Snapshots of tropical diversity: collecting plants in Colonial and Imperial Brazil

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The natural historian Richard Spruce was one of the most prodigious collectors of Amazonian plants in Imperial Brazil. During 15 years (1849-64) he explored the length of the River Amazonas from the Atlantic to the Andes, collected tens of thousands of plant specimens and discovered hundreds of new species. In his posthumously published memoire *Notes of a botanist on the Amazon & the Andes* (1908), Spruce was concerned about his 'apparent vandalism' through felling trees hundreds of years old and as many feet high for the sake of a few specimens (Spruce 1908: vol. 1, 2-4)[1]. He salved this conscience arguing a 'forest which is practically unlimited' would hardly be affected by the removal of a single tree and his 'specimens would be stored in the principal public and private museums in the world', thus adding to knowledge and enhancing commerce.

[Fig 1. here]

In the early nineteenth century, the French zoologist Georges Cuvier caricatured practitioners of European natural history as being, like him, those who studied minutiae in the laboratory and library, or those, like Alexander von Humboldt, engaged in the broad, 'cursory' practice of fieldwork (Outran 1996). Despite Cuvier's strategic slight at von Humboldt and fieldwork generally, natural historians have been willing to reward collectors for rare, well-prepared specimens from exotic places (Endersby 2008). Furthermore, 'closet natural historians' and 'field

[1] Gardner (1849: 231) expressed similar sentiments when he collected a specimen of *Qualea gardneriana* Warm. (*Gardner* 2821): 'there was no other way of obtaining specimens than by cutting the tree down … this fine tree, which I was sorry to see destroyed, came to the ground with a tremendous crash'.

naturalists' may be the same people, for example, Joseph Hooker, at different points in their lives (Desmond 1999).

Collecting and maintaining natural history objects is expensive. Even before a collection is made, a collector must acquire appropriate permissions, travel to remote places, equip and feed themselves, and pay helpers. Once collected, specimens must be processed, preserved and transported back to the collector's home country. At home, if specimens are to make a lasting scientific contribution, the expenses do not stop; they must be labelled, processed and incorporated into well-managed, accessible, permanent collections (Harris 2011).

Ever since its discovery, Brazil has captured the imaginations of Europeans because of its economic potential, strategic importance, exoticism or sheer biological diversity. Yet the efforts of the Portuguese monarchy meant foreigners were largely unwelcome until 1808, when the flight of the Portuguese Court from Lisbon forced Colonial Brazil to emerge from its prolonged isolation. In 1822, formal ties with the Portuguese Crown were cut and Brazil became an Empire (Disney 2009). By the middle of the century, foreigners were commonplace in Brazil, leading Victorian explorer Richard Burton to recognise five broad classes: merchants; engineers; naturalists; doctors; and, most incongruously of all, dentists (Burton 1869: 1). Foreigners investigating all aspects of Brazilian natural history became part of Brazilian everyday life.

The purpose of the present paper is to illustrate the field techniques used, and the problems faced, when foreigners collected dried plant (herbarium) specimens in Colonial and Imperial Brazil. The focus will be George Gardner, a poorly-know, Scottish professional plant collector, and the privateer and navigator William Dampier. Gardner (1849) rode and walked thousands of kilometres through unexplored areas of the interior of Brazil between 1836 and 1841, collecting between 120,000 and 180,000 specimens which made major contributions to our understanding of the Brazilian flora. In contrast, Dampier's month-long visit to the port-city of Bahia de Todos dos Santos (Salvador) in 1699 produced a small collection of dried plants which caused a flurry on interest when they were returned to London in 1701 but made no lasting contribution and were ignored for nearly 300 years (Harris *et al.* submitted).

Preparing specimens

In the 1540s, the Pisa-based physician Luca Ghini (1490-1556) developed a technique for long-term preservation of plants; he dried them flat under pressure (Morton 1981: 120-123, 153). The technology for making herbarium specimens soon circulated among European natural historians (Findlen 1996, Ogilvie 2006). In 1586, the English naturalist William Turner referred to the herbarium of John Falconer, a pupil of Ghini, although until the end of the seventeenth century such specimens were uncommon (Turner 1586: 12, Morton 1981). On 5th November 1665, Samuel Pepys was surprised by John Evelyn's *Hortus Hyemalis* with 'leaves laid up in a book of several plants kept dry, which preserve colour, however, and look very finely, better than any Herball' (Pepys 1854: 320). The naturalists Hans Sloane and William Sherard were amassing private collections, which became the foundations of the British Museum and Oxford University Herbaria, respectively, whilst Dutch and French institutions were busy building national collections (Dandy 1958, Clokie 1964). Of course, amidst collection-building activities, naturalists, such as John Ray and Leonard Plukenet, were using specimens to make catalogues and classifications of the ever-growing number of known plants (Morton 1981).

Labelled herbarium specimens, the gold standard of botanical documentation, are physical evidence for a species' occurrence at a particular point in time and space. Specimens avoid the problems of translating literature records of vernacular names, variously-applied scientific names or ambiguous images, into scientific names across time and cultures. Even poor specimens are better than trying to interpret limited descriptions made by poorly trained observers using arbitrary technical language, especially when differences among species are subtle. Specimen preparation, essential if the specimen is to survive in a collection and be useful, is an apparently simple process but requires attention to detail; 'there are many ways of making an herbarium, but few ways of making a good one' (Clute 1904: 1).

