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Dr. D. B. Limaye
The Founder of Institutionalized Chemical Research in Western India

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Abstract

The intelligence of human being, since the beginning of this world has resulted in the growth of science and technology. Science and technology have developed according to the interest and needs of humankind. They are having tremendous impact on human lives. Advances in DNA technology are being seen as significant, reliable, efficient and accurate tools for law enforcement agencies to fight crimes. DNA evidences are capable of proving guilt of accused or innocence of accused persons wrongly convicted. Forensic DNA Technology has transformed investigative methods of serious crimes due to its remarkable capability to convict wrongdoers or exonerate accused or convicted offenders. One of the most significant and great qualities of DNA evidence is its ability to solve cold cases. More importantly, DNA technology can quickly lead suspicion away by allowing samples of past crimes that were never solved to be reassessed. This can result in the arrest of suspect(s) years after the crime was committed. In essence, DNA evidence is rapidly becoming irrefutable proof of identification. The question whether DNA is advancing justice becomes relevant in cases where police, in their efforts, use DNA evidence to find suspects and solve crimes. Certainly, questions of justice weigh most heavily when the DNA samples of innocent person is taken, stored and analyzed and falls under the lens of suspicion. Therefore, this paper deals with the utility of DNA Technology in criminal investigation process. Advancement of DNA technology toward a vision of justice is a focal point of this research paper.

Keywords: Forensic DNA technology, technology of justice, cold case, criminal investigation.

Introduction

Dr. D.B. Limaye (1887-1971) institutionalized chemical research in Maharashtra in the early 20th century overcoming pecuniary and social hurdles, and testified to the world scientific community the potentials of an Indian chemist through his landmark research in organic chemistry. He made a path-breaking contribution to the evolution of organic chemistry, researching with inadequate financial assistance, in a laboratory ill equipped by modern standards. He brought Poona on the map of scientific research and was one of the few scientists of pre-independence India, who left an indelible imprint on international science in the hey days of colonialism, without having a glimpse of western shores.

The making of an organic chemist – Dr. D. B. Limaye born on 31st July, 1887, in a Chitpavan Brahmin family at Manache in Devgad Taluka, Ratnagiri District Maharashtra, Dattatray Balkrishna Limaye completed his primary education at Havnur, Nasik and Prabhu Seminary, Mumbai, where he passed Matriculation in 1905, ranking among the first 30. After initial few months in Elphinstone College Bombay, he shifted to Fergusson College, Poona in 1907. Influenced by Mr. T. K. Gajjar of Baroda, D. B. Limaye, still a college student, started the Balakrishna Rasashala in 1908, at Poona to produce chemicals. He passed B.A. with Physics in 1909, B.Sc. in 1910 and M.A. in Chemistry in 1911, obtaining the Balasaheb Mirajkar prize for securing the highest marks in the Bombay University[1]. As a follower of Lokmanya Tilak (who was his distant relative), D.B.Limaye refused government jobs, including the offers of lecturer in chemistry by principal Sharp of Elphistone College, Dr. T. H. Wheeler, the head, chemistry department of the Royal Institute of Science, Mumbai, (a leading centre of chemical research in 1920s), Bombay and job of soil analyst in the College of Agriculture Poona, under the principalship of Dr. Harold Mann.

In 1912, D. B. Limaye was employed as a research chemist with the salary of Rs. 60/- per month, on the recommendation of K.R. Kanitkar, Principal of Fergusson College, in the Ranade Industrial and Economic Institute, set up in 1911 by honourable G.K. Gokhale in the memory of Justice M.G. Ranade to spread industrial and technical knowledge[2].

As an Industrial chemist and later as the Assistant Director and Director of the Ranade Industrial and Economic Institute from 1912 to 1940, Limaye conducted research in pure and applied chemistry.

Under a project of the Ranade Institute for chemical investigation of natural products in the country, Limaye, guided by Dr. Harold Mann, researched the useful properties

of the Tarvad bark for tanning hides. His findings, published in 1916 in the House Journal of the Ranade Institute, were used by the British Government during the First World War[3].

Limaye analyzed iron, manganese and bauxite and helped the artisans of Poona, Yevale and Benaras in the Jari work. He guided artisans in gliding of mercury on glass, to manufacture mirrors as well as in the processing of soap and glass, in printing on cloth, cement testing, extraction of gum. On the direction of Harold Mann, Limaye conducted research on properties of vegetable oils like Nimboli, Undi and Karanjel and a camphor like substance, he isolated from Pangala, the findings of which Limaye published in 1921[4]. However conditions changed after Mann's departure from Ranade Institute.

