

## THE MAKING OF A CLASSIC: THE CONTEMPORARY SIGNIFICANCE OF P.C. RAY'S HISTORICAL APPROACH

Dhruv Raina\*

(Received 10 June 2014)

### Abstract

Amongst the histories of science produced in early twentieth century India, P. C. Ray's *History of Hindu Chemistry*, has acquired the status of a classic. This paper explores, as part of a more detailed study, the nineteenth century histories and historiography of chemistry as presented in the works of Thomson, Hoefler and Kopp, that shaped the writing of Ray's *History*. More specifically, it seeks to identify the historiographic elements and contexts of nineteenth century chemistry that Ray drew upon and subsequently improvised in order to insert the history of Indian alchemy and chemistry within the mainstream narrative of the histories of science of the late nineteenth and early twentieth century.

**Key words:** Alchemy, Chemical revolutions, History of chemistry, Iatrogenic chemistry

### 1. Introduction

Acharya Prafulla Chandra Ray, founder of the Indian school of modern chemistry, published the first volume of a landmark work called *History of Hindu Chemistry* (hereafter *History*) in 1902, that went on to become a classic in the field. The book has been the subject of scholarship and discussion among historians as well as historians of science and I myself return to it after a period of sixteen years (Raina, 1997). What is it that compels readers and scholars to revisit an author's historical magnum opus? How are the compulsions of the reader related to the process of the canonization or the making of a classic? This essay does not attempt to answer these questions.

However, the Italian writer Italo Calvino in his book on *The Uses of Literature* points out to some of the features of a work considered a classic: 'The classics are the books of which we usually hear people say, "I am rereading ...", and

never "I am reading"' (Calvino, 1986). This does not answer the question as much as postpones the response. For in order to become a classic a work must simultaneously be both relevant and outdated; and the context of relevance constantly changes with historical context, and as the philosopher of science Gaston Bachelard so eloquently argued with the evolution not only of theory but with the constellations of knowledge. How else is one to understand in a more recent context the Nobel Laureate and theoretical astrophysicist S. Chandrasekhar's preoccupation with Newton's *Principia* (Chandrasekhar, 2013). In other words returning to Calvino: "The classics are books that exert a particular influence, both when they refuse to be eradicated from the mind where they conceal themselves in the folds of memory, camouflaging themselves in the collective or individual consciousness" (Calvino, 1986).

What does it mean to speak of the simultaneous 'out-datedness' of a classic and its

---

\* Zakir Husain Center for Educational Studies, School of Social Sciences, Jawaharlal Nehru University, New Delhi 110067; Email: d\_raina@yahoo.com

extended relevance? Histories of Ayurveda and Indian alchemy anchored in recently discovered sources, and newer frames of interpretation confer on *History* a certain out-datedness if not irrelevance. Thus in an authoritative work on the Siddha Traditions published at the end of the last century David Gordon White pointed towards a “amplified scholarly error promulgated by Prafulla Chandra Ray...”, and subsequently in the works of renowned Indologists, and that was reiterated throughout the century by scholars. The error arose from a faulty manuscript that Ray consulted and attributed its authorship to Nāgarjuna (White, 1996, p. 160); which went to determine Ray’s conclusion that the early Tantric treatises were of Buddhist origin (White, 1996, p. 104). But the remedying of this scholarly error has not in any way eroded the merit of Ray’s history, based as it was in a close reading of relevant Sanskrit manuscripts and texts. The continued relevance of Ray’s work arises from the issues concerning scholars about the nature of Indian alchemy and its relation to chemistry, the issues concerning the circulation of Tantric knowledge not just about alchemy but medical practices, and in an area so little discussed it offers us one of the early discussions of the Needham question in the South Asian context – even before Needham framed the question in the form known to us today. The latter of course is nested with current debates on counterfactual, under determinationist and over determinationist theories of history and debates on modernity and social theory.

The powerful presence of *History* over a century amidst the relevant classics of the histories of science in South Asia could be comprehended in terms of this hypertextual density linked up with the fact that it does provide practicing Indian chemists with an anchor for their own historical and cultural bearings. In disciplinary academic communities, re-readings are as much prompted by the identification of a scotoma that obscured the earlier readings of historians, the scotoma

being a metaphor for a frame or a discourse beyond which one cannot pass. These earlier readings were understandably strongly entrenched in issues of cognitive justice (Visvanathan, 1999), the attempts to engage with questions of the decline of the sciences in India, or of the non-emergence of modern science (Raina, 2003).

More than a decade after the publication of *History* Ray as a practicing modern chemist reviewing the progress of chemistry in Bengal reflected upon his historical magnum opus where he had devoted a chapter to discussing the decline of the scientific spirit in India. He writes:

“...I lamented that the spirit of inquiry had died out amongst a nation naturally prone to speculation and metaphysical subtleties. Little did I dream then that in the course of a decade or so I should have to revise the estimate I then formed of the capacities of my own countrymen and chronicle that a bright chapter is about to dawn in our life history” (Ray, 1918, p.45).

For him too, the historical project and the spread of modern chemistry in India contributed to dispelling his image of the nation as predisposed to speculation and metaphysical reflection. The historical project provided a diagnosis of the past and offered cautionary lessons for the contemporary practice and development of modern chemistry. One has to go back to the beginnings of this article on chemistry in modern Bengal to pin down the intent of Ray’s historical digression.

