ACHARYA PRAFULLA CHANDRA RAY: A REVISIT TO HIS LIFE AND WORK
(PART-1)

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Acharaya Prafulla Chandra Ray, Pioneer of Modern Indian Chemistry, was a man of unique combination of virtues and activities. His multi-faceted activities are, to say the least, captivating. He was the founder of Bengal Chemical and Pharmaceutical Works (BCPW) and (along with Megh Nad Saha) Indian Science News Association. Besides, he was a passionate teacher, a social reformer, a historian of science, a remarkable entrepreneur, a true patriot, 'almost a politician', a linguist, a prolific and bilingual writer and, above all, a selfless philanthropist of austere lifestyle. His valuable contribution to the diverse array of the aforesaid domains fetched him global recognition and reverence. A revisit (in two parts) to the life and work of this great Indian Savant is just a humble tribute of the present author to this monumental personality.

Introduction

A mammoth task ahead – I am to write a short account of the life and work of the great Indian savant Acharya Prafulla Chandra Ray whose activities covered nearly all aspects of human interest, viz. pioneering research in chemistry in modern India, inspiring students for research and entrepreneurship, founding and promoting industries, writing history of ancient Hindu chemistry, authoring autobiography, textbooks and articles, pursuing educational and social reforms, carrying out philanthropic activities to the needy, nationalist activities and the uplift of the Bengalis in particular. In the words of Rabindranath Tagore, “as pioneer of chemical education, chemical research and chemical industries in India, and more possibly as a self-denying and dedicated worker for the uplift and emancipation of the country, and last but not least as a man of austere habits and sterling character with dynamic sympathy for the poor and downtrodden, ever alert to the call of humanity, Prafulla Chandra Ray occupied a unique position in India in his days".

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P.C. Ray (August 2, 1861 – June 16, 1944)
An anonymous, admiring pupil of Acharya Ray rightly pointed out that “one must be at the same time a scientist, an educationist, an industrialist, a social reformer, and a politician in order adequately to perform the difficult task of giving an account of his life.” Clearly, I do not even dream of satisfying these criteria. Nevertheless, that a rather large number of articles, book chapters and books have been published on the various aspects of the life and work of this legendary figure instills in me a seed of confidence. With a bit of indulgence from your end, let me begin my sojourn.

Family Background and School Education

P.C. Ray was born on August 02, 1861 in the village of Raruli, often called Raruli-Katipara, on the banks of Kapotakshi river in Paikgachha Upazila in the then Jessore district, Bengal Presidency, India (now Bangladesh and later included in the Khulna district).

Ancestral Details: In order to be able to appreciate the inherent abstract qualities of P.C. Ray, it is imperative that one should know about his ancestry, particularly about the three previous generations. The ancestral origin of Prafulla Chandra Ray can be traced back to one Bejoy Hari Deb who migrated from the Deccan to ancient Karna Subarna, now known as Rangamati in Murshidabad. The surname Ray Chowdhury was borne from the 17th generation onwards, perhaps indicating that they were landlords.

Maniklal Ray (Chowdhury): P.C. Ray’s great-grandfather: His great-grandfather Maniklal Ray (Chowdhury), who had been a Dewan of the District Collector of Krishnanagar and later of Jessore, amassed plenty of wealth during his lifetime. In his childhood, P.C. Ray ‘used to hear fairy tales of the wealth amassed by him’ and how Sicca Rupees (of East India Company) used to be dispatched home in earthen pots, covered with ‘batasas’, to befool the dacoits thronging Nadia-Jessore Grant Trunk Road.

Anandalal Ray (Chowdhury): P.C. Ray’s grandfather: After the death of Maniklal Ray, his son Anandalal Ray (Chowdhury) became the Seristadar of Jessore, inherited huge wealth, including landed property, and continued to...
increase it. Anandalal was a progressive man. In 1846, he got his son Harish Chandra admitted into Krishnanagar English Collegiate School so that he could receive modern education. Harish Chandra was well versed in English, Sanskrit and Persian languages and had working knowledge of Arabic as well.

**Harish Chandra: P.C. Ray’s father:** P.C. Ray was born to Harish Chandra Ray, a cultured landlord, and Bhubanmohini Devi, the daughter of a local Taluqdar. In 1851, having heard that Anandalal all on a sudden had become a victim of fatal apoplexy, Harish Chandra rushed to Jessore to receive parting message from his father. But when he reached Jessore, Anandalal Ray had already died. In those days, banks did not exist, and Maniklal Ray used to hide his cash and jewelry in secret vaults underground and inside brick walls of their house. This system was going on from earlier generations. Harish Chandra tried to find out the wealth hidden in his ancestral house, but to no avail. Harish Chandra thus suddenly became financially handicapped.

