Travels and science in Brazil

Viagens e ciência no Brasil

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Bearing in mind the distinction between the universally-curious explorer and the scientist with a theory to test, we shall ask three questions as we look at scientific travellers coming to Brazil in the eighteenth and nineteenth centuries. These questions are: Why did they come? What did they notice? and What were the consequences of their work? In the early days, visitors were chiefly impelled by curiosity about the world and especially by the tropical abundance of Brazil. In the nineteenth century, naturalists arrived with theories to test and noticed unexpected phenomena, such as the mimicry among butterflies on the Amazon. Colonial authorities were suspicious of visitors, who might find out too much and try to seize the products of Brazil for themselves. Besides, economically-oriented botanists were also becoming interested in Brazilian rubber and the possibility of cultivating it elsewhere. Perhaps colonial officials were wise to be suspicious.

KEYWORDS: Natural History, collections, discovery, banks, Bates, Darwin, Wallace, Trail.

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Tendo em vista as diferenças existentes entre o explorador universalmente curioso e o cientista possuidor de uma teoria a ser testada, fazem-se necessárias três perguntas quanto aos cientistas estrangeiros que viajaram ao Brasil nos séculos XVIII e XIX. Estas perguntas são: Por que vieram? O que viram? e Quais foram as conseqüências de seu trabalho? No início, os visitantes eram impelidos pela curiosidade em relação ao mundo, em geral, e à abundância tropical do Brasil, em particular. No século XIX, os naturalistas chegavam ao Brasil com teorias a serem testadas e notavam outros fenômenos inesperados como, por exemplo, o mimetismo existente entre as borboletas do rio Amazonas. As autoridades coloniais suspeitavam dos viajantes, que poderiam encontrar produtos demais e deles se apossarem para seu próprio proveito. Além do mais, alguns botânicos também começavam a se interessar pela borracha brasileira e pela possibilidade de cultivá-la em outras terras. Talvez as autoridades coloniais tivessem razão ao suspeitar das atividades dos viajantes.

PALAVRAS-CHAVE: história natural, coleções, descobertas, margens de rio, Bates, Darwin, Wallace, Trail.

Explorers and scientists

Looking back forty years on, at the end of an active life in science, the great English physicist J. J. Thomson reflected on his research of 1897, identifying the mysterious cathode rays as a stream of electrons, which had brought him his Nobel Prize. He compared himself to his predecessor in this work (and later in the office of president of the Royal Society) William Crookes. Crookes' success, he wrote (Thomson, 1936, pp. 378-9):

> Was due not only to his skill as an experimenter, but also to his powers of observation. He was very quick to observe anything abnormal and set to work to get some explanation. He tried one thing after another in the hope of increasing the effect, so as to make it easy to observe and measure; his work on the radiometer and the cathode rays are striking examples of this. In his investigations he was like an explorer in an unknown country, examining everything that seemed of interest, rather than a traveller wishing to reach some particular place, and regarding the intervening country as something to be rushed through as quickly as possible.

This is a wonderful exploration of the difference between the explorer and the scientist — which for Thomson meant of course, 'physicist', for Crookes was a chemist. Early science was full of wonders and wondering: as Robert Louis Stevenson put it, "The world is so full of a number of things, that I'm sure we should all be as happy as kings."

The chemist had, a hundred years ago, to begin by collecting information, and hoping to generalise from it; while physicists already saw their best method of proceeding as forming a hypothesis and deducing from it testable consequences. That was just what Thomson had done. His triumph was to devise a crucial experiment which would discriminate between the theories that the cathode rays were a form of electromagnetic wave, like light or X-rays, or were minute negatively-charged sub-atomic particles.

