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Early modern natural history: Contributions from the Americas and India

RAJESH KOCHHAR
Indian Institute of Science Education and Research, Mohali 140 306 Punjab, India

(Email, rkochhar2000@yahoo.com)

The early success of its oceanic voyages brought contrary pulls to bear on Europe, with the practical needs of the hour standing in contradistinction to the age-old religious authority, sectarian antagonism and the recovered Greco-Roman intellectual tradition. How in course of time the former triumphed over the latter in the case of natural history is an interesting and instructive line of enquiry. This article examines in some detail how the Materia Medica of the Americas and India were incorporated into the European mainstream.

When the English East India Company was established in 1600, the telescope had not yet come into existence. It is no more than a coincidence that the telescope was invented in the Netherlands (van Helden 1977) the same year (1608) the first English ship reached India. This brings home the important point that modern science and technology grew hand in hand with maritime exploration, colonial expansion and domination over nature and fellow human beings. And yet a distinction needs to be made between exact sciences on the one hand and botany and zoology on the other. A sailor with skill, experience and luck could still steer his ship safely even before the benefits of scientific navigation became available, but there was no way to avoid disease and death on ship and in distant lands. While developments in astronomy and related disciplines were an all-European affair, in the case of natural history and healthcare, traditional knowledge and wisdom of the local people had to be tapped. The requirements operated at two distinct levels. There were health concerns and needs of sailors and administrators who went to the distant colonies. At the same time Europe was interested in new medicines and exotic remedies from America and Asia. Distant lands introduced Europeans to new diseases, which called for new cures and remedies. At the same time new drugs could be tried for old diseases as well. Medical botany was a necessity. Scientific botany emerged from it. Colonialism in course of time created a composite world natural history.

The first books on new medical materials were published in Portuguese and Spanish for the benefit of merchants, physicians, apothecaries and lay persons. For the same reasons, they were translated into other European vernaculars. Later, these works were rendered into Latin as well, the language of the learned. However, the vernacular and the learned streams were not antagonistic but mutually supportive. A work in one language soon became available in the others, very often not as a mere translation but as a critically revised and enlarged edition. There was thus a certain collectivity in the European efforts. It is notable that the European sharing of medical knowledge proceeded independently of political and religious strifes. This European feature of sharing scientific knowledge even while fighting over technology, territory or commerce was seen later in other fields also.

Even though Christopher Columbus was accompanied by a physician on his voyages, he failed to correctly identify the drug plants (Varey *et al.* 2000, p 111). Europe, however, learnt fast. Information on some drugs from what to Europe was the New World was included by Pedro Martir de Angleria (1457–1526) in his compilation of letters and reports published in Latin during 1511–1530. Next came the accounts based on field observations in Central America. Gonzalo Fernandez de Oviedo y Valdes (1478–1557), known simply as Oviedo, published his influential text *Sumario de la Natural historia de las Indias* in 1526 and followed it in 1535 with the first part of *Historia general y natural de las Indias*. In this, he described more than 250 animals and plants.

As part of general Renaissance, there was a revival of interest in the ancient Greek learned medicine, and a desire

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to go back to the original sources. For medical botany, an obvious starting point was the *Materia Medica* prepared by Dioscorides about 50–70 CE. It was seen 'as a repository of ancient wisdom that had been used by the great Galen, and which could be retrieved if Dioscorides' plants could be found again and securely identified'. The text was available to the Middle Ages in a Latin version, but old manuscripts were located and collated to reconstruct the original. 'This was another example of the humanist enterprise of restoring an ancient classic to as pristine a stage as possible'. There was also the additional need to find a place for new drugs in the old scheme of things. In 1533 Padua University appointed its first-ever professor in botany, who in turn established a botanic garden in 1545. The object of the Padua garden was explicitly stated to be 'the rebirth of the material medica of the ancients' (Conrad *et al.* 1998, pp 301–303). When Andres Laguna (c. 1510–1559) published his Spanish translation of the commentary on Dioscorides' *Materia Medica* in 1555, he mentioned a small number of the New World drugs. Some of these drugs Laguna could fit into the Galenic system. The ones he could not he termed gifts from God (Huguet-Termes 2001, p 363). Many more such godly gifts would come Europe's way.

1. Aztec medicine (1552–1580)

Soon after Spain's conquest of the Aztec empire in 1521, Europe was given a glimpse of the Aztec system of healthcare, but Europe was not ready for it. In 1536, the Franciscan friars founded the Colegio de Santa Cruz at Tlatelolco in Mexico for theological and cultural instruction of the influential local people. In 1552, the friars commissioned an Aztec (or Nahua) physician, Martin de la Cruz, to prepare a digest of local healing practices and herbs, in the Nahuatl language, and Juan Badiano was asked to translate it into Latin. The Nahuatl original has not survived. Consistent with the spirit of the time, the manuscript goes beyond medical botany. In case of overheated eyes, the recommendation is to tie fox's eye on the upper arm. In case of bloodshot eyes, the 'trouble is removed if the suffered eyes are sprinkled with powdered human excrement' (Gates 1939, pp 15–16). The real value of the work, however, lies in the fact that it describes 249 medicinal plants, the Nahuatl names of which are given. Out of these, as many as 184 are illustrated in brilliant colours. It is now recognized as a valuable document from medical, linguistic, ethnological and cultural points of view. In the present era, when healthcare tradition is being molecularized with a view to creating new synthetic drugs, there is renewed interest in the pharmacological parts of the manuscript (Montellano 1975). But in its time no notice was taken of the work. The Franciscans were under attack from other religious orders for being too sympathetic to the traditional ways of the local population. Since this was a living Aztec work, it was decided to ignore it. It is, however, creditable that the manuscript was not destroyed. It was handed over to King Philip II (c. 1556–1598), but at some stage it came into the hands of his apothecary, who presented it to Cardinal Francesco Barberini (1597–1679) in 1626, when accompanied by Cassiano dal Pozzo (1588–1657) he visited Madrid. The manuscript was transferred to the Vatican Library in 1902, where it was catalogued as Codex Barberini, Latin, 241. It was 'discovered' in 1939 when at long last it became part of the intellectual discourse. In 1990, the Pope returned it to Mexico from where it had come. In 1626 or 1627, Pozzo in Rome got a 'quasi-facsimilar' copy of the manuscript made, which comprised both illustrations and text. This was eventually purchased by the English King George III and placed in the Windsor Palace Library. It has recently been edited and published (Clayton *et al.* 2009). A handful of the illustrations from the Pozzo copy were eventually used in a 1651 publication.