Harish Chandra had to drop out from school in order to take charge of his family. With an overall annual income of around Rs. 10,000/-, he used to lead a cultured life. When in Calcutta, he used to mingle with the then cultural leaders of Bengal like Iswar Chandra Vidyasagar, Kristo Das Pal, Digambar Mitra (later ‘Raja’ and C.S.I.) and Jatindra Mohan Tagore. He even became a member of the then British Indian Association. He was also in touch with Brahmo Samaj. He was well known for his eloquence, social activities and love for music. He was an expert violin player. He set up an expensive library at his home and two middle schools in his village – the first school for girls (named after Bhubanmohini Devi) and later another English medium schools in his village for nearly a couple of years was a blessing in disguise for him. He wrote, “Freed from the routine studies of dry school textbooks, I got the opportunity of studying as per my own will and interest.” While convalescing, he

Jnanendra Chandra passed the minor scholarship examination, Harish Chandra decided to shift to Calcutta with a view to imparting higher education to his sons and bringing them up in a cultural ambience. After a preliminary month-long acquaintance with the state of affairs in Calcutta in August, 1870, Harish Chandra shifted his whole family to a rented house at 132, Amherst Street, Calcutta in December that year. They lived there for nearly a decade. Both P.C. Ray and his elder brother were admitted to Hare School. In the school, P.C. Ray’s classmates, hailing from Calcutta, used to make fun of him and ridicule him as a ‘Bangal’, a derogatory term then used for those hailing from East Bengal. Still he continued to be a student of Hare School.

1874, when P.C. Ray was a student of the fourth class, was an eventful year in his life. In August that year, he suffered from a severe bout of dysentery perhaps because of his sustained habit of reading till late hours at night. It compelled him to postpone his studies for a year (Aug., 1874 to Aug., 1875) and return to his native village. Although the acute stage of the disease was over after seven months, he became a hypochondriac and submitted himself ‘to strict dietary regimen and discipline’. Even then, it made him a lifelong victim of indigestion, diarrhoea and later on insomnia.

**Education at Albert School:** He returned to Calcutta in 1875 and got admission in the third class (equivalent to class VIII) at the newly founded Albert School (original residence of Keshab Chandra Sen) in the middle of the academic session. Although he was faring very well in his studies, he did not sit for the Annual Examination because he had a secret desire to resume his education in Hare School. He went back to his native village. In January 1876, he again returned to Calcutta and asked for a certificate from the authorities of Albert School so that he could get admission in the corresponding class at Hare School. However, the teachers en masse, particularly Kali Krishna Bhattacharyya (teacher of Sanskrit), dissuaded him from doing so. P.C. Ray, therefore, resumed his studies at Albert School. Half a century later P.C. Ray gratefully acknowledged his obligations to the teachers and ambience of Albert School. He passed the Entrance Examination (equivalent to Matriculation, School Final and Secondary Examinations) of Calcutta University in the first division in 1879.

P.C. Ray’s absence from school and living in his native village for nearly a couple of years was a blessing in disguise for him. He wrote, “Freed from the routine studies of dry school textbooks, I got the opportunity of studying as per my own will and interest.” While convalescing, he
used to voraciously read newspapers, magazines, encyclopedias, books on history, geography, Bengali literature, politics, biographies and articles on science and even studied Greek, Latin, French and Sanskrit. During this period he read the histories of England, Rome and Spain.

P.C. Ray’s Attachment to Brahmo Samaj: P.C. Ray strongly disliked the Caste System of the Hindu society, because it appeared to him as “the very negation of the relation existing between man and man”. He was also against child marriage and other abuses of the Hindus. Right from his boyhood he ‘was unconsciously drawn towards the Brahmo Samaj’. Even before the attainment of his teenage, P.C. Ray used to attend the evening sermons of the Bharatbarshiya Brahmo Samaj (set up by Keshab Shandra Sen as an offshoot of Adi Brahmo Samaj) and go through the weekly magazine Sulabh Samachar (also started by Keshab Chandra Sen), which made him further inclined to the Brahmo Samaj. A liberal and reformist P.C. Ray was thus in the making.

Higher Education

F.A. Course at Metropolitan Institution: At this juncture, P.C. Ray’s father got into serious financial crisis. He had to sell his landed properties to pay off his debts. Unable to bear the financial burden of living in Calcutta, Harish Chandra along with his family returned to Raruli, but P.C. Ray and his brothers stayed in Calcutta. In 1879, P.C. Ray got admitted into the newly founded (1872) Metropolitan Institution (named Vidyasagar College in 1917), established by Pandit Ishwar Chandra Vidyasagar, for the F.A. (i.e. First Arts) Diploma course of the Calcutta University. He chose this college because, as he wrote, “this was the first bold experiment in India of making high education as cheap as secondary education, — was a national institution and something we could look upon as our own,” and stalwarts like Surendra Nath Banerjee (later the first President of Indian National Congress) and the great Shakespearean scholar Prasanna Kumar Lahiri were teachers in English in this college. S.N. Banerjee’s nationalistic spirit instilled in P.C. Ray a deep sense of patriotism, and excellent teaching of English literature by the aforesaid teachers deepened P.C. Ray’s love for English. In the same year, P.C. Ray also joined Sadharan Brahmo Samaj (a more moderate faction of the Adi Brahmo Samaj and set up by Keshab Chandra Sen on May 15, 1878 at the Town Hall, Calcutta).

Chemistry was a compulsory subject in the F.A. course, but there was no provision for theoretical and practical classes in chemistry at the Metropolitan Institution. P.C. Ray, therefore, attended classes in chemistry at the Presidency College, Calcutta as an External Student with nominal fees. Alexander Pedler (later Knighted) at the Presidency College was a brilliant teacher and a very good experimentalist, and P.C. Ray was simply moved by his lectures and his ‘manipulative skill’ in the laboratory. P.C. Ray commented on the influence of Pedler, “I began almost unconsciously to be attracted to this branch of science.” Consequently, despite his inclination for history and literature, P.C. Ray decided to pursue further studies in chemistry. Chemist P.C. Ray was thus seeded. P.C. Ray passed the F.A. examination in 1881 in the second division and took admission in the B.A. (‘B’ course; meant for science stream) degree of Calcutta University.

