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Natural history in India during the 18th and 19th centuries

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1. Introduction

European access to India was multi-dimensional: The merchant-rulers were keen to identify commodities that could be profitably exported to Europe, cultivate commercial plants in India that grew outside their possessions, and find substitutes for drugs and simples that were obtained from the Americas. The ever-increasing scientific community in Europe was excited about the opportunities that the vast landmass of India offered in natural history studies. On their part, the Christianity enthusiasts in Europe viewed European rule in India as a godsend for propagating the Gospel in the East. These seemingly diverse interests converged at various levels. Christian missionaries as a body were the first educated Europeans in India. As in philology, they were pioneers in natural history also. They constituted a valuable resource for naturalists in Europe. European interest in their field work brought them scientific recognition as well as the much needed cash. More significantly, they introduced the colonial administrators, especially the medical men, to systematic botany.

One can make a clear distinction between pre-Linnaean and Linnaean phases in European foray into Indian natural history. Europe was introduced to western Indian drugs and simples by the 1563 work of the Goa-based Portuguese physician Garcia d'Orta (1501/2–1568). A century later, during 1678–1693, the Dutch administrator Hendrik Adriaan van Rheede tot Drakenstein (1636–1691) furnished Europe with information from South India. In both cases, the initiative originated in the colonies itself (Kochhar 2012). Things changed in the second half of the 18th century. Now, individual European naturalists and institutions wanted not only specimens from India but also bits of tacit knowledge resident in the local population. European India was ready and willing to oblige, but as a collaborator rather than a courier. We shall focus on India-based Europeans who built a scientific reputation for themselves; there were of course others who merely served as suppliers.

2. Tranquebar and Madras (1768–1793)

As in geography, the earliest centre for botanical and zoological research was South India. Europe-dictated scientific botany was begun in India by a direct pupil of Linnaeus not in the British possessions but in the tiny Danish enclave of Tranquebar, which though of little significance as far as commerce or geo-politics was concerned, came to play an extraordinary role in the cultural and scientific history of India.

Using Tranquebar as their (initial) base, the missionaries carried out field work in the whole of the peninsula as well as Ceylon. They made their own investigations, supplemented them with traditional knowledge obtained from local people, and passed on the package to Europe, where it was handsomely acknowledged and incorporated into the mainstream. These activities produced profound impact on British India as well. Its introduction to scientific biology came from interaction with missionaries-cum-naturalists and led to its institutionalization. Tranquebar even served as a waiting room for entry into British India. Capable persons from Europe came to the Danish enclave confident that sooner than later British India would absorb them.

Tranquebar is well known for the Royal Danish Mission established in 1706. While the India-bound Lutherans were taught theology in Halle, those who additionally wanted education in science subjects were sent to Copenhagen. It was, however, not this mission but the Moravian Mission which took the lead in the 'systematic investigation of Indian vegetation'. The latter was established in 1760 on the

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outskirts of Tranquebar with the permission of the Danish King. It was meant to serve as a base for religious activity in Nicobar. It failed in its religious mission and was closed in 1803, but it did leave behind its scientific impact. The first modern botanist in India was Dr Johann Gerhard Koenig (1728–1785), who arrived in 1768 and remained in India till the end, though not with the Mission. Koenig was born in the duchy of Courland, now in Latvia, and was originally trained as a pharmacist in Riga. In 1748 he took appointment in Denmark. During 1757–1758 he studied natural history in Uppsala as a student of Linnaeus, with whom he maintained correspondence. In 1759 Koenig was appointed to the Royal Frederick's Hospital in Copenhagen as a surgeon and pharmacist, being allowed, by special permission, to study medicine at the University. In 1764 he became amanuensis to Georg Christian Oeder, curator of the newly launched Flora Danica project. It would seem that Koenig's proximity to Linnaeus did not go well with Oeder, and Koenig was left with no alternative but to move out. He came to India to pursue his vocation as a naturalist. His dissertation, dated 1773, was submitted in absentia under Prof Friis Rottboel (Sterll 2008 p 117). Koenig then may well be the first person in India with a scientific doctorate from a European university.

Koenig was unable to fund field trips from his meagre Mission income. In 1774, he accepted the post of naturalist to the Nawab of Arcot (*http://www.kew.org/floraIndica*). It is not known whether the initiative came genuinely from the Nawab himself or, as is more likely, he was persuaded by his European friends to employ Koenig. The appointment allowed Koenig frequent excursions to the hills and even a voyage to Ceylon. Payments to Koenig, however, were irregular (Royle 1840 p 49), and in 1778 Koenig successfully applied to the Madras Government for appointment as the Company's first-ever natural historian (Love 1913 p 178) (the designation was interchangeably used along with botanist and naturalist). In 1778–1780 he was sent to Thailand and the Straits of Malacca to bring economic plants such as cardamom and gamboges for cultivation in India. He also brought information on tin ore and minerals. For himself, he collected huge information on Thai orchids.

Indian botany was greatly supported by Sir Joseph Banks (1743–1820), well-known botanist, influential scientist, and a friend of King George III. He was appointed the (informal) director of Royal Botanic Gardens at Kew in 1773 and president of the Royal Society in 1778, both of which positions he held till his death. Luckily, Bank's secretary Daniel Carl Solander (1736–1782), who had also studied in Uppsala, was Koenig's 'learned Friend and Fellow disciple' (Love 1913 p 178). Banks declared that Koenig had repaid the Company 'a thousand-fold over in matters of investment, by the discovery of drugs and dying materials fit for the European market'. Koenig bequeathed his manuscripts and herbarium to Banks (*http://apps.kew.org/floraindica/htm/biography_koenig.htm*). Koenig dutifully sent his results to his friends in Europe and to Banks. There are three shells in the Linnaeus collection marked Tranquebar. The name of the sender, however, is not mentioned. On 20 December 1771, Linnaeus wrote to a friend, John Ellis, that 'Koenig had found a lot of new things in Tranquebar' (Dance 1967 p 8).

Koenig's earliest pupils and collaborators were the two missionaries from the Danish-Halle Mission: Christoph Samuel John (1746–1813), who arrived in 1771, and Johan Peter Rottler (1749–1836), who arrived in 1776. Both remained here for the rest of their lives. From among others, the most famous is Dr William Roxburgh (1751–1815), who was hailed by his contemporaries as father of modern Indian botany. Much later, after Koenig's death, two other names became well known: Johann Gottfried Klein (1766–1821) and Dr Benjamin Heyne (1770–1819). Johann Klein was a local boy. He is the first India-born modern botanist. His father Jakob Klein (1721–1790) was a Lutheran missionary who came to the Danish Mission in 1746 and remained here till the end. Junior Klein was born in Tranquebar, went to Copenhagen to study medicine and returned in 1791 as the mission doctor (Fenger 1863 pp 297–298). His 30-page dissertation dealing with the treatment of venereal disease in India was submitted to the University of Copenhagen and published in 1795. Heyne was a Dane who arrived in Tranquebar in 1793 as a Moravian and was soon engaged by the Company.

In Tranquebar, at one time, there were two missions, two Kleins and two Koenigs. The resulting confusion has a long history but that is no reason to perpetuate it. Our Koenig did have a connection of sorts with the Danish Mission, in that he was for a while its medical adviser. But he was not a part of it. As it happened, an ordained priest, Rev Johann Friedrich Koenig (1741–1795) came to the Danish Mission in 1767 and remained there till his death (Fenger 1863 p 316). Accounts of these two individuals have been hopelessly intermingled. Interestingly, the complaint had been made as early as 1861 (Foulker 1861 p 3n). The botanist Koenig would have known Dr Klein as a boy, but could not have collaborated with him. By the time Klein junior returned from Europe, Koenig was dead. By confusion with his father, junior Klein has at times been made a member of Koenig's original band. The Moravian Mission and the Danish Mission were distinct. The Danish Mission was much older and already well known; it was often called Tranquebar Mission. These two Missions have very often been treated as one and the same thing. For example, Desmond (1992 p 39) and Arnold (2000 p 46) treat the Moravian and the Halle missions as one. This is ironic because the Danish Mission as a body was openly hostile to the Moravian.

The Moravians entered into a contract with Banks to send him plant specimens on payment. Accordingly, as many as

500 specimens were sent between 1775 and 1778 (Burkill 1965 p 15). It would seem that Koenig-led natural history enthusiasts formed themselves into an informal society to pool their resources in general and to honour the Banks contract in particular. Perhaps the name United Brethren was first given to the core group comprising the Moravians and the Lutherans to highlight the fact that though theology pulled them apart, natural history served as a unifying force. Koenig and his collaborators assiduously collected plants throughout the Indian peninsula and in Ceylon and, at least in the initial stages, named them jointly. In such cases, *nob*., short for the Latin *nobis* (meaning us), was appended to the given name (How 1878 pp 369–370). 'Nomenclature has always been regarded by systematic botanists as practically the most important department of their science, of which classification is the framework, and in no other department of knowledge so much careful attention been paid to it' (How 1878 pp 369–370). The specimens were transmitted to Europe, many of which were published in different works, sometimes under the names given by the donor, sometimes under a new name (Wight and Walker-Arnott 1834 p xi). The fact that India-based European naturalists decided to give names themselves shows their level of confidence and knowledge. What the India-based European botanists lacked by way of access to current scholarship and publications was more than made up by the novelty of the material in their hands.

In the early years in India, John's income was so low that he and his wife lived in extreme poverty. To earn some extra money, 'John went out and collected shells and such like curiosities' which he sold to European collectors. This way 'he made some hundred dollars which enabled him to pay off his debts' (Fenger 1863 p 289). He set up the missionary garden in Tranquebar, where he introduced many plants from other parts of South India and also from Ceylon (Wight and Walker-Arnott 1834 p xii). He found a recurring if controversial way of supplementing his income. In addition to the mission school, he ran a private school for a better class of people, namely the half-caste children whose European fathers were anxious to see them well educated. These pupils in turn served as assistants for field work. In the afternoon, after school time, he took the children to the garden, and occupied them with gardening and collecting plants and insects (Fenger 1863 p 291).

John became a dependable informant for German naturalists. In 1792, Johann Reinhold Forster (1729–1798) wrote to the missionaries in South India asking for information on poisonous snakes and traditional antidotes. John collected the information and sent it to Forster. Similarly, John was of great assistance to Berlin-based Marcus Elieser Bloch (1723–1799), who emerged as the pioneering authority on fishes with his well-illustrated 12-volume *Natural history of fishes* published during 1785–1799. Bloch wrote that 'his assertion respecting the generation of some fishes, that the eggs are retained in the mouth till the young are hatched, has been confirmed by Mr. John, in his last letters from Tranquebar, who says it is a fact known to the fishermen there' (*Analytical Review* 1796 vol 23 p 219). It is interesting to see Indian fishermen's common knowledge emerging as a European research finding. Bloch named three fishes in John's honour. He similarly honoured Rottler and Klein. In 1795, John received a doctorate from Erlangen University.

Rottler remained with the Tranquebar Mission only for eight years, that is until 1804, when he transferred to the Company's service in Madras. At the close of 1795, Sir Hugh Cleghorn (1752–1837), the first colonial secretary to Ceylon, was deputed by the government to make a general tour of the island. (He was the father of Dr Hugh Francis Clarke Cleghorn (1820–1895) of Madras Medical Service, Inspector General Of Forestry in Madras.) He engaged Rottler 'at a very moderate expense' to accompany him as a Tamil–English interpreter and naturalist. Rottler stayed back for some time to 'render his assortment more complete'. Rottler's Ceylonese collection was subsequently incorporated into the general herbarium at King's College London (Foulker 1861 pp 7–8). Indian flora reached Canada also. Sir Thomas Andrew Lumisden Strange (1756–1841), the chief justice of Nova Scotia during 1789–1797, served as the first chief justice of Madras Supreme Court 1801–1817. In 1802, Rottler and Klein presented a collection of 168 plant specimens to Strange, which he in turn passed on to King's College, Windsor (How 1878 p 373).

Rottler was in contact with various professors in Europe: Johann Christian Daniel von Schreber (1739–1810) in Erlangen, Carl Ludwig Willednow (1765–1812) in Berlin, and Martin Hendriksen Vahl (1749–1805) in Copenhagen. In 1795 Schreber was instrumental in getting both Rottler and John the degree of doctor of philosophy (Foulker 1861 p 5). The same year Rottler also received the honorary degree of doctor of physical sciences from the Imperial Academy of Vienna (*Gentleman's Magazine* 1837 vol 8 p 431). Rottler is the first India-based botanist to publish in European journals. In 1830 as part of his missionary duties Rottler began work on his Tamil–English dictionary, which was partly published in his own lifetime in 1834. An interesting feature of the dictionary is that it 'contains a very extensive list of the vernacular names of South Indian Plants, with the technical names by which they were known attached, not a few of them were of his own choosing; and this list will be found to be of very considerable help to Botanists in identifying the plants prescribed in the earlier letters on Indian Botany' (Foulker 1861 p 2). He bequeathed his herbarium to the Vepery Mission. Put up for sale in England it reached King's College London, which in 1872 presented it to Royal Botanic Garden Kew (*Gentleman's Magazine* 1837 vol 8 pp 431–432; Stansfield 1957 p 29).

