Appendix : Details

Quotation from C. K. Raju, "Approximation and proof in the Yuktibhasa derivation of Madhava's sine series" paper presented at the National Conference on Applied Sciences in Sanskrit Literature: Various Aspects of Utility, Univ. of Agra, 20-22 Feb 1999. See p. 12-13 of the attached soft copy (from the version of 21 March 1999, the one sent for publication) for the detailed context. Comments in square brackets have been added here.

"It is not so well known that the famous Jesuit astronomer and mathematician, Matteo Ricci, was, at exactly this exciting time, very active in Cochin having completed his theological studies in India, and having been ordained in Goa in 1580. He was in touch with Ludovico Maselli, the then Rector of the Collegium Romano.[1] I find it difficult to believe that he whiled away two years in Cochin, without attempting to gather information about astronomy from local sources—especially since he was 'requested to apply himself to the scientific study of this new and imperfectly known country.'[2] The key repository of astronomical knowledge was located not too far away, at a distance of barely 70 km at the Brahmin college in Trichur, from where Heyne and Whish later acknowledged having obtained manuscripts. (16th century CE Jesuits like Fr Fernicio, who sought astronomical knowledge, from India, were aware that the knowledgeable people were located not in Madurai but in Trichur.) Indeed, it was 'the reputation of "mathematician" that Ricci had thus acquired that made him wanted in China.' Matteo Ricci's record of interactions with China in mathematics and astronomy is well known; though this is the first time his interactions with India are being brought out, it is clear from the prizes offered by the Spanish government in 1576 [for navigation] that the same motivation applied, *a fortiori*, for acquisition of astronomical information in 1580.

"Material gathered by the Jesuits could easily have diffused all over Europe. The key centres in Europe at that time were Pisa (the oldest university) and Paris (the most prestigious). At Pisa, Galileo never got around to writing on the calculus, and his student Cavalieri, after waiting patiently for five years, himself started writing on it. Wallis' spent time at Pisa, before his work on infinite series. Newton, as is well known, followed Wallis.[3] Gregory spent time in Padua. At Paris, Mersenne, as is well known, acted as a clearinghouse for mathematical ideas. He corresponded with Galileo, Wallis, Fermat, and Pascal. Therefore, the case for transmission is still wide open...."

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1 *Documenta Indica*, Vol 13, p 146, Letter from Matthaeus Ricci, Cochin, dated 29 Nov 1580. Ricci who, trained for seven years in mathematics and astronomy, reached India on 13 Sep 1578 was ordained in Goa in 1580, and worked with the Cochin mission. Ricci left for Macao reaching there on 7 Aug 1582.

2 H. Bernard, *Matteo Ricci's Scientific Contribution to China*. I am indebted to Dennis Almeida for this and the subsequent quotation. [This footnote was intended to delineate Almeida's *exact* contribution of two quotes of marginal value.]

3 e.g. Carl B. Boyer, *A History of Mathematics*, Wiley, 1968, p 424. C. H. Edwards, *The Historical Development of the Calculus*, Springer, 1979, p 113.

Quotation from G. Joseph, The Crest of the Peacock*, 2000 edition from the Princeton University press, p. 356. This material is NOT found in the earlier edition of this book, and was added only after the above Agra paper on the Yuktibhasa.*

"However, a more important connection was the possible role of the Jesuits and the Portuguese: there is evidence that Matteo Ricci, the Jesuit astronomer and mathematician who is generally credited with bringing European sciences to the Chinese, spent almost two years in Cochin, South India, after being ordained in Goa in 1580. During that time he was in correspondence with the Rector of the Collegio Romano, the primary institution for the education of those who wished to become Jesuits. The Jesuits of that time were not merely priests, but also scholars who were very knowledgeable in science and mathematics. In fact, if you wanted to be trained as a mathematician in Italy at that time, you couldn't do better than go to a Jesuit seminary. For a number of Jesuits who followed Ricci, Cochin was a staging post on the way to China. Cochin was only 70 km from the largest repository of astronomical manuscripts in Trissur (Trichur) from where, two hundred years later, Whish...and Heyne...obtained their manuscripts. ...Material gathered by Jesuits was scattered all over Europe: at Pisa where Galileo Cavalieri and Wallis spent time; at Padua, where James Gregory was engaged in mathematical studies, and at Paris, where Mersenne, through his correspondence with Galileo, Wallis, Fermat, and Pascal, acted as an agent for the transmission of mathematical ideas."

The earlier edition of Joseph's *Crest of the Peacock* **did not contain this** (the following page numbers are from the Penguin edition of 1991):

1. p. 281 suggests that Indian trigonometry originated from Greek trigonometry from Ptolemy and then went from Arabs to Europe to Regiomontanus. This is the stock belief commonly found in all secondary sources. **Nothing new here.**

2. p. 287 states that the quality of Kerala mathematics is fundamentally different from mathematics in the classical period, and that there must be "'missing links' to bridge the gap between the two period". (This is not correct; there is no fundamental difference at all, "Kerala" mathematics is just a direct extension of Aryabhata's techniques. Joseph's wrong statement is just another indication that he is neither a mathematician, nor familiar with the primary sources in Sanskrit, and therefore not qualified to research this area.)

3. Joseph's book goes on to consider and reject the possibility of a "convenient external agency". (There have been suggestions in the literature that the "Kerala calculus" may have originated through contacts with Europeans.)

4. It then states that "Kerala mathematics" is comparable with "later discoveries in European mathematics". He does raise the question "whether the developments in Kerala mathematics had any influence on European mathematics", but immediately retreats from even this vague question to say that this requires careful investigation, and cites Lach 1965 as providing "some evidence of transfer of technology and products". Note the vagueness of the question: **it does not even use the word "calculus", for the developments in India.** This is a critically important point, as is clear from a report of my book (Annexure 11). Further the 1991 edition of Joseph's book makes no mention of Jesuits, as agents, or navigation, as the motivation, both of which are again critically important to understand the process of transmission. Also "any influence" is another vague term, and the reference cited actually pertains to "transfer of

technology and products" which is commonly accepted, and but natural. Many other instances of transfer of technology are long known, but they do not count as evidence for transmission of calculus. For example, in my 1998 paper on the *kamal*, I had mentioned the well known fact that the *kamal*, an Indo-Arabic navigational instrument, was taken back to Portugal by Vasco da Gama, but even that is a far cry from a definite claim of transmission of the calculus by Jesuits.

5. Joseph is well aware that such vague and ambiguous statements can be exploited, since they can be retrospectively disambiguated in a wide variety of ways as convenient to the occasion, and this is a common sharp practice also used by astrologers. Note that Joseph is a trained lawyer.

6. In contrast, my statements (in my 1999 Agra paper) are a very definite assertion that Jesuits (and particularly Matteo Ricci) in Cochin were looking for a solution to the European navigational problem which was provided by the Indian astronomical texts. This definite statement was repeated by Joseph in the 2000 edition of his book.

7. Instead of a straightforward acknowledgment to my Agra paper, the 2000 edition of Joseph's book vaguely says "there is some research on this in India". The real reasons for this vagueness have become quite clear in retrospect: Joseph desired credit for this research himself, and left the door open for a future false claim. He did not acknowledge my work just because he well knew that the statements in the earlier edition of his book were grossly insufficient for him to claim any sort of priority in this regard.