Gilchrist Scholarship Saga: Higher Education Abroad: While P.C. Ray was a student of the B.A. degree course, a major incident took place that shaped his academic future. He knew that his father, though financially handicapped at that time, had a dream of sending at least one of his sons to England for higher studies. To fulfil his father’s earnest desire, P.C. Ray decided to compete for Gilchrist Scholarship (of the Gilchrist Educational Trust, established in 1841 and amounting to a scholarship of £100 per annum). The examination for the scholarship was of the same standard as that of London University Entrance examination and required a fair knowledge of four languages, viz. English, Latin, Greek or Sanskrit, and French or German. P.C. Ray studied hard and sat for the examination. After several months, the result was published in the Statesman, and he came to know that he and one Bahadurjee, a Parsee from Bombay, were the two winners from India. It was a dream come true for P.C. Ray. The Principal of the College congratulated him, and the newspaper Hindu Patriot wrote that he “had added a new feather to the cap of the Institution.”

His parents permitted him to go abroad for higher studies. He came to know that one Dwarka Nath Ray was also going to England to study medicine. He made acquaintance with him, and they travelled together by S.S. California in first class saloon (Rs. 400/- per berth). The steamer called on several ports, viz. Colombo, Aden, Port Said, Malta and Gibraltar. P.C. Ray (but not D.N. Ray) suffered from sea sickness. During the voyage he read a lot of books that he was carrying with him. After 33 days, the ship arrived at Gravesend, Kent, England, from where they travelled by train to reach Fenchurch Street Station, London. They were received by Jagadish Chandra Bose (then a student at London) and Satyaranjan Das (elder brother of late Law Member of the Viceroy’s Executive
P.C. Ray at the University of Edinburgh: P.C. Ray reached Edinburgh in the second week of October, 1882 a few days before the beginning of the winter session. He stayed in a flat with one furnished sitting room and one bedroom at a weekly rent of 12 s 6 d with no extra charge for unlimited supply of coal required for the fireplace. When the session started, P.C. Ray enrolled himself as ‘Civis academiae Edinburgensis’ and joined classes in Chemistry, Physics and Zoology (with Botany reserved for the summer session) for the First B.Sc. examination. In the chemistry class comprising 400-500 students, most of whom were medical students, the teacher was Alexander Crum Brown (the first D.Sc. (1862) of the University of London), an erudite linguist and a perfect gentleman reputed for the introduction of the ‘graphic formulae’. P.C. Ray learnt German language during this period.

Curiously, P.C. Ray himself wrote his year of birth as 1863, instead of 1861, in his First Degree examination documents in 1884.

Essay: ‘India before and after the Mutiny’: Sometime in 1885, Lord Iddesleigh, Rector of Edinburgh University and earlier the Secretary of State for India in 1867-’68, announced a Prize for the best essay on ‘India before and after the Mutiny’. P.C. Ray’s inherent love for history got the better of chemistry this time, and he decided to compete for the Prize. He read a lot of articles and books, all relating to India, political economy, Indian finance, Parliamentary debates on certain burning historic problems in India and the like. P.C. Ray could “wield the pen with some degree of facility, at least with as much facility as I (he) could handle the test-tube.” He submitted the essay duly. When the result was announced, P.C. Ray’s write-up was not adjudged the best, but his essay and that of another competitor were marked as proxime accesserunt, meaning ‘nearest to the best’.

P.C. Ray wanted to publish his essay. He got back his essay which was marked with the comment “Another remarkable essay is that bearing the motto — is full of bitter diatribes against British rule”, made by one of his Adjudicators - Sir William Muir (an Anglo-Indian, the then Principal of Edinburgh University and earlier a Lieutenant-Governor of U.P.) and Professor Masson. Later during his Inaugural Address to the students of the 1885 session, Muir referred to all the three essays as “bearing marks of rare excellence.”

P.C. Ray got his essay printed and published at his own cost in 1886. He distributed copies of it mainly to the students of the University with the following appeal: “The lamentable condition in India at present is due to England’s culpable neglect of; and gross apathy to, the affairs of that Empire. England has hitherto failed – grievously failed – in the discharge of her sacred duties to India. It is to you, the rising generation of Great Britain and Ireland, that we look for the inauguration of a more just, generous and humane policy as to India ...” He sent a copy his essay to John Bright, then a Parliamentarian for Birmingham and known to be a critic of British foreign policy. Bright gave him a sympathetic reply, copies of which were sent by P.C. Ray to the leading newspapers in U.K. They flashed the news with the caption ‘Mr. Bright’s letter to an Indian student’, and P.C. Ray became famous overnight. In a review on the book, The Scotsman, a leading journal of the North, commented, “It is a most interesting little book. It contains information in reference to India which will not be found elsewhere and it is deserving of the utmost notice.” Pertinently, P.C. Ray later referred to this book also as ‘my Essay on India’ in his autobiography. P.C. Ray passed the final, i.e. the Second B.Sc. examination in 1885.