The explorer (natural historian or chemist!) is then a good observer, quick to note what is abnormal and keen to account for it somehow. Explorers measure; they examine everything that seems of interest, trying one thing after another; they are in no hurry. In Pierre Duhem's classic taxonomy (1962, pp. 55-75), they have 'ample', broad and shallow, minds (typical of the English, but also like Napoleon) good at making surprising connections, rather than the deep and penetrating ones (typical of the French, but also like Newton) which characterise the greatest physical scientists and mathematicians. Physicists have sometimes liked to see an evolutionary sequence in the sciences, all of which are progressing from a natural history stage of Baconian induction towards the consummation of becoming a branch of physics. We may suspect

that the story is, like that of our own evolution, less straightforward; that even chemistry, for example, has not been 'reduced' to physics. Certainly, one of the nineteenth century's great physicists, John Herschel, edited for the British Admiralty *A Manual of Scientific Enquiry* which despite its title was addressed to naval officers and travellers in general — explorers in fact, in the tradition of Captain James Cook — and included a chapter by the traveller not long returned to England from Latin America, Charles Darwin. But for our purposes here it may be useful to bear in mind Thomson's distinction. Over time, we shall find that our scientific visitors from Britain to Brazil changed a little from those with a general and well-developed curiosity about the brave new world that had such people and creatures in it (Shakespeare, c. 1600), towards those who came with a hypothesis to test — Thomson's travellers in a hurry, like too many of us.

Three questions

When we come to look at a few scientific travellers from northern Europe to Brazil over the centuries, three questions will be in our minds: Why did they come? What did they notice? And, What were the consequences? Looking in my case chiefly at the eighteenth and nineteenth centuries, we shall see what a range of answers can be, and have been, given to these simple-seeming questions. Since we have a range of five hundred years altogether, no doubt we shall find overall that at the conference we have assembled a remarkably wide range of answers. But I hope that bearing such questions in mind will make us a little more like scientists than like explorers with quite unfocussed curiosity.

Why did they come? — the early years

The Portuguese who stumbled upon Brazil in 1500 were like most Europeans venturing overseas then, seeking riches. Naturally, having found them, they regarded the natural resources of so vast a country as something to be kept secret from others; reasonably fearing invasion or piracy: plunder or conquest seemed only too likely if outsiders should find out what there was, and how feebly a small country like Portugal could defend it. Moreover, since it was held upon the basis of the Pope's division of the globe between Spain and Portugal, Protestant powers such as the Dutch and the British were especially to be feared. During the wars of religion in Europe, in the sixteenth and seventeenth centuries, they could suppose it a positive duty to harry the colonies of Catholic states. Though Portugal was England's oldest ally, she became fair game when for a time subjugated by Spain. Portugal's sea-borne empire in the East was won with astonishing speed in a heroic and tragic history (Boxer, 1959-68); and then mostly lost to the Dutch and

English. Brazil must also have seemed greatly at risk. Information about it was not to be made public knowledge, as science is supposed to be; so that most of Latin America remained *Terra incognita* in northern Europe. But despite the views of the colonial powers and their representatives, colonists often welcomed the opportunity to trade even with the heretics rather than conduct all their business through taxed official channels. The lines between pirates, buccaneers, privateers and unlicensed traders were hard to draw, and regulations could not be enforced regularly and everywhere.

By the mid eighteenth century, the British were building up their sea-borne empire: we are prone to deplore the power of international corporations, but it is not new — the rival East India Companies based in Britain and the Netherlands carved up most of the trade of the Far East between them, and were the most formidable military powers in Asia. Then in the course of the wars, mostly with France, which were a feature of the century, the British entered the Pacific. In 1740 Lord Anson's squadron (Heaps, 1973, p. 54) called at the island of Santa Catarina to pick up wood and water, and other fresh supplies, in this fine harbour and smugglers' haunt. The arrival of a powerful taskforce caused alarm, and Captain Saumarez of *HMS Centurion* reported on "the natural circumspection of these people who are jealous of all foreigners coming in their ports and contribute what they can to render it disagreeable". The British also suspected that news of their movements would be passed on to the Spaniards at Rio de la Plata. The squadron rounded Cape Horn and, with terrible loss of ships and men due to storms and scurvy, attacked Spanish coastal shipping and then set out to capture the Manila Galleon. By now they were down to two ships; but even this was too much for the reduced numbers, and *HMS Gloucester* was abandoned and set on fire in mid-Pacific; her explosion generating an alarming mushroom cloud. Now on her own, the *Centurion* fell in with the Galleon off the Philippines (there was no hope of ever finding her on the open sea) and battered her into submission. Anson returned to Britain a hero, his cartfuls of captured treasure carried in procession through cheering crowds to the Tower of London.