About sixty years after Ghini's development of the technique, the Flemish anatomist Adriaan van den Spiegel gave brief instructions for herbarium specimen

preparation (van den Spiegel 1606: 79-81). He emphasised that samples, comprising flowers, leaves and seeds, be placed between sheets of paper among the pages of a book. As samples dried, they were to be checked daily and weights gradually applied so the specimens were kept flat.

When William Dampier returned to Britain at the beginning of the eighteenth century, with a 'good number of Plants, dried between the leaves of Books' (Dampier 1703: 72, Harris *et al.* submitted), he appears to have been relying on John Woodward's (1696: 12) *Brief instructions for making observations in all parts of the world*:

> To *preserve* these Samples of Plants, put them each *separately*, betwixt the leaves of some large *Book*, or into a Quire of brown *Paper*, displaying and spreading them *smooth* and even. The *next day*, and *afterwards three or four times* at due distance, *shift* them into *other Books* or *Paper*, till they are *sufficiently* dryed, when a *weight* may be laid upon them to press and smooth them; and so keep them, in some *dry place*, till they be sent over, sending them in Quires of brown Paper, and writeing on the outside *in what Country* the inclosed Collection of Plants were *gathered*. For, both of these, and all other things, 'twill be proper to put up the *Productions of each Country apart*, or at least with such distinction it may be known *whence* they all came.

Woodward emphasised that it was essential to collect the right material:

> As to *Plants* (as well those that grow at Sea, in Rivers, and Lakes, as those that grow at Land) *four Samples of each kind* (wherever there is any difference in Colour, or Figure, of the Leaf or Flower) will be sufficient. Where the Plant is large, as in *Trees*, *Shrubs*, and the like, a *fair sprig*, about a *foot* in length, with the *Flower* on, [illegible word] if that be to be had, may suffice: but of the *lesser Plants*, such as *Sea-Weeds*, *Grasses*, *Mosses*, *Ferns*, &c. take up the *whole Plant*, root and all. Chuse all these Samples of Plants *when they are in prime*, I mean in *Flower*, *Head*, or *Seed*, if possible; And if the *lower* or *ground Leaves* of any Plant de *different* from the *upper leaves*, take two or three of them, and put them up along with the Sample.

By the beginning of the nineteenth century the basic principles were unchanged, but collection paraphernalia was increasing (Graves 1818: 294-295):

> [specimens] must be gathered on a dry day, and placed in a common tin vasculum or pocket herborizing Box, as collected, and secluded as much as possible from the air, on returning home the plants should be

> carefully spread upon paper, and covered with a few sheets of common blotting paper and placed under some small degree of pressure, after the plants have remained in this state for twenty-four hours, the papers should be examined to observe if any of the leaves or flowers are in a distorted or unnatural position, as they will at this time be perfectly flexile, and can easily be restored to a natural position, they should be again covered with blotting paper, and the plants gently smoothed with a heated flat iron, such as used for domestic purposes; this maybe repeated till they are quite dry … Such plants as are evergreens, or succulent, will retain their foliage better if previously to drying they are immersed in boiling water, and then carefully dried.

Some manual authors, concerned specimens 'soon lose their colours in an herbal', recommended elaborate methods to preserve colour, involving paint or chemical cocktails (Donovan 1805: 81). In contrast, William Hooker offered 'a few plain instructions for collecting and transporting plants in foreign lands' (Hooker 1849: 400). Rather than fussing with colour-conservation concoctions, Hooker gave simple, practical instructions to produce scientifically-valuable specimens. Despite its simplicity, the technique was time consuming and considerable practise was needed if useful specimens were to be made from Hooker's cursory instructions.

Plants were to be treated in 'such a manner that their moisture may be quickly absorbed, the colours, so far as possible, preserved, and such a degree of pressure imparted that they may not curl in drying'. To do this it was necessary to have abundant paper 'of moderate folio size and rather absorbent quality' (Hooker 1849: 402). Hooker recommended Bentall's Botanical Paper (20.5 cm x 25.6 cm at 15 shillings per ream), a paper specifically manufactured to supply the burgeoning interest in botanical collecting (Allen 1984; Endersby 2008). Specimens also had to be protected in paper folders once they were dry and boxed. In practise, it is likely tropical collectors relied on local resources for their paper rather than the import special European paper

Solutions to the recurrent problem of drying damp paper were sometimes ingenious. Spruce for example had recourse to 'a French baker who lived near to have the use of his oven every morning after the daily bread had been withdrawn from it', although 'paper never got half so well dried in this way as it did when spread out on the sand under a broiling sun' (Spruce 1908: vol. 1, 119). On at least

one occasion Gardner was forced to dry specimens and paper in the enormous pans used to make *farinha*, the sawdust-like, staple food Brazilians make from cassava (*Manihot esculenta* Crantz; Gardner 1849: 252).

Hooker's recommended process for drying plants was unsophisticated and required a minimum amount of equipment, all of which would have been locally available. Yet for succulents, pines and heathers a dip into boiling water was recommended; hardly a practical field technique (Hooker 1849: 403-404).

> Two boards are required, of the same size as the paper, one for the top, the other for the bottom of the mass of papers. Some pieces of pasteboard (or millboard) placed between the specimens, if these are numerous or particularly thick and woody, are very useful. For pressure nothing is better than a heavy weight on the topmost board, or, while travelling, three leathern straps and buckles, two to bind the boards transversely, and one longitudinally. ... Place them [plants], as quickly after being gathered as you can, side by side, but never one upon the other, on the same sheet of paper, taking care than one part of the bundle be not materially thicker than the other; and lay over the specimens one, two, three, or more sheets of paper, according to the thickness of your paper and of your plants; and so on, layer above layer of paper [and] specimens, subjecting them to pressure. In a day or two, according to [t]he more or less succulent nature of the plants and the heat and dryness of the climate, remove then into fresh papers, twice or oftener, till the moisture be absorbed, and dry the spare papers in the sun or by a fire for future use.

