RECALCITRANT SEEDS: MATERIAL CULTURE AND THE GLOBAL HISTORY OF SCIENCE*

In March 1788, France's premier botanical garden, the Jardin du Roi of Paris, sent a gardener on an expedition to the Île de France (now Mauritius), one of its Indian Ocean colonies.[1] The gardener, Joseph Martin (fl. 1788–*c.*1819), was instructed to bring back to Paris plants from the botanical garden on the Île, especially 'precious Indian trees', and numerous vegetables that had been transplanted to the island from elsewhere in the world. Martin was also given a second mission, however. He was to take to the island a consignment of European plants identified as 'the most useful' for food, medicine, arts or manufactures. The plants were initially destined for cultivation in the island's botanic garden. Once they had been established there, cuttings or seeds would be distributed onwards among the inhabitants of the Île de France and its close neighbour, the Île Bourbon (now Réunion).[2]

On the face of it, Joseph Martin's mission conforms precisely with a model developed within the history of science that describes the relationship between Enlightenment science and European colonialism. Often referred to in the literature as 'colonial botany' or even 'bioprospecting', plant transfer schemes such as the one outlined above helped to increase European knowledge about the natural world and thus to enhance the potential exploitation of land and peoples via the imposition of colonial power. Situated alongside

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[1] On Joseph Martin, see Madeleine Ly-Tio-Fane, 'A Reconnaissance of Tropical Resources during Revolutionary Years: The Role of the Paris Museum d'Histoire Naturelle', Archives of Natural History, xviii (1991); Madeleine Ly-Tio-Fane, 'Botanic Gardens: Connecting Links in Plant Transfer between the Indo-Pacific and Caribbean Regions', Harvard Papers in Botany, viii (1996).

[2] Bibliothèque Centrale du Muséum National d'Histoire Naturelle, Paris (hereafter MNHN), MS 56, Joseph Martin, 'Journal d'un voyage fait par ordre du Roi à l'Isle de France . . . 27 Mars 1788 à 30 Juillet 1789', fo. 1.

astronomy and cartography, complimentary arenas of knowledge that were essential for navigation and for laying claim to land, botany has been considered a colonial science par excellence.[3]

The image presented by this model has certainly been helpful for thinking about colonial processes from the viewpoint of those at the top. We can identify the aspirations of governments and royal institutions and can describe the organizational structures put into place to help achieve those goals. However, the perspective that such an approach offers reveals little about how such objectives were actually achieved. Further, it provides a limited view of the extent to which the individuals involved negotiated or manipulated broader agendas. Perhaps inevitably, macro-narratives of colonial power over nature break down on closer inspection. This article considers how we might understand the relationships forged between individual actors who collected and transported biota across the world, and bigger structures such as imperialist states. It emphasizes the value to be gained from using material culture to help define our research agendas, because these sources can offer insights into actors and individuals who otherwise make scant appearance — if any — in conventional histories of science.

As we will see, objects — in this case, plants, seeds and the containers in which they were transported — affected the nature of the social relationships formed within scientific collecting networks. Understanding materials and how to preserve and transport them was an essential task for the individuals involved in collecting and transporting biota. Such expertise was important because the incidence of loss in eighteenth-century oceanic plant transfers was very high: in fact, the vast majority were unsuccessful. Collectors and scholars sought information not only about the materials on which their attention was formally focused, but also about the people who acted as couriers for data. With regard to eighteenth-century French collecting networks, this boiled down to judgements about an individual's *mœurs*, or their

[3] Richard Drayton, *Nature's Government: Science, Imperial Britain, and the 'Improvement' of the World* (New Haven and London, 2000); Larry Stewart, 'Global Pillage. Science, Commerce and Empire', in Roy Porter (ed.), *The Cambridge History of Science*, 7 vols., iv (Cambridge, 2003); Londa Schiebinger, *Plants and Empire: Colonial Bioprospecting in the Atlantic World* (Cambridge, Mass., 2004); Londa Schiebinger and Claudia Swan (eds.), *Colonial Botany: Science, Commerce and Politics in the Early Modern World* (Philadelphia, 2005); Londa Schiebinger, 'Forum Introduction: The European Colonial Science Complex', *Isis*, xcvi (2005); Yota Batsaki, Sarah Burke Cahalan and Anatole Tchikine (eds.), *The Botany of Empire in the Long Eighteenth Century* (Washington, DC, 2016).

character and comportment.[4] The detailed attention paid to such judgements invites us to analyse in turn *who* was involved in collecting and transferring data and how social diversity conditioned the nature of global knowledge transfer.

This article engages with the multiple contexts through which such objects and their couriers moved. Each of these influenced the way that information about nature was developed and each created new possibilities — and constraints — for the eventual making of formal scientific knowledge. Distance, environmental ecologies and the capricious behaviour of individual people influenced early modern European efforts to obtain and manipulate information from the wider world. I will begin by discussing shifts in analytical focus within the history of science since the mid twentieth century and will consider the ways in which the field has engaged with the opportunities and challenges offered by micro and global approaches to history. I then focus on examples of eighteenth-century French botanical collecting in the Indian and Atlantic Oceans. The different milieus within which schemes for plant collection and transfer were worked out range from that provided by the French state (via royal institutions) through to those of the individuals who tended live plants and seeds aboard ship. The overall impression we gain is that although eighteenth-century scientific networks were global in terms of their geographical extent and the intellectual aspirations of the scholars working for state institutions, the processes through which information was gathered and knowledge composed were always locally situated and dependent on individuals. Some of those individuals even worked up practice-based botanical knowledge, such as observations about seed recalcitrance,[5] which were essential for global plant transfers but ignored by contemporary institutional botanists. In sum, this paper moves away from what are now quite hackneyed debates about the relationship between colonial governments and individual agency. It proposes instead that we might research and write global histories of science that explore agency at all social levels.

[4] For more on the relevance of *mœurs* to a range of different arenas of eighteenth-century French thought, start with Paul Cheney, *Revolutionary Commerce: Globalization and the French Monarchy* (Cambridge, Mass., 2010), ch. 1; David Bell, 'The Unbearable Lightness of Being French: Law, Republicanism and National Identity at the End of the Old Regime', *American Historical Review*, iv, 4 (2001).

[5] The seeds of a minority of plant species, such as avocado and cocoa, are recalcitrant. This means that they cannot survive if they are either dried or stored in temperatures below around 10°C. It is therefore not possible to store them for long periods of time.

I
GLOBAL HISTORIES OF SCIENCE

Historians of science have shown great interest in global history since its (re)emergence over the last twenty years or so.[6] This openness is the product of several key historiographical shifts that have taken place since the mid twentieth century concerning the conceptualization of scientific knowledge, and resulting from engagement with postcolonial scholarship.

With regard to the first of these, mid twentieth-century scholars who defined science as a system of formal discoveries or propositions documented the progressive development of innovations in knowledge over time. Historians interested in the relationship between western science and the wider world, such as George Basalla and his students, assumed uncritically that European knowledge was diffused outwards, and they sought to write grand narratives of this process.[7] This conception has been substantially revised: most historians of science now view scientific knowledge as something that is socially situated and whose development was not self-evident.[8] The work of sociologists of science such as Bruno Latour further encouraged detailed studies of the practices and processes that contributed to the making of 'science'.[9]

Increasing attention has also been given to the significance of movement — transfer, circulation, exchange or appropriation — to the composition of new knowledge. This has led many historians of science towards global history. Indeed, 'science' is now considered, as James Secord put it in 2004, to be the product of 'knowledge in transit': it purports to be a universal entity, but in

[6] Sujit Sivasundaram, 'Introduction: Focus. Global Histories of Science', *Isis* ci, 1 (2010). The timing of the uptake of interest in global history among Francophone and Anglophone historians of science seems to have been roughly parallel, despite the fact that French historiography overall demonstrated some qualms in the 2000s towards engaging with 'Anglo-Saxon' global history. For a summary of French historiographical responses to global history, see Chloé Maurel, *Manuel d'histoire globale: Comprendre le 'global turn' des sciences humaines* (Paris, 2014).