In 1834, while paying tributes to the Tranquebar missionaries 'for their dedicated exertions towards the advancement of Botany', Wight and Arnott rather defensively added in the very first paragraph of their preface that these studies were merely a recreation for the missionaries turned botanists; their more important duties were 'instructing the natives of India in the wisdom of the west, and of thus fitting them to become partakers of the promise of the Gospel' (Wight and Walker-Arnott 1834 p vii). The authors would have found it difficult to substantiate their pious assessment. In fact botany became a compense for the missionaries for their failure on the evangelical front. Referring to the later decades of the 18th century, the pastor Johannes Ferdinand Fenger wrote in 1863 in his *History of the Tranquebar Mission*: 'During these very sad times, the Missionaries tried to be useful to science. Botanical and other scientific remarks are most frequent in their accounts of their journies [sic] which were published at Halle. They were in many ways connected with learned men, more especially with such as were interested in Natural History, both in Europe and India. The botanical collection of Dr. Rottler, John's conchological and Klein's ornithological and entomological collections were of great importance. Eight different learned Societies voluntarily elected them as members'. Incidentally, for 35 long years, John was a valuable source of information even on the subject of Indian languages to one Professor Ruediger at Halle (Fenger 1863 pp 302–303).

In 1785 Koenig was succeeded by Dr Patrick Russell (1726–1805), who was already in India on his own. Russell came to Vizagapatam in 1782, where his younger brother Claud, member of the Madras civil servant since 1752, was posted as the chief administrator. One of Patrick's very first tasks after arrival was calling on Koenig in Tranquebar. In Vizagapatam Russell did not confine his attention to the vegetable kingdom alone but eagerly collected, figured, and described the fishes and the serpents in the Carnatic plain, which stretches along the coast of Coromandel. On appointment Russell was asked to catalogue the economically useful plants of Madras and publish König's scientific notes. It was, however, not sufficient that the Company naturalists worked for the government. They must be of help to the scientists back home also. Payment to Russell was made contingent on his writing an annual report for the Royal Society (Love 1913 p 332). Far-sightedly, he suggested to the Madras Governor that information on all economically useful Indian plants be collected. 'He proposed that letters should issue from the highest authority, inviting the gentlemen, particularly of the medical department, resident at the different stations, to transmit every information in their power concerning such useful plants, accompanied with specimens of each plant, including the leaf, flower, and fruit, with a view to publication.' Russell's plan, with a list of the plants he had selected to begin with, was approved by the Court of Directors which requested Banks to oversee the project. Russell left in 1789, but the project continued.

Russell's greatest contribution was his initiation of a study of snakes. This was a subject of great importance because visit to tropical lands also meant encounter with snakes. He wished to educate the people on the distinction between poisonous and non-poisonous snakes so that a snake bite did not always cause fear and anxiety, and harmless snakes were not killed out of ignorance. Harmless snakes have teeth in both the upper and lower jaws, while the poisonous snakes do not possess upper teeth. It may not be prudent to check the teeth while the snake is still alive. Keeping this in mind, he prepared detailed description of various snakes, towards the end of 1787. His write-up and figures were published by the government and widely distributed. His major publications came out after his return to Britain.

The Company took up the expense of publication of coloured figures of the snakes along with their descriptions by Russell. He published the first volume of his book *An account of serpents collected on the Coast of Coromandel* in 1796, while the second volume was published in four parts during 1801–1809. He named red sand boa *Eryx johnii* in John's honour, while his own name was assigned to the viper species. Different combinations, based on different specimens, were tried: *Coluber russelii* (Russell's snake) in 1797; *Vipera daboia*, the genus named after a Hindi word meaning lurker, in 1803; *Daboia russelii* in 1842; and finally *Vipera russelii* in 1890 (Hawgood 1994 p 1303).

Russell also took note of folk practices and subjected them to scientific scrutiny. He acquired numerous samples of *tabasheer*, found in the hollow stem of the bamboo and said to be 'possessed of extraordinary virtue'. The samples were analysed by James Macie and the results presented to the Royal Society in 1790. Tabasheer turned out to be almost pure silica (*European Magazine and London Review* 1811 vol 59 p 6). While tabasheer was a mere curiosity, the so-called Tanjore pill merited serious consideration, because it was presented as a remedy for the bite of venomous and rabid animals. The pill contained arsenic, and the medical opinion on it remained divided (Robinson 2003 p 4).

After Russell, there came a man of outstanding merit and long service. Edinburgh-educated Roxburgh, who, probably an illegitimate son of an influential family in Scotland, was able to overcome the disadvantage of birth, thanks to the social patronage received from the Boswells of Auchinleck and the professional patronage from Professor John Hope and Sir John Pringle (1707–1782), president of the Royal Society during 1772–1780 (Robinson 2003 p 4). He began his career as a surgeon's mate on Company ships and joined Madras Medical Service as an assistant surgeon in 1776. In 1781, he was appointed surgeon to the garrison at Samulcotta [Samalkot] in what was known as Northern

Sircars. Located at the edge of a hilly region, 27 miles from one of the mouths of Godavari River, Samulcotta is endowed with 'a very interesting Flora', and was the site of an old Mughal garden. Now, Roxburgh established a Company garden and began to develop a collection of living plants which he studied for their economic value. In the task of collecting, sorting and naming his material, Roxburgh received direct help from Koenig. In 1786, he reported the significant discovery that 'the Pepper Plant was a native of the Hills in the Rajamundry Circar'. During 1787, Roxburgh procured 400 slips of the pepper vine from the Rampa hills, and within 12 months raised upwards of 40,000 plants (Love 1913 pp 333–334). He cultivated coffee, and worked on a number of topics including various dyes including lac and caducay gall; culture and manufacture of silk; and various grasses. He spent considerable time and energy on the study of *Swietenia febrifuga* as a possible substitute for cinchona (Robinson 2003 pp 172–173).

Within the overall ruthlessness of the Company, there was individual thoughtfulness which was listened to. Although Roxburgh could not have pointed to the Company how its policies caused famines in India, he suggested that cocoanut trees be planted on canal banks and street side. He also advocated the cultivation of the sago, date, palmyra, plantain, jack, bread-fruit and opuntia, all of which possess food value (Love 1913 pp 409–410). He also experimented with teak, which would become a priority in the Calcutta garden. In addition to the Company garden, which he supervised, Roxburgh set up a private garden of his own. Interestingly, he made a considerable fortune for himself from private trade in collaboration with Andrew Ross, former mayor of Madras (Robinson 2003 p 38.).

On the basis of the botanical work he carried out at Samulcotta and Patrick Russell's recommendation, Roxburgh was appointed Russell's successor as the Madras naturalist. We have already noted Russell's proposal for a systematic publication of Indian flora. Roxburgh immediately began work on the project. In 1793, Roxburgh left Madras to take over as the first full-time salaried superintendent of the Calcutta Botanic Garden, and the project went with him.

3. Calcutta (1787–1846)

Initiative for Calcutta Botanic Garden came from Lieutenant Colonel Robert Kyd (1746–1793), secretary to the military department in Calcutta, and a horticulture enthusiast who cultivated a private garden of his own. On 15 April 1786 Kyd suggested to the government that plants of the Sago tree growing in the Malay Peninsula be brought and grown all over British possessions (Biswas 1950 p 4). He followed this up with a broader proposal, couching it in a mercantile idiom he knew the Company would understand. He suggested 'establishing a botanical Garden, not for the Purpose of collecting rare plants…but for establishing a stock for the disseminating such articles as…may tend to the Extension of the National Commerce and Riches' (Biswas 1950 p 8). The letter was accompanied by a long list of plants he wanted for the garden including Dacca cotton, indigo, Sarasparilla, teak wood, pepper, cardamom, gum copal, asafoetida, nutmeg, clove, tea green, China laquer, and papia. The Court of Directors consulted Banks, who supported the proposal and emphasized the need for reciprocal exchange of plants and seeds between Calcutta and West Indies. The Company accepted Kyd's proposal on 31 July 1787, seeing 'a great source of wealth' for itself in the cultivation of cinnamon, which would break the Dutch world monopoly. Accordingly, a botanic garden was established in 300 acres in Sibpur on the banks of Hooghly, with Kyd as its honorary superintendent, and with his private garden merged into it (Carey 1814 p ii)

Speaking in 1899, Sir George King (1840–1909) who had been the superintendent of the Garden during 1871–1897, rather uncharitably described Kyd as a 'gardener rather than a botanist'. King went on to summarize the main reasons for the establishment of the Garden a century previously. It would grow teak which was required in larger and larger amounts for making more and more and bigger and bigger ships because of increasing trade, but had to be imported. Another incentive was the cultivation of spices in which the Company territories were deficient. However, under Roxburgh the Calcutta Garden moved beyond horticulture and utilitarianism.

For Roxburgh there was continuity between Samulcotta and Calcutta. Between 1790 and 1795 he transmitted about 500 specimens with drawings and descriptions to England. The final product of the monumental effort was the *Plants of the Coast of Coromandel,* with a preface by Russell. The first volume was published in 1795, the second in 1798, and the third as late as in 1819.

In 1805 when it seemed that Roxburgh's illness would render his post vacant, Banks reminded the Company that the superintendent of the garden should be 'capable of communicating advantageously to the learned world such discoveries in the animal, the vegetable and the mineral kingdoms as are made from time to time in the extensive regions of the east to the intimate advancement of natural knowledge'. This was a significant observation which the Company accepted. By this time, the British government had a say in the Company affairs and scientists in the British government. Calcutta Botanic Garden was no longer a mere Company depot, but an international research centre.

After Roxburgh's departure in 1813 the Garden remained leaderless for four years. Roxburgh handed over charge to William Carey who held it till April 1814. In 1814 itself Carey published from his Serampore mission press a

catalogue of the plants growing in the garden, under the title *Hortus Bengalensis*, with financial support from the government. This was an important development, because Europe at large learnt about the garden from it. Carey's own 12-page introduction sums up the progress of the Garden up to that time. We thus learn that at the beginning of Roxburgh's term the Garden had about 300 plants. By the time he left in 1813, the Garden had an inventory of about 3500 plants. Taking into account some plants not yet introduced into the Garden, the number of plants drawn and described by Roxburgh stood at 1963 (Carey 1814 p ii).

Francis Buchanan was appointed the superintendent in 1814 but he left in 1815. It would be another two years until the Garden got a permanent director. Nathaniel Wallich's (1786–1854) association with the Garden began under the shadow of war. Wallich was educated at Copenhagen under Professor Martin Vahl (1749–1804). But since he was a Jew (his original name was Nathan Wolff), he could not have been employed in Denmark itself (Crawford 1914 vol 2 p 143; Sterll 2008 p 117). Wallich arrived in the Danish enclave of Serampore as a surgeon in November 1807. When in 1808 the British annexed Danish territories in India in continuation of developments in Europe, he was among the prisoners of war taken. He was released, on 1 January 1809, on Roxburgh's intervention, to be employed at the Garden (Robinson 2003 p 82). An official letter dated 30 June 1809 says: 'Dr Wallich, a Danish prisoner, has been appointed to assist Dr Roxburgh, but without any additional allowances. In the event of his pursuing his researches in the interior of the country he is to be granted Rs 200 per month for travelling charges' (Crawford 1914 Vol 2 p 144). Wallich was absorbed in the medical service in 1814. The same year he proposed to the Asiatick Society the establishment of a museum which blossomed into Indian Museum. He held temporary charge of the Calcutta Garden from 24 February 1815 till 20 April 1816 when James Hare (d. 1831) of Bengal Medical Service and Apothecary General took charge. Eventually Wallich was given the regular appointment from 1 August 1817 which he retained for thirty long fruitful years, till his retirement in 1846. It may be noted in passing that Sanskrit studies in continental Europe were similarly initiated by a prisoner of war, in 1803. The prisoner was British (Alexander Hamilton) and the venue Paris. There was thus a certain collectivity in European intellectual pursuits.

Wallich's tenure 'constitutes the most prominent era in the botany of India'. At his suggestion, the government allotted an area, five miles in circumference, for the Garden, and employed upwards of 300 gardeners and labourers. Subordinate gardens were formed in remote parts of the Indian possessions; collectors were sent out to discover new, and especially useful, plants; and the British residents were invited to send the vegetable productions of their respective districts to Calcutta, both in a living and dried state. In 1816, following war with Nepal, Britain appointed a Resident, Edward Gardner, in Kathmandu. Four years later, in 1820, Wallich came over and spent more than a year assiduously collecting specimens for more than a year in the vicinity of the capital. Since the interior was closed to the Europeans, he arranged for local collectors. He was thus able to add a fair knowledge of the alpine flora to the abundant information on the temperate and tropical regions that he obtained by his personal exertions. Before returning, he trained a number of collectors, who continued, during a long series of years, to transmit dried specimens from Nepal.