Squarely locating the identity of modern chemistry or what he calls “Scientific Chemistry” in the work of Lavoisier, he feels that his argument can only be understood in the light of the education of Bengali youth in the first half of the nineteenth century:

“...for the first 60 years or more the intellectual pabulum of the Bengali youths was furnished by Shakespeare and Milton, Bacon and Locke and Hume and

Gibbon. It is barely two decades since Bengal has seriously taken to original investigations in the fruitful field of chemistry” (Ibid., p.40)

Clearly, the moment of transition relates to the introduction of science courses in the university towards the end of the 19<sup>th</sup> century – courses that had been neglected to the exclusion of instruction in the humanities.

Returning to the landmark history of chemistry authored by P.C. Ray, there are some new questions that I would like to examine. The work entitled *History of Hindu Chemistry* has often been construed as, whether consciously or not, inaugurating a discourse on Hindu Science and inadvertently creating an intellectual space for Hindu nationalism. This possibly arises from too quick and non-contextualized readings of passages such as the following:

“In that morning of ancient history, the world looked forward to India for light and guidance, for knowledge of the accurate sciences such as algebra and chemistry as shown in my *History of Hindu Chemistry*, for personal and social purity, for sacrifice and abstinence, for plain living and high thinking. Now, thanks to the cumulative effect of centuries of social inequalities and oppression, of the degradation of the condition of women and of large sections of the people, and the walls of differences raised between man and man by custom and tradition, India now lies at the feet of nations powerless and helpless. The blood that flows from her heart and goes to her brain does no longer reach the lower limbs of the body-politic. As the consequence of this abnormal condition, India finds these parts of her organism practically paralysed and atrophied. So long as the blood does not begin to reflow and vitalise the limbs which now remain palsied, there is no chance for India to get back a place in the sun”. (Ray, 1918, p.234)

More than revivalism the passage seeks to pin point social inequality as the cause for the

decline of the sciences in India that in turn disrupted any participation in the exciting journey of scientific discovery. The appeal to the past was not so much about revival as to legitimate the contemporary pursuit of science. Speaking of the progress of chemistry in early twentieth century Bengal he would again remind his readers:

“In my *History of Hindu Chemistry* I have devoted a chapter to the discussion of some of the causes which brought about the decline of scientific spirit in India, and how, during the period of intellectual stagnation which set in, our unhappy land was rendered morally unfit for the birth of a Boyle, a Descartes or a Newton. We hope we have slept off the torpor of ages and that it will be ours once more to extend the bounds of knowledge”. (Ray, 1918, p.24)

The lament about India’s recent history is certainly about decline and social inequality but this as much prefigures a variant of the Needham question itself grounded in a comparative history of science – but more of the Acharya’s method later. Is one not over-interpreting Ray here and stretching the reading too far? Again while reviewing the progress of modern chemistry over a period of forty years in Bengal he would begin by pointing out where his own disquiet began:

“Thirty years ago, while a student at Edinburgh, I began to notice that original contributions by Japanese students of Science had become a prominent feature in the Journals of the London and Berlin Chemical Societies. Here was an Asiatic people, who could scarcely look back to a glorious past, adding to the world’s stock of knowledge; while India, the land of Buddha, which through the medium of China had contributed in no small degree to the civilization of Japan, was sleeping the sleep of ages. This thought had often filled me alternately with pangs of despair as also with emulation. It is a matter for sincere congratulation that contributions from our advanced post-graduate students now bulk largely in the pages of the Chemical Journals of England, Germany

and America, and are beginning to shed lustre to the chemical laboratory of the Presidency College” (Ray, 1918, p.32)

The other Asian countries are comparatively benchmarked with respect to each other, and with respect to the West. Reading today his essays on the practice of chemistry in early twentieth century India alongside his *History*, the reader cannot escape wondering whether Ray recognized the “institutional background” necessary for the evolution of scientific ideas and programmes. The elements of an argument are certainly there, but given the currency of the discussion in our own times, the shadow of the institutional argument acquires salience. To see the shadow of our contemporary concerns in a work from another century is certainly one of the markers of work considered a classic.

Amongst the many contemporary criticisms of *History* is also the charge that Ray over interprets an alchemical tradition as a “chemical” one. It is not my purpose to refute these charges because they do not stand up to a serious and close reading of the *History*, or its contextualization. In what follows I shall seek to discuss the process of framing the *History*, the sources, context and the historiographical premises. In a paper published more than seventeen years ago, I had argued that in South Asia Ray must be considered the inaugurator of the social history of science – this beginning arose from his reckoning with the limitations of internalism<sup>1</sup>. However, the social history that he did inaugurate was not of the same historiographic nuance as we understand the social history of the 1960s that coruscated in the work of Christopher Hill and others. However, many of the conclusions of that limited social history continue to occupy historians of alchemy and Ayurveda even today and guide their work. But now that social history has been circumscribed in presentist terms, or put differently characterized as belonging to the prehistory in a teleological schema leading up to

contemporary approaches to the social history, we still need to specify its contemporary relevance.

In the discussion that follows it is argued that there are three counts on which the work remains significantly relevant to contemporaneous concerns. The first relates to the method adopted in framing his history of chemistry; the second addresses the appropriate unit of historical analysis; and finally the conceptual focus of the history itself. We could label the first the comparative method and an underlying hypothesis of the relationship between science and society; the second entails stretching of the idea of the late nineteenth century internationalism of science towards a history that transcended the nation – it would be an over-interpretation to call it a transnational history, simply because he was writing in the heyday of a burgeoning Indian nationalism and some of that nationalism rubbed off on him but not in a cultural nationalist way. And the third falls squarely within the contemporary renewal in the history of chemistry dealing with the “sites of chemistry” and as the history of science undergoes a larger transition from the history of science to the history of knowledge.