[7] George Basalla, 'The Spread of Western Science', *Science*, clvi (1967). See also Paolo Palladino and Michael Worboys, 'Science and Imperialism', *Isis*, lxxxiv, 1 (1993).

[8] The classic works developing this view include Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago, 1962); David Bloor, 'The Strengths of the Strong Programme', *Philosophy of the Social Sciences*, xi (1981); Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump: Hobbes, Boyle and the Experimental Life* (Princeton, 1985); Jan Golinski, *Making Natural Knowledge: Constructivism and the History of Science* (Cambridge, 1998).

[9] Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Beverley Hills, 1979); Bruno Latour, *Les Microbes: Guerre et paix* (Paris, 1984).

fact it is something that is contingent, negotiated and situated, the result of local production of information. Facts are communicated between places, this information is combined, analysed and turned into 'knowledge'.[10] As a consequence of these observations, it is now relatively common to deploy microhistorical methods in histories of science that seek, collectively, to understand how concepts that claim to be universal emerged across geographically and socially disparate spaces. The task of understanding the vectors along which information has travelled and the processes through which it has been constructed as scientific knowledge thus invites us to consider skills, practices, procedures and methods and to assess how these have responded to changing social, cultural and cognitive contexts.

The second key historiographical development concerns a more recent turn away from straightforward histories of colonial science. Many of the latter, produced towards the end of the twentieth century, were based on assumptions about centre–periphery relationships and have perhaps inadvertently encouraged the production of a divided historiography exploring different 'colonial' and 'colonized' epistemological worlds. The relationship between Enlightenment botany and colonialism has thus been examined for all the major eighteenth-century European colonial powers.[11] Imperial power certainly provided many opportunities for global travel and knowledge exchange in the eighteenth century.[12] However, neither travel nor scientific activity was ever fully restricted to state control. More recent research has

[10] James A. Secord, 'Knowledge in Transit', *Isis*, xcv (2004).

[11] For examples, see Drayton, *Nature's Government*; Roy MacLeod (ed.), *Nature and Empire: Science and the Colonial Enterprise*, special issue of *Osiris*, xv (2000); Mark Harrison, 'Science and the British Empire', *Isis*, xcvi (2005); John Gascoigne, *Science in the Service of Empire: Joseph Banks, the British State and the Uses of Science in the Age of Revolution* (Cambridge, 2008); Harold J. Cook, *Matters of Exchange: Commerce, Medicine and Science in the Dutch Golden Age* (New Haven, 2008); James E. McClellan III and François Regourd, *The Colonial Machine: French Science and Overseas Expansion in the Old Regime* (Turnhout, 2011); Daniela Bleichmar, *Visible Empire: Botanical Expeditions and Visual Culture in the Hispanic Enlightenment* (Chicago, 2012). Two edited books, Schiebinger and Swan (eds.), *Colonial Botany*; and Batsaki, Cahalan and Tchikine (eds.), *Botany of Empire* also explore the relationship between botany and colonialism from a range of national perspectives.

[12] Much historiography has explored the networks that emanated from or passed through state institutions such as botanical gardens and scientific academies. See John Law, 'On the Methods of Long-Distance Control: Vessels, Navigation and the Portuguese Route to India', *Sociological Review*, xxxii (1984); David Philip Miller, 'Joseph Banks, Empire and Centres of Calculation in Late Hanoverian London', in David Philip Miller and Peter Hans Reill (eds.), *Visions of Empire: Voyages, Botany, and Representations of Nature*

started to expose the roles played by (for example) merchants and even joint stock companies in collecting and processing data about the areas of the world with which they wished to trade.[13] One key conclusion from this scholarship is that, while the development of natural knowledge always involved power inequalities, these disparities were not always structured along a centre–periphery axis. They were also certainly not all biased towards Europe.[14] Using the term 'colonial', then, can potentially over-simplify the nature of the interactions and dynamics at play.

Global history, by contrast, with its stress on examining the nature of long-distance connections and its engagement with multiple forms of movement, circulation and resistance, has the capacity to open up analytical attention to diverse interactions. Several key concepts have been subject to careful reconsideration, including the terms used to describe and analyse the movement of knowledge across and between different cultures (especially between Europeans and non-Europeans), and the relationship between the specificities of local places and more general global contexts.[15] Critical discussion has also been bolstered by an openness among historians of science towards

(Cambridge, 1996); E. C. Spary, *Utopia's Garden: French Natural History from Old Regime to Revolution* (Chicago, 2000), ch. 2.

[13] Anna Winterbottom, *Hybrid Knowledge in the Early East India Company World* (Basingstoke, 2016); Vinita Damodaran, Anna Winterbottom and Alan Lester (eds.), *The East India Company and the Natural World* (Basingstoke, 2015). One key conclusion is that such data collection was not restricted to one arena of knowledge (such as 'nature') but crossed over several: Romain Bertrand, 'Les savoirs du commerce: le cas d'Asie', in Stéphane Van Damme (ed.), *De la Renaissance aux Lumières* (Seuil, 2015)

[14] For work exploring the polycentricity of such networks, see David Wade Chambers and Richard Gillespie, 'Locality in the History of Science: Colonial Science, Technoscience and Indigenous Knowledge', in *Nature and Empire: Science and the Colonial Enterprise*, special issue of *Osiris*, xv (2000); Lissa Roberts, '"*Le centre de toutes choses*": Constructing and Managing Centralization on the Isle de France', *History of Science*, lii, 3 (2014); John McAleer, '"A Young Slip of Botany": Botanical Networks, the South Atlantic and Britain's Maritime Worlds, *c.*1790–1810', *Journal of Global History*, xi, 1 (2016); Dorit Brixius, 'A Pepper Acquiring Nutmeg: Pierre Poivre, the French Spice Quest and the Role of Mediators in South-east Asia, 1740s to 1770s', *Journal of the Western Society for French History*, xliii (2015).

[15] Roberts, '*Le centre de toutes choses*', 322; Stefanie Gänger, 'Circulation: Reflections on Circularity, Entity and Liquidity in the Language of Global History', *Journal of Global History*, xii (2017). See also Kapil Raj, 'Beyond Postcolonialism . . . and Postpositivism: Circulation and the Global History of Science', *Isis*, civ (2013); Lissa Roberts (ed.), *Centres and Cycles of Accumulation in and around the Netherlands during the Early Modern Period* (Zurich and Berlin, 2011).

spatial history.[16] This, in turn, has encouraged detailed considerations of the possibilities and problems offered by small-scale analyses and those that aspire to a broader perspective.[17] But as David Lux and Harold Cook stressed back in 1998, shifting 'from the local to the global' does not necessarily mean moving 'from the personal to the abstract'.[18] This article upholds the same emphasis and argues for the continued value of paying close contextual attention to certain individuals and particular circumstances. In the case of botany, these consist of gardeners as well as governments, and seeds as well as state politics.

Just as the term 'colonial' has come under critical scrutiny, there are also some caveats to bear in mind when using the term 'global'. It is very important that issues relating to power and agency should not actually disappear from view, in spite of the anodyne associations that the word 'global' can convey in English.[19] Indeed, it is essential that we understand the inequalities that structured the composition of scientific knowledge if we are to write socially responsible histories of science. Taking a microhistorical approach brings into view the ways in which individuals enacted and negotiated larger structures and contributes to debates about how best to move away from westernized notions of modern science and how to engage with knowledge developed outside the academic frameworks of the global north. Discussions

[16] Adi Ophir and Stephen Shapin, 'The Place of Knowledge: A Methodological Survey', *Science in Context*, iv (1991); David Livingstone, *Putting Science in its Place: Geographies of Scientific Knowledge* (Chicago, 2004). Natural historical study has been identified as a specific means through which certain cultures developed an understanding of space, and a mechanism through which to reinforce notions of territory. See Marie Noëlle Bourguet, Christian Licoppe and H. Otto Sibum (eds.), *Instruments, Travel and Science: Itineraries of Precision from the Seventeenth to the Twentieth Century* (London and New York, 2002); Chandrika Mukerji, 'Dominion, Demonstration and Domination: Religious Doctrine, Territorial Politics, and French Plant Collection', in Schiebinger and Swan (eds.), *Colonial Botany*.

