

Economic biology and James Anderson in eighteenth century Coromandel

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James Anderson (JA, 1739–1809)¹ (see note 1; Figure 1) will be remembered for the two structured botanical gardens in 18th century Madras: the Nopalry in Marmelon (now Mambalam–Saidapet suburbs) and the Anderson Gardens (now in Nungambakkam suburb) vouch for his spirited efforts to know plants and their usefulness to humans. An underpinning urge to improve Britain's economy by exporting knowledge and material resources of India to Britain permeates his efforts. Nonetheless, his efforts are worthy of recall. JA was a qualified surgeon, who came to Madras from Scotland on an East India Company ship in 1761. He died in Madras on 6 August 1809 and is interred in St Mary's Cemetery². JA became an assistant surgeon with the English East India Company (EEIC) in Fort St George, Madras in 1765. He was promoted to a full surgeon in 1786, and later became the Physician-General.

At Fort St George, JA made efforts to promote industries to the benefit of the EEIC and local population. Raising cochineal insects seems to have been an obsession for him. Soon after the Spanish conquest of the Aztec Empire, cochineal was exported to Spain, and by the 17th century it was traded as far as India³. A raw crimson dye was extracted from female cochineal insects, which was used in the production of scarlet, orange and other red shades. The colouring comes from carminic acid, which has extensive relevance to humans⁴. JA believed that the quality and colour of carminic acid was influenced by the plant on which the insects fed; therefore, by feeding local 'cochineal' insects on the cacti – already growing in Madras – he hoped to obtain cochineal dye. In his letter # 5 to Joseph Banks (1743–1820)⁵, JA explains the context of the term cochineal (see note 2): 'the Cochineal in all my letters as it is understood by the Spaniards, in a general sense'. The name 'cochineal insect', in English language, generally refers to a species that produces cochineal dye, whereas in Spanish *cochinillas* (*cochenilles*, French) refers to the entire group, known in English as scale insects, the Coccoidea belonging to the Hemiptera⁶.

JA wrote *Varnish and Tallow-Trees* (1791), *Culture of Bastard Cedar Trees on the Coast of Coromandel* (1794), *Minerals of Coromandel* (1797), and *A Journal of the Establishment of Nopal and Tuna for the Prevention or Cure of Scurvy* (1808). He was a member of the Royal Society of Edinburgh. *Andersonia* (Meliaceae)⁷ celebrates his contributions to Indian botany, which has been replaced by *Aphanamixis* in recent years. JA arrived in Madras at the age of 30 in 1769. Coming to a tropical region, in high likelihood, excited JA to search for plant materials for better human health. His serious botanical researches started in 1771.

Plant explorations by the European surgeon–naturalists working in the Coromandel in the 18th century led to travel accounts and plant lists; the latter evolved into flora documents. They prepared botanical illustrations, recorded the botany of economically useful plants, and introduced plants into botanical gardens for horticultural and forestry purposes^{8–10}. The last tactic used by European surgeon–naturalists introduced many foreign plants into peninsular India. For example, Clements Markham, a clerk in India Office, Calcutta went to the Cordilleras (Peru) in January 1860 and returned to India in October 1860 with species of *Cinchona* that were established in Naduvattam (The Nilgiris, in 1861)¹¹.

JA's interest in economic biology: evidences from published notes

Unlike his contemporaries, JA's interests were more on plants that had immediate economic relevance to humans. Natural dyes (both of plant and animal origins) of the Coromandel interested him more than any others.

Cochineal insects and establishment of Nopalry in Marmelon

JA sent specimens of scale insects he collected on a grass (*Spinifex littoralis*?) growing on Madras beaches, and the dye they produced, to Joseph Banks for veri-

fication. Juvenile stages of the insects obtained from the grass survived hardly for eight days when raised on locally available *Opuntia* (Cactaceae; prickly pear). However, some of the other 'cochineal' insects survived on *Opuntia* for a greater number of days. Cochineal dye is produced by several species of *Dactylopius* (Hemiptera: Coccoidea), which feed on different species of Cactaceae, although most of them would prefer species of *Opuntia*. Four species of *Dactylopius* occur in Mexico. In his time the cochineal produced in Mexico was from *D. coccus*, which was most valued. Spain controlled the production and sale of the cochineal and levied several tiers of tax on its export; therefore the price of the cochineal was dear. Because inferior quality cochineal could be produced from other species of scale insects, in Mexico cochineal insects were raised in special nurseries known as the 'nopalries' (nursery for the nopal, which refers to the cactus in Spanish in Central and South Americas)¹².