[Fig 2. here]

The other piece of equipment recommended by Hooker was a vasculum; 'if the specimen cannot be laid down as soon as gathered, they should be deposited in a tin box [vasculum], which indeed is essential to the botanist when travelling; there they will remain uninjured for a day and night, supposing the box to be well filled and securely closed to prevent evaporation' (Hooker 1849: 403-404, Baker 1958, Allen 1965). Initially, vascula were rare, coveted objects and, as well as being practical, acted, like hand lens, as badges to identify serious botanists (Endersby 2008). An alternative method of temporarily keeping plants was a field press,

similar in construction to the drying press but lighter and less robust (Clute 1904: 1-5).

Woodward emphasised the importance of collecting plants from all parts of the natural world and in all seasons. Furthermore, notes were to accompany specimens, although he was pragmatic about how much data would, or could, really be collected (Woodward 1696: 15-16):

> *Observations* to be made both at Sea and Land are *very many*, and the Plants. Minerals, and Animals, to be *collected*, are also very *numerous*, 'tis not expected that any one *single Person* will have *leisure* to attend to *so many things*, and therefore 'tis only requested that he make such Observations and Collections, more or less, as may be best *suitable* to his Convenience, and to his *Business.*

To ease the burden, physical collection and preservation of natural history objects could always be delegated to the '*Hands of Servants*', although, prudently, in 'their spare and *leisure times*' (Woodward 1696: 16).

Plant collectors were encouraged to acquire economically valuable information since 'we frequently lose the advantage that might otherwise accrue from the introduction of exotic plants' (Graves 1818: 291). Surprisingly, Hooker omitted to make mention of the type of data collectors should record with their specimens, although collectors were encouraged to take careful note of all plants that might give economic advantage to the British Empire (Hooker 1849: 403-404). Covert means of plant collection were even recommended for 'countries which we are not permitted to explore'; for example, 'the curious traveller may obtain many rare plants, if he will examine the fodder that is brought down from the country, by the natives' (Donovan 1805: 78).

If natural history objects so carefully selected, collected and preserved in the field were to be of scientific use, they had to be safely returned to England. For collectors who were in the field for long periods it was essential to return specimens in batches to spread risk of loss, maintain income and create space to collect more specimens. Space limitations could leave collectors with frustrating choices: 'I [Spruce] had been able to take … only two small bundles of drying paper which I wished to reserve for the plants of humble growth … I had left several

interesting plants … the specimens of which would have been so bulky as speedily to fill the papers' (Spruce 1908: vol. 1, 429).

Woodward was concerned with packing specimens such 'that the things be not *broken*, or *rifled* and *confounded* by the *Custom-house Officers* and *Searchers*' (Woodward 1696: 16). Hooker was also particular about how specimens were to be shipped (Hooker 1849: 403):

> When sufficiently dry the specimens should be put into dry papers, one sheet or folio between each layer of plants, except they be unusually woody ... and then more paper must be employed, care being used to distribute the specimens pretty equally over the sheets, and thus a great many may be safely arranged in a small compass. They are now ready for transport, either packed in boxes or covered with oil-cloth. It is almost needless to add that all plants, whether living or dried, ought to be transmitted to Europe with the least possible delay: the latter, especially in hot or moist climates, are often soon destroyed by the depredations of insects.

For collectors who amassed tens of thousands of herbarium specimens, and shipped them back to Europe in Hooker's prescribed manner, hundreds of reams of paper were needed; paper that had to be carried either by pack animal or boat.

In 1851, Spruce encountered an unexpected difficulty dispatching specimens to London: 'In this land of forests I cannot find boards to make a packing case! I brought a large one with me from Santarem, but how I shall get another I cannot tell. As I found no difficulty in this matter at Santarem, I did not dream of any here, but a sawmill which existed here was burnt down two years ago, and since then no planks have been prepared at the Barra [Manaus]' (Spruce 1908: vol. 1, 209).

Besides formal instruction manuals, foreign plant collectors in Brazil had the published memoires of their predecessors as sources of advice. However, this created the twin problems of: separating the tales of those 'more famed for their wit than their veracity' (Gardner 1849: 11) from those who reported useful information from personal observations; and obtaining information untainted by authors' political, social or religious prejudices.

Instruction manuals provided advice on broad collection and preservation techniques. Authors of memoires provided information about general conditions in

a country or region and how they coped under particular circumstances. Once abroad plant collectors were alone and had to respond to circumstances, modifying their activities in the light of experience and the conditions they found; the very best collectors were able to do this, and frequently sustain it for years. Plant collectors had to be dedicated and adaptable. In the nineteenth century, men such as William Hooker recognised that if his personal collection (and ultimately that of the Royal Botanic Gardens Kew) and other European collections were to expand with tropical plants excellent collectors had to be sponsored. Among Hooker's harvesters were Gardner and Spruce.