One Mr Blinkworth, an active collector, at the same time, explored Kumaon, and Mr Gomez contributed extensive collections from the rich province of Sylhet, and from the neighbouring Khasia hills, while Wallich himself visited Penang and Singapore, thus adding a knowledge of the Malayan flora to that of the rest of India. In 1825, he examined and collected the plants of the kingdom of Oude [Avadh] and the province of Rohailkhand, the valley of Dehra, etc. His last mission was to Ava. The number of species in Calcutta by 1828 was estimated to be 8000–9000 (*Edinburgh Literary Journal* 1831 Jan–Jun p 308). It is interesting to see what the acerbic Victor Jacquemont, the French traveller and letter writer, had to say about Wallich in 1829 while Wallich was away to Europe: 'A Danish botanist, of mediocre talents, who passes here for the first in the world, is the director of this establishment; he has certainly the best income of any savant in existence' (Jacquemont 1834 p 90).

4. Saharanpur Garden (1817)

Next in importance to Calcutta there stood the Saharanpur Garden, which was a revival rather than a creation. A 40-acre public garden aptly called Farhat Baksh [delight giver] was established at Saharanpur in 1779 by the Rohilla Fauzdar Zabita Khan, who appropriated the revenue of seven villages for its maintenance. His son Ghulam Qadir, who pitilessly blinded the hapless Mughal emperor Shah Alam in 1788, continued the arrangement. The Mahrattas after him reduced the quantum to two villages (Hyde 1962 p 48). Saharanpur passed into British hands in 1803. In 1816 George Govan (1787–1865), who had joined as civil surgeon at Saharanpur the previous year, wrote a letter to the Governor General strongly arguing for the revival of the old, now dilapidated garden. In particular he advocated the cultivation of chocolate, sarasparilla, guaiacum, cassia, liquorice, vanilla, and 'various species of cinchona furnishing the Peruvian bark'. His advocacy of tea cultivation anticipated later developments. He very sensibly pointed out that tea could not be unique to China and should grow in conditions similar to

those in tea-growing parts of China (Hyde 1962 p 50). The Governor General agreed that 'considerable advantages would result not only to Science but to the interests of the Honourable Company from the proper management of the Botanic Garden at Saharanpur'. Govan's appointment as Superintendent was sanctioned on 13 June 1817 (Hyde 1962 pp 51–52). Govan's tenure, however, was short. In 1821, he left India on sick leave and Saharanpur for good. When he resumed duty, it was as a geologist. Like in Europe, natural history served to decrease the distance between the aristocrat and the commoner. In 1827 at the newly founded hill station of Simla, Lady Amherst and the Governor General Lord Amherst liked to go out every morning after breakfast with Dr Govan 'walking or rather scrambling up the mountains…in search of plants'. It may be noted that Jacquemont, who met Govan at Simla in June 1830, described him as 'rigid Scot, a good man but a poor botanist' (Hyde 1962 p 55, quoting the original French, without translation). History however has chosen to ignore Govan rather than be harsh on him. Jacquemont was generally appalled at the good time and high salaries many people less gifted than him were enjoying under the British auspices.

In Govan's time the Saharanpur Garden was an independent entity, but after him it was placed under the control of the Calcutta Garden. Many Saharanpur superintendents in fact rose to head the latter. In 1823, the Saharanpur charge was handed over to the civil surgeon John Forbes Royle (1798–1858). Kanpur-born Royle was educated at Edinburgh and Addiscombe with a view to a career in the army like his father, but thanks to his pupilage of Anthony Todd Thomson (1778–1849), he became interested in botany, obtained his diploma and came to Bengal in 1819 as an assistant surgeon. In 1823, he was appointed the superintendent of the now 400-acre Saharanpur gardens, which position he held till 1831. In addition, he had hospital duties; accouchier to the civilians' wives and body surgeon to the convicts (*Calcutta Review* 1845 3 164n) Scientifically the Calcutta and Saharanpur gardens were complementary; commercial plants which would not grow in the former had a chance in the latter. Royle successfully sent collectors to Kashmir under the guidance of shawl dealers when they were returning home (Burkill 1965 p 33). Royle returned to England in 1831 bringing duplicates of all his collections with him. After a long spell of leave, he retired in England in 1837. The same year he took the MD degree from Munich. In 1833, he published the first part of his *Illustrations of the botany and other branches of the natural history of the Himalayan Mountains, and of the flora of Cashmere*. The second part, containing the plates, came out in 1839.

On the opening of King's College London in 1836, Royle was appointed lecturer on materia medica, which post he filled till 1856. On the basis of his course material he published in 1837 *An essay on the antiquity of Hindoo medicine: Including an introductory lecture to the course of Materia Medica and Therapeutics, delivered at King's College*. From 1847 to 1857 he was reporter on economic products to the East India Company. In a lecture delivered at the Society of Arts in 1854 during the war with Russia, Royle drew attention to India as a source of various fibrous materials used in the manufacture of cardage, clothing, etc. The lecture was expanded into a valuable book *On the fibrous plants of India*, published the next year. He took an active interest in cultivation of tea in the East Indies. Royle's life sums up a capable European botanist's professional career driven by India, collection of live plants and specimens in India; enrichment of herbariums in Britain, and advancement of Company's commercial interests. Royle was succeeded by Hugh Falconer (1808–1865), who made a name for himself by the discovery of the Shivalik zoological fossils.

Falconer first studied at the University of Aberdeen, 'aided by the resources' of an elder brother who was a merchant in Bengal. In 1830, he obtained his MD from Edinburgh and was almost immediately appointed assistant surgeon in Bengal. Since he had not yet reached the required age of 22, he came to London to assist Wallich in the distribution of the herbarium. At the same time, he studied the collection of fossil mammalia from the banks of Iravati River, which had been brought by John Crawfurd during his mission to Ava and which was now housed in the museum of Geological Society of London.

Falconer joined Bengal Medical Service in September 1830 and met Royle in April 1831 in Saharanpur when his official duties brought him there. On Royle's recommendation, Falconer was speedily appointed to officiate for him during his leave of absence. When Royle left for England in 1832, Falconer succeeded him. 'Thus, at an early age of twenty-three, did he find himself advanced to a responsible and independent public post, offering to a naturalist the most enviable opportunities for research; so fertile was the Indian service then in chance to rise for any young officer who chose to make the exertion' (Murchison 1868 p xxv).

5. Fossil fauna

In 1847 Falconer became the superintendent of the Calcutta Garden as also professor of botany in the Medical College there. The British desire for exploration and increased revenue indirectly led to the epoch making discovery of fossil fauna in the Shivalik hills. The story deserves to be told in some detail, because it brightens a particularly dark period at Delhi (Kochhar 1992). As early as 1351 CE, Ferozeshah Tughlaq cut through a hill with the help of 50,000 men to dig the West Yamuna (or Delhi) canal. In 1568 Akbar ordered that it be excavated deeper and wider. East

Yamuna, or Doab canal, was constructed in 1626 during the reign of Shah Jahan. Both these canals had ceased to flow by the middle of the 18th century (*Quarterly Journal of Science* 1868 vol 5 p 482). The British Indian government took up the task of restoring these two old canals. After preliminary survey in 1810–1811, work on the Ferozeshah canal was begun in 1817, and on the Doab canal in 1822, Saharanpur being the head of both. Sir Proby Thomas Cautley (1802–1871), in charge of the doab canal, had already discovered fossil bones, but their real nature had been overlooked. Falconer was aware of a report by Ferozeshah's historian Farishta, where he described unearthing of three-yard-long bones of giants while digging the east canal. Towards the end of 1831, Falconer and Cautley discovered bones of crocodiles, tortoises, and other fossil remains in the tertiary strata of the Shivalik hills. Cautley was able to follow the lead by discovering more fossils through blasting the hills (Murchison 1868 p xxvii). On 16 November 1834, the superintending engineer Lieutenant (later Sir) William Erskine Baker (1808–1881) received a present of a fossil of an elephant's tooth from the Raja of Nahan. Promptly, he sent a sketch to the secretary of the Asiatick Society Calcutta. On hearing this, Dr Falconer made enquiries and had a fragment of a similar tooth presented to him also: 'I got a hint where they [the teeth] came from and on going to the spot. I reaped a rich harvest. Only conceive my good fortune. Within six hours [on 20 November 1834] I got upwards of 300 specimens of fossil bones' (Murchison 1868 p xxviii). These discoveries proved that in the remote past a sea occupied the valleys of the Indus and Ganga. Incidentally, in 1835, Falconer and Cautley discovered the remains of the giant Miocene fossil tortoise, 'which by its colossal size realized the mythological conception of the Tortoise which sustained the Elephant and the World together on its back' (Murchison 1868 p xlv). In simpler words, if the existence of such fossils was known in ancient times that may explain the concept of Vishnu's incarnation as a tortoise (*kurma*) which carries the weight of the whole earth.

It would be instructive to see how the colonial researchers 'far distant from any living authorities or books on Comparative Anatomy to which they could refer' carried out their work. '[I]n the surrounding plains, hills and jungles', 'they slew the wild tigers, buffaloes, antelopes, and other Indian quadrupeds', and preserved their skeletons. 'They also obtained specimens of all the reptiles which inhabited that region' (Murchison 1868 p xxx). To construct a barometer for mountain exploration, broken tumblers were melted and blown into a tube; mercury was distilled from cinnabar purchased in the bazaar; and 'a brass scale was cast, shaped, and even graduated, by a native blacksmith, under the superintending eye of the [European] amateur' (Murchison 1868 p xxvi). In 1837, both Falconer and Cautley were jointed awarded the prestigious Wollaston Medal of the Geological Society of London. It has been suggested that the award 'had great symbolic value, not just for the recipients but for all geologists working in India'. It 'was taken as evidence that the geology of India, and those labouring in its elucidation, were considered important by metropolitan savants' (Grout 1995 p 83). Discovery of Shivalik fossils was an extraordinary find. It emerged as a corollary of giant government undertaking, namely digging of canals, and burst on the scientific scene. There can, however, be no doubt that no matter what the driving force for field studies in India, recognition by the British scientific power centres was coveted and solicited.

In 1842 Falconer left for Europe on sick leave and remained there till 1847. He brought with him his natural history collections amassed during ten years of exploration. These included 70 large chests of dried plants from Kashmir, Afghanistan, Tibet, Punjab, Himalaya, plains of what is now western Uttar Pradesh, and from the neighbourhood of Darjeeling, Assam and Sylhet. His collections from Kashmir and Little Tibet were particularly valued, he being one of the first botanists to visit these areas. His collection also included 48 cases containing five tons of fossil bones, together with geological specimens, illustrative of the Himalayan formations from the Indus to the Gogra, and from the plains of the Punjab across the mountains north to the Mooztagh range.

Cautley had already in 1840 deposited his collection with the British Museum, the transportation costs from India being paid by the Indian government. Falconer's collections were divided between East India House and the British Museum. There were other fossil collections in the university museums in Oxford and Edinburgh. In July 1844, the presidents of various learned societies sent a memorial to the Court of Directors pointing out the desirability of having the specimens in the various collections prepared, arranged and displayed and also of publishing an illustrated work to convey to the men of science a 'knowledge of the content of Sewalik Hills'. They further suggested Falconer's name for carrying out this work. Since the Company does not seem to have been too enthused with the idea, the President of British Association for the Advancement of Science along with the presidents of other societies asked Her Majesty's government for support. The government responded promptly by making a grant of 1000 pound sterling to prepare the materials in the British Museum in a paleontological gallery. In December 1844, Falconer was entrusted with the work. The Company now fell in line, treating Falconer on duty. Both the Company and the British government agreed to buy 40 copies, 9 of the envisaged 12 parts of the illustrated work titled *Fauna Antiqua Sivalensis* were published within three years. In June 1847, on Wallich's retirement, Falconer was appointed superintendent of Calcutta Botanic Garden and professor of Botany at Medical College. He would have

liked to work on his on the Shivalik fauna in London on his Indian salary. But the Company refused to extend Falconer's stay in London, compelling him in December 1847, under threat of loss of pension, to return to his duties in India. Falconer tried to resume the work in 1856, on his return to England after retirement, but eventually the work was completed in 1868 after his death.

6. From coal to continental drift

Early British India did require some coal for use by its arsenal for casting ordnance. This coal was imported from England. As early as 1774, attempts were made to replace sea-coal with Indian coal but the experiment was not a success. The initiative came from a Bengal civil servant, Suetonius Grant Heatly (1741–1793), at the time the commissioner of Chhota Nagpur and Purnea. The area included the hilly Ramgarh country (Ramgur or Ramghur), where Subarnrekha River runs for some miles through a coal mine. 'The whole of this country was then subjected to the rule of the Raja of Ramghur; and it is an historical fact, that Mr Heatly, at that time being politically employed by the Government captured the Raja, and probably obtained Government permission' (Homphray 1842 p 734).

