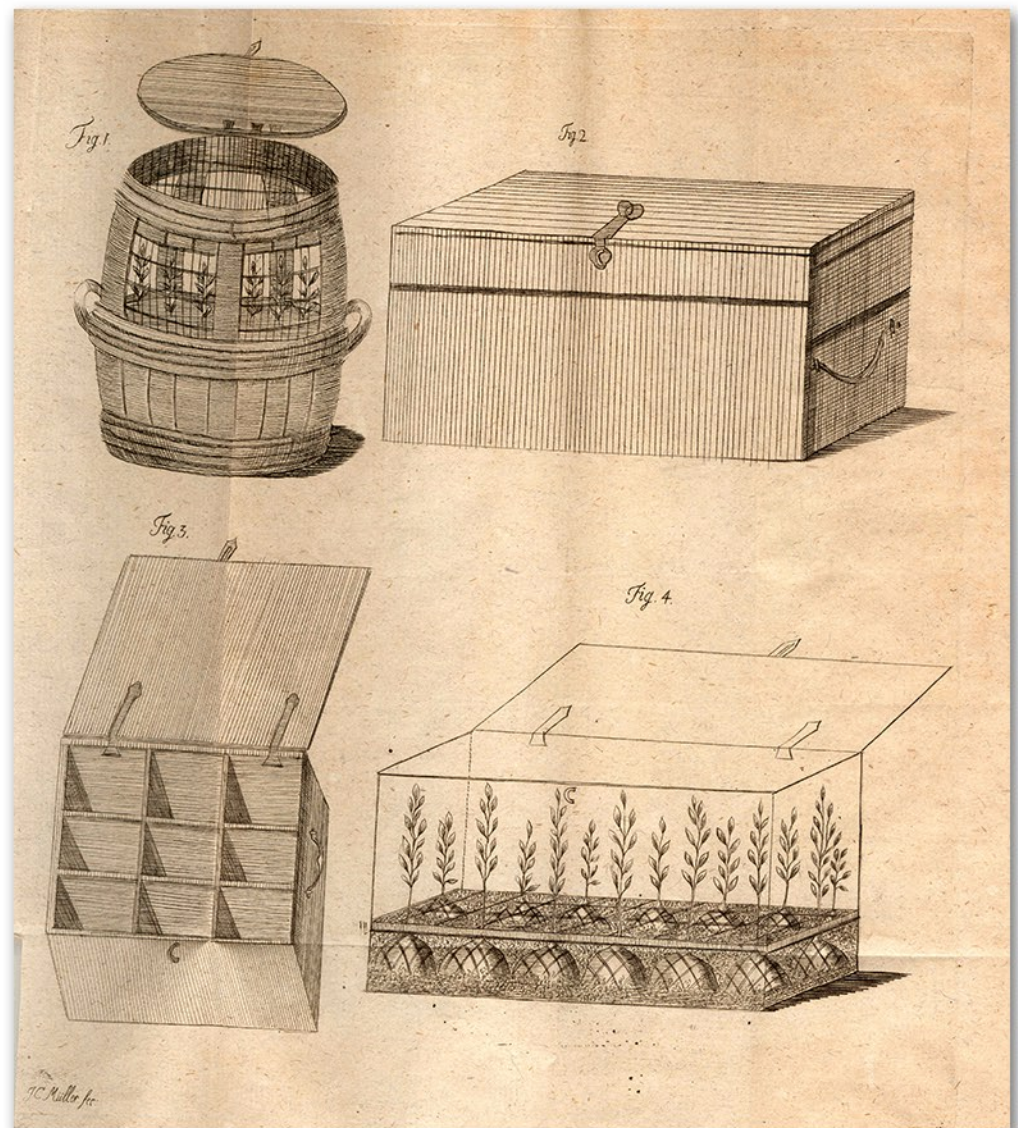
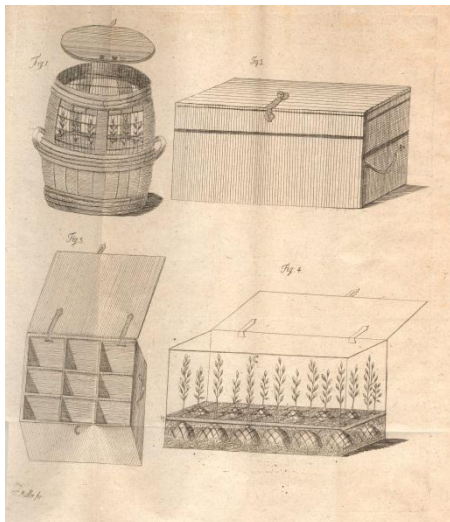


Moved Natural Objects. Spaces in Between



Cover



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

Journal of History of Science and Technology

Vol.5, Spring 2012

ISSN 1646-7752

www.johost.eu

Published by

Interuniversity Centre for the History of Science and Technology (CIUHCT) – Faculty of Sciences

(University of Lisbon)

www.ciuht.com

Faculty of Sciences and Technology (New University of Lisbon)

Institute of Social Sciences (ICS) - University of Lisbon

www.ics.ul.pt

Interdisciplinary Centre for History, Cultures and Society (CIDEHUS) – University of Évora

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Editorial Note

*By Ana Carneiro**

As stated in the editorial note of the first issue of HoST, released in the summer of 2007, the journal was born out of a joint effort of a group of Portuguese scholars sharing the goal of strengthening History of Science and Technology in Portugal. It is only fair to say, however, that the driving force behind the initiative of launching HoST was its first chief editor, Tiago Saraiva, to whom the journal owes a great deal in most respects.

For professional and personal reasons, Tiago Saraiva could no longer serve as HoST chief editor, and I was assigned the difficult task of replacing him and meeting the high standards he has imprinted on the journal. Marta Macedo, in turn, has replaced me as book review editor, and I am most pleased to be able to count on her efficient collaboration. The changeover, however, does not alter the basic principles underlying the creation of HoST, which will continue to be a peer-reviewed journal open to both national and international contributions. This remains our priority because its promoters deem highly important to foster an open dialogue between local historians of science and technology and the international community.

Despite the economic crisis and the drastic reduction or even total absence of funds impending on Portuguese research centres – in this case on CIUHCT and CIDEHUS, the centres which together with ICS have sustained HoST's life and activities - the editorial committee and myself are, nevertheless, deeply committed to its survival and wish to evade the usual fate of so many Portuguese journals, which fade away following the publication of a few issues. Our firm intention is to publish two HoST issues per year, spring and autumn respectively, one being thematic and, whenever possible, associated with the organization of a thematic HoST Workshop.

2012 HoST Spring issue gathers together the contributions derived from the session *'Moved' Natural Objects – 'Spaces in Between'*, which addressed the circulation of natural objects, in spaces between the place of collection and their destination. This session was organized in the context of the 4th International Conference of the

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European Society for the History of Science, held in Barcelona in November 2010, by Marianne Klemun, who kindly agreed to arrange with the participants in her session to have their articles published in HoST and to be guest editor of this thematic issue.

In the preparation for the 2012 HoST Spring issue, I also had the pleasure of relying on the invaluable collaboration of Sue Turner as language editor, whose work clearly transcended this task. I am personally indebted to her, in as much as she took into consideration the journal's difficult financial situation in charging a fee for her most competent work.

Finally, a word of gratitude goes to all authors for their interesting contributions and work on such a tight schedule, as well as to the referees who kindly agreed to review the articles, in this way contributing decisively to raise the quality of this issue.

Introduction: ‘Moved’ Natural Objects – ‘Spaces in Between’

Marianne Klemun*

The growth in knowledge of natural history in the 18th and 19th centuries cannot be imagined without reference to objects or specimens and their circulation. In all corners of the globe natural objects were collected and transported to knowledge centres, moved between locations and added to collections. Closely related to these activities is the establishment of scientific spaces, such as the natural history cabinet (*Naturalienkabinett*), the museum and the botanical garden. These are spaces where the specimens ultimately find a permanent setting as scientific and culturally determined objects¹.

It was Bruno Latour who articulated the simple but important question², how knowledge concerning distant entities is produced: apart from museums this question guides us to the different cultural activities of acquiring, gaining, preserving, documenting, understanding, promoting and mediating of objects. This increased attention derives from a change of paradigm within the history of science itself. It leads from ideas to practice, and this has brought questions of ‘tacit knowledge’³ into the centre of attention.

Until the point when the collected objects reach a museum location, they undergo a variety of cultural transformations. And they cross physically the vast space between the field and the museum or other institutions such as botanical gardens. The ultimate inclusion of the objects in a museum display is preceded by many different activities that will be investigated here separately from the career of the

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¹ Krzysztof Pomian, *Der Ursprung des Museums. Vom Sammeln* (Berlin: Wagenbach, 1998); Robert E. Kohler, *All Creatures. Naturalists, Collectors, and Biodiversity, 1850-1950* (Princeton, N.Y.: Princeton University Press, 2006); Anke te Heesen and Emma Spary (Eds.), *Sammeln als Wissen. Das Sammeln und seine wissenschaftsgeschichtliche Bedeutung* (Göttingen: Wallstein, 2001); Nicholas Jardine, James A. Secord, Emma Spary (eds.): *Cultures of Natural History* (Cambridge: Cambridge University Press, 1996).

² Bruno Latour, *Pandora’s Hope. Essays on the Reality of Science Studies* (Cambridge /Mass.: Havard Press, 1999) 306.

³ Knowledge to Science as Practice, in Andrew Pickering (Eds.), *Science as practice and culture* (Chicago: The University of Chicago Press, 1992) 1-26.

objects in the museum. These activities are the principal focus of this volume. In order to be able to look away from the museum and offer a better analysis of these operations, I have given them a space of their own that I call 'space in between'. This research strategy will facilitate a new approach to constellations that in the past were not seen as belonging together.

'Space in between' can address the route between the field and the museum, between administration and pharmacy, between different spaces of knowledge (for example between botanical gardens) and other spatial entities (such as ships). I shall explain more fully below how the concept was established. Whatever the case, a variety of different skills and actors are involved in the acquisition and circulation of objects. These include not only the natural scientists, or the different preparation techniques and forms of packing, but also words in the form of instructions, and the documentation and letters that accompany the journey. The different scientific, cultural or public interpretations of meaning can also constitute a metaphorical space that needs to be examined case by case.

In comparison with the flourishing history of collection and the history of museums⁴, the question of the movement and transformation of specimens seems to have lagged behind to a considerable extent. Of course, one might argue that the circulation of the objects themselves has been a well-researched field in the context of the investigation of networks⁵. And the growing research into transfer⁶ is going in the same direction. In addition there are very many concepts that focus on the mobility of objects. For what purpose do we need the term 'moved natural objects' that I am proposing here, if there are already a range of analytical approaches that are pursuing the same goal? A consideration of the research landscape will help justify my choice of term and distinguish our concept from those that already exist.

The sociologist of knowledge Bruno Latour postulated the immutability of objects when he introduced the term 'immutable mobiles'. Like many other historians of science he does not believe that scientific knowledge is the product of individual

⁴ Esp. Andrew Pickering, *From Science to For example*: Simon Knell, "National Museums and the national imagination", in Knell (Eds. et al.), *National Museums: new Studies from around the World* (London: Routledge 2010) and Simon J Knell (Eds.), *Museums and the future of collecting* (Aldershot: Ashgate, 2004); Paula Findlen, *Possessing Nature. Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994); Andreas Grote, *Macrocosmos in Microcosmo. Die Welt in der Stube. Zur Geschichte des Sammelns 1450-1800* (Berliner Schriften zur Museumskunde 10, Opladen: Leske und Budrich, 1994).

⁵ See especially: Michel Espagne, *Le Transferts culturels franco-allemands* (Paris: PUF, 1996).

⁶ For example: Martin Stuber, Stefan Hächler and Luc Lienhard, *Hallers Netz. Ein europäischer Gelehrtenbriefwechsel zur Zeit der Aufklärung* (Basel: Schwabe Verlag, 2005).

minds. Instead, it is the outcome of many activities, distributed across a broad terrain, but conducted through quite specific exchanges or collaboration between both human and non-human actors. 'Mutable mobiles' include instruments, equipment, writing instruments, images, representations such maps and the objects of study themselves, which are brought along on expeditions. All are 'transformations through which an entity becomes materialized into a sign, an archive, a document, a piece of paper, a trace [.....] They are always mobile, that is, they allow new translations and articulations while keeping some types of relations intact'⁷. The characteristic of objects is their mobility, but their immutability will be questioned here. As will be demonstrated in our case studies, immutability is not always guaranteed. For this reason we do not adhere to Latour's stimulating but greatly disputed concept.

In a totally different context, namely in the question of mechanisms of the multi-disciplinary institutionalization of ecology, Susan Leigh Star and James E. Grisam created the notion of a 'boundary object'. This concept was published in an article that has become canonical. Such objects are capable of unifying divergent discourses: 'Boundary objects are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete in more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is a key in developing and maintaining coherence across intersecting social worlds'⁸. Whilst Latour places connectivity and the availability of the phenomenon for further research at the centre of interest, what is decisive for Star is the role of the object as an 'interface between different communities of practice'⁹. In our studies, however, we are not concerned with the direct exchange of knowledge between different social communities of knowledge but ultimately with the question of whether the material and documentary aspects of a transfer have any epistemic relevance. Is it possible to determine any relationships between the conditions of the transfer, the techniques of transport and the transformations? Do the processes involved in the mobilization of natural objects, or

⁷ Latour, *Ibid.* 306.

⁸ Susan Leigh Star und James R. Grisemer (1989) "Institutional Ecology, Translation and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39", *Social Studies of Science*, 1989, 19, Nr. 4: 387-420, here 393.

⁹ *Ibid.*, "Institutional Ecology" 393.

indeed the containers, have any influence on knowledge itself? Or, conversely, what social and cultural settings condition or result in the mobility of objects?

The concepts of Latour and Star mentioned above are directed at the functionality and potential of objects. Both aspects are significant but are not our centre of attention. In her essay 'Scientific Objects and their Visualization' Anke te Heesen expresses, in this connection, an idea that is considered as fundamental in our studies, 'that motion, not stasis, is the hallmark of these paradigmatic objects'¹⁰. Irrespective of which of these models is followed or not followed, for us it is important to place the dynamic factor in which objects and knowledge are embedded at the centre of our studies. That is why I call the object 'moved'. And for this reason we have allotted this factor its own space, the 'space in between', where the objects, by virtue of a variety of operations, acquire through mobility their scientific, cultural or economic significance. Together they create a space of one's own. If, in our studies, we follow the path of a natural object as a transformation or translation into a scientific or cultural or economic object, then different practices and local knowledge transitions are at work.

The 'movement' I included in my title is both real and ambiguous: it may be diverse in nature. It can change the nature of objects themselves, position them as cultural or economic things, and alter the material nature of the objects. What factors are involved in these activities in the process of translation, or of transition, is our principal question. Totally different phenomena are identified as 'spaces in between': the spectrum begins with the container, the letter, the package, the plant receptacle in which the specimens were transported. It then passes to knowledge spaces, the botanical garden, the ship - as connected instances and actors - and extends to a variety of different forms of recording, instructions and regulations, which are used to initiate the handling of objects, to escort them or even to replace them. How these epistemic relations are generated, how they connect together and ultimately how they create knowledge will be explained with the help of case studies.

In this volume, therefore, authors focus on developments in the history of science that lead to material culture. The move to 'material culture' has been the trend in a range of scientific fields for many years. Since Peter Galison's 'Image and

¹⁰ Anke te Heesen (2007) "On Scientific Objects and Their Visualization", in: *Objects in Transition. An Exhibition at the Max Planck Institute for History of Science*, (Berlin: Rainer Kaufmann Ausstellungsproduktion, 2007) 34-37, here 37.

Logic'¹¹, however, the history of science has also rediscovered 'material culture' as a hobby-horse. Galison determines this in the case of physics through practices that precede the pictures. The material culture of the process of scientific production is manifest, he claims, in the mutual relationship of different entities: 'the engine grease meets up with experimental results and theoretical constructions'¹². Tools, actors and methods join together in one place and work together as 'mediators between the production of phenomenon and the production of evidence'¹³.

Following Galison's approach, in this volume we also direct our attention to the material and medial nature of objects and to the cooperation of different actors, naturalists, objects, spaces of knowledge and documentations. And to repeat, our view leads us away from the familiar spaces of knowledge, away from collections and museums. Apart from these, we shall now consciously address other spaces that are not concerned either with the place of origin of natural objects nor the museum as the final destination for specimen. 'Spaces in between' are found precisely between these two poles or cornerstones. In the following contributions we are mainly concerned with the independent space unit in which elementary processes of knowledge production take place and within which, at the same time, natural objects are transformed into scientific objects. And we are not only concerned with a space, in the sense of a transfer space in which description and labelling are carried out, or a waiting space, such as a harbour, which—in the case of plants—may serve as an acclimatization station, or an anti-room, a corridor or even a storeroom in the repository of a museum. We are concerned, rather, with agendas that are played out in the 'space in between' in relation with connected activities which constitute a space of their own.

With the 'in between' we are orienting ourselves in terms of a sociological concept of space, which understands this as an 'array of bodies set in motion'¹⁴. The space in question arises from positional relationships. A material–physical substratum is indeed involved in this, but it is simultaneously also determined by collective interaction and action structures, as well as normative regulations, and also signs, symbols and representations. In the 'inter', according to the German philosopher

¹¹ Peter Galison, *Image and Logic: A Material Culture of Microphysics* (Chicago: University of Chicago Press, 1997).

¹² Ibid. Introduction, XVII.

¹³ Galison, Ibid. 4.

¹⁴ Martina Löw, *Raumsoziologie* (Frankfurt am Main: Suhrkamp Verlag, 2001)132.

Martin Heidegger, what has been separated becomes close. It gathers and remains joined together¹⁵. The concept of space is flexible and situationally determined. And it is made up of the particular constellation of space-determining parameters, which constitute the character of the process¹⁶ that we place at the centre of our interest.

The term 'in between' has had a particular history in ethnology and anthropology, but also in political science: it functions as a concept for a global time that is determined by migration and hybridism¹⁷. The concept of 'in between' constitutes the centre of historical epistemology, and for this I am indebted to a note in a volume that appeared recently under the title *Parasiten und Sirenen* (Parasites and Sirens). In this Bernhard J. Dotzler and Henning Schmidgen refer to a lecture by Hans-Jörg Rheinberger, in which he explains historical epistemology: 'if I were to reduce [historical epistemology] to a common denominator, I would say: historical epistemology - instead of looking, on the one hand, at sapient subjects and their capabilities and, on the other hand, at knowable objects - is now directing its attention to the 'in between'. It looks at the historical-technical, cultural, and so on, - conditions under which and within which the process of knowledge acquisition takes place. It is therefore the investigation of the means and media of knowledge production'¹⁸.

The concentration on the means and media on the path of knowledge is not new. It has also experienced a particular manifestation in the pioneering work of Bruno Latour and Steve Woolgar in *Laboratory Life* (1979)¹⁹. With the mapping of laboratory architecture (its life between the machines, its forms of recording, proceeding to the so-called 'inscription devices' and the recording media of individuals), knowledge traced by historians of science follows its path as far as publication. The fact that this consists of a series of transformations is central to this approach, as McLuhan, incidentally, had already noted in his classic study: 'a gap is an interface, an area of ferment and change'²⁰.

¹⁵ Martin Heidegger, *Unterwegs zur Sprache* (Stuttgart: Klett-Cotta 2007, 14th edition) 24.

¹⁶ Norbert Elias, *Was ist Soziologie* (7. Auflage, München: Weinheim, 1993, 124).

¹⁷ Claudia Berger and Tobias Döring (Eds.), *Figuren der/des Dritten. Erkundungen kultur eller Zwischenräume* (Internationalen Forschungen zur Allgemeinen und Vergleichenden Literaturwissenschaft, Amsterdam-Atlanta: Editions Rodopi, 1994).

¹⁸ Hans-Jörg Rheinberger, "Was ist historische Epistemologie?," *Colloquium des Max-Planck-Instituts für Wissenschaftsgeschichte*, Berlin, Quoted in: Bernhard J. Dotzler und Henning Schmidgen, *Einleitung zu einer Epistemologie der Zwischenräume*, in *Parasiten und Sirenen* (Bielefeld: transcript Verlag, 2008) 7-18, here 8 und 9.

¹⁹ Bruno Latour and Steve Woolgar, *Laboratory Life: The Social Construction of Scientific Facts* (Beverly Hills: Sage Publications 1979).

²⁰ Marshall McLuhan, *Culture Is Our Business* (Toronto: McGraw-Hill Book Co., 1970) 70.

In their article ‘Seeds of Knowledge’ Annalisa Managlia, Umberto Mossetti and Ariane Dröschner investigate the epistemological and technological implications of the exchange of seeds, by analysing letters and botanical gardens as ‘spaces in between’ and as actors that facilitate the interplay between various locations such as Egypt, Bologna, Turin and Uppsala. The objects passed on in the form of seeds cannot be understood as ‘immutable mobiles’, and this is shown most emphatically in the study: for the seeds that are cultivated in the garden modify knowledge, produce varieties of plants and in this way expand the findings and the taxonomy. Mobile seeds do not only function as tools to solve open questions; it is rather the case that they themselves pose questions.

In my own essay I am also concerned with examining the global transfer of plants to botanical gardens. Taking ships, notions of paradise, islands and containers, I see all of these as instances of transfer and systemically linked ‘spaces in between’. Their common features I ascertain in the cognitive defence against a surrounding but different nature to which they are exposed. This paradigm of permeability that determines the ship, gardens and Islands may be seen, with regard to the construction of the containers for live plants, as an obstacle to an innovative solution that was only to be found later with the Wardian case.

Marcelo Fabián Figueroa’s study is also concerned with plants, which admittedly were brought from the colonies to Madrid either alive or already prepared into medical products such as balsam. Instructions and catalogues of questions initiated and guided these operations along scientifically intended paths. They are part of a process of regulation that determines not only the transports themselves, but also the administrative reform and the centralization of the government. The transport of scientific evidence was related to a complex administrative body that transformed unknown unstable products into scientifically and also commercially useful objects, which we may describe as ‘entangled’.

Kurt Schmutzer, in his study, concentrates on ‘Collections in the Making’, which he characterizes as a ‘Metamorphosis between field and museum’. The journey to Brazil of the Austrian natural history researcher Johann Natterer, which lasted 18 years and acquired thousands of specimen (for example 12293 birds), included numerous different practices: hunting and annotating, preservation in alcohol and dry form, transportation and shipping. The collector tried to maintain control of the collected specimen on the way because it was managed by traders and diplomats. Therefore the dispatches accompanied by different types of documentation (reports,

letters, sketches, notes, labels and inventories) were not to be opened during transportation so as to preserve the identity of the specimen. The high point of a series of interventions that culturally determined the natural objects consisted of the ultimate provision of glass eyes, which were acquired in Venice.

A completely different approach to our topic is to be found in Bernhard Fritscher's study of the *Heidelberger Mineralien-Comptoir* - the first leading European mineral shop. He asks through what uses the new space of dealing with minerals was established. Its result was located between the scientific, economic and public/popular spheres and their implications. He shows how the increase in mineral dealing was determined by the Biedermeier culture, with its notion of pedagogy and its profound interest in teaching and education. But this new space of dealing would not, in itself, be successful if it were not generated by public handbooks in mineralogy and promotion in journals and catalogues that made the minerals accessible. In this respect he identifies the transformation of minerals as a new economization of objects/nature that does not relate to economic or practical application but rather to a significant role within a cultural practice of collecting.

In general terms the studies support the idea that the concept of 'spaces in between' is extremely useful as an analytical category. It helps to put together essential features of the process of growth of knowledge in natural history and facilitates an understanding of how it could be so successful during the 18th and 19th centuries. If the dynamic of knowledge production in natural history is to be linked not only to ideas and theories but also to such ephemeral phenomena as packaging, transport and transformations, then these entities are also embedded in a further field of material culture and practices. Interwoven with actors and different forms of documentation they are part of a complex 'entangled'²¹ history of the 'Coming into Being of Scientific Objects'²²: and its knowledge, and this probably takes place - as is shown in our examples - outside familiar institutions such as the museum.

²¹ Nicholas Thomas, *Entangled Objects: Exchange, Material Culture and Colonialism in the Pacific* (Harvard: Harvard University Press, 1997).

²² Lorraine Daston (2000) "The Coming into Being of Scientific Objects", in Lorraine Daston (Eds.), *Biographies of Scientific Objects* (Chicago and London: The University of Chicago Press 2000) 1-14.

Seeds of Knowledge

Unveiling hidden information through letters and gardens in Bologna, Turin and Uppsala

Annalisa Managlia*, Umberto Mossetti*, Ariane Dröscher†

... il piacere grandissimo dell'animo, che risulta dall'aspetto delle piante. [...] Il che tanto piu accresce contento all'animo, quanto piu sono periti questi tali nella cognitione, & vera dottrina de i Semplici. Imperò che non si potrebbe con lingua esplicare il piacere, & la giocondità, che ne risultà nell'animo, quando una pianta, lungamente ricercata, si ritrova;

[... the immense spiritual delight which results from looking at plants; [...] The contentment of the soul enhances, the more someone is an expert of the knowledge and the true doctrine of the Simples. For this reason you cannot express with words the pleasure and the jocundity, which springs in your soul, when a plant, long sought for, is found.]

(Matthioli, 1552, in his dedication to cardinal Madruzzo)¹

ABSTRACT

Travel and exchange of persons, objects, technologies, skills and ideas, though practiced at all times of humankind, are two of the most particular characteristics of the modern Western world. The exchange of seeds and of the information concerning them deserves a special importance in the history of agriculture and botany. On the one hand, seeds were simple and inexpensive to store and to travel, on the other hand they exposed botanists and gardeners to unexpected conceptual and technical challenges. We will first describe some of the particular features of the information contained in seeds, namely their delay in time and space. In the case of Bolognese botanist Ferdinando Bassi (1710-1774) and his extensive correspondence with other botanists like Linnaeus, we highlight how late 18th-century scholars handled the hidden knowledge contained in these plain little objects.

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¹ Pietro Andrea Matthioli, *Il Dioscoride dell'eccellente dottor medico M.P. And. Matthioli da Siena; con li suoi discorsi ...* (In Vinegia: appresso Vincenzo Valgrisi alla bottega d'Erasmus, 1552), p. 4.