A similar fate befell the Franciscan friar Bernardino de Sahagun's (1499–1590) monumental work who arrived in Mexico in 1529 and remained there for the rest of his life. He is retrospectively hailed as the father of modern ethnography on the basis of his magnum opus *Historia General*, best known from a manuscript called *Florentine Codex*. This is a massive richly illustrated work comprising 1223 folios arranged in 12 books, with Nahuatl and Spanish texts printed side by side in double-column format. Books 10 and 11 provide information on flora and fauna and include a pharmacopeia. The work is based on information supplied by or collected through native people of high status and was first completed in Nahuatl. Although Sahagun had done some work earlier, it was in 1558 that he was commissioned by his Order to undertake the project. It was believed that a systematic investigation of the native culture would be useful in the 'indoctrination, propagation and perpetuation of Christianization of these natives'. The Nahuatl version was completed by 1569, and the Spanish version about 1577. The Codex was prepared, apparently, during 1578–1580. His adversaries argued that his work celebrated and preserved idolatry and ancient beliefs instead of eradicating them. In 1577 his work was ordered, by a royal decree, to be confiscated. Sahagun was constantly at work preparing and revising his manuscripts. It is, therefore, difficult to say which manuscript was handed over in response to the confiscation order. As for the Codex, it was handed over to Sahagun's mentor Friar Rodrigo de Sequera, who returned to Spain in 1580. Sahagun never knew the fate of his celebrated manuscript, which eventually reached Florence, 'probably no later than 1588'. Sahagun was first published in 1829, in Mexico, but from a manuscript other than the Florentine (León-Portilla 2002, pp 201–14; Sullivan 1997, pp 2–3).

While the Franciscan attempts at acquainting Europe with the Aztec worldview were doomed to failure from

day one, the Jesuit Jose de Acosta's (1540–1600) 1590 Spanish publication *Historia Natural y Moral de las Indias*, based on inquiry and experiences, presents an account of the Americas from a Western point of view and valiantly tries to fit the new lands and people into a Christian, Renaissance framework. As part of the exercise, Acosta provides valuable information on the flora of western South America (Ford 1998).

Very quickly, import of plant and animal remedies from the New World became big business in Europe. It was believed that since the New World had given Europe syphilis, it should provide a cure also. There was a great demand for a natural drug that would replace the conventional mercury treatment which had severe side effects. For a long time, Guaiacum (also called lignum vitae) was touted as a cure for syphilis (Munger 1949). The monopoly for its import was obtained by House of Fugger, the most influential financiers of the time, as part of quid pro quo for financing the 1519 installation of Charles V as the Holy Roman Emperor. The Fuggers opened a hospital of their own in Augsburg for the treatment of syphilis with guaiacum and brazenly enticed pliant doctors to do so through financial incentives. The monopoly lasted until 1525 (Varey *et al.* 2000, p 214).

2. Nicolas Bautista Monardes (c. 1493–1588)

Trade and medicine combined very well in the career of Nicolas Bautista Monardes (c. 1493–1588), who was based in Seville, the sole entrepôt for Spanish trade with the New World. Monardes was a successful physician who additionally exported merchandise and slaves to the New World and imported medicinal plants. He established Europe's first garden for the cultivation of American medicinal plants that his agents and other travellers brought to him. He sought information on the plants' use in their own habitat and conducted experiments of his own. His first book appeared in 1536 in which he deprecated the therapeutic value of American plants, but in course of time he reversed his views. His first work extolling American Materia Medica appeared in 1565. Monardes expanded his work in 1569 and finally consolidated the whole work carried to date in 1574. In it he described and commented on the use of about 100 American drugs, including tobacco (Huguet-Termes 2001, p 365). Monardes wrote in Spanish and his work was translated into English and Italian in his own life time and after his death into French and German. The English translation titled *Joyfull Newes out of the New Founde Worlde* (1577) was carried out by John Frampton, a merchant who had spent many years in Seville. He talks about America as a source for 'the wonderful cures of sundry great diseases that otherwise by these remedies, they were uncurable' (Bercovitch 1997, p 120). Monardes was translated into Latin, in 1574, by the Flemish doctor Charles de l'Ecluse, or Carolus Clusius (1526–1609), well-known translator and synthesizer of his time.

The sense of desperation in healthcare and fascination with the exotic both combined to popularize remedies that, today, would be called bizarre, like the bezoar stones, which Monardes discussed at length. The name bezoar is a corruption of the Persian *bad-zuhr*, meaning antidote (Elgood 1951, p 369). These stones, obtained from inside the animals, were invested with magical remedial powers. Monardes claimed that little stones found in the heads of sharks when crushed and administered as a powder would dissolve the stones in the kidney and bladder. As a trader he maintained that the stones from the West Indies were far superior to those from the East because for ten real ones from the latter source 'we receive hundred which are counterfeits' (Asua and French 2005, pp 106–107). It is not surprising that fakes were being made. These stones cost a fortune. A genuine stone was valued at 50 gold crown in Calcutta, while another was bought for 130 crown (Kunz 1915, p 204).