Heatly in collaboration with some other civil servants obtained the lease for working six mines in Pachete and Beerbhoom. The enterprise, however, failed because, the entrepreneurs felt, the Government refused to buy coal 'owing to the strong interest made by the coal contractors at home' (Heatly 1842 p 825). As England industrialized, it needed the coal for itself. At the same time demand in India also increased with the result that England could not supply it to India in sufficient quantities year after year. In September 1808, the Governor General, Earl of Minto, asked the Military Board to examine 'the practicability of substituting Bheerbhoom coal for sea-coal' (Heatly 1842 p 825). It was, however, only in 1814 that the government decided to sponsor the quest for better quality coal. One William Jones (d. 1821), known as Guru Jones, and better remembered as the architect of Bishop's College Calcutta, was hired for coal exploration. The result of his mission was that he rediscovered some of Heatly's old workings and more importantly 'discovered' the Raniganj seam (Blanford 1863 p 156). The site did not have a name. It was called Raniganj because of the 133-bigha land grant given by the Rani of Burdwan (Ghosh 1997 p 146). Jones was the first person to bring Indian coal to the general market. This historical distinction notwithstanding, he could not make a commercial success of his enterprise. In 1836, the mine passed on to a firm owned by Dwarkanath Tagore, giving him virtual control over the fuel supply in the Bengal presidency, with the government as the biggest buyer.

While the British Indian government was interested in coal for local use, the Court of Directors eyed the Himalayan region's legendary mineral wealth for its own profit. The first geological appointment in British India was an imposition from the very top, with disastrous results. In 1816, one Alexander Laidlaw (d. 1836), already noticed for his lack of 'liberal education', was sent out to India, where he was asked by the Governor General to seek 'indications of metallic veins' in the tracts which were being surveyed in the Kumaon region. The Governor General however cautioned: 'To copper or iron I would not point Mr Laidlaw's attention, as I think the working either might injuriously affect important articles of British export'. The idea was to add trade items to the Company's list, but not to offer competition to England. As it turned out, Laidlaw did not pay attention to these instructions and was dismissed. Kumar (1980 p 107) is certainly wrong in calling him as one of 'noted mineralogists and surveyors'.

A more systematic approach was initiated at the time of reorganization of the Great Trigonometrical Survey of India (GTS) in 1818, when it was decided to appoint a surgeon and geologist to the survey. University-trained surgeon-turned-naturalist, Henry Wesley Voysey (1791–1824), who joined towards the end of 1818, was the first effective geologist in India. He wrote a report on the stone used in the construction of Taj Mahal, which he visited in 1822. Far more to the point was the one on the diamond mines in Banganpalle (now Andhra Pradesh), which he visited in January 1821.

While influential geologists in Britain were keen to expand their zone of influence, 'much of the impetus to increased geological activity originated within India rather than from Britain' (Grout 1995 p 83).Introduction of steam machinery in manufacture and in river and ocean navigation brought home the realization that local coal was more important than local diamonds. A six-member committee was set up in 1835 for investigating the coal and mineral resources of India with Dr John McClelland (1805–1875) of the Bengal medical service as its secretary. Its report submitted in 1838 largely dealt with coal. The work done so far had been sporadic and isolated. Time had now come for a systematic survey. England had already done so. England instituted Ordnance Geological Survey (later renamed Geological Survey of Great Britain) in 1835 with Sir Henry Thomas De la Beche (1796–1855) as its director. The same year, a Museum of Economic Geology was established, also under Beche. In February 1846 David Hiram Williams (c. 1812–1848), who had earlier assisted Beche in the survey of coal field of South Wales, took up appointment as the Geological Surveyor in the Service of the East India Company. His reasons for accepting the assignment were primarily financial. The addition 'to my present pay will be received by me with gratitude…My wife will regret the separation, but she is too good to object to the idea

as it will do much for our little ones'. As it turned out, he never saw see his family again.

The Company's directions to William were explicit: 'you will direct your principal attention to those localities which promise to afford supplies of coal, and which are so situated with respect to water carriage, as to give a real commercial value to the coal which they may produce' (Kumar 1995 p 45). The geologists travelled on elephants that were trained to pick up fossils. Joseph Dalton Hooker (1817–1911), who explored the Himalayas during 1848–1851, described his 1848 field trip with Williams in his *Himalayan Journal*: 'Our elephant was an excellent one, when he did not take obstinate fits, and so intelligent as to pick up pieces of stone when desired, and with a jerk of the trunk throw them over his head for the rider to catch, thus saving the trouble of dismounting to geologise'. During one of his field explorations, Williams fell off from an elephant, and again from a precipice; and caught jungle fever from which he never recovered.

Like many other impoverished young professionals in Britain and Ireland, European professionals in India believed that their financial interests, the Company's commercial interests and Europe's scientific interests would all converge. William hoped that the survey of Indian coalfields 'will eventually turn out both in an economic point of view and a branch of the Geological Survey of Great Britain' (Sharpe and McCartney 1998 p142). Like many other Europeans in India, Williams also complained that the establishment back home was not very responsive to his work. He sent fossil plants from Indian coal-beds to the British Geological Survey in 1847. Hooker later recorded that Williams 'complained that of all the letters he had written to the Survey but one was answered & the magnificent series of coal fossils not even acknowledged' (*http://www.darwinproject.ac.uk/entry-1257*). In general, European scientists based in India were able to make an impact back home only if they were suitably networked.

Hiram Williams was succeeded by Thomas Oldham (1816–1878), who was at the time professor of geology at Trinity College Dublin as well as the local director of geological survey. He joined his post in India on 5 March 1851 and held it till 1876. In 1856, the survey was constituted as a government department under the name Geological Survey. Under the Survey, geological explorations would continue uninterruptedly and move from merely the economic to the manifestly scientific. In 1863, Blanford noted that although the coal in the Ramghur and Bokaroh coal fields was of poor quality, they offer 'many points of very high interest to the geologist' (Blanford 1863 p 17).

A high point of Indian geology was the evidence for the continental drift hypothesis. The Trinity College Dublin–educated Henry Benedict Medlicott (1829–1905) left the British Geological Survey to take up an appointment in the Geological Survey of India in 1854. From then till 1862, he taught geology at Roorkee Engineering College but remained available for survey work. Finally, in 1862 he returned to the Geological Survey. He succeeded Oldham as superintendent in 1876, designated director in 1885, and retired in 1887. In 1872 in an administrative report he used the term Gondwana system for coal-bearing formations. The term is now used in preference to the tautological Gondwanaland for a hypothesized supercontinent in the southern hemisphere.

We have seen above that Williams took charge as Geological Surveyor in 1846, and Oldham was appointed as his successor in 1851. When his contract was renewed six years later, the same designation was used (Fox 1947 p 889). The term 'geological survey of India' was employed in a descriptive sense till in 1856 it was given a specific meaning as a government department. Regrettably, most publications, including the official ones, make the date of Oldham's appointment the date of the beginning of the Geological Survey of India. The Government of India even brought out a stamp in 1951 commemorating the Survey's centenary. The counting is wrong. The year 1851 is neither here nor there. Either the Geological Survey should be taken to begin in 1856 when it was formally so constituted, or in 1846 when Williams was appointed Geological Surveyor. It is relevant to note that the Survey of India takes its roots back to the 1767 appointment of Rennell as Surveyor General of Bengal. In any case, Survey of India, Geological Survey and the Medical Service were the only three science services in the British India under the Company rule.

7. Tea

Import of tea from China was a very profitable line of business for the British East India Company. Some attempts were made to grow tea in India, but they were all half-hearted. As long as the Company's monopoly over China tea lasted, Calcutta, including its science establishment, closed their eyes to the possibility of tea in Assam. When the monopoly was broken by the 1833 Charter, the Company opened its eyes and found Assam tea in front of it.

In 1834, the Governor General William Bentinck appointed a 12-member Committee of Tea Culture with George James Gordon formerly of the firm of Mackintosh and Co. as its secretary with the substantial salary of Rs 1000 per month (Phipps 1836 p 65). The first thought was to Indianize the Chinese tea. Towards this end, Gordon was sent out to China not only to bring the genuine plant but also the actual cultivators who 'shall be employed, with the promise of a liberal remuneration, to carry on the cultivation'. The other important member of the Committee was Nathaniel Wallich, who officiated as honorary secretary

during Gordon's absence. Falconer was not a member, but as he wrote, immodestly but privately, 'The experiment was attempted on my recommendation, and conducted under me; the first tea was manufactured under me, and the produce declared by three sets of brokers to be equal to the best China tea' (Murchison 1868 p xxx). The Committee included two Indian members as well, Radhakant Deb and Ramcomul Sen, but they hardly had any role.

As soon as it was formed, the Committee decided to direct enquiries to 'specific gentlemen, who are believed to be possessed of such local information as may serve for our guidance'. This is how the 'pre-history' of British acquaintance with Assam tea came to be recorded. As early as 1815, one Colonel Salter knew about the tea that was brought to the Rungpore market in a manufactured state. (Rangpur, present-day Sibsagar, was the capital of the Ahom kings. It is not to be confused with another Rangpur in Bengal.) In 1818, Edward Gardner, the Company's Resident in Nepal, sent flowers and ripe fruit of the plant to Wallich, who simply forwarded them to Sir Joseph Banks (Johnson 1843 p 67). Many British officers became aware of Assam tea during and after the first Anglo-Burmese war 1824–1826.

Systematic efforts began with two Scottish brothers, Major Robert Bruce (d. 1825) and Charles Alexander Bruce (b. 1793). Some time before the war, Robert Bruce, who was an armament dealer and a mercenary soldier, obtained two tea plants at Rungpur from the Singhpo chief Bessa Gaum in exchange for 'a valuable snuff box' (*Sydney Gazette and the New South Wales Advertiser* 8 March 1842). Robert, however, died soon thereafter, but the thread was picked up by his younger brother Charles. At the breaking out of the war, Charles Bruce offered his services to the British who appointed him to command gun boats at Suddeah. His employer was David Scott (1786–1831), who occupied the important post of Agent to the Governor General on the North East Frontier of Bengal from 1823 till death (*Journal of the Society of Arts* 1861 vol 9 p 140). Charles obtained a canoe full of the plants and seeds from his late brother's contact man, and initiated a distribution process. He sent them to Scott and others in Assam and even to officials in Calcutta. Remarkably, one of the recipients was an army officer in Lucknow who had earlier served in Assam and who obviously knew of tea because he asked for it (Johnson 1843 p 68).

Once informed of the wild tea in Assam, Scott decided to follow the lead without naming Bruce or anybody else as his source. In 1825, 1826 and then again in 1827, Scott sent Wallich leaves and/or seeds obtained from three different locations: Rungpur, probably Manipur, and an area bordering Yunan. He asked Wallich to let him know 'what you consider it to be' (*Sydney Gazette and the New South Wales Advertiser* 8 March 1842; *Journal of the Society of Arts* 1861 vol 9 p 140).

Wallich was the Empire's arbiter on all matters botanical. Unfortunately, the Wallich of the 1820s had convinced himself that true tea grew only in China. No doubt, Wallich could not have identified the Assam tea plant merely on the basis of leaves and seeds that Scott had sent him. However, if he had had an open mind, he could have specifically asked for fruits and flowers. This he did not do. The impression went around that the expert opinion was that the Assam sample was not true tea, but camellia. The time for Indian tea had not yet come.

The arrival in Assam of Lieutenant Andrew Charlton in 1830 turned out be historically significant. Learning about the tea plant from his gardener, he procured it and cultivated it in his own garden in Jorhat. When in October 1831 he came to Calcutta he brought with him a small number of plants which he presented to the Agricultural and Horticultural Society through Dr John Tytler (*Asiatic Journal and Monthly Miscellany* 1841 vol 36 p 263). The present was ignored. But when in November 1834, he sent the fruit of the tea plant to Wallich for his examination, the whole Empire stood up and took notice. Assam tea was as real as the tea of China (Phipps 1836 p 64). Wallich wrote to the Tea Committee on 6 December 1834: 'I humbly submit that a more interesting and more valuable fact has never before been brought to light in Indian Agriculture than has been established beyond all dispute by Lieut. Charlton' (*Sydney Gazette and the New South Wales Advertiser* 19 February 1842).

Earlier, Captain (later Major General) Francis Jenkins (1793–1866) spent six months, October 1832 to April 1833, on a wide-ranging survey of Assam on orders from the government (*http://www.internationalministries.org/download/38072-timeline-baptist-mission-in-northeast-india-doc*). This was an important assignment, because it was a prelude to his appointment in 1834 as Governor General's Agen, which post he held till death. Early 1833, Bruce told Jenkins privately and wrote him publicly that 'the tea plants were growing wild all over the country' (*Sydney Gazette and the New South Wales Advertiser* 8 March 1842).

Given Wallich's conversion to the tea party, things moved fast. On 11 February 1835, Charles Bruce was appointed in charge of nurseries to be developed in Upper Assam, at Sadiya and other places (Tea Parliamentary Papers 1839 p 40; hereafter TPP). A year later, from January 1836, Bruce was designated Superintendent of Tea Plantations at a salary of Rs 400 per month. With this appointment, Charles Bruce closed his personal business and resigned the gunboat charge. Seven months later, in August 1836, his late brother Charles' Assam-born son Captain R Bruce resigned as head of Purandhar Singh's [Poorunder Sing] militia and joined the Company as his uncle's assistant (TPP 1839 pp 71, 84). This was a significant development. Assam was ready to move from gunboat to commerce.