In an unsigned note by Anderson LLD¹³, a reference to JA's pioneering efforts to raise the cochineal in Madras exists: 'In the course of his (*sic.* JA) usual investigations ..., in the year 1787,

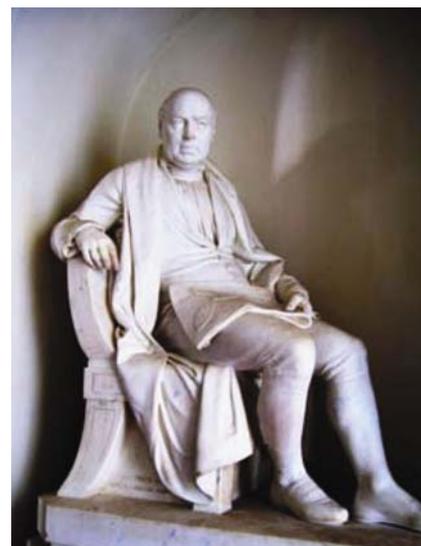


Figure 1. Statue of James Anderson MD in St George's Cathedral, Chennai (Photo courtesy: Simon Charsley, Glasgow, Scotland).

discovered an insect of the coccus tribe, very like the real cochineal insect, in great numbers feeding on a kind of marine grass, frequent in the neighbourhood of Fort St George. It immediately occurred, that if this insect possessed any thing of the qualities of the true cochineal, it might turn out greatly for the benefit of this country (*sic*. Britain) by rearing it there; as he easily foresaw it would be furnished at a much less expence than is paid for cochineal imported from the Spanish Main.⁷

Anderson LLD refers to JA's efforts as outlined in his letters to Joseph Banks (see ref. 5 for details) with the following remark¹³: 'As it is well known that all the animals of this class afford juices that stain woollen goods of a permanent dye, it is probable that, in future times, these inquiries may lay the foundations of several useful discoveries in arts.'

This note outlines introductions of different species of cacti – host plants of cochineal scales. JA searched for *Cactus Cochinitifer* (currently *Nopalea cochenillifera*, Cactaceae) on which the cochineal insects could be reared. His searches for similar cacti in India were unsuccessful. However, by chance, he found a similar one in China, which he imported into Madras for cultivation. Another plant was imported from Manila, a third from the Cape of Good Hope, and a fourth from the King's Garden at Kew (now the Royal Botanic Garden, Kew). The Kew specimen was sent on the behest of Joseph Banks. The following remark, '... all of which arrived safe at Madras, and proved exactly the same plant.' has implications in the context of our contemporary understanding of 'species' and 'biological diversity'.

Some of the cochineal insects collected along with cacti in Brazil by one Captain Nielson were stored at the Cape of Good Hope¹⁴. JA sent some to St Helena and Bombay and delivered others to the Calcutta Botanical Garden (CBG). Anderson MD argued to EEIC, that the soil and climate of the coast of Coromandel sufficiently resembled those of Mexico^{14,15}. The EEIC on the advice of Banks recognized the advantages that Britain would gain by cultivating the cactus and the insect in Indian settlements and ordered the start of a nopalry in Madras. A site was chosen in Marmelon and it started functioning in 1791. Measures to 'fend' the cochineal insect were also implemented to secure that the garden served its prin-

cipal purpose of dye extraction. In preparing for the nopalry, JA directed that a 2 acre (0.4 ha) levelled plot with a southerly aspect be allotted. The plot was embanked and on the top embankment he had the milk hedge (*Euphorbia aphylla*, Euphorbiaceae is mentioned in the literature; possibly *E. tirucalli*, which has a natural distribution from southern Africa to Indonesian islands through India) and *mirgosa* (margosa; *Azadirachta indica*, Meliaceae) placed and along the bottom embankment he had a ditch 2' (0.2 m)-wide to drain water during flooding. Andrew Berry (JA's nephew, surgeon) was appointed the Superintendent of the nopalry. *Nopal de Castile* (*sensu* Thiery de Memonville) JA grew had such fine spines that they can be seen only with a magnifying glass. He had the nopals planted 6' (c. 2 m) apart¹⁶.

Andrew Berry¹⁷ reported trials made on the dyeing of cloth with the dye extracted. Berry says: 'As the insects became shrivelled and hard, I rubbed them gently between my hands so as to detach the coverings, and having them winnowed as the natives do their rice to separate the husk, all impurities were got rid of.'