Although promoted as Assistant Secretary of the Ranade Institute in 1920 with double salary, his position in the Ranade Institute still remained insecure, partly because the organization dominated by economists wanted to research in applied science against D. B. Limaye's insistence on pure science and fundamental research (which Limaye viewed as a solid bedrock to construct the edifice of applied research) and partly because Limaye was the only Tilakite among the majority of moderates in the Institute. Thus Limaye became a square peg in a round hole[5].

Limaye enjoyed neither medical, house, dearness allowances, nor provident fund. In 1925 Limaye constructed a new house christened Kapilashra accommodating laboratory in Navi Peth Poona and he annually earmarked a fixed sum, finally ranging to Rs. 1000 for chemical research, out of which he established Rasayannidhi in 1930[6].

A Watershed in Organic Chemistry: With the help of charcoal furnace, Limaye's alternative to the widely used but costly Fisher Furnace, Limaye succeeded in determining the formula of Karanjin [$C_{18}H_2O_4$] (a colourless crystal like compound which he had isolated from the oil seeds of Karanj) which the nobel prize winner Professor Paul Kahrer of Zurich University had failed to achieve despite most modern equipments at his disposal. Limaye proved that the molecule of Karanjin consisted of three rings fused together, of which at the centre, the carbocyclic benzene nucleus had on either sides one ring each, containing oxygen atoms besides carbon. In order to synthesize Karanjin Limaye first endeavoured to synthesize Bergaptin and Xantho toxin, the only compounds with some structural similarity with Karanjin, known at that time. For this he required a reagent between twenty groups of resorcinol derivatives, a carbonyl group. He christened the process, which he invented to synthesize such resorcinol as the Nidhone process, Nidhi denoting Rasayananidhi which had financed his research and One' to indicate a compound from Ketone Group. Sir C.V. Raman rightly observed that owing to Limaye's modesty, Limaye, contrary to the tradition in the scientific world, refrained from christening his research findings as Limaye Effect.

Prof. Limaye's original research work on the chemistry of flavones, flovonals, furoflavones and furo-coumarius and furocurochromeries was of fundamental importance in understanding the chemistry of naturally occurring compounds and their synthesis. Prof. Limaye also carried out a series of new syntheses of betadiketone and glutaconic acids. He discovered Benzoyl Resorcinal as a reagent to fill up the vacuum between two atoms of an OH organic compound. His Nidhone process to devise reagents for OH compounds was used by many researchers in the west to derive reagents for other OH Compounds, thus opening a new chapter in the history of organic chemistry.

D.B. Limaye's research papers on furocoumarin and Nidhone process published in Berishte, the journal of the Austrian Chemicals Society of Vienna in 1932 and 1934 respectively, established him as a chemist of international repute. It was appreciated by Prof. Earnest of Vienna University, Nasemesgenav and Sarevich the researchers on crop diseases in the agriculture department of the former Soviet Union, whereas Dr. Grobmet of Vienna University, Dr. Becker from London Sugasava of the medical faculty and Masayati Yanagita of the pharmaceutical faculty of the Tokyo University devised new chemical compounds with the help of Nidhone Process. A host of furocoumarins were synthesized and studied by Limaye's students after Limaye was recognized as a M.Sc. and Ph.D. guide of Bombay University in 1930[7].

In order to achieve his original objective of synthesizing Karanjin, he first synthesized a compound very close to Karanjin. When he was on the point of obtaining the synthesis of Karanjin, despite his meager resources at the Ranade Institute, he blundered in prematurely exhibiting a specimen of Karanjin in the Lucknow Session of the Indian Science Congress. At this very juncture, Dr. Sheshadri of the well equipped Andhra University Laboratory, synthesized Karanjin in 1941, snatching away D.B. Limaye's credit for his labour of two decades. From this event, D.B. Limaye drew the conclusion that in order to get their due credit, in the present world of ruthless competition, small research institutes ought to build up funds to acquire more facilities[8].

The Rasayananidhi Its Origin and Aims: D. B. Limaye founded the trust Rasayananidhi in 1930, to promote chemical research in view of marginal research in Western India, in the absence of research centers and negligible research grants. N.C. kelkar (the then edeitor of *Kesari)* and Dhondo Keshav Karve (the social reformer and the founder of SNDT Women's University of Bombay) were a few subscribers of Rasayananidhi in the beginning, while Babasaheb Ghorpade (the ruler of Ichalkaranji) instituted a scholarship for Ph. D. students[9].