Eight chests of Assam teas were auctioned in London in January 1839 (Desmond 1992 p 238). The next consignment was a considerable improvement on the earlier one. Of the 95 boxes, 10 were distributed free of charge while the remaining 85 were sold by public auction on 17 March 1840 (Transactions of the Agricultural and Horticultural society of India 1841 Vol 8 p 283). This was the beginning of the end of Chinese domination of the tea market that had lasted a century and a half.

In 1841, the Agricultural and Horticultural Society of India presented a gold medal to Charlton 'for being the first to establish to the satisfaction of the Tea Committee and its Secretary that the tea tree was indigenous in Assam'. Jenkins was also given a gold medal, 'for bringing to a successful result the inquiry in regard to the establishment of the tea plant in Assam' (*Annual Report of Agricultural and Horticultural Society of India for 1841* p 9).

The Society of Arts in London had been awarding a gold medal since 1825 to encourage tea production in British territories with a view to eliminating dependence on China. In 1840, it presented its gold medal to Charles Bruce 'for his meritorious Services in discovering the Indigenous Tea-Tracts, and cultivating and preparing Tea in Assam' (*Transactions of the Society of Arts* 1840 vol 53 p 37). Belatedly but more substantially, sometime before 1864, the Indian government gave a land grant to Charles Bruce for his 'discovery' of tea, and more importantly, for ' his subsequent services in fostering the cultivation of the shrub and manufacture of tea' (*Calcutta Review* 1864 vol 40 p 295).

8. Madras (1793–1853)

On the transfer of Roxburgh to Calcutta in 1793, Benjamin Heyne, who had been strongly recommended to Roxburgh by Rev CS John, was appointed superintendent of the Madras Presidency's pepper and cinnamon plantations. His own major interest, however, lay in geology. He wrote on diamond and copper mines and on garnets as also on iron smelting in Ramanaikpetta near Ellore. The next year he wrote on copper mines at 'Agrcondula in the District of Innacondah', which had been neglected or abandoned for two centuries. He also wrote on garnets, and the geology of the 'Boggleconda Hill' near Innaconda (Love 1913 p 410).

The 1799 defeat of Tipu of Mysore was an event of great administrative and scientific significance. So far the Company had been confined in the peripheral areas in South India, but now it became successor to a well-run state. Its territories now extended from the east coast to the west. From a scientific point of view this was an exciting development because the new lands presented different flora and geology. Post Tipu, the first task for the Company was the compilation of maps from whatever 'meagre and unsatisfactory material' was already extant. Next, the Governor General ordered a thorough and systematic Mysore survey. It was to comprise two components. The mathematical survey would fix the external boundaries and also lay down the 'Country in detail' through primary triangulation. The physical survey would deal with botany, mineralogy, medicine; diseases, weather, rains, soil, agricultural produce, animals, revenue, population, etc. The survey was placed under the over all charge of Colin Mackenzie, while Francis Buchanan was appointed to investigate 'the state of agriculture, arts, and commerce, in the dominions lately acquired from Tippoo Sultan'. The departments of botany, mineralogy and natural history were entrusted to Benjamin Heyne

For his Mysore survey establishment, Heyne drew on Samulcotta. It included a European painter; two local painters; two plant collectors who were 'natives accustomed to this service'; and three peons and harkaras for preserving and carrying minerals, plants, and other objects of natural history (Phillimore 1950 p 113). Bangalore already had a beautiful garden, known as Lal Bagh. It was placed under Heyne's charge, to be appropriated as a botanical garden … 'as a depository for useful plants sent from different parts of the country'. The Governor General's directions were explicit and materialistic: 'A decided superiority must be given to useful plants over those which are merely recommended by their rarity or their beauty, to collect with care all that is connected with the arts and manufactures of this country, or that promises to be useful in our own: to give due attention to the timber employed in the various provinces of his route, and to collect with particular diligence the valuable plants connected with his own immediate profession [medicine]' (Phillimore 1950 p 113).

In 1802, he was made independent of Mackenzie's survey and given the appointment of Madras naturalist (Phillimore 1950 p 406; Noltie 2007 vol 1 p 31). For about two years, 1812–1814, he was in Europe on furlough. In 1813, he passed on a considerable number of plant specimens to the German botanist Albrecht William Roth (1757–1834), who published an account of 200 of them in *Novae plantarum species praesertium Indiae Orientalis*, from Berlin in 1821 (Stansfield 1957 p 26). In 1814, in keeping with the general trend of officers serving in India, Heyne published his *Tracts, historical and statistical, on India*. Although much of the material in the book is of a scientific nature, there is a mandatory essay, 'On the propagation of the Christian religion in India, and on the moral character of the Hindoos'.

There were two little-known short-term successors to Heyne. William Sommerville Mitchell held the appointment for less than two months, October–November 1819, followed by George Hyne (1800–1826), who remained in office January–June 1821 (Noltie 2007 vol 1 p 32). His successor's name James, 'formerly of Madeira', was

appointed assistant surgeon on 14 June 1821 and botanist a year later, on 12 July 1822 (*Madras Quarterly Journal of Medical Science* 1865 vol 8 p 1370; *Asiatic Journal and Monthly Register* 1822 vol 13 p 97) He returned to England on sick leave in January 1826, but died on 12 October 1826 (*Asiatic Journal and Monthly Register* 1826 vol 22 p 625). While in office, Shuter prepared a vegetable materia medica, which the Madras Governor Sir Thomas Munro presented to the University of Edinburgh in 1826. On a personal level, Shuter on his visit home took with him a collection made for the Glasgow University botany professor William Jackson Hooker (1785–1865) (*London Literary Gazette and Journal of Belles Letters for 1826* p 111). We thus see that even when an India-based European naturalist was rather mediocre, he was of great use to European naturalists.

9. Robert Wight (1796–1872)

Shuter's successor, Robert Wight (1796–1872), was a botanist of great fame. He was the last one to hold the Madras naturalist's post and saw the focus shift from scientific botany to the economic. Unlike many surgeons in India, Wight came after obtaining his MD. Coming from a well-connected Scottish family which had seen better days, Wight was educated at Edinburgh University, where in 1818 he wrote a 14-page dissertation in Latin with the translated titled 'On the nature of fevers dissected with a scalpel' (that is, by surgical investigations). It is said that he joined a ship as a surgeon and made many voyages including one to America. It is not clear when this was done. He came to Madras in 1819 as an assistant surgeon in a regiment of which his elder brother James subsequently became a colonel. Wight had had no particular training in botany. Earlier botanists were all gone so that there was no one to induct him into the discipline. He educated himself with the help of books which he managed to obtain: Willdenow's *Species Plantarum* (published 1797–1806), Persoon's *Synopsis* (1805–1807), and Lichfield's translation of Linnaeus' *Genera Plantarum* (1787). Wight hired local plant collectors and set out to prepare specimens. In 1823 he sent a collection to Dr Robert Graham, professor of botany at Edinburgh, who however did not respond. It has been defensively said that the consignment was lost on sea (Cleghorn 1873 4). but the fact of the matter is that Graham did get the specimens but chose to ignore them (Noltie 2006 p 15).

The Madras government decided to make use of his earlier anatomical training. Tipu had maintained a cattle breeding establishment named Amrit Mahal at his capital Seringapatam for military purposes. In 1824 the establishment was placed under Wight's charge. His staff comprised an Indian draftsman, two senior medical pupils and an Indian doctor. Wight, however, resigned the job for reasons of health, and was replaced by Dr AE Best. In July 1825 Wight was given a new posting, as assistant surgeon to a different regiment, but this was short-lived. Next year he was appointed to the vacant post of naturalist. In this position, he undertook a nine-month collecting tour of South India. Next, he planned an extensive two-year tour that would have taken him to 'all the richest botanic districts in the south of India including the Malabar coast'. He hoped to collect and describe as many as possible of the plants that figured in Rheede's *Hortus Malabaricus*, and make drawings of all the little known useful plants mentioned in Buchanan's *Travels in Mysore, Malabar and Canara*. But that was not to be (Cleghorn 1873 pp 3–4). Munro's successor as Governor, Stephen Lushington, was a man of limited vision, who additionally held a personal grudge against Wight. In February 1828, the governor abolished the post of naturalist on grounds of economy, dismissed the valuable collections built over the years as mere curiosities, and dispatched them to India Office, London. These included apart from Wight's own collection older specimens that Russell had collected or Wight had bought from Rottler. The collection also included 150 botanical drawings (now at Kew) (Noltie 2006). Wight was sent back as surgeon to a garrison stationed in Nagapatam. Disappointed but not disheartened, he continued his botanical work in his spare time and with his own resources. The value of his work lies in the fact his field area in South India was different from the one earlier covered by Koenig and others. Wight now established a valuable collaboration with William Hooker in Glasgow, who published his work in *Botanical Miscellany* during 1830–1832, and as thanks sent books to Wight in India. (Curiously, in the first three articles, Wight's first name is wrongly given as Richard.) Wight spent three valuable years 1831–1834 in Britain on furlough, while maintaining his establishment in India. He brought with him an herbarium of 4000 species (weighing two tons), and about 100,000 specimens of plants of the presidency of Madras. He distributed his duplicates, established himself in professional circles, and initiated a very fruitful collaboration with his school and university friend George Arnott Walker (1799–1868). This collaboration resulted in the publication in 1834 of *Prodromus Florae Peninsulae Indiae Orientalis*, containing description of plants found in peninsular India.

Wight's stay in Britain partially overlapped with that of Wallich, who spent four years, 1828–1832, on leave but with full salary. Wallich was in fact on an important public relations exercise for the Company. He was entrusted with the onerous task of cataloguing the plant specimens owned by the Company and distribute the duplicates to interested parties. Many specimens had been collected under Walllich's own superintendence while others were older. Where botany stood in 1830 in India, Calcutta and Madras combined, can be seen from the list of the Company

herbariums: (i) Herbarium collected by Patrick Russell, mostly in the Circars; (ii) an extensive herbarium from the peninsula collected by Klein, Heyne and Rottler; (iii) a very extensive herbarium collected in various parts by Francis Buchanan; (iv) A small herbarium of Roxburgh; (v) an herbarium collected by George Finlayson (1790–1823), surgeon and naturalist to the Crawfurd trade mission sent out to Siam and Cochin China (Viet Nam) by the Bengal government in 1821; (vi) a most extensive herbarium collected in various parts of the peninsula by Wight; and (vii) special collection forwarded by Wallich to the Company's museum (*Bulletin of Miscellaneous Information (Royal Garden Kew)* 1913 no 7 pp 255–263, p 256). The enormity of the exercise can be gauged from the fact that Wallich distributed 250,000 specimens in 641 parcels to 66 individuals and institutions (Noltie 2007 vol 1 p 14). In this dispersion, he was aided among others by Augustin Pyramus de Candolle (1778–1841) from Geneva, and Professor Kunth from Berlin. The Company's primary collection, the Wallichian herbarium, was given to the Linnaean Society in 1832, which in 1913 transferred it along with later additions to Kew Gardens, but only after a well-wisher, Sir Frank Crisp, reimbursed the Society the cost of the mahogany-faced cabinets which housed the specimens (*Bulletin of Miscellaneous Information (Royal Garden Kew)* 1913 no 7 pp 255–263, p 262).

The Company's dispersal of plant specimens and the transfer of its herbarium to a learned body were well timed. They came at a time when the Company's 1833 Charter was under discussion. An Edinburgh journal wrote in 1831: 'Duplicates of these plants have been liberally issued by the Company to botanists of all nations, who have been encouraged to examine and publish them. Under the auspices of our merchant princes of Leadenhall Street, several splendid works of botanical illustration have already appeared, of which Dr Wallich's *Planta Asiatics Rariorcs* is the chief. Such powerful exertions in behalf of science are the proudest boast of a Company, which, maligned as it has been, will still remain one of the most stupendous exhibitions of British power' (*Edinburgh Literary Journal* 1831 (Jan–Jun) p 308). On return to India, in 1834, Wight was posted in Bellary (now in Karnataka) in a medical capacity. His regiment's march to Palamcotta, near Cape Camorin, gave Wight a chance to botanise.

Finally in 1836 Wight, thanks to the Scottish network he had activated during his long furlough, was relieved of his medical duties so that he could now spend full time on botany. He was transferred to the revenue department, to 'enquire and report on the cultivation of cotton, tobacco, senna and generally of all Indian products' (Cleghorn 1873 p 9). The last 11 years of Wight's Madras career, 1842–1853, were spent working on cotton at Coimbatore. The work on economic plants so far had focused on Indian species. But now the plan was to introduce new varieties from US and export raw material to by now industrialized Europe. The project was more or less a costly failure, but it does tell us about the British priorities of the time.