Keywords: biography; Linnaean taxonomy; seeds; exchange; botanical gardens; species

Since the end of the 16th century botanists and commercial nurserymen had been passionately prospecting newly discovered lands for new plants.² These travels resulted in the introduction to Europe of many new exotic plants. Most scholars agree that the trade in plants and seeds was, and still is, responsible for some of the most significant changes in global history. Alfred Crosby has shown, for example, that the early modern age saw an exceptional demographic increase because of better nutrition that was a direct product of the introduction of new food plants from overseas.³

During the 18th century European scientific travelers and settlers played more important roles than ever in the distribution of new species and the redistribution of known ones.⁴ The far-reaching economic, political, and ecological implications of these processes have been the object of many analyses.⁵

Here we would like to focus on both epistemological and technical implications related to the exchange and cultivation of seeds in botanical gardens. In the words of Linnaeus' student Bogislaus Hornborg (1739-1789), 'Qui naturam plantarum rite vult intelligere, necessum est [...] Debet *Hortos* intrare *Academicos*, ubi millena semina, quotannis e plagis remotissimis orbis advecta, seruntur, & videre, quod singula promant suam plantam, nec aliam. [To understand the nature of plants correctly one has to go into botanical gardens, where thousands of seeds collected from the most distant regions of the world are sown out each year, and one will see,

² For the importance of gardens, herbaria and exchange during Renaissance botany see Brian Ogilvie, *The science of describing: Natural history in Renaissance Europe* (Chicago: Chicago University Press, 2006).

³ Alfred Crosby, *The Columbian exchange. Biological and cultural consequences of 1492* (Westport, Conn.: Greenwood Publishing Group, 1972).

⁴ See e.g. Staffan Müller-Wille, *Botanik und weltweiter Handel. Zur Begründung eines Natürlichen Systems der Pflanzen durch Carl von Linné (1707-1778)* (Berlin: VWB, 1999); Emma C. Spary, *Utopia's garden: French natural history from Old Regime to revolution* (Chicago: Chicago University Press, 2000); Londa Schiebinger and Claudia Swan (eds.), *Colonial botany. Science, commerce, and politics in the early modern world* (Philadelphia: University of Pennsylvania Press, 2005); Harold J. Cook, *Matters of exchange: commerce, medicine, and science in the Dutch Golden Age* (New Haven; London: Yale University Press, 2007); Regina Dauser, Stefan Hächler, Michael Kempe, Franz Mauelshagen, and Martin Stuber (eds.), *Wissen im Netz: Botanik und Pflanzentransfer in europäischen Korrespondenznetzen des 18. Jahrhunderts* (Oldenbourg: Akademie Verlag, 2008).

⁵ e.g. Michael E. Osborne, *The system of colonial gardens and the exploitation of French Algeria, 1830-1852*, in E.P. Fitzgerald (ed.), *Proceedings of the Eighth Annual Meeting of the French Colonial History Society, 1982* (Lanham, MD: University Press of America, 1985), pp. 160-168; Bugos, Glenn E. and Daniel J. Kevles (1992) "Plants as intellectual property: American practice, law and policy in world context", *Osiris*, 1992, 7: 75-104; David Philip Miller and Peter Hanns Reill (eds.), *Visions of Empire: voyages, botany, and representations of Nature* (Cambridge: Cambridge University Press, 1996).

how the single plant brings forth its own kind and not others].’⁶

Exchange and skill of cultivation were two of the most essential features of botanical gardens throughout time. In the course of the 18th century both were developed to a degree that most of the gardens can be considered as kinds of proto-laboratories. Staffan Müller-Wille has shown in the case of Linnaeus the two complementary functions of botanical gardens: on the one hand, the flow of plants (by means of seeds) from their original location to the botanical gardens, and their reproduction (by means of seeds) in the gardens; on the other hand, the dense network of mutual exchange of seeds between the botanical gardens. Both aspects rendered the objects of botany continuously observable in their genealogical context, and, at the same time, embedded into a variety of habitats with different conditions, most of them controllable or at least recorded by the botanists. The result was a quasi-experimentally induced abstraction of the phenomena of local conditions. In a relatively short lapse of time a considerable amount of data could be collected, analyzed, and compared, leading to conclusions with a high level of generalization. Therefore, according to Müller-Wille, the system of botanical gardens is to be understood as a botanical means of representation, which effectively abstracts from possible variables such as local habitats.⁷ Letters and gardens thus represent two tightly interwoven und mutually dependant ‘spaces in between’ where botanical and, as we shall see, ecological knowledge was constituted.

Technically, too, traditional methods had been integrated with new ones. Although still not as systematic and integrated into the botanist’s work as these instruments would be in the 19th century, in order to scientifically approach the cultivation of exotic plants, new tools – mostly thermometers and the indication of the latitude and longitude of the site where the seeds had been picked up – had already been introduced in the late 18th century.⁸ Handling exotic seeds, in fact, exposed gardeners to some unexpected conceptual and technical challenges: ‘Indeed, no living

⁶ Bogislaus Hornborg, *Transmutatio frumentorum* [1757], in Carolus Linnaeus, *Amoenitates academicae seu dissertationes variae physicae, medicae, botanicae, anthec seorsim editae; nunc collectae et auctae, cum tabulis aenaeis* (Holmiae: Sumtu & Literis Direct. Laurentii Salvii, 1760), Vol. 5: pp. 106-119, on pp. 109-110; the English translation is taken from: Müller-Wille, Staffan (2001) “Gardens of paradise”, *Endeavour*, 2001, 25: 49-54, on p. 53.

⁷ Müller-Wille, Staffan (1998) “Varietäten auf ihre Arten zurückführen’: Zu Carl von Linnés Stellung in der Vorgeschichte der Genetik”, *Theory of the Biosciences*, 1998, 117: 346-374, especially pp. 364-365.

⁸ Bourguet, Marie-Noëlle and Christian Licoppe (1997) “Voyages, mesures et instruments: une nouvelle expérience du monde au siècle des Lumières”, *Annales. Histoire, Sciences Sociales*, 1997, 52: 1115-1151; Marie-Noëlle Bourguet, *Measurable difference. Botany, climate, and the gardener’s thermometer in eighteenth-century France*, in Londa Schiebinger and Claudia Swan (eds.), *Colonial botany. Science, commerce, and politics in the early modern world* (Philadelphia: University of Pennsylvania Press, 2005), pp. 270-286, on pp. 280-281.

plant or seed can be extracted from its native habitat and transferred elsewhere without some elements of its environment (type of soil, degree of heat or moisture) and some precise information (about mode of cultivation, techniques of preparation, or practices of consumption) being imported along with the sample to its new terrain – whether a greenhouse, a garden, or a plantation. [...] This tension between mobility and embedding lay at the core of 18th-century botanical science and practice.’⁹

Yet, the difficulties began even before the plants reached the botanical garden. The costs of shipping of the oft-voluminous collections were elevated. They became nearly prohibitively expensive, calculating that during prolonged sea voyages living plants were exposed to marine salt spray, shortage of freshwater, and cramped spaces, which resulted – at least until the Wardian case was invented – in the loss of 90% or more of the plants.¹⁰ Even the preparation of dry specimens for the herbaria required special care, special skills,¹¹ and a great deal of time, especially in tropical regions. The solution to these problems was for plants to travel as seeds. In Europe the seeds could be grown in botanical gardens and the plants obtained then prepared for herbarium collections. This relatively inexpensive method also allowed minor institutions to enrich their live and dried collections of exotic plants.

In the following, we will first describe the particularities of seeds as scientific objects and as carriers of special forms of (hidden) knowledge, and then present the case of Bolognese botanist Ferdinando Bassi (1710-1774), who received seeds from all over the world, his experiences in growing these seeds, and his participation in the information exchange network.

SEEDS AS CARRIERS OF TRANSFERABLE INFORMATION

Seeds are compact carriers of a massive amount of (genetic) information that can be transferred and preserved without particular complications, and that finally express their complexity in the form of living plants in a botanical garden. This means that botanical gardens can be seen not just as a final destination, but also as a place for an additional, pivotal transformation that takes place before selected material becomes part of a museum collection: a ‘space in between’ that connects the ‘information for becoming a plant’ with the plant itself.

A seed is, simply speaking, a mature fertilized plant ovule, consisting of three

⁹ Bourguet, *Measurable difference*, pp. 270-271.

¹⁰ See Marianne Klemun’s essay in this volume.

¹¹ See Marcelo Fabián Figueroa’s essay in this volume.

basic parts: an embryo, a supply of nutrients for the embryo, and a protective seed coat. The embryo is the immature plant from which a new plant will grow under proper conditions. As will be shown in the case of Ferdinando Bassi, it was not that easy to recreate the proper conditions. Rather it required lifelong experience and extensive and careful experimentation.

The choice of the research organism remarkably influences the development of the research undertaken.¹² In the case of seeds, especially when they come from unknown or poorly known plants, the experimentation requires not only detailed knowledge of both its general and particular features, also its ecological context might influence it greatly. This context is mostly lost when receiving seeds from plants growing in different ecosystems. Thus, at the moment of their cultivation, the exchanged seeds are far from being standardized model organisms. This means that seeds are not only a tool to investigate biological questions, rather they are themselves questions: ‘What is it?’, ‘Do we already know it or is it a new species?’, ‘How do we have to handle it to have it grow?’ Though these questions might seem less than scientific, they were the basic steps toward developing familiarity and thus transforming a previously unknown and undomesticated organism into a scientific object.

From a botanical point of view, too, seeds are special objects. They serve several functions for the plants that produce them. Key among these functions are the nourishment of the embryo, dispersal to a new location, and dormancy during unfavorable conditions. Seeds fundamentally are the means for plants to delay reproduction in both space and time.

Temporal Delay

Seeds remain viable for periods that vary greatly, depending on the species and the storage conditions. A seed of an Oriental Sacred Lotus, *Nelumbo nucifera*, for example, collected from the sediment of a dry lake bottom near a small village in Northeastern China germinated after being dormant for over 1,200 years.¹³ Protected by an impenetrable seed coat, and mired in an oxygen-deficient mud, the seed

¹² Burian, Richard and Muriel Lederman (eds.), (1993) “The right organism for the job”, *Journal of the History of Biology*, 1993, 26(2): 235-367.

¹³ Shen-Miller, J., Mary Beth Mudgett, J. William Schopf, Steven Clarke, and Rainer Berger (1995) “Exceptional Seed Longevity and Robust Growth: Ancient Sacred Lotus From China”, *American Journal of Botany*, 1995, 82(11): 1367-1380.

maintained intact its genetic and enzymatic systems, which reactivated when the seed was split open and soaked in water.

The topic of seed viability became the object of some scientific consideration in the mid-19th century. In 1849 German botanist Carl Friedrich von Gärtner (1772-1850) reported on viable seeds found in graves over 1000 years old. Charles Darwin, too, became interested in the phenomenon, which he discussed with John Lindley (1799-1865) and Charles Lyell (1797-1875)¹⁴. In one of these letters Darwin expressed his surprise at seeing seeds found in millenary Druidical mounds germinate, especially upon realizing that some of the seeds were from not-indigenous British plants.¹⁵

But the delay in time is not only between the past and the present. Seeds can also represent a delay between the present and the future in contemporary Seed Banks, which provide insurance against the loss of plant species in the wild. Kew Royal Botanic Gardens' Millennium Seed Bank is the largest *ex situ* (i.e. the seeds are conserved outside their native habitat) plant conservation project in the world. Its focus is on global plant life faced with extinction and on plants likely to be most useful in the future. Kew's Millennium Seed Bank has already saved the seeds from six plant species now extinct in the wild.¹⁶ Similarly, the Svalbard Global Seed Vault, constructed in a cavern excavated into permafrost, is intended to store duplicates of seed collections from gene banks all over the world, and has a storage capacity of over four million different samples. Under this aspect seed banks could probably be considered another 'space in between'.

Spatial delay

Even more incisive than the sometimes considerable temporal discrepancy between the production of a seed and its growing, is the delay in space. Plants, travelling as seeds, were grown in botanical gardens and then prepared for herbarium collections. As we will now illustrate through the informative correspondence between Linnaeus and Ferdinando Bassi, this delay in space often resulted in new discoveries.

¹⁴ See especially letter 577 to Lyell on September 1843, in: Francis Darwin and Albert Charles Seward (eds.), *More letters of Charles Darwin. A record of his work in a series of hitherto unpublished letters* (London: John Murray, 1903), vol. 2: pp. 244-245; also: Letter 696: Darwin to Lyell, Charles (15 or 22 September 1843), Darwin Correspondence Database, <http://www.darwinproject.ac.uk/entry-696> (consulted 4 April 2012).

¹⁵ Porter, Duncan M. (1986) "Charles Darwin and 'ancient seeds'", *Archives of Natural History*, 1986, 13(2): 165-168.

¹⁶ <http://www.kew.org/science-conservation/save-seed-prosper/millennium-seedbank/about-the-msb/seed-banks-save-plants/index.htm>

FERDINANDO BASSI

Although even among botanists his name is not well known today, in the 18th century Ferdinando Bassi had been one of the most renowned scientists. In 1772, Antoine Gouan (1733-1821) dedicated his *Illustrationes et Observationes Botanicae* to the ten most distinguished botanists of his time, among them was Bassi. In a letter written in 1769 by botanist Antonio Turra (1736-1797) to Carl Linnaeus, Bassi was listed as one of only four noteworthy contemporary Italian botanists: '*pauci sunt hodie Botanici Itali praeter Montium et Bassium Bononienses, praeter Tillium Pisanum, praeterquae Battarium clodiense amicum meum*' [nowadays there are few botanists in Italy apart from Monti and Bassi in Bologna, Tilli in Pisa and Battarra in Chioggia who is a friend of mine].¹⁷

Ferdinando Bassi was born in Bologna in 1710, the son of a merchant and shipping agent. During this period, Bologna saw a renewed scientific splendour and became a distinguished centre of the European *Republic of Letters* mainly due to the Institute of the Sciences, founded in 1714 by count Luigi Ferdinando Marsili (1658-1730). In the Institute, the Academy of the Sciences cohabited with the *Accademia Clementina* (named after Pope Clemente XI) of Painting, Sculpture and Architecture. After 1745, under the guidance of pope Benedict XIV, the Academy of Sciences was devoted to experimental science becoming the main reference point of scholars such as Jacopo Bartolomeo Beccari (1682-1766), Giuseppe Veratti (1707-1793), Laura Bassi (1711-1778) and Luigi Galvani (1737-1798) and furnishing an important impulse to university reform as well as to the general intellectual climate of Bologna. Although Bassi did not follow any university curriculum, he was trained in natural sciences by astronomer Eustachio Zanotti (1709-1782) and above all by the botanist Giuseppe Monti (1682-1760), both eminent members of the Academy. Monti held the chair of Botany and the direction of the botanical garden for about 40 years. He introduced Bassi to the scientific world and, by letting him deal with the exchanges of scientific specimens for the academy museum, allowed him to get in touch with the chief Italian and European naturalists.

As time passed, these relationships were maintained and intensified, and Bassi's name became very familiar amongst European scientists. He exchanged

¹⁷ Antonio Turra to Carl Linnaeus, 28 November 1769, in: *The Linnaean correspondence*, linnaeus.c18.net, letter L4288 (consulted 4 July 2011).

hundreds of letters with the main scientists of his time.¹⁸ Among them, the most famous botanists: Henri Louis Duhamel du Monceau (1700-1782), Antoine-Joseph Dezallier d'Argenville (1680-1765), Vitalino Donati (1717-1762), Christian Gottlieb Ludwig (1709-1773), Carlo Allioni (1728-1804) and, particularly noteworthy, the Swedish naturalist Carl Linnaeus, but also naturalists and physicians like Lazzaro Spallanzani (1729-1799) and Giovanni Battista Morgagni (1682-1771).

Ferdinando Bassi wrote nine letters to Linnaeus, beginning in 1762 and continuing throughout Bassi's life (until 1773).¹⁹ Correspondent of Linnaeus, Bassi received a massive quantity of seeds from all over the world, grew them in Bologna's botanical garden and developed a valuable herbarium with newly discovered species.²⁰ In 1763 he obtained the post of Keeper of the Garden of Exotic Plants, a position he held for the rest of his life. Growing of exotic plants represented a special challenge for gardeners. Soon they became aware that many of them required conditions that were not given in European gardens. Bassi however became rather successful. Under his direction the garden became considerably larger and more diverse in species. He succeeded in cultivating new species and first-ever flowering of poorly known plants. The main key of his success was the construction of a new glasshouse to keep exotic plants during the coldest months of the year.²¹ The construction of this new facility was firmly requested by Bassi since the first years of his activity as keeper; as he wrote to the city government, in order to complete the garden 'it is necessary a new hot greenhouse, where to grow a larger number of exotic plants, and where the hardier amongst them can fruit'. 'Hot' meant that several stoves were located inside the greenhouse.

Importantly, Bassi associated a request for a new gardener 'who has to live, in winter, in the small apartment over the glasshouse so that he can easily control the heating during the night'. Differently, 'you're always anxious, because the efforts of years could be destroyed in one night'.²²

¹⁸ Bassi, conscious of the scientific value of his correspondence gave a special order that after his death the letters should be handed to the University Library of Bologna that still conserves them in ten volumes; see Annalisa Managlia, *Ferdinando Bassi corrispondente di Linneo*, in Donatella Biagi Maino and Giovanni Cristofolini (eds.), *Linneo a Bologna: L'arte della conoscenza* (Torino: Umberto Allemandi & C., 2007), pp. 63-78.

¹⁹ These letters are part of the Linnaean Correspondence, available on-line at linnaeus.c18.net

²⁰ <http://www.sma.unibo.it/erbario/bassi.html>

²¹ Umberto Mossetti, *Ferdinando Bassi botanico*, in Biagi Maino and Cristofolini, "Linneo a Bologna", pp. 55-62.

²² Quoted in Tugnoli Pattaro, Sandra "L'Orto Botanico bolognese di Porta Santo Stefano (con alcuni documenti inediti)", *Natura e Montagna*, 1975, XXII (4): 29-39: "si sta sempre con timore, perché può bastare una notte per far perire le fatiche di molt'anni".

It was Linnaeus, looking for reliable naturalists from the Italian peninsula, who contacted Bassi and invited him to exchange information.²³ Linnaeus received from Bassi at least 13 botanical specimens, along with accurate drawings of newly discovered species: such drawings and specimens helped Linnaeus to illustrate plant species never described before. Nowadays the Linnaean herbarium still preserves six specimens sent by Bassi. Amongst them, the two leaves of *Ambrosinia bassi*, sent in 1770, with Bassi's regret that he could not send a dried flower having just one specimen left;²⁴ *Alisma parnassifolia* and *Cynanchum viminale* (today known as *Sarcostemma viminale*) were enclosed in a letter in which he accurately described these new species;²⁵ later he also sent a drawing illustrating the floral structure of *Cynanchum*.

KNOWLEDGE TRANSFER THROUGH SEEDS BETWEEN BOLOGNA, TURIN AND UPPSALA

Although the botanical school of Bologna was rather critical towards the Linnaean nomenclature, considered to contribute more to the confusion rather than to the simplification of taxonomy,²⁶ Bassi communicated his new findings to the Bolognese Academy of Sciences, as well as to Linnaeus in the hope of receiving his authoritative agreement and support. These notes were often based on a seed's characteristic of being a carrier of hitherto unknown information brought through space: from exotic native localities to botanical gardens. This became especially evident when unknown seeds were sent to Bassi from his friend Vitaliano Donati, Italian explorer, archaeologist, and botanist born in Padua.

In 1750 Charles Emmanuel III, king of Sardinia, had offered Donati the chair of Botany and Natural history at the University of Turin. He held the position of Director of Turin's Botanical Gardens from then until his death in February 1762 on board ship in the Indian Ocean, when travelling to India. In 1759, Donati visited Egypt, where he collected and sent to Turin some antiquities that formed the original nucleus of the city's Egyptian Museum.

²³ Managlia, "Ferdinando Bassi corrispondente", p. 64.

²⁴ *Ferdinando Bassi to Carl Linnaeus, 15 March 1770*, in: *The Linnaean correspondence*, linnaeus.c18.net, letter L4456 (consulted 4 July 2011).

²⁵ *Ferdinando Bassi to Carl Linnaeus, 13 December 1767*, in *The Linnaean correspondence*, linnaeus.c18.net, letter L4012 (consulted 4 July 2011).

²⁶ Mossetti, "Ferdinando Bassi botanico", pp. 57-58.

While in Egypt he sent Bassi some seeds, the history of which is detailed in a letter to Linnaeus: Bassi told Linnaeus that Donati had asked him to sow these seeds and to see if any of them produced a new species, in which case Donati should be informed when he returned to Europe.²⁷ Actually, only one seed produced an unknown plant. Bassi intended to conceal this information until Donati's return, but when he learned of Donati's death, he informed Carlo Allioni (1728-1804), who had succeeded Donati in the chair of botany and the direction of the botanical garden in Turin, as the latter's travel had been made at the expense of that university. In early 1763 Bassi sent Allioni the seeds of Donati's plants.

The new plant had travelled as seed from Egypt to Bologna, expressed its genetic information in Bologna where it produced new seeds, which travelled again as seed from Bologna to Turin, where Allioni grew them and named the resultant plant *Bassia aegyptica* after Bassi. Bassi was grateful for the dedication of the new genus – '*unicum et summum praemium laboris*' in Linnaeus' words – but, unfortunately, the story of the plant had not come to its final point. In 1768 the plant travelled again as seed from Turin to Uppsala, sent by Allioni to Linnaeus as the undisputed leader of botanical classification. Allioni hoped to receive authoritative support for the discovery but was disappointed to be told that what he thought to be a new genus was a species already described by Linnaeus himself as *Salsola muricata*.²⁸

In this case we can see that the three botanical gardens in Bologna, Turin and Uppsala were the 'spaces in between' that connected the 'information for being a plant', the plant itself, and the (sometimes different) interpretation of the meaning of the information thus expressed. In all of these gardens seeds were grown and plants were cultivated – some of them to produce seeds again and some of them to be prepared as herbarium specimens.

The accompanying letters may be seen as 'spaces in between', too. Interestingly, most of them contain very poor information about how to grow the seeds. Presumably this does not indicate jealously hidden secrets. Rather, most gardeners confided in their colleague's experience. It was simply thought superfluous to add further

²⁷ *Ferdinando Bassi to Carl Linnaeus, 15 March 1770*, in: *The Linnaean correspondence*, linnaeus.c18.net, letter L4456 (consulted 4 July 2011): "Plantae semina cum aliis nonnullis primus omnium ego accepi a Vitaliano Donato tunc per Aegyptum peregrinatore. Misit Donatus semina casu collecta ut sata nec non germinantia viderem, an aliquid novi esset, quod si aliquid novi, id caute custodirem, eique reduci in Italiam traderem, ut publici juris ille faceret, fiduciam enim suam, et totam in mea tantum honestate illi bene cognita collocaverat. Ex seminibus germinantibus unice tantum illam Plantam novam animadverti, et datam fidem servabam".

²⁸ www.linnean-online.org/3478/

explanations. These letters, therefore, demonstrate the great importance of ‘tacit knowledge’ among botanists. However, as we shall see in the next paragraph, sometimes unexpected difficulties arose, revealing differences in handling and making it indispensable for single gardeners to furnish more detailed information about their procedures.

Botanical gardens were also the places where colonial empires exposed exotic plants as symbols of their power. Since Italian states had no colonies at this point, exotic seed growing was less impacted by political and social motives, and the same level of care was given to indigenous and exotic plants, as can be seen in two incidents revealed by the Linnaeus–Bassi correspondence.

Indigenous and Exotic plants

Bassi noted that sometimes plants collected in the wild in different localities of the Apennines around Bologna differed slightly from the cultivated ones. In 1763, considering the classification of the so-called *Papia michelii*, described by Michelangelo Tilli (1655–1740) as a new Italian species, Bassi wrote to Linnaeus that specimens with that name should be considered as specimens of the already-known *Lamium orvala* ‘*in humidioribus et umbrosis locis proveniens*’ [growing in wet and shady places],²⁹ an explanation that nowadays would be considered ecological. This too was important information hidden in seeds and coming out unexpectedly when grown in the botanical gardens. It constrained botanists to investigate the influence of the environment on the development of plants. Yet, it seems that Bassi did not deepen this aspect but limited himself to talk about ‘abnormal variations’ and to indicate the different habitats.³⁰ As in the case of *Lamium*, the two varieties of the same species may indeed differ considerably in shape: in 1) the rim of the leaf, in one case deeply dentate and in the other only lobed, and 2) the shape of the lower part of the flower lip, in one case divided in the other entire.

Seeds were even more longed-for when they came from exotic plants. At least from 1751 Linnaeus was searching for a seed of *Dalechampia scandens*, a Euphorbiacea growing in tropical lowlands. Despite asking all major European gardeners he did not succeed to find any, or, as in the case of the *Jardin du Roy* of

²⁹ *Ferdinando Bassi to Carl Linnaeus, 15 March 1763*, in: *The Linnaean correspondence*, linnaeus.c18.net, letter L3691 (consulted 4 July 2011).

³⁰ Though Bassi refers in this letter to a more detailed study on *Lamium* in the *Acta Bononiensis*, it was impossible to find any trace of it.

Paris, if he received seeds, these were not vital.³¹ Finally, in 1770, Bassi sent him the desired seeds. He was sincerely astonished about Linnaeus' difficulties, because in Bologna the plant was flourishing and producing useful seeds every year.³²

In 1772, Bassi wrote to Linnaeus of his success in obtaining for the first time the flowering of the South-African species *Crassula portulacaria*. He carefully described the cultivation technique: 'the plant grows in a small pot, although it becomes more than three feet high. It is not watered in the winter, when it is kept in a cold greenhouse, and then it is placed outdoors from May to October.'³³

It is worth noting that thanks to the observation of the flower, Bassi was able to correctly classify the plant: it was not a *Crassula*, belonging to the Linnaean Order Pentandrya Pentagynia, but a species of the genus *Claytonia*, of the Linnaean Order Pentandrya Monogynia. So, in this case, a successfully resolved technical challenge produced a conceptual challenge. The constitution of taxonomic knowledge depended on the interplay between several places, skills and means of communication: vital seeds of a South-African plant had to be sent by letter, arrive safely and intact, and then be induced by special techniques to flower inside a Bolognese garden; the information thus unveiled had to be inserted first into the context of Linnaean classification and then into the network of botanists in order to be confirmed or falsified. Each 'space in between', letters as well as gardens, slightly modified the object and the knowledge about it.

CONCLUSION

Detailed care and constant attention, overcoming climatic and ecological obstacles, grasping and elaborating often unexpected knowledge emerging from the cultivation of seeds, and finally the pleasure of seeing a plant grow, these are the activities that exemplify the intimate relationship between botanists, seeds and plants. For botanists, who travel through time and space to bring to life something new from an unknown

³¹ Managlia, "Ferdinando Bassi corrispondente", pp. 64-65.

³² *Ferdinando Bassi to Carl Linnaeus, 15 March 1770*, in: *The Linnaean correspondence*, linnaeus.c18.net, letter L4456 (consulted 4 July 2011).

³³ *Ferdinando Bassi to Carl Linnaeus, 15 May 1772*, in: *The Linnaean correspondence*, linnaeus.c18.net, letter L4779 (consulted 4 July 2011).

seed, the words of Pietro Andrea Mattioli with which we prefaced this essay, ring as true today as they did half a millennium ago.