By the late nineteenth century the comparative method in history had been standardized in order to explain differences in the trajectory of historical development of distinct cultures and civilizations – underlying it was an overdeterminationist theory of history, that evoked “deficits” to explain distinct historical trajectories. Ray worked within that framework and to that extent was subject to its limitations and its critique that developed in the 1980s. But the method he adopted recognized different ways of classifying and organizing nature and he himself sought explanations within the language of chemistry, but let the historians speak about the social context. But it is here that Ray surprises his contemporaneous reader inasmuch as he displays that rare faculty acquired normally by the seasoned reader of historical texts, interpretations and

manuscripts – an exemplary faculty of historical judgment so central to historical work.

And finally, a number of historians of science have been lately, in a fit of epistemological reflexivity, reinventing themselves as historians of knowledge, and not without reason. For one the term science makes sense within an institutional and disciplinary matrix, which in turn precludes other classification of knowledge and other forms of institutional belonging or embeddedness. The term knowledge provides more scope of play and runs against particular formats of exceptionalism. The French sociologist of knowledge Christian Jacob has produced several gigantic volumes on the sites of knowledge and more recently in a similar spirit Perkins has been inspiring historians of chemistry to look at the sites of chemistry, wherein the production, circulation and dissemination of chemical knowledge is not restricted to the laboratory of the university or industrial research institute (Jacob, 2007; Perkins, 2013). A close scrutiny of Ray's *History* would reveal the amount of time and space he had dedicated to detailing alchemical practices in ancient India as well as to the different sites of chemical knowledge from the goldsmith to the dyer and a range of other professions but more importantly the artisan. The sources of this radicalism in Ray's case and the revisionism in the case of Perkins are naturally quite distinct and rooted in very different compulsions. All the same they do share an overlap with the evolution of chemical practices and knowledge.

In terms of Ray's theory of history, one gets the feeling, in the light of his very extensive and detailed reading of the history of sciences and the copious evidence that he sights, that he saw history as providing lessons – the large number of historical episodes that he cites are strung together as if they fell into a general pattern from which one could make two inferences. The first that history was for him perhaps a quasi-nomothetic discipline which implied that it was

possible to draw object lessons for the future. The evidence of historical episodes that repeatedly come up in his discussions and writings are of three kinds – ethical, political and methodological. At the ethical level the history of science offered lessons of two kinds – of the persona of the scientist as a sage that provided future scientists with a role model; and secondly the idea that beyond the individual and the nation the richness of science drew upon an ethic of internationalism. Secondly, in political terms, the history of science, inspired by the ideals of the enlightenment provided the justification of narratives of emancipation and progress – and it is not for me here to discuss whether he was misled or plainly wrong. And finally, the history of science offered methodological lessons for the practice of science itself – in which case, like for Eduard Dijksterhuis the history of science becomes the epistemological laboratory of science. These issues have been discussed in more detail in (Raina, 1997), though not in these very terms.

As will be seen, it is with respect to this task of reconstructing *de nouveau* the history of chemistry of India that Ray is confronted with a double challenge. On the one hand, nineteenth century historians of chemistry, still practicing chemists, needed to engage with the scientisation of their discipline, to identify the moment of rupture, the epistemic dimensions of the break with the past, when chemistry outgrew alchemy – this problematic is that of the scientificity of chemistry as a discipline. The disciplinary identity of chemistry or alchemy has been and continues to be a subject of historical accounts. Secondly, and related to this is the task then of producing a history of chemistry in English, framed within a discourse of the modernity of science. As has been pointed out, the autonomous discipline of chemistry emerges in the eighteenth century and retrospectively it is in the nineteenth century that chemistry is seen as a “mature science” (Bensaude-Vincent, 2008). It is this side of Ray's

work that the reader is invited to revisit – the engagement with the notion of alchemy, and the manner in which he employs the historiographies of English, French and German chemists as resource to frame his own narrative. For we are informed rather soon in *History* that: “... Thomson, Hoefler and Kopp have been my companions for the last twelve years or more” (Ray, 1902). The works of these chemists are not cited for what they say on the history of chemistry on the subcontinent, but provide an European comparative or contextual backdrop for his own framing or intercalation into that “universalizing” project (Chakrabarty, 2000).

Interestingly enough, the history of chemistry as a discipline unfolding as a positive science was invented by chemists such as Thomas Thomson in the early nineteenth century down to the opus of Partington in the twentieth century. The others who had a role to play in the invention of this history were Hermann Kopp, Adolphe Wurtz and Marcelin Berthelot (Bensaude-Vincent, 2008, p.53); and from his own writings Prafulla Chandra Ray was familiar with the chemical researches and historical works of several of these writers and was as he says in his *Autobiography* responding to request of one of them (Ray, 1932).

In any case, since the historical account of a discipline may also be framed along several axes, one of which is contingent upon the disciplinary posture adopted. Bensaude-Vincent has suggested that there are two *longue-durée* postures chemistry has acquired in its relation with proximate disciplines, which she calls *the modest attitude* and *the arrogant attitude* (Bensaude-Vincent, 2008, p. 54). According to the modest attitude “... the urgency of chemistry for pharmaceuticals and medical training was the foundation of the establishment of Chemistry Chairs in European universities...” Public experimental demonstrations appealed to medical and pharmaceutical audiences and set the agenda for chemical research. This further entailed the

development of new analytical techniques such as solvent analysis and the creation of concepts such as constituent element. As a result medical and pharmaceutical applications fostered the development of both chemical science and chemical technologies. In other words the modest attitude is premised on the hypothesis that chemistry served the liberal arts such as medicine which was no obstacle to the growth of the discipline (Ibid., p.55).