Once freed from his peripatetic medical duties, Wight mastered the art of lithography and set out to publish illustrations of his plant specimens. He simultaneously began work in 1838 on the hand-coloured *Illustrations of Indian Botany* and the un-coloured *Icones Plantarum Indiae Orientalis*. The Illustrations appeared in two volumes published in 1840 and 1850 and contained 182 plates, of which all accept the last one were coloured. The Icones, carrying a total of 2101 un-coloured plates were published in six volumes over an extended period of 15 years, 1838–1853. The government partially subsidized the enterprise by order 50 copies of each publication. Wight selected about 200 Nilgiri plants from his *Icones*, had them coloured and issued as *Spicilegium Nielgherrense* (1846–1851) Wight could claim with justifiable pride that 'the Indian Flora can now … boast of being more thoroughly illustrated than any other country under British sway, Great Britain alone excepted' (Desmond 1992 p 118). Wight's contributions were handsomely acknowledged by Sir Joseph Dalton Hooker and Thomas Thomson in their celebrated 1855 publication *Flora Indica*: 'The volumes form the most important contributions, not only to botany, but to natural science, which have ever been published in India, and they have been of the greatest service to us throughout our labours' (Hooker and Thomson 1855 p 50).

10. Indians on the periphery

Collection of plants from the field, preparation of specimens and drawing their sketches were important parts of a European naturalist's project. These tasks were entrusted to the Indians. To retain ownership of drawings and specimens, the part-time naturalists preferred to pay their staff from their own pocket rather than bill the Company, as was done by Buchanan and Roxburgh to their disadvantage (Noltie 2007 vol 2 p 15).

To protect the specimens and the paper on which they were preserved from attacks by the ants, the feet of the wooden cabinets were kept immersed in troughs of water. To replenish the water lost by evaporation, a person was hired whose job was to keep the troughs filled with water 'until the shadows of evening came on' (*Encyclopædia of Geography (Philadelphia: Lea and Blanchard)* 1839 vol 2 p 330).

Calcutta Garden did have artists on its staff. Who were these people? The type of details we are interested in today would not have been considered important then. Many Europeans did not bother to record the names of the artists working for them. In other cases, we know the names but nothing else. To our frustration, but not surprisingly, none of the Indians so employed seems to have left behind any

account. Indians who first took to sketching the flora under the watchful European eye came from families with painting tradition. In recent times, there has been interest in examining how these artists' work represents a combination of two distinct traditions (Desmond 1992 pp 148–152; see also Kelley 2012). Towards this end, bits and pieces of scattered information have been collected and attempts made to create a contextual account.

In his 27 years of career in Madras Presidency, Wight employed two Telugu artists. Rungiah worked from Wight's arrival in 1826 till 1845 and the former's pupil Govindoo from 1845 till Wight's retirement in 1853. Rungiah was taught the use of microscope by William Griffith. Wight even immortalized Govindoo in the generic name Govindooia. Rungiah might have served Wight's predecessors as well, and Govindoo continued to work post Wight at Madras for Hugh Cleghorn and Richard Henry Beddone (1830–1911). Note that only their first names are on record. Rungiah belonged to the Raju community; Govindoo was probably related to him. There is indirect evidence to suggest that their forefathers had worked for the rajas of Tanjore. It has been speculated whether the early South Indian flora painters transferred from textile or mica painting to European natural history (Noltie 2007 vol 1 p 15).

The artists in North India came from the royal court tradition rather than the temple. A painter notable for his versatility was Lutchman Singh (Lakshman Singh or Lachhman Singh), who was employed in Calcutta garden (Arnold 2000 p 49). He painted a portrait of George Potter in the 'Murshidabad style' in 1828, when Wallich was away to Europe. His services were borrowed by Royle in Saharanpur where he made three zoological drawings. Interestingly, Lachhman Singh 'decamped for a spell to work as a Court painter in one of the Punjab hill states' (Noltie 2007 Vol 2 p 35).

But, once the new art of lithography was introduced, talented persons who had no previous connection with painting could become professionals. This was part of a broader phenomenon. The traditional caste–profession equation underwent a significant transformation. Old professions which were learnt through apprenticeship remained the preserve of the associated caste as before. But if a profession was taught in the educational institutions, it got decoupled from caste. Newly introduced professions by definition had no caste connotation and could be adopted by any one. (this was first pointed out by Rajshekhar Bose; see Ray 1932 p 494.)

11. Domestication of Cinchona

Malaria was the scourge of the tropics and the biggest obstacle to colonial expansion. We have seen how the only remedy for it then available, the wild cinchona bark, was introduced into Europe in the 16th century, how it became popular and how it was subjected to scientific scrutiny (Kochhar 2012). We shall now see how it was successively decoupled from its natural habitat through a long-drawn exercise.

In 1834 a French army doctor, Francois Clement Maillot (1804–1894), deviating from the current medical practice, cured his patients of malaria by giving them high dose of quinine and good nutrition. In 1881, glowing tributes were paid to him: 'It is thanks to Maillot that Algeria has become a French land; it is he who closed and sealed forever this tomb of Christians'. Next, in 1854, thanks to quinine, the English ship *Pleid* sensationally returned after 112 days of voyage in Africa, with all European members alive (Headrick 1981 pp 67, 69). At this time all the world's cinchona bark came from the forests of Peru, Bolivia, Ecuador and Colombia. The message was clear. If Europe was to retain and expand its colonial empire, dependence on the Andes for cinchona should cease.

The lead for domestication came from France. England-born but France-educated physician and botanist Hugh Algernon Weddell (1819–1877) was expressly sent to South America in 1843 initially as a botanist member of an official natural history expedition. He spent two years, 1845–1847, in the forests of Bolivia studying cinchona trees. He identified no less than 15 distinct species and brought the calisaya seeds to France which germinated. At his instance and with his help, the French government tried to grow cinchona in Algeria but the experiment failed due to a combination of factors such as inexperience of officials, lack of proper adoptive habitat, etc. (Cinchona Parliamentary Papers 1863 p 39; hereafter CPP). Weddel's advice and his calisaya were made available to all in Europe.

Europe's operation cinchona proceeded in three stages. First, attempts were made to grow cinchona in European colonies, using Weddel's seeds and saplings. On the failure of the exercise, the Dutch and the English sent official expeditions to South America. If the European colonialists had followed the advice given by European merchants already in South America and trading in cinchona, they would have saved themselves much trouble and expense. The best bark came from big trees in Bolivia, which however was inaccessible. The other varieties were useless or less than satisfactory, but there was a great sense of adventure and a certain amount of romanticism attached to getting the plants out of the far-off dense forests, the more so when the exercise was illegal. These expeditions did serve a purpose, though. They made Europeans functioning in South America aware of the needs back home. They also permitted experimentation in cross-breeding. Finally, almost in an anticlimax, the Netherlands simply bought a packet of Bolivian seeds in London and made Java into the world supplier of natural quinine.

In 1851 the Netherlands obtained a Weddel calisaya tree from Paris in exchanged for some East Indies plants, nursed

it in Leyden, and successfully planted a cutting in the mountainous region of Java, where it flourished and multiplied. In December 1852 the Dutch Minister for the Colonies, CF Pahud, sponsored Justus Karl Hasskarl's (1811–1894) trip to South America. Hasskarl left Europe for Peru under a pseudonym and assembled his cargo of plants and seeds. From Peru itself he sent some seeds and plants to the Netherlands which were raised there and then brought to Java. He himself returned to Java in December 1854 with his precious baggage of 80 surviving plants, *C. calisaya* and *C. pahudiana* (at first mistaken to be ovata) (Gorkom 1881 pp 182, 184). Notwithstanding the great effort, the pahudiana plants would turn out to be quite useless.

In the case of India, Royle, formerly at Saharanpur and Calcutta and presently in London, recommended the introduction of cinchona, and decided to act upon his own recommendation. First in 1852 seeds were sent to Calcutta but they failed to germinate. Next year a handful of saplings were sent by an overland route, which were planted in the open air at a rather high altitude in Darjeeling. They all died. The climate of Calcutta was too hot for them and the chosen mountain site too cold (CPP 1863 p 206). While reporting on these failures in 1855 Falconer the superintendent of the Calcutta Garden made the important point that 'the experiment must be conducted upon a sufficiently large scale to admit of a full trial' (CPP 1863 p 7).

At last, Britain decided to go to the cinchona source itself. Its expedition comprised three branches as they were called which collected plants and seeds of different species from different areas, namely South Peru, North Peru and Ecuador. In December 1859 Clements Robert Markham (1830–1916) then a junior clerk at the India Office accompanied by John Weir a gardener at the Royal Botanic Gardens at Kew set out for South America. In the South Peru district of Caravaya he found that calisaya did grow there as Weddel had shown but as shrub rather than tree. He was told by the European 'commercial men' that the shrub bark was of no value so much so that the house of Gibbs had forbidden its agents to purchase it. Markham was informed that good calisaya bark comes from big trees in Bolivia (CPP 1863 p 39). At the time, however, it was too risky to venture into Bolivia. So Markham contented himself with a collection of 529 yellow bark calisaya shrubs. How worthless they were was never found because none of them would survive. Northern Peru was scouted by 'an agent engaged by Mr Markham', GJ Pritchett, who collected the grey barks (*C. nitida*, *C. micrantha* and *C. peruviana*).

The greatest success attended that branch of the expedition which was led by a European already familiar with the cinchona land of Ecuador. Dr Richard Spruce (1817–1893), an English school master turned botanist and botanical explorer, spent 15 years, 1849–1864, exploring Amazon from the Andes down to its mouth. Towards the end of 1859 Spruce was entrusted the task of collecting red bark seeds and plants, and a gardener Robert Mackenzie Cross was sent from England to assist him. Spruce focused on *C. succirubra* grown in the Guayaquil region. Another species *C. condominea* flowered at the same time but was located in Loja (then spelt Loxa), 15 days' journey away. Bringing its seeds was entrusted to Cross. Both collected about 100,000 seeds and went on to raise some plants themselves. The seeds and the saplings were then dutifully sent to Kew. Interestingly, of the three teams only the activities of Spruce and Cross were within the framework of law of the time. Brockway (1979 p 456) wrongly places Cross in Bolivia and makes him independent of Spruce.

South India was readied for the reception of cinchona. A garden was set up in Ootacamund in the Nilgiri Hills in 1847 with a view to providing vegetables for the European residents. The next year a public subscription was raised to convert it into a public garden, which was placed under the charge of William Graham McIvor (1825–1876) expressly brought from Kew. Markham and his consignment arrived in Bombay on 27 September 1860. From there they were conveyed to Calicut by a special steamer and then taken to Ootacamund. Most of Markham's plants arrived in sickly condition and within two months, that is, by December 1860, they were all dead.

At this stage Calcutta entered the picture. The man to look after cinchona in Calcutta was Thomas Anderson (1832–1870), superintendent of the Calcutta Botanic Garden from 1861 to 1868. (He is at times confused or merged with his younger brother John Anderson (1833–1900), the curator of the India Museum from his arrival in Calcutta in 1865 till retirement in 1886.) When Anderson arrived in Calcutta from England in January 1861 he brought with him two plants of calisaya for the cinchona nursery in Ceylon. They all were extensively propagated. Pritchett's grey bark seeds arrived in Calcutta on 13 January 1861 and Spruce and Cross' red barks in February 1861. These seeds were sown in Calcutta and distributed to Ootacamund and Ceylon. They were sown at Kew also in the propagating room kept ready for them. In April 1861 Cross personally brought to Ootacamund his collection of red bark plants fit for propagation (Williams 1962 p 436). Cross also brought with him six calisaya plants 'propagated in England from old plants which had existed for several years in England as curiosities' (CPP 1863 p 207).

In 1860 or 1861, the Indian Viceroy Lord Canning wrote to the Governor General of the Dutch East Indies asking for cinchona plants. On 13 June 1861, the latter offered 100–200 pahudiana plants and 50–100 of the well-known calisaya (CPP 1863 p 191). Java in fact abounded in the former. On 18 July 1861, McIvor wrote to the Viceroy pointing out on the authority of the London-based John Eliot Howard (1807–1883), a famous manufacturer of and specialist on quinine, that the bark was worthless and the species had no value. It was Howard who gave the name pahudana to the

species in honour of the Dutch minister (CPP 1863 p 187). In spite of this sound expert advice, Anderson accompanied by his principal Indian gardener proceeded to Java and returned to Calcutta on 28 November 1861 with a consignment the bulk of which was the useless pahudiana. His 412 plants comprised 350 pahudiana, 56 calisaya and 6 lancifolia (a new species) (CPP 1863 p 189). On 10 December 1861, Anderson took the major portion of this collection to Ootacamund. While returning, he filled the empty cases with various species grown there, to add to the experimental stock at Calcutta (CPP 1863 p 200).

Earlier, in July 1861, McIvor was designated superintendent of Cinchona Cultivation in the Madras Presidency. The other, larger, site for new cinchona plantation chosen by McIvor in consultation with Markham was near Neddiwuttum in Wynad district and at a lower elevation than Ootacamund (CPP 1863 p 142). Here open-air nurseries were established. In Java the practice had been to propagate the pahudiana by seeds, but the process was slow. McIvor discovered that the plants could be much more rapidly and extensively propagated by slips (*Quarterly Journal of Science* 1865 vol 2 p 349). He exposed the plants to direct sunlight rather than keep them in the shade as was being done in Java, and thereby increased their quinine yield. Arrangement for investigating the alkaloidal yield of cultivated plants was made in 1866 when John Broughton was appointed as a chemist in Ootacamund. The average yield of cultivated plants was nearly 2% higher than that of the wild South American samples; 7% as against 4.16–5.66%. 'The only drawback is that the kind which grows most freely in India is the red bark, the quinine from which is usually mixed with a considerable portion of chinconidine and other allied alkaloids, along with resin and colouring material, not easily separable' (*Quarterly Journal of Science* 1867 vol 4 p 526). Once the prices fell, Nilgiri cinchona cultivation would become economically unattractive.

