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Peacock in the “Land of the Peacock” ?

Gregory Peacock’s *Arithmetic* in the historiography of mathematics in India

This is a draft.

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Raina and MJ Durand-Richard)**

Agathe Keller

Abstract

This paper concerns the influence of Peacock’s history of arithmetic, a text published in the *Encyclopaedia Metropolitana* in the Indian subcontinent. After questioning the material and intellectual diffusion of the *Encyclopaedia Metropolitana* in India, it explores the early historiography of arithmetic, as written by Indian authors in English. This article’s focus is on the debate that raged at the end of the XIXth century and in the early decades of the XXth century concerning the origin of Indian numerals, concentrating specifically on the origins of the decimal place value notation. It describes the arguments exchanged on this subject by a number of authors including S. Ganguly and G. R. Kaye thus attempting to map out a portion of the historiography of arithmetic in India.

Introduction

This paper is an exploration of the posterity of Peacock's *Arithmetic*. It focusses on one of the places the *Encyclopaedia Metropolitana*, which contained Peacock's *Arithmetic* was shipped to: India. Its aim will be to assess whether Peacock's point of view on the history of numeration echoed into the first articles and books, on the history of mathematics in India, written by Indians, in the last decades of the XIXth century, and the first decades of the XXth century. This paper then will highlight the awakening of a nationalist historiography of mathematics in India.

One of the themes, which provoked fierce debates at the time, was the question of the origins of Indian numerals and of the decimal place value notation. These debates culminated in the publication, in 1935, in Lahore, of Datta and Singh's *History of Hindu Mathematics*¹, which devotes roughly 120 pages to Indian numerals, and another 120 to arithmetic. One of the key polemical texts of the beginning of the XXth century² referred to Peacock in its introduction. Hence the question of Peacock's posterity in the Indian sub-continent will be a thread to guide us in the more general topic of how the history of arithmetic was first narrated by Indians: to what assertions were they replying? what was their historiographical positions?

In this paper, I will first, briefly, allude to the institutions of teaching, learning and research that existed in India at the time the *Metropolitana* was published (1845-49), and maybe shipped to India. Afterwards, I will turn to the history of science in XIXth century India and describe the debates on the history of numbers and arithmetic, before concluding on the influence of Peacock's arithmetic on this debate in the literature in English.

A. Institutions of teaching, learning and research in XIXth century India and the Encyclopaedia *Metropolitana*

The *Encyclopaedia Metropolitana* was first published in 1845 in London, after having been issued in weekly and monthly parts from 1817 onwards³. As for all encyclopaedias, its aimed readership was universal⁴. The *Metropolitana*, however seems to have been specifically devised to cater to the needs of those who were forging the British Empire far from the British Isles:

‘An Encyclopaedia is indispensable to every library (...) As a concentration of human knowledge; (...) while to the Voyager, the Naval and Military Officer, the Colonist, and that numerous class of enterprising Britons whose want of a settled residence may isolate them from the world of letters, it is the only possible substitute for all other books’⁵.

India was under British rule when the *Metropolitana* was published. Our question then will be: Was the Encyclopedia shipped to India? If yes, to what institutions could it have been shipped to? Who would have read it? How did the Indians who read it receive Peacock’s text? For now, I have nothing but sketchy answers.

The India of the mid XIXth had a diverse range of scholarly institutions, which used the English medium, and to which the *Metropolitana* could have been shipped⁶. If some were created by British officials, others were in the hand of missionaries, and others again were in the hand of private Indian patrons. Dissiminated on the huge territory of the Indian sub-continent, amidst local differences, they went through many changes during the XIXth century and the beginning of the XXth century.

Within this diversity, the story of the first British institutions of learning on Indian culture is the one which has been the most extensively studied⁷. At first, in an enlightened colonial

spirit, it was believed that a profound knowledge of Indian culture would enable to « graft » on it the seeds of « civilization », and turn India into a better place⁸. The Asiatic Society of Bengal in 1784 was inaugurated with the aim of developing knowledge on Asian cultures⁹. This inauguration is the starting point for the creation and inauguration of other institutions of learning on India in the Indian sub-continent, favouring the interactions between literate Indians and British residents in India¹⁰. Some such institutions were at first restricted to European Company employees. Thus, the Asiatic Society of Bengal only opened to Indians in 1829. But others, from the beginning, were devoted to forming Indian assistants, for different categories of British officials. The Benares Sanskrit University¹¹ was created in 1791 to form a body of judicial aids to the British administrators, and creating new judicial texts in Indian languages. At first collaborations focussed on texts which were of immediate usefulness for administrators and missionaries. As the field of Indology developed, astronomy and mathematics attracted also some attention maybe for questions of prestige¹². Slowly and progressively the Indian pundits that exchanged with British scholars gained to be named in Orientalist's publications. And as they learned English these educated Indians also would earn the right to publish their own works, some of which will concern the history of science in India¹³. After an initial movement promoting the double acculturation of Indians and British, the atmosphere in England soured. Influenced by J. Mill's utilitarianism and his History of British India but also by an evangelitarian spirit, the Macaulay minute of 1835 symbolises a turning point in the way Great Britain thought of the relations between British and India. In the realm of education, the idea of engrafting was officially abandoned, and a strictly English education was promoted.