The arrogant posture portrays chemists playing God, where sometimes the image of Paracelsus is evoked, an image that was reinforced in the nineteenth century with the emergence of synthetic chemistry (Ibid., p. 55). It could be suggested that Ray, given his own work at the conjuncture of synthetic chemistry and pharmacology adopted the modest attitude in framing his history of chemistry even though the work is not entirely free of some of the millenarianism that histories of chemistry sometimes offered, a posture adopted to inspire and win over converts to the discipline.

## **2. The Nineteenth Century Historiography of Chemistry in the *History***

The intent of this excursus into the history of the history of chemistry is to essentially point out that the *History* was written during a half-century when practicing chemists were still writing histories to celebrate the arrival of chemistry as a positive science among other positive sciences. An imperative for these histories was to identify and establish the moment, epoch and the content of the rupture for alchemy – which for many practicing chemists was a memory they would choose to forget. The canonized histories of Thomson, Hoefler and Kopp, that inspired Ray, had detailed and marked the conceptual and practical departures that placed chemistry on its path to achieving scientificity.

I shall argue in the paragraphs that follow that Thomson's *The History of Chemistry* (1830), Ferd Hoefer's, *Histoire de la Chimie depuis les Temps les Plus Reculés* (1842) and Hermann Kopp's *Geschichte der Chemie* (1875) provided Ray with a cognitive frame endowed with important chronological markers, pharmacological and experimental milestones enabling him to sequence and order the historical materials and texts on Hindu chemistry, guided by the concerns of chemists engaging with the historical past of their recently acquired disciplinary identity. These markers, milestones and ruptures enabled what has retrospectively been labeled settling issues of cognitive justice, in addition to which in India Ray was appealing to new audiences and readerships. The first of these concerns has been discussed in an earlier paper and I shall merely reiterate where necessary what has been argued there.

On the contrary, three important issues that appear in the standard nineteenth centuries histories of chemistry, serve as exemplars in the Kuhnian sense of the term, for the Acharya's history. In pointing this out it must not be assumed that the disciplinary identity of chemistry as a positive science had been irreversibly settled but rather that Ray himself has to perform the task of navigating between the task of producing a history of "Hindu chemistry" that finds its place alongside the histories of Western and/or modern chemistry, while reckoning that in the West too the disciplinary history of chemistry had not yet put to rest the ghosts and the gremlins that haunted the past of the discipline.<sup>2</sup> Hoefer, in his magisterial *Histoire de la Chimie* warns his readers that he has no model or encyclopaedic method with which to approach the problem of the history of chemistry and that he could only but return to the sources and cite original texts in the hope of throwing light on the problem (Hoefer, 1842, p. v-vi)

Typical of most histories of chemistry published in the late eighteenth and through the

nineteenth century, the history of chemistry was characterized as having passed through three major epochs. Hoefer would suggest three epochs characterizing the history of sciences that have displayed an oscillatory motion between theoretical and practical orientations. In the first epoch, according to him the intelligence which compares facts is independent and free from the hindrances of superstition and systematic prejudice. Although devoid of scientific proof, the doctrines of primitive intuition often surprise us by their correctness. This epoch, which is obviously inclined towards practice, embraces antiquity, and stretches until the epoch of the unforgettable conflict between rising Christianity and paganism. In the second epoch, the orientation towards observation gets weaker or is lost. Subjected to spiritual authority, thought leaves the field of experience to take refuge in the domain of mystical and supernatural speculation. We encounter in this epoch much that is strange, the doctrines of the adherents of sacred art and of alchemy. This epoch, which is inclined more particularly towards theory, extends from the Middle Ages, until modern times<sup>3</sup> (Hoefer, 1842, p. 1-2). Evident here is a version of the Comtean stages of social development and the stadial thinking that marked much of Enlightenment thought. In the third epoch finally, which is ours, light seems to appear after darkness, as though the law of contrast had to be necessarily fulfilled everywhere. During the last stage chemistry as science emancipates itself from the clutches of alchemy in early modernity, with Paracelsus and his school inaugurating this epoch in the history of the discipline. Ray finds this chronology very useful and adapts it to his narrative, while at other times on some issues subverts it, in framing the evolution of alchemy-chemistry in South Asia. Thus he quotes the work of another important organic chemist, Carl Schorlemmer, *The Rise and Development of Organic Chemistry* (1894):

"Up to the XVIth century almost the sole object of chemical research had been to

find the philosopher's stone. But now chemistry began to develop itself two new and different paths, opened by two distinguished men – Agricola, the father of metallurgy, and Paracelsus, the founder of iatro-chemistry or medical chemistry<sup>4</sup>. Both contributed chiefly to the development of inorganic chemistry... In opposition to the school of Galen and Avicenna, Paracelsus and his followers chiefly employed metallic preparations as medicines". (Ray, 1902, p. c-ci)