[17] Carla Nappi, 'The Global and Beyond: Adventures in Local Historiographies of Science', *Isis* civ, 1 (2013); Benjamin A. Elman, 'New Directions in the History of Modern Science in China: Global Science and Comparative History', *Isis*, xcviii, 3 (2007).

[18] David S. Lux and Harold J. Cook, 'Closed Circles or Open Networks?: Communicating at a Distance During the Scientific Revolution', *History of Science*, xxxvi, 2 (1998), 201.

[19] On concerns that the negative aspects of connectivity tend to become muted in global histories, and for concerns that global history over-emphasizes connectivity, see Jeremy Adelman, 'What Is Global History Now?', *Aeon*, 2 March 2017; Richard Drayton and David Motadel, 'Discussion: The Futures of Global History', *Journal of Global History*, xiii (2018); and the responses from Jeremy Adelman and David Bell that follow this article.

about precisely how these aspirations can be achieved are ongoing, but two areas of equal priority have emerged.[20] The first concerns the need to re-evaluate constantly our methods and terminology to avoid falling back on concepts based in western knowledge systems that might occlude other forms of knowing. The second relates to the importance of 'fragmenting' what we understand to be western science per se, a point to which this article contributes.[21]

II
SOURCES

Our understanding of the significance of global connections to the composition of new knowledge changes as we integrate material culture into historical analyses. Thinking about and through things invites detailed consideration of the ways in which human relationships were formed around the manipulation and exchange of objects. This approach also draws critical attention to the multiple kinds of knowledge that circulated within and became essential to the constitution of intellectual networks. The history of eighteenth-century botany would appear to lend itself brilliantly to

[20] These debates have taken place across Francophone and Anglophone historiographies. For summaries of French historiographical debates, see Antonella Romano, 'Fabriquer l'histoire des sciences modernes: réflexions sur une discipline à l'ère de la mondialisation', *Annales: Histoire, Sciences Sociales*, lxx (2015); and the contributions to Dominique Pestre (ed.), *Histoire des sciences et des savoirs*, 3 vols. (Paris, 2015), i, Stéphane Van Damme (ed.), *De la Renaissance aux Lumières*, esp. 33–6. The journal *Isis* has been a notable forum for English-language discussion: see esp. Sujit Sivasundaram, 'Sciences and the Global: On Methods, Questions, and Theory', *Isis*, ci, 1 (2010); Neil Safier, 'Global Knowledge on the Move: Itineraries, Amerindian Narratives and Deep Histories of Science', *Isis*, ci, 1 (2010); Raj, 'Beyond Postcolonialism . . . and Postpositivism'. Other special issues include 'Colonial Science', *Isis*, xcvi (2006); and 'Bridging Concepts: Connecting and Globalizing History of Science, History of Technology and Economic History', *Isis*, cvi (2015). See also J. B. Shank, 'Special Issue: After the Scientific Revolution. Thinking Globally about the Histories of the Modern Sciences', *Journal of Early Modern History*, xxi (2017). For an influential earlier analysis of the significance of non-European knowledge to western botany, see Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Scientific Knowledge in South Asia and Europe. Seventeenth to Nineteenth Centuries* (Delhi, 2006).

[21] For two interventions offering contrasting methodological solutions within the same journal issue, see Carla Nappi, 'Paying Attention: Early Modern Science Beyond Genealogy', *Journal of Early Modern History*, xxi (2017); and Kapil Raj, 'Thinking Without the Scientific Revolution: Global Interactions and the Construction of Knowledge', *Journal of Early Modern History*, xxi (2017). On 'fragmenting' specifically, see Sivasundaram, 'Sciences and the Global', 154–5.

networked, object-based global history. Enlightenment botanists were, after all, fixated on transferring information and objects (as carriers of knowledge) across large distances. Material culture was the medium through which different localities were connected.[22] The source-base that I use in this article largely relates to the experiences of Europeans who travelled through the world, normally under the (loose) auspices of the French state. The knowledge subcultures they developed contribute to breaking down assumptions of a uniform western science and can lead into the kinds of cross-contextualized readings that Sujit Sivasundaram recommends.[23]

The history of botany, however, poses an unusual set of challenges to historians seeking to integrate material culture into the global history of science. On the one hand, a huge number of specimens collected in the eighteenth century survive in some form or other — as dried or bottled herbarium specimens, or even occasionally as living plants.[24] On the other hand, however, the facts of environmental change, natural decay and the necessary transformations caused by preservation techniques mean that no specimens now exist in their original eighteenth-century state. Likewise, very little of the apparatus that supported botanical collecting, such as tools, boxes or plant presses, survives, yet these ancillary devices were essential to the success of the endeavour. Eighteenth-century botanical correspondence abounds with extensive discussions of the reliability of these items, as we shall see. A global history of botany that wishes to take seriously the possibilities proposed by material culture thus faces a significant problem: very little physical evidence actually remains.

In spite of the absence of the actual things with which our historical subjects were concerned, numerous sources — mostly textual but also some visual — can permit us to regain a sense of the objects themselves.[25]

[22] In this sense, the study of material culture is akin to approaches developed among spatial historians, as pointed out in Anne Gerritsen, 'From Long-Distance Trade to the Global Lives of Things: Writing the History of Early Modern Trade and Material Culture', *Journal of Early Modern History*, xx (2016), 6–8. For more on material culture as a historical source, see Anne Gerritsen and Giorgio Riello (eds.), *Writing Material Culture History* (London and New York, 2015); Karen Harvey (ed.), *History and Material Culture: A Student's Guide to Approaching Alternative Sources* (London and New York, 2009).

[23] Sivasundaram, 'Sciences and the Global'.

[24] The few surviving exotic specimens planted in the eighteenth century are mostly trees. For example, the six oldest specimens at the Royal Botanic Gardens, Kew, now known as the 'Old Lions', are trees planted around 1762.

[25] For a helpful discussion of how we might approach 'absent' objects, see Glenn Adamson, 'The Case of the Missing Footstool: Reading the Absent Object', in Harvey (ed.), *History and Material Culture*.

Perhaps in reflection of the long distances travelled by my subjects and the various authorities and jurisdictions that they encountered, these tend to be scattered across multiple archives. These repositories range from collections of botanical correspondence compiled in France's Muséum National d'Histoire Naturelle (National Museum of Natural History) to bureaucratic correspondence stored in its national 'overseas' archives, and from the municipal documents preserved in provincial port town archives to individual scholars' private notebooks. Published books and journal articles provide further evidence. What we find is that eighteenth-century botanists were engaged in extensive discussions — via manuscript correspondence and in published form — about how to package up and convey precious living cargo. A close reading of these sources reveals the ways in which relationships were formed around and through the manipulation of the material and social cultures that comprised natural history collecting. The visual materials that sometimes accompanied these discussions can offer further insights into the material and epistemological worlds that structured global plant transfers — worlds that were not necessarily recorded in writing.[26]

The botanical specimens collected and cultivated by European global travellers were understood in relation to a number of political and social settings. Each bore consequences for the transfer and composition of knowledge, and each thus requires contextualization. Firstly, great symbolic significance was attributed to certain plants, especially if they had been transplanted from one part of the world to another. The maritime transport of specimens itself thus also requires careful contextualization. Transferring plants posed practical problems that disrupted state initiatives and aspirations, but which also encouraged a range of solutions. The latter related as much to the management of people as of the plants themselves. The final aspect to explore — also the most difficult to access due to the low status of the people involved — concerns the activities of gardeners who cared for specimens aboard ship. Taken together, the settings considered below range from government-directed activities through to more focused studies of shipboard dynamics and the maritime gardening practised by decidedly non-elite individuals.

[26] Daniela Bleichmar makes a powerful case for the value of visual culture to botanical history in *Visible Empire*, an argument with which I strongly agree. However, the sources consulted for this article are noteworthy for the absence of images within them. It appears that practical information was conveyed orally or through demonstration. If any images were produced, they were evidently considered ephemeral and thus not worthy of preservation.