D.B. Limaye became the first trustee of *Rasayananidhi*, Dattatraya Laxman Sahasrabuddhe (the Professor of Chemistry in the college of Agriculture, Poona and the Chemist to the Bombay Government) the second trustee from the beginning and Govind Ramchandra Kelkar, Limaye's Ph.D. student the Third trustee in 1941[10].

On October 22, 1930, the inauguration ceremony of Rasayananidhi was held at Kapilashram in the presence of around one fifty individuals including N.C. Kelkar, who donated Rs. 500/- on behalf of Kesari Maratha Trust. Initially, two students researched in Kapilashram laboratory (with a stipend of Rs. 3,000/- per year) from the funds of Rasayananidhi.

In 1933, the Silver Jubilee of D.B. Limaye's association with Balakrishna Rasashala and Ranade Institute was celebrated under the chairmanship of Balasaheb, the ruler of Miraj. Rasayananidhi donated to the Ranade Institute, Rs. one hundred fifty in the function of publication of its tri-annual report on August 19, 1934, chaired by Sir C.V. Raman, whom Limaye worshipped not only for his scientific research but also for his patriotism, which had motivated him to leave his government job in favour of the Presidency college, Calcutta.

Sir Raman, to whose Institute of Science, D. B. Limaye had donated his warbonds of Rs. One thousand and a cash of Rs. five hundred, lauded in his presidential address Limaye's pathbreaking achievements in chemical research, his skill of making the best of the least available resources and gave him the epithet of "a True Brahmin" for his intellectual quest. On this occasion, Rasayananidhi the symbol of which was Banyan tree, donated Rs. one thousand for the projected Maharashtra University, in conformity with Limaye's public pledge on the death anniversary of Vishnushastri Chiplunkar on 22nd April, 1932[11].

On 16th January 1936, D. B. Limaye with the help of his son and a researcher, Dr. S. D. Limaye, commemorated the 35th death anniversary of Justice M.G. Ranade at his residence describing Justice Ranade's contribution as the first Chairman of Aryan Education Society and dedicating to Justice Ranade, Ranjal and Ramel, the chemical synthesized by Rasayananidhi. A report on Rasayananidhi's Research was read out[12].

Rasayanam: Limaye began publishing research papers in the journal of Bombay University and the proceedings of Indian Academy of Science of Sir Raman after they developed friendship[13]. Although a founder of the Indian Chemical Society, publication of research papers of Limaye's own students was often delayed in the Society's journal. In 1925, when a few significant footnotes were dropped from Limaye's research paper without his permission, he found only one sympathizer among the members of the Indian Chemical Society during his eight months correspondence with the Committee appointed to examine his charges. Consequently, in 1936, Limaye launched the English chemical Journal Rasayanam, edited by D. D. Karve (the son of the social reformer, D. K. Karve)and V.K. Bhagwat, in order to give a platform to his own research and that of his students. From 1936 to 1956 Rasayanam published altogether 83 research papers in 12 issues bound in two volumes[14].

Dr. T. H. Wheeler, the Principal, Royal Institute of Science Bombay, in his inaugural speech on 21st March 1936, he called *Rasayanam* a solitary chemical journal from the Bombay Presidency, and D. B. Limaye, a first class organic chemist who, made pathbreaking contribution to research, by his selfless devotion to fundamental chemical research (useful to industries), in his laboratory, constructed with meager resources[15.]

The circulation of Rasayanam gradually increased in U.K., U.S.A. and Germany. According to the Agharkar Birth centenary Souvenir, D. B.Limaye was a member of the committee (chaired by Jaykar and set up on 17th October, 1944 by Principal J. R. Gharpure) for the establishment of Maharashtra Association for Cultivation of Science now known as Agharkar Institute and headed it's Chemistry department, from 1947-48 set up at Poona by the well known Botanist Dr. Shankar Purushottam Agharkar, after his retirement in 1946[16]. However, according to his granddaughter Kunda Deval this was not D.B. Limaye but his nephew Prabhakar Atmaram Limaye[17].

Rasayan Mandir: After guiding M.Sc. and Ph.D. students from 1943 to 1949 on behalf of Ranade Institute, Limaye established Rasayan Mandir as a separate laboratory for Rasayananidhi. Rasayan Mandir, was a fullfledged chemical research laboratory consisting of central library and four wings each for theoretical, inorganic, organic and applied chemistry. Special attention was focussed on organic chemistry and the ground available at Kapilashram was utilized for the laboratory. Out of the subscription of Rs.15667, for Rasayananidhi Rs. 700 were contributed by D. B. Limaye alone.