The studies in Asian and American pharmacopeias were carried out independently of each other, with a synthesis first appearing in 1582. Chronologically speaking, the first book on non-Western Materia Medica was published in Goa in 1563. Written by Garcia d'Orta (1501/2–1568) in Portuguese, it marked Europe's introduction to Western Indian plants and drugs and to details of tropical diseases (such as Asian cholera). Also, Europe's first Latin work on non-Western Materia Medica, published in 1567, is an abridgement of d'Orta. This date, then, nominally marks the introduction of non-Western medical botany into the European academic mainstream.

3. Garcia d'Orta (1501/2–1568)

D'Orta pointedly sought to distance himself from the received intellectual tradition prevalent in Europe at the time. He came to India in 1534 and remained there until his death (Markham 1913, p vii). Before taking up a discussion of his work, it would be appropriate to examine details of his life, because his intellectual attitude seems to have been moulded by his family background. Orta's parents were Spanish Jews who migrated to Portugal in 1492, when Jews were expelled from Spain. Forced in 1497 to choose between exile and conversion, the family nominally converted to Christianity. D'Orta was fortunate to find a patron in Dom Fernao de Sousa, 'of a noble family descended from a natural son of King Alfonso III by a very beautiful Moor, daughter of the Cadi of Faro' (Markham 1913, p viii).

D'Orta studied at the Spanish universities of Salamanca and Alcala, from 1515 to 1523, although it is not certain where he went first. After graduating from the university, he practised in his home town, Castelo de Vide, until 1526,

when he came to Lisbon, where he remained for the next eight years. He secured a university chair in 1530 and was even elected a member of the university council in 1533. In March 1534 he sailed for Goa in the fleet commanded by his life-long friend, patron and protector, Martim Affonso de Sousa (c. 1500–1571), who was Captain-Major of Indian Ocean during 1534–1538 and then served as the Governor-General of the Portuguese Asia 1542–1545. It is believed that the major reason for his leaving Portugal was the increasing pressure being felt by the New Christians. It was probably due to Sousa's influence that d'Orta was permitted to sail as his personal physician despite the law enacted in 1532 prohibiting any New Christian from leaving Portugal. A supporting reason would have been the opportunity to learn about new plants and cures.

In Goa, d'Orta served as physician to the governors of Goa as also to Burham Nizam Shah, the Sultan of Ahmadnagar. He grew many medicinal herbs in Goa. In 1554 or 1555 the Viceroy of Goa granted d'Orta the lease of the islet of Bombay (part of Bombay as it came to be), where he maintained a house and a garden (Cunha 1900, p 97). In addition to maintaining an extensive medical practice, he was also a trader, chiefly in Materia Medica, jewels and precious stones, and a ship owner. He knew personally all the plants within his reach from which drugs were derived. For the rest, he made sustained efforts. He met Persians, Arabs, Malays, and traders from all over Goa. He was on friendly terms with learned Muslims and Hindus and conversed familiarly with ordinary Asian traders, shopkeepers and physicians in his quest for knowledge. Additionally he paid correspondents and agents who sent him plants and seeds from elsewhere (Boxer 1963, p 9). He acknowledges the assistance of 'his intelligent Konkani servant girl Antonia' (Markham 1913, p ix).

The celebrated Portuguese poet Luis de Camoes (1524–1580) spent time in Goa twice. He first arrived in 1554 for a compulsory two-year service in the Indian Ocean and again in 1561. He would probably have met d'Orta during his first visit also. But we are told that during the later visit he passed many agreeable and instructive hours in d'Orta's house, admiring his collections and examining his extensive library. Camoes composed an ode '*Aquele unico exemplo*' to Goa's Viceroy, the Count of Redondo. It was written in support of d'Orta's petition to the Viceroy requesting permission for the publication of the former's treatise. Camoes compares the Count of Redondo to the Greek hero Achilles. Just as Achilles had been the scourge of the Trojans for ten years, Portugal's enemies in the East Indies trembled at the Count's name. Camoes reminds the Count that Achilles was in addition 'a scholar in herbs and medical doctrine' so that 'the hands that brought so many of grief restored an equivalent number to life'. Since Horta in Portuguese means a garden, Camoes could indulge in obvious word play. He implores the Count to ' look kindly on that obscure knowledge that once Achilles valued; take care that you favour the green shoots today displayed as fruits of that Orta, where new plants flourish even experts do not know'. Camoes hoped that in the years to come 'some famous Orta produces in Portuguese meadows all the various herbs'. He referred to Dr Orta as 'an ancient, lettered man, hardened by years and vast experience, [who has been] instructed by the muses of the River Ganges'. D'Orta's 'mighty tome' if published 'will give medicine a new flame, and will make its way revealing facts that to the ancients were veiled secrets'. In the end, Camoes asks Redondo to balance bloodshed with healing : 'In conscience, you cannot refuse him who petitions you just renown; though your honour would first choose hectic battle with Moor and India, aid him who turns death's other cheek and thus resemble the powerful Greek'(White 2008, pp 266–68. I thank White for giving me a copy of his translation of Camoes' Goa ode. For an earlier loose translation of some parts, see Markham 1913, p xi)

Thanks to Camoes' poetical support and d'Orta's own equation with the Viceroy, d'Orta's book was published in 1563, with the ode included. This was the first time Camoes was getting published. However, it could not have helped Camoes much because very few people ever saw the book. D'Orta's book in Portuguese whose title in brief translates as *Colloquies on the Simples*, *Drugs and Materia Medica of India* was first written in Latin and then translated by d'Orta himself so that it could reach a wider readership in Portuguese Asia (Boxer 1963, p 14). Goa had earlier published a *Catechism* by St Francis Xavier (1557) and a *Compendio Espiritual da vida crista* by Dom Casper de Leao Pereira, the first archbishop of Goa (1561). D'Orta's was thus the third book to be printed in Goa and India, and the first on a non-religious subject. What set it apart from other publications of the time was the extent of its errata. The body of the book consisted of 57 drugs and simple colloquies, mostly on drugs of vegetable origin, also including items like ivory, diamonds and the bezoar stone. Among other things, it described the effects of *bhang* (cannabis) and furnished Europe with first account of symptoms and treatment of a case of Asian cholera (Markham 1913, pp 154–157). In addition, there is much interesting matter, for example, on the fights between the cobra and mongoose (Markham 1913 p 337), and the etiquette of chewing betel nut (Markham 1913, p 195).