More recent reinvestigations⁶ reveal that *Dactylopius coccus*, the true cochineal insect, was never introduced into Madras during JA's time and the species he received was probably *D. ceylonicus*, which is common in the Indian subcontinent. Unlike *D. coccus*, *D. ceylonicus* produces a dense covering of white mealy wax and it was probably this that Berry was rubbing in his hands.

However, by 1796, JA's attention got diverted to setting up the Anderson Gardens (about 40 ha) in Nungambakkam. With receding attention from JA, by 1793, the government decided to devote a part of the nopalry to Government Botanical Gardens (GBG; also known as the Lushington Garden), where experiments were initiated to grow rubber tree under the supervision of Berry. Madras was ravaged by a severe cyclone on 9 December 1807 and the nopalry was its casualty¹⁸. By 1809, the nopalry was in a state of ruin. The plants that managed to survive the cyclone were sago palm (*Saguerus rumphii*, Arecaceae) and the nopal (prickly pear)¹⁹. A remark on the discovery of the anti-scorbutic capacity of prickly pear by JA (see note 3) is available¹⁹. Materials in GBG were transferred by Lord Clive (Edward Clive,

1754–1839, son of Robert Clive, Governor of Madras 1798–1803) to the Sultan Gardens (now Lal Bagh), Bangalore, with the nopalry declared a failure. The ex-Lushington Garden land was subdivided and sold for development.

In an extensive letter to Alexander Beatson (Governor of St Helena)²⁰, Berry refers to variations in nopal plants he worked on while at the nopalry, which again reinforce our contemporary understanding of species and biological diversity.

Anderson Gardens in Nungambakkam and sericulture

JA developed his private botanical garden in Nungambakkam in 1778–1792, and it existed until 1828. Tipu Sultan (1750–1799) was introducing sericulture in Mysore at this time. Taking the cue from this economic enterprise, JA imported silkworms into Madras from Bengal in December 1790, and for the next six years he tried to impress EEIC into silk production²¹.

In the Nungambakkam garden, JA established several species of *Morus* (Moraceae, mulberry) among other plants. With his conviction that the climate of Madras was the most conducive for insect management, he was enthusiastic about rearing silkworms. By 1790, he recognized the need for mulberry if the silk industry were to be established. He was not the first to import worms into Madras. Because previous efforts had failed, he persuaded EEIC to get its officers, stationed widely in Madras, to start planting mulberry in preparation for the arrival of silkworms. Silkworms were available in Bengal, but bringing them to Madras was a problem. The only practical way was to ship silkworm eggs from Calcutta, but even that could be done only under favourable circumstances. JA had made two unsuccessful previous attempts, before he finally succeeded. The first batch of silkworm eggs hatched in Madras in December 1790. He did not initially know of the worms he had imported; at first he was even confused as to the white and yellow cocoons they produced.

By 1791, JA could stimulate widespread action along the Coromandel Coast and inland Madras²². The Anderson MD (1809) publication includes several letters between JA and many other officers

of EEIC across the Presidency on the relevance and cultivation of mulberry. Two months after receiving silkworms, JA was already sending silk reeled from their cocoons to London. He had obtained an experienced reeler from Bengal, Mahomed Arif Mulna, and using an illustration of a Piedmontese reeling machine, he had his own machine constructed²¹.

Importing plants into Madras

In an undated letter²³ to John Holland (Governor of Madras, 1789–1790) JA refers to importing of ‘valuable’ plants (into Madras-?). He starts with a brief description on the usefulness of the native Mahwah tree (*Bassia latifolia*, Sapotaceae, iluppai [Tamil]) and talks about different native species of Meliaceae, Mimosa-s (which presently also include different *Acacia*-s), Ficus-es, and Cassia-s. He refers to *Andropogon nardus* (Poaceae) (= *Cymbopogon nardus*, which yields the citronella oil) used as thatch (karpurapul, Tamil) and to the importation of Pegu Teak (teak – *Tectona grandis* – from Pegu Ranges, Myanmar) for their usefulness in building gun carriages and houses. His following remarks are worthy of quoting:

‘It is a distant prospect to look forward to the growth of trees: but this affords the best reason why no time should be lost in beginning to plant them: Some vines I planted here gave grapes in thirteen months, when they were of such a size, that a native of the territory of Berry assured me, would be deemed the growth of seven years in France; and I am convinced that timber trees come to as much size and perfection here in twenty years, as the timber trees attain in sixty.’