In the function held on 23rd April, 1949 for the establishment of *Rasayanmandir*, after D.L. Sahasrabuddhe, the trustee of Rasayananidhi read out the history of Rasayananidhi. N.V. Gadgil, the then Union Minister for iron and steel in his presidential address expressed the desire to encourage private initiative in scientific research and donated Rs. 1000/- in his personal capacity. In his speech, D. B. Limaye explained how Rasayananidhi had surpassed England and Russia in the Research on Aluminum and urged people to value fundamental research, instead of viewing research from utilitarian point of view. On his visit to Rasayan Mandir on 8th October 1949, B.D. Kher, the then Chief Minister of

Bombay Presidency, appreciated the spirit of the workers and the adverse circumstances, in which research was being carried out.

A meeting convened on 27th November 1949, set up a committee named Rasayan Mandir Sahayyak Mandal with the objective of collecting the additional three lakhs of Rupees, of which an amount of Rs. One lakh was urgently needed for laboratory premise, apparatus, library and miscellaneous purposes. As soon as the laboratory was erected, the number of research students increased rapidly from five to ten. However, contrary to Limaye's expectations, Poona University refused to recognize "Rasayan Mandir" as a research centre on the grounds that it lacked adequate amenities for research such as books, apparatus and a special premise for laboratory to accommodate adequate number of students. However, Limaye was so popular that students flocked to him in spite of his higher fees, compared to university fees. Dr. D. B. Limaye's son, Dr. S. D. Limaye who had guided five M.Sc. students of Bombay University in eight years, got recognition as a research guide of Poona University only when he completed his post doctoral research in the U.S.A. in 1952.

Nevertheless, with waning public response and drying public funds, in the absence of Government grants, "Rasayan Mandir" was dissolved in 1962. The funds of Rs. 67,000/- and the books of Rasayan Mandir Library were donated to the Poona University on 20th December, 1963. Out of the Rs. 67,000/- funds of Rasayan Mandir, scholarship for post doctoral research on chemistry was instituted in Poona University in Dr. D. B. Limaye's memory. After the Central Defense Ministry added Rs. 1,00,000 to the scholarship amountin 1987, the fellowship was converted into doctoral fellowship in 2006[18] .

D. B. Limaye was awarded D.Sc. by the Poona University on his eightieth birthday in 1967 in view of his eleven research papers published and 40 M.Sc. and 2 Ph.D. students guided. D. B. Limaye died subsequent upon kidney trouble and fever on 26th February, 1971. On 31st July and 1st August 1987, the Chemistry department of Poona University and the Science and Technology Department of the Government of India jointly celebrated D. B. Limaye's Birth centenary[19].

Dr. Limaye, A Teacher, A Guide and A Thinker: Owing to D.B. Limaye's insistence on evidence, and precision and his habit of avoiding overstatement in his writings and in his students theses, D.B. limaye never had to take back any of his claims and statements made in the scientific world.

Limaye, a member of German Chemical Society had mastery over English and German, comparatable to his mother tongue.

The laboratory of Kapilashram was open to outsiders, college students and science teachers whom Limaye guided meticulously, in writing articles and research papers. depressed to see B.Sc. degenerating into matriculation in Science, Limaye championed the cause of a limited number of subjects in school curriculum and viewed scientific articles in the text books, as a channel to popularize Science among masses. D.B. Limaye had asked his student D.B. Gangal to explore the opportunity for Indian research scientist in Japanese laboratories during his visit to Japan and encouraged Gangal's endeavours to set up in Poona an All India organization of science teachers on the Japanese model. D. B. Limaye's insistence on fundamental research, which demanded, in general, maximum wastage of resources, by exhausting minimum resources was at the root of early extinction of Rasayan Mandir. Unlike Dr. S. P. Agharkar, who, by procuring research projects, through his contacts with the All India Scientific Community, established during his service as Ghosh Professor of Botany at Calcutta, the then hub of resurgent Indian Science rescued his M.A.C.S. from "Infant casualty", ultimately fetching the affiliation of Poona University, D.B. Limaye, due to his failure to penetrate into the inner circles of the All India Scientific community rendered Rasayannidhi financially incompetent to secure affiliation of Poona University. The decision of D. B. Limaye, a Tilakite, to reject the jobs in leading scientific research organisations such as Royal Institute of Science, Bombay and Agriculture College, Poona for being Government funded was partly responsible for hampering his research career. However, he also refrained from joining active politics, as open conflict with the British Government would have ended to his scientific research. In short, Dr. Limaye was clear about his goals and did not want to diversify his energy. According to Dr. Kunda Deval, D. B. Limaye's granddaughter, a scientist to his finger tip, he could not fit in the bureaucratic culture of the chemical laboratories in post independence India, due to Limaye's old age and urge for individual freedom. D.B. Limaye christened his house, after Kapila, the rationalist exponent of Sankhya philosophy and due to his insistence on rationalism, traditional festivals like Haldi-kumkum and Mangalagauri gradually lost importance in Limaye's household[18].