Botanical exploration in Brazil

Brazil came to European attention when Pedro Álvares Cabral made landfall near present-day Porto Seguro (Bahia) in 1500. Cabral's discovery was quickly followed by Portuguese expeditions to explore the Brazilian coast, name prominent coastal features and establish fortified trading posts. Portugal's initial interests in Brazil were to establish a foothold in the Americas and secure supplies of the dye Brazil, extracted from the wood of *Caesalpinia echinata* Lam. (Disney 2009: 206-207, Gesteira 2013: 31).

Specific mention of Brazilian plants had started to appear from the mid-sixteenth century, for example, André de Thevet's *Singularités de la France antarctique* (1558) and Jean de Léry's *Histoire d'un voyage faict en la terre du Bresil autrement dite Amerique* (1578) (da Cunha 1999: 15-38, Kury 2012). Despite hyperbole in these reports, botanical details were often astutely observed, especially regarding local names, medicinal uses and cultivation. For example, Thevet gives the earliest recognisable descriptions of cassava, pineapple (*Ananas comosus* (L.) Merr.), peanut (*Arachis hypogaea* L.) and tobacco (*Nicotiana tabacum* L.). However, it is the German astronomer Georg Markgraf, at the beginning of the seventeenth century, who is credited with the first investigation of Brazilian plants that returned herbarium specimens to Europe (von Ihering 1914).

Markgraf was part of Johan Maurits van Nassau-Siegen's entourage, charged with establishing a government in Dutch Brazil (present-day northeast Brazil),

between 1637 and 1644 (van den Boogaart *et al.* 1979). Markgraf systematically catalogued plants and animals, and his edited notes were posthumously published in Piso and Markgraf's *Historia Naturalis Brasiliae* (1648), establishing him as the most important natural historian of early modern Brazil (Gesteira 2013). Following expulsion of the Dutch from Brazil in the mid-seventeenth century, scientific study of Brazilian plants was virtually ignored until the researches of the Italian-born naturalist Domenico Vandelli at the end of the eighteenth century (Urban 1906, Gesteira 2012)[2].

At the beginning of the eighteenth century there was brief interest in a small collection of Brazilian plants made by William Dampier (Harris et al. submitted). In 1699, the English Crown commanded Dampier, an experienced sailor, to circumnavigate *Terra Australis* and investigate its commercial potential. Dampier arrived in Salvador, historic capital of Colonial Brazil, on 25th March 1699. On 23rd April, he hurriedly departed concerned he had been denounced to the Inquisition. During his month in Brazil Dampier collected plants around the city as he was want to 'recreate' himself 'in the Fields' (Dampier 1703: 89). Despite Woodward's instructions, Dampier's specimens are usually fragmentary; the largest would fit within the borders of a sheet of A4 paper (Harris et al. submitted)[3]. Dampier returned to England in August 1701 with his collection which was given to Woodward, where it was studied by Ray and Plukenet, before being passed on to William Sherard and effectively 'lost' (Harris et al. submitted).

[Fig 3. here]

In 1766, Louis-Antoine de Bougainville on his circumnavigation of the world made a brief stop in Rio de Janeiro. This expedition was notable because the 'male' assistant of the ship's naturalist Philibert Commerson, was found to be female; Jeanne Baret became the first woman to circumnavigate the world (Schiebinger

[2] Vandelli's *Fasciculus Plantarum cum novis generibus et speciebus* (1774) and *Florae Lusitanicae et Brasiliensis specimen* (1788) included Brazilian plants, although Vandelli never visited Brazil himself.

[3] Twenty seven of Dampier's Brazilian specimens are deposited in the Sherardian Herbarium (Oxford University Herbaria). Dampier also recorded the names and uses of 73 plants he encountered in Brazil. Importantly he distinguished between first- and second-hand information (Dampier 1703).

2003). Four years later, James Cook and his crew were prevented from coming ashore in Rio because their ship was believed to be a smuggling vessel (Parkinson 1773). Joseph Banks, the ship's naturalist, sent Daniel Solander ashore to collect plants and animals covertly (de Lima *et al.* 2012). Banks was well aware hurried collections of itinerant travellers were no substitute for collections made by naturalists with detailed insights into the areas they were investigating. Banks returned to England, convinced professional collectors were essential to secure the plants needed by the British Empire (Desmond 1998).

Forty-six years after his frustrating visit to Rio, Banks, *de facto* head of the Royal Botanic Gardens Kew, ordered Allan Cunningham and James Bowie, to collect plants in Brazil (Hewaud 1842: 237-238). Despite their successes, Cunningham and Bowie remained functionaries, subservient to the caprices of their powerful employer. In contrast, other collectors were independent of the whims of employers and could spend extensive periods collecting plants when and where they wanted. William Burchell was tied to neither employer nor learned society and took full advantage of this freedom. Between 1805 and 1810 he collected plants on the mid-Atlantic island of St. Helena and in 1811 began collecting in Africa. In 1825, at the age of 44, he went to Brazil and spent five years exploring and collecting from São Paulo in the south to Belém in the north (Smith and Smith 1967, Martins and Drive 2005).

Many scientific expeditions collected botanical specimens in Brazil. For example, Friedrich Sellow began exploring Brazil in 1814 with funding from Banks and Aylmer Lambert. He sent vast amounts of material back to Europe; 'no botanist, who has trodden the soil of Brazil, has ever so thoroughly examined the country, and in such various directions as Sellow. … the herbarium left by this indefatigable but unfortunate botanist and traveller, amounts to 10,000 species!' (von Martius 1837: 31). Between 1816 and 1822, Augustin Saint-Hilaire undertook some of the most extensive and important botanical exploration of nineteenth-century Brazil; he returned to France with a collection of approximately 7,000 species (Gesteira 2013). Georg von Langsdorff's expedition explored Brazil from the state of São Paulo in the south to Pará in the north between 1821 and 1829 (Barman 1971).

