Live plants on the way: ship, island, botanical garden, paradise and container as systemic flexible connected spaces in between

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Abstract

In the 18th century the global transfer of plants from the colonies to the scientific and political centres of Europe and places in the colonies was basically optimized. Some European Botanical gardens moved to new sites on exotic islands such as the Isle de France, Ceylon and Jamaica. The transfer of plants was accelerated by the transport of live plants, which became evident in an intensive search for more adequate transfer conditions, but there was no innovation in respect of containers. This happened only in the first half of the 19th century, because of the invention of the Wardian case. Why it took so long to happen will be explained by a consideration of the systemic connections of the spaces identified as ship, garden, island and container as instances of transfer that were connected by the paradigm of flexibility of use based on the idea of paradise.

Keywords: plant transfer, ship, island, Botanical Gardens, container, Wardian Case, paradigm of flexibility.

The ruling elites and nobility of the early modern period loved exotic plants, admired them and brought them from distant places to Europe. In addition to Botany as a hobby, it had been, since the 18th century, more a matter of tangible economic interests on the part of the colonial powers whose goal was to move exotic agricultural plants from one region to another, to cultivate them there on a large scale and to exploit them economically. At the same time the movement of plants from one part of the world to another, and across oceans, had moved to a new organized stage,

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particularly since it was taking place in the framework of a process of co - operation between science, economy, the state and colonialism[1]. Economically useful plants, such as the tea - bush or the clove tree, both from East Asia, represented a major requirement[2], since both products were dominating European consumption, but their cultivation in European gardens had not yet been mastered by the gardeners, botanists, farmers and experts, and planting outside their regions of origin had not been successful. Equally, the protagonists adhered to really Utopian expectations of success, which were related to the idea of unlimited possibilities for Europeans to ship tropical plants from one region of the globe to another and then to be able to transplant them permanently. For example, it is well - known of the botanist Carl von Linné that he thought out a successful acclimatization process for tea plants in the cool climate of Sweden and that he mobilized his dense and widespread network of botanists for this purpose[3]. In this vital process of plant movement, the phenomenon of acclimatization was the great unknown.

Whereas previous lay merchants, missionaries and diplomats had been concerned only incidentally with the transfer of plants—delivering them together with novelties, and thus arousing the desires of the elites—more and more botanists during the 18th century were involved in the transfer[4], and the unification between the economy, state interests and scientific curiosity resulted in a new and systematic procedure, which brought about new organizational forms, such as state - financed expeditions and a standardized system of naming and describing the plants. As the historian Richard Drayton has stressed[5], British colonial botany emerged, owing to individual initiative, along Dutch lines until the latter part of the 18th century, when the English adopted the successful French model of cooperation between the state,

[1] David Mackay, "Agents of Empire: The Banksian Collectors and Evaluation of New Lands", in David Philip Miller, Peter Hanns Reill (eds.), *Visions of Empire. Voyages, Botany, and Representation of Nature* (Cambridge: Cambridge University Press, 1996), 38 - 57; particularly on this: Londa Schiebinger and Claudia Swan (eds.), *Colonial Botany. Science, Commerce, and Politics in the Early Modern World* (Philadelphia: University of Pennsylvania Press, 2004).

[2] Particularly: Alfred W. Crosby, *The Columbian Exchange. Biological and Cultural Consequences of* 1492 (Westport, Conn.: Greenwood Press 1972); Norbert Ortmayr, "Kulturpflanzen: Transfers und Ausbreitungsprozesse im 18. Jahrhundert", in Margarete Grandner, Andrea Komlosy (eds.), *Vom Weltgeist beseelt. Globalgeschichte* 1700 – 1815 (Edition Weltregionen, Vol. 7, Wien: Promedia, 2004), 73 - 101; Norbert Ortmayr (2002) "Kulturpflanzentransfers 1492 - 1900", *Beiträge zur historischen Sozialkunde*, 2002, 32: 22 - 30.

[3] Lisbet Körner, "Carl Linnaeus in his time and place", in Nicholas Jardine, James A. Secord, & Emma C. Spary (eds.), *Cultures of Natural History* (Cambridge: Cambridge University Press, 1996), 145 - 162.

[4] On the term Transfer: see: Marianne Klemun (2006) "Globaler Pflanzentransfer und seine Transferinstanzen als Kultur - , Wissens - und Wissenschaftstransfer der frühen Neuzeit" Berichte *zur Wissenschaftsgeschichte. Organ der Deutschen Gesellschaft für Wissenschaftsgeschichte,* 2006, 29: 205 - 223.

[5] Richard Drayton, Nature's Government: Science, Imperial Britain, and the 'Improvement' of the World (New Haven: Yale University Press, 2000).

military intelligence and colonial governors. The rules were eventually shared by all working botanists on the basis of the Linnaean code for naming and describing plants. These overseas expeditions could be seen as a growing net that was spun over the entire globe by the European powers and science, and as Pratt pointed out, the expeditions and the Linnaean code of nomenclature created a completely new quality of a 'planetary consciousness'[6] among Europeans, in which science and especially botany was involved. In spite of this professionalization of the nature of expeditions, and the great interest on the part of the European powers and the deployment of botanists, there was no satisfactory solution to the problem of handling plants during transport for more than one hundred years until 1829 and the invention of Nathaniel Bagshaw Ward (1791–1868).