Doctoral Research at University of Edinburgh: Although a student of Professor Crum Brown who was an organic chemist, P.C. Ray decided to pursue research in inorganic chemistry for a D.Sc. degree. He noticed in the literature that as early as 1855, the preparation of double double sulphates of the general formulae \([M_2SO_4,M'SO_4.6H_2O]\), \([M_2SO_4,M'SO_4.6H_2O]\) were reported, where \(M\) and \(M'\) represent different metals. But a subsequent report (1877) raised doubts on the very
existence of this kind of molecules. P.C. Ray, therefore, chose to sort out this problem in his intended doctoral research.

He prepared crystalline double double sulphates of the general formulae $x[M_2SO_4 \cdot MSO_4 \cdot 6H_2O]$. $y[M_1SO_3 \cdot M´SO_4 \cdot 6H_2O]$ with variable but integral $x$ and $y$ values, where $M$ was K, NH$_4$, and $M$ and $M´$ were Fe, Co, Ni, Cu, Zn, Mg and Cd. Based on his thesis entitled ‘Conjugated Sulphates of Copper-Magnesium Group: A Study of Isomorphous Mixtures and Molecular Combinations’, P.C Ray obtained the D.Sc. degree from the University of Edinburgh in 1887. Decades later (since 1930’s), the application of X-ray crystallography to these crystalline substances established that all the reported double double sulphates, including those of P.C. Ray, were either solid solutions or mixtures thereof. But this does in no way undermine the accomplishments of P.C. Ray in view of the non-availability of this and other sophisticated techniques in his time. P.C. Ray published his D.Sc. research work immediately thereafter. The doctoral research work of P.C. Ray has been comprehensively covered in a recent article.

**Hope Prize Scholarship:** At this juncture, P.C. Ray himself expressed his thoughts on his future course of activities as follows: “By this time I had become so passionately fond of chemistry that I made up my mind to protract my stay for at least another year and pursue my studies uninterrupted to my heart’s content.” He was awarded the ‘Hope Prize Scholarship’ of the University of Edinburgh. This award used to be bestowed every year upon four of its students who got the highest marks (at first sitting) in the First Term examination in chemistry. The Hope scholars were also entitled to use the laboratory facilities during the following term. P.C. Ray was elected a Vice-President of the student Chemical Society at Edinburgh University, the world’s oldest Chemical Society (established in 1785), for the 1887-'88 session.

At the end of the winter session of 1888, P.C. Ray’s “thoughts were turned homewards”. But before returning to India, P.C. Ray along with a friend made a tour of the Highlands, which was his long-cherished desire. He also collected letters of recommendation/introduction from Professor Crum Brown, Sir Muir and Lord Playfair (Crum Brown’s predecessor in the Chair of Chemistry) in order to get an appointment in the Educational Service in Bengal. But since his expectations were belied, he decided to return to India.

**Return to India and Teaching Assignment at Presidency College**

With the help of £50 (passage money from the Gilchrist Trust), P.C. Ray travelled from London to Brindisi, a port town in Southern Italy, by a passenger omnibus train, and from Brindisi to India by the P. & O. Mail in a second class berth (£37). He reached Calcutta in the first week of August, 1888. Clad in Dhoti and Chaddar, purchased by borrowed money, P.C. Ray went to Raruli, then a part of the newly formed Khulna district. He came to know that his youngest sister Belamati had expired. After a few days at Raruli, P.C. Ray returned to Calcutta and put up with Dr. Amulya Charan Bose, M.B., an old fellow-student of P.C. Ray and a successful medical practitioner, who had a lasting contribution to the future activities of P.C. Ray.

Despite his best efforts, P.C. Ray could not get a teaching assignment till the middle of 1889, which made him feel “helpless and powerless.” During this period, P.C. Ray was “mostly under the hospitable roof of Dr. and Mrs. Jagadis Chandra Bose”, and he utilized the time by going through chemical journals and collecting and identifying plant species. Finally, he got appointment as a temporary Assistant Professor at Presidency College with monthly emoluments of Rs. 250/-, the highest pay that a new entrant in the Provincial Educational Service could get. However, P.C. Ray pondered, “It is, however; time I left this chapter in my life and turned to my career at the...
P.C. Ray had to work hard during these years. Every afternoon he used to return from Presidency College at around 4.30 p.m. and become busy with file work of BC till 7 p.m. On Sundays and holidays, he used to work for 10-12 hours a day with half an hour’s break for bath and meals. But he did not feel tired since, in his own words, “The migration from my college laboratory to the pharmacy laboratory was to me a recreation and a change of occupation...the very idea of locally manufacturing pharmaceutical preparations, which hitherto had to be imported, acted like a tonic.” P.C. Ray never took any salary from the Company.

P.C. Ray faced three damaging incidents in the next few years. The first one was about Satis Chandra Sinha, M.A. (Chemistry), brother-in-law of Amulya Charan Bose, who had joined BC, invested some capital in it and worked hand-in-hand with P.C. Ray. One evening P.C. Ray came to know that Satis Chandra had died of accidental poisoning by hydrocyanic acid, which was a shock to him. The second blow was the sudden demise of P.C. Ray’s father during the summer vacation in 1894. P.C. Ray and his eldest brother rushed to Raruli and, after arranging to pay off his father’s debts by mortgaging their landed property, P.C. Ray returned to Calcutta after a week. In September, 1898, Amulya Charan Bose suddenly died of bubonic plague which he contracted from one of his patients - the third incident.