III
PLANTS AS POLITICAL SYMBOLS

The image that government sources present is one in which accrued botanical expertise appears to have straightforwardly facilitated eighteenth-century colonization. Indeed, from the perspective of botanists and governments, the very small was clearly very big. A huge amount of time and resources were invested in obtaining individual specimens such as chinchona, rhubarb or ginseng because the success or otherwise of imperial projects rested on their fortunes.[27] Old regime France has received particular attention from historians because the absolutist government explicitly attempted to control the collection and processing of data. In contrast to the British, for example, who appeared to leave much of the direction of scientific research to individual patrons, the French crown was overtly interventionist. For example, it issued proclamations from the early eighteenth century onwards instructing merchants, sea captains and other travellers to collect and bring back any specimens of potential use; naval ships were then supposed to offer free, prioritized, passage to these objects.[28]

The expertise sought by governments and botanists concerned with colonization was decidedly practical. This contrasts with assumptions that eighteenth-century botany was a descriptive science of taxonomy. French and other European botanists were concerned with understanding how specimens might be cultivated, and what their useful properties might be — an area of enquiry that is now known as economic botany.[29] The botanists'

[27] For some specimen-specific examples (among many), see Saul Jarcho, *Quinine's Predecessor: Francesco Torti and the Early History of Chinchona* (Baltimore, 1993); Matthew P. Romaniello, 'True Rhubarb? Trading Eurasian Botanical and Medical Knowledge in the Eighteenth Century', *Journal of Global History*, xi, 1 (2016); Shigehisa Kuriyama, 'The Geography of Ginseng and the Strange Alchemy of Needs', in Batsaki, Cahalan and Tchikine (eds.), *Botany of Empire*.

[28] Archives départementales de Loire-Atlantique, C632, folder 2, Ordonnance du Roy, Fontainebleau, 20 September 1726. See also Christopher M. Parsons and Kathleen S. Murphy, 'Ecosystems Under Sail: Specimen Transport in the Eighteenth-Century French and British Atlantics', *Early American Studies: An Interdisciplinary Journal*, x, 3 (2012).

[29] The classic portrayal of eighteenth-century scholars as solely concerned with taxonomy is that developed in Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (London and New York, 1970; first pubd 1966). For a selection of work on botany and utility, see Patrice Bret, '"La conservation et l'utilité journalière du jardin botanique": l'apothicaire Jacques Tartelin (1748–1823) et le premier Jardin de Dijon', in Jean-Louis Fischer (ed.), *Le Jardin entre science et representation* (Paris, 1999); François Regourd, 'La Société royale d'agriculture de Paris face à l'espace colonial (1761–1793)', *Bulletin du Centre d'Histoire des Espaces Atlantiques*, viii (1998).

knowledge was limited, however, because the tacit knowledge necessary for cultivation did not usually travel with specimens. As Antoine de Jussieu (1686–1758) had explained in the early eighteenth century, the plants and seeds sent from France's *comptoirs* (trading posts) were useless unless their European recipients knew how to grow them: 'If we see little success with the seeds that we receive [from overseas correspondents], it's due to being insufficiently informed about [what] . . . to observe for their cultivation'. Without such information, plants might wither and die or seeds might never shoot: 'Either one tries to make plants grow as individuals that, like wheat, are not in the habit of growing except in groups, or [one gives] . . . too much attention to . . . others whose nature is to be wild'.[30] Getting hold of a plant or seed, then, was not enough: the real work lay in naturalizing a specimen in its new environment, in understanding how it liked to grow, and then in cultivating it successfully.

This is a significant point, because botany has generally been considered in the history of science as an area of knowledge that lends itself to codification, and that can thus be transferred with ease across distance. As Bruno Latour has emphasized, it is relatively easy to create representations of plants, either by pressing and drying the specimens for inclusion in herbaria, or through the production of images.[31] These 'immutable mobiles' can then be moved with ease and, indeed, have made a significant contribution to eighteenth-century taxonomic work. However, the fragility and environmental specificity of most live seeds and plants makes them the antithesis of Latour's immutable mobiles. Working out how to transport them thus became a central feature of colonial botanical schemes, especially as most were not easily moved. To increase specimens' chances of survival, it was necessary to transmit information about the ways in which they grew and how they might be cultivated. Such information was best conveyed in person rather than through a representation.

The eighteenth-century French government was acutely aware of the problem that new plants might die within days of entry into a new climate. Political

[30] MNHN, MS Jus 3, fos. 98–9.

[31] Bruno Latour, 'Visualization and Cognition: Thinking with Eyes and Hands', *Knowledge and Society: Studies in the Sociology of Culture Past and Present*, vi (1986); and Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, Mass., 1987), 227–37. For discussions of Latour's concept of immutable mobiles among historians of eighteenth-century botany specifically, start with Bleichmar, *Visible Empire*, 60–5; Spary, *Utopia's Garden*, 84– 5, 97; Dirk Stemerding, *Plants, Animals and Formulae: Natural History in the Light of Latour's Science in Action and Foucault's The Order of Things* (Enschede, 1991), 85–9.

emphasis was placed accordingly on celebrating successful cultivations. In 1778, for example, the first French nutmeg was harvested on the Île de France.[32] Nutmeg, which was valued not only as a culinary ingredient but also for its medicinal properties, had been a Dutch monopoly for most of the eighteenth century. The French had only finally obtained the true variety (through stealing it) by 1770. It had then taken at least eight years for a French nutmeg tree to become mature enough to bear fruit, at which point Jean-Nicolas Céré, the Intendant of the Jardin du Roi on the Île de France, declared that France finally possessed its own fertile nutmeg.

To commemorate this wonderful fact, Céré convened local dignitaries from the Île de France and the neighbouring Île Bourbon to witness the official harvesting of the first nutmeg. He had the report about the ceremony published and circulated throughout the French colonies and metropolitan France:

> Monday seventh of this month [December], Messieurs the governors and administrators of this colony, accompanied by many respectable people, gathered at the King's garden, at Mont-Plaisir, where M. Céré, . . . to whom M. de Sartines (*sic*), Minister of the Navy, had entrusted the direction [of the Jardin du Roi], showed them a female nutmeg tree, fragrant . . . and in flowers, the product of a nut planted in 1770 by M. Poivre, from which tree he had detached a nut grown to the size suitable to reproduce the species.[33]

The report continued by describing how Céré then asked the governor-general and the Intendant to send the nutmeg to Paris, where the Minister of the Navy would present it to Louis XVI, 'as a proof of the complete success of this spice plantation on the Île de France'.[34] The care taken by Céré to invite reputable witnesses to view the moment when a tiny nutmeg was plucked from its tree, and then to disseminate a detailed description of the ceremony

[32] The significance of the nutmeg to eighteenth-century colonial botany has been underlined in particular in E. C. Spary, 'Of Nutmegs and Botanists: The Colonial Cultivation of Botanical Identity', in Schiebinger and Swan (eds.), *Colonial Botany*; Madeleine Ly-Tio-Fane, *Mauritius and the Spice Trade*, 2 vols. ii, *The Triumph of Jean-Nicolas Céré and his Isle Bourbon Collaborators* (Paris, 1970).

[33] 'Cueillette de la première muscade au Jardin du Roi de Monplaisir, Lundi, 7 Décembre 1778', *Annonces, affiches et avis divers pour les colonies des Isles de France et de Bourbon*, Weds. 9 Dec. 1778, reproduced in Jean-Paul Morel (ed.), 'Base Documentaire Pierre Poivre 1773–1779', doc-78-12-7, <http://www.pierre-poivre.fr/Base-doc-73-79.html> (accessed 17 June 2019).

[34] *Ibid.*

through the French empire, underlines the importance placed on the successful cultivation of this one single plant. Similar examples exist for other precious plants. The first French cloves had been presented at court in 1777 as confirmation of French possession; their pungent aroma apparently delighted the king, the court, and 'all true and honest patriots'.[35] Their significance was related both to their economic value as lucrative spice plants and to their symbolic value as emblems of France's power over nature and over its colonies.