The main interest of my paper is to ask why the solution to the problem of successfully transporting plants around the globe took as long as it did and was not discovered until Ward suggested it with the principle of the closed case in 1829, although there had already been, during the preceding hundred years, a busy engagement in the improvement of containers. The concentration of transport of live plants rather than seeds, of course, implied acceleration in the process, since otherwise years would have passed before a seed had matured into a substantial plant, but it did also mean that transport on the high seas became more difficult. Live plants on sea voyages suffered considerable stress and only a small number survived the long journey. The voyages usually took months and passed through different climatic zones. The plants were therefore exposed to extreme changes of temperature. Plants had to have light and could not survive below the deck in darkness. They had to be brought on deck frequently, in order to thrive. But room on the decks of the ships was rather limited and was mostly reserved for things other than goods considered to be of value. On deck the plants indeed had access to life - sustaining light, but on the other hand they were exposed to harmful saltwater, particularly when, depending on the strength of the wind, there was salt in the air. If the plants remained below deck they were threatened by other dangers, especially if rats and mice gnawed at their roots, ate the leaves or used their soil as a latrine. Freshwater for the plants was also rare on ships. In all it has to be said: plants were a very delicate cargo, for they required a very demanding and specific type of care that was difficult to achieve on ships, purely on the basis of personnel.

[6] Mary Louise Pratt, *Imperial Eyes: Travel Writing and Transculturation* (London and New York: Routledge, 1992), p. 15.

The Wardian Case and the revolution in plant transfer

For the sake of a faster tempo, in this phase of plant transfer, conditioned by economic and political factors, it was no longer exclusively a matter of bringing seeds, but also live specimens. The mode of construction of suitable containers was contentious, because very often the individual plants did not survive the long sea voyage in ships. In the course of the increasingly forced transfer from Asia to Europe, the ships' passages also lasted considerably longer than those from the Americas to Europe, and as a result failure was to be expected more frequently. The desire that was rooted in the necessity to have available an ideal container for transportation was only fulfilled after 1829 with the invention of the Wardian case. This innovation was constructed from glass as a kind of terrarium in which plants could thrive in a microclimate fully insulated from the external environment for months on end[7]. The Wardian case was a closely glazed, portable mini - greenhouse that had a fundamental impact not only on the transfer of plants but also on gardening in the second half of the 19th century throughout the British empire[8]. It was invented in the grimy polluted dockland area of East London by the physician Nathaniel Ward, a busy amateur naturalist. It was around 1829 when, pursuing his interest in entomology, Ward saved the pupa of a moth in a 'natural environment' in a sealed jar. After some time he had noticed that a fern and some grass had started to develop in the soil on the bottom of the jar[9]. As Ward lived in a house surrounded by numerous 'new manufactories'[10] and enveloped in their smoke, moreover, a nearby black ash manufactory on the Thames 'stunted, or altogether blasted' the vegetation 'in the prevailing direction of the wind'[11], Ward learned from the fern in the bottle that he had by accident built a better environment within his glass box. This 'closely glazed case'[12], as he called it, was tightly closed in order to contain its own

[7] On this particularly: Ray Desmond, *The European Discovery of the Indian Flora* (Oxford: Oxford University Press, 1992), esp. pp. 316 - 322; Nigel Rigby, "The Politics and Pragmatics of Seaborne Plant Transportation, 1769 - 1805", in Margarette Lincoln (ed.), *Science and Exploration in the Pacific* (Suffolk: Boydell Press, 1998), 81 - 100.

[8] See more about this topic: Brent Elliott, *Victorian Gardens* (Portland: Timber, 1986); Tom Carter, *The Victorian Garden* (London: Cameron, 1984).

[9] David Elliston Allen, *The Naturalist in Britain. A Social History* (London: A. Lane, 1976; here Princeton: Princeton University Press, 1994), p.119; David Elliston Allen, *The Victorian Fern Craze: A history of pteridomania* (London: Hutchinson, 1969).

[10] Nathaniel Bagshaw Ward, *On the Growth of Plants in Closely Glazed Cases* (London: John Van Voorst, 1842), p. 25.

[11] Ibid. 26.

[12] Ibid. 35 - Ward has chosen the title of his book with these words.

atmosphere, its own climate. 'The Wardian case, as it is still called, thereby escaped the degraded nature surrounding it in every Victorian city and industrial town,'[13] as Margaret Flanders Darby pointed out. And she finishes her article: 'Ward's invention is both an extreme and characteristic example of the Victorians' artificial manipulation of nature: a portable, frugal expression of Victorian collecting manias, of the development of the private sphere, of a response to industrial pollution that depended on the very innovative industrial technologies that created the problem.'[14]

It was a Scottish botanist and garden designer John Loudon who visited Ward and saw Ward's experiments, and they convinced him that the principle of close glazing made possible 'a ready mode of importing most plants, without risk, from the most distant regions of the globe'[15].

Loudon was right in his prediction, when he wrote in 1834: 'the success attending Mr. Ward's experiments opens up extensive views as their application in transporting plants from one country to another; in preserving plants in rooms, or in towns; and in forming miniature gardens or conservatories.'[16] Subsequently, ships' captains and travellers were commissioned by Ward to test the Wardian case. From the middle of the 19th century the contained became more effective in the economically so - successful transfer of rubber plants from Brazil to Ceylon (today Sri Lanka) and in the transfer of more than 20,000 tea plants from China to Assam: a process in which British botanical gardens were involved[17]. The story of the invention of the Wardian case is well known. What interests me at this point is another research question related to the Wardian case that constitutes the core of my study: Ward's invention was a long time coming, in spite of the serious efforts to professionalize the transfer of plants throughout the 18th century. This is all the more surprising since in this period glass boxes were already in use. They did indeed look like Wardian cases but they were not used in the same way, and this was the crucial difference. To stress this once more, the form of the Wardian case was already known in the 18th century, but not its use as an enclosed microsystem. The answer to the question why it took as long as it did will include a focus on the mobile relation among the spaces in between

[13] Margaret Flanders Darby (2007) "*UN*Natural History: Ward's Glass Cases", *Victorian Literature and Culture,* 2007, 35: 635 - 647, on p. 635.