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

*Marianne Klemun**

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 colonialism¹. Economically useful plants, such as the tea-bush or the clove tree, both from East Asia, represented a major requirement², 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 purpose³. 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 transfer⁴, 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 stressed⁵, 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 end⁷. 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 empire⁸. 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 jar⁹. 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 involved¹⁷. 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) “UNNatural 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 academies¹⁸. 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 islands¹⁹. 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 were 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 Vienna²⁰. 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 Caesaris 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 1783–1797²², 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 Vienna²³. 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 thesesianischen 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 instructions²⁴ 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 instructions²⁵ 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. Dispositif 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 - transfer²⁶. 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 Dille, 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 Ellis²⁸ 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 years²⁹.

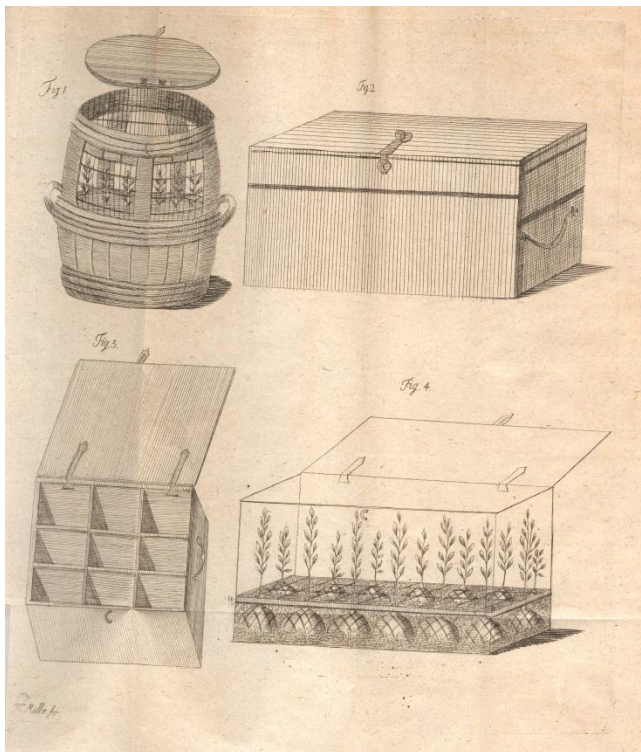


Figure 1 - John Ellis, *Directions of Bringing over Seeds and Plants* (London: L. Davis 1770). Library of the University of Vienna.

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 Science³⁰. 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 means³¹. 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, too³². 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 (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 condition³⁴. 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, "UNNatural History", she gives credit to Margherita Azzi Videntini for translation from Latin.

potential and then is held there'³⁶. Ward, pre - emptying 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 realised³⁸. 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, "UNNatural 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 Caribbean⁴⁰. 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 imitated⁴¹. Gardens such as these served the purpose of adapting European forms of culture to the unfamiliar climate⁴².

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. Merrill 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 Paradise⁴³, 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 collection⁴⁴. 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.')

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, fornemmelig 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 powers⁴⁶ - 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 instructions⁴⁷. 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 1727⁴⁸ 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 Ihrer Majestät des Königs von Dänemark[!] 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 sap⁴⁹, 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 from 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: Flammarion, 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 indispensable⁵⁰.

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.

Packing techniques and political obedience as scientific issues: 18th-century medicinal balsams, gums and resins from the Indies to Madrid

*Marcelo Fabián Figueroa**

Abstract

This paper studies the administrative, legal and scientific instructions issued by the Spanish Ministry of the Indies during the 1780s to furnish the Royal Pharmacy in Madrid, especially it focuses on the transportation of medicinal vegetal products from the American colonies. Transporting such products was a challenging operation in which various colonial authorities were involved: what were the technical, scientific and political challenges faced by this scientific practice enforced by the central government? How did political power relations interrelate to obtain natural objects suitable for the Royal Pharmacy? The successive shipments of plants and the instructions regarding them highlight the problems triggered by the systematization of transportation of medicinal plants pursued by the Ministry of the Indies.

Keywords: natural objects, circulation, instructions, bureaucracy.

Transporting plants and their by-products by long transoceanic voyages was a complex operation which Spanish botanists and reformist bureaucrats attempted to engineer throughout the 18th century. In a crucial effort to discover new drugs, the Spanish Crown endorsed a pharmaceutical approach to botany¹, which transformed pharmacological research on plants from their American colonies. However,

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¹ Francisco Javier Puerto Sarmiento, *La Ilusión Quebrada. Botánica, sanidad y política científica en la España Ilustrada* (Madrid: Serbal/CSIC, 1988), Jean Pierre Clément and Raúl Rodríguez Nozal (1996) "L'Espagne apothicairerie de L'Europe. L'Exploitation médico-commerciale des ressources végétales américaines à la fin du XVIII^e siècle", *Bulletin Hispanique*, 1996, 98 (1): 137-159, Paula De Vos (2007) "Natural History and the pursuit of Empire in Eighteenth-Century Spain", *Eighteenth-Century Studies*, 2007, 40 (2): 209-239.

achieving this scientific ambition depended on the material state in which these objects reached the metropolis. That is why packaging, identification and preservation of fresh or dry plants became three significant logistic activities which the Crown strived to orchestrate by means of a set of administrative, legal and scientific protocols.

This paper explores the administrative protocols developed by the Spanish Ministry of the Indies during the 1780s to organize the transportation of vegetal medicinal products from the colonies to the Royal Pharmacy in Madrid. These written documents ordered the mobilization of the vegetal products through the long journey by sea; they were protocols used to create a space in between colonies and metropolis. During the 18th century, the Royal Pharmacy, together with the Royal Botanical Garden, was one of the institutions in charge of recognizing and analysing medicinal plants from the Indies². This paper focuses particularly on the administrative arrangements issued by the Ministry of the Indies in 1785 and 1787.

The 1780s was a prosperous period for the reformation of the Spanish colonial empire undertaken by Charles III (1759–1788) in connection with the new international context bequeathed by the Seven Years' War³. This reformation was intended to improve the military defense of the American possessions, to centralize the government and tax collection throughout the western Indian viceroyalties and to reformulate transatlantic commerce with the colonies⁴. Hence, consistent with the design of Don José de Gálvez Marquee of Sonora (1720–1787) as Minister of the Indies, the policy of collection of data and natural evidences was extended during the 1780s with the shipment of more scientific expeditions⁵ and royal orders⁶ to the Indies than during the rest of the 18th century.

The distribution of questionnaires, instructions or royal orders that instructed the colonial authorities in the collection of geographical, botanical or ethnographic

² Raúl Rodríguez Nozal and Antonio González Bueno (1995) "Real Academia Médica matritense y expediciones botánicas ilustradas. Una conexión médico-terapéutica", *Dynamis*, 1995, 15: 375-399, on p. 378.

³ During the war Great Britain gained territories in North America at the expense of the France, in consequence Great Britain and Spain were transformed into the two principal colonial powers in the Americas.

⁴ John Elliott, *Imperios del Mundo Atlántico. España y Gran Bretaña en América, 1492-1830*, (Madrid: Taurus, 2006), p. 443-447.

⁵ The period of expeditionary heyday runs from 1771 to 1791. According to the reigns, the expeditions organized were: Philip V, 2; Ferdinand VI, 4; Charles III, 33 and Charles IV, 24. See Ángel Guirao de Vierna, "Análisis cuantitativo de las Expediciones españolas con destino al Nuevo Mundo", in José Luis Peset, *Ciencia, vida y espacio en Iberoamérica*. Vol. 1 (Madrid: CSIC, 1989), p. 68, 90 and 91.

⁶ Between 1745 and 1819 natural and vegetal objects were sent from the Indies on 345 shipments in response to the royal orders sent out from Madrid. Almost 60% of these shipments correspond to the reign of Charles III. See Paula De Vos (2007) "Natural History and the pursuit of Empire in Eighteenth-Century Spain", *Eighteenth-Century Studies*, 2007, 40 (2): 209-239, on p. 217.

information was a typical governmental practice of the Spanish colonial administration of the Indies. During the 18th century, the *Relaciones Geográficas* delivered by the Council of the Indies to investigate the peoples and natural resources of the territories conquered by Hernán Cortés (1485–1547), as well as the questionnaires of the metropolitan academies with the purpose of supplying their shelves⁷, were founded upon the political power of the Crown throughout its American and peninsular possessions⁸. The appropriation of a political–bureaucratic mechanism for scientific purposes has been marked by historians of science as an original Spanish contribution to the configuration of scientific practices during Early Modern History. These practices were coupled with the needs of the colonial government and were the consequence of the conquest and permanent colonization of the territories carried out by the Spanish Crown since the 16th century⁹.

As historians of science have remarked in recent years, the transportation of scientific evidences was related to a body of technical and administrative proceedings that went beyond the narrow limits of the metropolitan academies¹⁰. Consequently, historiography underscores the study of political, religious or economic corporations as well as the institutional protocols, which were designed to build a channel through which agents, orders and data flowed according to the requirements of the metropolis¹¹. Historiography is also interested in exploring the interactions among the agents in the transportation of scientific data and the tension caused by the commercial and coercive nature of the mobility¹². Finally, historiography studies the

⁷ Francisco de Solano, *Cuestionarios para la formación de las relaciones geográficas de Indias, siglos XVI-XIX*, (Madrid: CSIC, 1988), Sylvia Vilar (1970) “La trajectoire des curiosités espagnoles sur les Indes. Trois siècles D’Interrogatorios et Relaciones”, *Melanges de la Casa de Velázquez*, 1970, VI: 247-308, Sylvia Vilar (1971) “Últimas proyecciones coloniales de la España Ilustrada: Dos Interrogatorios de Indias inéditos (1760-1812)”, *Hispania*, 1971, XXXI (119): 617-655, Antonio Barrera (2006), “Empire and knowledge: Reporting from the New World”, *Colonial Latin American Review*, 2006, 15 (1): 39-54.

⁸ The *Relaciones Geográficas de Indias* of 1573 had their peninsular correlate in the *Relaciones Topográficas* of Philip II, which were used between 1575 and 1578 in the towns of New Castilla with the same aim as their American predecessors: to survey the peoples subjected to the Castilian Crown for tax purposes. See Alfredo Alvar Ezquerro, *Relaciones Topográficas de Felipe II*, (Madrid: Comunidad de Madrid/CSIC, 1993).

⁹ Juan Pimentel (2000) “The Iberian vision: Science and Empire in the framework of a universal monarchy, 1500-1800”, *Osiris*, 2000, 15: 17-31, Jorge Cañizares-Esguerra (2005) “Iberian colonial science, *Isis*, 2005, 96 (1): 64-70”.

¹⁰ Marie-Noëlle Bourguet, Christian Licoppe and Otto Sibum, *Instruments, travel and science. Itineraries of precision from the seventeenth to the twentieth century*, (London and New York: Routledge, 2002), on p. 3, 4, 5.

¹¹ S. J. Harris (1998) “Long-distance corporations, big sciences, and the geography of knowledge”, *Configurations*, 1998, 6 (2): 269-304, on p. 276, Antonio Lafuente and Nuria Valverde, “La producción de objetos y valores científicos: tecnología, gobierno e ilustración”, in Agustín Guimerá Ravina and Víctor Peralta Ruiz, *El equilibrio de los imperios: de Utrecht a Trafalgar. Actas de la VIII Reunión Científica de la Fundación Española de Historia Moderna. Vol. 2*, (Madrid: Fundación Española de Historia Moderna, 2005), on p. 336-337.

¹² Emma Spary, “Of nutmegs and botanists. The colonial cultivation of botanical identity”, in Londa Schiebinger and Claudia Swan, *Colonial Botany. Science, commerce, and politics in the early modern world*, (Philadelphia:

connection between mobility and precision caused by the overlapping of the scientific and political institutions that participated in the transportation¹³.

By contrast with other studies devoted to the collection policies of the Royal Botanical Garden¹⁴, this paper explores the policies followed by the Ministry of the Indies to supply the Royal Pharmacy, which never lost its traditional prerogative to carry out chemical and pharmacological analyses on the drugs sent to the Court, despite disputes with the Royal Botanical Garden over the analysis of medicinal plants from the Indies. This paper pays special attention to the administrative orders delivered during the years 1785 and 1787 by the Ministry of the Indies with the purpose of regulating the packaging and transportation of the shipments destined for the Royal Pharmacy. These documents prompt the following questions: what were the technical, scientific and political challenges faced by this scientific practice enforced by the government? How was the packaging of the plants shipped by the colonial officials engineered? How did political power relations interrelate to obtain natural objects suitable for analysis?

The documentary corpus is made up of instructions, mailshots, inventories and registers of experiments kept in the Palace General Archive (Madrid), the General Archive of the Indies (Seville) and the National General Archive (Buenos Aires). The successive shipments of plants and mailshot orders highlight the problems and tensions triggered by the systematization of packaging and transportation of medicinal products that were pursued by the Ministry of the Indies. That is why the balsams, gums and resins as well as the parts of plants from which they had been produced were both a commodity and a scientific object¹⁵, which the Bourbon reformist policy turned into key pieces of the sanitary and commercial reform it had undertaken. The medicinal products that the royal mailshot orders and

University of Pennsylvania Press, 2005), on p. 187, Harold Cook, *Matters of Exchange. Commerce, Medicine, and Science in the Dutch Golden Age*, (New Haven and London: Yale University Press, 1999), on p. 3.

¹³ François Regourd, "Diffusion et assimilation des techniques académiques de collecte et d'expertise dans l'espace caraïbe français (XVIIe-XVIIIe s.)", in P. Hrodej and S. Llinares, *Techniques et colonies (XVIIe-XVIIIe siècles)*, (Paris: Publication de la Société Française d'Histoire d'Outre-Mer, 2005), on p. 37, Marie-Noëlle Bourguet, "Measurable difference. Botany, climate and the gardener's thermometer in eighteenth-century France", in Londa Schiebinger and Claudia Swan, *Colonial Botany. Science, Commerce, and Politics in the Early Modern World*, (Philadelphia: University of Pennsylvania Press, 2005), on p. 271.

¹⁴ Francisco Javier Puerto Sarmiento, *La Ilusión Quebrada. Botánica, sanidad y política científica en la España Ilustrada* (Madrid: Serbal/CSIC, 1988), Daniela Bleichmar, "Atlantic competitions. Botany in the eighteenth-century Spanish empire", in James Delbourgo and Nicholas Dew, *Science in the Atlantic World*, (New York and London: Routledge, 2008).

¹⁵ Igor Kopytoff, "The cultural biography of things: commoditization as Process", in Arjun Appadurai, *The social life of things. Commodities in cultural perspective*, (Cambridge: Cambridge University Press, 1995), on p. 66.

the instructions ordered to package them were mutable objects¹⁶, the material and conceptual collection and stabilization of which were intended to be accomplished by the Crown by means of the systematization of their packaging and transportation. Both practices aimed at transforming unknown and unstable objects into familiar and stable products¹⁷, suitable for sanitary, scientific and commercial use.

In relation to this, it can be claimed that the aim of these orders were: to supply the Royal Pharmacy with quality vegetal products; to produce material evidence which would be suitable for pharmacological analysis; to instruct colonial officers in this practice; and to fine officers who would not comply with these political-administrative measures.

The Royal Pharmacy, provision of the Court, vegetal therapeutic research and the reformation of colonial commerce throughout the Spanish Empire

During the 18th century the Royal Pharmacy was one of the institutions devoted to the pharmacological research of American Indian plants¹⁸, together with the Royal Botanical Garden and the Madrilenian Medical Academy. Even though the Royal Botanical Garden had the exclusiveness the pharmacological research of the plants discovered by the scientific expeditions sent out to America¹⁹ since 1780, the Royal Pharmacy continued to develop research on vegetal therapeutics.

The Royal Pharmacy had been created in 1593 by Philip II to cater for the health of the king and his family²⁰. In fact, the pharmacy was responsible for analyzing and certifying the quality of the plants shipped to the court. This seems to be one of its inherent purposes besides supplying, storing, keeping and administering the medicines destined for the Royal family. So, during the 18th century, when the use

¹⁶ Nicholas Thomas, *Entangled objects. Exchange, material culture, and colonialismo in the Pacific*, (USA: Harvard University Press, 1991), on p. 28, Lorraine Daston, *Things that talk. Objects lessons from Art and Science*, (New York: Zone Books, 2004), on p. 16.

¹⁷ Simon Schaffer, "Una ciencia para explotar. Las pompas de jabón como mercancías en la física clásica", in Simon Schaffer, *Trabajos de cristal. Ensayos de historia de la ciencia, 1650-1900*, (Madrid: Marcial Pons, 2011), on p. 435.

¹⁸ Raúl Rodríguez Nozal and Antonio González Bueno (1995) "Real Academia Médica matritense y expediciones botánicas ilustradas. Una conexión médico-terapéutica", *Dynamis*, 1995, 15: 375-399, on p. 378, 379.

¹⁹ In 1780 the Crown reformed the Royal Court of Protomedicato, which expanded the prerogatives for teaching and research at the Royal Botanical Garden. See Francisco Javier Puerto Sarmiento, "El Real Jardín Botánico de Madrid durante el reinado de Carlos III", in Manuel Sellés, José Luis Peset and Antonio Lafuente, *Carlos III y la ciencia de la Ilustración*, (Madrid: Alianza, 1988).

²⁰ María Esther Alegre Pérez (2001) "Los orígenes de la Real Botica y su actuación al servicio de los Austrias", *Arbor*, 2001, CLXIX, 66: 239-265, on p. 244.

of Indian medicinal drugs increased²¹, the Royal Pharmacy continued doing research and advising the king about their pharmacological and commercial quality.

The Royal Pharmacy was part of the Royal Chamber, which was subordinate to the *Sumiller de Corps* who, in turn, was responsible for guarding the king²². The pharmacy was in charge of catering for the pharmaceutical treatment of the king, the royal family, the members of the court and the body of servants as well as for the administration of a storehouse for Peruvian bark (*Cinchona pubescens*) established in 1768²³. Furthermore, it counseled the king by means of reports dealing with different botanical, therapeutic and economic topics concerning the Indian plants and drugs. Since its functions and administrative location were in the realm of the *Casa Real* (Royal Palace), its tasks were mainly domestic; hence the *Boticario Mayor* (Chief Apothecary), as other employees who worked there, was considered a servant of the king²⁴.

The supply of plants and medicinal drugs and the certification of their pharmacological quality were administered by the Royal Pharmacy. These processes were closely related to their colonial collection and metropolitan investigation. That is why the Royal Pharmacy went beyond its domestic functions and became connected with other places, such as the American vicerealties and the royal hospitals near Madrid. Thus the pharmacy became involved in the collection, research and recording of the geographical location of the Indian plants as it followed royal mailshot orders sent out by the Ministry of the Indies. These activities were related to its scientific, sanitary and administrative functions. This is illustrated in a document produced by the Royal Pharmacy, *Razón de los Géneros Medicinales que producen nuestras Américas...*²⁵, which records the qualities of various plants and their geographical location, and which demonstrates that the colonial collection of drugs

²¹ José Luis Valverde (1982) "La experimentación farmacológica de drogas americanas", *Ars Pharmaceutica*, 1982, 23 (2): 151-192, on p. 176, Pilar García de Yébenes Torres, *La Real Botica durante el reinado de Felipe V (1700-1746)*, Unpublished Ph D (Ph.D.) dissertation, Universidad Complutense de Madrid, 1994, on p. 162.

<http://eprints.ucm.es/tesis/19911996/D/1/AD1022301.pdf>

²² Carlos Gómez centurión Jiménez (2003) "Al cuidado del cuerpo del Rey: Los sumilleres de corps en el siglo XVIII", *Cuadernos de Historia Moderna*, 2003, II: 199-239, on p. 211.

²³ Eduardo Valverde Ruiz, *La Real Botica en el siglo XIX*. Vol. I. Unpublished Ph.D. dissertation, Universidad Complutense de Madrid, 1999, on p. 38. <http://eprints.ucm.es/tesis/19972000/D/1/D1056501.pdf>

²⁴ Pilar García de Yébenes Torres, *La Real Botica durante el reinado de Felipe V (1700-1746)*, Unpublished Ph D dissertation, Universidad Complutense de Madrid, 1994, on p. 27-29. <http://eprints.ucm.es/tesis/19911996/D/1/AD1022301.pdf>

²⁵ Archivo General de Indias, Sevilla (hereafter AGI-S) Indiferente General, 1547. *Razón de los géneros medicinales que producen nuestras Américas y que para ahorro de la Real Hacienda convendría se mandasen hacer venir para la servidumbre de la Real Botica*.

and plants was essential. *La Razón...* was a scientific and administrative document based upon policies of botanical and pharmacological data collection. The document is divided into four columns, each with precise facts: the first holds the amount of plants required by the Royal Pharmacy; the second states the local plant names; the third reviews the parts of the plant which were used and the proportion of intake; and the fourth identifies the environments in which they grew. *La Razón...* classified 40 plants, and their respective by-products, which were distributed throughout Spanish overseas territories, such as to California, Patagonia and as far as the Philippines.

In addition, the certification of the pharmacological quality of the plants was done in three stages. In the same way as with the Peruvian bark, the first and second stages were developed at the Royal Pharmacy, while the third was carried out at the Royal hospitals²⁶. When the plants reached the customs office in Cadiz, the Arrivals Judge informed the *Sommelier de Corps* about the shipment of the crates to the court. This was then communicated to the Senior Apothecary, who was in charge of receiving the shipments at the Royal Pharmacy. When the Indian drugs and the plants were received at the court, the Senior Apothecary undertook the task of going over the crates and comparing their contents with the corresponding bill of landing. The first stage was related to visual observation and the botanical description of the plants dispatched. The second stage used chemical analyses, which were recorded in writing by the apothecaries. The third stage consisted in clinical experimentation, which Madrid doctors carried out on their hospital patients. Generally speaking, these studies were done with new medicinal drugs. The purpose was to certify the qualities attributed to these products with a written report²⁷. However, it must be stated that occasionally these clinical studies were also carried out at the court where the Royal chamber doctors experimented on the servants. At the end of this sequence, the *Boticarios Reales* had evidence with which to write out reports that were finally sent to counsel the king.

²⁶ María Esther Alegre Pérez and María Luisa de Andrés Turrión, "Estudios sobre la clasificación, calidad y pruebas clínicas de productos vegetales ultramarinos para la corona española, en el siglo XVIII", in Juan Esteva de Sagrera and Antonio González Bueno, *Cordialero de libros y medicamentos. Homenaje al Dr. José María Suñé Arbúsd*, (Madrid: Sociedad de Docentes Universitarios de Historia de la Farmacia de España, 2009), on p. 160, María Luisa de Andrés Turrión and María Rosario Terreros Gómez (1996) "First hospital experiences with cinchona ordered by Spanish court (ca. 1770)", *Revue d'histoire de la pharmacie*, 1996, 312: 363-367, on p. 365.

²⁷ Among the plants and drugs whose therapeutic qualities were studied by the Royal Pharmacy jointly with the royal hospitals, the following can be mentioned: the Angel's Hair herb (*cuscuta corymbosa*), which grew in Montevideo and which had been sent to the viceroyalty of Río de la Plata in 1787. This herb was sent to the general hospital of the court in 1789 by the *Sommelier de Corps* to certify its effectiveness against blood loss, as the report sent from Buenos Aires asserted. AGI-S. Indiferente General, 1545. Palacio, 17 September, 1789.

The supply and certification of the pharmacological quality of the Indies medicinal plants and drugs allowed the Royal Pharmacy to go beyond the limits of the court and to participate in the reformation policies developed by Charles III (1759–1788). For the reformists of the second half of the 18th century, commercial exploitation of the Indies was to be the foundation of the empire instead of the evangelizing endeavour, as it had been since the 16th century²⁸. Pedro Rodríguez de Campomanes (1723-1802), who was one of the publicists of the reformation of Spanish colonial commerce, had an neo-mercantilist imperial notion that purported reformations such as: the abolition of the monopolist system of a single port created in the time of the Habsburgs; the opening of new ports in American and peninsular possessions to strengthen commerce; the promotion of agriculture, manufacture and navigation, and the encouragement of population growth²⁹. The Spanish Crown aspired to transform the colonies of the Indies into producers of raw materials and consumers of merchandise manufactured by the metropolis.

Therefore, in the sanitary as well as in the commercial sense, the therapeutic examination of plants enabled the discovery, or discarding, of new drugs, which could then be transformed into commodities. The reformation of Spanish colonial commerce was linked to the discovery and the production of commodities which Spain and her colonies purchased from other European powers. Hence, the research into useful plants from the Indies became a primary imperative. The study of the American flora enabled the discovery of native varieties to substitute expensive Asian commodities and new or unknown products in Europe.

The commercial interest of the Crown transformed the Indian plants into commodities privileged by the reformation of Spanish colonial commerce, even though metals were still the main export during the period between 1778 and 1796. Within 56% of the total, natural commodities expanded to 44%³⁰. The 1778 *Reglamento de Libre Comercio* sanctioned 13 Spanish ports and 24 American ones. Article 43 included medicinal plants, highlighting the noteworthy interest of the Spanish Crown to foster commerce and investigation of exotic plants. On the one

²⁸ José Manuel Portillo Valdéz (2008) “La crisis imperial de la monarquía española”, *Secuencia*, 2008, (Número conmemorativo: Soberanía, lealtad e igualdad: las respuestas americanas a la crisis imperial hispana, 1808-1810): 25-42, on p. 28.

²⁹ Pedro Campomanes, *Reflexiones sobre el comercio español a Indias* (1762), (Madrid: Instituto de Estudios Fiscales, Ministerio de Economía y Hacienda, 1988), on p. 3 and 10.

³⁰ José Luis Valverde (1983) “El comercio de drogas americanas en el siglo XVIII y el aprovisionamiento de la Real Botica”, *Anales de la Real Academia de Farmacia*, 1983, 49: 309-334, on p. 325, John Fisher, “Estructuras comerciales en el mundo hispánico y el reformismo borbónico”, in Agustín Guimerá, *El reformismo borbónico*, (Madrid: Alianza, 1996), on p. 112, 118 and 119.

hand, it exempted taxes on the plants that came to Spain from the Indies and assessed their departure towards other ‘dominions’; on the other, it encouraged the discovery of new commodities by exempting taxes on ‘all the other native productions of the Indies, and Philippines which until now have not been brought to these kingdoms’³¹.

‘Embarrassments are always to be feared at such a distance’³²

Colonial officers in remote overseas territories undertook the collection of plants and medicinal products. So, distance constituted a major obstacle, which Spanish bureaucrats and botanists attempted to overcome by developing mechanisms such as the royal mailshot orders and special instructions. Packaging and transporting plants and their by-products were two further concerns they tackled and these processes became crucial matters for scientific policies of botanical data collection at imperial scale. The development of scientific–administrative discourse and practices which guaranteed the transportation of facts to metropolitan institutions³³, as well as the governmental interest in that the colonial officers would assimilate these practices, were two closely related concerns, particularly if we consider that the therapeutic efficacy of a plant depended exclusively on the care put into its transportation³⁴.