The *Metropolitana* was precisely shipped to India in the years following the Macaulay minute. The latter's effect on Universities, Colleges and institutions of learning led to a great disorganisation that until independence, the British authorities despaired to rule. Parallely, it

impelled a steady growth of English medium institutions, especially those patroned by Indians¹⁴. Ideologically, a family of enchanted orientalist will fade away to let the stage in the 1860's and afterwards to a more acrimonious anglicist type of European and American Indologists. This will be particularly the case, as we will see, in the field of History of Mathematics in India. Resistance to this movement, in radical English circles will progressively develop as well among the English educated Indians. In the last quarter of the nineteenth century, precisely among the Indian scholars that interacted with the English, nationalist ideologies developed¹⁵. Thus explaining the will of British authorities to control these institutions.

This is, very allusively, the India to which the *Metropolitana* was sent and the stage on which will emerge the first articles on the history of mathematics in India, written by Indian scholars.

I do not have any figures regarding the diffusion of the *Metropolitana*. Nor in India, or elsewhere. It was however, overwhelmingly a commercial failure¹⁶. To what sort of institutions was it shipped? Did private colleges, missionary funded schools pursue copies of this encyclopedia? Some fieldwork at the Indian Office would probably give us some precise information on the subject. I can only say that the libraries I visited, which were created under the British Rule, and belonged to British institutions¹⁷, all had copies of the *Metropolitana*¹⁸. This doesn't tell us if they were read and if so, who read it, and what part of it was read.

We have thus seen that during the time Peacock wrote his text, had it published and then shipped within the *Metropolitana* to India, the intellectual landscape had underwent many changes in Great Britain and in India¹⁹. The algebraist's influenced had wavered in Cambridge, and the anglicist's had administratively won over orientalist, eventhought such a

battle didn't prevent the existence of niches, were European and Indian scholars could continue to interact and exchange. By the beginning of the 1880's, nationalist ideologies started to develop, especially in circles of impoverished english schooled Indian literati.

The question then will be, who was interested in the history of mathematics in India, in the Indian subcontinent at the time? And who would have been interested in this context, with Peacock's *Arithmetic*?

Let us turn now more specifically the historiographical landscape of science in which the *Metropolitana* came into.

B. The emergence of Indian writings on the History of arithmetics in India

The story of how history of science in the XIXth century was written by Indian scholars is a subject matter that has been given some attention since the 1990's²⁰. To situate the arrival of the first Indian authors concerned with history of mathematics on the scene, I will first draw a general historiographical backdrop for the debates on the origin of Indian numbers and system of numeration, as written by European scholars. This will set the stage on which the first Indian scholars will arrive progressively in the 1860's and more vocally in the early twenties and thirties of the XXth century.

Dhruv Raina and F. Charrette have shown that in Europe at the beginning of the XIXth century a debate opposed (English) philologists and (French) astronomers/mathematicians over who had the authority to write the history of astronomy and mathematics in India. This opposition somewhat continued to be played out until the end of the nineteenth century, sort of as a projection of the more general opposition between « orientalists » and « anglicists ».

However, when looking at the nature of the arguments exchanged, it is quite obvious that by the turn of the century discussions were mainly philological in nature²¹.

B. 1 Terms of the debate

By the time the *Metropolitana* was published, the question of the Indian origin of the « Arabic numerals », from their script to the use of a positional decimal notation had been challenged. Looking at the articles succeeding each other from the late 1830's to 1907 date of George Rusby Kaye's key polemical article on the origin of Indian numbers, it is noteworthy to see a concert of conflicting opinions voiced by authors who do not always seem to know that their publications contradict one another. Whether in Paris, London, Rome or Calcutta people speculate on the Arabic, Greco-roman or Indian origins of the numeral system that we use today. The debate on the question of the origin of numbers was but one in the midst of others, such as the question of the origins of algebra, of Diophantine indeterminate algebra, of the origins of the signs of the zodiac or that of the lunar mansions. Obviously several social groups and separate networks were at play here. The way they interacted, the values they defended, all this still very much needs to be mapped out. How the arithmetical debate was articulated to these other questions, still also needs to be understood.

I have listed so far a total of 32 titles dealing exclusively with the question of the origin of numbers and arithmetics between 1834 and 1907. I have not looked at all of them and do not think this list is exhaustive. Most of the debates have an epigraphical and philological turn to them, that is that they conflicted not on the epistemological nature of the systems described, but on the linguistic and epigraphical evidence that would prove the existence of systems of numeration.

Most of the arguments circulating at the time have aged badly, not only because their knowledge is outdated but also because a series of fakes entered in the discussion.

B.1.1. Virulent debates

The most famous of these virulent arguments on the origin of numbers opposed in the late 1830's Libri and Chasles at the academy of science in France. This debate was provoked by an apocryphical manuscript of a « Geometry » attributed to Boece, that led Chasles to defend a Pythagorean origin for the « Indian » or « Arabic » numerals²². Libri disagreed with him. Once the apocryphical nature of the text was established, the debate lost its interest²³. This story sheds a light on the network of scholars that fuelled the discussion. Indeed, this debate inspired Joseph Toussaint Reinaud, a professor of Arabic at the Langues Orientales and member of the academie des inscriptions et belles lettres, who was a friend of Libri to include in the information he could compile from Arabic sources on India, all that he could find relating to numbers. He thus published in the mid 1840's information on Al-Bīrūnī, a Persian astronomer of the XI th century, whose testimonies on the numeration system used in India at the time were often discussed subsequently to defend the origin of India for the decimal place value notation. Al-Bīrūnī's text is until this day a landmark testimony on the history of mathematics and astronomy in India during the XIth century²⁴.

