returned to Dunlop when identified.

In total, 424 objects were dispatched to Warrington over ten events, and they encompass the full range of what then constituted an economic botany collection, from plant parts (71%) to plant products (17%) to artefacts (12%), reflecting in their provenance the imperial geographies to which Kew had access.

Amgueddfa Cymru – National Museum Wales, Cardiff

The National Museum of Wales (NMW) was instituted in 1905, and its royal charter granted in 1907; it opened to the public in 1922. It was founded as a multidisciplinary museum comprising art, archaeology, botany, geology and zoology departments (Bassett 1982, 1983). The Economic Botany Collection has accumulated over time through donation, purchase and bequest, including the gift of the Cardiff Museum Collection in 1912.

1919 marked a key moment in the development of the Economic Botany Collection, when the first paid Keeper, Dr Ethel Miles Thomas (1876–1944), was appointed. As the annual report of 1919–1920 stated, “the making of an economic collection has been begun. About 350 specimens of this nature have been received from the Royal Gardens at Kew, the Imperial Institute, the British Oil and Cake Mills, the Rubber Estate Agency etc. These illustrate important commercial products such as gums, oils, fibres, resins, cotton, rubber etc.” (Anonymous 1920). However, most economic specimens came to the Museum during the 1920s and 1930s. Servicemen and businessmen working abroad sent specimens at a time when the British Empire was at its peak.

From the public opening of the Museum until 1998, there was always a dedicated Botany Gallery featuring economic botany specimens. New natural history galleries opened in 1993, reflecting the move to integrate the established Botany and Zoology Departments; the displays therein include seeds, cones, superb wax models and timber. Two temporary exhibitions utilizing the economic botany collection are worth mention. “Plants in the Service of Man” (1939) emphasized the importance of economic botany to the everyday lives of Welsh people by focusing on plants as food and medicine sources (Hyde 1939). Demonstrations and lectures accompanied the exhibition, and economic botany specimens were loaned to local schools. In total, the exhibition was seen by more than 83,000 people (Anonymous 1940, 1941). In 1958, the Museum mounted an exhibition entitled “Paper and its Uses”, with the aims of educating visitors on the plant sources for paper, and of illustrating the craft of papermaking (Morgan 1958; Anonymous 1959) (Figure 6).

Today the Economic Botany Collection consists of approximately 5,500 plant-based specimens (together with 12,000 timber specimens). This includes a range of medicinal plants; food products; dyes and tannins; gums, resins and fibres; and seeds – in fact “anything in the vegetable kingdom which may be of economic interest” (Harrison 1982). The collections are stored in the Department of Natural Sciences at the National Museum Cardiff and include specimens from around the world, with a significant number from India, Southeast Asia and East Africa. Surprisingly few specimens originate in Wales.

Towards the end of the twentieth century, the rate of collecting economic botany slowed down significantly. There have been interesting developments since the beginning of the twenty-first century: in 2007, 469 *materia medica* specimens were donated by Professor Terence D. Turner, formerly of Cardiff University;²⁹ in 2017 there was renewed research on the collection when Poppy Nicol was awarded an NERC Valuing Nature programme placement, charged with reassessing the collection and the interests of stakeholders and with increasing access and engagement. As a result, there are now plans in place to develop the collection by purchasing new specimens – primarily food items – and to acquire specimens specifically for



Figure 6. “Paper and its Uses” exhibition at National Museum Wales, Cardiff, 1958. © Amgueddfa Cymru – National Museum Wales. Photograph by E. Broadbent. Amgueddfa Cymru – National Museum Wales CC BY-NC-ND.

educational activities. One aim is to increase the number of native Welsh specimens, and, in the longer-term, there are plans to produce digital images of the specimens, accessible online.

Cardiff and Kew

The relationship between Kew and Cardiff in the period before the Second World War was purely of a donor-recipient nature, and donations included both herbarium and economic specimens. Donations of the latter extended over just three events in 1920, 1921 and 1924 respectively, very much in the early stages of the NMW. In 1920 and 1921, around 85 specimens of fibres, fruits and seeds, rubber, gums and barks – the core material of an economic botany collection – were sent to Thomas from Kew. The contact had been initiated by Thomas, who wrote to Kew director Sir David Prain (1857–1944) in March 1920, requesting duplicate specimens of economic plants and products and adding that she had recently secured just such a set of specimens (cocoa, coffee, sugar, fibres, oil seeds) from the Imperial Institute “as a start”.