The impression that such sources can offer is that the absolutist government successfully created a communication channel for botanical specimens and information that led directly from French colonies and trading posts to Paris via its port cities. Studying initiatives such as these, James E. McClellan III and François Regourd have depicted the overall structure created by the eighteenth-century French kings as a 'colonial machine' through which data was collected and processed.[36] According to this model, the government's ability to collect information and use it to further exploit its colonial resources apparently resulted in French science becoming 'institutionally and intellectually the strongest of any nation'.[37]

However, closer examination shows that the absolutist state's ability to collect scientific data, and thus to assert control, was hampered by obstructions that were often so minute that, on first sight, they appear hardly significant enough to merit sustained historical attention. Yet, like pivot levers, these tiny impediments had a great impact upon French colonial aspirations.

[35] Pierre Poivre (La Fréta) to Jean-Nicolas Céré (Île de France), 1 Nov. 1777, reproduced in Jean-Paul Morel (ed.), 'Pierre Poivre & Compagnie', <http://www.pierre-poivre.fr/> (accessed 17 June 2019). Poivre maliciously claimed that Céré's detractors were completely overwhelmed by the cloves' smell. This example underlines the effect that individual personalities and rivalries could have on the history of botany, as discussed by Spary in 'Of Nutmegs and Botanists'.

[36] James E. McClellan III and François Regourd, 'The Colonial Machine: French Science and Colonization in the Ancien Régime', *Osiris*, xv (2001); McClellan and Regourd, *Colonial Machine*. The 'colonial machine' thesis developed by McClellan and Regourd has been the subject of extensive discussion, see esp. Loïc Charles and Paul Cheney, 'The Colonial Machine Dismantled: Knowledge and Empire in the French Atlantic', *Past and Present*, no. 219 (May 2013); Parsons and Murphy, 'Ecosystems Under Sail'; Kenneth Banks, 'Communications and "Imperial Overstretch": Lessons from the Eighteenth-Century French Atlantic', *French Colonial History*, vi (2005). The debate has primarily focused on the movement of knowledge across the Atlantic world, however, with the exception of Roberts, '*Le centre de toutes choses*'.

[37] McClellan and Regourd, 'Colonial Machine', 32.

IV
MARITIME ENVIRONMENTS

The close attention paid to tiny objects by members of the French government invites us also to consider the plants themselves and the practicalities of their transport. Focused studies of small things (literally and figuratively) reveal the extent to which the relationship between eighteenth-century science and empire was capricious, contested and never certain. The arrival of new, fertile, specimens was especially important because, as intimated above, transferring plants over long distances was very difficult. Botanists regularly reported that the majority of their shipments died. Indeed, on the very first page of his 1753 manual on oceanic plant transfers, French amateur of botany H. L. Duhamel du Monceau explained that '[t]hose who, for their utility, or to satisfy their taste or that of others, wish to transport plants or seeds . . . from one place to another very far away, should know that these transports are almost always pure losses'.[38] Duhamel du Monceau's instructions, which extended over ninety pages, were intended to reduce the fatalities experienced, but plants nevertheless continued to expire in great quantities while at sea. In a letter published forty years later in the revolutionary *Mémoires d'agriculture* (1791), botanical gardener Hippolyte Nectoux (1759–1836)[39] detailed the continued problems that he and his botanist colleagues in the Caribbean were experiencing. Citing two shipments recently sent from the Jardin du Roi of the Île de France to its counterpart in Saint Domingue (now Haiti), Nectoux explained that of 477 plants on the first ship only sixty-four had survived (an 87 per cent loss); on the second ship only twenty plants survived from a similar initial total (a 96 per cent loss).[40]

Botanical correspondence throughout the eighteenth century abounds with distressed descriptions of opening parcels and packages to find contents that had (for example) either withered in the heat or mouldered in the damp, that had been poisoned by the salt air or by tar washed into the pots from the

[38] H. L. Duhamel du Monceau, *Avis pour le transport par mer des arbres, des plantes vivaces, des semences, et de diverses autres curiosités d'histoire naturelle:seconde édition, considérablement augmentée* (Paris, 1753), 1–2.

[39] Hippolyte Nectoux travelled to French Guiana in 1787 on a search for cinchona, and was then appointed director of the botanical garden at Saint Domingue in 1788. 'Nectoux, Hippolyte (1759–1836)', in JSTOR, *Global Plants*, <http://plants.jstor.org/stable/10.5555/al.ap.person.bm000005979> (accessed 17 June 2019). See also James E. McClellan III, *Colonialism and Science: Saint Domingue in the Old Regime* (Chicago, 2010).

[40] Hippoyte Nectoux, 'Observations sur la préparation des envois de plantes & arbres des Indes Orientales pour l'Amérique, & leur traitement pendant la traversée', *Mémoires d'agriculture, d'économie rurale et domestique* (Hiver 1791), 110.

ship, that had been scratched to pieces by ships' cats, eaten by rats or insects, or that had been bumped about so much during the voyage that their labels and other information about them had become detached, rendering the specimens useless.[41] Plants were exposed to a huge number of hazards aboard ship, which made the challenge of successfully transferring them seem almost insurmountable. Nevertheless, governments and patrons of botany agreed that ensuring the material survival of each and every individual specimen was essential for the political economy of empire, and for science.

Plant transfers were extremely complex, then, and largely characterized by failure. Plant hunters in the field first had to identify and then obtain the right variety of a specimen, then should — if possible — cultivate the plant in the place of origin until it was hardy enough to move. Cultivating a plant *in situ* would also allow a plant hunter to gather data about its growth that might help later recipients. Next, it was necessary to find an appropriate vessel on which to convey the plant, with a compliant captain and officers who would ensure its survival during the journey at sea. The plant would often also have to endure an onward journey on land once it reached its country of destination. Finally, its recipients had to cultivate it successfully at its destination, in a new climate and in new soil.

European governments made structural changes over the course of the eighteenth century that did improve plants' chances of survival. The most significant of these were new networks of colonial botanical gardens, through which tender plants could rest during a long and complex journey. By 1777 France had established botanical gardens in all its most significant colonies, including Guadeloupe (1716), the Île de France (1735, 1748 and 1775), the Île Bourbon (1767), Martinique and Saint Domingue (both 1777).[42] The government also encouraged the creation of botanical gardens in the French port towns. As the landlocked city of Paris was the ultimate destination for most plants, the littoral gardens offered essential places of rest where fragile specimens could recover before completing their overland journeys. In 1773, for example, Louis XV agreed to the construction of a greenhouse at Lorient (the main French East India Company port), expressly to house exotic plants newly arrived in France.[43] Eleven years later, André Thouin, the head

[41] For further discussion of the problems encountered with oceanic transfers of plants and other natural history specimens, see Parsons and Murphy, 'Ecosystems Under Sail'; and Bleichmar, *Visible Empire*, 63.

[42] James E. McClellan III, 'Scientific Institutions and the Organization of Science', in Porter (ed.), *Cambridge History of Science*, iv, 102.

[43] De Boynes (Versailles) to Chevalier de Ternay et Maillart Dumesle, gouverneur général et intendant aux Isles de France et de Bourbon, 11 Dec. 1773, reproduced in Jean-Paul

gardener of Paris's Jardin du Roi, noted that he had 'received' a packet of North African seeds that was in fact physically in Marseilles: he had arranged with a correspondent in Marseilles to plant them there first, on his behalf. The specimens would be forwarded to Paris only if they grew successfully.[44] Finally, and as stated earlier, the French government also sought to improve the efficiency of plant transfers by insisting that the navy provided transport for specimens collected on behalf of the crown. These strategies were still not sufficient, however. Seeds failed to sprout and live plants continued to expire in great numbers as a result of their oceanic journeys.

V
SHIPS AND *MOEURS*

History, and perhaps especially the history of science, has traditionally lent itself to being written by the victors. The plants that survived their gruelling journeys and were transplanted into new locations are the ones that have been best remembered and most studied. Many of those successful transfers, after all, have had a huge impact on their hosts' landscapes, science and culture.[45] Their presence has led to the production of narratives in which the outcomes of colonial botanical projects are portrayed as both predictable and certain. However, these fruitful importations were in the minority. Global botanical transfers were incredibly difficult, and most plants died.