In a different way, a debate will oppose James Prinsep, once head of the Asiatic Society of Bengal and Edward Thomas on the interpretation of numerical data on early copper plate inscriptions. James Prinsep published an article on this subject in 1834 to which Edward Thomas replied in 1848 and 1856. In 1858, after James Prinsep's death, Edward Thomas will compile a number of his articles, and include in his re-edition of James Prinsep's article on « Sanskrit Numerals » an extensive reply that goes beyond the ones he already published, in which incidentally he also provides quotations of Libri's work²⁵.

The social networks drawn by these examples, between the Académie des Sciences, Académie des Inscriptions et Belles Lettres and the Asiatic Society seem to be quite separate from the circles in which Peacock would have been included, exchanging with Playfair and

De Morgan. The question then would be to assess how separate these worlds were, if they have or could have interacted, which is the scope for further research.

B.1.2.Three debated lines

The debate had three threads.

The first thread questioned whether all the different traces of alphabetical notations for numbers in India should be attributed to Greek or Latin origins or not. Alphabetical notations are those that use a letter (in Sanskrit in fact a syllable) to represent a number. An alphabetical notation will thus concatenate letters as in a word (and sometimes allow puns) to represent a number. In India, sometimes these notations were positional, sometimes they were not. The debates on alphabetical notations in India came from the fact that in relatively rare instances, scholarly astronomers devised alphabetical notations to make numerical data tables easier to memorize. These alphabetical notations didn't have a great posterity, and were seldom used outside of scholarly treatises. The first scholars who encountered them, such as James Prinsep, were tempted to analyze these notations as traces of an early Greek influence, since Greeks used to note numbers with letters²⁶.

The second thread wondered whether the « invention » of zero and of the decimal place value notation came from India, something Peacock took for granted. Numerous ways of noting numbers were found in old inscriptions. A specific way of expressing big numbers on copper plate inscriptions as well as in astronomical texts, was often studied and described: these numbers were noted as we do, with the smallest digit on the right and then from right to left advancing in power (\leftarrow). A list of digits nominally came with these notations in order to prevent mistakes in their transmission; it usually listed them in reverse order, from left to right (\rightarrow). For instance the digits forming one thousand ninety-eight will be given as: 'nine, zero, eight, one' and noted: 1809. This way of stating larger numbers, even when no noted numbers

comes behind it, is a proof of the use of the decimal place value. Endless bickering on the dating and reliability of the copies of the copper plates fuelled a large number of exchanges. For instance, until today the dating of the earliest epigraphical testimonies for zero are still unclear. Much of the debate then was concerned with epigraphical evidence rather than with Sanskrit scholarly treatises. Indeed, when medieval Sanskrit scholarly texts will be edited and translated, part of the debate will fade away as they include definitions of the decimal place value notation²⁷.

Finally, the third thread debated the existence of an early abacus in India. Its existence was seen by some as a pre-requisite for the use of a decimal place value notation. For an obscure reason Bayley stated in an article of the Royal Asiatic Society that abacuses were of use in every small bazaar in India²⁸. This fuelled a certain number of speculations by European historians of sciences such as Leon Rodet or Indologists such as Burnell and Warren. This enabled them to further justify that the decimal place value notation came from India, when there is in fact no tradition of use of the abacus in India today, and seemingly not in the past.

There is no trace of Peacock's influence in the discussions here. It is for instance not considered that the abacus was characteristic of lay people's computation. Nor is there any reference to the fact that counting in base 10, is "natural".

We can observe a slow evolution of the level of the debate from a naive search for very old inscriptions using the numeral scripts we know with a decimal place value notation and a zero, to intricate analysis of Brāhmī and Karoṣṭi inscriptions, Gujara copper plates and the way they represent digits. Even though, Peacock reflected on these problems, his thoughts do not seem to have been taken into account by the authors involved in such discussions. We can thus conclude that Peacock's *Arithmetic* does not seem to have been taken account in the main discussion on this problem.

B.1.3. G. R. Kaye's booming opinions

In July 1907 G. R. Kaye, from the « Bureau of Education », Simla (North India)²⁹ published an article in the Journal of the Asiatic Society of Bengal entitled *Notes on Indian Mathematics.- Arithmetical Notation*³⁰. The article starts as follows:

‘ We are told that our modern arithmetical notation is of Indian Origin. Peacock, Chasles, Woepcke, Cantor, Bayley, Bühler, Macdonnell and others state this more or less emphatically, and the encyclopaedias and dictionaries follow suit.’

Note here that mathematicians (Chasles, Peacock) and philologists (Bühler, Macdonnell) of all origins (German, American, French and Scottish) are lumped together, a sign that the distinctions that were at play a hundred years ago did not have meaning anymore. In a typical G. R. Kaye mode, he includes a faux sens: Chasles was in fact against the idea of an Indian origin for numbers. The reference to Peacock probably echoes in his allusion to encyclopaedias.