The Marquee of Valdecarzana (1739-1810) was *Sommelier de Corps* between 1783 and 1792. For him, supplying the Royal Pharmacy and the kingdom with quality Indian plants and drugs was a crucial matter. This was related to the experiments carried out to certify the use of these elements; the collaboration of the local agents in charge of the collection and shipment from America; and the ‘political talent’ necessary to conduct the operation as a whole³⁵. Valdecarzana’s report, which was written to counsel the king about the Peruvian bark that José Celestino Mutis (1732 –1808) had discovered in the viceroyalty of New Granada, had discredited the experiments carried out at the Royal Pharmacy, contrary to the positive assessment of Italian, English and French botanists and apothecaries. This report highlights the

³¹ Reglamento y aranceles reales para el comercio de España e Indias de 12 de octubre de 1778 (Madrid: Casa Editorial de Pedro Marin, 1778), on p. 50, 51 and 52.

³² Archivo General de Palacio, Madrid (hereafter AGP-M) Fondo Farmacia, Caja 4540, Legajo 33. Informe del Marqués de Valdecarzana a Don Antonio Porlier, Palacio septiembre de 1789. f. 10.

³³ Antonio Lafuente and Nuria Valverde, “Linnean Botany and Spanish imperial biopolitics”, in Londa Schiebinger and Claudia Swan, *Colonial Botany. Science, commerce, and politics in the early modern world*, (Philadelphia: University of Pennsylvania Press, 2005), on p. 136.

³⁴ Antonio Lafuente and Nuria Valverde, “Linean Botany and Spanish imperial biopolitics”, p. 136.

³⁵ A.G.P-M, Fondo Farmacia, Caja 4540, Legajo 33. Informe del Marqués de Valdecarzana a Don Antonio Porlier, Palacio septiembre de 1789. f. 10.

importance of having vegetal samples in good material condition for their experimentation. The Marquee of Valdecarzana advised to avoid the fraud of the 'mixture and adulteration with other barks'; to control and make sure that the 'parcels', in which the plants were transported, were 'closed, tied and sealed', as was the practice with 'cinnamon, musk and tea', in order to preserve them and determine their therapeutic and commercial value; and to establish a representative of the Crown, who would contact the local authorities, and two botanists, who would investigate the plants of the region, at the collection sites³⁶.

Furthermore, according to Hipólito Ruiz (1754-1816), who conducted the Botanical Expedition of the Viceroyalty of Peru between 1777 and 1788, preserving the good material condition of the plant samples was an essential premise since it conditioned the investigation and the discovery of the healing principles attributed to the plant under analysis. Ruiz considered the transportation of plants in *Memoria sobre la legítima Calaguala...*³⁷ which he wrote in 1796 to announce the medical virtues of the Peruvian plant whose qualities had been questioned in Europe³⁸. According to Ruiz, this discredit was related to the deficient methods of collection and transportation deployed. When the plants were collected, they were irresponsibly jumbled with other plants and they were often insufficiently dried. What's more, the samples were packaged inefficiently in damp leather sacks and the storeroom on the ships that transported the plants was also damp and poorly ventilated, among other deficient practices. These are some of the reasons why the genuine calaguala roots (*Polypodium calaguala*) reached Cadiz corrupted and turned into 'a noxious drug instead of a remedy'³⁹, also many of the roots sold in Spain as calaguala were illegitimate.

Furthermore, while the fresh calaguala was effective in Peru because it was packed in a right way, its dry roots did nothing in Spain. This situation was more closely related to the deficiencies in the transportation and less to its pharmacological

³⁶ A.G.P-M, Fondo Farmacia, Caja 4540, Lagajo 33. Informe del Marqués de Valdecarzana a Don Antonio Porlier, Palacio septiembre de 1789. f. 3 and 11.

³⁷ Hipólito Ruiz, *Memoria sobre la legítima calaguala y otras dos raíces que con el mismo nombre nos vienen de la América Meridional* (1796), (Madrid: en la Casa Editorial de D. José del Collado, 1805), on p. 21.

³⁸ For Hipólito Ruiz the European doubts about the therapeutic quality of the Calaguala were due to the experiments carried out upon samples mixed with other roots, such as the case of the experiments carried out by Caminati in 1791, which Ruiz disparaged. See José Oriol Ronquillo, *Diccionario de materia mercantil, industrial y agrícola que contiene la indicación, la descripción y los usos de todas las mercancías*. Vol. I, (Barcelona: Casa Editora de Dn. Agustín Gaspar, 1851), on p. 532.

³⁹ Hipólito Ruiz, *Memoria sobre la legítima calaguala y otras dos raíces que con el mismo nombre nos vienen de la América Meridional* (1796), (Madrid: en la Casa Editorial de D. José del Collado, 1805), on p. 21.

efficacy as a dried root⁴⁰. According to Ruiz the solution to the adulteration and decomposition of the legitimate calaguala was to be found in the systematization of the gathering and transportation ordered by the Crown, that is, with the organization, guidance and control of the packaging process⁴¹ in order to avoid ‘such a harmful damage to humankind’⁴². Therefore, packaging and transportation of the plants and their by-products were two technical and political–administrative operations that controlled the provision of the Royal Pharmacy, the experimentation and certification of the therapeutic quality of the drugs and plants, as well as the pharmacological and commercial use given to them by the Spanish Crown.

Royal mailshot orders and instructions: transportation of medicinal products, packaging techniques and political obedience

The Royal mailshot order of 22 July 1785, the reserved instruction of 17 November 1785 and the post of 27 April 1787 were three dispositions sent out by the Minister of the Indies, the aim of which was to regulate the transportation and packaging of medicinal products and shipment to the Royal Pharmacy. These arrangements constituted the political and administrative framework created by the Ministry to guarantee the shipment of the products ordered in 1783.

These documents highlight the Crown’s interest in studying and supplying the Royal Pharmacy with Indian pharmacological products, as well as the underlying political and administrative basis of the scientific works developed therein. The dispositions of the Ministry of the Indies were the result of the political and administrative centralization that characterized the Bourbon reformism in general and which reached its prime during the ministry of José de Gálvez in 1776 and 1787⁴³. Similarly, they show the limitations which restricted the political and administrative procedures of data and evidence collection deployed by the Spanish Crown, since the

⁴⁰ Hipólito Ruiz, *Memoria sobre la legítima calaguala y otras dos raíces que con el mismo nombre nos vienen de la América Meridional*, p. 20.

⁴¹ Hipólito Ruiz, *Memoria sobre la legítima calaguala y otras dos raíces que con el mismo nombre nos vienen de la América Meridional*, p. 37.

⁴² Hipólito Ruiz, *Memoria sobre la legítima calaguala y otras dos raíces que con el mismo nombre nos vienen de la América Meridional*, p. 22.

⁴³ The policies followed by José de Gálvez from the Ministry of the Indies were characterized in America by the urge for political, administrative and tax centralization. His job as ‘general visitor’ of New Spain in the 1760s brought him into contact with the Indian reality and allowed him to design an intervention plan in the Indies that was characterized by American territorial reorganization by means of the creation in 1776 of the Viceroyalty of Río de la Plata to stop the Portuguese and English advances into the estuary of the Río de la Plata and Patagonia, etc; the creation of the system of quartermasters in 1782, which, as in the Spanish peninsula, aspired to accomplish political centralization by this means; and the reform of colonial commerce by means of the Free Trade Rules of 1778. See John Lynch, *La España del siglo XVIII*, (Barcelona: Crítica, 1991).

shipment of the royal mailshot orders during the 1780s shows the problems caused by this governmental method of doing long-distance science.

The royal mailshot order of 22 July 1785 was sent out to the viceroys of New Spain, Peru, Río de la Plata, New Granada, and to the governors of Guatemala, Quito, Caracas, Yucatan, and the Philippines. This document and the instructions that accompanied it set up a protocol to organize the packaging and transportation of the medicinal products shipped to Madrid. The royal order praised the compliance of the colonial officers with the earlier requirements for the shipment of medicinal products. However, it also expressed that this obedience would be complete only if the colonial officers packaged the medicinal products according to their material and therapeutic value:

*Although the royal shipment orders of Balsams, Gums and medicinal Plants to Spain in order to supply the Royal Pharmacy are obeyed, they are of no use if due care and precaution are not taken so that they arrive accordingly, and far from producing a benefit on public health, which should result from these collections, the Royal Estate is assessed without pursuing the desired result, because the jugs and Bottles arrive damaged and broken, and in such a state that it is necessary to throw them away [...]*⁴⁴

The packaging and transportation of medicinal products was then a crucial feature related to the provision of the Royal Pharmacy, to the policies of sanitary and commercial reformation developed by the Crown and the efficient use of public funds. Hence, packaging techniques and political obedience were two closely related issues that directed the collection of medicinal products and their subsequent therapeutic studies.

The royal order of the Ministry of the Indies had two aims: to instruct the colonial authorities in the packaging and shipment of medicinal products ‘so that henceforth unawareness cannot be alleged’, and to include practices of collecting natural objects to the set of preexisting functions that colonial officers had had before the 1780s, when the Crown re-launched its policies of data collection and scientific information. In fact, the royal order demanded that the dispositions be followed with ‘utmost rigor and precision’ since contravention could result in ‘the most severe measures’ to offenders.

In any event, long distance scientific practices demanded the inclusion of middlemen who, like the Spanish colonial officers, were responsible for collecting and

⁴⁴ AGI-S. Indiferente General, 1553. San Ildefonso 22 de julio de 1785. f. 243.

transporting natural evidences. That is why the metropolitan organization attempted to institutionalize those practices according to their own criteria of precision⁴⁵. The instruction which accompanied the royal mailshot order is a plain text, without an explicit author, in accordance with the administrative context in which it was produced. The instruction indicated in a simple manner the way in which the solid and liquid vegetal balsams, gums and resins were to be packaged.

Concerning the solid balsams, the instruction advised to ship them in separate crates according to each type. Inside the crates the balsams were to be packaged in 'tin jars, or well lidded and unbreakable jugs'⁴⁶. These containers were to be not only securely contained but also separate in the crate by 'crossing boards so well adjusted' so that the contents would not get mixed in case of breakage or melting.

In relation to liquid balsams and oils, the instruction advised to ship them in well-labeled crates. These liquids were to be packaged in 'glass bottles', which should also be separated by boards forming niches in which to place each of the bottles. To avoid the 'danger' of the movement, these niches were to be filled with 'paper' or 'cotton' and the necks of the bottles were to be tied or attached to the cover of the crate, which would 'make it unusual for anyone to break on the way to Spain'⁴⁷.

The instruction also explained the way in which the cocoa butter was to be packaged in hollowed 'coconuts' or 'glazed earthenware' since the cocoa butter could 'melt during the voyage [...] with the slightest degree of heat'⁴⁸. Finally, the instruction also indicated that each crate should include a detailed list of the products shipped as well as the 'individual reports of the virtues of the balsams, oils, their medicinal effects and manner of using them'⁴⁹.

The reserved instruction of 17 November 1785 completed what had been ordered by the royal mailshot order and the instruction mentioned above. This further instruction signed by Minister of the Indies Gálvez took two issues into account. On the one hand it stipulated that all the 'crates with medicines and products of Natural History'⁵⁰ shipped to the royal estate were to be addressed to him as

⁴⁵ Simon Schaffer, Lissa Roberts, Kapil Raj and James Delbourgo, *The brokered World. Go-betweens and global intelligence, 1770-1820*, (USA: Watson Publishing International LLC, 2009), on p. XXIV.

⁴⁶ AGI-S. Indiferente General, 1553. Instrucción. f. 245.

⁴⁷ AGI-S. Indiferente General, 1553. Instrucción. f. 245 v.

⁴⁸ AGI-S. Indiferente General, 1553. Instrucción. f. 245 v.

⁴⁹ AGI-S. Indiferente General, 1553. Instrucción. f. 246.

⁵⁰ Archivo General de la Nación, Buenos Aires (hereafter AGN-Bs. As.), sala IX. San Lorenzo, 17 November 1785. f. 330 v.

Secretary of State in charge of the Universal Dispatch of the Indies. These crates should not carry any indication of their final destination, since it was the responsibility of the Secretary of State to determine whether they would be sent to the Royal Cabinet of Natural History or to the Royal Pharmacy, unless they were natural products or objects that had been specially required by either institution. On the other hand, the instruction reinforced by repetition that each crate should include a written report of the 'place' from which the natural objects came and information about their 'uses and virtues'⁵¹.

The reserved instruction highlights the political and bureaucratic character of the colonial recollections. The provision of the Royal Pharmacy and the Royal Cabinet of Natural History, besides their inclusion in a domestic or public domain, reveals the imbrications of political and scientific institutions involved in the policies of collection of scientific data and information. In fact, the provision of the Royal Pharmacy was the responsibility of the Secretary of State who could purchase the medicines from the druggists of Madrid or defray their transportation from the Indies. The systematization of the recollection and transportation of American natural objects designed by the Ministry of the Indies was closely related to the centralization of government, which the Bourbon dynasty propitiated and which was expressed in the political macro-plane of the sanitary reformation, as well as in the political micro-plane of the provision of the King's pharmacy.

The document issued by the Ministry of the Indies on 27 April 1787 was sent to the viceroys and governors of the Indies to re-state what had been stipulated by the royal mailshot order of July 1785, which had been sent to give 'exact and punctual information upon how the balsams, gums and medicinal goods should be sent to Spain so that they arrive accordingly and so that the Royal Estate will not be assessed unnecessarily'⁵². However, this document introduced new dispositions, which determined with greater precision the administrative procedure that was to be followed in the packaging and transportation of the medicinal products. On the one hand, it was ordered that the letter, which should be sent by ordinary mail to inform of the shipment of each crate, was to be done in triplicate and placed inside the crate with the jars and a detailed list of the shipment. Thus, the intention was to avoid the confusion that reigned in Cadiz when the crates were opened, as the letter sent by ordinary mail arrived before the crates. On the other hand, the penalty that would be

⁵¹ AGN-Bs. As., sala IX. San Lorenzo, 17 November 1785. f. 330 v.

⁵² AGI-S. Indiferente General, 1553. Aranjuez 27 April 1787. f. 278.

imposed upon offenders was specified as a pecuniary ‘fine of two hundred pesos’⁵³. So, the relation between order and obedience which made the collection and shipment of colonial medicinal products possible was established by sanctions on the officers who did not comply to the king’s will.

It can be claimed that the obligation established by the aforementioned documents constituted an innovation for the colonial officers since, even though since the 16th century there had been an obligation to answer the official questionnaires sent by the Council of the Indies in writing, the physical and material character of the analysis of nature during the 18th century introduced the innovation of sending material objects in good condition (De Vos, 2001, p. 219). For the royal officers of the port of Veracruz in the viceroyalty of New Spain, for instance, this demand was a novelty because before the royal mailshot order of July 1785, they did not have

*record [...] that prevention had ever been taken concerning particular indications, nor that medicine had been gathered to be sent to Spain on account of His Majesty, since they were required on the occasions of their lack in Havana, [and] they were provided [...] without us having to do more than verify their shipment [...]*⁵⁴.

The reaction of the royal officers of Veracruz reveals the issues presented to the colonial officers as a result of the renewed policies of recollection of natural products displayed by the Crown during the 1780s. The new recollection standards introduced by the Crown were conducive to the accomplishment of collecting scientific data with greater precision. From then on, complete samples would be required so that the apothecaries of the Royal Pharmacy could not only experiment with a certain medicinal product but also describe the plant from which it was made.

This is the case of the Aguaribay balsam (*Schinus areira*), which had been shipped from the viceroyalty of Río de la Plata in compliance with the royal mailshot order of 14 April 1783, before the dispositions of 1785. This balsam had been received at the Royal Pharmacy on 17 October 1784 and the first analyses revealed its usefulness to cure fever. However, in order to certify its therapeutic quality with precision it was necessary to have the parts of the plant from which this balsam was produced. That is why on 28 July 1785, a few days after the royal mailshot order of

⁵³ AGI-S. Indiferente General, 1553. Aranjuez 27 April 1787. f. 278 v.

⁵⁴ AGI-S. Indiferente General, 1553. Veracruz 21 December 1785. f. 274 y 274 v.

22 July had been issued to the viceroalties, the Royal Pharmacy required the mayor of Buenos Aires

*[...] to send [...] the leaves, flowers and fruit of the so-called Pepper tree, with the other reports which Your Highness could collect about the way in which said balsam is made, so that a safe judgment can be issued here about the usefulness brought about by its consumption and in which terms and on what occasions it should be supplied*⁵⁵.

Nevertheless, the precision required of the colonial officers by means of the protocols of 1785 was difficult to attain. The Aguaribay balsam was finally shipped in 1787 and analysed by the royal apothecaries at the beginning of 1789. Although the product had arrived well packaged—according to the dispositions issued during the 1780s—in a crate in which the ‘[...] jars of wood and clay [had been] well sealed [...] covered with parchment and blister and a label that says Aguaribay Balsam made in the town of Santa Ana and on [...] a list [which] says Aguaribay Extract’⁵⁶, a sliver and parts of the required plant were still missing. Instead, what was sent was an incomplete written description of the leaves and flowers of the tree that produced the balsam, which enabled the apothecaries to ‘presume that it was ordinary mastic’. The lack of ‘intelligents’, that is agents, who had the skills required for the kind of collection of data and material evidence demanded by the royal decrees and the instructions, was an inconvenience frequently communicated by the colonial officers in charge of conducting the collections⁵⁷. Thence, the pedagogical function intended by the royal orders and instructions was not always satisfactory to a great extent. In this sense, the incomplete evidence of the missing parts of the Aguaribay plant did not prevent the royal apothecaries from subjecting the balsam to clinical experimentation, which had proven that it did not have ‘such prodigious effects’⁵⁸. So, instead, the balsam was disparaged because it lacked pharmacological and commercial value⁵⁹.

⁵⁵ AGI-S. Indiferente General, 1553. San Ildefonso 28 July 1785. f. 131.

⁵⁶ AGI-S. Indiferente General, 1553. Informe del Boticario Reales Luis Blett y Castor Ruiz del Cerro, Madrid 10 February 1789. f. 432 v.

⁵⁷ A.GI-S. Indiferente General, 1553. Gobernador Pedro Melo de Portugal, Asunción, 13 November 1783. f. 175 v.

⁵⁸ AGI-S. Indiferente General, 1553. Informe del Boticario Reales Luis Blett y Castor Ruiz del Cerro, Madrid 10 February 1789. f. 433.

⁵⁹ AGI-S. Indiferente General, 1553. Informe del Boticario Mayor Juan Díaz, Madrid 5 March 1789.

Conclusion

The royal mailshot orders and instructions issued by the Ministry of the Indies between 1785 and 1787 with the purpose of systematizing the packaging and transportation of vegetal products destined to supply the Royal Pharmacy are a good example of the governmental policies ruling the collection of scientific data and evidences deployed by the Spanish Crown throughout the 18th century. The royal mailshot orders were a scientific device, which had been created in the 17th century in relation to the needs of the colonial government of the Indies and which was later perfected during the 18th century to collect the material evidence demanded by the scientific study of nature.

For de Gálvez, the Minister of the Indies, the shipments of vegetal products were '[...] of great interest to the humanity and health of the subjects of Your Highness [...]'⁶⁰. However, the innovations introduced by the protocols of collection during the 1780s faced the atavistic procedures of colonial bureaucracy that restricted the effectiveness of the dispositions, the high costs of transport by sea, and the effects of the distance on the practices of collection, packaging and transportation of natural objects.

Although the remission of instructions carried out by the Spanish Crown was acknowledged throughout the 18th century as an instrument for data and material evidence collection, their effectiveness was often questioned.

The Baron of Bourgoing⁶¹, who stayed in Madrid during the last quarter of the century, remarked after his visit to the gardens and cabinets of Madrid that

[...] the king has the means to obtain, above all in the plant kingdom, the most valuable collection of the world, thanks to the variety of climates in his numerous states.

*For only twenty years has this been taken advantage of. From the Ministry of the Indies, Gálvez commissioned all the civilian, military and ecclesiastic employees of the colonies to send to Spain samples of the three natural kingdoms which they judge worthy of being sent and if possible shipped, however pricy. His intentions have been fulfilled, at least as far as the plant kingdom is concerned. Not a year goes by without some new plants, seeds and bulbs arriving from the Spanish Indies [...]*⁶²

⁶⁰ AGI-S. Indiferente General, 1553. José de Gálvez, San Ildefonso 28 July 1785. f. 62.

⁶¹ Baron de Bourgoing, Un paseo por España durante la Revolución Francesa, 1777-1795, in Juan García Mercadal, *Viajes de extranjeros por España y Portugal*. Vol. V (España: Junta de Castilla y León, Consejería de educación, 1999).

⁶² Bourgoing, Un paseo por España durante la Revolución Francesa, 1777-1795, p. 480.

Similarly, Pedro Franco Dávila (1711–1786), who was director of the Royal Cabinet of Natural History of Madrid between 1771 and 1786 and author of an instruction for the shipment of natural objects from the Indies, considered that it was more useful and economical to purchase natural collections in Europe than to commission them by means of mailshot orders to the viceroys because

*[...] although by the mailshot order sent by Your Majesty to the Viceroys and governors of America to inform that a great amount of these productions was expected, it has been almost three years that this order was informed and what has arrived, besides being little, has come in useless conditions and running such useless shipments will always cost more than what these very collections cost in Holland where the animals are very well made and preserved.*⁶³

Consequently, the dispatch of the royal orders and instructions was an expensive method of collection, subjected to the fluctuations of the will and obedience of colonial officers, which, in addition, did not always allow the collection of data and material evidence of scientific quality, despite the systematization it was subject to. Even in 1806 the *Gazeta* of Madrid published, on 15 August, the complaint of botanist Juan Tafalla (1755-1811) about the imprecise methods that were still being used to package, transport and preserve the Peruvian bark, which reached the Royal Pharmacy in a ‘muddled’⁶⁴ condition.

The systematization of packaging and transportation of vegetal products explored here was driven by the need to supply the Royal Pharmacy with medicines and to collect vegetal evidences that would allow the development of pharmacological and clinical experiments. In effect, the good material state of the vegetal products received in Madrid conditioned the work of the royal apothecaries in charge of supplying the Royal Pharmacy with quality medicine while they discovered other new ones. Hence the royal mailshot orders and instructions sketched the figure of the objects in an economic and scientific plane, according to the expectations of the institutions that collected them⁶⁵, and they included the responsibilities that the colonial officers should follow for the meticulous packaging of the commodities and the scientific specimens. In this sense this administrative practice was turned into a

⁶³ AHH-M. Estado, Libro 1031, volumen 2. Reptiles and animales que deben ser enviados a Holanda por el Gabinete. Madrid, 11 March 1779. f. 347.

⁶⁴ AGP-M. Fondo Farmacia, caja 4540, legajo 25. *Gazeta* de Madrid, Friday 15 August 1806 N° 67. f. 701.

⁶⁵ Lorraine Daston, *Biographies of scientific objects*, (Chicago: University of Chicago Press, 1999), on p. 9 and 10.

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kind of scientific practice inherent in the development of the long-distance science, which the Spanish Crown impelled during the 1780s upon the foundations of the power relations and obedience of the colonial administration of the Indies.

Acknowledgements

I am especially grateful for the comments from anonymous referees and generous reviews of Professors Marianne Klemun and María Portuondo.

Metamorphosis between field and museum: collections in the making.

*Kurt Schmutzer**

Abstract

Millions of specimens assembled in museums for Natural History around the world represent the outcome of numerous historic scientific voyages. Before individual animals become part of an exhibition or collection as classic representatives of its species, the specimens undergo several transformations. The specimens shown at the museum are ‘made’ objects, produced by cultural practices. The collections of the Austrian zoologist Johann Natterer (1787–1843), gathered during his travels throughout Brazil in the years 1817 to 1835, give an excellent example to show how specimens are moved and changed on their way from ‘field’ to ‘museum’, between two spaces of knowledge.

Keywords: natural history, preservation, museum, Austria, Brazil

In 1817 an expedition of Austrian naturalists and painters set out in order to explore the interior of Brazil, which was at that time a region quite unknown and unexplored by European scientists.¹ Only a few reports existed, mostly concentrating on the eastern coastal areas of the former Portuguese colony.² A voyage to Brazil promised

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¹ For detailed information on the expedition and Natterer’s travels see Kurt Schmutzer, *Der Liebe zur Naturgeschichte halber. Johann Natterers Reisen in Brasilien 1817 – 1836* (= Veröffentlichungen der Kommission für Geschichte der Naturwissenschaften, Mathematik und Medizin 64) (Wien: Akademie der Wissenschaften, 2011). The expedition, besides Natterer as zoologist, consisted of the following: Johann Christian Mikan (1769-1844) – professor for Natural History and botanist; Johann B. Emanuel Pohl (1782-1834) – botanist and mineralogist; Heinrich Wilhelm Schott (1794-1865) – gardener; Dominik Sochor (+1826) – hunter; Thomas Ender (1793-1875) – landscape-painter; and Johann Buchberger (+ 1821) – plant artist. By request of the Bavarian King Maximilian I. Joseph, the zoologist Johann B. von Spix (1781-1826) and the botanist Carl Friedrich Philipp von Martius (1794-1868) joined the group and Grand-Duke Ferdinand of Tuscany also sent the botanist Guisepppe Raddi (1770-1829) to Brazil. Natterer’s reports and letters, which are the prime sources for his travels, are kept mainly at the archives of the Museum für Völkerkunde in Vienna (MVK), the collection of autographs at the Wienbibliothek in Vienna and the Austrian State Archive – Haus-, Hof- und Staatsarchiv (HHStA).

² In 1807 the Portuguese royal family and a large part of the court fled to Brazil, seeking refuge from Napoleon’s troops as they invaded Portugal. In the following years Brazil went through a phase of modernization and social

an abundance of animals, plants and minerals to collect that were hitherto not already on display in European museums. The expedition was initiated by the Austrian emperor Francis I and carried out by and for the imperial cabinet for natural history, the *Naturalienkabinett*. Johann Natterer (1787-1843) (Figure 1) was the expedition's zoologist and he returned to Vienna only in 1836, after he had spent more than 18 years assembling specimens for natural history. While all the other members of the expedition left Brazil within a few years, Natterer managed to cross the central plains of Brazil (via Goiás and Cuiabá) and the western province of Mato Grosso. Under difficult circumstances, suffering from several diseases, sometimes life threatening and sometimes sick almost to the point of dying, he contrived to reach the Amazon basin and even travelled several northern tributaries (Rio Negro and Rio Branco) as far as the borders to Columbia and Venezuela, thus covering several thousand miles throughout Brazil. His collections of Brazilian fauna are to this day a valuable part of the stock of the Museum of Natural History in Vienna. In collecting, Natterer and his superiors at the imperial cabinet saw the appropriate solution for their major scientific task, which was to bring order into the 'realms of nature' by taxonomy and classification.³ Natterer was one of the many naturalists who made specimens available for scientific research and for display in the museum.⁴ Natterer's overall output included a significant 1146 mammals, 12293 birds, 1678 amphibians, 1621 fishes, 32825 insects und 1729 glass jars with 'wet' specimens of intestinal worms.⁵

improvement, and for the first time foreign scientists got access to this hitherto quite isolated colony. In 1815 Brazil was raised to the status of a kingdom and in 1822 independence from Portugal was declared.