The format used by d'Orta for his book is significant. It is in the form of a dialogue between two persons. One of them, the questioner, is a fictitious character, Dr Ruano, who had studied at d'Orta's alma mater, Salamanca, and is very much a man of the school, erudite and ready with quotations. Ruano is probably what d'Orta was in his younger, bookish days. The answerer is the maturer d'Orta, traveller and observer, perpetual learner and pluralist, who rejects received wisdom in

favour of empirical knowledge: 'For me the testimony of an eye-witness is worth more than that of all the physicians, and all the fathers of medicine who wrote on false information'. In a similar vein, he tells Ruano, 'Do not try to frighten me with Dioscorides or Galen, because I merely speak the truth and say what I know' (Markham 1913, p 60).

It is of interest to see what d'Orta had to say on tamarind. Tamarind is a produce special to India, as can be seen from the name itself. The name is derived from the Arabic/Persian *Tamar al Hind*, or Indian date, which was coined by traders. Tamarind was sent out from the Indian west coast to Cairo from where it was taken to Alexandria and then Venice for use in Europe. It was not known to the ancient Greeks. It is mentioned by Yuhanna bin Masawayh (777–857), the celebrated Persian-Christian physician who attended on four Caliphs at Baghdad. He is Ruano's authority on tamarind: 'Mesue, who is so much admired by his Arabian imitators, says that they (tamarinds) are from the wild palms of India' (Markham 1913, p 424). No doubt, Masawayh's description was based on a paraphrase of tamarind's name. But, as Orta explained, 'It is not a kind of date, nor has it the form of a date tree, except that both have stone'. Mesue, declared Orta, 'does not know what he is talking about' (Markham 1913, p 425). Describing tamarind firsthand thus provides Orta with an opportunity to debunk old authorities, because as he says elsewhere, 'even I, when in Spain, did not dare to say anything against Galen or the Greeks' (Markham 1913 p 275).

As soon as d'Orta died, in 1568, his hidden Judaism caught up with him and his family. His sister Catarina was arrested as a Jew the same year and burned at the stake next year. Garcia himself was posthumously convicted of Judaism. His remains were exhumed and burned publicly in 1580.

4. D'Orta in Europe

Monardes' would-be translator Clusius came across a copy of the *Colloquies* in Lisbon in 1564 and, recognizing its worth, decided to translate it into Latin, not in its entirety but by omitting parts that would appear to be 'insignificant' to European readership. Further, he rearranged the selected matter and added valuable notes (Fluckinger and Hanbury 1879, p 760). Clusius' version achieved great popularity in European universities, ran into five editions in Clusius's lifetime, and 'is the form in which da Orta's original work was chiefly disseminated for the next two centuries' (D'Cruz 1991, p 1594). It was not d'Orta's book but the Clusius version that was translated into European languages. Antoine Brigant's translation into Italian appeared in 1576 and went into many revised editions. The French translation, by Antoine Colin, came in 1619. Secondhand translations meant that Orta's historiography, which he consistently hammered in his book, went unnoticed in Europe. In 1872, Francisco Adolfo de Varnhagen (1816–1878), Brazilian historian, reprinted d'Orta's book, with an introduction that he wrote himself. It contains many lacunae and imperfections, is without notes, and only attempted the identification of one plant, which is quite wrong' (Markham 1913, p xi). Still, it would be instructive to see what Varnhagen wrote by way of introduction. The standard edition of d'Orta's work, edited and annotated by an accomplished botanist, Count Ficalho, appeared as late as 1891 and 1895 (in two volumes). It was translated into English in 1913 by Clements Markham. The most reliable biography of d'Orta is by Augusto da Silva Cavalho, published in Portuguese in 1934, summarized by Charles Ralph Boxer, from whom much of the above information is taken.

Spain entered Asia with the colonization of Philippines in 1565 and hoped to participate in the spice trade. D'Orta thus became relevant for Spain. In 1572 King Philip II's physician Juan Fragoso published his *Discursos* in Spanish, based on the *Colloquies*. Fragoso selects a few plants from d'Orta, arranges them alphabetically and gives a succinct account of each. What makes the book particularly valuable is that it lists earlier writers on Asian flora and points out discrepancies between d'Orta and them. Fragoso was translated into Latin in 1600 (Lach 1994, p 436). The next influential author on Asian flora was a Portuguese converted Jew, Christobal Acosta (c. 1514–1594), who spent many years in the East. He met d'Orta in Goa before 1550 and again visited Goa in 1568, a few months after d'Orta's death. He even served as a physician in the Royal Hospital in Cochin. His *Tractado* was published in Spanish in 1578. The work describing 69 plants and other sources of drugs and medicines is based on d'Orta's but goes beyond it. The great merit of Acosta's works is that it includes well-drawn full-page illustrations of 46 plants with roots. Thus, 'His work completed what the learned Portuguese, Dr. Orta, began'. Not content with translating from Monardes and d'Orta, Clusius combined their work with that of Acosta in 1582, providing Europe with access to information on Asian and American flora in one volume, and brought out a final edition in 1605.

What the Mexico-based Franciscans failed to achieve, that is enthusing the Spanish King about the medical knowledge of New Spain, was accomplished by purely commercial concerns. Monardes' success propelled the King into action. If the natural produce of distant parts of his empire commanded such high value in Europe, it needed to be systematically explored and suitably exploited.