G. R. Kaye also seems to have been the only one to have read Peacock in the debate as it was fuelled in India. We know very little about him, but that he worked at a “bureau of education” in Simla. Working thus for the British administration on questions related to education, he might have been part of a network, less prestigious than that of the orientalist and mathematicians of the Asiatic Societies, that of educationists. Now, Dhruv Raina and Irfan S. Habib have shown that Peacock's colleague and friend Augustus De Morgan had an echo in India, precisely as an educationist. At least, he was in contact with Ramchandra a mathematician at Delhi University, who had a correspondance with him³¹. Maybe then Peacock works were familiar to the teachers and administrators who reflected on questions of science education. This is the scope for further research.

G. R. Kaye will continuously publish in the early teens of the XXth century, before achieving in 1915 a synthetic publication on “Indian Mathematics”³², and another one on “Hindu Astronomy” in 1924³³. He will then turn to the study of a birch wood manuscript, the *Bhakshālī Manuscript* that he will edit and publish in 1927³⁴. This is roughly the time when his opinions will prompt a vehement reaction from Saradakanta Ganguly and after that by Bibhutsan Datta and Avadesh Narayan Singh. G. R. Kaye from that time on will be, among others, a delightful reservoir of anti-Indian absurd quotations.

G. R. Kaye’s aim indeed, was to show that the numerals and the decimal place value position did not come from India. He will do so, by trying to invalidate the arguments put forth in all three threads.

The first thread, the question of the alphabetical notations, he will tackle first in the above mentioned 1907 article on Indian numerical notations. This will be followed by arguments developed in his 1908 article on Āryabhaṭa’s mathematics. He will come back to this point, back-referring to this article in his 1915 article called ‘Indian Mathematics’. His main argument rests on a misinterpretation of Āryabhaṭa’s alphabetical notation. Kern had edited Āryabhaṭa’s *Āryabhaṭīya* in 1874³⁵. The first English translation was due to P. C. Sengupta in 1927³⁶. This text contains two rules to note numbers, one “alphabetical” stated in its first chapter, the *gītikāpāda*, a second, which defines the decimal place value notation in its second chapter, the *ganitapāda*. Curiously, Kaye will only concentrate on the “alphabetical notation”, first omitting the second one, and then referring to it vaguely as if it was not essential to his demonstration and didn’t invalidate it.

Āryabhaṭa’s alphabetical notation has been extensively described, discussed and interpreted, with or more less clarity in all the secondary literature on the subject³⁷. It uses base ten, and is semi-positional in its theoretical use. Indeed, only even power tens are

denoted by vowels; thus to single out uneven power of tens from even ones, the first is noted at the left of the second. Uneven and even power of tens are given in pairs. And powers of tens can also be associated with zero. In practice, Āryabhaṭa doesn't mingle different pairs of powers ten in a haphazard order, but gives them all in decreasing order, as when noted with the decimal place value notation. This is a sign among others³⁸ that the device was closely related to the decimal place value notation.

Kaye however seems to have not understood this. He repeatedly affirms that Āryabhaṭa's notation is not positional. He also discusses other alphabetical notations that are not positional. The confusion is overall heightened by the fact that he looks for epigraphical evidence of these, and because he doesn't find any, concludes that in any case they cannot be of Indian origin.

Concerning the second thread, Kaye's objective is to establish that the Arabic sources that point towards an Indian origin for their numerals and arithmetic have been misinterpreted. He alludes to an Arabic origin of the notations. He doesn't do so openly, but by systematically discussing the evidence against the idea of an Indian origin. He thus denounces spurious copper plates, absurd statements in the commentaries, and makes use of philological arguments of all sorts. For instance, in his 1907 article, Kaye discusses Woepcke's interpretation of the adjective « hindasi » used in Arabic to qualify computations. Does « hindasi » mean « Hindu », or is derived from the word « measure » (*andazah*)? Kaye devotes four pages of discussions quoting numerous Arab philologists to defend the second point. His main argument then is to note the discrepancy in between the way the numbers are enumerated and the way they are noted, thus implicitly considering that the notation was imported from a place where people wrote from right to left. Kaye includes in his discussion a number of texts of the scholarly Sanskrit tradition. He discusses Colebrooke's interpretation of Brahmagupta, Bayley's interpretation of Āryabhaṭa and Hoernle's dating of the *Bhāskari*

Manuscript, denying in all these texts the presence of a decimal place value notation. The 1907 article ends by stating vocally:

« We can go further and state with perfect truth that, in the whole range of Hindu mathematics, there is not the slightest indication of the use of any idea of place-value before the tenth century A. D. »³⁹

We are here in one of these strange but familiar moments that history of science encounters, usually in stories of science: the denial of facts. How can we understand G. R. Kaye's attitude? Is it that he had no first hand knowledge of the texts at the time? His later articles lead us to think that, on the contrary, he had indeed read the texts, at least the known English translations. But he seems to have done so gliding, omitting, systematically looking elsewhere, when evidence appeared that went against his convictions. This is especially clear if we look at the way he treats Āryabhaṭa's definition of the place value system. If the existence of this notation is not recognized in the 1907 article, in the 1908 article that is devoted to this astronomer, Kaye gives a translation of the definition (p. 117). He first concentrates on the names given to the different powers of ten, and then questions the existence of specific symbols to note numbers (p. 118), omitting any reference to positions that are however clearly stated in the translation he gives of the verse. It is true that he doubts that the author of the second chapter is indeed Āryabhaṭa (p. 115-117). By 1915, never stating explicitly that Āryabhaṭa does give a definition of the place value notation, he attempts to show that "the work of Indian mathematicians from Āryabhaṭa to Bhāskara are essentially based on western knowledge"⁴⁰. So evidently the fact that there did exist a definition of the place value in early Sanskrit mathematical texts nagged him, since he used all possible resources to disqualify them, but he never clearly refers to this fact. We are here at the heart of Kaye's mysterious (un)reasoning.