³ Anke te Heesen and Emma C. Spary, "Sammeln als Wissen", in: Anke te Heesen and Emma C. Spary (Ed.), *Sammeln als Wissen. Das Sammeln und seine wissenschaftsgeschichtliche Bedeutung* (Göttingen: Wallstein, 2001), pp. 7-21.

⁴ Ilse Jahn, "Sammlungen – Aneignung und Verfügbarkeit", in: Andreas Grote (Ed.), *Macrocosmos in Microcosmo. Die Welt in der Stube. Zur Geschichte des Sammelns 1450 bis 1800* (Opladen: Leske + Budrich, 1994), pp. 475-500.

⁵ Josef Natterer, *Totalübersicht des Gehalts aller aus Brasilien während den Jahren 1817-1836 von den K.K. Naturforschern eingeschickten Sendungen*, February 1837, MVK.

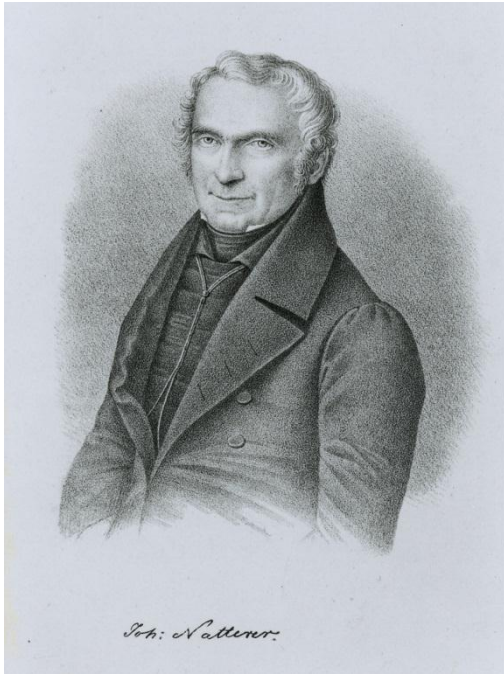


Figure 1 - Johann Natterer (Österreichische Nationalbibliothek / Bildarchiv / PORT-12690/01)

Long before Johann Natterer even touched American soil he was concerned with the collections he expected to make. While in Venice (Italy) waiting for his passage to Brazil he tried to organize the acquisition of large quantities of glass eyes for the imperial cabinet. Venice, as a centre of glass making, gave him the opportunity to select specially made glass eyes, composed of melted glasses in different colours, which he and his colleagues would use (after the voyage) to re-construct the bodies of the animals hunted in Brazil for display at the cabinet.⁶ Glass eyes like these would add a more natural impression to the specimens than the simple glass semi-spheres coloured on the flat rear side that were being used at that time by many naturalists.⁷

Natterer's interest in Venetian glass eyes points to some of the aspects which I am interested in: the specimens, as we can examine them at the museum today, are artificially made objects, created and designed with the help of a number of means of preservation. Fixing the glass eyes on a specimen is only one of the final transformations which convert an individual animal from its living existence in its natural environment to its appearance as exhibited in the museum. I will try to work

⁶ Natterer reflects on the buying and the use of glass eyes several times in a letter to his brother: Johann Natterer to Josef Natterer, Chioggia / Venice, May 16/18/19, 1817, Wienbibliothek, H.I.N. 7860.

⁷ Theodor Thon, *Handbuch für Naturaliensammler oder gründliche Anweisung, die Naturkörper aller drei Reiche zu sammeln, im Naturalienkabinett aufzustellen und aufzubewahren*. Frei nach dem Französischen bearbeitet und vervollständigt (Ilmenau: Voigt, 1827), pp. 454-460; Johann Friedrich Naumann, *Taxidermie oder die Lehre Thiere aller Klassen am einfachsten und zweckmässigsten für Naturaliensammlungen auszustopfen und aufzubewahren*. 2. Gänzlich umgearbeitete und vielfach vermehrte Auflage (Halle: Schwetschke, 1848; first published in 1815), pp. 21-25.

out a better understanding of what Natterer as a collector of zoological specimens was actually doing in the field with the help of his own reports and diaries. It might also be helpful to examine contemporary handbooks to see what they have to say on the naturalist's practices of collecting and preserving. All the time while travelling, Natterer not only had to take care for every financial and practical detail of his expedition, but he was busily engaged in hunting and documenting his finds, preserving the specimens and packing and sending them to Europe on occasion. The space (and time) between 'field' and 'museum' is filled with a range of activities and practices.

Hunting and Documentation

Killing an animal is surely the most dramatic transformation of all, changing the animal from life to death. The collector's goal is to cause as little damage to the corpse as possible. For hunting birds the use of a 'wind-gun' was Natterer's choice to preserve an intact animal body. The 'wind-gun' was a kind of air rifle that operated with compressed air und shot. The appropriate container for compressed air had to be filled with 2500 pushes, and that allowed the hunter to fire 30 to 40 shots.⁸ The efforts required to hunt with this 'wind-gun' were considerable. It took two mules to transport the whole equipment in large cases, but it was worth the trouble. Natterer successfully hunted birds with the help of this machine with less damage than usual when hunting with bullet rifles, and he had the advantage of firing silently so that other animals were not alarmed.⁹ In the course of his voyages Natterer turned to a much easier way of hunting birds. When he reached the Amazon basin in the late 1820s he adopted local practises. Here he met with indigenous groups who used a blowpipe and poisoned arrows for hunting, a weapon that also allowed silent hunting practices and it too caused very little damage to the animal's skin. Probably happy to have skilled hunters at hand, Natterer hired tribesmen to hunt birds.¹⁰

Once the animal was killed the naturalist had to record his finds with the help of notes, diaries, pictures and reports. Documentation included date, location, local

⁸ Friedrich Wilhelm Schembor, "Von der Windbüchsenpumpmaschine zum Kohlensäureverflüssigungsapparat. Ein Beitrag zur Technikgeschichte des 19. Jahrhunderts", *Blätter zur Technikgeschichte*, 1991/92, 53/54, pp. 59-123, on pp. 74-80.

⁹ Natterer refers to hunting with the "wind gun" in several letters to his brother, e.g. Johann Natterer to Josef Natterer, Salto, October 26, 1822, Wienbibliothek, H.I.N. 7880; Johann Natterer to Josef Natterer, Ipanema, July 8/14, 1820, Wienbibliothek, H.I.N. 7874.

¹⁰ Johann Natterer to Wenzel Philipp Leopold von Mareschal, Manaus, 19. September 1830, Archiv MVK; Johann Natterer to Francisco Ricardo Zany, Borba, 11. Jänner 1830, Archiv MVK; Johann Natterer to Karl von Schreibers, Borba, 29. Juni 1830, Archiv MVK.

name, measurements and scientific denotation of the specimen. One of Natterer's water colours of a catfish may serve as an example for his practices. His annotations are barely visible today, but one can still discern a reference number ('No. 29'), a scientific name of the time ('*Silurus Pintado*'), location and date of acquisition (Cuiabá, January 1824), a measure and several measurements (in Viennese inch = ca. 26.34 mm) and a local, indigenous name ('Man joö') on the bottom of his sketch (see Figure 2).¹¹ Apparently this is one of several specimens, to which he referred in a letter to his brother Josef as 'large *Silurus* species, true showpieces',¹² that he caught in the region of Cuiabá, the capital of Mato Grosso, and depicted in water colour in early 1824. The reference number links together the painting, Natterer's occasional remarks in his letters or field notes, inventories for transport and the label attached to the preserved specimen. As a reference Natterer used a numbering system based on different species, not on different specimens.¹³

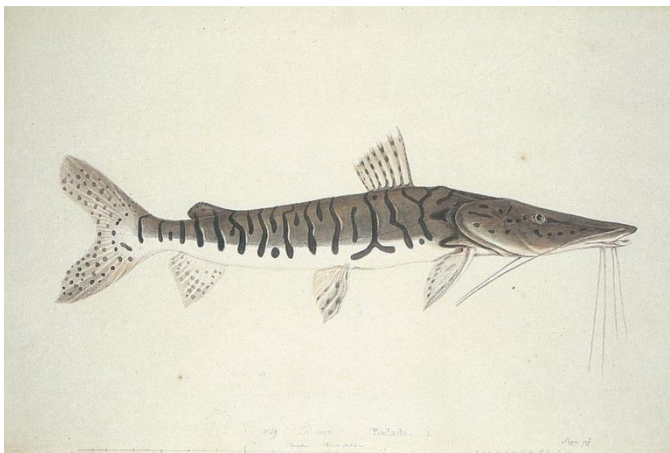


Figure 2 - *Pseudoplatysoma fasciatum* (Linn. 1766) (Naturhistorisches Museum Wien / Archiv für Wissenschaftsgeschichte)

Contemporary manuals for naturalists stress the importance of denoting all parts subject to change with the help of sketches, drawings or water colour paintings: e.g., the colour of eyes, feet, beaks and generally (for birds) all parts without feathers, even with numbered colour displays if possible.¹⁴ When taking sketches of living animals the main issue was not to study the habits of the animals or their social life,

¹¹ Natterer's paintings and sketches were published by Christa Riedl-Dorn, Johann Natterer und die österreichische Brasilienexpedition (Petrópolis 2000). The catfish is shown on p. 115.

¹² Johann Natterer to Josef Natterer, Cuiabá, December 16, 1824, Wienbibliothek, H.I.N. 7882: "grosse *Silurus*-Arten, wahre Kabinetsstücke".

¹³ Simon Engelberger, Annotated catalogue of primate type specimens in the mammal collection of the Museum of Natural History Vienna, unpublished magisterial thesis (Wien 2010), p. 10.

¹⁴ Thon, *Handbuch*, pp. 5-6.

but their movements. Manuals for collectors of the time repeatedly demanded meticulous observations and drawings in order to be able to imitate a ‘natural’ or ‘true to life’ display of the animals at the museum.¹⁵

Certainly Natterer also followed these practices. In a letter to his brother, he explained his work, assuring him that he had carefully noted the measurements of length and breadth of all the birds, mammals, amphibians and fishes he had gathered, together with descriptions of those parts of the body that were subject to change after death, and of many even the colour of the body. He also had made watercolour paintings and sketches.¹⁶ Before the invention of photography the ability to draw was a necessary prerequisite for the naturalist to document his finds, or else he had to find the help of an artist. Consequently, in the beginning two professional artists took part in the Austrian expedition: Thomas Ender (1793–1875) was an expert in landscape painting, and Johann Buchberger (+ 1821) was hired to paint plants.¹⁷ Natterer had skills and education enough to do the job for the zoological collections by himself. This was all the more important as Natterer for the most part travelled on his own, separated from the other Austrian naturalists and artists who came to Brazil with him, accompanied only by his assistant Dominik Sochor as a hunter and Brazilian servants and slaves (who did most of the daily work such as attending the mules which carried the expedition’s equipment and supply or putting up encampments, and occasionally they helped in hunting and preserving the zoologist’s catch).¹⁸

When Natterer describes his proceedings, he tries to testify that his work is done properly and according to accepted general standards. Letters, reports, diaries, notes, inventories, labels, sketches and paintings, all aiming to record information and data as precisely as possible, were at the time regarded as essential to guarantee the authenticity and identity of the specimens in order to create reliable scientific knowledge.¹⁹ The scientific value of the specimens collected depends not exclusively on the naturalist’s individual intellectual qualities, but also on the accuracy of

¹⁵ Thon, *Handbuch*, p. 5; Naumann, *Taxidermie*, p. 4.

¹⁶ Johann Natterer to Josef Natterer, Borba, December 21/28, 1829, Wienbibliothek, H.I.N. 7883: “Von allen Vögeln habe ich Längen- und Breitenmass, die Beschreibung der nach dem Tode veränderlichen Theile des Körpers, von vielen selbst die Farbe des Körpers. Dasselbe gilt von Säugethieren, Amphibien und Fischen. Von Säugethieren habe ich viele kleinere gezeichnet, besonders viele Fledermäuse, von Amphibien und Fischen habe ich viele kolorirte Abbildungen und Skitzen.“

¹⁷ Schmutzer, *Der Liebe zur Naturgeschichte halber*, pp. 26–28.

¹⁸ Like many of his contemporaries Natterer bought and employed slaves, obviously without any doubt or concern about the slave system. See Schmutzer, *Der Liebe zur Naturgeschichte halber*, pp. 119–122.

¹⁹ Lorraine Daston, “Die Kultur der wissenschaftlichen Objektivität“, in: Michael Hagner (Ed.), *Ansichten der Wissenschaftsgeschichte* (Frankfurt/Main: Fischer, 2001), pp. 137–158, on pp.147–154.

observations, data and measurements, which could then move and circulate among scientists. 'Scientific data are judged valid to the extent that they can travel beyond the limits of a laboratory or the exotic site, be reproduced elsewhere, and collated with other precise and calibrated data.'²⁰

But in following Natterer's practices we will find that there were more and different principles and ideas of natural history involved, which influenced his work. Producing reliable and exact data and measurements was only one aspect of collecting specimens for the museum.

PRESERVATION AND THE ART OF TAXIDERMY

The key problem for naturalists in the field was to preserve the specimen in a condition as close to nature (size, colour and structure) as possible, to prevent decay and keep away insects.

In all probability Johann Natterer, who had enjoyed academic training only to a limited extent, learned the art of preservation from his father Joseph Natterer senior (+1823), who was a falconer at the imperial summer residence in Laxenburg near Vienna and privately also a passionate collector of birds.²¹ Apart from scattered short notes there are no detailed information about the means and methods Natterer used. But with the help of contemporary manuals we can try to illustrate how a zoologist at the beginning of the 19th century worked 'in the field'.

Until the mid-18th century it was only possible to store bones, shells or other hard parts for a longer period of time. Small fishes, amphibians or molluscs could be immersed in alcohol in glass jars (wet specimens), or one could achieve quite good results with smaller vertebrates like birds by drying them and hoping that a treatment with alum, herbs, pepper, tobacco, cinnamon or camphor would prevent insects from devouring the specimens. To create dry specimens of the skins of larger animals (mammals, amphibians and fishes) was, for a long time, an unsolved problem, especially in a tropical climate. It was only with the improvement of taxidermy, the art of preserving animals, in the late 18th century, that museums for natural history acquired the necessary means of assembling and storing large, stable and lasting collections of large vertebrates as we know them today.

²⁰ Marie-Noëlle Bourguet, Christian Licoppe and H. Otto Sibum, "Introduction", in: Marie-Noëlle Bourguet, Christian Licoppe and H. Otto Sibum (Ed.), *Science, Scientific Instruments and Travel: Itineraries of precision from the seventeenth to the twentieth century* (London, New York: Routledge, 2002), pp. 1-19, on p. 3.

²¹ Schmutzer, *Der Liebe zur Naturgeschichte halber*, pp. 16-18.

It was the Frenchman Jean-Baptiste Bécoeur (1718-1777), apothecary and naturalist from Metz, who invented an effective mixture for the preservation of animals in a dry state. He never published the recipe, but passed it on to the taxidermists at the *Muséum national d'Histoire naturelle* in Paris. The new method must have reached public knowledge at least after its publication in Louis Dufresne's *Nouveau dictionnaire d'histoire naturelle* (Paris 1803–1804). According to this, after the removal of all internal organs and soft parts the animal bodies had to be treated with a mixture of white arsenic powder, salt of tartaric acid, camphor, soap and quicklime powder. Even though several formulas existed before, only Bécoeur's use of poisonous arsenic – much debated for its dangerous effects for the user – created a means by which a permanent durability of pelts and hides was guaranteed. The enhancement of taxidermy had a major impact on zoological research and on the practicability of collecting. Stable and permanent collections facilitated new scientific questions. With large quantities of specimens to hand one could intensify comparison, one could specialize in certain groups of animals, classification and systematics could be improved.²²

Bécoeur's successful recipe was copied and transmitted in the following decades in several manuals for naturalists.²³ It was around the same time, in the second half of the 18th century, that manuals began to spread the use of certain methods, tools and materials, thus establishing standards for the taxidermist's work and making them accessible not only to professional naturalists, but also popular for everyone interested in natural history.²⁴ Early examples of such treatises were Etienne-François Turgot's *Mémoire instructif* (Lyon 1758)²⁵ and John Coakley Lettson's *The Naturalist's and Traveller's Companion* (London 1774).²⁶ While Lettson dispensed with images, Turgot used illustrations to stress the importance of certain practices of preservation, for example the preservation of birds, the tools needed and where to cut the skin for a proper treatment of the specimens (Figure 3).

²² Paul Lawrence Farber, "The Development of Taxidermy and the History of Ornithology", *Isis*, 1977, 68, pp. 550-566, on pp. 557-566.

²³ See for example Thon, *Handbuch*, p. 166.

²⁴ Marianne Klemun, *Werkstatt Natur. Pioniere der Forschung in Kärnten*. Katalog zur Ausstellung anlässlich des 150jährigen Bestehens des Naturwissenschaftlichen Vereines für Kärnten (Klagenfurt: Verlag des Naturwissenschaftlichen Vereines für Kärnten, 1998), p. 206.

²⁵ Etienne-François Turgot, *Mémoire instructif sur la manière de rassembler, de preparer, de conserver, et d'envoyer les diverses curiosités d'histoire naturelle* (Lyon: Bruyset, 1758).

²⁶ John Coakley Lettson, *The Naturalist's and Traveller's Companion, Containing Instructions for Collecting and Preserving Objects of Natural History, and for promoting inquiries after Human Knowledge in General* (London: E. & C. Dilly, 1774).



Figure 3 - Turgot, *Mémoire instructif*, pl. 6

But compared to botany or entomology there seems not to have been a rich supply of instruments and tools for vertebrate zoology. A small knife, tweezers and tools to scratch the fat off the skin were considered to be sufficient for the zoologist in the field.²⁷ The illustration from Turgot's book also refers to the fact that birds were very popular among naturalists and as examples for handbooks, because they were easier to preserve than other animals, and since their plumage did not bleach, the preservation of birds guaranteed satisfying results. With the improvement of preservation new kinds of specimens became available for museums and scientists in large quantities. And accordingly in the course of the 19th century new images entered the guidebooks: mammals, amphibians and fish (Figure 4).

²⁷ Naumann, *Taxidermie*, p. 8.

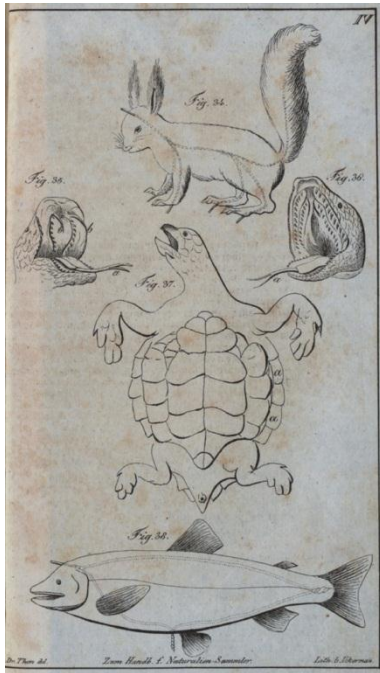


Figure 4 - Thon, *Handbuch*, pl. IV

Natterer was not only an experienced preserver of specimens in the dry state, he also produced wet specimens of molluscs and amphibians. The methods applied influenced the knowledge derived from its objects. There is certainly a relationship between practices of collecting and classification in natural history. Since, for example, French naturalists widely used alcohol to preserve animals as a whole they advanced in anatomical studies more than others at that time.²⁸

Both methods had their advantages and disadvantages. The use of alcohol for wet specimens in glass jars hardened the tissue, it bleached the colours and the results were generally not very attractive to show, but the animal was preserved as a whole. For animals with fur or feathers preservation in alcohol was not applicable. Transforming an animal into a 'dry' specimen inevitably created a rigid torso and prevented further anatomical examination.

In fact Johann Natterer himself conducted many anatomical examinations, not to examine the internal organs, but to bring something from the inside to the outside, namely intestinal worms (roundworm, tapeworm and the like). By this means Natterer acquired one of the largest collections of parasitic worms (helminths) of the time. This special interest answered the demands of Karl von Schreibers (1775–1852), director of the *Naturalienkabinett* in Vienna and Natterer's superior, and his

²⁸ Anne Larsen, "Equipment to the field", in: Nicholas Jardine, James A. Secord and Emma Spary (Ed.), *Cultures of natural history* (Cambridge: University Press, 1996), pp. 358-377, on pp. 359-360; see also Klemun, *Werkstatt Natur*, pp. 206-207.

colleague Johann Gottfried Bremser (1767–1827), who tried to establish a systematic description of helminths.²⁹ But when later on Natterer and his colleague at the museum in Vienna, Leopold Fitzinger (1802–1884) discussed the nature of the South American lungfish (*Lepidosiren paradoxa*), first discovered by Natterer in Brazil, whether it was a reptile (Fitzinger) or a fish (Natterer), Fitzinger complained that he had no internal organs available for anatomical investigation because Natterer had removed them while searching for helminths, thus limiting the possibilities of scientific research.³⁰

TRANSPORTATION AND SHIPPING

Johann Natterer's reports are full of accounts of his travels, but the remarks on hunting, collecting or preserving are few. When working most intensively on his collections during a longer residence in one place, he is telling least of all about it. Periods of longer stays are covered only by short accounts and lists or enumerations of acquired animals. The travelling naturalist composed his reports as 'diaries' of movements throughout Brazil, but the making of his collections is 'a space in between', a space between movements, scarcely mentioned. Addressing most of his reports to Karl von Schreibers, his director, or to his brother Josef, who was curator of the Viennese museum zoological collection, and thus writing to experts, Natterer obviously felt no need to go into detail on preservation. In many other letters, like those to the Austrian embassy in Rio de Janeiro, there was also no reason to discuss any specific subject of natural history. Information on his practices of preservation is limited to several short remarks about minor difficulties in getting the specimens dry or keeping them in their original size and shape. Consequently Natterer has a lot more to say about his specimens, when they are on the move again, on their way to Europe.

The preserved specimens were usually packed in large cases or trunks. These cases were filled with a mixture of glass jars, drawers with insects and butterflies, animal skins, fish and amphibians wrapped in cotton, indigenous weapons and crafts, each piece labelled and numbered, accompanied by inventories, reports, notes, and additional information for the curator receiving them at the museum. Glass jars with wet specimens had to be wrapped up in cotton; tin boxes for smaller animals had to be

²⁹ Schmutzer, *Der Liebe zur Naturgeschichte halber*, p. 18 and p. 123-124.

³⁰ Leopold Joseph Fitzinger, „Vorläufiger Bericht ueber eine hoechst interessante Entdeckung Dr. Natterer's in Brasilien“, *Isis von Oken*, 1837, Heft III, pp. 379-380.

soldered (with lead and tin) and covered with wax. The large cases were protected with ox hides against water and humidity.³¹

Transportation of these cases was not easy, the distances from Rio de Janeiro to remote provincial towns like Cuiabá or Goiás were enormous, the roads were difficult to travel, the danger of losing the cases through accidents or shipwreck was high, the outcome insecure. While travelling throughout Brazil Natterer usually moved along established trade routes. For the transportation of his collections he could use this network of commerce and communication, but he was forced to put his valuable specimens in the hands of people whom he met by chance. Military personnel, travelling merchants or anybody who was willing to do so would be engaged to carry the cases hundreds of miles across Brazil by land and waterways, on the back of stubborn mules, with clumsy ox-carts or aboard tiny river boats.

As an example: in May 1825 a certain capitão Sabino José de Mello Breuner took over 24 trunks filled with specimens from Johann Natterer in Cuiabá. Sabino was made personally responsible for bringing the cases either to the British consul in Porto Feliz (SP) near São Paulo, or to Rio de Janeiro, as circumstances would allow. Despite his obligation capitão Sabino delayed his departure from Cuiabá until March 1826 and Natterer, who in the meantime had travelled to the western parts of Mato Grosso, had no control over what was going on with his cases.³² The treatment of the cases was a point of the highest consideration for Natterer. In a letter to Sabino he instructed him to take care, that the trunks should be exposed to the sun in order to keep them dry, except those two cases with glass jars, containing wet specimens, immersed in alcohol, which were to be kept in the shade. Each case also bore a mark, indicating which side was to be held upside.³³ The Austrian charge d'affaires in Rio was obliged to send the cases by ship either to London or to Trieste. There the ambassador or certain merchants organized further dispatch to Vienna. It took more than two years before the trunks of Sabino's transport finally reached their destination in September 1827. In his letters Natterer frequently urged his confidants that the transport of his trunks had to continue without interference and the boxes should not be opened. It was not only damage to the specimens themselves that

³¹ Johann Natterer to Josef Natterer, Ipanema, July 8/14, 1820, Wienbibliothek, H.I.N. 7874; see also Karl von Schreibers, *Nachrichten von den kaiserlich-österreichischen Naturforschern in Brasilien und den Resultaten ihrer Betriebsamkeit*. Vol. 1 (Brünn: Traßler, 1820), pp 23-25 and Maximilian zu Wied-Neuwied, *Reise nach Brasilien in den Jahren 1815 bis 1817*. Vol. 2 (Frankfurt/Main: Brönnner, 1821), pp. 296-301.

³² Johann Natterer an Wenzel Philipp Leopold Baron von Mareschal, Caiçara, 16. Juni 1826, HHStA, Staatskanzlei, Brasilien, Karton 13, Konv. 2 (alt Fasz. 13), Varia 1826, fol. 8r-11v.

³³ Johann Natterer to Sabino José de Mello Breuner, [Cuiabá, June 1825], MVK.

worried him, but the fear that this would happen uncontrolled and unauthorized by an expert, and through the actions of ignorant customs officials.³⁴ In a letter to his superior von Schreibers, Natterer expressed his deep concern to prevent any opening of his trunks at the customs houses, ‘because this could hardly happen without any apparent damage’³⁵ to the specimens. He also tried to secure the support of the Austrian ambassador in London, arguing that if the cases were opened the British customs certainly would be missing ‘that accuracy and care’³⁶ necessary to avoid any loss. With perceptible anxiety Natterer received the news that some of his carefully packed boxes had been opened by customs officials in Belém, although he had even asked the provincial president to take proper care for his valuable transport.³⁷

Transportation without interference is the necessary precondition to ascertain a continuous transmission of specimens. Opening the boxes would break the continuity and put the authenticity of the specimens in danger. In the context of these boxes the specimens do not stand for themselves alone, they are embedded in a ‘set’ of information (texts, drawings, numbers, lists) to document their identity. With this continuous transmission the ‘specimens acquired authority in matters of identity and authenticity’.³⁸ Therefore, the success of an expedition that aimed to send natural history collections from overseas depended upon effective methods of preservation, which made it possible that zoological specimens could withstand even a journey of several years by land and sea without constant attention and care.