Thomas suggested the Kew Museum send examples from their list of duplicates, which had been compiled at the request of the British Association, “to consider what could be done in their respective Sections to meet problems which would arise after the war”. It was circulated in pamphlet form – which was how Thomas had encountered it – and it was also published in the *Kew Bulletin* (Rendle 1917). This, in turn, prompted Thomas to enquire about the availability of the *Bulletin*.³⁰ The following year she wrote to ask after suppliers of plant models. At this stage, NMW had not yet opened to the public and needed not only specimens, but pedagogical



Figure 7. Sieve hoops of elm wood received from Kew in 1924. © Amgueddfa Cymru – National Museum Wales. Photograph by Robin Maggs. Amgueddfa Cymru – National Museum Wales CC BY-NC-ND.

aids and texts too. In 1924, Thomas’s successor, Harold Augustus Hyde (1892–1973), received a collection of manufactured articles from home grown timber, thought to be from the 1924 British Empire Exhibition at Wembley and now in the wood collection at NMW (Figure 7). In total, Amgueddfa Cymru – National Museum Wales still has 93 of the 112 economic botany specimens donated by Kew in the 1920s.

Liverpool

World Museum (previously Liverpool Museum) is one of eight venues which make up National Museums Liverpool. It houses internationally important science, antiquities and ethnology collections. The Museum was founded in 1851 with a major bequest of zoological specimens from Edward Smith-Stanley, the 13th Earl of Derby (1775–1851). The botanical collection predates this bequest and has its origins in the first Liverpool Botanic Garden founded by William Roscoe (1753–1831) in 1802.

The history of economic botany collections at the Museum can be traced back to 1856, when the stockbook records the acquisition of “one bundle of fibre from *Agave americana*, for the manufacture of brushes” (Edmondson *et al.* 1989). It became a discrete collection in 1931, when Harold Stansfield was appointed the first Keeper of Botany at the Museum. A year later, Stansfield established the Gallery of Economic Botany, claiming in the supporting handbook to be the “first of its kind in the country” (Stansfield 1933). The Gallery had cases for commercial plant products, such as rubber, cotton, cocoa and tobacco. John Millard described the gallery as “a flowering of the spirit of the British Empire, showing produce of Empire countries, and suggesting how production of essential commodities could be improved with increased European settlement”.³¹ A photograph in the handbook shows the cases full of herbarium sheets, illustrations, models and specimens, again redolent of the display principal adopted at Kew (Figure 8).