With the return of doubtful peace, the Royal Navy began, in the interests of national power and trade, the systematic surveys of Patagonia and the Pacific which were to be a feature of the next hundred years. Captain John Byron (grandfather of the poet) on his voyage (1764-66) noted how poorly charted the coast of Brazil was, and called at Rio de Janeiro (Gallagher, 1964, pp. 22-5, lxxv). He was welcomed in great state by the Viceroy, and they conversed in French; Byron hired caulkers to repair his ships, lodged his sick on shore, and bought fresh supplies. One of his officers noted that six or seven men of the line could knock out the fortifications of Rio: just the sort of observation that the authorities there feared that naval visitors would be making, for refreshment, surveying and spying were hard to keep separate. Byron also reported

that while he was there Lord Clive put in to Rio in the *Kent* East India Man, one of the powerful ships sailing between Britain and India; as it had been for the original Portuguese, Rio was an important stopping place for refreshment, especially in the days of scurvy on the route to India.

Though Byron had given his crew 'greens' whenever possible, it is Cook who is remembered for the practical conquest of scurvy on his voyage of *HMS Endeavour* in 1768-71. This voyage was to observe the transit of the planet Venus across the Sun, something that happens approximately twice a century, the two occasions being about eight years apart. The astronomer and explorer Edmond Halley had worked that if observations of the transit were to be made from two distant places whose whereabouts were exactly known, then the distance of the Sun from the Earth could be computed; though it would not happen in his lifetime. The 1761 transit provided opportunities for rehearsal; and soon after that, in 1766-68, *HMS Dolphin* venturing into the Pacific discovered Tahiti (Carrington, 1948). This island looked the ideal place to observe, being both an earthly paradise and a great way from Greenwich; and Cook was chosen to take charge, fresh from his triumphant survey of the St. Lawrence River which had made possible General Wolfe's successful assault upon Quebec, capital of the French dominions in North America. Cook was accompanied by Joseph Banks, a wealthy landowner with a passion for botany, who instead of going on the customary Grand Tour of France and Italy determined to go round the world. He brought with him Daniel Solander, a pupil of Carolus Linnaeus, and two artists. Their orders were to proceed to Tahiti and make the necessary observations in 1769; and then to search for the unknown southern continent. They duly circumnavigated New Zealand, and discovered New South Wales where Banks botanised at Botany Bay and subsequently recommended that British convicts, no longer wanted in the independent USA, should be transported and exiled there. He also recommended that merino sheep might be acclimatised in Australia: making him the godfather of that country, and of its economy.

The *Endeavour* visited Rio de Janeiro in December 1768, on the way to Cape Horn and therefore like the others seeking refreshment and stores for the voyage ahead.[1] They had expected a welcome like Byron's; but only the captain and such sailors as were required on duty were permitted to go ashore, the passengers being expressly forbidden to leave the ship. A sentinel was appointed to accompany anyone who landed; allegedly as a compliment, but recognised as surveillance. A rich and botanically new world lay before the party, and yet they were sweatily confined to their cramped ship; the Portuguese clearly did not believe in their peaceful intentions despite the documents they carried exempting them from warfare, and the look of the *Endeavour,* an adapted coal-carrying vessel rather than a frigate. They had also

[1] See Beaglehole (1962, pp. 187-205); *The journals of Capitain James Cook* (1968, pp. 22-34); Carter (1988, pp. 76-7).

alternative fears that they were a shipful of smugglers, seeking illegal trade. Cook did indeed, with the eye of one who had surveyed Quebec, note that the batteries defending the city were very weak, though it would require five or six ships of the line to be confident of taking the place: and, though no smuggler, he remarked also the plenty and cheapness of stores. Solander got ashore as a medical man, to attend to a friar; and Banks was smuggled ashore also, by night, and spent a tantalising single day shooting birds and collecting plants. Banks referred to the Portuguese authorities as 'illiterate impolite gentry' and 'despotick', but from those shipmates who went ashore (notably William Monkhouse the surgeon) he gathered information about the city. As well as foodstuffs, he mentioned gold and precious stones; but clearly this visit had been very frustrating. On the strength of his social status, his voyage, and his subsequent decision to devote his life to scientific administration, Banks was in 1778 elected president of the Royal Society — he held the office until his death in 1820, the longest-ever tenure going on right through the French Wars.

