

CALCUTTA UNIVERSITY AND SCIENCE

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Despite the fact that the Presidency College at Calcutta witnessed great scientific research by Jagdish Chandra Bose and Prafulla Chandra Ray in the last decade of the nineteenth and the first decade of the present century, organised scientific research at Calcutta University began with the establishment of its University College of Science in March 1914. A galaxy of Indian scientists joined the Chairs set up with the income of the endowments donated by Palit and Ghosh, both associated with the National Education Movement in Bengal since the Indian Universities Act of 1904-5 and the partition of Bengal in 1905. The holders of the Chairs often worked under great financial constraints and with whatever apparatus was locally available in Calcutta. Yet their scientific research was soon to put Calcutta University on the map of world recognition. The science that developed at the Calcutta University in colonial India was not a colonial science, as it was hardly supported by any large scale imperial funds and was solely meant for "the promotion and diffusion of scientific and technical education and the cultivation and advancement of science, pure and applied" among Indians.

The year 1914 which saw the outbreak of the First World War was a turning point in the history of Calcutta University and Science in India. It was the year which witnessed the establishment of Calcutta University's University College of Science. No other department of the University had brought it so much lustre and fame as it did within two decades of its foundation. The establishment of the College marked the beginning of a hectic period of scientific research among Indians which was soon to put Calcutta University on the map of world recognition.

SCIENCE IN CALCUTTA UNIVERSITY BEFORE 1914

It will, however, be a travesty of truth to say that scientific research in Calcutta University originated with the University College of Science. Many years before its birth, the Presidency College, a constituent college of the University, was the scene of great scientific research activities by Jagdish Chandra Bose and Prafulla Chandra Ray. Bose joined the College as an Assistant Professor in Physics in 1885 and retired from it as a Senior Professor in 1915 a year after the birth of the University College. Between 1885 and 1915, Bose was deeply engaged in physical as well as plant physiological investigations¹. P.C. Ray joined the Presidency College in 1889 as an Assistant Professor of Chemistry after obtaining his doctorate degree in 1887 from Edinburgh University working under Professor Alexander C. Brown. Ray was at the Presidency College till 1916, when he joined the newly founded University College of Science. Between 1889 and 1916, Ray did great work in Chemistry. It was he who discovered mercurous nitrite in 1896, prepared a number of new nitrites, their double

salts and their reaction products with mercaptans; started with his meagre income and active co-operation of his friends, the Bengal Chemical and Pharmaceutical Works, which became a limited concern in 1901 and influenced by Berthelot's *Greek Alchemy* published *History of Hindu Chemistry* in two volumes in 1902 and 1909 – an outstanding contribution to the history of science in India².

HINDRANCES TO THE GROWTH OF SCIENCE AT THE POST GRADUATE LEVEL

One reason why Calcutta University could not develop a research programme in science earlier than 1914 was partly because of a great handicap inherent in its constitution and partly because of the paucity of funds needed for the development of such a programme at the post-graduate level.

The handicap in the constitution of the Calcutta University occurred when the three Acts of Incorporation were passed by the Governor-General and Viceroy, Lord Canning, in January 1857 which provided for the establishment of three universities at Calcutta, Bombay and Madras on the model of the University of London, as directed by the Education Despatch of 1854. The preambles in the three Acts of Incorporation were identical. They defined the objects of the universities to be “ascertaining by means of examination the persons who have acquired proficiency in different branches of Literatures, Science and Art and of rewarding them by Academic Degrees as evidence of their respective attainments.” There was to be a Chancellor, a Vice-Chancellor, and Fellows, both *ex-officio* and ordinary, who together would constitute the “Body Politic and Corporate” for each of the three universities. The number of the Fellows, excluding the Chancellor and Vice-Chancellor, was to be not less than 30. While the Fellows *ex-officio* were to hold their fellowships during their official tenure only, the ordinary Fellows were to be appointed by government for life – vacancies in their ranks could arise only by death, resignation or permanent retirement from India in the case of European officials, or by cancellation of the appointment by government.