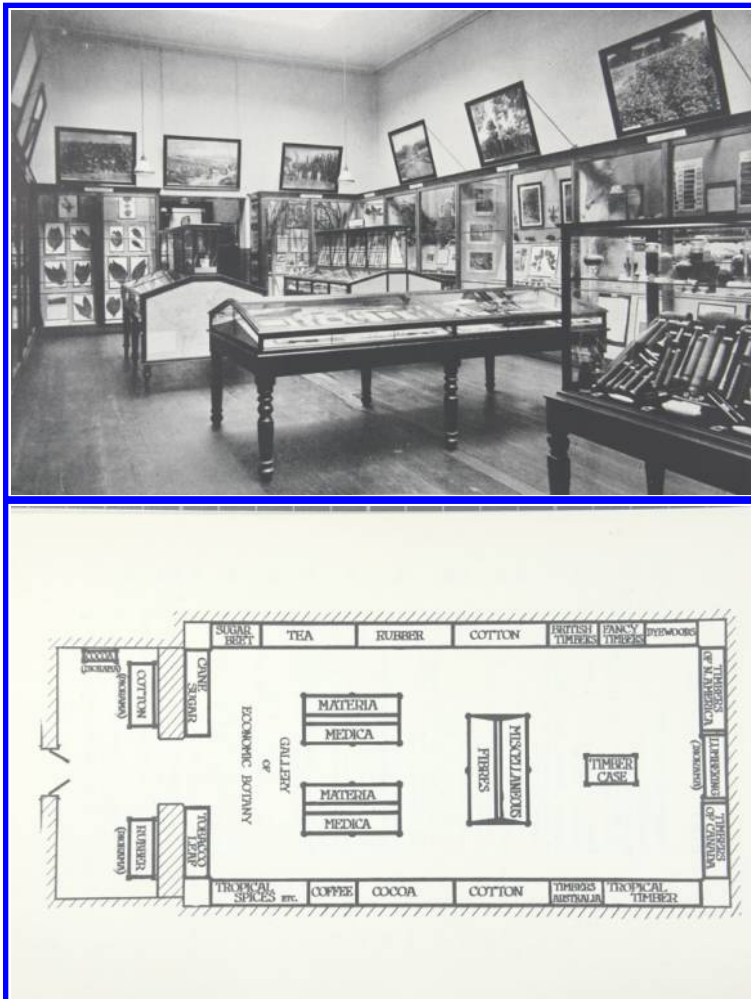


Figure 8. Liverpool Museum's Gallery of Economic Botany c.1932 (*top*); plan of gallery giving contents of cases c.1932 (*bottom*). © National Museums Liverpool.

No direct reference was made in the Gallery handbook to individual donors, but acknowledgement was given to the “various commercial organisations, government officials and private individuals, who have contributed specimens and illustrations” (Stansfield 1933). Some material was acquired from Kew, for example, a rubber tree trunk, used in a diorama of a Malaysian rubber plantation, was accessioned in 1932.

At the onset of war in 1939, the Museum evacuated many of its collections to safe refuges in north Wales and Cheshire, but due to the complexity of the task, most of the botanical collection remained in the Museum. On 3 May 1941, an incendiary bomb destroyed whole galleries, including the Economic Botany Gallery, as well as store rooms and collection documentation. The original Gallery handbook recorded the subjects covered, but not the contents. Fortunately, a good indication of their scope is provided in a document dated February 1942 in which “war losses” were listed to assess the financial impact of the damage.³²

These included herbarium specimens, wax models, illustrations, resins, dyes, fruits, fibres, wood sections, pharmaceutical material and carpological specimens. However, the Museum's post-war accession registers show that most of the required "replacement" material was never acquired.

The Museum's current economic botany collection includes some pre-war material which was evacuated or salvaged. A small number of contemporary items, mostly resulting from staff fieldwork, have since been added, together with items specifically procured for display or outreach activities. One notable new addition, in 1986, was the Liverpool Salvage Corporation (1842–1984) reference collection of 400 "samples of commodities imported through the Port of Liverpool" (Bird and Hallett 1984). The Museum's timber collection comprises small blocks, veneer samples and thin sections and includes a set of Hermann von Nördlinger's (1818–1897) volumes of mounted sections, which alone cover 1,100 species (Nördlinger 1856–1860). In 1986, a large part of the timber collection of the British Museum (Natural History) – including specimens collected by Sir Hans Sloane (1660–1753) – was acquired, the remainder going to Kew (Edmondson *et al.* 1989). The timber collection and economic botany databases have been combined and the total now comprises 13,300 items.

World Museum no longer has an economic botany gallery, although it does continue to display and promote the knowledge of plants that are used as food, medicine, clothing and industry. The award-winning interactive Clore Natural History Centre contains drawers of economic botany items, along with handling collections. They are actively used in formal education sessions as well as themed activity days within the public programme.

Liverpool and Kew

The relationship with Liverpool corresponds to the Harry Stansfield era of economic botany at the Liverpool Museum and, as at NMW, was purely one of donor-recipient. Over a ten-year period, from 1927 to 1936, the Kew Museum sent specimens in response to requests from Liverpool. Amounting to a total of 32 objects, they suggest a less-engaged association than others we have examined here, and none of the Kew items survived the bombings of the Second World War. It would indeed be more accurate to understand the Kew–Liverpool interaction, as in the case of Cambridge, as one between two herbaria.³³

DISCUSSION AND CONCLUSIONS

Our chosen case studies make clear the term "regional" is inadequate to describe museums beyond London then, or indeed now. Our list contains two national museums (Liverpool³⁴ and Cardiff), two university museums (Cambridge and Manchester), and three municipal museums originally funded by the rates, one in an industrial town (Warrington) and two in major port cities (Glasgow and Liverpool). Each of these has a distinct history and geography which have shaped their museum practices. Furthermore, as can be seen, none of them has been static over the time-period examined: one of them is no longer extant (Cambridge); some have shifted purpose and audiences (Kew, Liverpool, Glasgow); most have experienced multiple name changes.