Clearly, as discussed elsewhere this epistemological milestone in the history of the discipline orders the evolution of chemistry in South Asia (Raina, 1997). However, an observation that requires salience here is that Ray's own account disrupts what I have in another context called the "narrative of progress" that characterizes the enlightenment and post-enlightenment histories of science (Raina, 2011). The just mentioned histories of science had often to encounter these disruptions when encountering histories of knowledge of other cultures and civilizations, and a number of innovative strategies were invented to either accommodate them or resignify them within the chronology of progress. This disruption of the standard chronology is not quite insisted upon by Ray in a nationalist "We-did-it-first" manner. He thus points out that

"In the European histories of chemistry, the credit of being the first to press chemical knowledge into the service of medicine and introduce the use of the internal administration of mercurial preparations, is given to Paracelsus... The Nāgarjunas and Patānjalis of India, however, had the merit of anticipating Paracelsus and his followers by several centuries... We have indeed reasons to suspect that Paracelsus got his ideas from the East, and in Chapter on Arabian indebtedness to India we have pointed out the media through which Indian sciences filtered into Europe" (Ray, 1902, p. cii).

The point here is not to adjudicate Ray's claim, but more importantly to see how the standard chronology operates within his work.

The Paracelsan revolution, if one may call it that, beyond the chronological indexing, is qualified by a second epistemological aspect. This transition and departure is marked by the rise of iatro-chemistry and the possible decentering of the search for the philosopher's stone. For Schorlemmer, as we have seen above, it was the work of Agricola and Paracelsus that announces the emergence of chemistry, but Ray's argument seems to place more significance on the Paracelsan stream. The contributions of Paracelsus as inaugurating a phase of iatro-chemistry as well as the introduction of mercurial and metallic preparations into medical practice are seen to be of central importance, and in some way flags the beginnings of the phase of modern chemistry<sup>5</sup>. Paracelsus' views about ill and healthy human bodies were based on a chemical view of the body and treatment. In other words, it was oriented towards chemistry, applied to pharmacology – a subject not too far from Ray's own area of research concerns. Paracelsus himself explained that chemistry was one of the four pillars of medicine, but had thus far been pursued as alchemy; he also sometimes speaks of the (religious) art of refining metals in a way that could be employed for the same purposes, and emphasized his achievements in this art (Kopp, 1875, p.134). This move from alchemy to a naturalist view of the body and its treatment through the administration of chemical drugs goes some distance in explaining Paracelsus' reception as one of the inaugurators of modern chemistry. This left a deep signature on Ray's own historiography and is reflected in his popular writing on Paracelsus as well, providing him a comparative context and an important opening for his detailed discussion on Rasayana seen as the science of mercury.

And finally, a crucial premise of the modest posture in the historiography of chemistry has been, in the conceptual vocabulary of Hacking, the view of chemistry as a science of intervening more than representing [Bensaude-Vincent, 2008].

In that sense too, the Paracelsian traditions was construed as very close to the crafts, artisanal and practical traditions rather than those of the high university scholars. These traditions as understood by these chemist-historians, were ones where the practitioners soiled their hands with the murky substances they worked with and upon, and thereby elaborated upon centuries of experience and testing<sup>6</sup>. The metatheoretical presupposition of course being that the chemical revolution like the revolution in physics and astronomy was an outcome of the conjunction of the theoretical traditions and the practical arts. This remained a central metatheoretical thesis in Ray's historical writing, and would surface in the social explanations on either the decline of the sciences in India or the phenomenon of the non-emergence of the scientific revolution.

### 3. Framing the History of Alchemy-Chemistry

However, as a historian of science it would be interesting to re-read the *History* and to have examined how Ray frames the field of Indian alchemy and Indian chemistry. The term framing is deliberately and consciously employed to allude to the literary process of telling a story within a story. The historiography of chemistry as evidenced in the works of Thomson, Hoefer and Kopp are reworked by Ray to tell a related but different story. The compositional or structural elements are about the same, but the details are arranged differently. The first chapter of his history is entitled "Alchemical Ideas in the Vedas", where he points out that the "...progress of chemical knowledge in the ancient civilized world was invariably...associated with medicinal preparations, metallurgical operations, the technical arts and the transmutation of metals". The special feature of chemistry in India was that it developed as the "handmaid of medicine, and somewhat later on, as an adjunct of the Tantric cult". (Ray, 1902, p. i). It is important to note the

distinction here from the European context, because Thomson must struggle with a situation where disciplinary differentiation characterizes the practice of the sciences in nineteenth century Europe – so where is iatro-chemistry to be situated? It is "intimately connected with the history of medicine", but "... undoubtedly contributed to the improvement of chemistry". The rationale he finally employs for opting for the history of chemistry is the application to the discovery of "chemical medicines" [Thomson, 1830, p.iv-v]. The second volume of Hoefer's *Histoire de la Chimie* is entitled "Chémiatrie", which he elaborates upon as a chemistry applied to medicine (Hoefer, 1843, p.9). This is rationale enough for Ray to incorporate iatro-chemistry in the discussion on the history of chemistry.

Discussing the status of alchemy in India in the 10<sup>th</sup> century he relies on Al Biruni whom he quotes in extenso: "...The Hindus do pay particular attention to alchemy, but no nation is free from it, and one nation has more bias for it than another, which must not be construed as proving intelligence or ignorance; for we find that many intelligent people are entirely given to alchemy, whilst ignorant people ridicule the art and its adept ... I have not been able to learn from the Hindus which methods they follow in this science and what element they principally use, whether a mineral or an animal or a vegetable one. I only heard them speaking of the process of sublimation, of calcination, of analysis, and of the waxing of talc, which they call in their language "talaka" and so I guess that they incline towards the mineralogical method of alchemy...They have a science similar to alchemy which is quite peculiar to them...They call it *Rasāyana*...It means the art which is restricted to certain operations, drugs and compound medicines, most of which are taken from plants. Its principles restore the health of those who were ill beyond hope"(Ray, 1902. p.lix-lxi).