[14] Ibid. 647.

[15] John Claudius Loudon (1834), *Gardener's Magazine* 1834, 10: 162 - 63; 207 - 08, here on p. 208.

[16] Ibid. 163.

[17] Lucile H. Brockway, Science and Colonial Expansion. The Role of the British Royal Botanic Gardens (New York and London: Yale University Press, 1979); Donal P. McCracken, Gardens of Empire. Botanical Institutions of the Victorian British Empire (London and Washington: Leicester University Press, 1997).

which were involved in the transfer: botanical gardens, ships, islands and containers. Together they created flexibility in practice that delayed understanding of the closed environment. But this practice was invigorated through the metaphor of paradise that connected island and garden.

Transfer containers in the 18th century

The discovery of the Principle of the Wardian case was accidental and took place outside of the systematic context of expeditions on the high seas. It is a demonstration of the fact that important inventions happen by accident and deliberate effort at the same time, as they were part of different practical spaces: the gardening and the shipping. My remarks will now introduce the reasons why it took so long before the Wardian case was used as an enclosed system. In my study, and with a focus on one famous visualized reference - to do with the variants of transport containers - I go back to a time when European science in the second half of the 18th century had not developed any specific theory concerning the acclimatization of plants, when many different explanations co-existed and, at the same time, different forms of container were being tested.

In the second half of the 18th century, because of the competition between European states, plant transfers mutated into a vital symbol for the world powers. This transfer was played out globally between two scientific spaces: between botanical gardens and islands, for the most part. From the 16th century 'scientific' botanical gardens were established in Europe at universities (Padua 1546, Bologna 1567, Leyden 1577, Heidelberg 1593, Montpellier 1593, Oxford 1621, Vienna 1749), then at courts (Royal Garden near London, later called as Kew Gardens and the Jardin du Roi in Paris), companies (1653 at the Cape of Good Hope founded by the East India Company), and academies[18]. Between the gardens, the expeditions and the botanists there existed an exchange of knowledge combined with the collecting and exchanging of new plants. This co-operation also caused the extension, such as through botanical gardens, to overseas locations, first to tropical islands[19]. L'Île de France (now Mauritius), then Ceylon (today Sri Lanka), St. Helena and St. Vincent (Jamaica),

[18] Staffan Müller - Wille, „Botanischer Garten", in Friedrich Jaeger (eds.), *Enzyklopädie der Neuzeit,Vol. 2* (Stuttgart and Weimar: J.B. Metzler, 2005), 357 - 360; Gerhard Wagenitz, „Botanische Gärten und Herbarien und die Emanzipation der Botanik von der Medizin", in *Die Entstehung biologischer Disziplinen I* (Verhandlungen zur Geschichte und Theorie der Biologie 8, 2002), 57 - 73; William T. Stearn (1962) "The Influence of Leyden on Botany in the Seventeenth and Eighteenth centuries", *The British Journal for the History of Science,* 1962, Vol. 1, Nr. 2: 137 - 159; on p. 145.

[19] Brockway, "Science ".

were famous, to name only the first few. These islands served the ships as support locations and guesthouses on the long voyages, and for the plants as acclimatization stations on the long routes of the transfer.

Which containers where used in the 18th century? First on the list were natural materials such as moss and leaves. We know this from the experience of Nicolaus Jacquin (1727–1817), who had developed his own methods of transporting plants during his expedition in the years 1754–59 to the Caribbean islands on behalf of the Court in Vienna[20]. As he pointed out in his introduction to the printed volume about the Schönbrunn Gardens, it was the natural material that functioned as an envelope for the roots of the trees:

> The trees which had mostly borne fruit in their homeland, rejoiced in a trunk of human height and of the strength of a forearm or even greater. Their foliage had been knocked off as a result of which substantial twigs two feet long remained. The little trees had remained unharmed. Both types had been so excavated, by means of trenches dug around them, that – wherever possible – a lump of their home soil remained attached to the undamaged roots. This lump was wrapped up with a thick covering and several layers of moss, and this was strengthened with stripped bark (raffia) of the *hibiscus tiliaceus*, that were wound like rope very tightly around the ball and knotted into a net. Thus no earth could fall out, the root stocks were carefully watered at intervals, and because they were placed in the open air, in open boxes, they did not interrupt their growth. A single tree thus often weighed more than 100 pounds. So that no movement would loosen the earth and force the fine roots out of their location, the small trees from the outlying islands were carried in boats over the sea to the city and brought to St. Peter's harbour, to be loaded on to ships and from there to reach Europe. From Marseille they were again transported by sea to Leghorn, and from there they were carried by mules to Vienna.[21]

[20] Marianne Klemun (2000) "Botanische Gärten und Pflanzengeographie als Herrschafts repräsentationen", *Berichte zu Wissenschaftsgeschichte*, 2000, 23: 330–346.

[21] I am citing here the Latin preface to the Hortus Schönbrunnensis, in my own translation. Nicolaus Joseph Jacquin, *Plantarum rariorum horti Caesarei Schoenbrunnensis descriptiones* et icones (Vindobonae: Wappler, Vol. 1, 1797), Introduction.

Several layers of moss protected the soil against the climate that surrounded the roots of the plant. This method corresponds to the principle of 'similia similibus curentur' in the sense that like is cured by like. The simile - principle is already found in the Hippocratic Corpus and also in the writing of Theophrast von Hohenheim, known as Paracelsus. Like is treated with like and not with opposites. Paracelsus formulated it thus and thereby attacked the old doctrine of signatures. Jacquin, as a trained doctor who had studied in Paris and Vienna, was evidently transmitting a principle here that he knew from his studies. In his description a marginal role is attributed to the containers: the organic permeable material used as packaging is in the foreground. It was the moss that systematically linked the point of departure and the destination.