Since more funds were needed for the expansion of the factory, BC was converted into a Limited Company on April 12, 1901 and named Bengal Chemical and Pharmaceutical Works Ltd. (BCPW). A plot of land measuring 13 acres was purchased at 90, Manicktala Main Road, Calcutta. The new factory was built there during 1904-1907, and it started functioning with 70 workers and the noted literateur Rajsekhar Bose, also an M.A. in chemistry from Presidency College, as its Manager. After visiting the new factory during its construction, Dr. Morris W. Travers, the first Director of the Indian Institute of Science, Bangalore highly praised this enterprise as follows: “.. the design and construction of the sulphuric acid plant...required a large amount of research work of the kind which is likely to be of the greatest service to this country and does the greatest credit to those concerned” in his report to the Calcutta University. P.C. Ray set up the Employees’ Co-operative at BCPW in 1917. Another factory of BCPW was set up at Panihati, North 24-Parganas, W. Bengal in 1920.

In 1921, as a result of a sharp difference of opinion between P.C. Ray and others in a meeting of the Board of
Directors with the shareholders of the Company, P.C. Ray resigned from the Board of Directors of BCPW. Two more factories of BCPW were subsequently founded – one in Mumbai in 1938 and the last one in Kanpur in 1949. Two production units were even shifted to Lahore in 1942. In the early 1930’s, BCPW had 2,000 employees, the net assets were around half-a-Crore Rupees and the registered office of BCPW was at 6, Ganesh Chandra Avenue, Kolkata 700013. For a vivid account of the history of BCPW, one may go through two authoritative write-ups – a book edited by Debabrata Mukherjee9 and an article by Syamal Chakrabarti in the ISNA book10.

Legal battle between BCPW and Hoechst India Ltd.

A curious incident took place in the history of BCPW in 1968. A legal battle cropped up between Hoechst India Ltd. and BCPW over the infringement of patent right over a particular sulphonamide drug. The experts in chemistry for both the Companies were from the Chemistry Department of Calcutta University - Professor Dukhaharan Chakrabarty, the then Head of the Dept. of Chemistry, was an expert for Hoechst, and Professor (Mrs.) Asima Chatterjee was the expert for BCPW. Through the sustained efforts of Mrs. Chatterjee as an expert for days together, BCPW won the case. But Mrs. Chatterjee did not take any fees for her appearances. This incidence pointed to the magnanimity of Mrs. Chatterjee, showed her firm mentality against a very sad background – only a year ago (1967), her husband, Professor Baradananda Chatterjee, had passed away and this legal win saved BCPW from going into acute financial crisis. Besides, it is also a pointer to the high degree of respect that Professor (Mrs.) Chatterjee had for Acharya P.C. Ray, her grandteacher11.

The Downfall, Rise and Bleak Future of BCPW

The death of P.C. Ray in 1944, followed by the partition of India, steadily worsened the financial situation of BCPW, and the Company started incurring losses since early 1950s. It was nationalised and renamed Bengal Chemical and Pharmaceuticals Ltd. (BCPL) in 1981, declared a sick firm in 1992 and placed under BIFR (Board for Industrial and Financial Reconstruction). Fortunately, after six decades of losses, the company is turning around, albeit under a different management. In 2015-16, BCPL received the ‘Excellent Rating of Corporate Governance’ tag from the Department of Public Enterprises. In 2016-17, the Company recorded for the first time after six decades a net profit of Rs. 4 Crores, and the profit increased in the subsequent years12. Currently, BCPL manufactures industrial chemicals (e.g. sulphuric acid, ferric alum), surgical instrument, anti-venom serums, vaccines, household products (e.g. Naphthalene Balls, Bleaching Powder, Pheneol and Pheneol-D disinfectants, Klin Toilet, Lesol antiseptic detergent for surface cleaning, White Tiger floor cleaner, Liquid Soap), cosmetics (e.g. Cantharidine Hair Oil, Aguru perfume) and drugs.

A ‘Swadeshi’ venture started by P.C. Ray at the beginning of the twentieth century has indeed withstood the test of time. But a recent news item from the Lok Sabha says that P.C. Ray’s dream venture is facing a grim future. Its ongoing profits and huge immovable properties notwithstanding, BCPL has been marked as one of the three Pharma PSUs that the Government of India has decided to disinvest13.

Research at Presidency College (1894-1936)

On Mercurous Nitrite: A Discovery in Serendipity:

In mid-1894, a new, reasonably equipped research
laboratory was set up in a new building at Presidency College, whence P.C. Ray could start his research properly. At that time P.C. Ray was trying to prepare water-soluble mercurous nitrate, an intermediate for the synthesis of calomel, by treating excess mercury with dilute aqueous (1:4) nitric acid in cold. He got a yellow crystalline deposit which, he thought, was unlikely to be a basic salt as the reaction medium was strongly acidic. A preliminary analysis of this product by P.C. Ray proved the presence of both mercurous and nitrite moieties. A quantitative analysis of it led to its identification as hitherto elusive mercurous nitrite. He further observed that it undergoes disproportionation reaction in water to yield, as expected, mercurous nitrite and mercury, as shown below.