As has been made clear above, the oceanic journey was a problematic phase within these long-distance specimen transfer initiatives. We might assume that seeds potentially offered an effective alternative to live plants because they required less space and less care while in transit. Indeed, European governments and patrons of botany encouraged travellers to take packets of seeds with them and to plant them in new locations. French circumnavigator Jean-François Galaup de la Pérouse planted European seeds on Easter Island, for example, during a one-day stopover in April 1786. As he explained in his journal, this act was one part of a broader fact-finding mission to learn about the local environment: 'We . . . split into two groups; the first . . . was to go as far as possible into the interior of the island, to sow seeds in every place that appeared suitable for them, to study the soil, the plants, any cultivation, the

Morel (ed.), 'Base Documentaire Pierre Poivre 1773–1779', doc-73-12-11, <http://www.pierre-poivre.fr/Base-doc-73-79.html> (accessed 17 June 2019).

[44] André Thouin (Paris) to Pierre Poivre, 20 August 1785, reproduced in Jean-Paul Morel (ed.), 'Base Documentaire Pierre Poivre 1780– & Documents non datés', doc-85-8-20 <http://www.pierre-poivre.fr/doc-85-8-20.pdf> (accessed 17 June 2019).

[45] Alfred Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (Cambridge, 1993).

population'. The travellers also looked for and assessed the growth of seeds that they knew had been planted by other European travellers, including James Cook, in whose wake the mission self-consciously travelled.[46] However, although seeds might appear to be the best means of moving biota across long distances, biological factors that I will outline below mean that seed transfers could be just as difficult as those of live plants.

La Pérouse and his entourage travelled aboard vessels that had been specially commissioned for scientific exploration and research. The vast majority of botanical travellers in the eighteenth century, however, made their way round the globe on regular mercantile ships that were thus not necessarily set up to accommodate live cargo.[47] Joseph Martin, for example, travelled to the Île de France aboard a packet boat that sailed regularly between metropolitan France and the Indian Ocean.[48] It was especially difficult to ensure that botanical shipments on such vessels would receive adequate space or the specialist treatment that they needed during their journeys.

A further context to explore, then, is that of the ship and the people who lived aboard alongside the vegetables. It is perhaps unsurprising that the extant correspondence about oceanic plant transfers abounds with examples of tensions between ships' crews, botanical travellers and their importunate passengers. One of the most infamous incidents in British history is that of *The Bounty*: in 1788, the crew mutinied over the conditions that they were subjected to during a voyage transporting breadfruit trees from Tahiti to the Caribbean. There are many more examples of arguments and conflicts, if not outright insurrection, in the archives. Live plants demanded not only large quantities of precious fresh water, but also took up excessive amounts of space, potentially impeding the operation of the ship at sea. The stern of the vessel was the place most likely to assure the specimens' survival because it was least subjected to the motion of the sea and more protected from sea spray. This, however, is where the captain's quarters were located. Requests that captains might share their space with a forest of leafy companions were rarely taken kindly.[49]

[46] *The Journal of Jean-François de Galaup de la Pérouse, 1785–1788*, ed. and trans. John Dunmore, 2 vols. (London, 1994), i, 61. See also M. Crozet, *Nouveau voyage à la Mer du Sud* (Paris, 1783), 161–2.

[47] John Ellis, *Directions for Bringing over Seeds and Plants, from the East Indies and other Distant Countries, in a State of Vegetation* (London, 1770), 9.

[48] MNHN, MS 56, Martin, 'Journal d'un voyage'.

[49] Sarah Easterby-Smith, 'On Diplomacy and Botanical Gifts: France, Mysore and Mauritius in 1788', in Batsaki, Cahalan and Tchikine (eds.), *Botany of Empire*.

Eighteenth-century botanists concurred that the actual survival of plants depended as much on the attentiveness and skill of the individual(s) to whom their care was entrusted as on the specific conditions aboard ship. The close attention they paid to the characters of the people sent to tend to plants during their oceanic voyages underlines the culturally embedded nature of science and scientific practice. I have discussed elsewhere the ways in which character judgements affected the relationships formed between interlocutors, with direct consequences for the construction of trust and for the subsequent assessments of the quality of information circulated.[50] The same attitudes extended into discussions about how to improve plants' chances of survival aboard ship, as will become evident if we return to the 1791 letter sent by head gardener Hippolyte Nectoux to the *Mémoires d'agriculture*. Nectoux explained that parcels of plants 'must be entrusted only to *educated* and careful individuals'. He claimed that specimens could be transferred with near complete success provided that their custodians were well trained, honest and attentive. Nectoux emphasized that conveying plants at sea required 'study [and] vigilance'. He did not, however, discuss what kind of botanical expertise was required, and noted only that botanical travellers must possess a highly developed capacity of sight so that they could observe and attend to the slightest change in the plants' conditions.[51] Nectoux's account otherwise focused on the *mœurs* of the interlocutor.

What kind of person, then, might be considered an appropriate custodian for live plants aboard ship? In his article, Nectoux offered character assessments of two suitable plant hunters: Joseph Martin, discussed above, and himself; he argued that they possessed the necessary moral rectitude to transport precious specimens.[52] The emphasis that Nectoux placed on character and probity, rather than on training and expertise, is not surprising if considered in the context of the sociology of early modern science: a well-established historiography has identified how elite social status was associated with trustworthiness and reliability in early modern intellectual circles.[53]

[50] Sarah Easterby-Smith, 'Reputation in a Box: Objects, Communication and Trust in Late Eighteenth-Century Botanical Networks', *History of Science*, liii, 2 (2015). For those working at a distance from each other, furthermore, material objects — be they letters, boxes, or the plants themselves — took on added significance as representatives of the people who sent them.

[51] Nectoux, 'Observations sur la préparation des envois de plantes & arbres', 119–21. My emphasis.

[52] *Ibid.*

[53] Shapin and Schaffer, *Leviathan and the Air Pump*; Stephen Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England* (Chicago, 1995).

However, Nectoux's stress on character carries further significance because neither he nor Martin possessed such an elevated status. Indeed, as botany became increasingly enlaced within government agendas over the course of the eighteenth century, and as the number of attempted oceanic plant transfers increased, the proportion of elite individuals available to accompany plants was correspondingly reduced.

By the late 1780s, the directors of botanical gardens were sending out emissaries from very lowly backgrounds indeed. In the autumn of 1788, for example, the Jardin du Roi engaged two young men to accompany a consignment of specimens destined for India who, though skilled at gardening, were only semi-literate. The pair could read but their letters to head gardener André Thouin indicate that they were not confident writers.[54] Earlier that same year (February 1788), the head gardener of the French botanical garden on the Île de France, Jean-Nicolas Céré, arranged for around sixty boxes of spice trees and a consignment of birds (to eat the locusts that had previously ravaged France's Caribbean spice plantations) to be sent to Saint Domingue and Cayenne.[55] These, he explained, would be cared for by one Sieur d'Arras, 'my right-hand man', and by 'the only pupil who remains at the Jardin du Roi', a creole gardener.[56] Although the gardener was not named in this letter, Céré underlined that he was essential to the success of the mission. Such social diversity was a major feature of botanical transfers. From the perspective of an individual such as Nectoux, it was thus important to show that lower-ranking men such as himself could be trusted — and that their scientific observations might be worthy of value.

VI
WILLING GARDENERS AND RECALCITRANT SEEDS

In spite of de Jussieu's early eighteenth-century emphasis on the significance to botany of practical knowledge, and despite Nectoux's revolutionary aspirations, gardeners' low social status means that details of their contributions are mostly absent from eighteenth-century botanical records. Nevertheless,

[54] MNHN, MS 307, 'Végétaux envoyés au Sultan Tippoo Zaib par le Jardin du Roi 1788'. See Easterby-Smith, 'On Diplomacy and Botanical Gifts'.

[55] Céré referred to the birds simply as 'l'oiseau martin'. They were probably *Halcyon coromanda* ('Martin-chasseur violet' or 'Ruddy Kingfisher'), a migratory bird endemic to east and south-east Asia. It was not successfully introduced to the Caribbean.