Finally, concerning the third thread, Kaye published a separate article on the subject of the abacus in 1908⁴¹. This article collects testimonies of all sorts of different modes of computations, all grouped under the name ‘abacus’. He shows that there is no testimony of their use in ancient India.

Kaye, thus, doesn’t seem to really need to discuss and refute Peacock. There is just one remark that seems to be addressed to the readers of the *Arithmetic*:

‘The popular idea that the order of our (European) arithmetical notation is the more natural and convenient order is not correct.’⁴² .

This statement, however, will never be discussed in the subsequent debate fuelled by G. R. Kaye’s booming opinions. Indeed, his articles will prompt a new generation of Indian historians of mathematics to appear loudly on the scene.

B.2. Indians from background to foreground

B.2.1. Generalities

As shown by Dhruv Raina⁴³ the two first histories of Science in India, published at the end of the XIXth century and beginning of the XXth century by B. N. Seal and P. C. Ray were deeply connected to the values of the “Bengali Renaissance”⁴⁴. As historians of science, they adopted, with some nuance, the values of positivist history of science to oppose a growing literature that tended to describe India as having no scientific tradition of its own. P. C. Ray was a scientist while B. N. Seal was professor of philosophy at Calcutta College⁴⁵. When we turn to mathematics, in the same way, the first participants in the debates were both Sanskritists and trained mathematicians, seemingly interacting more with indologists than with mathematicians⁴⁶. We will have to wait for the arrival of Datta and Ganguly on the scene

after Kaye's article to see trained Indian mathematicians in the field of the history of numbers and arithmetic, who seem to be more familiar with other mathematicians than with indologists. After them, almost all the Indian historians of mathematics will be trained mathematicians, until maybe the end of the 1980's, when a new political historiography emerges⁴⁷. But this is another story.

So far the use of Indian informants, if any had been only in the background of the writings of those who wrote on the history of mathematics in India⁴⁸. For instance, James Prinsep tells us that he uses a Pandit, called Kamalākānta, but it is often difficult to know how much he participated and influenced his work. Prinsep for instance writes:

« To aid in prosecuting my inquiry, I begged Kamalākānta to point out any allusions to the forms of the ancient numerals he might have met with in grammars or other works, but he could produce but very few instances to the point. »

This is surprising as many Sanskrit texts are replete with very big numbers, and until today there is a vast literature listing the higher numbers quoted in ancient texts, something which even Peacock noted. Prinsep was obsessed with the alphabetical names for big numbers, is it then that he would only accept « alphabetical » names for big numbers as an « instance to the point »?

However in the period which brings us to Kaye's 1907 article which will be the focus of argumentation in the Datta & Singh, a certain number of scholars of clearly Indian origin published in the *Journal of the Asiatic Society of Bengal* on subjects related to the history of Indian mathematics and astronomy. Their works were almost exclusively the edition of Sanskrit texts and translations of these in other Indian languages. They sometimes wrote synthetical essays as well. There are some joint publications such as Bapu Deva Sastri, who

translated in 1861 with Wilkinson two astronomical texts the *Sūrya Siddhānta* and *Siddhānta Śīromāni*, or Sudhakara Dvivedin who published in 1888 with G. Thibaut the *Pañcasiddhāntikā*⁴⁹. More often we find publication in their own names, alone. Thus Bhau Dāji published in 1865 an article on the dates of Āryabhaṭa, Varahamihira, and Bhāskara, that is of Vth to VIIth century astronomers, who are also mathematicians. In 1877 Bhāgvantlal Indraji published a hindi text on the history of numbers in India, in 1893 H.C. Bannerji published a new translation and edition of the *Līlavāṭī*, in 1902 Dvivedin edited the *Brahmsphuṭasiddhānta*, in 1904 Sita Ram published a Hindi version of *Līlavāṭī* and in 1907 a Hindi version of *Bījagaṇita*⁵⁰. These Hindi translations were probably not the first, but they were referenced by scholars of the Asiatic Society, sign that they were considered as worthy academic scholarship. The texts published by these Indian authors were so far very courteous and quite unlike the harsh debates that opposed there European counterparts, at least when they published in English⁵¹. So that slowly Indian scholars were entering the scene of the history of mathematics and astronomy in India, but without seemingly engaging in direct front headed debates with their European colleagues.

With the publication of Kaye's edition of the *Bhākshālī Manuscript* things will change and a new set of mathematicians will challenge his claims, vehemently.