It was a pity that the Portuguese authorities were so unhelpful to visitors who were so scientifically important. And things were no different when Alexander von Humboldt neared the Brazilian frontier on his great expedition in Spanish America (1799-1804): the proximity of so distinguished a savant produced panic, and orders that he should be arrested if he were to show his face. He was travelling under French auspices, at a time when Napoleon's armies occupied Spain and threatened Portugal; which was only preserved by British intervention with an army under the future Duke of Wellington. But rather than take at face value Banks' verdict upon the unwelcoming, ignorant and impolite gentry — what damaging adjectives to apply to Portuguese officers — who had blocked his attempts to botanise, we should look through their eyes. Conscious of the weakness of their position, and aware of the actual and potential wealth of Brazil, they regarded the natural productions of the country as state secrets to be kept from the prying eyes of alien visitors coming from greedy and powerful nations.

After 1815: a new state of affairs

After the Battle of Waterloo in 1815 (Wellington's final triumph over Napoleon) things were different. Latin America was opened up. The heirs of Francis Drake, naval hero or buccaneer, were keen to invest and to get their hands on profitable trades in natural products such as logwood for dyeing. Admiral Cochrane, another hero or desperado, secured Peruvian independence by cutting out and capturing the Spanish frigate *Esmeralda* in the harbour of Callao. Independent Latin America was drawn into the informal British Empire; which avoided problems with the Americans and their Monroe Doctrine, or with colonial governors and bureaucracy, and promised economic development. Ships of the

Royal Navy, otherwise underemployed now that the war was over, came to occupy 'stations' on the coasts, protecting British commerce and inhibiting the slave trade. Cook had established that in circumnavigating the globe, now commonplace with settlement in Australia, it was wise to go out by way of the Cape of Good Hope and catch the westerly winds; and to return by way of Cape Horn. Careful surveys were required, and a succession of vessels were employed on these; their officers learned on the job, passing on the lessons they had had from Cook or his disciples (Day, 1967; Deacon, 1971, pp. 175-250).

But the first man of science from Britain to visit the newly accessible Brazil was William Swainson, son of a customs-house official in Liverpool and itching to witness Humboldtian tropical riches, and to make a name and a career for himself in natural history. And for him, the country did not turn out to be open after all. Political turmoil in 1816 meant that he hardly set foot on shore (Knight, 1998a, pp.197-224; Swainson, 1989; Natusch and Swainson, 1987). In the Linnean manner, he had hoped to collect plants and animals unknown in Europe, and name them. He was very interested in classification, and became one of the protagonists of the Quinary System in which organisms were arranged in fives in a hierarchy of circles: there should have been room for creatures from Brazil, which might indeed fill in gaps in the arrangement. After interesting Darwin, A. R. Wallace and T. H. Huxley, the system fell into disrepute: it ceased to be credible that there was such a neat geometrical order behind all the species which we encounter. But Swainson was also a keen and very able illustrator. Although he did not bring back much from the tropics, the trip was sufficient to launch him on a career as a naturalist; he was elected a fellow of the Royal Society. And he took up the newly-perfected process of lithography, where a drawing is made with a wax crayon on a stone which is then wetted: an oil-based ink is next rolled on, and sticks to the waxy but not the wet places on the stone, so the picture can be printed (Rudwick, 1976, pp. 149-95). This was much cheaper than engraving on copper, and also allowed a more flowing and informal style. Few artists were also engravers, and printed pictures had therefore had to be translated from freehand sketches into the hard lines and cross-hatchings of the copperplate medium; whereas now artists might well be capable of working on stone rather than paper themselves. The print would therefore be the original, directly what the artist had done. A craftsman would no longer come between the artist and the public.