[56] Jean-Nicolas Céré (Îsle de France) to La Luzerne [minister of the navy] (France), 14 February 1788, reproduced in Jean-Paul Morel (ed.), 'Base Documentaire Pierre Poivre 1780– & Documents non datés', doc-88-2-14, <http://www.pierre-poivre.fr/Base-doc-80-86.html> (accessed 17 June 2019).

western botanical science benefited from their practical knowledge and skill, both in terms of working within specific environments and, from a broader purview, of enabling European botanists to incorporate data from across the globe. The final context that we need to investigate concerns the ways in which gardeners attempted to manipulate the objects in their care. Such investigation reveals two important aspects of eighteenth-century botany. First, botanical transfers depended completely on the tacit knowledge and expertise of gardeners who remain all but invisible to us in the sources. Second, in some cases it took botanists working in European institutions several centuries to 'discover' knowledge that had long been known among practical gardeners.

One set of sources that at least gestures towards the essential role played by gardeners are the notebooks composed by Chrétien-Guillaume de Lamoignon de Malesherbes (1721–93). In the late 1780s and early 1790s, the French royal minister composed a huge number of manuscript notes and essays about botany which remain unpublished. He began a twenty-eight-page manuscript dissertation about plane trees by stating emphatically that he was drawing on the observations made by his gardener rather than those published in botanical dissertations that were orientated towards theory.[57] The very next entry in his notebook, entitled 'Observations on the observers', offered further explanation for his decision to rely on gardeners' knowledge rather than on that of established botanists:

> Our great botanists have heaped . . . opprobrium on those who identify genera [plant classifications] by taking aspects into consideration other than the parts of fructification, and who . . . consider features other than those that the grand masters have decided are the sole specific traits. They [the great botanists] reproach Tournefort, and those who have preceded him even more, for having placed too much importance on observations that appear to them to be worthy only of a gardener, and not of a savant.[58]

For Malesherbes, as for the great seventeenth-century French botanist Joseph Pitton de Tournefort (1656–1708), the study of plants was grounded in the observation of living specimens, and thus required extensive collaboration between botanists and gardeners.

Malesherbes' emphatic statements about the intellectual gains that could result from collaboration with gardeners underline their centrality to

[57] MNHN, MS 238, 'Mémoires de botanique: nouvelles observations sur le platane tortillard faites dans l'hyver 1791 à 1792', fo. 1.

[58] MNHN, MS 238, 'Mémoires de botanique: observations sur les observateurs'.

eighteenth-century botanical research and practice. He was unusual among Enlightenment botanical scholars, however, because he attempted to articulate the *kind* of value that gardeners' knowledge could bring to botany. It was clear that European botany depended on gardeners for practical reasons: they could accompany plants as they travelled across the world, and they knew how to cultivate and thus preserve specimens new to European science. However, the expertise developed among gardeners also had significant intellectual components that were simply not recorded by most eighteenth-century botanical scholars. As Malesherbes pointed out, the majority of his counterparts were preoccupied with solving theory-based problems relating to taxonomy and did not pay much intellectual attention to what was happening in their gardens. Yet, traces scattered among archival records show that gardeners actually made numerous observations relating to plant physiology. Understanding plant growth, after all, was essential for ensuring successful long-distance transfers.

Evidence for such expertise emerges when we return to the question of plant transport and particularly to gardeners' observations about the germination and growth of seeds. We have seen that European governments invested a great deal of time and energy in supporting global plant transport schemes. The gardeners employed by botanical institutions accordingly investigated methods that might guarantee specimens' well-being while at sea, and that might reduce their potential to be nuisances aboard ship. In common with other plant transfer expeditions organized by Paris's Jardin du Roi in the 1780s, André Thouin issued Joseph Martin with detailed instructions about the observations and experiments that he was to undertake during the journey. He had to keep two journals, one detailing observations about the condition of the plants under his care, and the other recording changes in the weather. He was equipped with thermometers with which to measure temperature and was instructed to pay particular attention to the plant boxes carrying the most fragile specimens.[59] In addition, Martin was instructed to undertake experiments on the seeds in his care. Among the eight crates consigned to him, crate 6 contained nine tinplate boxes that were ultimately to be used for dried specimens and seeds that Martin was to collect and bring back to Paris. On their outward journey, however, these boxes were used for experiments in seed preservation and germination. Each contained seeds of the same set of kitchen-garden plants, and each had been closed up in a slightly different way. One box was hermetically sealed, so that no moisture or fresh air could enter; another contained the same seeds but packed into paper envelopes and otherwise exposed to the sea air. A further

[59] MNHN, MS 56, Martin, 'Journal d'un voyage', fos. 3–17.

box contained seeds in paper envelopes *and* little bags made from horsehair, and it was to be unpacked immediately on arrival in the ship. The seed packages in their horsehair bags were to be suspended from the boards in the ceiling above Martin's hammock, and thus would have swung along with the motion of the ship throughout the journey. Martin was to hand over these seeds so that they could be planted on the Île de France, in order to see which would grow most effectively. The instructions underlined, furthermore, that all had been harvested from healthy plants which were easy to grow from seed in France.[60]

The experiments that Joseph Martin was asked to undertake gesture towards the attempts made by eighteenth-century botanical gardeners to stabilize the environments in which the plants aboard ship were cultivated. While most kinds of seed would arrive looking physically intact (unless eaten by vermin along the way), a seed could easily lose its germinative properties in transit, either due to climatic variations or simply because it needed to be planted at a particular time. In 1770, for example, British gardener and botanist John Ellis (1710–76) had proposed several kinds of container adapted to the properties of different specimens. As '[t]he smallest seeds' were 'very liable to lose their vegetative power by long voyages through warm climates', Ellis proposed that readers should attempt to preserve them by dipping some square pieces of cotton cloth in melted wax, and while it is soft and almost cold, strew the surface of each piece over with each sort of small seed, then roll them up tight, and inclose (*sic*) each roll in some soft bees-wax, wrapping up each of them in a piece of paper, with the name of the seed on it.[61]

While this method might protect some of the smaller seeds, Ellis noted that there were nevertheless 'many . . . which the gardeners find very difficult to raise here [in England]'. He proposed that the seeds of plants that needed to sprout quickly, such as avocado and cinnamon, should be planted in specially divided boxes, with segments filled with earth and moss that was 'rather inclining to dry than wet' (see Plate). The box would then be nailed shut 'very close' during the voyage and should be stored 'in an airy situation.'[62] This method, however, only worked for plants spending less than two months at sea and was therefore only appropriate for journeys across the Atlantic or between selected colonial botanical gardens. The biological fact that some seeds need to germinate at times that might be sooner than the length of a transoceanic journey to Europe, meant that they therefore needed to be

[60] MNHN, MS 56, Martin, 'Journal d'un voyage', fos. 11–14.

[61] Ellis, *Directions for Bringing over Seeds and Plants*, 11.

[62] *Ibid.*

planted in botanical gardens along the way. Here, the plants — if they grew — might eventually produce new seeds for the next stage in the voyage. Taking certain specimens alive to Europe was a process that could take years.