Anderson held Markham in open contempt; while he himself was a university-educated man of science, Markham was a clerk, marked by 'ignorance of botany and science generally' (CPP 1863 p 219). If Anderson had had his way, even McIvor would have been dismissed from service. Anderson was officially admonished for his scientific jealousy, but the government very wisely separated the two zones of influence. The Nilgiris was the arena of Markham and his protégé McIvor while Darjeeling was to be Anderson's territory. Cinchona plantation in Darjeeling was begun in 1862 and turned out to be very successful indeed.

Late 1861, India returned Java's compliment by presenting some red bark cinchona to the Dutch government, from the Nilgiris. They, however, could not possibly have significantly affected the Java portfolio. At the end of 1864, Java had a little more than 10 million plants. Out of these, as many as 96.5% were the worthless pahudiana (*Calcutta Review* 1866 vol 42 p 394). Things would change in 1865 when the Peruvian bark was combined with the Bolivian bark.

Markham's expedition and the earlier Hasskarl's Dutch expedition have been much discussed. They are important as case studies of 19th century colonial adventures. The initiative, planning and subversion of the laws and regulations of cinchona-producing countries all greatly added to the colonial aura. The scientific value of these expeditions was however limited. As we have seen Hasskarl's mission and the one personally led by Markaham were a failure. The seeds and plants from the Spruce-Cross team led to cultivation of cinchona in India which fulfilled the British Empire's own needs. But, as far as the world production is concerned, it was made possible not by the much publicized adventures of colonialists but through the initiative of an unscrupulous and patriotic Englishman. In the Euro-centric world of the 19th century, how the natives were exploited and sacrificed in furtherance of the colonial cause was described in detail and with relish. As the times changed these accounts became brief and sanitized. For example Brockway (1979 p 57) blandly says that the seeds of high-yielding species were 'smuggled out of Bolivia by the Aymara servant of a British trader, who sold one pound of seed to the Dutch government in 1865'. The story, however, deserves to be told in some detail and in the framework of its own time.

Charles Ledger (1818–1905) came to Peru in 1836, at the age of 18 to join a merchant house which was trading in that country's two staples: cinchona bark and alpaca wool. After two years he was sent to run a branch in the southern port of Tacna, where he set up his own business (Esch 2007 p 197; Allen 1988 p 388). Ledger had the good fortune to have in his employ a knowledgeable and loyal man, Manuel Incra Mamani, who joined his service in 1843. Ledger may have been short on scruples from today's standards and a failure as an entrepreneur, but his patriotism cannot be doubted. We know about his activities from a letter he wrote to his brother George in 1880, which was published in a magazine called *The Field* on 5 February 1881 and reprinted in *American Journal of Pharmacy* a month later (Ledger 1881). The letter does not read as part of correspondence between two brothers, but as a write-up meant for publication. This, of course, is not to doubt the veracity of the basic points.

Ledger read in the newspaper about Markham's visit and his plans to visit Bolivia. Mamani told Ledger that the inhabitants of the cinchona district of the Yungas 'most implicitly' believed that if their cinchona was successfully propagated in other countries by plants or seeds, their own plants would perish. Mamani ominously told Ledger that if Markham really obtained the 'rojo' plants and seeds, he would not 'leave the Yungas in good health'. Ledger decided to convey this intelligence to Markham, whom he did not know personally. Towards this end he dispatched messenger on foot to the British consul situated 600 miles away

warning Markham against venturing into Bolivia (Ledger 1881 p 10). The letter arrived too late to be placed in Markham's hands who in any case had already decided to skip Bolivia. Ledger's account is corroborated by Markham who recorded that while he was in Peru, Ledger 'made some attempt to open up communication with me which unfortunately was not successful' (Holland 1932 p 1).

Europe had to wait for 20 years and Ledger's personal initiative before it could lay its hands on the right seeds. Wishing to see his 'own dear country' 'free from being dependent on Peru or Bolivia for supply of life-giving quinine', Ledger decided 'to do all in my power to obtain the very best cinchona seed produced in Bolivia' through Mamani and deception. 'Manuel was never aware of my requiring seed and leaves for propagating purposes; he was always told that they were wanted to make a special remedy for a special illness'. Ledger was honest enough to admit to himself and to his brother that if Mamani had been told the truth, he would have refused, even though 'he was very much attached to me'. At the end of May 1865, Mamani arrived with the precious cargo. By July 1865, Ledger had sent the seeds to his brother George in London.

In 1872–1873, the loyal servant was sent again 'to get another supply of the same class of seed for me', but this time 'poor Manuel' 'lost his life'. An undeterred Ledger lost 'another old Indian friend, poor Poli, when bringing seed and flowers in 1877' (Ledger 1881 pp 10–11). Ledger had already done his patriotic duty by depositing the Bolivian cinchona seeds in England. If Mamani and Poli had come back alive, what would have Ledger done with the new consignments? May be, he had various European botanic gardens in mind as potential buyers.

Ledger's brother tried to sell the 1865 consignment to the Kew Garden. But Sir William Hooker had just died, his son Joseph was away ill, and the curator was not interested. Through JE Howard, George Ledger then sold a pound weight of the seeds to the Dutch consul general in London, for use in Java. A down payment of 100 francs was made, and a further payment was promised if the seeds germinated. After a year it was reported that about 20,000 had germinated. Ledger was now paid the further sum of 500 francs. As it turned out, the volcanic soil in the Preanger district of Java turned out to be very good for the new species, which in 1876, was named *C. calisaya* ledgeriana by Howard. (There was obviously no question of naming it after Mamani.) Java successfully combined these plants with the red bark species to produce a sturdier version.

Contrary to popular perception, these seeds did reach India. As against purchase of only one pound weight by the Dutch, the remaining 13 pounds were purchased by James William Bayley Money (1818–1890), a barrister and cinchona cultivator in the Nilgiris. He, however, exchanged them for a quantity of the red bark seed, which had by then begun to be freely produced on the Nilgiri plantation. (Did he buy the seeds so that they would not go elsewhere?) About 60,000 seedlings were raised by McIver, but 'It would appear that most of these died out'. Some seeds were sown in the Sikkim Himalayas including Darjeeling, where they did well (Howard 1932 p 3). In the three decades, from 1893 to 1913, prices dropped drastically by more than 90%. Java because of economy of scale and through cartelization was able to withstand the price drop, but India and Ceylon were driven out of competition. In Ceylon, plantation area dropped from 26000 hectares in 1883 to a mere 300 in 1910. Similarly in India many trees were uprooted (Headrick 1981 p 235). The end result was that Java came to control more than 90% of the world quinine market.

Quinine was an empirical solution to the malaria problem, but there were studies of the cause as well. The Almora-born British physician Ronald Ross (1857–1932) showed that the germ of malaria is carried by Anopheles mosquito, and received the 1902 Nobel medicine prize. Not unexpectedly, he could carry out his research only intermittently during his spare time when he was not on duty as regimental doctor and entirely at his own expense, which included payment of an anna (one sixteenth of a rupee) per mosquito to the patient (Husein Khan) who permitted Ross's 10 mosquitoes to have a good feast on his blood. The handsome bribe would prevent him from killing the mosquitoes in annoyance (Dodd 1956 p 40). During his visit to USA in 1904, he was invited to visit Panama, which he did for a week in October 1904. (The Canal had a medical adviser, John W. Ross of the US Navy; the two Rosses have at times been confused.)

The American historian David Gaub McCullough (b. 1933) addressing an audience in a college in 2005 declared: 'I think often about why the French failed at Panama and why we succeeded. One of the reasons we succeeded is that we were gifted, we were attuned to adaptation, to doing what works, whereas they were trained to do everything in a certain way. We have a gift for improvisation' (*http://teacherweb.com/KS/StMarysColgan/KyleWolf/READ——Knowing-History-and-Knowing-Who-We-Are.pdf*). Americans are welcome to self-congratulation on Panama, but the fact remains that the French failed because in their time the cause of malaria was not understood. The canal could not have been dug before a Ronald Ross came on the scientific scene. While Panama Canal was constructed after eliminating the mosquito, the European conquest of Inner Africa was accomplished by the mass production of quinine. The Africans lost their independence because of advancement of science, but they still had malaria.

12. Zoology

Zoology was a late starter in British India, because animals had no commercial value. Academic studies could not take

place early because of the known aversion of Sir William Jones, the founder of the Asiatick Society. In his tenth anniversary discourse in 1793, he famously expressed himself in poetic language: 'Could the figure, instincts, and qualities of birds, beasts, insects, reptiles, and fish be ascertained either on the plan of BUFFON, or on that of LINNÆUS, without giving pain to the objects of our examination, few studies would afford us more solid instruction or more exquisite delight; but I never could learn by what right, nor conceive with what feelings, a naturalist can occasion the misery of an innocent bird and leave its young, perhaps, to perish in a cold nest, because it has gay plumage and has never been accurately delineated, or deprive even a butterfly of its natural enjoyments, because it has the misfortune to be rare or beautiful'. In 1796, two years after Jones' death, the Society announced their intention of establishing a natural history museum and invited donations. It was, however, only in 1814 that contributions of animals, plants, minerals, etc., were solicited, and arrangement made for their reception. In 1837, Dr JT Pearson of Bengal Medical Service was appointed to look after the Museum. Two years later, in 1839, the Court of Directors sanctioned a grant for the Museum. In 1841 Edward Blyth (1810–1873) was brought from England as the curator. He remained in office till 1863, when he returned to England due to ill health.

In spite of drudgery of his routine work and unpleasant disputes within his employers, Blyth built up the museum and emerged as an authority on Indian and Burmese birds. In 1888, he was described as the Father of Indian Ornithology. He became an acclaimed expert on Indian fauna and domesticated animals, and was Charles Darwin's informant on these for 15 years.

Like many others, Blyth turned towards India because of poverty (he had to seek 100 pound sterling in advance from the Asiatick Society to enable him to make the journey to Calcutta.) Unlike others, however, he remained poor. His salary was low to begin with, and remained stagnant throughout. From 1844 he indulged in the ethically dubious but the then normal two-way trade of live animals. He even tried to strike a deal with Darwin and John Gould. They declined, but significantly, there was no sense of outrage. Blyth arranged to supply to England animals which were in demand there for private and public zoos. Similarly he imported live animals into India: 'Natives of enormous wealth are the purchasers, who care not what they give for what they particularly fancy'. A particularly fancied import item for the zenana was a pair of marmosets, monkeys imported from the Americas (Brandon-Jones 1997 p 147).

Thanks to Blyth's official exertions, the Museum built an impressive collection. John Anderson took over as the Curator in 1865. Next year he became the superintendent of Indian Museum, which was founded using the Asiatic Society Museum collection as its nucleus.

In 1891 Botanical Survey of India was constituted but by this time the best in colonial field science was already over. Further, in 1916, the anthropological and zoological sections of the Museum were made into Zoological Survey of India, a step of administrative significance rather than scientific.

13. Agriculture and animal husbandry

Farming and animal husbandry were the two most important economic activities in India. The colonial government's interests in them were, however, selective and self-centered. In agriculture, it was interested only in exports, but for administrative reasons it wished to avoid famines. From among the animals, for a long time, its attention was focused on the horse which was required for service in the military. An army stud department was established in Bengal as early as 1779, and a horse breeding farm was established in 1784 in a vast 1350-acre estate near a village called Pusa in Bihar (now in Samastipur district). In 1808, the charge was handed over to a well-regarded English veterinarian, William Moorcroft (1767–1825), better known as a geographical explorer. The farm was closed in 1874.

We have already noticed how the pre-existing Amrit Mahal cattle breeding establishment in Mysore was taken over by Madras government in 1813 for research on pack animals for the army. Developments in Europe forced a look at cattle in general. Influenced by the severe cattle plague (rinderpest) epidemic in Britain during 1865–1867, an Indian Cattle Plague Commission was set up in 1869 under the chairmanship of Colonel John Herbert Brockencote Hallen (1829–1901), principal veterinary surgeon in the Bombay army. On its recommendation, an Imperial Bacteriological Laboratory was established in Poona in 1890, and Dr Alfred Lingard appointed its head. Typically, for some years, Lingard worked mainly on investigations of surra in horses. On his recommendation, the Laboratory was shifted to Muktesar in Kumaon hills in 1893. For sustained activity during winter months, a branch was opened in the plains, in Izatnagar in Bareilly district. The name was changed to a more impressive Imperial Veterinary Research Institute in 1925.