Swainson saw the potential of the process, and began publishing illustrated works, on shells and on the birds of Brazil. He produced them in parts: subscribers would receive and pay for small sections of the books as they came out, and the receipts from part 1 would pay for the preparation of part 2 and so on. This became the standard way of publishing luxury, and sometimes standard, works of natural history in nineteenth-century Britain. The lithograph at this time was not coloured

(that was tricky with the delicate shading required for natural history plates), and so the artist would colour a 'pattern plate' and a team of colourists at the publishers or booksellers would copy this as exactly as possible for the subscribers, and subsequently as further orders came in. William Leach, curator of zoology at the British Museum in London, had encouraged him in his project of lithographic illustration; and in 1822 Swainson hoped to become Leach's successor. This was not to be. Humphry Davy, president of the Royal Society and a Trustee of the Museum, had a friend J. G. Children who was a mineralogist and banker down on his luck: and he was appointed, and in the event turned out well (Knight, 1998b, pp. 146-7). Swainson , a much younger man (born 1789) was embittered by his rejection; but he turned to authorship, writing numerous volumes for *Lardner's Cabinet Cyclopedia* a series which was published by Longman. Such publications were a feature of the March of Mind of the 1820s and 1830s, where increasing literacy went with cheaper books as wood-pulp or esparto-grass paper, steam-presses, and cloth case-bindings were introduced. Wallace's copy of the volume on the geographical distribution of animals is in the Linnean Society's library, fully annotated. Disillusioned with what he saw as only moderate success, and overworked by his editor, the tyrannical Dionysius Lardner, Swainson emigrated in a huff to New Zealand.

His career was ambiguous, but for many of his approximate contemporaries a voyage of discovery (the 'big science' of the time) was the equivalent of graduate study in science today. Charles Darwin (Browne, 1995; Desmond and Moore, 1991), Edward Sabine, Huxley (Desmond, 1994-97) and Joseph Hooker all like Banks made reputations and launched themselves into scientific eminence on voyages. In 1832 Darwin's *HMS Beagle* called in Brazil (Burckhardt *et al*., 1985, pp. 201-47) and in letters home he vividly described the thrill of encountering the riches of tropical life. His collecting was so enthusiastic and full that he regularly sent back consignments of carefully-labelled specimens by naval vessels leaving Rio de Janeiro and other ports, making him famous at home by the time he returned; but Brazil only featured at the early stages of his voyage, when it made him feel that all the seasickness had been worthwhile. Our visitors so far have all been 'explorers' in J. J. Thomson's classification; they came to look at everything, and to wonder at it. While Darwin was made to think about the distribution of organisms, living and fossil, and the relations between them later on the voyage, it was really only after he got home that he began to turn himself into Thomson's 'traveller', with a theory to test.

Like Humboldt's, Darwin's writing about his travels excited others; and Kew Gardens, which Banks had managed for King George III, also began to play an important part in botanical exploration (Jardine *et al*., 1996). After the death of the King and of Banks in 1820, Kew had declined; but in 1841 it was reorganised and formally recognised as the

national botanic garden, under the direction of Sir William Hooker. Banks had been keen on acclimatising plants: breadfruit in the West Indies, wheat in Australia, and so on. Davy and Stamford Raffles in founding the London Zoo had hoped that exotic animals might be acclimatised through it; though in the event alpacas did not graze English meadows, or zebras draw elegant carriages, the process of taking plants and animals from their natural habitat and planting them where they would be useful or decorative was much speeded up (and seen as a part of science) in the nineteenth century. Kew, under the direction of Sir William and then his son Sir Joseph Hooker also acquired an imperial function. The British Empire may have been acquired in a fit of absent-mindedness, but once it was there it made sense to see how its resources could be rationalised and maximised.