Despite the number of botanical specimens returned to Europe, it was the Österreichische-Brasilien Expedition (1817-1835), a systematic exploration of Brazilian plants, animals and ethnography, which was to have the greatest effects on understanding of the Brazilian flora (von Spix and von Martius 1824). Financed by the Austrian Empire, the Expedition began following the marriage of Archduchess Maria Leopoldina and the Crown Prince of Portugal, later Dom Pedro I of Brazil. The principal botanical contributors to the Expedition were by Carl von Martius, who returned to Europe in 1820, and Johann Pohl, who returned a year later.

Once material had been collected in Brazil it needed to be processed and published in a timely fashion. The quantity of material collected and the diversity so great that in some cases publication was a slow process. Saint-Hilaire spent the last 31 years of his life writing up publications based on the collections he had made in six years of Brazilian fieldwork, whilst von Martius devoted the last 48 years of his life preparing publications from three-years fieldwork, and writing the *Flora Brasiliensis* (1840-1906); still the most important general work on Brazilian plants.

In 1837, von Martius complained of Burchell's tardiness in publishing the results of his Brazilian research: 'he is said to have taken home noble collections from the provinces of Minas, Goyaz, and Mato Grosso; but at present we hear nothing of the probability of their being published' (Martius 1837: 47, Smith and Smith 1967). Burchell's problem was he had collected so much material during his lifetime that it was unrealistic that he could ever hope to sort, identify and publish all of it (Martins and Drive 2005). He was defeated by his own enthusiasm for collecting, fieldwork and the realities of life outside the field; a familiar failing of natural history collectors, including Gardner.

Failure to publish may be outside of the control of the collector. For example, at the end of the eighteenth century, the Brazilian-born, Portuguese-educated naturalist Alexandre Rodrigues Ferreira was employed by the Portuguese Crown to explore the economic potential of central and northern Brazil. The numerous natural history specimens his tiny, poorly-resourced team collected were dutifully shipped back to Lisbon. The specimens, together with Ferreira's extensive notes,

gathered dust in archives, unstudied and unappreciated for over a century (Rodrigues Areia *et al.* 1991).

[Fig 4. here]

Financing fieldwork

Funds are essential for successful fieldwork (Harris 2011). It was not unusual for natural historians to fund their travels through selling specimens. In the 1720s, the English botanist Mark Catesby was funded by a cartel of wealthy subscribers to collect plants and animals in the southern parts of the United States of America (Harris 2015). Sixteen initial subscribers benefited from Gardner's Brazilian labours, as he sent bundles of herbarium specimens back to Britain for Hooker to distribute[4]. Gardner's subscribers included 'elder statesmen' of European botany, e.g., Jules Delessert and Nathaniel John Winch, but most were at the start of their botanical careers, e.g., John Hutton Balfour who became Regius Keeper of the Royal Botanic Garden Edinburgh, Stephan Endlicher later Director of the Botanical Garden of Vienna, whilst George Bentham and John Lindley became two of the foremost taxonomists of their day. Nathaniel Ward, inventor of the Wardian Case, subscribed to Gardner's expedition, as did the accumulator of herbarium specimens Henry Borron Fielding[5]. For horticulturalists, such as the sixth Duke of Bedford, at Woburn Abbey, and Stewart Murray at Glasgow Botanic Garden, the living plants Gardner packed into Wardian cases were of greater appeal than dried specimens.

Initially dried specimens were returned to Hooker and living material to Murray for distribution to Gardner's subscribers[6]. However, the diverse requirements of Gardner's subscribers strained Gardner's resources and, despite a frugal life style,

[4] Letter from Gardner to William Hooker, Rio de Janeiro, 25th August 1837 (Royal Botanic Gardens Kew, Directors' Correspondence 67/13).

[5] On Gardner's return from Brazil, and following his unsuccessful attempt to establish himself at the Andersonian University, Glasgow, Fielding briefly employed Gardner as an assistant (Clokie 1964: 43-44).

[6] Letter from Gardner to William Hooker, Rio de Janeiro, 25th August 1837 (Royal Botanic Gardens Kew, Directors' Correspondence 67/13).

he was forced to limit living specimens to the Duke of Bedford and Murray[7]. By 1840, Hooker was not perceived as an honest broker (Gardner 1840: 194)[8]. Hooker's vested interest in Gardner's specimens meant subscribers were concerned Hooker was removing the best material before sending material to them. Hooker rejected these accusations but handed over management of specimen dispersal to the professional bookseller and botanical agent William Pamplin (Gardner 1840: 194)[9].

Gardner could not fund his journey from 16 subscriptions; he had to collect more material for sale. Consequently, he was collecting many duplicates of each collection. When Gardner wrote to Hooker from Arraias, Goiás, in 1840 he had collected 1,486 species, most of which were represented by 30 duplicates[10]; managing and transporting about 44,000 separate herbarium specimens would have been a major logistical challenge. In 1840, Pamplin charged £2 for 100 specimens (Gardner 1840: 210)[11].