During all the major expeditions of the European powers, there was at least one professionally educated botanist on board. The Austrian expedition team of the year 1783–1797[22], however, consisted of people who did practical botanical work, such as the four gardeners, Boos, Bredemeyer, Schüch und Scholl. It was only Franz Joseph Märter, who, as a teacher of natural history, was truly educated, but he also had gained many useful skills in gardening when he developed a centre for practical teaching about useful plants in the Academy for Noblemen (Theresianum) in Vienna[23]. In terms of the tasks of acclimatization the gardeners seemed to be more suitable than any taxonomist. The professionalization of plant transports, i.e. the transportation of live plants, entered a new stage and the Austrian teams therefore began to involve experts in this work. It is important to note that the focus on the improvement in the mobilization of plants played a special role in the instruction for the journey written by the director of court gardens, Richard van der Schot at Schönbrunn. In this there was a conscious reference to the experiences of Nicolaus Jacquin, who had developed his own methods of transfer during his 1750s expedition as he pointed out in his introduction to the Schönbrunn Gardens volume previously cited.

[22] Marianne Klemun, "Austrian Botanical Journeys (1783 - 1792). Network - patterns in Expedition: Global Intentions Interwoven with Local Dimensions" in B. Hoppe, N. Robin & S. Strbanova (eds.), *International Networks, Exchange and Circulation of Knowledge in Life Sciences, 18th to 20th Centuries* (Archives Internationales d'Histoire des Sciences, 2006, 56), 233–245.

[23] See more about this economical garden: Marianne Klemun, "Exotik, Nutzen, Wissenschaft. Praktiken der Pflanzenaneignung im ‚Ökonomisch - Botanischen Garten der Theresianischen Akademie, "in Franz M. Eybl (eds.), *Strukturwandel kultureller Praxis. Beiträge zu einer kulturwissenschaftlichen Sicht des theresianischen Zeitalters,* (Jahrbuch der Österreichischen Gesellschaft zur Erforschung des achtzehnten Jahrhunderts 2002, 17), 303–333.

The involvement of the leadership of the gardens in Schönbrunn in the production of instructions[24] corresponded to the official court bureaucracy, but also had a basis in systems of knowledge, since the gardeners seem predestined for this task. Care was particularly important for the management of live plants, beginning with their removal from their original 'domicile', as it was often described in the sources, via their adjustment for the transfer and their integration into the Schönbrunn garden. From the instructions[25] it may be seen that in the preparation for transport special containers had been developed. It was prescribed that only this 'model' (Schönbrunn) was to be used, but it was not made known to the general public what these containers looked like.

Systemic connection between container, ship, island and botanical garden

Looking at the worldwide transfer of live plants that was established by botanists in the 18th century, it is important to emphasize the question of the transport - container. A wooden box, a willow barrel, a wooden case and a display cabinet made of glass: these were the forms that containers took during the 18th century. But these transport - containers are not the only 'space in - between' concerning the question of the plant transfer that took place between the original site where the plants were collected and the place where the plants arrived and were cultivated. Between departure and arrival there are four other 'spaces - in - between' in action: ship, island, botanical garden and paradise. Botanical Gardens outside Europe, located on islands, were involved to bring plants from outside Europe to botanical 'centres of calculation' and to other botanical gardens within colonial spaces.

However, for the 18th century in particular I postulate a systemic relationship between all these spaces, and I ask what effect this relationship had on the practices of dealing with the plants on the ships, and if the variety of containers has any connection to an epistemic frame. Looking for and at the shape of the containers

[24] There is no time here to go into the genre of "instruction", see more: Philippe Despoix, Die Welt vermessen. Dispositive der Entdeckungsreise im Zeitalter der Aufklärung, (Göttingen: Wallstein Verlag, 2009), esp. pp. 81 - 97; Philippe Depoix, Le monde mesuré: Dispositifs de l'exploration à l'âge des Lumières (Genève: Groz, 2005); Marianne Klemun,"Verwaltete Wissenschaft – Instruktionen und Forschungsreisen", in Anita Hipfinger, Josef Löffler, Jean Paul Niederkorn, Martin Scheutz et al (eds.), Ordnung durch Tinte und Feder? Genese und Wirkung von Instruktionen im zeitlichen Längsschnitt vom Mittelalter bis zum 19. Jahrhundert (Veröffentlichungen des Instituts für Österreichische Geschichtsforschung, Wien 2012, 60), 391 - 414.

[25] ÖNB, Österreichische Nationalbibliothek [Austrian National Library], [Handschriften - und Inkunabelsammlung], Codex Ser. nova 1596, fol. 108.

means that I am primarily interested in practical questions of plant - transfer[26]. Both botanical garden and island are not only characterized by their specific conditions, but they also show themselves, rather, as instances of transfer. But particularly because of the metaphorical connection between these spaces—so I will argue—the qualitative change in the transfer failed, because of systematically driven process. This is not a story about the progress of the management of plant transfer but the story about a success that did not happen.

All three - ship, island and botanical garden - constituted spaces that were clearly distinguishable from one another and which formed a connective system for the 'travelling plants'. Island, ship and botanical garden certainly had something in common with one another from a systemic point of view: they were culturally regimented and cognitively cut off from the immediate surrounding nature. In spatial terms they defined themselves by means of a constantly different dominating natural element within an environment. We find nature and plants both inside and outside of a garden. Nevertheless there was a demarcation from the inside to the outside in the form of the wall. Plants also grow outside the garden, and their pollination can disturb the interior of the garden. In spite of demarcation there are reciprocal undesired interactions. The island, like the ship, was surrounded by water and was more strongly defined than any other territory by the winds which came from the sea.