Agriculture was a low-priority area for colonial India. The British interest in Indian agriculture primarily focused on industrial cash crops. An agricultural department was established in 1871 'chiefly in relation to the supply of cotton from India'. The department was, however, declared to be a failure and closed in 1878. The Famine Commissioners in 1880 strongly recommended creation of agricultural departments in all provinces. These departments would inform the government of 'approach of famines', suggest measures for their prevention in future and take charge of operations in case of an actual famine. Accordingly a central agriculture

department was set up afresh in 1881. Agricultural research began as late as 1905 on the personal initiative of the Viceroy Lord Curzon, when an institute was established in the Pusa estate. Significantly, funding for it did not come from the government but from an American philanthropist Henry Phipps through the family connections of the Viceroy's wife.

14. Discussion

When the British East India Company was established, modern science had not yet come into existence, Galileo's use of the telescope being still nine years into the future. Modern science thus grew hand in hand with maritime trade and colonialism. The making of a scientific and industrial Europe took place in three ways. First, concerted efforts to decrease the human cost of the voyages and make navigation safe brought about advances in astronomical and related sciences. Secondly, the introduction of natural produce-based processes (textile dying and printing) and empirical technologies from Asia (zinc, carbon steel) inspired Europe to take up industrial and scientific research, which led to the industrial revolution. Thirdly, Europe was introduced to nature in its full global diversity and glory. Systematization of natural history knowledge remained consistently high on Europe's agenda. Note that the development of physical sciences was strictly an internal matter of Europe while industrial activity required only initial inputs from outside. But natural history required continuous interaction with distant lands and their people.

Whatever science could be done in Europe was carried out there; there was no need to take it to the colonies. Thus physics never became a part of colonial science in India. (The term colonial science is used not in a pejorative sense but to denote science under colonial auspices.) A small exception had to be made in the case of chemistry because it was required as an administrative aid. A fairly well-equipped chemistry laboratory was set up in the Presidency College Calcutta in 1874. One of the first experiments the newly arrived chemistry professor Alexander Pedler (1849–1918) was asked to do dealt with the chemical analysis of the cobra poison with a view to finding effective antidotes. His citation for election to the fellowship of the Royal Society in 1892 mentions this work as also the one on Calcutta's water supply.

The same college's Indian physics professor Jagadis Chunder Bose (1858–1937) won international acclaim for his pioneering experimental work on short radio waves begun in 1895. Interestingly, this personal work was fashioned by Bengal's climate. Europe was happy to work with metal to make radio detectors and receivers. But since metal rusts in the damp climate of Bengal, Bose experimented with a whole new class of 'natural substances' including even jute. His work on galena crystal has especially been of great intrinsic value to the world of science.

Colonial science was a complex and multi-dimensional phenomenon. A number of questions have been asked and addressed variously. What were the Company's requirements and what were the European demands on it in the field of science? How did the European men of science in India conduct themselves? What was their self-perception and how were they viewed and treated by European savants? Where did the Indians stand in the colonial scheme of things?

The British-sponsored science, by the very reason of its existence, was field science. Geography, geodesy, geology, botany, zoology, paleontology, archaeology, medicine and even astronomy – all these stemmed from the physical and cultural novelty of India. British rulers were not interested in science in India for its own sake, but in using it to further their interests. Whenever their practical needs pointed a finger towards a particular branch of science, attention was paid to that science. Harnessing science advances it also. Thus, in the process of empire building, India was added as a field station to the edifice of world science.

Europe's centrality in science was discipline-specific. It arose from the accomplishments in physics and chemistry and technologies based on them. It did not extend to botany and zoology. In the directions given to the Madras Observatory for observing the solar eclipse of 12 December 1871, 'the home astronomers' even laid down the exposure time for the photographic plates (Administrative Report of Madras Observatory for 1871, para 4, p 3). Such remote control would have been unthinkable in natural history. The naturalist in the colonies no doubt looked up to Europe for guidance, help, appreciation and recognition but at the same time viewed himself as a pioneer researcher or a collaborator rather than a subordinate.

Within natural history, rocks stood apart from plants and animals. Geology was seen as intimately connected with mining. The Company did not want any European involvement in mining. On their part, the British mining and manufacturing interests viewed India as a profitable captive market and did not want any competition emerging from within India (Grout 1995 p 248). Consequently, the mining and prospecting rules in operation throughout the 19th century were so designed as to make it impossible for anyone to break the Company monopoly on mining (Harris 1958 pp 153–154). It is only when Germany and Belgium snatched the Indian iron and steel market from the British that the latter liberalized their mining policy in India on the principle that if Britain was not going to sell its iron and steel to India, it could as well permit India to make them (Rungta 1970 p 277; Harris 1958 p 154). This is how Jamsetji Nusserwanji Tata was able to establish an iron and steel mill in what was later named Jamshedpur. Decisive scientific advice for Tata

came from the London-educated Pramatha Nath Bose, who had retired from the Geological Survey of India and was now Mayurbhanj's state geologist. Thus, by the end of the 19th century, the colonial pursuit of geology had provided India with its own geologist.

While geology could be pursued only as a large-scale labour-intensive organized enterprise, in the case of botany the medical, exotic, aesthetic, commercial and scientific aspects all combined in a seamless fashion. It is remarkable that scientific botany was initiated in India not by merchants but by missionaries. Who remained particularly active for half a century, from Koenig's arrival in 1768 till Rottler's death in 1836. Sent out to spread the Gospel, the missionaries were ready to live a life of poverty. They had the linguistic ability to interact with the local population as also the intellectual capability, training, discipline, time and contacts with European academe to carry out high-quality natural history studies. One wonders what course colonial botany would have taken if it had not been preceded by missionary botany.

There was a qualitative difference between the India-bound and Australia-bound English manpower. Those who went to Australia belonged to the lower social strata and had no intention of returning. India, in contrast, generally attracted young men from respectable but impoverished families who hoped to go back home. There were even transfers from British government service to the Company service (the geographer George Rennell and the surveyor-astronomer Thomas Deane Pearse).

Most Company naturalists in India were doctors trained in Scottish and Irish medical schools. Many left their studies half way as soon as they found employment while a few came after obtaining their degrees or returned to do so. Service in India not only made them personally wealthy but also helped them gain social and professional recognition back home.

Since the number of Europeans in India was small, merit and usefulness came to transform the social dynamics. Mathematically gifted Reuben Burrow who in England was considered low-bred could in Calcutta count a supreme court judge (Sir William Jones) as his personal friend. Colonial service was a great social equalizer. A man born to extremely poor parents (William Lambton) could tutor and make friends with a French nobleman (John Warren). Colonial service and scientific accomplishments remove the stigma of illegitimate birth innthe case of m Roxburgh. Lambton's teacher the 18th century eccentric English mathematician William Emerson (1701–1782) refused the offer of fellowship of the Royal Society because it cost too much. But, for the colonies-returned, 50 pounds as a fee for joining the Society represented upward social movement. It was a commonplace for officials in India to write their memoirs or tracts to be able to earn the label 'well-versed in oriental curiosities'.

India offered such wonderful opportunities for scientific exploration that even those European officials who may not have come to much had they remained in Europe were transformed into respectable scientists. Even when their contribution to science was not great they served the cause of their country well. Falconer could become the director of a botanic garden at the young age of 23, and conduct post-mortem of wild animals to understand the better the fossils he had unearthed. Opportunity to build a personal fortune, obtain professional recognition and achieve a higher social status back home all acted as powerful incentives for conducting natural history researches beyond the call of official duty.

European men engaged in scientific pursuits in India sought recognition in Europe which was not always forthcoming. There was a common complaint that science big wigs in Britain did not even acknowledge letters leave aside appreciate the work. Wight got the same treatment from Graham at Edinburgh but was able to establish an excellent equation with William Hooker at Glasgow who received specimens from Wight and sent him books in return. Interestingly, for three years the British publications gave his first name wrongly, as Richard (Basak 1981 p 785). Obviously, the name of a European labouring in a far-off colony did not quite matter in Europe's own circles.

While the European naturalists in India were happy with the material, they had at hand they were acutely conscious of their intellectual isolation, non-access to published works and lack of opportunity to interact with 'living authorities'. Arnold makes this point convincingly but he overstates his case and over-reads the evidence. When Charles Lyell complimented the Wollaston medallists Falconer and Cautley on the manner in which they overcame their disadvantages, Arnold (2000 p 27) would like to believe that Lyell was imputing that 'science in the colonies was inevitably a more amateurish pursuit than in the metropole'. Similarly, he asserts that 'Even those who gained a reputation outside India-such as Falconer, Everest and the surgeon-botanist J. Forbes Royle- felt like novices when they first ventured into scientific circles in Britain'. He does not state on what basis this assertion is made. An 1845 Calcutta magazine essay that he cites in support merely states that 'they underwent some slight eclipse on their first entrance into their new orbit' (*Calcutta Review* 1845 4 165). The essay was not comparing India-based naturalists with those in Europe but better-quality ones with pretenders in India.

15. Company as a reluctant patron of science

Just as evangelicals in Britain wanted the Company's help in spreading the Gospel in its territories, the British men of science wanted the Company to lend its support in advancing science. Both were disappointed; the former fully, the latter partially. The Company knew the value of science and

pressed it into service whenever the need arose. It, however, was extremely reluctant to support science for its own sake. Yet, the Company, though powerful, had its limitations and compulsions. It was answerable to the parliament, subject to government control and sensitive to home public opinion. As a result, a small amount of noblesse oblige was thrust upon it. As science progressed in Europe and scientific community became visible and influential the merchant rulers were forced to pay homage to science, but only to a point. The Company did sponsor the publication of Roxburgh's lavishly produced three-volume *Flora of the Coromandel Coast* 1795–1819, but the failure to recover the costs put a stop to such extravagance (Arnold 2000 p 20). Yielding to appeals by the scientific community, the Company permitted Hugh Falconer to remain on full salary in London from 1844 till 1847 to work on the Shivalik fossils, but then brought him back under threat of forfeiture of pension. The work was finally published in the post-Company period, in 1868. Similarly, in 1851 notwithstanding a memorandum from the British Association, the Company refused to promote a project on *Flora Indica* by Joseph Dalton Hooker and his collaborator Thomas Thomson (1817–1878), later the superintendent of Calcutta Garden 1854–1861. After the demise of the Company rule 'the scantiness of the encouragement given by the East India Company towards the development of natural history of this great country' was taken note of and steps taken 'to redeem India from this disgrace'. Finally Hooker's monumental seven-volume *Flora of British India* was published 1875- 1897 with funding from the India Office (Desmond 1992 p 194).

16. The role assigned to Indians

The missionaries interacted with the Indians and documented their tacit knowledge with a view to incorporating it into the European mainstream. There was no question of identifying individual informants. Indians by and large remained nameless and faceless attendants in the European club of science. Whenever an Indian served particularly well, credit went to his master and mentor for his success in improving the natives. There were rare exceptions to this general rule. In 1843 George Everest successfully interceded with the Court of Directors to obtain for his gifted Indian mathematical instrument maker Syed Mir Mohsin Hussain the same designation if not the same salary as his European predecessor (Kochhar 1991 p 89).

When the Indian explorer Nain Singh was awarded a gold watch by the Royal Geographical Society, he was almost irrelevant at the award ceremony held in England on 25 May 1868. There was no question of his being invited to the ceremony; he was not even mentioned by name. He was the 'wily' and 'skilful' 'Pundit employed by Captain Montgomerie', who was the real hero as far as the Geographical Society was concerned. The Pundit 'had proved himself in every way worthy of Captain Montgomerie's selection'. For this, 'tribute of gratitude and admiration' was due to him. Others before him had employed the native agency 'for the purpose of acquiring political and statistical information' but it was Montgomerie who 'discovered that they could use a sextant or a theodolite as well as Europeans. That was really a most valuable discovery'. Hope was expressed that further explorations would be carried out by 'native enterprise directed by English intelligence' (*Proceedings of the Royal Geographical Society* 1868 vol 12 p 169).

In the same vein Falconer's 1868 biographer Murchison smugly noted that 'the intelligence, docility, and exquisite manual dexterity of the natives' when 'backed by their faith in the guiding head of the European' 'furnished an inexhaustible fund of resource' (Murchison 1868 p xxvi).

Probably the most trivial duty assigned to Indians in the cause of natural history was at Botanic Garden Calcutta. To prevent ants from eating the specimens and the paper on which they were glued, the feet of the cabinets were kept immersed in troughs of water. To replenish the water lost by evaporation, Wallich hired a person to keep the troughs filled with water 'until the cool shadows of evening came on and relieved him from his tedious and monotonous task' (Murray H 1834 *An encyclopædia of geography* 1834 p 967). The task assigned to the locals could be dangerous also. Pedler thanked his assistant 'Balm [Babu?] Poolin Behary Saor' for his help in extracting poison from live cobras – 'a work not always pleasant to the feelings, and always more or less dangerous in its nature' (*Proceedings of the Royal Society of London* 1878 vol 27 p 29).

The most creative use of the locals was in painting natural history specimens. As already discussed, the court tradition in North India and the temple tradition in South India were combined with European requirements to give rise to a unique style, which is of interest not only to students of natural history but also art history.

The 100-year span from Roxburgh's first volume in 1795 to Hooker's last in 1897 illustrates how considerable advantage accrued to science while the interests of colonial India were being served. Three phrases now in common use are constant reminders of that period: Gondwana supercontinent, Russell's viper and Mount Everest.

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