Two decades later George Bentham was performing similar services for Spruce (Spruce, 1908: vol. 1, xxxiii, xliv-xlv):

> Bentham agreed to receive all his botanical collections, name the already described species, sort them into sets under their several genera, and send them to the various subscribers in Great Britain, as well as in different parts of Europe. He also undertook to describe the more interesting new species and genera, and to

[7] Letters from Gardner to William Hooker, Rio de Janeiro, between 27th July 1836 and 25th August 1837 (Royal Botanic Gardens Kew, Directors' Correspondence 67/29-67/33, 67/36, 68/16-68/17).

[8] Gardner (1839: 328) had made it clear that as far as he was concerned Hooker was to have the best specimens, with Gardner having the second best set. However, Gardner's subscribers appeared to have been doubtful (Letter from Gardner to William Hooker, Peradenia, 14th October 1847; Royal Botanic Gardens Kew, Directors' Correspondence 54/186).

[9] Hooker states in a footnote 'this task of dividing the specimens for subscribers is, I trust, now generally understood, confided to Mr Wm. [William] Pamplin' (Gardner 1840: 194).

[10] Letter from Gardner to William Hooker, Arraias, 5th May 1840 (Royal Botanic Gardens Kew, Directors' Correspondence 68/34).

[11] As Gardner was preparing to leave Britain for Sri Lanka, four sets of Brazilian plants (*Gardner* 923 to *Gardner* 1463) remained; he was willing to accept 30 shillings per 100 specimens (Letter from Gardner to William Hooker, Hammersmith, 2nd October 1843; Royal Botanic Gardens Kew, Directors' Correspondence 69/100).

> collect the subscriptions and keep all accounts, in return for which invaluable services he was to receive the first (complete) set of the plants collected. Later letters show that only eleven subscribers were obtained at first; but that after the early collections arrived and were reported on by Sir W[illiam]. Hooker in the Journal of Botany and by so great a botanist as Mr. Bentham, subscribers were at once found for twenty sets, which, a few years later, when the great novelty of the collections and their admirable condition as specimens became more widely known, increased to over thirty.

Gardner also financed his expedition by using his skills as a surgeon. Not only was he able to earn money or barter his medical knowledge, his reputation preceded him on his journey so was often assured of a warm welcome in even remote parts of Brazil (Gardner 1849).

Learning to be a tropical botanist

European botanists came to tropical Brazil their interests in natural history nurtured in temperate Europe, their Brazilian knowledge having been gained from lectures, books and museum collections. Learning to collect tropical natural history specimens was a process of trial and error that required naturalists to develop field skills different to those required in Europe.

When Johann Baptist von Spix and von Martius first arrived in Rio de Janeiro in 1817, they were eloquent about the beauty of the surrounding forests (von Spix and von Martius 1824: vol. 2, 207). However, few naturalists, trained in temperate climes, have summed-up the overwhelming experience of a first tropical encounter more clearly, and succinctly, than von Humboldt when he wrote of his friend and colleague Aimé Bonpland: ‘Bonpland assured me that he would go stark mad if the excitement didn’t stop soon’ S(Wilson 1995: lii).

The feeling of wonder at the diversity of the tropics never leaves a naturalist; no matter how experienced. William Burchell, a veteran collector of tropical natural history specimens was effusive when he first saw Brazilian vegetation (Martins and Driver 2005: 74):

> as to the Botanical riches of this country [Brazil] … you cannot form an adequate idea, even though you pictured to yourself all

> the fine plants of our hot houses growing wild and clothing the hills and vallies with their utmost luxuriance. … What pleasure should I not feel, in conducting you through forests where lofty trees decorated with garlands of Begonias, Passifloras, and trunks and branches covered with ferns, Pothos, Tillandsias, Bromeliads and a multitude unknown to me, are intermingled with graceful Palms … combined in the most picturesque manner, tempt one to turn often from Natural History to Painting.

However, enthusiasm for the natural history must not blind the collector to the dangers. von Spix and von Martius recommended naturalist follow Brazilian habits (von Spix and von Martius 1824: vol. 1, 164-165):

> the health of the inhabitants of so hot a country is especially promoted by their praiseworthy temperance at meals. The Brazilian eats but moderately of his few dishes, drinks chiefly water, … following that strict order which is observable in all the phenomena of nature between the tropics. In the evening, he very prudently takes scarcely anything, … and avoids, especially at night, eating cool fruits. Only such a regimen, and conforming with the nature of the climate, preserves him from many diseases to which the stranger exposes himself, through inattention or ignorance. Above all things, therefore, the stranger should be advised to observe the same regimen as the Brazilians; neither to expose himself to the fatal effects of the sun's rays, … nor to the dangerous consequences of taking cold in the night dews, and above all, not to indulge in sexual pleasures. Precaution is necessary also in drinking water to appease the almost insatiable thirst; we were advised to drink the water mixed with wine or brandy.

Banks impressed similar warnings upon Cunningham and Bowie: 'you are by no means to presume on the vigour of your youth and the [strength] of your constitution but diligently conform yourselves to the practice of the Natives in avoiding the dangers of the Climate and the hazard of visiting unhealthy districts' (Martins and Driver 2005: 61-62). In contrast, Richard Burton's advised 'let no weak regard for sex or age deter you from taking, or at least trying to take, the strongest beast, the best room, the superior cut, the last glass of sherry' (Burton 1869: 187).