5. Royal Spanish mission (1570–1577)

In 1570, King Philip II directed Francisco Hernandez (1515–1587) to make a field trip to Mexico. Hernandez was eminently

suitable for the task. He was a reputed doctor of his time, a scholar of distinction and a prolific writer, and held the post of chief physician to the King. Appointed chief medical officer of the West Indies, Hernandez' instructions were to 'gather information generally about herbs, trees, and medicinal plants' in consultation with the Spaniards as well as indigenous people. He was to bring back descriptions about the practical use of the plants, their power, place and manner of cultivation, etc. (Varey *et al.* 2000, p 35). During his stay in Mexico, in 1570–1577, Hernandez interviewed people, collected samples, collaborated with local physicians, conducted experiments and post mortems, and commissioned local artists to make colour paintings of plants and animals. The Royal instructions to Hernandez may have been utilitarian, but he allowed himself to be seduced by Mexico. In view of the importance of Hernandez' work, it is important to keep track of its dissemination. His work came to exist at three levels: (i) The Royal version was sent to his King in 1576 when Hernandez was still in Mexico. (ii) He retained a personal manuscript, which he brought with him. (iii) In 1582, the botanical part of the Royal version was taken out and rearranged on Royal orders. Hernandez' was a massive work. The Royal version comprised 893 pages of text (arranged in six books) and 2071 pages of paintings (10 books).It discussed more than 3000 plants, 40 quadrupeds, 229 birds, 38 reptiles, 30 insects, 54 aquatic animals and 35 minerals (Chabran and Varey 2000, p 4). The King casually hung some of the illustrations in his study but got the manuscripts neatly bound and placed in his library at the Escorial. Much to the ailing Hernandez' disappointment, it was decided not to publish the work because the King's council felt that the descriptions and illustrations 'were of Indian plants that could not be used in Spain, and besides the book had no order to it' (Freedberg 2002, p 248). Hernandez had ordered his material according to the Nahua custom, that is etymologically, and not as trees, shrubs and herbs as was the European practice. In 1580 the King asked his Royal physician Nardo Antonio Recchi to take out those parts that had a practical value. Dutifully Recchi made a selection of some 400 plants, rearranging the material as ordered. Recchi finished his work in 1582, but it was not published. In 1589 Recchi took his work with him to Naples. A number of copies or copies of copies became extant. Around 1790, Philip II presented a beautiful natural history album to Jaime Honorato Pomar (c. 1550–1606), professor of herbs at Valencia and later advisor to the King. The album, now known as Pomar Codex, contains illustration of 218 plants and animals from the Old World and the New World. The Codex contains illustrations of 7 animals and 25 plants from Hernandez' collection. The plants grown in European gardens are painted in Florentine style while those copied from Hernandez retain native American touch (Huguet-Termes 2001, p 367).

During his 1626 visit to Madrid , already referred to, Pozzo got a copy made of Hernandez' work on animals and minerals, which was not touched by Recchi, and took it with him to Rome. He also persuaded the Escorial librarian to prepare an index of Hernandez' manuscripts (Varey *et al.* 2000, p 123). This turned out to be historically an extremely significant step because in 1671 a fire destroyed the original manuscripts leaving the Index as the only guide to the content of the Royal edition. Hernandez' personal manuscript was subsequently given to the Imperial College of the Society of Jesus in Madrid. The manuscripts are still in Madrid, but split between two locations. While the academic use of Henandez' work would be made in Rome, it was immediately employed in the colonial and mercantile cause, as represented by Mexico and the Netherlands.

For Europe, American Materia Medica was an add on, but for the Spaniards in Mexico it was a matter of life and death. The European medical knowledge of the day was not great to begin with. Uncertainty in the arrival of the drugs because of the long distance and loss of efficacy because of long travel time all made dependence on local drugs unavoidable. In 1578 Hernandez' Mexican collaborator Alonso López de Hinojosos (1534–1597) brought out a book on anatomy for the benefit of barber surgeons like himself. In the next quarter century, there were published three other books based on Hernandez manuscripts. The work by the Dominican priest Francisco Ximenez is particularly notable. *Quatro Libros* was published in 1615, and was noticed in Europe also. This work is based on a copy of Recchi's selection. Such was the importance of the selection that Ximenez managed to get it in Mexico by 'extraordinary means' (Varey and Chabran 1994, p 130). It goes to Ximenez' credit that he did not merely translate Hernandez but 'augmented it with many simples and compounds' (Varey and Chabran 1994, p 125). He pointedly draws attention to a mistake by Monardes, who as we know had no firsthand knowledge of America (Varey and Chabran 1994, p 133).

It is at this stage that the trading companies entered the picture. In 1625 Johannes de Laet (1581–1649), director of the Dutch West Indies Company, brought out *Nieuwe Wereldt* for use by its sailors and officials meant for foreign service. It included description of the best-known Mexican plants. By the time the second edition appeared in 1630, Laet had become aware of Hernandez' work more and more of which was incorporated in later editions. The third edition, in 1633, was in Latin, signifying that it was directed at a learned audience. It was followed by a French edition in 1640. These editions also describe the bezoar stone, the most popular stone in European pharmacy (Chabran and Varey 2000, p 10). This was the first published use of Hernandez in Europe. Soon thereafter, in 1635, the Jesuit scholar Juan Eusebio Nieremberg incorporated about 160 descriptions of plants, animals and minerals from Hernandez in his *Historia*

Naturae. The significance of this work lies in the fact that it was taken directly from Hernandez personal edition and represents the first extensive use of his work. By this time, work on publishing Hernandez was already in progress in Rome at the Accademia dei Lincei (the Lyncean Academy), set up by the young Roman aristocrat Prince Federico Cesi (1585–1634.