While the detailed textual reading of *History* is presented in (Raina, 2014) it must be pointed out here that Ray does not commit the historiographical error of presentism or conflates the epistemology of alchemy with that of modern chemistry. Thus he writes: “As Hindu medicine has seldom been able to shake itself completely free from the influence of magic and alchemy as auxiliaries, physicians, as practitioners of the black art have been given an inferior position in the legal treatises”(Ray, 1902, p. viii). As pointed out in (Raina, 1997) he is the inaugurator in India of a version of the social history of science for a variety of reasons one of which was to explain the impediments to the growth of a tradition as function of the social status of the practitioners. This was a fundamental asymmetry of internalist-externalist explanations. The epistemological was evoked to explain successful scientific development and the social to explain failure. This bimodal frame of explanation was to infect the history of sciences almost till the rise of social constructivism and the arrival of sociological history of science.

Furthermore, when speaking of the second period of the history of Hindu Chemistry that he labels the Ayurvedic period he points out that: “...the Hindu system methodised and arranged on rational basis, with a scientific methodology”. Suggesting that about a thousand or more years separated the age of the *Atharva Veda* from that of Caraka (Ray, 1902, .xi). In the comparative context, he then extrapolates an idea from John William Draper’s *History of the Intellectual Development of Europe*, in quoting him: “The necessary consequence of this great success was the separation of the pursuits of the physician from those of the priest”(Ray, 1902, p.xii). In other words the transition from Atharvan period to the Ayurvedic one is marked by a division of labour separating the hieratic from the curative professions. Caraka and Suśruta not only mark an epistemic (methodological) and sociological

departure (separation of the function of the priest and physician), more importantly there appears the idea that the medical profession was extended over a geographical space and that medical texts were written for and speaking to these dispersed communities who shared a technical language. For this reading he draws on the studies of the French Indologist Palmyr Cordier to conclude that: “On reading the Caraka, one often feels as if it embodies the deliberations of an international congress of medical experts, held in the Himalayan regions to which distant Balkh (Bactriana) sent a representative of Kāmkhāyana (Ray, 1902, p. xxii).

The struggle for cognitive justice manifests itself here in the form of an ambivalent nationalism, for in a way he almost reiterates another French contemporary Louis Pasteur when he points out that:

“... The capacity of a nation must be judged by what it has independently achieved in the several fields of knowledge and branches of literature – Mathematics, including Arithmetic and Algebra, geometry and Astronomy; Phonetics, Philology, Grammar, law, Philosophy and Theology”. (Ray, 1902, p. xl).

But more than the nationalism for there are many more occasions, as with Pasteur, where his internationalism trumps the nationalism - this is a matter and a struggle for justice. So he goes on to write that:

“...It is curious to reflect that the upholders of the “Greek Culture” are often found ready, though unconsciously, to exist and torture facts and conclusions to serve their own purpose, and reserve to themselves the benefit of doubt as regards date; but whenever the priority of Hindus is unquestionable, an appeal is made to the theory of common origin and independent parallelism of growth. These scholars seem to smart under a sense of injury if they have to confess that Europe owes an intellectual debt to India”(Ray, 1902, p. xlii).

Clearly then he identifies that there is travesty of the norm, a sliding in the format of explication on occasions when the evidence for the priority of scientific discovery or invention points towards India - clearly he had put his finger on the widespread nature of nationalist historiography that was anchored in Adasian apercu that not only machines but ideas had become the measure of civilization (Adas, 1990).

The Acharya was reacting to an article by Goblet D'Alviella and of course the more disparaging remarks of Dugald Stewart on Sanskrit literature and language. But this trend he goes on to point out has been compensated by the writings of Max Müller et. al. (Ray, 1902, p. xlii-p. xliii). Hence he was not taking on a monolithic entity called European scholarship but referring to specific authors. But the intent of this diversion over several pages is to argue that far "... too much has been made of the resemblance between the Greek and Hindu theory and practice of medicine" (Ray, 1902, p. xlvi). And finally the chapter concludes by pointing out: "... that Hindu Pharmacopoeia in the 7<sup>th</sup> century ran on the lines of the Caraka and the Suśruta, and did not include any elaborate metallic preparations is evident from the testimonies of Vāna and of the Chinese pilgrim, I-Tsing" (Ray, 1902, p. lii).

This last conclusion prepares the ground for the radical break he would argue for as the next landmark in the history of Indian medicine and chemistry. The third chapter deals with the transitional period extending from Circa 800 – 1100 AD that is characterized by "... the parting of ways in the progress of Hindu medicine... Since the days of Vāgbhaṭa, metallic preparations had begun to slowly creep into use, and at the time of Cakrapāni and his predecessor Vrinda, they had so fully established their claims that they could no longer be ignored ...from the tenth century and downward every medical work more or less recommending compounds of metals which can only be synthetically prepared" (Ray, 1902, p. liv-lv).