The isolation and interdependence on their environment is a key for understanding the situation of all three spaces in - between: ship, garden and island. In the same way as ship, island and garden, the differently configured plant - transport containers, in spite of great variation, marked their isolation and connection to and from their environment. All the containers were constructed in such a way that they could be shut and thereby insulated from their natural environment, but also so that if necessary the plants could be protected from the outside against harmful influences. It was the dream of perfect control underlined by the idea of paradise, which created a flexibility of use that delayed the understanding of the closed environment. The notion of flexibility in opening and closing the containers is an undoubted fact. This insight I owe to the interpretation of a picture which I shall refer to below. In his book *The Natural History of the Tea - tree* (1772)[27], the collector

[26] Marianne Klemun,"Räume und Paradies zwischen Insel, Schiff und Garten – Pflanzen transportbehälter im Bild" in, H. Bredekamp und M. Werner (eds.), *Systemische Räume* (Bildwelten des Wissens. Kunsthistorisches Jahrbuch für Bildkritik, 2007, 5/1), 67–76.

[27] John Coakly Lettsom, *The Natural History of the Tea - tree* (London: Edward and Charles Dilley, 1772).

and doctor John Coakley Lettsom recommended, to world - travellers, interested persons, botanists and dealers, a variety of containers that might be used for the transportation of plants on the journey to Europe across the oceans of the world. Shortly before, the natural researcher John Ellis[28] had first published instructive guidelines for these activities. His explanations were accompanied by an engraving, which presented to contemporary observers the most unspectacular of objects: a wooden box, a willow barrel, a wooden case and a display cabinet made of glass (Fig. 1). In spite of—or because of—the apparently simple picture content, the visualization functions associated with these objects interest me greatly. They imply a question about botanical practice, which, as a research approach, has motivated the history of science for many years[29].

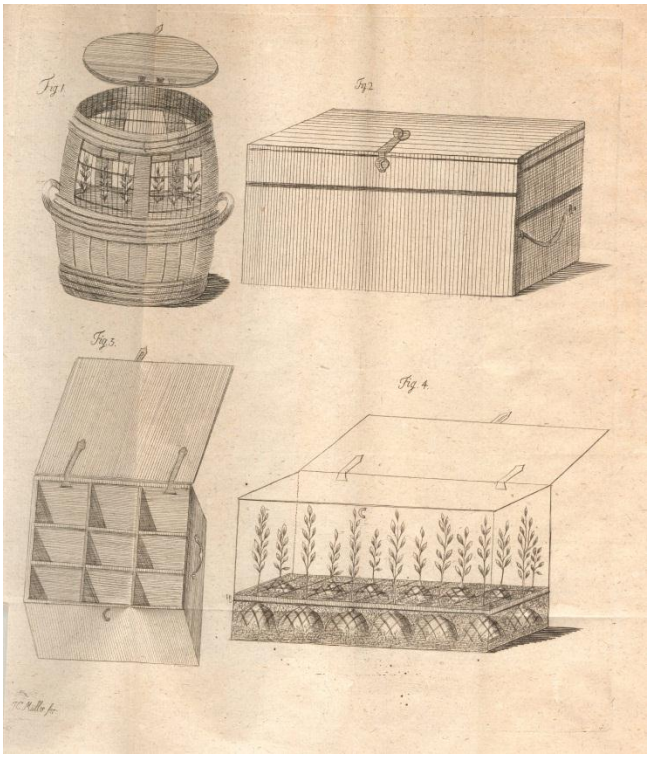

Figure 1 - John Ellis, Directions of Bringing over Seeds and Plants (London: L. Davis 1770). Library of the University of Vienna.

The visualization that Ellis used for 'universally familiar' objects, such as the barrel or the wooden box, raised them, by means of the accompanying text, to the

[28] John Ellis, Directions for Bringing over Seeds and Plants (London: L. Davis, 1770); here the German translation is quoted. Cf. Johann Ellis, Anweisung wie man Saamen und Pflanzen aus Ostindien und andern entlegenen Ländern frisch und grünend über See bringen kann (Leipzig: Flittner - und Müllersche Buchhandlung, 1775).

[29] From the wealth of literature on natural history, in particular: Nicholas Jardine, James A. Secord, Emma C. Spary (eds.): *Cultures of Natural History* (Cambridge: Cambridge University Press, 1996), 3 - 13.

status of scientifically based and purposeful tools. The illustrations also documented the mode of transfer, as was required at this stage of co - operation between the state and science. The representations could be understood quite simply as models of objects made by human hands, which could be copied by the readers and it could be understood as illustrations for imitation. But readers of Ellis's works could have achieved that without visual support by following the accompanying verbal description. The fact that the rich palette of possibilities for different forms of container is made accessible to the observer in a context does indicate a function of visualization; but in my opinion that is not sufficient to come to terms with the meaning - creating potential of the concrete visual images. Visual representation I understand here as a virtual phenomenon of testimony following the concept, which was introduced by Simon Schaffer, Stephen Shapin and many other Historians of Science[30]. In the image, this concept was introduced paradigmatically by Ellis, in that he referred back to the configuration of the inner life and uses the explanatory strategy of analogy. The lids of the containers are all presented as movable—open or closed—and this emphasizes a mode of handling the receptacles in a way that corresponds to the given situation and which focuses on the variable function of opening and closing.