Banks had paid and sent out collectors to find plants and build up his holdings and those of Kew and the British Museum. He had also ensured that ships' surgeons and other officers received encouragement to do likewise. Under the Hookers, collection became much more systematic, and was geared to utility, to economic botany, as well as discovery. Joseph (Darwin's closest friend) in particular had to justify the government grants coming from a hard-fisted Treasury, which could not see why Kew cost so much more than ordinary public gardens. Successes with the propagation of quinine and rubber trees, and their subsequent acclimatising in plantations around the Empire, were a powerful argument among politicians for supporting botanical research at Kew. The Hookers also thought along the lines of Francis Bacon's *New Atlantis* (1627); his utopia was a small island to which people brought raw information to be processed into scientific knowledge, just as raw materials were brought to industrialising Britain to be made into useful objects. Kew was a centre, and South America or Australia (Home, 1988) the periphery. So we begin to find among Darwin's successors (usually paying longer visits than he could, and thus able to take their time) not only a commitment to theory, but also an imperial feeling that propagation, naming and classification should be done at home; and that the economy of Britain (and other European states) depended upon finding useful animals, plants and minerals overseas.

In 1848-50 Henry Walter Bates and Alfred Russel Wallace came to Amazonia to collect for Kew and for dealers in natural history. Bates stayed on until 1859, after Wallace had returned to England (losing his immensely valuable collections in a fire on shipboard) and then gone to Malaysia — where in 1858 he wrote the famous letter about evolution by natural selection which propelled Darwin into writing the *Origin of species* (1859). Out there he also pondered the geographical distribution of organisms, observing what is now called the 'Wallace line' between Bali and Lombko, neighbouring islands whose organisms are characteristic of different regions. Neither Wallace nor Bates made much money from their activities; Bates

told Darwin that his years of activity in Brazil had brought him only £800 (Burckhardt *et al*., 1999, pp. 330, 73, 323, 300, 326). But they represent something new, being experts who gave themselves time to notice things.

What did they notice?

Bates' work had developed from a Linnean spirit of collecting into something more critical: he worked out his idea of mimicry among butterflies. Species belonging to groups tasty to birds had evolved so that, surprisingly, they resembled, or 'mimicked', those belonging to distasteful groups. This seemed to Bates, and to Darwin who befriended him on his return, to be excellent direct evidence for natural selection. Darwin helped him get a post at the Royal Geographical Society in London; he became president of the Entomological Society, and in 1881 a Fellow of the Royal Society: in his case, as in Wallace's (and indeed Huxley's) science learned on a voyage was a crucial feature in social mobility. Bates found himself drawn into the controversy over Darwin's theory, and when in 1863 with Darwin's encouragement he published his book *The naturalist on the river Amazons* he was sneered at in a review: "one of the principal objects of Mr. Bates's explorations was to gather facts towards solving the problem of the origin of species. He thinks he has found such a solution in adopting Mr. Darwin's theory and making many of his facts bend to it." That is a risk when Thomson's 'explorers' turn into 'travellers'; Darwin on the other hand saw the volumes as "the best book of natural history travels ever published in England", with close reasoning based on exact observation. He was very pleased with such passages as this on tropical forest: "the struggle which necessarily exists among vegetable forms in these crowded forests, where individual is competing with individual and species with species, all striving to reach light and air in order to unfold their leaves and perfect their organs of fructification". Bates' descriptions were infused with interpretation.

Between Bates' perception of tropical profusion and that of earlier naturalists, there was a great gulf fixed. He noticed not just the organisms, but their dynamic interaction. He and Wallace had also been very interested in the ethnology of the Amazon region; humans in very different societies came within their purview, and both were free of the commonplace racism of Victorian Britons. They had come out of intellectual curiosity, and to make careers in natural history; with increasingly-practised eyes, they noticed all kinds of things about the natural world, and human interaction with it, that earlier visitors had missed. Bates' book about the Amazon, and Wallace's about Malaysia, were notable contributions to the literature of travel which had delighted stay-at-homes ever since the time of Camoes' *Lusiads* and Hakluyt's *Principall navigations of the English nation* in the sixteenth century.

Cook, George Forster, Humboldt and Darwin were among those who made natural history more prominent in travel-writings.

Once Brazil was independent there was less need to examine the fortifications in its harbours, but the relative weakness of Latin American countries was obvious, and Humboldt's example encouraged naturalists to make economic observations. Geography from the 1830s, with the founding in London of the Royal Geographical Society where Bates later worked (by then, near the new British Museum, Natural History, in South Kensington) had pretensions as a science; and the Society made grants, and sought to promote trade. The wealthy competed over orchids in their greenhouses, and exotic birds in their aviaries; and there was a trade in plants, especially those which would grow in the temperate climate of northern Europe. Bates was unfortunate, or perhaps too dedicated to pure science rather than horticultural possibilities, that he made only £800 in eleven years. Collecting for commercial seedsmen or for scientific institutions was a chancy business, where payment by results rather than a regular salary was the norm: but a reasonable income, or perhaps a scientific reputation and a post in a learned institution, might result from it.