What confused me here was JA’s reference to cultivation of ‘grape’-s (*Vitis vinifera*-?); did he mean their cultivation in higher elevations of the Madras Presidency, e.g. Nallakonda ranges, since he talks of cheap labour of the Telugu country (Talinga) in succeeding paragraphs. In subsequent sections he refers to indigo (*Indigofera tinctoria*, Papilionoideae), a dye-yielding plant common in the Coromandel: ‘... how so little good indigo is made here, where the best indigo plant is a weed’.

In 1805 one Monsieur Fortin brought the root of a male calumba plant from

Mozambique to Madras, where it was raised and cultivated by JA. From this specimen Berry²⁴ published a botanical description. The specimen was transported later to GBG by Berry. Alphonse Pyramus de Candolle named this as *Cocculus palmatus* (Menispermaceae) in 1818; the present valid name is *Jateorhiza calumba*²⁵.

Roots of *Oldenlandia umbellata*

In a communication to Anderson LLD dated 3 August 1788, JA writes his observations on *Oldenlandia umbellata* (Rubiaceae), a native of India (sāya-vér, Tamil; meaning colouring roots)²⁶. He refers to *O. umbellata* as either *che* (read as *ché*) or *choy*. To quote Anderson: ‘It grows every where here a small weed; but its is only by particular culture the roots become possessed of the beautiful and permanent red dye, the seeds of which only are preserved for crop.’

Obviously JA was writing on cultivating *O. umbellata* in the West Indies because he refers to soil conditions in the Coromandel and West Indies. Later in the letter JA refers to achieving the best results with the dye on sun-drying. At the end of the letter he has included c. 500 word paragraph translating methods of cultivation of *O. umbellata* as practised in the Talinga (Telugu) country (broadly referring to the northern Coromandel, including Madras). His communication concludes with a note referring to the list of shipments of seeds of *O. umbellata* he sent to Britain: (1) to the Royal Society for the Promotion of Arts (RSPA), Strand, London, (2) Society of Agriculture, Bath, and (3) Philosophic and Literary Society, Manchester. During these dispatches, he had requested that from the parcel sent to RSPA, seeds should be communicated to Joseph Banks, the King’s Gardener at Kew, and appropriate persons in the West Indies ‘to give this plant a fair trial’. He adds: ‘It must, however, be admitted, that the use of this drug is not now so much wanted here as formerly, seeing an ingenious gentleman, now at Glasgow, has discovered a method of dying cotton of a permanent red, little inferior to that from India.’

Dispatch of seeds and plants from Madras to St Helena

Anderson LLD has published another JA communiqué dated 4 February 1789,

which refers to ‘improving’ the natural resources of St Helena²³. Under the presidency of Governor Robert Brooks, Governor of St Helena, St Helena Planters Society was established in 1788 with the objectives of promoting the improvement of St Helena by importing either seeds or plants, which will help prospering the island by stimulating the industry and awakening the attention of the common people to those important objects. Anderson LLD mentions that the St Helena Planters Society ‘cast’ their eyes on JA. The President of the Society (Brooks) wrote to JA seeking his help in procuring seeds and/or plants that JA judged appropriate for St Helena. In response to this request from Brooks, JA sent plant and seed materials with a detailed letter dated 4 February 1789.

A few key quotations from JA’s letter to Brooks are given below²³:

‘At present, however, I shall confine myself to the three objects that seem of the first importance, viz. the supply of roots, grain and herbage for food, wood for fuel, timber and shelter for yam vine, cotton, and indigo, as some employment for persons that might otherwise remain idle.’

‘The yam I have seen in your island being the *Arum Esculentum* requires a marshy soil; and the lofty situation of the arable land in St Helena will never admit of much land being laid out in this manner; whereas the yam *Dioscoria Alata* of Linnaeus, is more wholesome and pleasant for food, and in light garden mold, the dews from heaven will almost prove sufficient watering for its nourishment.’

‘The *Convolvulus Batatas* may be planted with the plough and affords a good kind of food. In case you establish tanks, I would recommend, as soon as their waters sink three or four feet (1–1.2 m) little holes may be dug near the water’s edge, and filled with garden mould into each of which two or three seeds of the *Nymphaea* (Egyptian bean) should be planted and gently watered till they vegetate; after which they can live at a considerable depth and will cover the water with their leaves and most beautiful flower. The seeds afford a good pulse, and the root a wholesome yam, that are eat by the natives of Southern Asia.’