In classical rhetoric analogy is generally employed to explain difficult content through pictorial means[31]. Traditionally, and more particularly since the epistemology of Descartes, analogy was a legitimate scientific strategy to make clear the 'moods' of nature or some particular mechanism, too[32]. One scientific collection that was favourably disposed to the contemporary style of argumentation defined analogy simply as 'the equivalence of two qualitative relationships; or a complete similarity of two relationships between quite dissimilar things'[33]. In the process of plant transfer all the spaces involved in this system, as opposed to their environment, were defined in terms of their borders, still connected to it, but independent of it. In the same way the

[30] See for a new stress on images: Stephen Shapin and Simon Schaffer, *Leviathan and the Air - Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985); Lorraine Daston and Peter Galison (1992) "The Image of Objectivity", *Representations,* 1992, 40:, 81 - 128 and Veronika Hofer and Marianne Klemun, "Wissenschaftshistorische Positionen von Bildfunktionen" in Veronika Hofer and Marianne Klemun (eds.), *Bildfunktionen in den Wissenschaften* (Wiener Zeitschrift zur Geschichte der Neuzeit 7, 2007), 3 - 8.

[31] Cf. M. J. F. M. Hoenen, Analogie, in *Historisches Wörterbuch der Rhetorik*. (Tübingen: Niemeyer, 1992), Vol. I, 498 - 514.

[32] Peter Galison (1984) "'Descartes' Comparisons: from the invisible to the visible", *Isis*, 1984, 75: 311 - 326.

[33] Allgemeine deutsche Real - Encyclopädie für gebildete Stände (Leipzig: F.A. Brockhaus, 1824), 1. vol., p. 211.

transport vessels functioned in accordance with this criterion, which included both hermetic closure and also permeability. With the mechanism of opening and closing a variable way of dealing with the inconstant and incessantly occurring imponderables on the high seas - wind, sun, salt and water - is also given. This phenomenon of permeability was dominant as an unquestioned principle, but it did not promote an innovative solution, but on the contrary it had inhibited and delayed an invention of the quality of Ward's case, in spite of the great love of experimentation. The most important aspect of the innovation in Ward's case was that it dispensed with the need for the production of variable permeability during a ship's voyage, because the practice of opening and closing the lid during the voyage was excluded. Its form resembled the display case that Ellis had already designed, but it differed in the kind of use to which it was connected. Ellis and all other botanists involved in the Instruction for the Expeditions had not intended that the interior of the glass case should have the significance of its own natural microcosm, but understood this as artificially conditioned; and for this the relationship with the macrocosm, the relationship with 'nature', would have to be facilitated artificially. For that reason the glass case was also treated as an open container. Shortly after the Ward's invention became known, ships' captains reported on the success of the Wardian case and drew attention to precisely these differences: On 26th March 1840, Dr Stanger gave an account of the success of the new practices: in a case left open for frequent inspection, all but one plant died. In a case left closed and unattended, all plants arrived in perfect condition[34]. Enthusiasm was also very great because the labour - intensive process of watering during the voyage was no longer necessary. Water vapour ran down inside the glass walls and was reabsorbed by the plants. But Ward, like all his predecessors, either did not know or did not recognise this principle of the ecosystem. It was, rather, an accidental discovery that came about in the polluted air of London, but there was no scientific explanation. Ward explained the functioning of the Wardian case not in scientific but in moral terms in quoting Catull: 'a flower blooming in a secret place is like children's souls developing without violence or disturbance from the outside'[35]. As Margaret Flanders Darby points out, 'The glass case protection allows the soul, the essential nature, to express itself, either of plant or child. It is a paradise of suspended animation as the bloom reaches the greatest

[34] Ward, "On the Growth", Appendix, 83.

[35] Ward Ibid. 34, quoted in Darby, "*UN*Natural History", she gives credit to Margherita Azzi Videntini for translation from Latin.

potential and then is held there'[36]. Ward, pre - empting Darby, compared the inside of his closed case to a recoverable but long lost Garden of Eden: 'when we reflect upon their independent state, we may, without any great stretch of imagination, carry our minds back to the primaeval condition of vegetation, when the "Lord God had not caused it to rain upon the earth, and there was not a man to till the ground"[37].

Paradise as productive and connective metaphor

Garden, ship and island—like the containers—were important in their function of mediation in the mobilization of plants. And there is one more thing that they all have in common: they each stand for an ideal in the world, whether it be the ship as the model of Christianity in Europe; the island as a symbol of the eternal rest of the blessed, as in the Greek myth; and the botanical garden as the place in which the Garden of Eden is realised[38]. These connotations bound all three spaces to images of Paradise. This kind of metaphor can be understood as the result of a direct transfer from the general to the particular. According to theorists, metaphors provide a 'grid' or a 'filter'[39], through which we 'see' the relevant phenomena. Particular perspectives of a phenomenon to which they relate will strengthen them, whereas others allow them to diminish. In this ability to imagine they had a productive effect on the activities of plant - transfer. The spaces of ship, island and garden were linked to each other and, so to speak, positively charged with a meaning that related them to each other: in spatial terms, paradise was traditionally designed as an island, where, as in a garden, unlimited fruitfulness and surplus prevailed. In the colonial phases of the Crusoe - style adventures these kinds of metaphor were again vital, but at the same time they were undermined by the experiences of cultivating plantations. Ultimately, the Europeans were indebted for their luxury goods to the islands of the Mediterranean, and later those of the Moluccas (now Maluku) and the Caribbean. Hadn't Venice, the first colonial power, used the islands it seized—Cyprus, Crete, Rhodes—as testing grounds to produce for itself a lucrative plantation of the sugar - cane that the Arabs had brought from North Africa? From this, in the 17th century,

[36] Darby, "*UN*Natural History", p. 644.

[37] Ward, "On the Growth", p. 28

[38] John Prest, *The Garden of Eden: the Botanic Garden and the Re - creation of Paradise*. (New Haven and London: Yale University Press, 1981); Staffan Müller - Wille (2001) "Gardens of paradise", *Endeavour*, 2001, 25: 49 - 54.