6. Lyncean Academy (1651)

Cesi and his colleagues at the Lyncean Academy embarked on an ambitious and finally successful project to build a richly illustrated encyclopedic work that used the available Hernandez' text as the nucleus but went beyond it by adding extensive learned commentaries. The final publication was issued in 1651 and titled *Rerum Medicarum Novae Hispaniae Thesaurus,* with Hernandez and Recchi listed as its authors. The publication was a significant development. So far, interest in the New World's natural history had largely been driven by utilitarian considerations or personal scholarship. But now natural history was being supported as a collective intellectual discipline for its own sake. Interestingly, the initial money being expended on it was not the new merchant's money that Spain had been earning but the old-style feudal money that Italy provided. It must, however, be appreciated that the final publication was made possible because of funds arranged through Alfonso de las Torres, secretary to the Spanish ambassador in Rome. Torres also helped with editorial work in the final stages (Asua and French 2005, p 95).

The Academy had valuable primary source material to work on: the Recchi selection with illustrations; the original Hernandez account of the Mexican animals and minerals; and the Pozzo copy of the still earlier Cruz-Badiano work. As part of the project, Johannes Faber (1574–1629) brought out in 1628 his *Animalia Mexicana*, which was later incorporated into the *Rerum*. Faber complemented the fauna illustrations by taking some flora illustrations from the de la Cruz-Badiano manuscript (Gomez 2008, p 83). Sadly, this was the only use this pioneering work was ever put to. The six-part *Rerum* included a section with glosses on plants by the great botanist Fabio Colonna (also written as Columna) (Asua and French 2005, p 95). The *Rerum* had a long shelf life. Alfrecht von Haller (1708–1777), Swiss-born professor at Gottingen, wrote to Carl von Linné (Linnaeus) (1707–1778) on 11 February 1738 that he valued the *Rerum* because of Fabio Colonna's notes. Linnaeus on his part described Colonna as 'best of all botanists'.

By this time, Europe had already been introduced to the richness of flora from the Malabar region of Western Ghats in South India under the auspices of the Dutch East India Company, thanks to a combination of executive initiative, commercial prospects, medicinal needs and the desire to help botanists in Europe. The trading companies' sponsorship of researches into the natural history, geography and geodesy of the colonies won them admiration from the European scientific community and diverted attention from their other, unsavoury, activities.

7. Hortus Malabaricus (1678–1693)

Hendrik Adriaan van Rheede tot Drakenstein (1636–1691) came to India in 1656, was largely responsible for the defeat of the Portuguese, rose steadily in rank and was appointed commander of the Dutch Malabar in 1669. Van Rheede's is the major European botanical effort in India after that of d'Orta whose influence is discernible on the former's work. Unlike d'Orta, van Rheede was a botany enthusiast rather than a botanist. His personal interest, organizational abilities and high administrative position all were required to see the work through. Like d'Orta's the Malabar work was not influenced by past authorities. Expectedly, there was a utilitarian trigger. In 1769, the East Indies' government asked its Ceylon counterpart to investigate the availability of medicinal plants there, because medicines from the Netherlands were not only expensive to import but also ran the risk of deterioration during transit. Van Rheede, stationed in an area of rich biodiversity, was also hopeful of self-sufficiency in medical supplies (Desmond 1992, p 20). He brought out a 114-page *Hortus Indicus Malabaricus* in 1678, with editorial and other help, from Amsterdam. In England it was described as 'excellent Work giving accounts of the most rare and strange Trees and Shrubs of the most fruitful and flourishing country of Malabar in the East Indies' (*Philosophical Transactions of the Royal Society* 1682 **13** p 100). It was followed by van Rheede's magnum opus, the 12-volume *Hortus Malabaricus*, which was published during 1686–1693, also from Amsterdam. It described about 780 species of plants, supported by 794 illustrations. This work won high praise from professional circles in Europe, including from Linnaeus, who found it very dependable.

For his information, van Rheede depended on the members of the Ezhava community of toddy-tappers, who were 'adept both at tree climbing and plant identification'. Some of them worked as Vaidyars, the traditional physicians with an extensive, time-tested knowledge of the medicinal value of plants. Van Rheede's chief helper was named Itti Achuden (also spelt Achudem). The German-Dutch botanist Karl Ludwig Blume (1796–1862), who worked in Java from 1817 until 1826, honoured Achuden by naming a genus *Achudemia* after him. [Years later, Robert Wight (1796–1832), Madras-based Scottish botanist named a genus of Orchid *Govindooia* in honour of Govindoo, who illustrated his specimens.] In the seventeenth and eighteenth centuries, when Europeans were interested in Indian knowledge that

resided in the field, they showed respect for people who owned that knowledge, even though they ranked very low in the hierarchy of their own society. In the nineteenth century, field India would be abandoned and focus shifted to archival India, literary sources and upper castes. On van Rheede's recommendation, a medical doctor, Paul Hermann (1646–1695), was given an appointment in Ceylon, where, from 1670 until 1677, he collected plants and prepared a hortus siccus (dry garden) or herbarium (Burkill 1965, p 6). From 1679 until his death, Hermann held the post of professor of botany at Leiden University. The work of van Rheede, Hermann and others in the East Indies established the Netherlands as a centre for tropical botany.