³⁴ Schmutzer, *Der Liebe zur Naturgeschichte halber*, pp. 135-138; for example Johann Natterer to Wenzel Philipp Leopold von Mareschal, Cuiabá, December 20, 1824, MVK; Johann Natterer to Wenzel Philipp Leopold von Mareschal, Vila Bela de Santissima Trindade, May 28, 1827, MVK; Johann Natterer to Nathan Mayer Rothschild, Borba, December 24, 1829, MVK; Johann Natterer to Nathan Mayer Rothschild, Borba, June 24, 1830, MVK.

³⁵ Johann Natterer to Karl von Schreibers, Borba, December 20, 1829, MVK: “... weil dies wohl schwerlich ohne offenbaren Schaden geschehen könnte.”

³⁶ Johann Natterer to Nathan Mayer Rothschild, Borba, November 30, 1829, MVK: „... mit jener Genauigkeit und Behutsamkeit ...“. Diplomatic personnel were frequently involved in the organization of scientific expeditions, for Austria see Marianne Klemun, “Austrian botanical collection journeys (1783-1792). Network-patterns in expeditions: Global intentions interwoven with local dimensions”, *Archives internationales d’histoire des sciences*, Vol. 56, 2006, 156/157, pp. 235-240.

³⁷ Johann Natterer to Karl von Schreibers, Marabitanas, February 1831, MVK.

³⁸ Staffan Müller-Wille, “Walnuts at Hudson Bay, Coral Reefs in Gotland: The Colonisation of Linnean Botany”, in: Londa Schiebinger and Claudia Swan (Ed.), *Colonial Botany. Science, Commerce, and Politics in the Early Modern World* (Philadelphia: University of Pennsylvania Press, 2005), pp. 34-48, on p. 47.

SPECIMENS ON DISPLAY

It is this 'set' assembled in transport trunks that finally enters the holdings of a museum and forms the basis for scientific research and for the display of a once single, unique individual animal as a representative of a whole species in the museum's exhibition.

Manuals of that time frequently insisted on a display 'true to life' or 'true to nature'. Detailed instructions on the best materials and methods to form the animal's body or how to use wire to bring head or wings of a specimen into a 'life-like' posture would help collectors to achieve a 'true' representation (see Figure 5).



Figure 5 - Thon, *Handbuch*, pl. III

This is where Natterer's Venetian glass eyes come into place. Made of melted glass of different colours they were supposed to create a more 'natural' appearance than glass semi-spheres simply painted on the flat rear side. Therefore they play a key part in creating an illusionistic image of an animal, the claim of which is to represent its species in a 'true to nature' manner.

In the early 19th century it was considered to be essential to preserve an authentic impression of the individual animal, first, in order to give reliable evidence for classification and, second, to enable the museum to put a representation of a species on display in its exhibition 'true to nature'. The epistemic ideal of 'truth-to-

nature'³⁹ does not concentrate on the 'true' description and understanding of a single, individual animal, but on the representation of an ideal 'type', which should represent all the qualities and distinctive features of a certain species. This goal of achieving 'truth-to-nature' in images or representations of 'nature' includes the employment of artistic means to create a more 'accurate' information of an animal's appearance than the authentic, unrestored remains of the body of one single individual alone could offer.

The treatment of fishes and amphibians may highlight this aspect. A major problem in preservation in the attempt to create a 'life-like' display occurred with those animals the colours of which fade immediately after death, as is the case with these lower vertebrates. As the demand for 'true to life' presentation is so prominent and persistent, it seems to be quite obvious that watercolours, paint brush and oil-varnish belong to the museum's laboratories as customary and necessary aids for giving back to these animals their 'natural' colouring.⁴⁰

CONCLUSION

These metamorphoses, produced by cultural practices like the art of taxidermy, altered the animals' physical composition, and their appearance could only be maintained with the help of artificial means (preservatives, colours, artificial parts). Therefore specimens are not a mere image of nature, but 'artificial things designed and constructed by naturalists to answer various scientific needs'.⁴¹ Despite all transformations and their artificial construction as cultural objects the specimens were regarded as authentic representations of a species and – together with other information (sketches, reports, notes) – accepted as valuable and reliable sources for certain scientific questions. The *Naturalienkabinett* in Vienna at that time was still devoted to taxonomy and classification based on the description of external distinguishing features whereas other scientists had turned their interest towards anatomy and physiology. The 'scientific needs' of the Viennese museum depended on the collector's skills to preserve the physical appearance of an animal as close to its natural condition as possible.

³⁹ Lorraine Daston and Peter Galison, *Objektivität* (Frankfurt/Main: Suhrkamp, 2007; engl. orig.: *Objectivity*, New York: Zone Books, 2007), pp. 59-119.

⁴⁰ Naumann, *Taxidermie*, pp. 144-148; Thon, *Handbuch*, pp. 268-272 and pp. 460-461.

⁴¹ Larsen, "Equipment to the field", p. 358.

Contemporary critics of the Austrian expedition remarked that collecting and classification alone would not be sufficient and that scientific research had to go further into anatomy and biology.⁴² Others favoured science as a literary business and as a ‘Humboldtian’ science of description, measurement, observation and writing, and therefore criticised the fact that the enterprise of collecting was too expensive, too complicated and too dangerous in comparison with its doubtful worth.⁴³ But for an understanding of natural history based on ‘truth-to-nature’ objects, which were the necessary basis for scientific denotation and classification of animals by their external features, the availability of large collections of specimens was indispensable.

All in all, it cost a great deal of effort and expense, trouble and risks, to bring these objects into the museum, and it even cost lives. Johann Buchberger (+ 1821), artist for plants to the Austrian expedition, suffered until his early death from the consequences of a riding accident in Brazil, and Dominik Sochor, Natterer’s assistant, died in Mato Grosso in 1826 of fever. But bringing back only descriptions, reports, notes or sketches would not have been sufficient for the museum. The quest to ‘discover’ new animals was tempting for the naturalists and vital for the aims of natural history committed to ‘truth-to-nature’, since the acknowledgement as the authentic evidence of a species and its existence was only awarded to those specimens that really and physically crossed the vast space between ‘field’ and ‘museum’.

⁴² Isis von Oken, 1823, Heft VII, p. 714.

⁴³ Schmutzer, *Der Liebe zur Naturgeschichte halber*, pp. 96-100.

Making objects move: On minerals and their dealers in 19th century Germany

*Bernhard Fritscher**

Abstract

Around 1804, the mineralogist and geognost Carl Caesar Leonhard (1779-1862) started a mineral business at Hanau (Germany), which immediately became widely known among mineral collectors. He ran the shop for about ten years before he moved, first to Munich, and then in 1818 to Heidelberg where he became a professor of mineralogy and geology. At Heidelberg, Leonhard restarted his business in the early 1820s and again, it rapidly became well known: for several decades the *Heidelberger Mineralien-Compoir* was one of Europe's leading mineral shops. The rapid growth of the company—and the foundation of further ones, such as the firm of Adam August Krantz (1808-1872)—in the first half of the 19th century might be seen as a striking example of a new need for circulating objects, for a new linking space between scientific, economic, and public/popular uses, that is, a need to make objects move. Focusing on the history of Leonhard's business, i.e., on mineral dealing in Germany, this paper outlines some of the conditions of its formation, and the strategies to promote the new space and make it work. The new private/civic culture of the Biedermeier era is set forth as a constitutive moment in the shaping of 19th century mineral dealing. At least implicitly, the paper also seeks to indicate some of the transformations of objects within that new space: this is, in one respect, an *economization of objects/nature*. In the first place, however, it seems to be a new kind of accessibility of objects. This means that objects—or rather, nature itself—became *accessible by catalogue*.

Keywords: mineral dealing, Carl Caesar Leonhard, *Heidelberger Mineralien -Comptoir*, Biedermeier era, 19th century.

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Introduction

In 1903, Lazarus Fletcher (1854-1921), curator of the mineralogical department of the British Museum of Natural History, wrote a letter to Emil Schlagintweit (1835-1904) concerning the geological collections resulting from the famous expedition to India and High Asia in 1854-1857 of his brothers Hermann (1826-1882), Adolph (1829-1857) and Robert Schlagintweit (1833-1885).¹ He had many items from their collections in his department; unfortunately, they were all unlabelled, and, thus completely useless to the museum. Among the unpublished manuscripts of the brothers, however, as he had heard from the Munich mineralogist Konrad Oebbecke (1853-1932), there should have been two volumes, which are now missing. These were volumes 31 and 32, which contained detailed descriptions, including copies of the labels of the geological collections. Fletcher might have expected them to still be with the family, or with other institutions holding further parts of the collection, and he hoped that Emil Schlagintweit might be able to help him in finding them: 'Have you or your relatives ever seen vols. 31 and 32'.² Actually, however, Emil (as noted by Emil's hand on Fletcher's letter) had to refer him to 'Dr. A. Krantz, Min[eralien]-Contor Bonn', the world-renowned German mineral dealer; the company had offered sets of the Schlagintweit geological collections for sale in a catalogue of 1904.³ Emil also contacted the then owner of the firm, Friedrich Krantz (1859-1926), who, however, was similarly unable to help Fletcher in his quest.⁴ Actually, all further

¹ On the Schlagintweit mission see, for instance, Bernhard Fritscher, 'Humboldtian views': Hermann and Adolf Schlagintweit's panoramas and views from India and High Asia, in: Form, Zahl, Ordnung: Studien zur Wissenschafts- und Technikgeschichte. Festschrift für Ivo Schneider zum 65. Geburtstag, ed. by Rudolf Seising, Menso Folkerts, Ulf Hashagen. (Boethius, 48) Stuttgart (2004), 603-613.

² 'Haben Sie oder ihre Verwandten Bde 31 u. 32 je gesehen?' Lazarus Fletcher to Emil Schlagintweit, London, 23.10.1903, Bavarian State Library, Manuscript Department, Schlagintweitiana VI.5.2. Since the Schlagintweit expedition was a British-Prussian joint enterprise, their various materials and collections were in part deposited in British and German institutions, whereas others remained with the family (such as great parts of the geological collections, which originally consisted of about 6000 rock specimens, and numerous fossils). Cf. Geoff Armitage, The Schlagintweit collections, in: *Earth Sciences History* 11 (1992), 2-8. The materials remaining with the family were first held by Emil Schlagintweit who deposited them at the Bavarian State Library in Munich in 1888.

³ Actually, there is an advertisement to be found in a sales catalogue of 1904, offering 'rocks from the Himalayas, collected by the brothers Schlagintweit' (also the requested manuscript volumes are mentioned). [Dr. F. Krantz - Rheinisches Mineralien-Contor], *Petrographie: Gesteine, Dünnschliffe, Diapositive, Petrographische Apparate*. Catalogue No. 4. 5th edition, Bonn (1904), 120. Very probably, however, the Schlagintweit specimens came to the Krantz firm as early as the 1880s.

⁴ Friedrich Krantz an Emil Schlagintweit, 7.11.1903, Bavarian State Library, Manuscript Department, Schlagintweitiana VI.5.2.

efforts to find the volumes 31 and 32—down the present day—have failed.⁵ Thus they are still missing from the Schlagintweit manuscripts held in the Manuscript Department of the Bavarian State Library in Munich.⁶

Nevertheless, we are not concerned with this problem in the present paper. The short episode has been chosen, rather, to introduce a particular *space in-between*, which is usually mentioned only marginally—but, as the story shows, has to be kept in view—when discussing the history and the practice of geological collecting in modern times, and this is the realm of mineral dealing, and mineral dealers.⁷ Concerning the common topic of the papers in the present volume, mineral dealing might be characterized as a space in-between essentially made up of moving objects, i.e. constructing a *space of circulating objects* between (geological/mineralogical) objects and the practice of (scientific) collecting, connecting science, economics, and the public, or, more generally, nature and society. In this sense the rapid growth in mineral dealing in the first half of the 19th century seems to indicate a new need of circulating objects, or of a new linking space—between scientific, economic, and public/popular uses—to make objects move. This space, to be sure, is not a one-way route. It is not constructed as a simple passage from outcrops or mines via the dealer to the collector or scientist. It is rather a space of exchange, of various demands (in particular of collecting on demand), of various ways of acquiring minerals, of sale and resale. Thus, it seems to be a true space of *circulating* objects.

The present paper seeks to outline some preliminary ideas on the conditions and the requirements of its formation, and the strategies to promote the new space and to make it work. Focusing on the best-known German mineral company of the first half of the 19th century, that is, Carl Caesar von Leonhard's (1779-1862) *Heidelberger Mineralien-Comptoir*, founded at the beginning of the century, the paper

⁵ Not least just recently by the author of this paper. I want to thank Dr. Ursula Müller-Krantz for her kind support, and in particular, for offering me a chance to look into the deposits and the family archive of the Krantz firm - a true treasury of objects!

⁶ Vgl. Anne Büchler/Rolf Schumacher, Die Nachlässe von Martius, Liebig und den Brüdern Schlagintweit in der Bayerischen Staatsbibliothek, (Catalogus codicum manu scriptorum Bibliotheca Monacensis, 10) Wiesbaden (1990), 100-157, here 121.

⁷ Although collecting/collectors and collections are a central topic in the recent history of earth sciences, mineral dealers and mineral dealing still seem to have been given little attention. As far as is known, there are only two more comprehensive studies, Michael P. Cooper, Robbing the sparry garniture: a 200 year history of British mineral dealers 1750-1950, Tucson/Arizona (2006). Gregor Markl, Bergbau und Mineralienhandel im fürstenbergischen Kinzigtal: Wirtschafts- und Sammlungsgeschichte unter besonderer Berücksichtigung der Zeit zwischen 1700 und 1858, (Schriftenreihe des Mineralienmuseums Oberwolfach, 2) Filderstadt (2005). Furthermore, a large quantity of very valuable information on individual dealers is to be found in Wendell E. Wilson, Mineralogical Record Label Archive & The Mineralogical Record Biographical Archive; see <http://www.minrec.org/labelarchive.asp> & <http://www.minrec.org/sitemap.asp> (last visited February 2012).

outlines some of the conditions of its formation, and the strategies to promote the new space and make it work. In this way, the new private/civic culture of the Biedermeier era is particularly highlighted as a constitutive moment in the shaping of 19th century mineral dealing in Germany—also posing the question concerning the emergence of mineral dealing as an indicator of a new civic practice of mineralogy/geology in general; in other words, a practice less related to mining, but rather to the new civic culture. And finally, the paper intends, at least implicitly, to indicate some of the transformations of objects within that new space. This is, in the first place, what might be called a new kind of *economization of objects/nature*. More interesting, however, seems to be another transformation, which is a new kind of accessibility of objects; objects—and, thus, nature itself—became *accessible by catalogue*.

Minerals for the Cultured Classes: Carl Caesar von Leonhard and the *Heidelberger Mineralien-Comptoir*

In March 1819, Johannes Menge (1788-1852), proprietor of the *Mineralien-Comptoir* at Hanau (Hessen, Germany), set out on a mineralogical trip to Northern Europe, in particular to Iceland, Norway, Sweden and England. Before doing so, he felt obliged to insert an advertisement on his expedition in a widely read popular magazine, the *Morgenblatt für gebildete Stände* (Morning paper for the cultured classes). *Cultured Classes* is an approximated translation of the then common German notion of *gebildete Stände*, denoting the various classes or social groups of culture, or lettered classes, namely physicians and apothecaries, lawyers, clergymen, teachers of all types of schools, scientists, state officials, writers, artists, and so on. A more common translation would have been *educated* or *learned (middle) classes*, but *gebildete Stände* is actually more than this by claiming implicitly a peculiar social position (see also below, chapter 3). In the magazine Menge announced that, notwithstanding his journey, the business at Hanau would be continued as usual. He further used the opportunity to introduce the future name of his shop, *Naturalien-Comptoir* (instead of *Mineralien-Comptoir*), and, last but not least, he did not forget to remind his potential customers of the offers and the services of his company: ⁸

⁸ 'Durch gegenwärtige Verbreitung unsers Instituts sind wir in den Stand gesetzt, alle Mineralien des In- und Auslandes uns anzuschaffen. Wir können deshalb leicht jede bestehende Sammlung nach und nach vervollständigen, wenn uns die Defektlste davon eingesendet wird. Ganze geordnete Sammlungen fertigen wir zu jedem beliebigen Preise, jedoch die Oryktognostischen nicht unter 11 fl und nicht über 5000 fl Rheinisch, die Geognostischen von 5 fl 30 kr bis zu 400 fl.' [Johann Menge, *Naturalien-Comptoir*, Hanau], in: *Intelligenzblatt zum Morgenblatt für gebildete Stände*, No. 14 (1819), 54 (my italics; B.F.).

Because of the present distribution of our company we are capable of procuring *all domestic and foreign minerals*. Hence, we can complete gradually every existing collection without difficulty, if a list of desiderata is sent to us. Complete and organized collections we prepare at any desired price; the oryctognostic ones, however, not for less than 11fl [Rhenisch Guilder] and not more than 5000 fl Rhenisch, the geognostical ones from 5 fl 30 kr [Kreuzer] up to 400 fl.

Neither Menge did forget to keep his customers informed about his mineralogical activities abroad. Just about two months later there was an announcement in the *Frankfurt General Post Office Magazin (Frankfurter Ober-Postamts-Zeitung)*, where he had also announced his absence, ‘that several large shipments of minerals from the North have already arrived [at Hanau; B.F.], among which several red and white cryolites from Greenland are particularly noteworthy. Hanau, June 18th 1819. Naturalien Comptoir.’⁹

With regard to particular aspects of the practice of mineral collecting in early 19th century Germany, Menge’s announcement might also be of interest for the destination of his mineralogical journey, i.e. to provide minerals from Northern Europe.¹⁰ Concerning the emergence of mineral dealing, however, attention might be drawn to two less conspicuous aspects: firstly, Menge placed his advertisements in popular journals rather than more particular scientific ones, and, secondly, he assured his customers of his ability to provide all domestic and foreign minerals. Both indicate, as early as 1819, a well-established company, and implicitly the existence of a well-organized and well-working international network of mineral collecting and mineral dealing, as well as, of course, a profound knowledge of minerals and their deposits. More generally, Menge’s advertisements indicate a new—public and independent—space for the acquisition, the moving and the international exchange of minerals, a space that had been opened up by the emergence of a new civic culture since the end of the 18th century. An assessor and amateur mineralogist from Hanau, together with his employee, seems to have been, at least in Germany, the first to realize the new space, that is, to realize that there would be a particular position for mineral dealing.

⁹ ‘... dass bereits mehrere starke Transporte Mineralien aus dem Norden eingetroffen sind, unter welchen sich mehrere rothe und weisse Kryolithe aus Grönland vorzugsweise auszeichnen. Hanau, den 18. Juni 1819.’ [Johann Menge, Naturalien Comptoir], in: *Frankfurter Ober-Postamts-Zeitung*, No. 184, Saturday, July 3rd (1819).

¹⁰ See Benigna Kasztner, *Mineraliengeschenke in Weimar-Jena um 1800. Ein mikrohistorischer Beitrag zum Wechselspiel von Kolonialismus und Wissenschaft*, in: *Wissenschaft und Kolonialismus*, hrsg. von Marianne Klemun, *Wiener Zeitschrift zur Geschichte der Neuzeit* 9, No. 2 (2009), 23–39, here 32–38.

Mineral dealing—or better the acquisition and exchange of minerals—was well established around 1800. Initially, it began in the mining areas of Freiberg and the Harz Mountains, where mining officials procured an additional income by offering minerals for sale. Their customers were aristocratic houses in particular, and more and more also private collectors (who often ordered minerals for resale).¹¹ Thus, in the second half of the 18th century numerous private collections were built up, which today are known mainly or only from the literature.¹² A usual practice of international mineral exchange was furthermore princely gifts—the exchange of minerals among the nobility.¹³

In the entry on ‘trading in natural history specimens’ (*Naturalienhandel*) in the 101st volume of Johann Georg Krünitz’s (1728-1796) *Economical Encyclopaedia* (published in 1806) a new interest of scholars in natural history is quoted as being the essential cause of the emergence of this new branch of trade. Its origins are seen in the Netherlands where, for instance, complete warehouses holding seashells had been established to meet the requirements of the fanciers of conchological studies. Ships were bringing various highly diverse natural produces from the East Indies and other remote parts of the world to be sold to collectors for high or sometimes also modest prices, depending on the scarcity of the specimens. It might be wished, the author continued, that this kind trade should become more widespread, so that not only the Netherlands, England, Denmark and other seafaring nations would be able to deal in natural products, but that also in Germany, at least in bigger cities, trading houses would be established to deal in indigenous natural products. Thus, foreigners would be able to buy (German) domestic natural specimens at lower costs as well as those from overseas. By this means one would be able to acquire a great number of specimens without difficulty, whereas currently it was necessary to spend a lot of money and time to assemble even a small number of inferior natural products.¹⁴

¹¹ For a detailed discussion of the practice of mineral dealing in this sense (for the area of the cobalt mining in the Kinzig Valley, Black Forest, Germany) see Markl, *Bergbau und Mineralienhandel* (see note 7), 241-258.

¹² As an example one might see the (incomplete) list of mineral collections/collectors given by Ch. Keferstein in his *Zeitung für Geognosie, Geologie und Naturgeschichte des Innern der Erde* (1826), No. 2, 107-139.

¹³ See Markl, *Bergbau und Mineralienhandel* (see note 7), 258-263; cf. also Kasztner, *Mineraliengeschenke* (see note 10), 31-32.

¹⁴ [Johann Georg Krünitz], *Naturalienhandel*, in: *Oeconomische Encyclopädie, oder allgemeines System der Staats- Stadt- Haus- u. Landwirthschaft* 101 (1806), 491-493, here 491.

In spite of this, however, in the German countries there were also a number of possibilities for buying minerals:¹⁵

... in particular various people are dealing in domestic and foreign natural history specimens, and therefore they are travelling from one district to another to provide themselves with a considerable number of mineral specimens, rocks and so on. Indeed, by this time, at Hanau there had even been established a regular *Mineral-Exchange and Trade-Store* (*Mineralien-Tausch- und Handlungs-Comptoir*), where one could get complete collections of 700 or more items, partly of a size of 5–6 inches (*zoll*) for 400 Thaler, as well as smaller collections of 200 small items for 6 Thaler.

Furthermore, Krünitz stated, while there was a more or less flourishing trade in minerals, there was nothing comparable for other natural history subjects; in particular, zoological specimens were hard to acquire (although there was some trade in insects). Moreover, trading in natural history specimens was limited by the small demand. And, since most of the fanciers who wished to buy something had very limited means, they usually preferred to collect themselves. Finally, Krünitz noted, that for a dealer of natural history specimens some learning was required; persons who have relevant knowledge, however, might be unwilling merely to do the work of a tradesman.¹⁶

Krünitz's article provides a contemporary statement on the emergence of mineral dealing. He is surely right to emphasize the growing scientific interest in natural history as an essential background for dealing in minerals. This interest increased further in the 19th century together with the emerging sciences of mineralogy and geology, and furthermore this is indicated by the founding of the great natural history museums all over the world (for instance, to name just one, the *Joanneum* at Graz, Austria, founded in 1811). Concerning Krünitz's statement that mineral dealing is ultimately also limited by the resources of the customers and

¹⁵ '...besonders handeln verschiedene Leute mit Mineralien, und reisen deshalb immer von einer Gegend zur andern, um sich mit einer gehörigen Anzahl von Stufen, Steinen etc. zu versehen. Ja, jetzt hat man in Hanau auch ein förmliches Mineralien-Tausch- und Handlungs-Comptoir errichtet, wo man ganze Sammlungen von 700 und mehr Stücken zum Theil von 5-6 Zoll Grösse für 400 Thaler, so wie auch kleine Sammlungen von 200 kleinen Stücken zu 6 Thaler bekommen kann.' [Krünitz], *Naturalienhandel* (see note 14), 492. It is also noted that the Hanau company at this time already had a kind of agent in Berlin, a student named Backofen, who would take orders for the Hanau firm. Similar shops were established at Freiberg/Saxony, in the Harz Mountains and in Thuringia, where, for instance, 'Herr Bergrath Voigt' [Johann Carl Wilhelm Voigt, 1752-1821] at Ilmenau would supply mineral specimens from the mines of that place to fanciers.

¹⁶ [Krünitz], *Naturalienhandel* (see note 14), 492-493.

collectors, and for the 19th century the new class of industrial and business men has to be kept in mind.¹⁷

We might now take particular note of Krünitz's mention of the *Hanau Mineralien-Comptoir* as the first regular German mineral firm, the shop quoted at the beginning of this section. There, Johannes Menge was named as its owner in 1819; actually, however, the shop is much more associated with the name of its founder, Carl Caesar von Leonhard, one of the central figures of mineral dealing in the first decades of the 19th century.¹⁸

Leonhard was born near Hanau in Hessen, where his father Johann Konrad Leonhard served as an administrator in the service of the Landgrave Karl of Hesse-Kassel (1744-1836). In 1797, he entered the University of Marburg to study cameralistics. A year later he moved to the University of Göttingen where he became more and more interested in mineralogy, influenced particularly by the well-known professor of zoology and anthropology, Johann Friedrich Blumenbach (1752-1840). Not least, however, the mineral dealers also increased his interest in the subject: in his autobiography, published in 1854, Leonhard remembered clearly the pleasure and delight he felt when he had bought his first excellent mineral specimens from dealers in the Harz Mountains.¹⁹

An intended study of mineralogy under Abraham Gottlob Werner (1749-1817) in Freiberg/Saxony was unsuccessful,²⁰ owing to an early betrothal in 1801 (to Marie Louise Wilhelmine Blum, eldest daughter of a financier in Hanau, whom he married one year later). Instead he took a job as an assessor in the Bureau of Land Taxes at Hanau.²¹ Nevertheless, the following years were a time of various activities in the field of mineralogy. Leonhard corresponded and became acquainted with some of the leading mineralogists of his time: Werner in Freiberg, Friedrich Mohs (1773-

¹⁷ The collection of the Saxon entrepreneur Richard Baldauf (1848-1931) might be named, at least, as one particular example. See Mareen Czekalla; Klaus Thalheim, *Die Sammlung Richard Baldauf (1848-1931) und ihr Bezug zu Österreich*, in: *Geo-Alp, Sonderband 1* (2007), 11-22.

¹⁸ On Leonhard as collector and mineral dealer see Wendell E. Wilson, *The history of mineral collecting: 1530-1799; with notes on twelve hundred early mineral collectors*, (*The Mineralogical Record*, 26, No.6) Tucson/Ariz. (1994), 180. See also Wendell E. Wilson: *The Heidelberger Mineralien-Comptoir: One of Europe's earliest mineral dealerships*, in: *The Mineralogical Record* 41 (2010), No. 6, 513-526. (Both articles are also to be found on www.mineralogicalrecord.com; last visited February 2012).

¹⁹ Carl Caesar Leonhard, *Aus unserer Zeit in meinem Leben*, 2 vols., Stuttgart (1854), here 1:82-83. Leonhard named 'Tapperten' and 'Mügge' as his providers, but on these persons no further information could be found.

²⁰ Leonhard was an admirer of Werner since he is supposed to have been the first one to discuss minerals as scientific objects (i.e. not as merely materials for metals). Leonhard, *Aus unserer Zeit* (see note 19) 1:105.