Despite their diversity, these museums demonstrate common themes. All were founded in the second half of the nineteenth century (Cardiff is later, but incorporates earlier museums), forming part of the great flowering of public museums at that time (Hill 2005). Botany formed a significant part of collections and displays from early in most museums' histories, but started

to disappear from public view in the twentieth century, after 1918, and is only prominent at Warrington and Manchester today. At Glasgow and Warrington, the volume of specimens supplied by Kew was transformational; at Manchester and Liverpool the access to specimens provided by the port and industrial complexes of those cities may have reduced the need to request material from Kew. The Botanical Museum in Cambridge was unusual in its lack of emphasis on economic botany, reflecting its own educational priorities.

These narratives demonstrate the importance of individual relationships in museum networks: the duration, frequency and symmetry of the relationships cited were largely contingent on the agency of individual curators in requesting material from Kew. In the examples given, transactions with Kew rarely extended beyond the lifetime of two successive curators. The degree of symmetry in these relationships was partly dictated by the status of the applicant, who ranged from fellow academic botanists like Gardiner at Cambridge (the most symmetrical of our examples) to the relatively new cadre of professional museum curators such as Paton at Glasgow and Madeley at Warrington, who tended to be recipients rather than exchange partners.

Research into botanical collections has previously focused on the assembling of herbaria, as discussed above, and on the social and institutional networks that facilitated communication between nineteenth-century botanists (Allen 1986, 2001; Secord 1994). There has been little investigation of the nature of the botanical displays that were so widespread, nor of the physical infrastructure and collecting practices that enabled these. This initial survey of six museums suggests both that there is a rich seam of evidence to be explored, and that the history of botanical museums and galleries can throw light on wider museum histories.

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NOTES

¹ Parliament, House of Commons, 1845 “Bill to enable Town Councils to establish Museums of Art in Corporate Towns (as amended by Committee). New title for third reading: an act for encouraging the establishment of museums in large towns” (Bills and Acts, 223), London.

² Parliament: House of Commons, 1852–1853. “Libraries and Museums. Abstract of Return of Boroughs in England and Wales in which Libraries and Museums have been formed, under the Acts 8 & 9 Vict, c. 43, and 13 & 14 Vict. c. 65” (Accounts and Papers, 312), London.

³ Parliament: House of Commons, 1878. “A bill to enable the trustees of the British Museum to remove portions of their collections” (Bills and Acts, 236), London.

⁴ J. Lindley, 1840. “Report to Treasury Committee on Management of Royal Gardens at Kew by Doctor Lindley, February 1838” (Accounts and Papers, 292), London.

⁵ Full title 1832–1851: Commissioners of Woods, Forests, Land Revenues, Works and Buildings.

⁶ Also referred to as the Kew Museum.

⁷ Parliament: House of Commons, 1872. “Royal Commission on Scientific Instruction and the Advancement of Science: First, Supplementary, and Second Reports with Minutes of Evidence and Appendices” (Reports of Commissioners, C. 536), London.

⁸ Distribution of duplicates ended following the assignment of catalogue numbers to the collection when it was databased in the late 1980s. Thereafter it was replaced by a formal system for distributing samples for scientific analysis.

⁹ Glasgow Museums, Library and Archive, GMA442. City Industrial Museum Kelvingrove Park, diary entry, July 1885 [MS]: “varnishing herbarium cabinets and whitewashing insides of wall cases in gallery”.

¹⁰ Glasgow Museums, Library and Archive, April 1891 GMA137, July 1891 GMA140, October 1892 GMA419, March 1893 GMA424, June 1893 GMA427, November 1893 GMA432, January 1894 GMA433, June 1894 GMA436. City Industrial Museum Kelvingrove Park, diary entries, April 1891 [MSS].

¹¹ R. Sutcliffe to P. Allan, pers. comm., 20 August 2018.

¹² Glasgow Museums, Library and Archive, William Rennie to Glasgow Museum staff, 1950 [MS], Details of the “Wild Flower Display” held within the Kelvingrove Museum, Glasgow during the years 1947–48–49–50.

¹³ Glasgow Museums, Library and Archive, Glasgow Art Gallery and Museums Reports [MSS], 1 July 1950–31 December 1951, p.16; 1 January to 31 December 1952, p.17; 1 January to 31 December 1953, pp.17–18; 1 January to 31 December 1954, p.20; 1 January to 31 December 1956, p.14.

¹⁴ R. Sutcliffe to P. Allan, pers. comm., 25 July 2018.

¹⁵ K. Watson to P. Allan, pers. comm., 25 July 2018.