B.2.2.Ganguly and Datta

Saradakanta Ganguly was a mathematics teacher at the Ravenshaw College in Cuttack. He published in 1932 an article in the *American Mathematical Monthly* entitled « the Indian origin of the modern place value arithmetical notation ». In this article he directly explains that he aims to counter Kaye's point of view⁵². The article indeed starts as follows :

“In the *Bhākshālī Manuscript* (1927) edited by G. R. Kaye we read that “there is no sound evidence of the employment in India of a place-value system earlier than about the ninth century A. D.” (p. 82) This view has been so insistently given prominence in

his articles published in various journals of India and Europe ever since July, 1907, that European and American scholars (...) have had no other alternative than to accept the view. (...). In this paper it is proposed to show that the above view of Kaye, accepted by Cajori and others, is not warranted by facts.” (p. 251)

Ganguly’s arguments are almost solely based on Sanskrit scholarly texts, some of which are the astronomical and mathematical texts that had been edited and published in the 50 years preceding him. Thus he inaugurates a movement that will slowly push the epigraphical data in the background. The focus of history of mathematics will then be scholarly mathematics rather than the administrative uses of mathematics that inscriptions testify of.

When this article comes out he has already published several other articles, building his arguments in the *American Mathematical Monthly* and in *Isis*, that is from the United States. We see here a new network at play, including American historians of mathematics and indologists. It is thus from outside the European realm that Ganguly choose to challenge the anglicist Kaye⁵³.

Accumulating evidence of the way numbers are named as many testimonies of the use of the decimal place value notation before the IXth century AD, he also explains extensively Brahmagupta’s rules for computations on zero, which provide him with a proof of the existence of zero in India prior to the Al-Bīrūnī’s visit to India. He quotes examples from the *Āryabhaṭīya*, the *Pāṭiganīta* and the *Brahmasphuṭasiddhānta* but also from non astronomical and non mathematical texts such as Patañjali’s *Yogasūtra* or Śankara’s commentary on the *Brahmasūtra*. He furthermore uses « mathematician’s » arguments. He thus reasons that the system which quotes numbers from the smallest decimal value to the highest enables one to represent progressively the value of the number in its totality. It does not need to be linked to a system of writing. He also remarks that the non-existence of an abacus does not prove that the decimal place value notation is not of Indian origin.

This article is published 3 years before Datta and Singh's History of Hindu Mathematics, which is a definitive reply to Kaye's arguments. Time and space prevent us here to develop the long and thorough argumentations that both scholars go through. We can note however that Ganguly and Datta form evidently a new network, if not community, which includes contacts with American scholars. They thus often cross-refer to one another's work. B. Datta had published numerous articles on the subject of Indian mathematics before the joint book came out as the crown of his career as a historian of mathematics. He had published in a great diversity of journals from the *Bulletin of the Calcutta Mathematical Society* to the *Journal of the Asiatic Society of Bengal*. And also an article in *Isis*. If we look at the structure of the part of the Datta and Singh devoted to the numerical system in India we can see it as a long and systematic effort to synthesize all the debates and answer to every objection.

Until this day Datta & Singh's book is a reference manual because of its exhaustivity and exactitude in the treatments of the mathematical questions. It also inaugurates a new moment in the history of mathematics in India, setting new standards of specialisation and a new range of questions and debates. It gave rise to a tradition of technical history of mathematics which argues priorities in a nationalist mode, that is still quite alive today.

Conclusion

For Peacock, a civilised country's politics and economy would reinforce the natural organisation of thought. Thus, mathematics, its teaching and history, could be understood in relation to an economical and political organisation of society. Reforms of the first could promote changes in the second and reciprocally. In the emergence of new Indian historiographies of arithmetics that we have chronicled here, politics is also on the table. However, it is not concerned with changing the world. For Ganguly, Datta and Singh the

politics of history of science has to do with narration: what is important is to rid the field of prejudices, to rigorously, rationally, distinguish right from wrong, the aim being the recognition of the intellectual feat of past Indian mathematical thinkers. So that if political concerns unite Peacock with these Indian historiographers, their aims and ideas do not coincide.

Who then had read and taken into account Peacock's *Arithmetic* in India? Indian indologists and scientists who had relations with English scholars would have had access to the text. But then they would have had access to more specialized writings as well, and may not have turned to an Encyclopaedia to reflect on the History of Mathematics. The hostile anglicist atmosphere could partially explain the fact that the Peacock enchanted with Indian arithmetic will not be really heard of in the scholarly Asiatic societies of the 1860's. However, we have seen that the *Metropolitana* could have arrived to a very diverse area of possible readers, in other English Medium circles. The influence of De Morgan as an educationist amongst the Indian mathematicians at Delhi University, the reference to Peacock by G. R. Kaye who seemingly worked in an educative administration in Shimla, seem to point to other circles where Peacock's article could have been noticed. Further research then could turn to educationist's networks. Other threads to explore Peacock's influence include the authors of histories of mathematics in Indian languages, and more generally the teachers of Colleges and Universities of small Presidency towns. Attention to how historians articulated arithmetic with the later development or not of a symbolical algebra, which was also the object of a still unresolved debate, can also maybe show some trace of Peacock's influence on the debate.

All in all, a greater attention to the different intersection or ignoring each other networks of historians of science, orientalist and scientists whether in Europe, the United States or India, still needs to be mapped out.

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¹ B. Datta and A. N. Singh, *History of Hindu Mathematics*, Lahore, 1935.

² Kaye, G. R. "Notes on Indian Mathematics- Arithmetical Notations." *Journal of the Asiatic Society of Bengal, New Series* **III**(7): 475-508, 1907.

³ S.T. Coleridge, "'Prospectus' to the *Encyclopaedia Metropolitana*" in *The Collected Works of S. T. Coleridge 11; Shorter Works and Fragments*, London & Princeton, 1995, 576.