These three Acts of Incorporation ignored an important passage in the Education Despatch of 1854 and this constituted the handicap in the constitutions of these universities. The important passage ignored suggested the possibility of “professorships for the purpose of the delivery of lectures in various branches of learning for the acquisition of which, at any rate in an advanced degree, facilities do not now exist in other institutions in India”. When the Universities of Lahore and Allahabad were accorded this privilege in 1882 and 1887 respectively, some Indians asked for its extension to the universities of Calcutta, Bombay and Madras, but European officials closely connected with the Universities refused it on two grounds. They said that the demand for such expansion was unjustified in as much as the need for a teaching university had in reality been satisfied by the collegiate system which had sprung into existence since 1857. They also said that it would be vain and foolish to constitute professorships or lectureships for students a more advanced than those who attended the college lectures, because there were insufficient such students and courses, and no funds for the purpose³ And so till the end of the nineteenth century, Calcutta University

remained mainly an examination body fed by a number of affiliated colleges which actually did the teaching and which were dispersed from Simla and Mussorie to Indore and Jaipur, and from Jaffna and Batticaloa to Sylhet and Chittagong.

TOWARDS THE TRANSFORMATION OF THE CALCUTTA UNIVERSITY INTO A TEACHING UNIVERSITY

In those colleges there was hardly any provision for teaching of science courses and with the exception of three colleges each in civil engineering and medicine, all the 85 colleges in British India by 1882 were teaching courses in liberal arts leading to Matriculation, F.A., B.A., Honours & M.A. and qualification in Law. By 1883, out of an estimated population of 250,000,000 in British India, some 25,000 had received their higher education in liberal arts, while the number of those receiving training in medicine and civil engineering together fell well below the 700 mark.

What was the prospect open to the large number of students who did not receive any training in civil engineering and medicine? For one thing a career in India was never virtually open to talent, though the principle had been asserted time and again in the Charter Act of 1833 and the Queen's Proclamation of 1858 after the Mutiny to allay fear, suspicion and distrust. Again, some avenues like army and politics were closed altogether. In those days, agriculture offered little incentive and so did manufacturing and commerce, for the latter was almost impossible without the skill, capital and equality of terms with which it could compete with European industry. As a matter of fact, the very nature of the courses with their unique and disproportionate attention to literature and philosophy compared with physical and cognate branches of practical instruction tended to limit the choice of a career to either government service or analogous employment. "What else can he do but qualify himself", lamented a Calcutta newspaper," or if he is father, train his son for the public service or one of the learned profession"? While it was not easy for them to enter the government civil services thrown open to the educated young Indians since 1853, little more than one third of the graduates were able to enter lower level of the government services. And most of them except those who took to law, teaching and journalism remained unemployed and so discontented. Discontent among the educated unemployed gave rise to militant nationalism threatening the very existence of the British empire in India. Higher education in India was singled out as the root for all evil: "When Erasmuns was reproached with having laid the egg from which come forth the Reformation, 'yes', he replied; but I laid a hen's egg and Luther had hatched a fighting cock". It was thought necessary to curb the growth of militant nationalism by controlling "the Educational Juggernaut" and this was done by Curzon in 1904 by passing the Indian Universities Act which was based on the recommendations of the Indian Universities Commission of 1902.

While the various recommendations of the Commission to enable the *Raj* to control higher education in Indian were not strictly relevant here, some at least relating to the creation of new courses in science are important. The Commission for the first

time suggested the creation of the Faculty of Science in addition to the existing four Faculties of Arts, Law, Medicine and Civil Engineering and suggested the following subjects for the science courses:

B.Sc. COURSE

One of the following groups of subjects:

1. Mathematics, physics and Chemistry
2. Physics, Chemistry and Natural Science.

M.Sc. Course

Anyone of the subjects included in the B.Sc. Course.