¹⁶ Royal Botanic Gardens, Kew (hereafter RBGK), Archives, Directors’ Correspondence (DC) 98, f. 72. J. Paton to W. Thiselton-Dyer, 2 September 1878 [MS].

¹⁷ RBGK, Archives, India Museum 1875–1892, Volume II, ff. 438–441, Lists of specimens [MSS].

¹⁸ Manchester Museum of Natural History, Peter Street, 1 September 1845. Original MS in Manchester Museum, University of Manchester (hereafter MM–UOM), MANCH 647133.

¹⁹ MM–UOM, MANCH 647135 and 647138. Original correspondence relating to botany acquisitions.

²⁰ MM–UOM, MANCH 647132. A. Neild, T. Ashton, J. Aitken, J. P. Joule and J. Cosmo Melville, 22 November 1882, open invitation to public meeting proposing museum construction.

²¹ Cambridge University Herbarium, Cambridge, Archive, Shelf List of Botanical Specimens [MS].

²² RBGK, Economic Botany Collection (EBC). Specimens Distributed 1881–1901, Volume 1, pp. 247, 250, 252 [MSS]. Available at: <https://www.biodiversitylibrary.org/subject/Economic%20Botany%20Collection/> (accessed 17 January 2020).

²³ A. C. Seward (hereafter AS) to W. Thiselton-Dyer, 27 November 1901 [MS]. RBGK, Archives, Directors’ Correspondence (DC) 194, f. 211; AS to A. W. Hill, 8 March 1923 and 21 March 1923 [MSS]. RBGK Archives, Museum Letterbook 15, pp. 59 and 65.

²⁴ AS to A. W. Hill, 3 October 1930 [MS]. RBGK, Archives, Museum Letterbook 19, p. 140.

²⁵ A. Henry to J. M. Hillier, 28 January 1909 [MS]. RBGK, Archives. Museum Letterbook 3, p. 189.

²⁶ G. A. Dunlop (hereafter GD) to D. Prain (hereafter DP), 11 October 1906 [MS]. RBGK, Archives, Museum Letterbook 2, p. 178; GA to DP, 20 March 1907 [MS]. RBGK, Archives, Museum Letterbook 3, p. 43.

²⁷ C. Madeley to DP, 11 May 1917 and 25 May 1917 [MSS]. RBGK, Archives, Museum Letterbook 11, pp. 147 and 150.

²⁸ GA to DP, 27 August 1918 [MS]. RBGK, Archives, Museum Letterbook 12, p. 141.

²⁹ V. Purewal, 2010. Old cures: Amgueddfa Cymru’s Historic Medicine Collection. Available at: <https://museum.wales/articles/2010-10-22/Old-cures-Amgueddfa-Cymrus-Historic-Medicine-Collection/> (accessed 4 January 2017).

³⁰ E. N. Miles Thomas to DP, March 9, 1920 [MS]. RBGK, Archives, Letterbook 13, p. 136.

³¹ J. Millard, 2010. Liverpool’s Museum: The First 150 Years. National Museums Liverpool. Available at: https://www.liverpoolmuseums.org.uk/wml/history/WML_150_years.pdf (accessed 20 January 2019).

³² World Museums Liverpool, 1942. War loss report of Botany collections, Liverpool City Museums: 1942 [MS].

³³ H. Stansfield (hereafter HS) to A. W. Hill, c.10 December 1931 [MS]. RBGK, Archives, Letterbook 19, p. 311. A. Allan to W. Dallimore, 8 August 1932 [MS]. RBGK, Archives, Letterbook 20, p. 90D. HS to W. Dallimore, 14 March 1934 and HS to A. W. Hill, 4 April 1934 [MSS]. RBGK, Archives, Letterbook 21, pp. 6 and 15. HS to

R. Melville, 2 December 1939, and HS to J. Hutchinson, c.15 October 1942 [MSS]. RBGK, Archives, Letterbook 23, pp. 72 and 275.

³⁴ Since 1 April 1986. The History of World Museum. Available at: <https://www.liverpoolmuseums.org.uk/wml/history/index.aspx> (accessed 7 November 2019).

³⁵ Further details of the project are available at: <https://royalholloway.ac.uk/mobilemuseum> (accessed 17 January 2020).

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NOTE: The supplementary data underlying this paper, consisting of a record of specimens sent from Kew's Museum of Economic Botany to the selected museums, and a record of specimens received from these museums at Kew, is available online at: <https://www.eupublishing.com/doi/suppl/10.3366/anh.2020.0627>