George Gardner arrived in Rio de Janeiro in 1836 with letters of introduction he assumed would take him to Chile, but he missed his contact. Forced to improvise

among a community of experienced tropical naturalists living in Rio, a naïve Gardner had the luck to meet, and the wit to nurture, John Miers, one of the foremost botanists in South America[12]. Rio de Janeiro proved to be an excellent place for Gardner to learn the rigours of tropical fieldwork and refine his field skills (Gardner 1849: 17). Rio's tropical forests, whilst apparently well collected, still held the potential for new discoveries. During his first five months in Brazil, Gardner collected approximately 370 plants from the Rio area, and estimated that 20% were new species (Gardner 1846: 191).

[Fig 5. here]

New discoveries were important if Gardner was to keep his subscribers satisfied, and the money flowing, especially since visitors, such as Alexander Cladcleugh, had stoked expectations by reporting 'the botanist, constantly occupied, will have some difficulty in persuading himself that new plants do not spring up every day under his feet' (Cladcleugh 1825: 32-33). Gardner was more realistic about what he could achieve: 'as an eternal spring and summer reign in this happy climate, and as almost every plant has its own season for the production of its flowers, every month is characterized by a different Flora. It is, then, scarcely to be expected that a residence of but a few months can afford more than a very partial knowledge of its vegetable riches' (Gardner 1849: 8).

Nearly a year into his journey, Gardner was a fully-fledged tropical plant collector. He was also become more independent, especially as his patron, William Hooker, had no personal experience of the day-to-day practicalities of tropical fieldwork (Desmond 1999). Gardner's first efforts at collecting specimens around Rio de Janeiro had been poorly received by Hooker[13]. Gardner, a man who did not mince words, was clearly irritated by his mentor's imputation he had been idle. He pointedly told Hooker he knew of no one who could have collected, dried, labelled and packed more than 15,000 herbarium specimens (not to mention living specimens) in eleven months in the tropics. Gardner went on to state he welcomed

[12] Letter from Gardner to William Hooker, Rio Comprido, 14th October 1836 (Royal Botanic Gardens Kew, Directors' Correspondence 68/16).
[13] Letter from Gardner to William Hooker, Rio de Janeiro, 14th August 1837 (Royal Botanic Gardens Kew, Directors' Correspondence 67/36).

'any hint' on how to do things better but underlined his irritation by inserting 'useful' between 'any' and 'hint' as an afterthought. Furthermore, Gardner implied Hooker's letters of introduction had been useless and that his successes were due to his own resourcefulness. If Gardner had given up collecting as he threatened, it may have been devastating for Hooker's ambitions to secure the Directorship of Kew (Desmond 1999).

[Fig 6. here]

Kit and working pattern

Presses, paper, notebooks and rations were obvious essentials to the Brazilian collector. Other essentials would have been a hand lens, or field microscope, to examine small objects[14]. Altitude could be measured using mercury-filled barometric tubes or by boiling water. The former was accurate but the equipment fragile and cumbersome; the latter needed only a thermometer. Other collecting kit might also include telescope, compass, *facão* and, for personal protection, swords and/or pistols.

Natural history collectors work in two broad ways. One method is to establish a base from which excursions of greater or lesser length are undertaken. The alternative is itinerant, the collector regularly moving from place to place. Both Spruce and Gardner used central bases and opportunistic excursions, and peripatetic collecting methods. Collectors needed to be well organised if they were to take full advantages of collecting seasons, day length, local customs and the daily routine of a natural history collector. The bulk of collector's luggage would comprise prepared specimens. The bulk of Gardner's luggage as he travelled through the interior of Brazil was specimens in various stages of preparation. There was the constant routine of changing absorbent papers in the plant presses and drying damp papers by a fire or in the sun. Such labour was particularly arduous on rainy or cloudy days when several reams of paper might need to be dried sheet by sheet over a fire. The essential work of packing and unpacking plant specimens and

[14] Letter from Gardner to William Hooker, Crato, 5th February 1839 (Royal Botanic Gardens Kew, Directors' Correspondence 68/30).

papers would become habitual. As plant specimens were prepared they would have been studied and compared with specimens he had already collected in Brazil or species he knew from the literature.

[Fig 7. here]

Collectors had to treat their specimens carefully since sales were funding their travels; poor specimens would give poor returns. Subscribers wanted new species to add to their collections but the specimens also had to look good; common species and mouldy or incomplete specimens were useless. Plant specimens had to be kept dry, and free from all manner of insect, fungal and vertebrate pests. Gardner wanted his specimens to have scientific value rather than just become curiosities in cabinets of the wealthy trophy collector. Consequently, he had to ensure every specimen was labelled so that they could be identified and sorted later. Occasionally Gardner was forced to admit that he had misplaced labels, whilst his method of preparing his specimens for dispatch meant that specimens may have become confused and labels separated from specimens. All the specimens Gardner collected were transported in leather boxes on the backs of pack animals (Gardner 1849).

To the modern plant collector, Gardner's method of working appears odd. Gardner only collated and numbered his specimens once he had amassed sufficient material from particular legs of his journey, and he was in a place with reasonable connections to the coast. Before numbering specimens, Gardner arranged them into botanical families according to the classification system of Auguste de Candolle (1819). He recorded the number of each specimen is a notebook with a minimum level of information, field identification, place of collection, specimen batch; although place of collection is often missing (Hind 2012)[15]. In contrast, Spruce (1908: vol. 2, 314-315) appears more rigorous in his working routine:

> When I bring home freshly-gathered plants, I make notes on them in books prepared for the purpose, and add numbers. If any plant seems strange to me, I keep flowers, etc., in water to await a spare interval when I can analyse them microscopically. So soon as the plants are dried I pack them into other paper and add the

[15] Lawson (c.1882) is a partial transcription of Hind (2012).