⁴ Coleridge, op. cit., 586, characterizes his readers as "Friends and Patrons of Art, Science, History and General Literature". He also evokes parts of the *Encyclopaedia* "interesting to every member of the purchaser's family". See also, Yeo, Richard, *Encyclopaedic Visions, Scientific Dictionaries and Enlightenment Culture*, Cambridge, 2001, 57.

⁵ Coleridge, op.-cit., 579.

⁶ A. Basu. *The Growth of Education and Political Development in India, 1898-1920*. Delhi, Oxford University Press, 1974, p.3-4.

⁷ This subject has been abundantly studied, the following paragraph uses: Basu, op. cit., (7), B. S. Cohn, 'The recruitment and Training of British Civil Servants in India, 1600-1800' in *An Anthropologist among the Historians and Other Essays*, 1987 500-553 (1st published in 1966). D. Kopf, *British Orientalism and the Bengali Renaissance, The Dynamics of Indian Modernization, 1773 - 1835*, (Berkeley) 1969. O. P Kejariwal, *The Asiatic Society of Bengal and the discovery of India's Past*. Oxford & New Delhi, 1988. And some observations from F. Charette's unpublished masters paper, *Orientalisme et histoire des sciences:*

l'historiographie européenne des sciences islamiques et hindoues, 1784-1900, Université Montréal, 1995.

⁸ It was also hoped that the employees of the EIC would slowly indianize, enabling the encounter of two civilizations. See Kopf, op. cit.

⁹ Kejariwal, op.cit., chap 2, 29-75.

The Asiatic Society of Bengal at its beginnings included sciences, medicine and technology in its areas of study. The encyclopaedic spirit in which it was opened can be seen in this quote of William Jones that served as a frontispiece for its Journal, where scientists and philologists are enumerated together:

‘It [the journal] will flourish if naturalists, chemists, antiquaries, philologists, men of science, in different parts of Asia will commit their observations to writing and send them to the Asiatic Society at Calcutta’

We can notice that no reference is made explicitly to mathematicians or astronomers, whereas naturalists and chemists are specified. This might be linked to the emerging disciplinary boundaries that Dhruv Raina referred to in his paper.

¹⁰ See C. A. Bayly, *Empire and information : intelligence gathering and social communication in India, 1780-1870*, Cambridge, New York, 1996. K. Raj, "Colonial Encounters and the Forging of New Knowledge and National Identities: Great Britain and India, 1760-1850." *Osiris* (2nd series) (2000) 15 (Nature and Empire: Science and the Colonial Enterprise): 119-134. K. Raj, *Relocating Modern Science: Circulation and the Construction of Scientific Knowledge in South Asia and Europe, 17th and 19th Centuries*, Delhi, 2006.

¹¹ At the time labeled Hindu College.

¹² Bayly, op. cit. (12) 263.

¹³ Charrette, op.cit. (7) 54-55.

¹⁴ Basu, op. cit. (7), Chapters 1, 2 and 4.

¹⁵ There is once again a substantial literature on this subject. See Bayly and Kopf, op. cit. and also the classic Sumit Sarkar, *A critique of Colonial India*. Calcutta, 1985.

¹⁶ Yeo, op. cit., notes the fact that it was a commercial failure.

¹⁷ The Asiatic Society Mumbai (formerly Asiatic Society of Bombay), the University of Mumbai Library, the University of Madras Library, the Asiatic Society of Bengal, the Benares Sanskrit University Library.

¹⁸ I omitted to check however what was their date of publication, and when these copies had arrived.

¹⁹ Yeo, op.cit. 282 notes its ideological anachronisms in respect to ordered encyclopaedism, by the time it came out.

²⁰ Charette, op.cit. (7).

Raina, D. *Images and contexts: the historiography of science and modernity in India*. Delhi, 2003.

Raina, D. and H. S. Irfan, *Domesticating modern science, A social history of science and culture in colonial India*. Delhi, 2004.

One can also note R.C. Gupta, 'India', in *Writing the History of Mathematics, Its Historical Development*, J. W. Dauben and C. J. Scriba (eds.), Basel, Boston, Berlin, 2002, 307-315.

²¹ We can thus observe, that the original link of linguistics and history of mathematics, described in Dhruv Raina's article is still at play.

²² C. Chasles, 'Sur le passage du premier livre de la géométrie de Boèce relatif à un nouveau système de numération', Bruxelles, 1836.

²³ See Charette, op. cit. (7), J. Pfeiffer, France, in *Writing the History of Mathematics, Its Historical Development*, J. W. Dauben and C. J. Scriba (eds.), Basel, Boston, Berlin, 2002, 20-22. K. Chemla, "Chasles", in *Dauben and Scriba (eds.) op. cit.*, 396-398.

²⁴ Charette, op. cit. (7).

²⁵ Prinsep, J. "On the ancient sanskrit numerals." *Journal of the Asiatic Society of Bengal*. 1834
Prinsep, J., E. Thomas, et al. *Essays on Indian antiquities, historic, numismatic, and palaeographic, of the late James Prinsep, to which are added his useful tables, illustrative of Indian history, chronology, modern coinages, weights, measures, etc.* London, 1858.

²⁶ See Prinsep 1834, op.cit.