JA describes useful planting and management techniques supplementing his notes on the materials he sent to St Helena. His list of seeds sent to St Helena Planters Society includes *Nymphaea*, *Phaseolus Bengalensis*, *Cynosurus Corocanus*, *Panicum*, *Milium*, *Zizania* (see note 4), *Tectiono*, *Erithrina Corollodendron*, *Mimosa odoretissima*, *Thespisia Populnea*, *Casalpina Sappan*, *Mimosa Nilotica*, *Mimosa Cinerea*, *Mimosa Madraspratensis*, *Robinia grandiflora*, *Annona Squamosa*, Cachu Nut, *Tamarindus*, *Gossypium*, *Indigofera* and *Moringha*²³. JA indicates that all the seeds were freshly gathered, some of them were mixed with powdered tobacco, and the bags in which they were shipped have been dipped in a solution of corrosive sublimated mercury to prevent insects destroying them.

Conclusion

JA contributed to the botany of the Coromandel substantially. His major contributions were establishing a nopalry and a mulberry garden. He paid considerable attention to other plants of commercial importance, such as sugarcane, coffee plant, American cotton and European apple.

In a letter to Brooks, JA says²³: 'What benefits would result to society, if men of letters would in general turn their attention towards useful pursuits! How much might the lot of mankind be meliorated in a few centuries of such pursuits! Europe, Asia, Africa and America would thus contribute its share to the general improvement. And every country on the globe would be bettered for it. The mention of one plant alone, introduced into Europe from America, the potatoe, is enough to awaken the attention of every person, whose soul can feel the expansive glow of beneficent affections, and make them look up with gratitude to those, who by attentions of this fort, have proved the best friends of mankind.'

The letter talks eloquently of his excitement in securing benefits from natural resources for the people. Nonetheless, as I mentioned in the introduction of this note that an underpinning urge to improve Britain's economy by exporting knowledge and material resources of India to Britain does lace his efforts.

CBG was established by Robert Kyd⁹ in 1787. My searches on JA revealed that

the Nungambakkam Anderson Garden was established in 1778–1792. On a road trip from Tranquebar to Madras and back, the Tranquebar Missionary Johann Peter Rottler collected plants which have been documented by Carl Ludwig Willdenow²⁷. In this document, in the section 'In Madras and its neighbourhood (between 8 October and 28 December 1799)', several plants from *horto Andersoniano* (the Nungambakkam Anderson Garden) are listed that go to show that the Anderson Garden was fully functional in 1799. Does this mean that the Anderson Garden precedes CBG as the earliest formal botanical garden in India?

JA's efforts made in the 18th century need to be viewed in the present-day context of importing plants and animals into 'new' territories. We now know that such introductions into new territories need to be done with caution, because many of them have the potential to turn into invasive organisms over time²⁸.

Notes

1. Another James Anderson (1739–1808)¹, a contemporary of James Anderson of Madras, lived concurrently in UK. He wrote on different themes in agriculture, commerce, manufacturing and fisheries, and lived a major part of his life in Edinburgh, and in London from 1797 to 1808. Both Andersons were born in Hermiston (near Currie, Scotland). They were related, educated together, and maintained correspondence throughout their lives. Notes written by the Anderson of Edinburgh were recognized highly and the University of Aberdeen conferred on him the degree of *Legum Doctore* (LLD, Doctor of Law) in 1780. Between December 1790 and January 1794, he edited the *Bee* or the *Literary Weekly Intelligencer* published from Edinburgh. Because of their contemporary nature and identical names they are referred to by their academic awards as 'James Anderson MD' and 'James Anderson LLD'. James Anderson LLD died in London in October 1808, whereas James Anderson MD died in Madras in 1809.
2. Quotations in this article are verbatim reproductions from originals, annotated with details of pagination, except 'f' replaced by 's': e.g. 'rifk' by 'risk', 'lofing' by 'losing', following contemporary usage. If I have used capital letters at the start of specific epithets of binomials, then they too have been reproduced as was the practice in JA's time.
3. For detailed remarks on the anti-scorbutic capability of *Nopalea cochenillifera* (*Cac-*

tus Cochinitifer) as discovered by JA refer to Andrew Berry's letter to Governor Alexander Beatson, Governor of St Helena, 12 March 1813 (http://www.bweaver.nom.sh/beatson/section_26.htm).