The central argument concerning the introduction of metallic preparations in pharmacopoeia as marking the beginning of the iatrogenic stage of alchemy is particularly relevant and in order to understand where it comes from the histories of Thomson, Hoefer and Kopp provide the clue from the nineteenth century that deeply influenced Ray's understanding. In Koppf's *Geschichte der Chimie* he elaborates the idea that Paracelsus's views about ill and healthy human bodies were based on certain images of Zusammensetzung of the latter (Kopp, 1875, p. 134). This Paracelsan moment in the historiography of European alchemy/chemistry is the turning point – the transition from alchemy to chemistry. Arguing by analogy then the Acharya was saying that the third moment in the history of Indian medicine was the turning point when Indian alchemy made its transition to chemistry. Whether the analogical extrapolation was a justifiable one or not is a moot question.

#### 4. The Long Shelf-life of Ray's *History*

We have learned from Kuhn that the internal can also be social, even though the social for Kuhn is often restricted to the community of scientific practitioners. In other words an attempt has been made to enter the discursive universe of practicing nineteenth century chemists from Europe – a universe in which Prafulla Ray, writing in Calcutta was equally immersed. As a genre of history produced within late nineteenth century Bengal, his *History* too has been refracted through several post-colonial lenses over the last four decades. This paper situates the *History* internally and argues that Ray sets out on his historical excursion confronted by a twofold conceptual instability. In the nineteenth century the chemist-historian, anywhere had to engage with chemistry's alchemical past in order to chart out its passage towards becoming a mature, positive science – an issue that had not been entirely settled at the time. Prafulla Ray does so by adopting a

historical and not presentist reading of chemistry's alchemical past, that he constantly triangulates with a symmetric reading across cultures and civilizations, and a comparative reading across alchemical cultures. In the second instance, he ends up writing a history of chemistry in India, arguing against the grain of the received scholarship. Eventually, he adopts and adapts the nineteenth century historiography of chemistry as a resource that is innovatively mobilized and re-interpreted to serve his objectives.

But this effort itself has been inspired by Loren Graham's paper published in 1985 that contextualized a paper on the history of science by Boris Hessen<sup>7</sup> in 1931 that sought to put Newton's *Principia* in social context. Graham writes:

"... externalist historians of science have not been as thorough as they should have been in their exploration of the social conditions which affect intellectual discourse. They have been much more willing to apply an externalist interpretation to the scientists they study than they have been to apply it to the historians who are studying the scientists. But surely social conditions affect historians as much as scientists. And this observation points to the need for the contextual study of historians of science going far beyond the subject..." (Graham, 1985).

It had been previously argued that (Raina, 1997) that it would be possible to dialectically examine the relationship between Ray's historical project and his practice of chemistry during the early part of his career – the science of mercury years. Listening in on the papers presented at the workshop and now appearing in this volume, it was indeed fascinating to learn how contemporary practicing scientists historicize their sub-disciplines and research programmes. But this is a matter for a separate paper. Here I restrict myself to a few observations particularly relating to the manner in which many of the contributors to this

volume traced their chemical genealogies to the school of chemistry founded by P.C. Ray, and identified themselves as students of his students or students of his student's students. This historical discourse operates within a Whig history of science. Some papers in addition to tracing the chemical genealogies of a research programme point out where Ray's modern chemical work was outdated or superseded by newer experiments or theoretical interpretations, and where lines of his work continued to link up with contemporary research programmes. In other words Ray's researches into modern chemistry had themselves entered the pantheon of classics, as was the case with *History*.

But beyond the common fate of the two it could be asked as to how the historical sensibilities of this age of chemists differed from that of Ray – or were his historical sensibilities idiosyncratic. This issue is difficult to settle for a social historian of science. What could be reasonably inferred is that disciplinary specialization and fragmentation has produced several cultures, separated by methodological and interpretative protocols. The canonization of *History* derives from a combination of historical sensibilities that included a command over the classical languages and texts of the ancient alchemical tradition, a recognition of the polysemy of the scientific concepts both in time and across time, a recognition that concepts are enfolded within metaphysical and cosmological schemas that does not render them any less scientific or deprive them of scientific utility, and most importantly that conceptual presentism is a sure recipe for historical error. Which of the elements in this combinatory was the most important is anybody's guess.

### Acknowledgements

Prof. Maïke Rotzoll from the University of Heidelberg was kind enough to translate some of the important passages from Kopp's *Geschichte*, and for alerting me to the problems in reading the

corpus of ‘Paracelsian’ writings. Benjamin Zachariah was always ready to discuss the Acharya’s ideas and writings. I thank the participants and organizers of the International Workshop at Jadavpur University and later IISER, Mohali for their comments.