\[
\text{Synthesis: } 3\text{Hg} + 4\text{HNO}_3 \rightarrow \text{Hg}_2(\text{NO}_2)_2 + \text{Hg(NO}_3)_2 + \text{H}_2\text{O}
\]

\[
\text{Disproportionation (in water): } \text{Hg}_2(\text{NO}_2)_2 \rightarrow \text{Hg(NO}_3)_2 + \text{Hg}
\]

His work on mercurous nitrite was published in 1896 – the first report in English in the *Journal of the Asiatic Society of Bengal* and a German version in *Zeitschrift für anorganische und allgemeine Chemie*. The journal *Nature* commented, “*The Journal of the Asiatic Society of Bengal ... contains a paper by Dr. P.C. Ray, of the Presidency College, Calcutta, on mercurous nitrite, that is worthy of note.*” P.C. Ray later said, “The discovery of mercurous nitrite opened a new chapter in my life.” Indeed, this discovery brought him recognition in the global community of chemists. More work on it was published later. Contrary to subsequent contradictions by two other groups, Animesh Chakravorty of Indian Association of the Cultivation of Science (IACS), Kolkata settled the planar structure of mercurous nitrite beyond doubt by the application of X-ray crystallography at low temperature. P.C. Ray’s work clearly established that, as against the then extant belief, nitrites are quite stable compounds. In fact, nearly 70% of P.C. Ray’s research work carried out in Presidency College involved studies on nitrites.

**Other Research Work by P.C. Ray at Presidency College:** P.C. Ray later studied the decomposition of ammonium nitrite in moderate vacuum at 70°C, determined its vapour density as well as the vapour densities of ammonium nitrate, benzoate and acetate. As the representatives of the University of Calcutta, P.C. Ray and Deva Prasad Sarvadhikari attended the Congress of the Universities of the Empire in London in 1912. In the first session, P.C. Ray presented his work (with his students Nilratan Dhar and Tincory Dey) on ammonium nitrite. Their work was highly applauded by, amongst others, Nobel Laureate William Ramsay.

In 1904, P.C. Ray prepared mercuric nitrite by the reaction of mercuric chloride and silver nitrite in aqueous medium and studied its reactions with various reagents. P.C. Ray, along with Jitendra Nath Rakshit and Rasik Lal Datta, was able to prepare alkylammonium nitrites from the reaction of amine hydrochlorides with silver nitrite and study their thermal stability (1911-1912).

P.C. Ray’s another achievement was the preparation of a series of double nitrites of mercuric nitrite with sodium, potassium, calcium, barium and strontium and the proof of the presence of the [Hg(NO₂)₂]²⁻ ion in these salts (1907-1912). Only in the 1960s, IR spectroscopy and X-ray crystallography confirmed the presence of this ion in a related salt. Later on (1912), P.C. Ray isolated the additive compounds of mercuric nitrite with aliphatic, aromatic and heterocyclic monoamines and ethylenediamine.

At an early stage (1902-1905), P.C. Ray prepared a hemihydrate of Hg₂N(NO₃) by the reaction of sodium mercuric nitrite with dilute ammonia and treated it with HX to form compounds of the type Hg₂N(X), where X = Cl, Br, NO₃, etc. Later (1910, 1915), he studied its thermal decomposition and reaction with ethyl iodide. A topic-wise and chronological description of the research work carried out by P.C. Ray throughout his academic career had earlier been presented by Animesh Chakravorty.

**Publications from P.C. Ray till 1916 (at Presidency College)**

A bibliometric study of the research papers of P.C. Ray unveiled some interesting aspects. Out of a total of 158 scientific publications – 146 in English and 12 in German - (excluding the Synopsis of his Doctoral Thesis published in the *Proceedings of the Royal Society of Edinburgh*) of P.C. Ray, 85 research papers were published till 1916 when he was at Presidency College. Of these, 53 papers were authored solely by P.C. Ray. Also, the highest number of his publications in a single year was 16 in the year 1912 when he was 51 years old. In these 16 papers, the co-authors were Jitendra Nath Rakshit (7), Rasik Lal Datta (5), Nil Ratan Dhar (5) and Tincory De (2). Clearly, in some of these publications, there were two or three authors. Also, some of his research work carried out in his last years at Presidency College was published in the following 2-3 years.
**History of Hindu Chemistry: ‘A Monumental Labour of Love’**

Motivation: While deeply involved in research on nitrites at Presidency College, P.C. Ray was also pursuing his favourite hobby - “researches into the History of Chemistry, including the lives of the makers of our science” - with equal fervour. From the ‘Materia Medica of the Hindus’, written by Udoychand Dutta, P.C Ray became aware that the Ayurvedic physicians have had been prescribing many metallic preparations. He started reading the original Sanskrit manuscripts and came across Pierre Eugène Marcellin Berthelot’s ‘Collection des anciens alchimistes grecs’ (1887)23 – a 3-volume translation of old Greek, Syriac and Arabic treatises on alchemy and chemistry during the middle ages - at the Presidency College library. In a letter to Berthelot, P.C. Ray pointed out Berthelot’s probable ignorance of the fact that alchemy used to be hotly pursued in ancient India as well and that the information was available in documents written in Sanskrit.