²⁷ The first scholarly text to define the decimal place value notation is the *Āryabhaṭṭya*, composed at the end of the Vth century. Following scholarly texts that have been handed down to us will contain such definitions or include algorithms which imply this. We can note thus the *Bhāskara II Manuscript*, Brahmagupta's work or Bhāskara II's, as they will be often quoted by European and Indian scholars alike.

²⁸ C. Bayley, , *Journal of the Royal Asiatic Society*, xiv.

²⁹ I do not know exactly what this institution was, nor have any information on his biography.

³⁰ Kaye 1907, op. cit.

³¹ Raina and Habib, op. cit. (20),***. Especially the reprint of D. Raina and I. S. Habib, 'Ramachandra's Treatise "The Haze of the Golden Sunset": An Aborted Pedagogy', *Social Studies of Science* (Aug. 1990), Vol. 2, No. 3, pp.464-467.

³² G. R. Kaye, "Notes on Indian Mathematics. no. 2. Āryabhaṭa." *Journal of the Asiatic Society of Bengal* **IV**(8): 111-141: 1908.

G. R. Kaye, "The Use of the Abacus in Ancient India." *Journal of the Asiatic Society of Bengal, New Series*. **IV**(6): 293-297. 1908.

G. R. Kaye, "A brief bibliography of Hindu Mathematics." *Journal of the Asiatic Society of Bengal, New Series* **VII**(10): 1911.

G. R. Kaye, *Indian Mathematics*, Calcutta & Simla, 1915.

³³ G. R. Kaye, *Hindu astronomy*. Calcutta, Gov. of India Central Pub. Branch. Archaeological Survey of India: Memoirs; v.18: 1924.

³⁴ G. R. Kaye, "The Bhakhshali Manuscript.", 1927.

³⁵ Kern, H. *The Āryabhaṭīya, with the commentary Bhaṭadīpika of Parameśvara*, Leiden, 1874.

³⁶ Sengupta, P. C."The *Aryabhatiyam*, translation." *Journal of the Departments of Letters of the University of Calcutta*. **XVI**.1927

³⁷ See Datta & Singh, op.cit. (1), 64-69 and K. S. Shukla, and K. V. Sharma, *Āryabhaṭīya of Āryabhaṭa, critically edited with translation* New-Delhi, 1976, 3-5, for a synthetic presentation.

³⁸ We can thus also note that the distinction between *varga* and *avarga* places, is also used by Āryabhaṭa in algorithms using the positional properties of the place value notation (such as the extraction of the square root). Furthermore, Āryabhaṭa's commentators link this notation with the decimal place value notation.

³⁹ Kaye 1907, op. cit. p. 493.

⁴⁰ Kaye 1915, op. cit. p. 44.

⁴¹ Kaye, G. R."The Use of the Abacus in Ancient India." *Journal of the Asiatic Society of Bengal, New Series*. **IV**(6): 293-297. 1908.

⁴² He refers then to Perry's *Practical Mathematics*, to make his point, a text I do not know of. And he doesn't quote back to Peacock.

⁴³ Raina, op. cit. (20)

⁴⁴ This term refers to a movement of ideas that took place in Calcutta, and which saw impoverished Indian intellectuals develop nationalist ideas.

⁴⁵ It is noteworthy that as for William Jones a century earlier, B.N Seal in his « Positive Science of the Hindus » doesn't seem to include mathematics or astronomy within the achievements he lists.

⁴⁶ The truth is that we need to know more about their lives and the networks they were involved in.

⁴⁷ For a description of a network of indologists and scientists in and outside of India interacting with one another (P. C. Ray and Marcellin Berthelot) see Raina, op. cit (20), ***. For the mathematical bent of subsequent history of mathematics see Raina, op. cit. (20),***.

⁴⁸ For a detailed account of the use of pandit scholarship in burgeoning indology, see the case study of Madhav Deshpande on Marathi pandits: M. M. Deshpande, "Pandit and Professor: Transformations in the 19th century Maharashtra", in *The Pandit, traditional scholarship in India*, Axel Michaels (ed.), Delhi, 2001.

⁴⁹ G. F., Thibaut and S. Dvivedi, *Pañcasiddhāntika*. 1888. Reprint Varanasi, 1968.

⁵⁰ S, Dvivedi, "The Brāhmasphuṭasiddhānta of Brahmagupta." *The Pandit*, 1902.

One can also note/

S, Dvivedi, *History of Mathematics (in Hindi)*. Benares. 1910

S, Dvivedi . "The Mahāsiddhānta of Āryabhaṭa." *Benares Sanskrit Studies*, 148-150, 1910.

⁵¹ For harsh debates in Sanskrit, on questions of cosmology see Minkowski, C, "The Pandit as public intellectual: the controversy over virodha or inconsistency in the astronomical sciences.", in *The Pandit. Traditional scholarship in India. Edited by Michaels, Axel*,79-96, Delhi. 2001.

⁵² S. Gānguli, "On the modern place-value notation in the Aryabhatiyam." *American Mathematical Monthly* **XXVII**. 1927.

S. Gānguli "The Indian Origin of the modern Place-value arithmetical notation." *American Mathematical Monthly* **XXXIX**: 251-256/389-393. 1932.

⁵³ Kaye had also interacted with American Scholars, since his 'Indian Mathematics' was initially to be published in Isis. The publication was temporarily stopped by the war, he thus decided to publish it in India, before having it re-published in Isis in 1919. The whole American network with historians of mathematics and indologists needs here to be further studied.