8. England

Characteristically, England of the day was interested in plants that have medical or commercial value but not in scientific botany. In 1673 the royally chartered Company of Apothecaries (later named Society) began cultivating a medical garden in Chelsea. It had an important part to play. Herbal cures from distant lands were in great demand, but the prescribing physicians were inclined to keep all the details secret lest their own earnings be adversely affected. Public cause demanded that description of plants be properly documented and faithful illustrations prepared. James Petiver (1663–1718), a successful apothecary and dedicated naturalist who 1709 onwards served as the demonstrator at the Chelsea garden, called for and received plants from all over, exchanged specimens within Europe, maintained a natural history museum and published the descriptions sent from the field along with his own 'Thoughts and Discoveries' . His informants included captains of ships and European surgeons working in the colonies . The career of Samuel Browne (d. 1698), appointed a surgeon in Madras in 1688, was rather controversial, but England gratefully remembered him as supplier of dried plants that now form a part of the British Museum. He sent Petiver a packet of 46 specimens collected at 'Unanercoonda', about 12 miles from Fort St George. The seeds were distributed to various gardens (including the Chelsea) where they were raised. Browne's observations and Petiver's remarks were published in *Philosophical Transactions* in numerous papers during 1700–1702. The cassumuniar root had been used in England since 1672, as a cure for epilepsy, but 'whence it came, and how to come by it', nobody would tell. Identification became possible only when Browne's plant collection was carefully examined. The druggists could now order the herb from India (*Philosophical Transactions of the Royal Society* 1700 **22** p 580). Linnaeus made several visits to the Chelsea garden during the 1730s. More generally, the Dutch and the British colonial collections provided him with material for his binomial system of taxonomy (1735).

Where medicine, quackery and commerce stood in the first half of the eighteenth century can be seen from the biography of Sir Hans Sloane (1660–1753), who became in 1716 the first physician to be honoured with a hereditary title in England and served as the president of Royal Society from 1727 till 1741 in succession to Isaac Newton. During his 15-month stay in Jamaica (1687–1688), Sloane invested almost his entire savings in purchasing cinchona bark, which he later sold in England at a considerable profit. On return, he introduced Europe to milk chocolate, which in its early days was sold as a medicine. The recipe was later sold to the Cadbury brothers, who marketed it as Sir Hans Sloane's milk chocolate. As a practising physician, Sloane gained a great reputation for the treatment of eye afflictions and his only academic medical paper is on this subject. He jealously guarded the formulation and published it only in 1745, when he was 85 and had retired from active practice. The recipe consisted in taking prescribed quantities of tutty [zinc oxide], Lapis Haematitis [ferric oxide], pearl and aloes, and grinding them in a pestle and mortar with viper's grease or fat to make a lineament (Hawkins 2010, p 27). Curiously, it was specified that the mortar and pestle be of marble. Apparently, the prescription would exclude poorer patients. While zinc oxide no doubt worked, use of viper's fat tells us something about the state of medical knowledge of the time.

9. Cinchona

The most remarkable addition to the medical and scientific knowledge in the colonial times was the Peruvian bark traditionally recognized as a cure for malarial fevers, the scourge of the tropics and the biggest obstacle to colonial expansion. The first Europeans to learn about the fever-controlling property of the bark of what came to be called the cinchona tree were the Jesuits who learnt about it in Peru in the 1620s or 1630s. According to an oft-told story, in 1638, Countess of Chinchon, the wife of the Spanish Viceroy of Peru, was cured of her fever by the intake of the powder of cinchona sent by the governor of the province of Loja. According to a 1662 England account, 'On her return to Europe, she carried with her a quantity of the healing bark, which was sold in Seville for a hundred reals the pound, and went by the name the Countess's powder' (*Saturday Review* 15 December 1862, p 717). The story is now declared to be a legend, and the Countess never returned to Spain. But there must be some basis for the later nomenclature. (Perhaps the Count himself was cured of his fever thanks to the bark.) The bark was regularly used in Jesuit colleges in Europe from 1650 with the Pope's approval. An early and enthusiastic popular dispenser of the remedy was the Rome-based Spanish Cardinal de Lugo (1583–1660), who probably obtained the Peruvian bark from Jesuit sources in the initial stages. He

purchased large amounts of it at his own expense, and 'gave it gratis to the fevered poor, on condition only, that they did not sell it and that they presented a physician's statement about the illness'. Such was the medicine's association with the Jesuits that it came to be known as the Jesuit's or the Cardinal's bark/powder (Lee 2002, p 189). It is said that Oliver Cromwell (1599–1658) preferred to die of fever than try the 'popish remedy'. The story may be apocryphal, but the message is clear. The bark was considered to be a Catholic remedy and accordingly shunned, at least in the initial stages, by the Protestants. The bark was popularized in England by Robert Talbor (1642–1681), who was a pharmacist and not a physician, and therefore open to 'observation and experiment'. The bark entered the London Pharmacopoeia in 1677 as Cortex peruanus (Bruce-Chwatt 1988, p 1486).

It is not very well known that cosmic science provided a convenient subterfuge for gathering botanical intelligence. In 1735, the French Government sent an expedition to South America ostensibly for the measurement of an arc of the meridian at Quito in Ecuador. Two officers of the Spanish marine, Jorge Juan (1713–1773) and Antonio de Ulloa (1716–1795), represented the Government of Spain on the voyage and also made independent observations in the interior (see Adams 1806). The expedition, led by Charles Marie de la Condamine (1701–1774), was secretly instructed to find the fever tree (Lee 2002, p 191). The first clear and detailed illustration of the tree was published by Condamime in 1738. On the bases of this publication and specimens provided by Condamime, Linnaeus described the tree in 1742 , labelling the genus Cinchona. It should have been called Chinchona, but the misspelt name has stuck. The alternative would have been to name it after Lugo. Probably Linnaeus preferred to name it after a Catholic countess rather than a Catholic cardinal.

A number of attempts were made to identify the active ingredient of the various types of fever barks. Finally in 1820, in a major breakthrough, two Frenchmen, the Director of the School of Pharmacy in Paris, Pierre Joseph Pelletier (1788–1842), and his colleague, Professor Joseph Caventou (1795–1877), succeeded in extracting the alkaloid of quinine from cinchona bark. About the same time, attempts at synthesizing quinine were also initiated. The exercise did produce an unexpected bonus. In 1856, an 18-year-old chemistry student, William Henry Perkin (1838–1907), while assisting his professor in the synthesizing experiment made the private discovery of the first aniline dye, mauveine, thus laying the foundation of synthetic chemical dye industry. Quinine was finally synthesized in 1944 by Robert Burns Woodward (1917–1979) and William von Eggers Doering (1917–2011) at Harvard.