²¹ *Ibid.*, 1:94.

1839) in Vienna, and Karl Maria Ehrenbert von Moll (1760-1838), Austrian naturalist, mineral collector, politician, and after 1804 a member of the Bavarian Academy of Sciences in Munich. Moreover, Leonhard travelled extensively—throughout Thuringia and Saxony in 1803, to Vienna, Salzburg, and the Austrian Alps in 1805, and so on—collecting and building up his own mineral collection.²² As early as 1803, when he had just finished his studies at Göttingen, Leonhard established a small laboratory at Hanau, and together with his friend Johann Heinrich Kopp (1777-1858), a physician and naturalist, he held popular lectures on chemistry for the cultured classes (*gebildete Stände*), thus also improving his own knowledge of chemistry: ‘We learned by teaching’, he later noted in his autobiography.²³

Nevertheless, the lack of any formal training in mineralogy was to remain a problem throughout Leonhard’s life. As a mineral collector he acquired an extensive practical knowledge of the physical properties of minerals and fossils, and he also occasionally referred to some acquaintance with mining in Hessen.²⁴ Nevertheless, his later works have been frequently criticized for neglecting the chemical and mathematical aspects of mineralogy. And in his later university lectures at Heidelberg, as it is reported, he is said to have used a ‘barbaric terminology’.²⁵

Around 1804, Leonhard began to sell minerals,²⁶ and by 1806 at the latest, his business was firmly established: in this year it was mentioned in Krünitz’s *Encyclopedia*. And it was also 1806 when Johannes Menge became an employee in Leonhard’s shop. He ran it together with Leonhard for about ten years. An essential

²² With regard to his travels in 1803, Leonhard later noted in his autobiography that it was at that time when his private collection began to increase substantially. Leonhard, *Aus unserer Zeit* (see note 19), 1:107.

²³ *Ibid.*, 1:93.

²⁴ From the mining area of the *Biebergrund* (mining on copper, silver, and lead) in the valley of the Kinzig River near Hanau (not to be confused with the mining area in the Black Forest, mentioned above; see note 7), which was quite important for the Landgraviate of Hesse-Kassel. Leonhard, *Aus unserer Zeit* (see note 19), 1:95.

²⁵ Wilson, Leonhard (see note 18).

²⁶ When Leonhard actually started his mineral business seems to be uncertain. The year of its foundation is usually given as 1804, but 1803 and 1802 are also occasionally mentioned. See Karl Peter Buttler; Walter Klein, *Oekonomisch-technische Flora der Wetterau von G. Gaertner, Dr. B. Meyer und Dr. J. Scherbius. Taxonomie, Nomenklatur und Floristik: eine Auswertung des Gefäßpflanzenteils*, (Jahresberichte der Wetterauischen Gesellschaft für die Gesamte Naturkunde, Sonderband 149/151) Hanau (2000), 63. The earliest product of the Hanau shop that I have found is a small booklet on the use of the blowpipe for the study of minerals (published anonymously, but most likely written by Leonhard) where the *Mineralien-Tausch- und Handlungs-Comtoir*[sic!] is named as publisher. [Anonymous]: *Anleitung zum Gebrauch des gemeinen Lötrohres zur Untersuchung der Mineralien*. Hanau 1803. Im Verlag des Mineralien-Tausch- und Handlungs-Comtoirs. Likewise the more particular reasons why Leonhard decided to enter the business are not known. However, it might be recalled that his mother Susanne Godeffroy was a member of the well-known Hamburg merchant family Godeffroy. See Leonhard, *Aus unserer Zeit* (see note 19), 1:1.

step towards his becoming an acknowledged mineralogist, however, was his foundation of a new magazine for mineralogy in 1807—still, admittedly, as an assessor in the tax office—the *Taschenbuch für die gesammte Mineralogie* (Notebook for the Whole of Mineralogy).²⁷ Just a few years before, in 1801, Karl Ernst Adolf von Hoff (1771-1837) in Göttingen had sought to establish a similar project by the edition of his *Magazine for the Whole of Mineralogy* (which, however, was abandoned after its first volume).²⁸ One of the reasons for Leonhard's immediate success was that, owing to his personal connections, he was able to win well-known authors for his journal, such as J. C. W. Voigt (see note 15), Von Hoff, Mohs, and also Johann Wolfgang von Goethe (1749-1832).²⁹ First of all, however, Leonhard's journal addressed a new audience, i.e. it was a popular journal rather than merely a scientific one, including in particular a multitude of amateur mineralogists and mineral collectors. To the 'friends of mineralogy', he presented his magazine, as he wrote in the preface to its second number,³⁰ and its contents would be the discoveries and improvements in the field of mineralogy in a broader meaning, including reviews of new literature, but not, for instance, the chemical analysis of minerals, or discussions of their economic use.³¹ In 1830, Leonhard, together with the Heidelberg palaeontologist Heinrich Georg Bronn (1800-1862), relaunched his journal as a *Yearbook for Mineralogy, Geognosy, Geology, and Palaeontology*, which finally, in 1863, became the *New Yearbook for Mineralogy, Geology, and Palaeontology*, a mineralogical journal that is still prestigious today.³²

²⁷ *Taschenbuch für die gesammte Mineralogie mit Hinsicht auf die neuesten Entdeckungen*, 18 vols. (1807-1824), Frankfurt.

²⁸ *Magazin für die gesammte Mineralogie, Geognosie und mineralogische Erdbeschreibung* 1 (1801).

²⁹ Who was also a customer and a specimen supplier of Leonhard's shop, cf. Wilson, Leonhard (see note 18).

³⁰ Leonhard, Preface, in: *Taschenbuch* (see note 27) 2 (1808), v.

³¹ Leonhard, Preface, in: *Taschenbuch* (see note 27) 1 (1807), vi-viii. Although Leonhard did not explicitly refer to it, he might also have had in mind a distinction from K.M.E. von Moll's *Yearbook of mining and metallurgy* (*Jahrbuch der Berg- und Hüttenkunde*), founded in 1797. Von Moll's journal was a leading one for mineralogical and geognostical subjects in the first decades of the 19th century; after 1826 it was combined with Leonhard's *Taschenbuch*. On Moll see also Marianne Klemun, *Beruf, Berufung und Wissenschaft—Karl E(h)renbert von Moll (1760-1838) Visionen als 'Akademiker' in politischen Umbruchzeiten (mit der Edition eines Briefes)*, in: *Jahrbuch der Geologischen Bundesanstalt* 149 (2009), 309-323, here 317.

³² The journal was first changed in 1825 to *Zeitschrift für Mineralogie* (5 vols., 1825-1829), publishing now several issues a year. The new journal, edited with Bronn, was started in 1830 as *Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde* and became the *Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde* in 1833; finally, in 1863, it got its most recent title *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*. For the history of Leonhard's *Taschenbuch* see also Otto Nowotny, Carl Caesar von Leonhards 'Taschenbuch für die gesammte Mineralogie' (1807-1826), in: *Cartographica Helvetica* No. 9 (1994), 32-38.

All these magazines, of course, were also used to promote mineral dealing, including Leonhard's own companies at Hanau and later at Heidelberg (even though he always tried to keep his own name out of advertisements and announcements). Starting with the third volume of the *Taschenbuch* in 1809, the journal included an independent column on mineral dealing, starting with a list of 40 mineral dealers in various European cities (for Vienna alone nine dealers are listed, and five for London).³³ A first detailed advertisement of the *Mineralien-Handels-Komptoir* at Hanau was inserted in 1811, offering 'oryctognostic' and 'geognostic' collections of various size. All the specimens, it is declared, would be fresh, i.e. recently collected, and delivered with detailed descriptions, including information on their localities. Detailed catalogues of the complete supply of minerals, i.e., types of collections, would be sent on request.³⁴ Similar advertisement for the Hanau mineral warehouse were inserted in all the subsequent volumes until 1816, and Leonhard also used several other popular journals for the promotion of his business.³⁵

Although the column on mineral dealings itself is continued in the subsequent volumes, there were no more announcements concerning the Hanau mineral store. This might be because Leonhard had sold his shop, together with considerable parts of his private collection,³⁶ to his co-worker Menge in 1817 (according to other sources: in 1816). With Menge he had run the business since 1806. After the end of the Napoleonic era, Leonhard got into political difficulties and because he had been accused of collaboration he was degraded to the rank of an assessor at the Bureau of Taxes. In 1816, therefore, he changed to the *Bavarian Academy of Sciences*,³⁷ and two years later, he accepted a professorship in mineralogy and geognosy at the University of Heidelberg, where he remained for the rest of his life.³⁸

The Hanau mineral shop, described above, was continued by Menge. He had had no formal education when he entered the shop, and also no particular training in mineralogy. He was given practical advice by Leonhard on mineralogical

³³ Leonhard, *Taschenbuch* (see note 27) 3 (1809), 395-399 & 4 (1810), 405. The list implicitly indicates a well-established practice of mineral dealing around 1800. Cf. once again Cooper (2006); Markl (2005).

³⁴ Leonhard, *Taschenbuch* (see note 27) 5 (1811), 396-397.

³⁵ See, for instance, advertisements in *Intelligenzblatt zum Morgenblatt für gebildete Stände*, No. 9 (1811), 36, and *ibid.*, No. 2 (1812), 8; *Intelligenzblatt der Jenaischen Allgemeinen Literatur-Zeitung*, Januar 1813, col. 32.

³⁶ On his early collection see Carl Caesar Leonhard, *Einige Worte über meine Mineralien-Sammlung*. Hanau, 1814.

³⁷ Leonhard was appointed (most probably on the recommendation of his friend K.M.E. von Moll, and on a salary of 2000 Guilder) as a member of the *Bavarian Academy of Sciences* in 1815. Leonhard, *Aus unserer Zeit* (see note 19), 1:503-505.

³⁸ *Ibid.*, 1:596-597.

excursions, and he was allowed to use his library. And in 1809-1810 he used a stay in Zurich to gain some knowledge in medicine and philosophy.³⁹ The mineralogical trip to the North in 1819, announced in the press (see above), was funded by the *Senckenberg Natural History Society* (*Senckenbergische Naturforschende Gesellschaft*) at Frankfurt (Menge was a corresponding member of the society), and it was designed to study the Icelandic geysers, and, of course, to collect minerals. In 1819, Menge published a small booklet on the utility of mineralogy.⁴⁰ Actually, the journey became the basis for a changing (and international) career. The journey brought him into contact with German Reformed churches, and this induced him to move to Lübeck (northern Germany) in 1820 (according to other sources: in 1819), and to transfer his mineral shop there. Over the following ten years we find him engaged in quite different matters. For instance, we find him on a mineralogical expedition to the Ural Mountains (1825/1826), and in Paris studying East Asian languages (1827).⁴¹ Nevertheless, during the 1820s, advertisements for Menge's *Naturalien-Comptoir* were sporadically to be found in various magazines. Finally, in 1830, following the death of his wife, he left Germany for England, and later, for Australia, where he became a pioneer in the mineral exploration of the country. One of the last notes to be found concerning the *Naturalien-Comptoir* (and this means: concerning Leonhard's first mineral shop) is a prospectus. This was among papers read to the members of the mineralogical section of the ninth meeting of the *Gesellschaft Deutscher Naturforscher und Ärzte* at Hamburg, in 1830, on the 'raffle of the mineral warehouse of Mr. Menge'.⁴²

Consequently, it was actually a relaunch of his business in more than one respect when Leonhard began to establish a mineral warehouse at his new residence, the *Heidelberger Mineralien-Comptoir*. Already in 1824, Leonhard handed over the proprietorship to a young mineralogist, Karl Friedrich August Moldenhauer (1797-

³⁹ On Menge, there is actually little information. The only more recent paper is Bernard O'Neil, Johannes Menge, in: *Neue deutsche Biographie* 17 (1994), 66-67. Cf. also Buttler et al., *Oekonomisch-technische Flora der Wetterau* (see note 26), 92. For Menge's later work see D.W.P. Corbett, The foundation of Australian geology, in: *Earth Sciences History* 6 (1988), 146-158.

⁴⁰ Johannes Menge, *Winke für die Würdigung der Mineralogie: als Grundlage aller Sachkenntnis*, Hanau (1819).

⁴¹ O'Neil, Johannes Menge (see note 39), 66-67.

⁴² '[...] Verloosung[sic!] der Mineralien-Niederlage des Herrn Menge [...]'. Announcement in: *Amtlicher Bericht über die Versammlung deutscher Naturforscher und Ärzte in Hamburg im September 1830*, ed. by J.H. Bartels and J.C.G. Fricke, Hamburg (1831), 40. According to other sources Johannes Menge had already sold the shop in 1820 to his brother Peter Menge. See Buttler et al., *Oekonomisch-technische Flora der Wetterau* (see note 26), 63.

1866),⁴³ although he remained seriously involved in the business.⁴⁴ Moldenhauer, however, left after just a few years in 1828, and Leonhard himself, with the help of his co-editor of the *Neues Jahrbuch für Mineralogie*, Heinrich Georg Bronn (1800-1862), sought to keep the *Heidelberger Mineralien-Comptoir* going.⁴⁵ Nevertheless, at this time, as with his first shop at Hanau and throughout the following years, Leonhard always endeavoured to keep his name out of advertisements (although everyone knew that he was the driving force behind the company). In 1841, another young mineralogist, J. Lommel (fl. 1826-1867/1868),⁴⁶ joined the *Heidelberger Mineralien-Comptoir*. Ultimately, Lommel inherited the business when Leonhard died in 1862,⁴⁷ and kept it going until his own death in 1868.⁴⁸

The four decades from its reestablishment in the 1820s until Lommel's death were the heyday of the *Heidelberger Mineralien-Comptoir*. This, again, is documented in several advertisements in various journals⁴⁹ and in several separately published catalogues.

As a particular example a double-sided advertisement of 1827 might be quoted. This was inserted in the *Journal for Geognosy, Geology, and Natural History of the Earth's Interior* (*Zeitung für Geognosie, Geologie und Naturgeschichte des Innern der Erde*) of Leonhard's contemporary and, as editor of a geological journal

⁴³ See <http://www.minrec.org/library.asp> (last visited February 2012).

⁴⁴ Leonhard's continuous engagement in mineral dealing is also shown by the continuation of relevant notes and announcements in the *Zeitschrift* and the *Yearbook* (see notes 32).

⁴⁵ Although there is not yet evidence, it might be assumed that the mineralogist Johann Reinhard Blum (1802-1883) was also involved in the business. Blum was Leonhard's brother-in-law. He was born at Hanau, and, like Leonhard himself, first studied cameralistics before changing to mineralogy, studying with his brother-in-law at Heidelberg. In 1828 he became a 'Privatdozent' and a professor of mineralogy in 1838 (succeeding Leonhard as Ordinary Professor in 1856); in 1853, Leonhard was also joined at Heidelberg by his son Gustav Leonhard (1816-1878) as an Extraordinary Professor of geology.

⁴⁶ See <http://www.minrec.org/labels.asp?page=1&colid=900> (last visited February 2012).

⁴⁷ Leonhard's personal collection of 8,000-10,000 specimens was bequeathed to the University of Göttingen upon his death (as several private collectors and mineral dealers had done in 19th century, i.e. various university collections owe essential parts of their holdings to the realms of mineral collecting and mineral dealing). Cf. Marco Beretta (ed.), *From private to public: natural collections and museums*, (Uppsala studies in history of science, 32; European studies in science history and the arts, 5) Sagamore Beach/MA (2005).

⁴⁸ For the further history of the *Heidelberger Mineralien-Comptoir* (still working in the 1920s) see Wilson, Leonhard (see note 18). Concerning the various managers of the *Heidelberger Mineralien-Comptoir*, and Leonhard's simultaneous and continuous engagement in the shop, it is in any case not possible to decide, according to the available sources, who was actually responsible for the *Heidelberger Mineralien-Comptoir* in a particular year. Nevertheless, from the point of view of his (national and international) customers, it was constantly Leonhard himself to whom the *Heidelberger Mineralien-Comptoir* was particularly related, i.e. to whom it owes the greatest part of its success.

⁴⁹ In 1825, the *Heidelberger Mineralien-Comptoir* offers collections of reagents (*Reagenzien-Sammlungen*) and chemical devices (designed mainly for pharmaceutical uses, i.e. less for chemical studies on minerals). Leonhard, *Zeitschrift* (see note 32) 1 (1825), 568. And in the *Yearbook* of 1832, for instance, the *Heidelberger Mineralien-Comptoir* announced a 'very comprehensive catalogue'. Leonhard, *Jahrbuch* (see note 32) 3 (1832), 256.

also competitor, Christian Keferstein (1784-1866).⁵⁰ The advertisement, signed 'Heidelberg, December 1st 1826', offered 'geognostic-paleontological collections' (geognostisch-petrefactologische Sammlungen), emphasizing that from now on the shop not only provided minerals, but also fossils. Collections of this type would scarcely be offered by mineral dealers because of their comparatively low prices (and, thus, they yielded smaller profits compared to oryctognostical, i.e. mineralogical collections). The collections, particularly recommended for the use in schools and for private study, were announced as being provided in partial shipments of 50-60 specimens, labelled in German, English, and French. The complete delivery would consist of about 8-10 such parts, comprising altogether some 500-600 specimens. Included in the last partial shipment a catalogue would be delivered, for easy organization of the collections, namely according to the systems of Alexander von Humboldt (1769-1859), Ami Boué (1794-1881), and Keferstein. Finally, the price of each partial delivery was 22 fl., or Rhenish guilders (200-220 guilder for a complete collection).⁵¹

What was not mentioned in Keferstein's journal were the various other types of collections offered at this time by the *Heidelberger Mineralien-Comptoir*. These were to be found, for example, one year later in an advertisement in the *Magazine for Pharmacy* (*Magazin für Pharmacie*). Apart from the geognostic collection of 600 specimens, and a fossil collection, the following were offered: an oryctognostic collection of 650 mineral specimens (organized according to Leonhard's *Textbook of oryctognosy*), a gemstone collection of 50 pieces, a pharmaceutical collection of minerals, a collection of 700 minerals of economic value, and also a collection of 123 crystal models.⁵²

Besides advertisements in various magazines, however, the essential instrument for promoting the business (always referred to in the advertisements as

⁵⁰ On Keferstein, known as author of the first coloured geological map of Germany, and his journal, see Kathrin Polenz, Christian Keferstein - ein Amateurgeologe im mitteleuropäischen Raum um 1800 und seine Zeitschrift 'Deutschland, geognostisch-geologisch dargestellt', in: *Sudhoffs Archiv* 95 (2011), 30-47.

⁵¹ [Heidelberger Mineralien-Comptoir], in: *Zeitung für Geognosie, Geologie und Naturgeschichte des Innern der Erde* (1827), No. 3, 417-418. Notwithstanding Leonhard's statement on minor profit expectations, and also considering that it is hardly possible to calculate an approximation of these prices in terms of modern currencies, it could be noted, at least, that complete oryctognostical/mineralogical collections extended to several thousand euros/US dollars, i.e., mineral dealing could actually be a lucrative business.

⁵² [Heidelberger Mineralien-Comptoir], in: *Magazin für Pharmazie und die dahin einschlagenden Wissenschaften* 6 (1828), quoted from Wilson, Leonhard (see note 18). See also Carl Caesar Leonhard, *Handbuch der Oryctognosie*, Heidelberg (1821).

being obtainable from the warehouse) were separately published lists or catalogues of the available mineral and rock specimens. From the earlier Hanau period of Leonhard's business, no such sales catalogue seems to have been preserved. There is, however, a catalogue of a *Natural History Specimens-Exchange- and Trading-Bureau at Hanau* (*Naturalien-, Tausch- und Handels-Bureau zu Hanau*), published in 1809, and signed, amongst others, by Leonhard and Gottfried Gaertner (1754-1825), the then president of the *Wetterau Society for the whole of Natural History* (*Wetterauische Gesellschaft für die Gesamte Naturkunde*). The shop was obviously founded according to the model of Leonhard's *Mineral-Exchange- and Trading-Comptoir* (*Mineralien-Tausch- und Handels-Kontor*) by members of this Society (founded in 1808, with Leonhard and Gaertner as founding members).⁵³ Unlike Leonhard, however, the Society's Bureau had not any commercial interest in view; rather, as noted in the introductory remarks of the catalogue, it aimed solely at the 'distribution/circulation of scientific knowledge'.⁵⁴ The catalogue itself, written in German and French, offers minerals—most likely from Leonhard's shop—plants and animals (i.e., birds, fish, insects), and in this all the minerals and animals are listed individually.⁵⁵

The earliest, more comprehensive catalogue, of the *Heidelberger Mineralien-Comptoir* itself, compiled by Moldenhauer, was published in 1825 (reprinted in 1826), again an alphabetical list giving short descriptions of some hundred specimens and explanations in German and French.⁵⁶ Until the 1860s, various catalogues (usually in several editions) followed, and of these we might mention, J. Lommel's *Catalogue of Collections of Fossils, according to Bronn's 'Lethaea geognostica'* (1841, in German, French, and English),⁵⁷ and a catalogue of 1848, addressing particularly school instruction, and also offering crystal models.⁵⁸

⁵³ [G.] Gaertner, [J.P.A.] Leisler, C.C. Leonhard, J.J. Schaumburg, *Naturalien-, Tausch- und Handels-Bureau zu Hanau* [Sales catalogue] 1809. On Gaertner, the *Wetterauische Gesellschaft für die gesamte Naturkunde* and its Bureau see Buttler et al., *Oekonomisch-technische Flora der Wetterau* (see note 26), 8-10 and 62-63.

⁵⁴ Quoted from *ibid.*, 62.

⁵⁵ *Ibid.*, 63.

⁵⁶ *Catalogue des minéraux et des collections classées du Comptoir de Minéraux à Heidelberg*, Heidelberg 1826, pp. 38. [Verzeichniss der Mineralien und geordneten Sammlungen des Heidelberger Mineralien-Comptoirs]. Cf. also the entry on K.F.A. Moldenhauer in *Curtis Schuh's* *Biobibliography of Mineralogy* (see note 43).

⁵⁷ [Heidelberger Mineralien-Comptoir], *Katalog von Petrefacten-Sammlungen, nach Bronn's Lethaea geognostica/ Catalogue of collections of fossils*, ed. by Heidelberger Mineralien-Comptoir, Heidelberg (1841). Heinrich G. Bronn, *Lethaea Geognostica, oder Abbildung und Beschreibung der für die Gebirgs-Formationen bezeichnendsten Versteinerungen*, 2 vols. Stuttgart (1834) (several later volumes and editions).

⁵⁸ [Heidelberger Mineralien-Comptoir], *Sammlung von Mineralien, Felsarten, Petrefacten und Krystall-Modellen für Unterricht und Selbst-Belehrung*, ed. by Heidelberger Mineralien-Comptoir, Heidelberg (1848). pp. 39. [Heidelberger Mineralien-Comptoir], *Erläuternder Catalog der Mineralien-Sammlungen von 300 Exemplaren, die besonders geeignet für Schulen, sowie zur Selbstbelehrung*, ed. by Heidelberger Mineralien-Comptoir, Heidelberg

In addition to advertisements and catalogues, Leonhard used several of his writings for *product placement*, that is, for the recommendation and popularization of mineral dealers and mineral warehouses as a means to build and complete collections. In his *Introduction to mineralogy (Propaedeutik der Mineralogie, 1817)*, again written with his friend Kopp and Carl Ludwig Gaertner (1785-1829),⁵⁹ a separate chapter is devoted to the buying of minerals. To purchase minerals that cannot be collected personally, Leonhard stated, is a good way, in general, of enlarging one's collection but he also cautioned the beginner to contact reliable dealers, for 'in no other branch of commerce are there more cases of more fraud than in mineral dealing'.⁶⁰ Travellers were particularly recommended to visit local mineral shops to get the domestic minerals of the visited regions that they had not been able to collect for themselves. Furthermore, Leonhard advised collectors to purchase complete and organized collections, where again they should be careful to get collections arranged 'in accordance with the recent methodological spirit of science'.⁶¹ Apart from such immediate recommendations to buy minerals, Leonhard's writings frequently include references to mineral dealers.⁶²

Finally, Leonhard's early writings, overall, might be seen as a further strategy to promote mineral collecting (and thus, mineral dealing). His first major publication, the three-volume *Manual of a General Topographic Mineralogy* (1805-1809) was actually a guide for mineral collectors.⁶³ And one year after its first volume, i.e. in 1806, Leonhard, together with his friends Kopp and Ernst Karl Friedrich Merz (about whom I have not been able to find any further information) provided the guide to arrange the collections according to his *Systematic-tabulated Overview and*

(1854). Moreover, in 1860 the *Mineralien-Comptoir* also published a separate catalogue on crystal models: [Heidelberger Mineralien-Comptoir], *Krystall-Modelle*, Heidelberg (1860), pp. 11.

⁵⁹ The chemist C.L. Gaertner was the then secretary of the *Wetterauische Gesellschaft für die Gesamte Naturkunde*, and the nephew of its president G. Gaertner (Leonhard's co-author of the 1809 catalogue of the Hanau Bureau, see note 53). See Buttler et al., *Oekonomisch-technische Flora der Wetterau* (see note 26), 19-20.

⁶⁰ '... denn bei keinem merkantilischen Zweige erlaubt man sich mehr Betrügereien als gerade bei dem Mineralien-Handel'. Carl Caesar Leonhard; Johann Heinrich Kopp; Carl L. Gaertner: *Propaedeutik der Mineralogie: mit 10 schwarzen und ausgemalten Tafeln*. (Einleitung und Vorbereitung zur Mineralogie) Frankfurt (1817), 223.

⁶¹ Leonhard et al., *Propaedeutik der Mineralogie* (see note 60), 223.

⁶² See, for instance, Carl Caesar Leonhard, *Handbuch der Oryktognosie* (see note 52), 6.

⁶³ Carl Caesar Leonhard, *Handbuch einer allgemeinen topographischen Mineralogie*, 3 vols., Frankfurt (1805-1809).

Characteristics of Mineral Compounds.⁶⁴ Also his *Introduction to mineralogy* (1817), quoted above, was first of all a valuable and instructive compendium of all sorts of information useful to the mineral collector.⁶⁵ Further examples are Leonhard's *Characteristics of Rocks* (*Charakteristik der Felsarten*, 1823-1824), addressing particularly the collectors working in the field,⁶⁶ and his *Agenda geognostica* (1829), which was, according to its subtitle, a 'Manual for Travelling Geognosts and a Textbook for Lectures on Applied Geognosy'.⁶⁷

Mineral dealing and Biedermeier culture

In the foregoing I have sought to sketch the various strategies by which Leonhard promoted mineral dealing in the first decades of the 19th century, and in particular the way he made his own company one of the best-known mineral warehouses in Europe. This he achieved by frequently inserting advertisements in popular journals, by publishing sales catalogues, and by providing manuals, lectures, and also a separate magazine particularly dedicated to mineral collecting and mineral collectors. All these strategies, however, feature to a greater or lesser extent an overall characteristic already occasionally indicated above; they all address a new audience, namely—as they were usually called at the time, and as Leonhard himself had explicitly done in his first lectures on chemistry at Hanau in 1803—the *Cultured Classes* (*gebildete Stände*).⁶⁸ In other words: he particular addresses the new civic/private culture emerging since the middle of the 18th century, which was particularly important in shaping the Biedermeier era from 1815-1848.