What were the consequences?

The Great Exhibition of 1851 in its Crystal Palace contained not only machinery, but also natural products brought to Britain by ship, some from Brazil (Davis, 1999). Indeed, one of the Prize Medals was awarded to "a large and elaborate group of Brazilian flowers, executed in feathers from Brazilian birds. It exhibits wonderful brilliancy of colour, and much accuracy of form."[2] Like the Mississippi, the Nile and the Indus, the Amazon had by the mid nineteenth century steamers navigating it, financed by British capital, and bringing travellers right into the middle of Brazil. Further south, a correspondent of Darwin's, John James Aubertin, was superintendant of the Sao Paulo railway, linking the coffee districts with the port of Santos (Burckhardt, 1999, pp. 358-61), Britain's most profitable railway enterprise in Latin America during the nineteenth and early twentieth centuries. With the discovery of synthetic dyes based on aniline, the logwood which had been brought back and shredded in mills in Britain was no longer in demand (Fox and Nieto-Galan, 1999; Homburg *et al*., 1998); but along with coffee and sugar, rubber enjoyed a great boom. It was not cultivated, but trees were found and tapped in the forest; and as they died, or more was required, the companies moved further into the apparently inexhaustible valleys. Tea from China had been planted in India and Ceylon, where it was very successfully cultivated in plantation; and the Hookers hoped to do the same with rubber, crucial for industry for its elastic and waterproofing

[2] Exhibition of the Works of Industry of all Nations, 1851 (Reports of the Juries, London, Royal Commission, 1852, p. 644).

properties. Along with quinine trees, the seeds of rubber trees were at the top of the list for collectors to bring home for Kew to cultivate.

Such export would be illegal, putting the collectors in the position of the heretical traders or smugglers of previous centuries when the Portuguese had worried about loss of natural resources. One of those who came out under these circumstances was James Trail, about whom dr. Magali Romero Sá (1998, pp. 99-254, see esp. pp. 163-71, 161-3) has written. He came, in 1873-75, like earlier naturalists, out of botanical curiosity, and in the hope of making a career in natural history, now much more professionalised with the development of universities in Britain; and he duly obtained a professorial chair on his return — though unlike Bates and Wallace he never became eminent, and was almost unknown until she began her researches. But he also came on behalf of a British steamship company which had obtained large concessions on the Amazon and wanted to survey them and estimate their economic possibilities. He became an expert on palm trees; acquiring his knowledge from a Brazilian, Barbosa Rodrigues who made an indignant protest that Trail had trespassed on his intellectual territory and failed to make acknowledgement of his priority. Trail, who had named the trees in consultation with Kew, seems to have been able to ignore such peripheral outbursts: naturalists in far-flung corners of the globe like Australia or Brazil were expected to produce raw data, but to defer to the judgement of those from European centres when it came to naming and publishing. Trail was on the lookout for rubber, but in the end it was not he but Henry Wickham who was responsible for the successful transfer of rubber trees to Kew, and on to Malaysia.

Conclusion

Scientific travel to Brazil had always been a matter of curiosity and economic interest. 'Dukes don't emigrate', or so the Americans tell us; for the most part the wealthy stay at home, and dangerous journeys overseas were generally undertaken by those with a career to make. But the search for glory might bring Portuguese noblemen, and in a different way later the landed grandee Sir Joseph Banks, to unexplored coasts and islands. Once established, colonial authorities did their best to keep the secrets of Brazil to themselves, and to deter as far as possible foreigners who might plunder and even perhaps conquer the country.