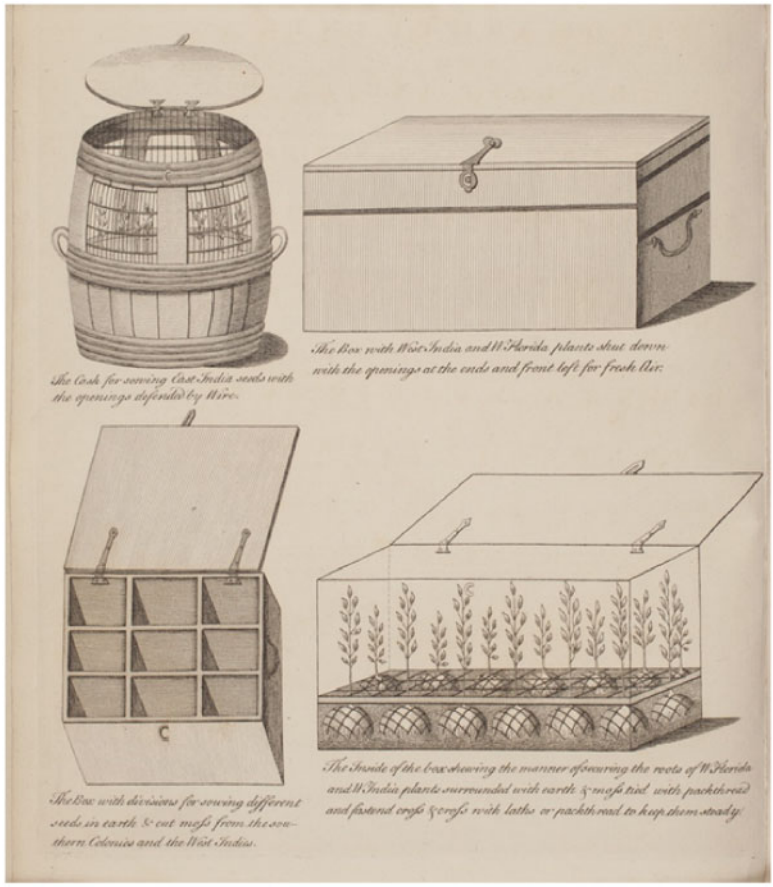
The debates surrounding how best to transfer plants and seeds came down to the design of boxes and manipulation of specimens, then, and so does the study of the way in which the global imposed practical constraints on European scientific aspirations. The search for a method of transferring plants and seeds reliably across long distances was a running theme in botanical conversations throughout the second half of the eighteenth century. In his 1791 letter, Hippolyte Nectoux devoted extended attention to the precise design of the crates used to transport botanical specimens, including the placement of plants within the boxes and the best types of screens and covers to use in order to protect them from excesses of temperature and humidity. Nectoux's proposal also made highly efficient use of the limited shipboard space and, he emphasized, his precise plans for placement of boxes on deck would not impede the sailing of the vessel.

In terms of the design of plant boxes, Nectoux's instructions actually represent little more than slight, nuanced improvements on the crates already in use. They did not on their own increase plants' chances of survival.[63] But what Nectoux does underline, however, is the value of experience and practical knowledge in ensuring successful plant transfers. Like Ellis, Nectoux discussed in particular the problem of transporting seeds which germinate quickly but which will lose their ability to sprout at all unless planted soon after they had reached their maturity.[64] He proposed that, rather than growing the plants in each box in individual pots, the space between each specimen should be packed with earth. Cinnamon and pepper seeds could then be planted, so that they could germinate and grow during the journey. Nectoux's innovative plant boxes would make it possible to transport such demanding seeds on journeys longer and further than the transatlantic ones discussed by Ellis.

The observations that gardeners such as Ellis and Nectoux made about seed growth do not survive in any detail. Evidence for their observations is apparent only in the pragmatic discussions that exist about box designs and planting schedules. These scant sources are significant, however, for the gardeners

[63] For comparisons, see Duché de Vancy's designs for plant boxes for the Comte de Lapérouse's 1785 circumnavigation, reproduced in Julia Ferloni, *Lapérouse: Voyage autour du monde* (Conti, 2005). See also François Lebreton's 1787 designs for breadfruit cases, reproduced in Spary, *Utopia's Garden*, 121. Botany had to wait until the 1830s for the invention of the Wardian case, the definitive oceanic plant box.

[64] Nectoux, 'Observations sur la préparation des envois de plantes & arbres', 115.



John Ellis, *Directions for Bringing over Seeds and Plants, from the East Indies and other Distant Countries, in a State of Vegetation* (London, 1770). © Dumbarton Oaks Research Library and Collection, Rare Book Collection, Washington, DC. The box for 'recalcitrant' seeds, discussed below, is at the bottom left.

had identified aspects of plant physiology that in fact only came to be systematically studied by botanists in the twentieth century: British botanist E. H. Roberts styled these fast-germinating seeds as 'recalcitrant' in the 1970s.[65]

[65] E. H. Roberts, 'Predicting the Storage Life of Seeds', *Seed Science and Technology*, i (1973); P. Berjak and N. W. Pammenter, 'Seed Recalcitrance: Current Perspectives', *South African Journal of Botany*, lxvii (2001).

It is evident, however, that the eighteenth-century gardeners' practical knowledge about plants was essential to western botany centuries before it received formal recognition and theoretical elaboration.

The transport of live plants across the oceans meant that certain ships effectively became 'floating laboratories' in which gardeners carried out research, often under very difficult conditions.[66] The shipboard environment had to be stabilized as much as possible, and this meant that the design of a box and its placement aboard a vessel were key considerations. But solving the practical problems relating to the transport of plants also involved developing a systematic and precise understanding of seed germination and plant growth. This expertise was central to the success — or otherwise — of colonial botanical schemes. It was far, however, from the minds of states, governments or even eighteenth-century scientific theorists. These were issues to be worked out within gardens and aboard ships.

VII
CONCLUSION

The spaces that matter to eighteenth-century botanical history are not amorphous global flows of knowledge from centre to periphery. Rather, they are the small spaces occupied by plant boxes and their attendants, who jostled for room and for resources as they traversed the oceans. This study of the challenges of seed transfer, of the emphasis placed on character judgements about botanical travellers and of the design and placement of boxes aboard ships counters narratives about the inevitability of western colonial science and disrupts broad-brush assumptions about the effectiveness of a so-called 'colonial machine' in old regime France. Further, by considering the micro both as a material entity and as an approach through which to examine eighteenth-century knowledge networks it has been possible to identify knowledge developed among non-canonical individuals within global networks and thus to start fragmenting European scientific knowledge from the inside out.

Approaching botanical collecting as a set of overlapping contexts, each of which requires microhistorical investigation, helps to separate them out analytically. In the French case, plant collecting was strongly encouraged by a state with imperialist aspirations. These ambitions were, at heart, focused on tiny, unpredictable material objects. The royal celebrations of the successful harvests of nutmeg and cloves were emblematic of the French government's

[66] On ships as laboratories, see Richard Sorrenson, 'The Ship as a Scientific Instrument in the Eighteenth Century', *Osiris*, xi (1996).

intention to use science to further its colonial schemes, but they also underline just how rarely those objectives were actually fulfilled. The ostensibly simple task of carrying a plant or seed from one part of the world to another proved almost insurmountable. Although most specimens were very small in size (and, if compared to the volume of mercantile shipping, absolutely miniscule in number), the effective transfer of specimens over long distances, and their subsequent successful acclimatization in new locations, had terrific ramifications for imperial aspirations.

The historiography on eighteenth-century colonial science has been concerned largely with identifying instances of autonomy or independence within colonial locations and, for later periods, in studying transitions towards autonomy from colonial powers. A parallel historiographical strand has explored the ways in which individual actors acted as brokers or mediators for knowledge transfer or resistance.[67] Taken together, this work can contribute towards breaking down assumptions about hegemonic colonial power but can also create a false distinction between 'colonial' and 'colonized' knowledge.[68] In the examples discussed here, the impetus for collecting and moving scientific data often came from the crown, but the details were always worked out by the individuals on the ground and at sea. By considering the specific material conditions of long-distance collection and transport, this article has exposed some of the multiple knowledge traditions that contributed to enlightenment science. The irony is, of course, that in the eighteenth century these epistemologies were rarely considered worth recording formally.

If viewed solely from a macro-perspective, without paying sufficient attention to localities (such as ships) and individuals (such as gardeners), the history of global knowledge transfer could offer a singular narrative of successful experimentation and intellectual development. But scientific research has been characterized by a great number of failures alongside those few, significant triumphs. Whether one seeks to understand either the many cross-cultural influences that shaped what we now consider to be modern science, or to understand the diverse and globally disparate social worlds that surrounded and created multiple scientific practices, it is important to focus on contingencies — or, in other words, to give as much space to the history of failure as to the history of success. Doing so requires micro-level studies that

[67] Simon Schaffer *et al.* (eds.), *The Brokered World: Go-Betweens and Global Intelligence, 1770–1820* (Sagamore Beach, Mass., 2009).

[68] Sivasundaram, 'Sciences and the Global', 154–5.

focus on the behaviour, activities, assumptions and decisions made by the people involved. These, after all, conditioned the possibilities for the collection and transfer of object-based data, and thus the creation, and occasionally the transmission, of myriad new forms of knowledge.

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