The reply that P.C. Ray received from Berthelot was the seeding of writing of a history of science in ancient India. Referring to his abovementioned 3-volume treatise on alchemy and also to another article of his, published earlier in *Journal des savants* (earliest academic journal published in Europe), on the chemical sciences in China, Berthelot was curious to know if P.C. Ray could provide him with the copies of the Indian treatises, written in Sanskrit, on the 13th century alchemy or translations thereof. On receiving this response from Berthelot, P.C. Ray was, so to say, electrified.

A History of Hindu Chemistry: In response, P.C. Ray prepared an English write-up on mainly the introductory chapters of ‘Rasendrasara Samgraha’ and sent it to Berthelot. Berthelot highly appreciated this work in an article in *Journal des savants*, in which he referred to P.C. Ray as a ‘savant’. This honour, bestowed upon P.C. Ray by none other than Berthelot, considered to be the then ‘most eminent living chemist in France’, inspired P.C. Ray to embark upon the uphill task of writing a book on ancient Indian alchemy and chemistry. He left no stone unturned to have access to the old Sanskrit manuscripts on Indian philosophy, mathematics, alchemy and medicine. He even took help of the Librarians of different libraries in India and even India Office, London. Through the assistance of Pandit Navakanta Kabibhusan, P.C. Ray’s magnum opus ‘A History of Hindu Chemistry’, Vol. 1, saw the day of light in 190224. The revised and enlarged second edition of this book was published in 1904.

Soon after its publication, the work was widely acclaimed in Indian and foreign newspapers and journals. The Times of India called it a “monumental labour of love.” But to P.C. Ray, more important was a review of his book by Berthelot, which was published in *Journal des savants* (January, 1903). In his review of this book in the *Calcutta Journal of Medicine [21 (10), 407 (1902)]*, Dr. Mahendra Lal Sircar of the IACS, Kolkata said, “It is, therefore, not only as a matter of duty but with sincere delight that we hailed the appearance of the first volume of *A History of Hindu Chemistry* by so skilful and zealous a chemist as Prof. Prafulla Chandra Ray, D.Sc., of the Presidency College, Calcutta.”

The second volume of the book, published in 1909, was dedicated to Berthelot who had just passed away25. The Preface of this volume was written by both of P.C. Ray and Dr. Brajendra Nath Seal, Principal, Victoria College, Cooch Behar. The book also contained some contributions from B.N. Seal. These are (i) The mechanical, physical and chemical theories of the ancient Hindus, and (ii) The weight of air. In his Preface to the second volume, P.C. Ray wrote, “It is with mingled feelings that I marked the hour of my final deliverance from a self-imposed task which has occupied all my spare time during the last fifteen years and more, … if the perusal of these pages will have the effect of stimulating my countrymen to strive to regain their old position in the intellectual hierarchy of nations, I shall have not laboured in vain.”
In his review on the second volume in Journal Asiatique, Professor Sylvain Lévi made the following remark, “His laboratory is the nursery from which issue forth the young chemists of New India.” However, in a recent critical review of this book, the authors were all praise for the chemistry and alchemy part of the book, but they also criticised it as “Moving on to the field of history... the author (P.C. Ray) has completely missed the chronology. ... Fixing Rasahridaya Tantra to the eleventh century A.D. and regarding Govinda Bhagavat as a Buddhist are only a few examples26.” Despite this criticism, these two books by P.C. Ray are undeniably the only reliable documents on the history of ancient Indian science, which received worldwide reviews and appreciations from eminent chemists and continue to be referred to even today.

Visits to Europe

Since P.C. Ray was simultaneously pursuing teaching, research and a multitude of other activities, it is well-nigh impossible to depict his life chronologically. Nevertheless, he visited Europe twice during his tenure at Presidency College, which needs to be detailed. P.C. Ray’s doctoral research at Edinburgh was during his first visit abroad.

Second Visit: After publishing the first volume of his book on the History of Hindu Chemistry, P.C. Ray realised that he had by then lost touch with the developments of modern science and he “had now to catch up and been courant with modern chemical literature.” He proceeded to England in the middle of August, 1904. Notably, Principal Pedler informed him that his commendable work on the History of Hindu Chemistry helped him get the necessary permission and financial help from the Government. He first visited many renowned laboratories in England, Scotland, Germany and Switzerland where he met eminent chemists like Sir James Dewar, Sir William Ramsay, Professors Cohen, Dixon, Perkin, Frankland, Erdman, Van’t Hoff, Emil Fischer and Richard Lorenz. He spent the Christmas vacation of 1904 at Edinburgh.

Finally, P.C. Ray went to Paris to meet Berthelot who was so highly regarded in Europe and America that P.C. Ray considered his sojourn at Paris as a pilgrimage. P.C. Ray met Berthelot at the College de France. Berthelot showed him his laboratory, invited him at his residence and also requested him to be present in a meeting of the French Academy of Sciences, which he did. He also visited the National Library and the laboratory of the Nobel Laureate, Professor Henry Moissan, a distinguished student of Berthelot. He then returned to Calcutta.

P.C. Ray described the impact of this tour as follows: “On my return to Calcutta I resumed my duties with zeal and ardour. I had rubbed shoulders with some of the great masters of our science and had seen much of the work carried out by them in their own laboratories and I now tried to emulate their activities as best as I could.”