[39] On the term "filter" v. Max Black,"Die Metapher", in Anselm Haverkamp (ed.), Theorie der Metapher (Darmstadt: Wilhelm Fink, 1996), 55 - 79, here p. 72; on the vigorous debate on the meaning and function of metaphors, v. Max Black, "How Metaphors Work: a reply to Donald Davidson", in Sheldon Sacks (ed.) On Metaphor (Chicago: University of Chicago Press, 1979), 189 - 191.

there was already the 'island - hopping' of this important crop, cultivated in plantations by the Portuguese and Spaniards, from the Atlantic islands into the Caribbean[40]. The limited resources on the islands swiftly became evident in this ecosystem, and because of the unreliability of fertility and erosion, the consequences of monoculture became even more visible, which was initially compensated for by a change to other major crops such as tobacco.

From this specifically positive experience of islands there came a confidence on the part of the colonial powers that they could juggle with agricultural plants as with trade commodities. In the case of coffee, which had been smuggled from Mocha (Yemen) to Java by the Dutch mariner Nikolaus Witten, the botanical gardens of the people of Amsterdam and also of Paris played a central role, and from there the coffee plant was brought to the New World, in 1718 to Surinam, and in 1723 to Haiti (S. Domingo), Cuba and Jamaica.

The fact that two colonial powers, France and England, moved their scientific institutions—their botanical gardens—to the colonies themselves in the course of the 18th century was an inevitable consequence of the colonial stabilization of power; and the fact that the first European gardens outside Europe were almost all set up on islands was symptomatic of the widespread use of island metaphors I described before. Islands, in the normal course of events, changed their rulers quite frequently, but at the same time were also easier to defend than the mainland. One particular example is the Ile de France (Mauritius), whose garden had been equipped for the provisioning of ships' crews with European fruits, in which the garden of the Dutch at the Cape of Good Hope was being imitated[41]. Gardens such as these served the purpose of adapting European forms of culture to the unfamiliar climate[42].

What the Europeans in the 18th century had not yet mastered was the growing of the most important spices, particularly the clove tree (*Syzygium aromaticum* L. Merill and L. M. Perry) and the Nutmeg tree (*Myristica fragrans* Houtt.). Until 1770 both of these spices grew exclusively in the Moluccas. The monopoly that was strictly guarded by the Dutch was broken by the transit through Pamplemousses, Mauritius, and from there to the West Indies (Cayenne and the French Antilles).

[40] Sidney W. Mintz, *Die süße Macht. Kulturgeschichte des Zuckers* (Frankfurt am Main and New York: Campus, 1992), p. 57.

[41] Guy Rouillard and Joseph Gueho, Le Jardin des Pamplemousses, 1729 - 1979: Histoire et Botanique (Les Pailles, Maurice: General Print, 1983); Madeleine Ly - Tio - Fane, Le Géographie et le Naturaliste à L'Île - de - France 1801, 1803. (Port Louis: MSM Limited, 2003), esp. p. 43.

[42] Richard H. Grove: Green Imperialism. Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600 - 1860 (Cambridge: Cambridge University Press 1995), esp. p. 180 - 222.

For this the garden became famous in Europe, but also because of the countless agricultural plants sourced from India, Asia and Polynesia.

After the establishment of the first botanical gardens (Pisa, Padua, and so on, noted above), experience intensified in this branch of knowledge, like on a ship or an island, and indicated questions that could only be posed and solved in that context. Gardens constituted the only possibility of bringing otherwise widely scattered plant treasures together in one place. The connotative process of equating the garden with paradise, the idea of a garden as a re - creation of Paradise[43], was one that was basically immanent in the garden from the beginning of his existence in the 15th century and very widespread. It represented a spectrum that permitted a variety of interpretations: infinite fertility and richness of nature, or a concentrated area of perfection, as, for example, idealists imagined it. Linné spoke about the 'hortus paradisus' in the sense of an ideal complete collection[44]. In 1796, the Danish poet Schack Staffeldt visited Vienna and, after having seen the botanical garden (called the *Holländische Garden*) in the grounds of the Schönbrunn Palace, he noted in his diary:

> Here, I am a Cook. Here, I find myself on a journey around the world, where the continents and the individual countries are represented by plants instead of drawn cities, mountains and rivers. ('Hier bin ich ein Cook, ich mache eine Reise um die Welt. Es ist eine Weltkarte, wo die Welttheile und Länder mit Gewächsen, statt gezeichneter Städte, Berge und Flüsse bezeichnet sind.')[45]

In the botanical garden the world shrank. Without travelling, the visitors could walk through landscapes, continents and experience foreign nature. Stories, narratives and discourses appeared. Labour and bodies, slavery and exotic flair lend wings to the imagination in which the known and the unknown plant receive a special meaning.

It was no coincidence that in the garden, the Danish poet Schack Staffeldt felt like James Cook, with whom a new model of journeys - paths of which followed the line round the world - was associated. Starting in the middle of the 18th century, a new

[43] Prest, "*Garden Eden*".

[44] Linné quoted in Staffan Müller - Wille, Botanik und weltweiter Handel. Zur Begründung eines Natürlichen Systems der Pflanzen durch Carl von Linné (1707 - 1778) (Berlin: VWB - Verlag für Wissenschaft und Bildung, 1999) p.252.