After 1815, in the face of British naval and economic power, and following Latin American independence, it became much easier for naturalists to explore; and they began in the tradition of J. J. Thomson's 'explorers'. But when the explorers were as able as Bates and Wallace, it was not long before they turned themselves also into 'travellers' in his

sense, with a destination, a theory to test — though this did not make them rush or notice only what bore upon their theory. Decisive evidence in favour of evolution by natural selection came from the Amazon forests. And the development of economic botany in the great gardens of Europe, which had earlier been (like Boerhaave's in Leyden, or Linnaeus' in Uppsala) chiefly medical in interest, led to a new kind of explorer, with products targeted to bring home (as gold and silver had of course been since the sixteenth century). We may applaud the more liberal governments of nineteenth-century Brazil for their openness to men of science from northern Europe; but first the logwood industry, and then the rubber boom, were undermined in different ways by the development of science. Maybe those earlier Portuguese officials had been right to fear strangers.

BIBLIOGRAPHICAL REFERENCES

Beaglehole, J. C. (ed.) 1962 — *The Endeavour Journal of Sir Joseph Banks.* Sydney, Angus and Robertson, vol. 1.

Boxer, C. R. (ed.) 1959-68 — *The tragic history of the sea.* Cambridge, Hakluyt Society, 2 vols.

Browne, Janet 1995 — *Charles Darwin: voyaging.* London, Jonathan Cape.

Burckhardt, Fredrick *et al*. (ed.) 1985 — *The correspondence of Charles Darwin.* Cambridge, Cambridge U. P. I.

Carrington, H. (ed.) 1948 — *The discovery of Tahiti.* Cambridge, Hakluyt Society.

Carter, Harold B. 1988 — *Sir Joseph Banks.* London, British Museum.

Davis, J. R. 1999 — *The great exhibition.* Stroud, Sutton Publishing.

Day, A. 1967 — *The Admiralty Hydrographic Service — 1795-1919.* London, H. M. S. O.

Deacon, Margaret 1971 — *Scientists and the Sea — 1650-1900.* London, Academic Press.

Desmond, Adrian 1994-97 — *Huxley.* London, Michael Joseph, 2 vols.

Desmond, Adrian and Moore, James 1991 — *Darwin.* London, Michael Joseph.

Duhem, Pierre 1962 — *The aim and structure of physical theory.* New York, Atheneum.

Fox, Robert and Nieto-Galan, Agusti 1999 — *Natural Dyestuffs and industrial culture in Europe, 1750-1880.* Canton MA, Science History Publications.

Gallagher, R. E. (ed.) 1964 — *Byron's Journal of his circumnavigation —1764-1766.* Cambridge, Hakluyt Society.

Heaps, L. 1973 — *Log of the centurion.* London, Granada Publishing.

Herschel, John F. W. (ed.) 1851 — *A manual of scientific enquiry.* 2nd ed., London, John Murray. (Reprinted Folkestone, Dawson, 1974, intr. D. M. Knight.)

Homburg, Ernst *et al.* (ed.) 1998 — *The chemical industry in Europe, 1850-1914.* Dordrecht, Kluwer.

Home, Rod (ed.) 1988 — *Australian science in the making.* Cambridge, Cambridge U. P.

Jardine, Nicolas *et al.* 1996 — *Cultures of natural history.* Cambridge, Cambridge U. P.

Knight, David M. 1998a — *Science in the Romantic Era.* Aldershot, Ashgate Variorum.

Knight, David M. 1998b — *Humphry Davy: science and power.* Cambridge, Cambridge U. P.

Natusch, Sheila and Swainson, Geoffrey M. 1987 — *William Swainson.* Wellington, NZ Founders Society.

Rudwick, Martin J. S. 1976 — 'A visual language for geology'. *History of Science,* 14.

Sá, Magali Romero 1998 — 'James William Helenus Trail: a British naturalist in nineteenth-century Amazonia'. *Historia Naturalis,* 1.

Shakespeare, William — *The tempest,* V, 1, 184.

Swainson, William 1989 — *Diaries 1808-1818.* Ed. and publ. G. M. Swainson, Palmerston North, N. Z.

1968 — *The journals of Captain James Cook, I, The Voyage of the* Endeavour. Cambridge, Hakluyt Society.

Thomson, Joseph J. 1936 — *Recollections and reflections.* London, G. Bell and Sons.

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