Third Visit: As stated earlier, P.C Ray and Deva Prasad Sarvadadhikari went to London in 1912 to attend the first session of the Congress of the Universities of the Empire as delegates of Calcutta University. P.C. Ray presented his just published work on ammonium nitrite before the full house of the Chemical Society18. “It created almost a mild sensation among the chemists. Sir William Ramsay warmly congratulated” P.C. Ray, and the octogenarian chemist Sir Henry Enfield Roscoe also appreciated his work. The journal Nature (vol. 89, Aug. 15, 1912) made the following remark on his work, “Professor P.C. Ray has added to his success in preparing ammonium nitrite in a tangible form, a further accomplishment in determining the vapour density of this very fugitive compound.”

Before returning to India, P.C. Ray also visited the University of Cambridge and some of the northern Universities, including the University of Sheffield, and some Companies in London. He also attended the 250th Anniversary of the Royal Society, which was being held in London at around the same time.

Fourth and Fifth Visits: P.C. Ray went to England twice more – in 1920 and in 1929. In the last visit, P.C. Ray went to attend the Congress of the Universities of Empire, held at the University of Cambridge, as a representative of the University of Calcutta. In his lecture in the Section ‘State and University’ in the Congress, P.C. Ray severely criticized the damaging attitude of the British Government towards higher education in India.

Retirement from Presidency College and Joining Science College, Calcutta University

In his letter, dated the 25th June, 1912, Asutosh Mookerjee, the then Vice-Chancellor of Calcutta University, invited P.C. Ray, still in London, to join the University College of Science as its first Professor of Chemistry. He replied in the affirmative, but he continued his teaching and research at Presidency College for a few more years. In his own words, “Now a new chapter was about to commence in my career. The Presidency College was the scene of the labours and activities of the best period of my life.” He finally joined the University College of Science (henceforth referred to as Science College) after the completion of the Puja holidays in October, 1916.
Research at Science College

In 1917, P.C. Ray published two papers, both solely authored by him, which bore the names of both Presidency College and Science College27. In the same year, he published another paper from Science College only28. During his last years at Presidency College, P.C. Ray started doing research on organic sulphur compounds, mainly thiols and thioethers, and their reactions. He continued this work at Science College. Some of his successful work carried out at Science College is briefly presented below.

P.C. Ray had earlier reported that the reaction of sodium mercuric nitrite with aliphatic thiols resulted in the formation of crystalline mercury mercaptide nitrite (RSHgNO2)29. While at Science College, P.C. Ray studied the reaction of this compound with alkyl iodides (RI), which furnished, inter alia, a product which, he thought, had the composition [R2S2.HgI2.RI]. P.C. Ray extended this study to the reaction of mercuric nitrite with thiols and alkyl iodides and proposed, based on conductivity measurements, that the products were sulphonium salts bearing S-S chains (1917, 1919). However, years later (1930, 1931) he demonstrated that these are ionic compounds but not chain (-S-S-) compounds of the sulphonium type; the compounds are indeed (1:1) electrolytic salts [R3S][HgI2]30.

P.C. Ray also worked on the synthesis, reactions and ligand substitution reactions of platinum-thioether complexes of three types, viz. [PtCl2.2R2S], [PtCl4.2R2S] and [PtCl3.2R2S], which led to more than a dozen of publications (1919-1934). In an extension of his doctoral work at Edinburgh, Ray prepared various types of double sulphates and studied their homomorphism (1927-1930). Towards the fag end of his career, P.C. Ray was engaged in research in two fields – study of the geometrical isomerism of trivalent iridium complexes of the type [IrCl3.3R2S], prepared from the reaction of IrCl4 with R2S (J. Indian Chem. Soc., 1932-1936), and application of anhydrous thallous fluoride (TIF) for the fluorination of organic compounds31.

Publications of P.C. Ray from 1917 onwards (at Science College)

P.C. Ray had 72 publications (56 in J. Indian Chem. Soc., 8 in Nature and 8 in Z. anorg. allg. Chem.) in the period 1917-1936. Out of these, he was the sole author in 23 papers (11 in J. Indian Chem. Soc., 7 in Nature and 5 in J. Chem. Soc., Trans.). In the rest 49 publications, there were 25 new co-authors, of whom Nadia Behari Ghosh (9) and Kshitish Chandra Bose Ray (8) had higher number of papers (shown within first brackets) with P.C. Ray. The highest number of papers in a single year during this period was 7 in 1919, in two of which P.C. Ray was the sole author and the rest mostly co-authored by P.C. Guha.

Interestingly, the bibliometric study, referred to earlier, further pointed out the following aspects of his total research publications: (i) the first 25% of his publications came out in a span of 21 years, the next 25% in the following 6 years and the rest 50% in the last 22 years; (ii) publications in decreasing numbers were in J. Chem. Soc. (66), J. Indian Chem. Soc. (37), Proc. Chem. Soc. (20), J. Asiat. Soc. Bengal (12), Z. anorg. allg. Chem. (11), Nature (8), The Chemical News (2), Proc. R. Soc. Edinb. (1) and Ann. Chem. (1), and (iii) major areas of work were chemistry of nitrogen oxyacids and their metal derivatives (51 papers), organic thio compounds and their metal derivatives (41), chemistry of platinum group metals (23) and mercury alkyl/aryl compounds (10)32.

Note: Unless otherwise stated, all statements within quotes have been taken from the autobiography of P.C. Ray, Vol. I.32

To be continued...

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