[45] Samlinger til Schack Staffeldts Levnet, fornemmeling af Digteren efterlade Haandskrifter adgione af F. L. Liebenberg, Kjobenhavn 1847, cited in E. M. Kronfeld, Jacquin (1905) Österreichische Rundschau, 1905, III: 237 - 251, on p.248.

type of overseas expedition gained momentum owing to the growing competition among the European powers[46] - expeditions that could be termed 'scientifically motivated'. The new expeditions are characterised by globality, which is signalled by sailing around the world, and a variety of goal and tasks, which manifest themselves in programmatic, carefully prepared instructions[47]. An organization based on the division of labour as well as the participation of scientific personnel, of surveying experts, physicians, botanists and drawers became typical characteristics of the expeditions. Moreover, the precise documentation by means of special instruments became absolutely imperative. The plants brought back from the expeditions, from botanical gardens located outside of Europe, functioned as mental bridges to the world which stands for a paradise. In this clearly professionalized climate of the 'expedition' undertaking, a number of quite different theories played a role as references for dealing with plants on the high seas

Gardens functioned as paradise. The metaphor stresses a vision of climate that fitted the original place where the plant came from. The hothouses and greenhouses located in botanical gardens imitated these conditions. But on a ship, unlike in a garden, there were different climatic conditions for plants, which affected not only all possible variants and extremes found on Earth, but which also differed in kind from conditions on land because of the salty air. Thinking about the process of transportation created practical knowledge, but it also integrated theories, which, under other circumstances, played no part in the cultivation of the plants. In designing the containers, account was taken of different approaches. Stephen Hales' physiological experiments, which sought to measure the quantity of water taken up by plants - 'Vegetable Staticks', as it was called in his publication of 1727[48] and which he had based on Newtonian physics - demonstrated an internal regulation of the management of water. What seemed to be important was the fact that the flow of water and the statics of the plant were not interrupted. Based on this - as Ellis had already shown - was the design of a form of container that would firmly anchor the

46 See: Alan Frost, Voyage of the Endeavour: Captain Cook and the Discovery of the Pacific (St. Leonards, N.S.W.: Allen & Unwin, 1998); Daniel A. Baugh, Seapower and Science: The Motives for Pacific Exploration, in Derek Howse (ed.), Background to Discovery: Pacific Exploration from Dampier to Cook (Berkeley: University of California Press, 1990), 1 - 55; Rob Iliffe, "Science and Voyages of Discovery", in Roy Porter (ed.), The Cambridge History of Science, Vol. 4: Eighteenth - Century Science (New York: Cambridge University Press) 2003, 618 - 645.

47 A very famous instruction that was a model for other instructions, see: Johann David Michaelis, *Fragen an eine Gesellschaft Gelehrter Männer, die auf Befehl Ihro Majestät des Königs von Dännemark[!] nach Arabien reisen* (Frankfurt am Main: Garbe, 1765).

48 *Stephen Hales, Statick der Gewächse oder angestellte Versuche mit dem Saft in Pflanzen und ihrem Wachsthum, nebst Proben von der in Körpern befindlichen Luft* (Halle: Rengerische Buchhandlung, 1748).

plant, so that its stability remained constant and the roots of the plant were secured in moss with wire. Ellis made very clear use of Hales in his description, and his representation of plants is very reminiscent of the engravings published in Hales' work, which provided a visual record of countless experiments. In this informed planners of expeditions had, 'before their eyes', an argument for giving preference to this form of container. The engravings brought this mode of selection into play; depending on which theory was preferred a suitable container could be chosen.

Containers made of glass were supported by Hales' observation that the vitality of the plant was dependent on the rising of sap within it, and this was one effect of the warmth of the sun. According to the traditional doctrine of sap[49], the plants should not be placed in a container during the hot season, since they would produce too much sap and therefore rot. In order for sap to move, fresh air was necessary, and for this reason containers had to be provided with windows that could be opened or closed. The barrel that Ellis depicts was suitable for this. Before the discoveries of Johann Ingenhousz ('Fotosynthese', or 'photosynthesis'), it was believed that growing plants produced foul air, and for that reason ventilation was very important for plants, while at the same time the plants had to be protected either in a firm box or with a piece of sailcloth. Botanists who were influenced by *physiocratism* were inclined to favour the role of the ground for the plant. They thought the goodness of the soil was the most urgent need, and rated all other measures lower than this. The most suitable for this was the case in which moss had been placed on top of soil.

The construction of every individual container implied a reference to at least one universally applicable theory concerned with the question of how nature was regulated. But depending on which general theory was preferred—physiocracy, Stephen Hales' transpiration theory, the miasma theory form medical discourse, the traditional theory of sap, or the theory postulated by Johann Ingenhousz that plants were capable of improving air—one or other of the proposed variant forms of container would be favoured. Uncertainty was great, and even Nikolaus Jacquin, despite his experience in the Caribbean, was unable—on being questioned about the

[49] See Alain Corbin, Le Miasme et la Jonquille. L'odorat et l'imaginaire social XVIIe –XIXe siècles (Paris: Flammorion, 1982); in German: Alain Corbin, Pesthauch und Blütenduft. Eine Geschichte des Geruchs (Berlin: Klaus Wagenbach, 1984), p. 35.

proposed transport of plants from the Cape of Good Hope to Vienna—to state any clear requirement, except that sunlight was indispensable[50].

The representation of variants in Ellis's work made it possible, dependent on the cognitive grounding of the observer in universally formulated theories, to decide in favour of one particular form. They functioned as associative bridges in the choice among a range of possibilities that was rich in both theoretical and practical terms.

Conclusion

In the transfer of live plants in the 18th century four different 'spaces in between' simultaneously played a major role: ships, islands, botanical gardens and the idea of paradise. The systematic relationship between all four spaces was in its double function between demarcation from the environment on the one hand and subjection to the natural environment, the powers of nature, on the other hand. Both aspects sought a lasting control of phenomena. Permeability with regard to the environment was a paradigm determined not only by the situation of the island, the garden or the ship, but also by the use of the containers, which, as late as the 1830s, were used variably—closed, open or porous. It was only when this flexible use was discontinued, in the sense of a situational opening and closing of the containers according to natural conditions, implying an end to experimentation and special care on the high seas, that plant transfer in the 19th century was revolutionized.

[50] Archiv of the Austrian State, HHStA [Österreichisches Haus - Hof - und Staatsarchiv], Wien, OMeA Sr 176, fol. 1 - 3.