4. Only *Zizania latifolia* occurs in Manipur, India. No species of *Zizania* occurs in the Coromandel. *Hygroryza aristata* in the Coromandel was earlier referred to as either *Z. aristata* or *Z. retzi* (P. Ravichandran, Manonmaniam Sundaranar University, Tirunelveli (pers. Commun.))

1. Grant, J., *Cassell's Old and New Edinburgh*, Cassell, Petter and Galpin, London, 1881–1883, vol. VI, pp. 335–337.
2. Penny, F. E., *Fort St George, Madras: A Short History of Our Possession in India*, Swan Sonnenschein & Co., London, 1900, p. 252.
3. Eiland Jr, M. L. and Eiland III, M. L., *Oriental Carpets*, Little, Brown & Company, Boston, 1998, p. 374.
4. Lloyd, A. G., *Food Chem.*, 1980, **5**, 91–107.
5. Anderson, J. M. D., *Five Letters to Sir Joseph Banks Baronet President of the Royal Society, on the Subject of Cochineal Insects, Discovered at Madras*, Honorable Company's Press, Madras, 1787, p. 13.
6. Williams, D. J., *J. Natl. Hist.*, 2002, **36**, 237–246.
7. Roxburgh, W., *Hortus Bengalensis (A Catalogue of the Plants Growing in the Honourable East India Company's Botanic Garden at Calcutta)*, The Mission Press, Serampore, 1814, p. 62.
8. Matthew, K. M., *Indian J. Hist. Sci.*, 1982, **17**, 353–364.
9. Thomas, A. P., *J. R. Asiatic Soc. G.B., and Ireland* (Third Ser.), 2006, **16**, 165–177.
10. Raman, A. and Prasad, S., *Int. J. Ecol. Environ. Sci.*, 2010, **36**, 205–214.
11. William, D., *Geogr. J.*, 1962, **128**, 431–442.
12. Chávez-Moreno, C. K., Tecante, A. and Casas, A., *Biodivers. Conserv.*, 2009, **18**, 3337–3355.
13. Anderson LLD, J., *Bee*, 1790–1791, **1**, 153–158.
14. Anderson, J. M. D., *Letters on Cochineal. Continued*, Charles Ford, Madras, 1789, p. 36.
15. Anderson, J. M. D., *An Account of the Importation of American Cochineal Insects into Hindostan*, William Urquart, Madras, 1795, p. 9.
16. Mease, J., *Archives of Useful Knowledge: A Work Devoted to Commerce, Manufactures, Rural and Domestic Economy, Agriculture, and the Useful Arts*. David Hogan, Philadelphia, 1811, vol. 1, pp. 262–263.

HISTORICAL NOTES

17. Berry, A., *Mon. Mag. Br. Register.*, 1796, **2**, 692–694.
18. Hamilton, W., *The East-India Gazetteer*, Parbury, Allen & Co, London, 1828, vol. II, 2nd edn, pp. 143–152.
19. Graham, M., *Journal of a Residence in India*, Archibald Constable & Co., Edinburgh and Longman, Hurst, Rees, Orme, & Brown, London, 1813, 2nd edn, pp. 125–131.
20. Berry, A., In *Tracts Relative to the Island of St Helena; Written During a Residence of Five Years by Major-General Alexander Beatson* (dated 1816), G & W Nicol and J Booth, London, 1813, Section XXVI.
21. Charsley, S., Silk in S. India: James Anderson of Madras; <http://simon-charsley.blogspot.com/2010> (accessed on 30 November 2010).
22. Anderson, J. M. D., *Miscellaneous Communications*, W S Cooper, Madras, 1809, p. 82.
23. Anderson LLD, J., *Bee*, 1790–1791, **1**, 194–198.
24. Berry, A., *Asiatic Res.*, 1811, **X**, 385.
25. Lloyd, J. U., *West. Druggist*, 1898, **20**, 8–11.
26. Anderson MD, J., An account of the culture of the plant, called by Linnaeus *Oldenlandia Umbellata*, and by the Indians on the Coromandel Coast, *Che*; – the roots of which affords the fine permanent red dye to cotton. *Bee*, 1790–1791, **1**, 238–240.
27. Willdenow, C. L., *Gesell. Naturforsch. Freund. Berlin (N.S.)*, 1803, **4**, 180–224.
28. Rabindra, J. and Bhummanavar, B. S., In *Biological Control of Tropical Weeds Using Arthropods* (eds Muniappan, R., Reddy, G. V. P. and Raman, A.), Cambridge University Press, Cambridge, pp. 438–452.

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