### Notes

1. This part of the paper abridges an argument made in (Raina, 2014), that contains a detailed discussion on the German and French histories of science that Ray relies upon.
2. In the Preface to *The History of Chemistry*, Thomson would remark that: “Alchymy, or the art of making gold, with which the science originated, furnishes too curious a portion of the aberrations of the human intellect to be passed over in silence” (Thomson, 1830, p. i).
3. In the second volume he would clarify: “Des deux époques que nous venons de parcourir, la première antérieure au moyen âge, avait une tendance matérialiste, associée à des théories devançant l’expérience; la seconde, qui comprend tout le moyen âge, avait une tendance spiritualiste et mystique. Dans la première époque, les faits, quoique en nombre fort restreint, étaient invoqués comme une autorité ; dans la seconde, l’esprit spéculatif imposait silence à l’observation. Dans la troisième époque enfin, qui est la nôtre, et dont les contemporains, par une illusion optique du temps, sont toujours portés à exagérer la valeur, la lumière semble apparaître après les ténèbres. La science se manifeste revêtue de ses formes sévères, et entourée de preuves propres à convaincre plutôt la raison qu’à parler à l’imagination” (Hoefler, 1843, p.1). But what he does do is caution the reader of a science that persuades through reason alone rather than imagination and the need to be wary of the arrogance that this could breed.
4. The importance of both Georges Agricola and Paracelsus in giving the science of chemistry a new direction is reaffirmed in Hoefler’s *Histoire* as well. The distinction between the two residing in that Paracelsus took on the ancients and turned the attention of doctors to the study of chemistry of living beings (chémiatrie), while the more modest Agricola turned to the study of metallurgy, incorporating it into chemistry (Hoefler, 1843, p.7). But here Paracelsus’ appeal was to the doctors and not to the alchemists (Hoefler, 1843, p. 16).
5. See endnote 5 in [Raina, 2014].
6. I summarize here a passage from Paracelsus’ complete works cited in French by Hoefler. In the passage Paracelsus wishes to speak to those chemist doctors, who are not dressed in velvet, silk or taffeta, with gold rings and white gloves. But those who patiently wait day and night for the outcome of their work, as a result they are rarely seen in public places but spend their time in the laboratory; and their hands are blackened with smoke as are those of blacksmith and coal men [Paracelsus quoted in Hoefler, 1843, p.11].
7. For more recent research on that paper see (Freudenthal and MacLaughlin, 2009).

### Bibliography

- Adas, Michael. *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance*. Oxford University Press, New Delhi, 1990
- Bensaude-Vincent, Bernadette. The new identity of chemistry as biometric and nano-science”, in José Ramón Bertomeu-Sánchez, Duncan Thorburn Burns, Brigitte Van Tiggelen (Editors), *Neighbours and Territories: The Evolving Identity of Chemistry*, 6<sup>th</sup> International Conference of the History of Chemistry, Belgium: 2008. ISBN 978-2-9600815-0-3, pp. 53-64.
- Calvino, Italo. *The Uses of Literature*. Harcourt Brace Jovanovich. 1986
- Chakrabarty, Dipesh. *Provincializing Europe: Postcolonial Thought and Historical Difference*, Princeton University Press, 2000.
- Chandrasekhar, S. *Newton’s Principia for the Common Reader*, Oxford University Press. 2013.
- Freudenthal, Gideon and McLaughlin, Peter. Classical Marxist Historiography of Science: The Hessen-Grossmann Thesis, in Freudenthal and McLaughlin (Ed.), *The Social and Economic Roots of the Scientific Revolution*; Texts by Boris Hessen and Henryk Grossmann, Springer, 2009. pp. 1-40.
- Graham, Loren. The Socio-Political Roots of Boris Hessen: Soviet Marxism and the History of Science, *Social Studies of Science*, 15, 1985, pp. 705-722.
- Hoefler, Jean Chrétien Ferdinand. *Histoire de la Chimie depuis les Temps les Plus Reculés*, Tome I, Chez L. Hachette. Paris 1842.
- Hoefler, Jean Chrétien Ferdinand. *Histoire de la Chimie depuis les Temps les Plus Reculés*, Tome II, Chez: L. Hachette, Paris, 1843/1869
- Jacob, Christian. *Lieux de Savoir: Espaces et Communautés*, Éditions Albin Michel, 2007

- Kopp, Hermann. *Geschichte der Chemie*, Braunschweig, 1875.
- Perkin, John. Sites of Chemistry in the Eighteenth Century. *Ambix*, 60.2 (2013): 95-98.
- Raina, Dhruv. The Young P.C.Ray and the Inauguration of the Social History of Science in India. *Science, Technology & Society*, 2.1(1997):1-40.
- Raina, Dhruv. *Images and Contexts: The Historiography of Science and Modernity in India*, Oxford University Press, Delhi, 2003
- Raina, Dhruv. Le Gentil's Voyage: Addressing Disruptions in the Narrative of Scientific Progress, in Siegfried Zielinski and Eckhard Furlus (Eds.), *Neapolitan Affairs: On Deep Time Relations of Arts, Sciences and Technologies*, Variantology 5, Walter König, Köln. 2011, pp. 385-397.
- Raina, Dhruv. Framing 'A History of Hindu Chemistry': The Influence of the Historiography of Chemistry on Acharya Prafulla Chandra Ray, in Nupur Dasgupta and Amit Bhattacharyya (Eds.), *Essays in History of Science Technology and Medicine*, Kolkata, 2014.
- Ray, Acharya Prafulla Chandra. *History of Hindu Chemistry*, Vol. 1 Chuckervertty, Chatterjee & Co. Ltd: Calcutta. 1902.
- Ray, P. C. *Essays and Discourses*, G.A. Natesan, Madras 1918
- Ray, Prafulla Chandra. *Life and Experiences of a Bengali Chemist*, 2 Volumes, The Asiatic Society, Calcutta, 1932.
- Schorlemmer, Carl. *The Rise and Development of Organic Chemistry*. Macmillan and Co. London, 1894
- Thomson, Thomas. *The History of Chemistry*, Henry Colburn and Richard Bentley, London 1830.
- Visvanathan, Shiv. The Strange Quest of Joseph Needham, in S.Irfan Habib and Dhruv Raina (Eds.), *Situating the History of Science: Dialogues with Joseph Needham*, Oxford University Press, 1999, pp. 198-219.
- White, David Gordon. *The Alchemical Body: Siddha Traditions in Medieval India*, University of Chicago Press, 1996.