A well-known and widely used phrase to characterize this peculiar civic culture, and one that was proclaimed by many as the quintessential activities of the Biedermeier, is *sammeln und hegen* (*collecting and nurturing*), which originally related to

⁶⁴ Carl Caesar Leonhard, *Systematisch-tabellarische Uebersicht und Charakteristik der Mineral-Körper*, Nürnberg (1806).

⁶⁵ Leonhard et al., *Propaedeutik der Mineralogie* (see note 60).

⁶⁶ Carl Caesar Leonhard, *Charakteristik der Felsarten für akademische Vorlesungen und zum Selbststudium*, 3 vols., Heidelberg (1823-1824). The book was one of the most comprehensive works on petrology to appear in the early 19th century. Nevertheless, it has been criticized for being based solely on visual examination, and thus appears arbitrary and largely unsatisfactory by modern standards.

⁶⁷ Carl Caesar Leonhard, *Agenda geognostica: Hülfsbuch für reisende Gebirgsforscher und Leitfaden zu Vorträgen über angewandte Geognosie*, Heidelberg (1829).

⁶⁸ As already indicated above, *Cultured Classes* is just an approximated translation of the German notion of *gebildete Stände*. For the historical meaning of this notion, intended in the present paper, see, for instance, Julia A. Schmidt-Funke, *Kommerz, Kultur und die 'gebildeten Stände'. Konsum um 1800* (15.01.2012), in: Goethezeitportal, URL: www.goethezeitportal.de/db/wiss/epoche/Schmidt-Funke_Konsum.pdf (last visited February 2012).

the descriptions of nature (*Naturschilderungen*) by the Austrian writer Adalbert Stifter (1805-1868). Although usually used to denote conservatism, i.e. the middle-class ethos of the time, it seems to be even more appropriate to regard this as part of the strong empiricist moments of the time. 'In literature as in life, flowerbeds, green houses, rock collections, gardens and tillage, libraries and museums expose the urge towards objective knowledge, factual precision, and pragmatism.'⁶⁹ This means that the success of the *Heidelberger Mineralien-Comptoir*, and the rapid growth of mineral dealing in the first half of 19th century can hardly be understood without relating it to this cultural background.

A more detailed discussion of the ties between mineral dealing and (German) Biedermeier culture would show that it was not the sheer number of new collectors that allowed for the establishment of a profitable trade, but rather a particular cultural affinity to minerals and mineralogy. Such a discussion would have to focus on the notion of vision (*Anschauung*) and its relation to education and learning (*Bildung* and *Erziehung*), i.e., on a peculiar pedagogical notion of vision. Education and learning in the Biedermeier era meant less the accumulation of knowledge, or the training of specific abilities, and more on the formation, or the shaping of the human character. And as an essential instrument of education in this sense, 'vision' has been cited, comprising both viewing, i.e., purely sensual perception, and contemplative consideration.⁷⁰

It was the philosopher and educationalist Johann Friedrich Herbart (1776-1841) who explicitly gave mineralogy its pedagogical meaning. 'Vision', he stated, 'this indispensable, this most solid and broadest bridge between man and nature,' has to be an essential concern of all pedagogical endeavours.⁷¹ And mineralogy, Herbart continued, is one of the essential means to form vision in that peculiar pedagogical meaning, 'in so far as it determines fossils [that is, 'things dug up'; here minerals] according to their external characters. There is hardly a similar opportunity, to

⁶⁹ Virgil Nemoianu, *The taming of romanticism: European literature and the age of Biedermeier*, Cambridge/Mass. (1984), 16.

⁷⁰ For a discussion of the pedagogical context of 19th century natural history see also Bernhard Fritscher, *Zwischen 'Humboldt'schem Ideal' und 'kolonialem Blick': Zur Praxis der Physischen Geographie der Gebrüder Schlagintweit*, in: *Wissenschaft und Kolonialismus* (see note 10), 72-97, here 85-89.

⁷¹ 'Das Anschauen, diese unentbehrliche, diese vesteste, breiteste Brücke zwischen Mensch und Natur, - verdient gewiß, so fern es nur irgend einer Kultur durch Kunst fähig ist, daß ihm ein Hauptfaden des pädagogischen Bemühens gewidmet werde.' Johann Friedrich Herbart, *Pestalozzi's Idee eines ABC der Anschauung als ein Cyklus von Vorübungen im Auffassen der Gestalten wissenschaftlich ausgeführt*, 2nd edition, Göttingen (1804), 198.

sharpen the eyes also for the smallest distinctions of structure, of brightness, of colour, and, to combine simultaneously with it further sensual perceptions.’⁷²

Furthermore, mineralogy has been related to Biedermeier culture by its widespread discussion as a peculiar German science, and thus, as an instrument within the political efforts to establish a United German Nation.⁷³ Concerning the Biedermeier practice of collecting itself, that is its peculiarities as against the aristocratic practice of mineral collecting prevalent in the 18th century (including a different need for professional mineral dealers), two aspects seem to merit consideration. Firstly, the interest of the Biedermeier collectors was less in curiosities, but rather in systematically ordered suites of minerals and rocks. And *completeness* of these suites related more to the various minerals and rocks of a particular region or country, than, for instance, to minerals of a particular mineralogical, i.e. chemical composition. This interest in systematically ordered suites of minerals and rocks, probably quite unspectacular in itself, but characteristic of a particular region, was evidenced, for instance, by Leonhard’s brother-in-law, Reinhard Blum, and the Hessian mineralogist August Klipstein (1801-1894), in offering ‘geognostic suites’ of rocks from several Hessian regions or areas (such as the Odenwald, the Wetterau, the Vogelsberg, Rhön mountains).⁷⁴ And, secondly, mineral collections were no longer destined to build up extensive separate cabinets, but rather to be presented in the living area, which might be paraphrased as an interest in *nature in the sitting-room*.⁷⁵

Leonhard’s work, therefore, in more than one respect, was closely linked to the Biedermeier culture. The introduction to his *Lehrbuch der Geognosie und Geologie* (1835), for instance, can be read as an example of the political meaning of mineralogy indicated above.⁷⁶ In particular, however, it was Leonhard’s strong interest in teaching or education that has to be related to the efforts of the epoch in improving

⁷² ‘Es ist die Mineralogie, sofern sie die Fossilien nach den äußerlichen Kennzeichen beurtheilt. Schwerlich giebt es eine andre gleich günstige Gelegenheit, das Auge auch für die kleinsten Verschiedenheiten der Textur, des Glanzes, der Farbe, zu schärfen, und damit zugleich so manche andre sinnliche Wahrnehmung zu verbinden.’ Herbart, Pestalozzi’s Idee eines ABC der Anschauung (see note 71), 215-216.

⁷³ See, for instance, Bernhard Fritscher, *Erdgeschichte zwischen Natur und Politik: Lorenz Oken’s ‘Zeugungsgeschichte’ der Erde*, in: *Von Freiheit und Verantwortung in der Forschung: Zum 150. Todestag von Lorenz Oken (1779-1851)*, ed. by Dietrich von Engelhardt and Jürgen Nolte. (Schriftenreihe zur Geschichte der Versammlungen Deutscher Naturforscher und Ärzte, 9) Stuttgart (2002), 110-129.

⁷⁴ Leonhard, *Zeitschrift* (see note 32) 1 (1825), advertisement in attachment.

⁷⁵ Cf. in this respect the invention of the aquarium in the 19th century as discussed by Bernd Brunner, *Wie das Meer nach Hause kam: die Erfindung des Aquariums*, Berlin (2003).

⁷⁶ Carl Cäsar Leonhard, *Lehrbuch der Geognosie und Geologie* [first edition published as vol. 3 of *Naturgeschichte der drei Reiche*], Stuttgart (1835), S. 5-10.

school and university teaching indicated here, that is to pedagogy as the leading science of the era. Actually, most of Leonhard's works were textbooks and manuals with a more or less introductory character; they were primarily designed for education, and, to clarify, they were in no way restricted to university teaching, but rather designed for teaching at all types of schools as well as for private study (by the Cultured Classes). Leonhard himself had written several books to be used for the teaching of geology and mineralogy at secondary schools.⁷⁷ And there seems actually to have been a demand for such books: in 1852, his son Gustav Leonhard (1816-1878), who was to join his father as an extraordinary professor of geology at Heidelberg in 1853, observed in his booklet on the minerals of Baden (Baden-Württemberg) and their deposits that currently an 'eagerness for mineralogy' is prevailing at various types of schools.⁷⁸ Finally, Leonhard's efforts in popularizing mineralogy and geology—science popularization was a further achievement of the Biedermeier era—have to be mentioned here, namely his *Geology, or a Natural History of the Earth, treated in an easily comprehensible manner*.⁷⁹

These few suggestions would surely require a more detailed discussion. Nevertheless, I hope to have indicated that the success of Leonhard's business—and the rapid growth of mineral collecting and mineral dealing in the first half of 19th century—was essentially due to the new civic culture of the Biedermeier era. In other words: Leonhard did not invent mineral dealing, but he connected it very successfully to the culture of his time. Moreover, the particular meaning of Biedermeier culture for the promotion of mineral dealing might be confirmed by the second great German mineral warehouse, which actually gave the initial ideas for this paper, that is the family firm of Adam August Krantz. It was founded in 1833 at Freiberg, moved to Berlin in 1837, and finally, in 1850, to Bonn, where it became famous as *Dr. A.*

⁷⁷ See Carl Caesar Leonhard, *Leitfaden zum Unterricht in der populären Geologie oder Naturgeschichte der Erde, für höhere und Mittelschulen jeder Art*, Stuttgart (1845). Ders., *Naturgeschichte des Mineralreiches: ein Lehrbuch für öffentliche Vorträge, besonders in Gymnasien und Realschulen, so wie zum Selbststudium*, Heidelberg (1825) (second edition in 2 vols., 1831/1833). See once again the specific catalogue of the Mineralien-Comptoir containing teaching materials (see note 58).

⁷⁸ Gustav Leonhard, *Die Mineralien Badens nach ihrem Vorkommen*, Stuttgart 1852 (preface, no pagination). However, in spite of this constant and increasing emphasis on minerals and mineral collections as a particular need in primary and secondary education since late 18th century, there is actually little knowledge on how these minerals, and mineral collections, were actually used in schools. Cf. Stefan Meier, *Eine Zeitreise in die Welt der Mineralienkabinette und Klosterschulen: die 'bewegte' Geschichte der Amberger Naturaliensammlung*, in: *Lapis* 37 (2012), No. 2, 32-38.

⁷⁹ Carl Caesar Leonhard, *Geologie oder Naturgeschichte der Erde, auf allgemein fassliche Weise abgehandelt*, 5 vols., Stuttgart (1836-1844).

Krantz Rheinisches Mineralien-Comptoir (from 1888 *Dr. F. Krantz Rheinisches Mineralien-Kontor*), and is still working today.⁸⁰

Conclusions and further research

The discussion of mineral dealing as a particular *space in-between* made up by making objects move was the initial idea of this paper. Focusing on the history of Carl Caesar Leonhard's *Heidelberger Mineralien-Comptoir*, it has been shown how this space was constructed between—and thus, connecting—scientific, economic, and public/popular uses of minerals. Furthermore, I have shown how the new civic culture of the Biedermeier era contributed to the specific construction of this space.⁸¹ Minerals in this sphere became 'cultural objects', i.e. they were no longer defined just as mineral compounds with particular economic or also pharmaceutical uses, and also not as mere scientific objects. Rather, minerals in the space of mineral dealing became reconstructed according to the cultural practice of collecting. The various transformations which minerals are subjected to in this process of reconstruction, that is, in this space of moving objects, needs to be an essential topic of further research. At least two of these transformations have been implicitly indicated in this paper. One of them might be called a *new economization* of minerals, i.e. an economization that no longer relates to their economic uses as minerals (as a material to extract metals or pharmaceuticals), but rather to their value within a cultural practice of collecting. This means that their value is no longer determined by their material components, nor primarily by their appearance, but rather by the place within a system of arrangement, and by the collector's purposes and particular needs (i.e. for minerals from a specific region).

A second transformation of minerals within this peculiar sphere of mineral dealing and moving objects relates to a new accessibility of minerals, of their overall nature, which might be paraphrased as an accessibility of *nature by catalogue*. The

⁸⁰ On the early years of the firm see Peter Schmidt, Adam August Krantz—Briefpartner Alexander von Humboldts, in: *Acta historica Leopoldina* 27 (1997), 75-88.

⁸¹ With regard to this meaning of the civic culture of the Biedermeier era, i.e. the close relation of Leonhard's work to it, in a broader sense, this work might also be discussed as a particular representation of a new (German) style or practice of earth sciences. This practice was related less to mining, and to technical and economical uses of minerals and rocks, than to the new civic culture of the Biedermeier era in the sense stated, and, thus, might be called civic mineralogy/geology. For a more particular discussion of (scientific) styles in 19th century German earth sciences see Bernhard Fritscher, *Erdgeschichtsschreibung als montanistische Praxis: Zum nationalen Stil einer 'preußischen Geognosie'*, in: *Staat, Bergbau und Bergakademien im 18. und frühen 19. Jahrhundert*, ed. by Hartmut Schleiff and Peter Konečný. (*Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte*, special issue) Stuttgart (2012) (forthcoming).

mineral dealer (i.e., dealing in minerals) works as a mediator between minerals and their collectors, or, in a broader sense, between nature and society. A new access to nature is provided which is no longer restricted by requirements such as, for instance, finding minerals at their deposits, or acquiring knowledge about minerals: rather, nature, as *nature by catalogue*, is open to anybody. Such a general availability, of course, might also support a kind of *amateur practice* of collecting, i.e. a simple ticking off of pre-labelled objects from a list (so-called 'stamp-collecting'), without the need for any mineralogical or geological knowledge. Professional mineral dealers, such as Leonhard, however, rather intended to thwart such a practice. Their intention was to offer systematically ordered collections to prevent their customers from mere collections of curiosities, or, in other words, they did not sell just minerals but also the scientific knowledge of these minerals. They did not only bring minerals to the sitting-rooms of their customers, but also (modern) science. In this sense a more detailed discussion of sales catalogues of mineral dealers—mentioned only marginally in this paper—should be the subject for particular investigation in further research.

Maria M. Portuondo, *Secret Science: Spanish Cosmography and the New World*. Chicago: The University of Chicago Press, 2009, 360 pp. ISBN: 978-0226675343.

*By Antonio Sánchez**

Today, the history of early modern science is directed towards less reductionist paths than those that characterized the traditional narratives of the so-called *Big Picture*. Following such trend, the scientific activity of the Spanish and Portuguese empires related to navigation, cosmography, and natural history began to attract a wide scholarly interest and became an important topic in the historiographical context of Atlantic history. This new line of research erupted within a field open several decades ago by authors such as José María López Piñero in Spain, and Luis de Albuquerque in Portugal.

Recent publications offer a revised approach to an old problem, namely, the intricate relationship between scientific knowledge and imperial power, in an era without modern nation-states or professional organization of scientific disciplines. The authors of such studies agree on the difficulty of both shed light on the conditions in which scientific knowledge was produced within the complex network of long distance, and on how to impose some control over that knowledge. However, there is an overall consensus that the encounter between the old and new continent anticipated those practices that Baconian philosophy considered favourable to exert control and domination over nature, with elements as important as experiment, empirical observation, the institutionalization of scientific practice, mapping or the collection of botanical information.

Maria M. Portuondo's *Secret Science: Spanish Cosmography and the New World* – recently awarded the prestigious John E. Fagg Prize from the American Historical Association – stands out among this revised literature. After the contributions of Jorge Cañizares-Esguerra, Antonio Barrera-Osorio and Alison D. Sandman, Portuondo joins the field of the history of early modern Iberian science with a provocative title. Portuondo's book explores the cosmographical activity of Spain in the sixteenth century, a cultural context in which the role of the *Cosmógrafo Real*

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(Royal Cosmographer) and cosmography was simultaneously bureaucratic and intellectual. While cosmographers tried to offer an efficient explanation of the New World, cosmography emerged in the midst of the social and cultural interactions that took place in a courtier context, responding to the demands of its patrons. The author shows how cartographic production was part of the humanist circles and courtier culture, as well as of bureaucratic structures in Philip II's Spain. Portuondo argues that scientific activities were never independent of the administrative needs of the Spanish empire and the curiosity of their monarchs, contrary to what has been sustained by traditional historiography. In this context, scientific projects sponsored by the monarchs were considered 'state secret', which, according to Portuondo, has led to the invisibility of the early modern Spanish science.

Portuondo's book focuses on famous sixteenth-century Spanish cosmographers such as Alonso de Santa Cruz, Juan López de Velasco, Juan Bautista Gesio and Andrés García de Céspedes. These and other cosmographers, servants of the crown, were committed to compile and organize the knowledge that would enable the definition of the geographic boundaries of the empire, in order to operate the administrative machinery of the Hapsburgs. Cosmographic knowledge had two main objectives: on the one hand, cosmography had a priceless domestic value for the operation of the internal politics of the monarchy; on the other, cosmography was a useful science for the international strategy of the Spanish monarchs.

Portuondo studies in depth three centres of knowledge production: the *Casa de la Contratación*, the Indian Council and the court. These spaces favoured what the author characterizes as 'cosmographical styles', an official scientific practice with different modalities. The development of such cosmographical styles at different centres was always carried out in the context of utilitarianism. Personal aspirations which did not serve the needs of the monarchy or were subordinate to the interest of the State had to be abandoned.

According to Portuondo, the utilitarian demands of the empire suggest that Spanish cosmographers had little to do with speculative natural philosophy, but had much to say about descriptions of the real, visible and tangible world. Aristotelian natural philosophy had no place in a patronage system driven by the usefulness of the results. In fact, cosmographers were not concerned with the causal analysis of the observed phenomena or with the revelation of the secrets of nature. Theirs was the task of identifying and organizing useful knowledge to the benefit of the empire. In this context, the crown did not require a new Baconian natural philosophy in as much

it was engaged in the explanation of the new reality that their vessels found across the Atlantic.

In short, Portuondo's work provides a fertile field to the new generation of historians of science and her book has definitively contributed to demolish the argumentative pillars on which rested traditional historiography.

Natalie Pigéard-Micault, Charles-Adolphe Wurtz : Un savant dans la tourmente: entre bouleversements politiques et revendications féministes. Paris: Éditions Hermann, 2011. 170 pp. ISBN 978 2 7056 8076 3.

*By Bernardo Herold**

After the publication of the comprehensive biography by Alan Rocke “Nationalizing Science, Adolphe Wurtz and the Battle for French Chemistry”, MIT Press 2001, and the presentation in 1992 of the unfortunately never published PhD thesis at the University of Kent by Ana Carneiro “The Research School of Chemistry of Adolphe Wurtz, Paris 1853-1884”, it looked as if there was nothing else to add to the existing literature on this outstanding French chemist. It is thus a pleasant surprise to be faced now with a captivating narrative, *Charles-Adolphe Wurtz, Un savant dans la tourmente*, authored by Natalie Pigéard-Micault, who adopts an entirely new point of view. Much of what has been covered by earlier biographies is well summarized in the introduction, which describes Wurtz’s origins, his evolution as a disciple of Liebig and Dumas and his early support of atomism. The main subject of the book is, however, Wurtz’s activity as dean of the Faculty of Medicine of Paris. He began his career in this institution, in 1853, as professor of organic and medical chemistry, and was appointed dean, in 1866, a position he held until 1875, when he resigned, keeping nevertheless the title of honorary dean, and becoming professor of organic chemistry at the Faculty of Sciences.

At the Faculty of Medicine, he established a research school, which hosted students from different nationalities and beliefs in an atmosphere of great tolerance. Pigéard-Micault shows how popular Wurtz was among his students. He took care of them both professionally and personally in different ways, including humanitarian support when one of them was imprisoned for political motives. The author also focuses on Wurtz’s role in giving women access to medical studies. She interprets Wurtz’s responsible care for the well-being of his students and his position towards women as a reflection of his upbringing.

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As dean Wurtz had to face the political turbulence caused by the opposition of republican and left wing students to the imperial regime. The author successfully provides readers with a view of the ideological and political intricacies of those days, and shows how Wurtz was able to rule the Faculty in a fair and benign way, without losing entirely the trust of the imperial government. At the same time he managed to keep freedom of teaching and learning inside the Faculty. Among the medicine students were some of the most radical socialist activists, including those of a Marxist orientation. This meant also that he found himself amidst enraged battles of doctrinal and ideological nature, which went on in Paris under Napoleon III. On the one hand, there were the conservatives influenced by the clergy, who opposed any ideas they thought of as being contrary to the most restrictive interpretations of the Catholic doctrine; on the other, were those rebellious students and teachers who preached atheism and materialism.

As the author shows, this conflict naturally penetrated scientific debates. The clergy and some of Wurtz's medical colleagues saw atomism as materialism, therefore denying the existence of a human soul in a body constituted by atoms and molecules obeying the laws of Physics and Chemistry. In turn, those who preached positivism as the exclusive pathway to truth saw in atoms something, which could not be observed or measured and thus as objectionable as the belief in the presence of Christ's body in the communion wafer. The political turmoil reached its climax during the siege of Paris in the Franco-Prussian war (1870/71) with the Paris Commune.

Pigeard-Micault's narrative concludes with Wurtz's return to Chemistry after his resignation as dean, in 1875. Atomism, however, was then losing ground. His main opponent in Paris was Marcelin Berthelot, but even some of his own students began to treat atomism as a mere unproven hypothesis.

The author deals very sensitively with the human aspects of Wurtz's role, by emphasizing the relevance of his origins as a son of a Lutheran minister in Strasbourg and how this helped him to stay independent from both extreme religious and secularist views. Theology, as taught then in countries and regions of protestant majority, began to incorporate certain aspects of historical critical interpretations of the Bible. In France, on the contrary, there was no possible conciliation between the Catholic Clergy and the ideas of thinkers such as Ernest Renan, the author of the famous *Life of Jesus*. Wurtz's cultural and religious roots certainly helped him to keep an independent posture in relation to these conflicts, and advocate freedom of thought and teaching.

Pigeard-Micault's account of Wurtz's activity as an academic leader gives a wealth of information not only on the Alsatian chemist and his school but also on the intellectual, social and political atmosphere, in France, under Napoleon III, notably the young leaders of the republican opposition who were to shape the III Republic. The book is written in clear classical French, but accessible to a reader, who learned French as a foreign language.

Johan Schot, Harry Lintsen, Arie Rip, eds. *Technology and The Making of the Netherlands: The Age of Contested Modernization, 1880-1970*. Zutphen/Cambridge MA: Walburg Press/The MIT Press, 2010. 635 pp. ISBN 978-90-5730-630-3; 978-0-262-01362-8.

By Maria Paula Diogo *

This edited volume presents an excellent overview of how 20th century Netherlands was constructed. However, its interest clearly crosses national borders, as the way in which the Dutch case is addressed is an opportunity to apply and discuss new concepts and methodological approaches.

The book, which is the English translation of the final volume of a Dutch series on technology in the Netherlands in the 20th century, is divided into 10 chapters, ranging from infrastructures to colonialism, from engineers' organization to industrial agriculture, from scale increase in industry to consumption standards, from airports to kitchens. Behind this large array of topics lays a unifying view that brings to the forefront the importance of technology in the building of national identities and transnational relationships.

In the preface, the editors offer readers a brief recollection of the process behind the making of the book, including the discussions, and research projects that made it possible, and the international networks that enriched it. Presiding over the book and presented both in the Preface and in the first chapter, one main concept and one methodological claim stand out: "contested modernization" and "history through the lens of technology".

As to the first notion, the editors and authors use it to highlight the dynamics of modernization, presented as a vivid, sometimes even tumultuous, site- and time-specific process, which cannot be perceived as a closed, monolithic category. In this context, building and theorizing "modernity" is not necessarily the same as experiencing it, and therefore modernizing priorities are not the same for elites, including engineers, architects, artists, management consultants, or business men, and for the common consumer. Nevertheless, and taking into account unsolved tensions that persist even today, technological development has asserted itself as the main path

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to modernity – “Beginning around 1890, the ambition to modernize using the technological avenue was shared by a large majority of the Dutch population (...)” (p. 17).

In a broader perspective, editors and authors share a methodological approach that aims at analyzing technology as a building block of contemporary historical processes, not just as a more or less influential accessory. To “render visible the co-construction of technology and society” (p. 14) is undoubtedly an ambitious and tantalizing proposal, which though not completely new, gains a new scope and depth in this volume.

Based on these two central ideas, the book offers a specific periodization for the late 19th century and 20th century Dutch history: a first period, from 1890 to 1914, in which the creation of a modern period is discussed; a second period, from 1918 to 1939, which focuses on the notion of “controlled modernization”, and raises parallels to mass consumption and mass production; the final period, between 1945 and 1970, deals with the establishment of a culture of modernity based on the dominance of mass production and mass consumption. In between these periods, the two world wars were instrumental to the Dutch modernizing agenda: during World War I, the Netherlands’s neutrality was crucial to the country’s agricultural and industrial growth, and was behind the building of international informal networks, as well as the strengthening of nationalism; during and after World War II Dutch, economy was able to successfully manage difficulties and benefiting from the Marshall Plan aid, to build a long cycle of sustained and significant growth. According to the editors, this period of about 20 years (the decades of 1950 and 1960) was at the core of the process of democratization of prosperity, which meant necessarily to have access to technological commodities: automobile, telephone, refrigerator, washing-machine, and central heating.

Within this framework, the authors of the remaining 9 chapters focus on specific technologies, on how, why and by whom they are used, and to whom are they addressed: the building of national infrastructures (chapter 2); the planning of individual and collective spaces (chapter 3); the development of mass production (chapter 4); the definition of a research and development policy, based on technical education and research laboratories (chapter 5); the construction of colonial technologies (chapter 6); the rise of a technocratic agenda among Dutch engineers (chapter 7); the relation between economic growth, technological development and welfare (chapter 8); the modernization of the Dutch economy, both on the agrarian

and industrial sectors, and the rise of the consumers' society (chapter 9); finally, the rise of a new technological consumer culture, born from the criticisms to the mass consumption pattern and the awareness to a new technological environment embedded in today's culture (chapter 10). All chapters are illustrated with suggestive pictures.

This volume is most appealing to a general informed public, interested in contemporary European history. Although based on the Dutch case, any European reader is able to empathize with the analysis provided by the authors, either due to similarities or differences with his/her own national history. For historians of science and technology, both researchers and students, this book is a *must*, a reference to be taken into account in future studies within these fields, and hopefully an encouragement to future comparative studies.

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Journal of History of Science and Technology

Vol.5, Spring 2012

ISSN 1646-7752

www.johost.eu