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' (Headrick 1981, p 67). If Europe was to prevail on Africa, its dependence on the Andes for cinchona should cease. All attempts to find local substitute for cinchona failed. As a last resort various species of cinchona were smuggled out of South America and crossed to produce high-yield, domesticated varieties, after many false starts, in Java and to a small extent in India (Darjeeling and the Nilgiri Hills). This is a fascinating, but separate, subject of study.

Systematic natural history studies in India were initiated by Linnaeus' pupil and informant, the Latvia born Johann Gerhard Koenig (1728–1785), who arrived in the Moravian Mission in Tranquebar, South India, in 1768 (Sterll 2008). (This Mission should not be confused with the much older better known Lutheran Mission also in Tranquebar.) Koenig left the Mission in 1778 to take up appointment as naturalist to the East India Company's government in the Madras Presidency. He trained other missionaries who constituted the pioneering body of naturalists in India. They had the scientific background, requisite discipline and the freedom of action. In addition they needed money for personal expenses and for Mission work, which they could earn by selling specimens to Europe. There were other missionaries who merely supplied specimens to their European contacts. But Koenig's associates and followers were collaborators rather than mere suppliers. They made their own investigations, supplemented them with traditional knowledge obtained from local people, and passed on the package including specimens to Europe, where it was handsomely acknowledged and incorporated into the mainstream. In addition, Koenig inducted British Indian officials to modern botany, paving the way for institutionalization of natural history researches under colonial auspices (Desmond 1992).

10. Discussion

Seen from the outside there is a continuity and flow of history in European colonial expansion. The Portuguese exploration of the African west coast in its crucial early years was sponsored by the Church through the Order of Christ, of which Prince Henry the 'Navigator' was the Grand Master. Not only did the Order furnish funds but also supplied the manpower. Without the support of the Church, Portugal could not have embarked on the voyages that changed the world history for all times to come. During the period of Iberian dominance in Europe, Christianity no doubt was an important part of the geo-politics, but this does not mean that the period remained static. There may well

have been a desire to fit new lands and new peoples in the old theoretical frameworks provided by the Bible and the ancient Greeks, but the exercise itself called for new enquiry and new experiences.

Once the centre of European power shifted to the Protestant nations, there was a desire to belittle the work done in the Iberian phase. Thus, HG Wells, more as a pamphleteer than a historian, declared in his 1920 *Outline of History* that 'It is a misfortune for science that the first Europeans to reach America were those rather incurious Spanish, without any scientific passion, thirsty for gold, and full of blind bigotry, of a recent religious war' (quoted in Ford 1998, p 19). In the sixteenth and the seventeenth centuries (and even later) awareness about the natural environment was no idle curiosity. Instincts of survival and self-preservation as well as considerations of commerce created a movement in the Catholic phase itself that may have been slow to begin with but was discernible all the same. In the initial stages, even Protestant nations were reluctant to adopt innovations that carried a Catholic stamp. Europe, Catholic and Protestant, took a long time recognizing that a whole world existed that would not fit into the Biblical worldview. Thus, as 'recently' as the late eighteenth and early nineteenth century, England found it impossible to reconcile the discovery of the antiquity of Sanskrit with the Mosaic ethnology (Trautman 1997, pp 28–61).

Just as the Indian kings and feudal lords routinely became patrons of dance, poetry and arts, it became fashionable for European royalty and nobility to collect natural curiosities. In 1751, Linnaeus was asked to begin work on full-length description of the natural history collection of his King Adolf Fredrik and Queen Lovisa Ulrike. The Queen had a magnificent and unrivalled collection of Indian butterflies and other insects as well as shells. The task was an education for Linnaeus because he was obliged to create a system of classification of shells. He became quite free with the King and the Queen to the extent that he was among the privileged few to play blindman's buff with the Queen and the courtiers. On such occasions it was considered a serious breach of etiquette for anyone to touch the Queen, but Linnaeus when he became the blindman could see a little and deliberately caught her. Linnaeus took no note of her reproof and clapped the Queen on the head, declaring that those who play a game must abide by its rules (Blunt 2001, p 211). This is an instructive anecdote. This highlights the social rise of men of science in Europe. Similarly, years later, in 1827, the superintendent of the Saharanpur botanic garden, Dr George Govan (1787–1865), became a companion of the Indian Governor General Lord Amherst and his wife in their post-breakfast walks at the newly founded hill station of Simla so that they could search for plants (Hyde 1962, p 54).

Scientific enquiry not only bridged social gulfs but also undermined religious authority. The German Biblical scholar Johann David Michaelis (1717–1791), who had been educated in Halle and was now a professor in Gottingen, wanted help on Biblical matters from the Lutheran missionaries stationed at Tranquebar in South India. He wanted to satisfy himself if the large animal behemoth mentioned in the Old Testament could be elephant as had recently been suggested. He was curious to learn about the elephant's habitat, food and reproductive habits. Obligingly, the missionaries forwarded the questions to their acquaintances in India and Ceylon and themselves spoke to the head of the mahouts in the kingdom of Tanjore. Michaelis also wanted to know the maximum number of people an elephant could carry. The considered answer from India was 28, smaller than the figure 32 mentioned in the Bible (Jurgens 2004, pp 63–64). (The behemoth is now identified with hippopotamus.) The Bible so far had been treated as a revealed text. It was now being subject to scientific scrutiny. In a way, the demolition or at least the weakening of the old order, be it religious, social, or classical, was a far more significant development than scientific curiosity in Europe about the East and the New World.

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