Limaye disapproved obsolete methods of production like hand-spinning of cotton and was convinced that the modern progress ought to reach every Indian village. Neither a communist nor a socialist, D. B. Limaye was critical of the workers' exploitation in Bombay Mills. An advocate of dignity of labour, D.B. Limaye manufactured glass tubes and various other equipments in his laboratory with the help of his students, participated with his family, in tilling the soil of the plot while constructing his house, swept his house, washed toilets and his own clothes and mended shoes[19].

Lack of adequate research equipments and financial support, far from being a stumbling block, turned into Limaye's

strong point, challenging his imagination to invent options to the essential but costly laboratory equipments. As an option to the Fisher furnace and Bunsen Burner, Limaye devised a combustion furnace working on charcoal and requiring two burners. As an alternative to the regular apparatus to separate the solid object from the mixture of the solids and liquids, Limaye attached a glass tube with rubber lid to a tin barrel.

Limaye himself joined broken glass tubes and capillaries by heating, made spatulas and other laboratory equipments out of the wasteful iron pieces of broken umbrellas and prepared in his own laboratory, essential chemicals which he was otherwise required to import from abroad. He avoided wastage of stationery and prepared ink at home, used kerosene chimney and broken pieces of China clay utensils as alternatives to frying oven and pumic stove respectively. Dr. Paul Kahrer of Zurich University appreciated Dr. Rishikesh Pendse's training under D.B. Limaye in achieving the maximum by exhausting the minimum laboratory resources.

Sir, C.V. Raman was astonished to learn that, Rasayannidhi with the annual income of Rs. 3000/- equivalent to Sir Raman's monthly salary, conducted pathbreaking research.

D.B. Limaye wanted Indians to spend only on necessities and not on luxuries. He appealed to make best use of abundant Indian natural resources instead of blindly copying those Western habits and research ventures which did not necessarily suit Indian climate and were unaffordable to Indian pockets. Foresighted, D. B. Limaye predicted energy crisis as early as 1960s, unless every Indian household saved electricity and fuel[20].

A patriotic scientist, D.B. Limaye christened in Marathi new processes and compounds he invented and the organizations and periodicals he launched. He made the trust deeds of Rasayananidhi and Rasayan Mandir in Marathi. Despite D.B. Limaye's reverence for ancient Indian culture, he appealed to highlight the lost thread between ancient Indian science and modern science and to investigate the causes for the stagnation of the former[21].

Conclusion

By institutionalizing science through research organization,s Dr. D. B. Limaye replicated, Dr. M.L. Sarkar, J.C. Bose and P.C. Ray, in Maharashtra[22]. In fact, Limaye's Rasayananidhi was the first organized and sustained Maharashtrian attempt to establish an association solely dedicated to the cause of scientific research. In Limaye's relentless unflinching advocacy of fundamental research, he mirrored M.M. Saha's call for autonomous science and like him, became a failure in his last days owing to lack of government support[23].

Prof. Limaye pioneered and institutionalized chemical research in Maharashtra, initiated a new branch of organic research and gave a chemical orientation to the Ranade Institute. For this reason he can be well called as P.C. Ray of Maharashtra However, unlike the support of the locals that P.C. Ray was fortunate enough to receive, Limaye had to confront political groupism, privation of resources and lack of recognition in Poona men, then not a centre of scientific culture. It is a great tribute to Prof. D. B. Limaye that he made a path-breaking contribution to the evolution of organic chemistry, researching with inadequate financial assistance, in a laboratory ill equipped by modern standards. He brought Poona on the map of scientific research and was one of the few scientists of pre-independence India, who left an indelible imprint on international science in the hey days of colonialism, without having a glimpse of Western shores[24].

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