> labels from my notes ... so completely does the reading over of my notes recall the features of the plants, that I feel sure if I were shown the whole of my plants classified in your herbarium, and on blank paper, I could, from consulting my notes, put to them the proper numbers and localities without making perhaps a single mistake. As to positive errors of observation, I am as liable as any other mortal. I would wish to speak with all modesty on that head; and working often in boats, or in dismal huts where a squall would suddenly enter the open doorway and disperse both specimens and labels, there must occasionally have been some transposition of both in gathering them up again. This risk of the blowing away or dropping out of labels was, in fact, what made me give up putting labels to the plants as they were drying'.

Arthropods, particularly ants, were a bane of Spruce's Amazonian collecting experience (Spruce 1908: Vol. 1, 292, 380-381; vol. 2, 366), recollecting with horror his 'house invaded by an army of Arriero or Saüba [*Atta*, Formicidae] ants who had fallen on a pile of dried specimens and were cutting them up most scientifically into circular disks whose radius was just equal to the artist's own longest diameter' but he had a grudging respect for them, since they 'deserve to be considered the actual owners of the Amazon valley far more than either the red or the white man' (Spruce 1908: vol. 2, 366). The only practical solution was constant vigilance, although once specimens were back in Europe, mercuric chloride was a popular preservative (Smith 1806).

Another problem of long-term fieldwork in Brazil was finding suitable field workers, at one point Spruce had to hire men who lived one thousand miles from his collection site. So difficult was the problem he even contemplated working in Venezuela instead (Spruce 1908: vol. 1, 264-265). Gardner experienced similar issues, for example, as he was preparing to leave Oeiras and a man he had employed refused to go. Gardner went to see his acquaintance the Barão da Parnaíba about finding a new employee: 'as soon as he learned what had occurred, he sent for the man, who still refusing to go, was sent to prison'. The Barão bribed one of his reluctant soldiers to go with an equally reluctant Gardner; 'I had no help but to accept his services' (Gardner 1849: 210).

Conclusion

Plant exploration is a serendipitous activity, depending on those plants that attract attention at particular times and in particular places. Knowledge of the natural world derived from fieldwork is hard-won, and plant collecting in the tropics arduous. Popular stereotypes of flower pressing as a juvenile activity, or an activity for genteel ladies and effete gentlemen to fill their spare time are far removed from the rigours of scientific fieldwork in the tropics. George Gardner summed up his experiences as (Gardner 1849: viii-ix):

> the privations which the traveller experiences in these uninhabited, and often desert countries, can scarcely be appreciated by those who have never ventured into them, where he is exposed at times to a burning sun, at others to torrents of rain, such as are only to be witnessed within the tropics, separated for years from all civilized society, sleeping for months together in the open air, in all seasons, surrounded by beast of prey and hordes of more savage Indians, often obliged to carry a supply of water on horseback over the desert tracts, and not unfrequently passing two or three days without tasting solid food, not even a monkey coming in the way to satisfy the cravings of hunger.

Unless actively managed, specimens in collections become those that happen to survive the ravages of pests, indifference and time. The natural history collections that pack the world's museums bear witness to the sheer volume of past collecting. The diversity of specimens in these collections is a testament to collectors' enterprise and bravura. The quality of specimens endorses their field methods and the subsequent dedication of collection curators. Plant collections remain snapshots of diversity, forever incomplete. Yet they are the basis upon which we understand the diversity of the Brazilian flora, from which decisions are taken about how to exploit Brazilian natural resources.

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Figure legends

Fig. 1. Isotype of *Anacardium spruceanum* Benth. ex Engl. (*Spruce* 1684, Oxford University Herbaria) collected by Richard Spruce on the Rio Negro in August 1851. Spruce (1908: vol. 1, 237) stated: 'Notwithstanding their formidable aspect, as I had determined to preserve specimens at any price, we set to work to cut one down, and after an hour's labour succeeded. This tree I measured after its fall and found it 90 feet in height by over 3 feet in diameter near the base, and perfectly straight and scarcely diminishing in thickness up to the first branch at 50 feet high'.

Fig. 2. View of Praya Rodriquez, Rio de Janeiro, showing a botanist with a field press (Rugendas 1835: part 1, pl. 1).

Fig. 3. Specimen of *Centropogon cornutus* (L.) Druce collected by William Dampier in 1699. Despite the polynomial name, 'Rapuntium Novae Hollandiae, flore magno coccineo' (Dampier 1703: 156, t.2, f.1), this plant must have been collected in Brazil. It is a case of mislabelling, probably by Dampier.

Fig. 4. Natural history collector and hunters in Imperial Brazil in the 1820s (Debret 1835: pl. 19).

Fig. 5. A party of natural history collectors on the the *Aqueduto da Carioca*, a classic collection locality in early nineteenth-century Brazil (Rugendas 1835: part 1, pl. 8).

Fig. 6. The route George Gardner took to travel through Brazil between 15th September 1837 and 31st October 1840. From Oeiras in the north he had traveled with 'upwards of 60,000 specimens in Botany alone' (Gardner 1849: 401).

Fig. 7. Pack animals were the main way Gardner transported specimens through Brazil (Rugendas 1835: part 1, pl. 15). He was astonished by the number of animals 'required to carry what, in his own country, would scarcely form a load for one' (each animal carried 90 kg to 120 kg, some 20 km to 25 km each day; Gardner 1849: 31). At one point in his journey Gardner had a troop of 16 pack horses under his control.