The Commission also recommended the award of the degree of Doctor of Science to be given to a Master of Science after some years spent in original investigations.⁴

BEGINNING OF POST-GRADUATE TEACHING AND RESEARCH AT CALCUTTA UNIVERSITY

The Indian Universities Act of 1904-5, which incorporated these recommendations of the Indian Universities Commission, merely endorsed a provision of the Education Despatch of 1854, which was violated by the Acts of Incorporation setting up in 1857 the three universities at Calcutta, Bombay and Madras. And it was left to Asutosh Mookerjee who became Vice-Chancellor of the Calcutta University in 1906, one year after the Indian Universities Act of 1904-5, to seize this provision of the Act to convert Calcutta University, hitherto an examination body, into a teaching university. He began with the Humanities Department and by 1912 he was not only able to start post-graduate teaching in English, Sanskrit, Pali, Arabic, Persian, Mental and Moral Philosophy, History, Economics and Mathematics but also establish Chairs in some of them with financial support from the government⁵

For seven years, Mookerjee struggled hard to establish postgraduate teaching and research in the Humanities, but as the University had no funds and government money was not forthcoming, he could not start post-graduate teaching in Science despite his best intentions. "If there were men, there was no accommodation, no laboratory, no workshops, no museums, no equipments". The paucity of funds and accommodation even in undergraduate courses in Science were really deplorable. In the Presidency College, the premier college of Calcutta, a small room measuring 35'6" by 25'6" was available to be used as a laboratory, a preparation room and as well as a practical class room for biology classes. Only students of B.Sc. course were able to get instruments in Practical Physiology and Practical Botany, whereas a large number of B.A. students did not get the opportunity of having a regular course of practical training⁶

ESTABLISHMENT OF THE UNIVERSITY COLLEGE OF SCIENCE

In these circumstances, Calcutta University was pleasantly surprised to receive the princely gifts of Taraknath Palit. Palit, an eminent barrister and an advocate of national education during the Anti-Partition Movement since 1905, made over to the University assets worth seven lakhs of rupees in June 1912, for “the promotion and diffusion of scientific and technical education and the cultivation and advancement of science, pure and applied, amongst his countrymen by and through indigenous agency”. In October of the same year, Palit executed another deed in favour of Calcutta University by which he further transferred his assets in money and property worth seven and a half lakhs of rupees – in all assets worth more than fourteen lakhs of rupees, including his own dwelling house, were made over to the university by Palit for the advancement of Science and Technology.⁷

As per the conditions of the two deeds executed by Palit in June and October 1912, the University was to maintain from the income of the endowment a Chair of Physics and a Chair of Chemistry and to institute scholarships to be awarded to the distinguished graduates of Calcutta University of either sex for the higher study of science in an advanced country. The university was to provide “from its own funds” suitable lecture rooms, libraries, museums, laboratories, workshops and other facilities for teaching and research in connection with the two Chairs of physics and Chemistry and as the money provided by the University was not fully adequate, Mookerjee approached the Government of India for financial support, which was rejected by Henry Sharp, Joint Secretary in the Department of Education, with the observation that “when funds were available the request of the university will be considered along with other claims”⁸. The opposition of Sharp mainly emanated from his dislike of Calcutta University which had not “ceased to be a political body, with a strong prejudice against the white man and the Europeans, the Senate are unable or afraid to stem the tide. Its work has been mainly an eyewash. To give money to this place, save on proper conditions, is to give money to the cause which will embarrass ourselves. The money will go to political ends rather than to truly educational ends”⁹.

In August 1913, Rashbehary Ghosh, an eminent jurist and scholar, in a letter to Asutosh Mookerjee placed in the hands of the University “a sum of rupees ten lakhs in furtherance of the University College of Science as projected by you with the sanction of the Senate”. As per the conditions of his gift, there were to be established four Chairs – one each in Applied Mathematics, Physics, Chemistry and Botany, with special reference to Agriculture, and eight studentships to be awarded to the distinguished graduates of this University “to carry on investigation” under the guidance of a Professor and “generally to assist him in his work of original research”¹⁰.

Both Plit and Ghosh wanted promotion and diffusion of scientific and technical education among their countrymen by indigenous agency and with the money now available through their endowments, Mookerjee could now launch his projected University College of Science. And four days before the expiry of the fourth term of

his Vice-Chancellorship, Mookerjee laid the foundation-stone of the University College of Science on 27 March 1914 hoping fervently that “although the College of Science is an integral component part of the University of Calcutta, it will be regarded not as a provincial but an all-India College of Science to which students will flock from every corner of the Indian Empire, attracted by the excellence of the instruction imparted and of the facilities provided for research”¹¹

The establishment of the Calcutta University College of Science signals the beginning of outstanding research in some branches of science, which put India on the map of world recognition. A galaxy of Indian scientists joined the departments set up with the income of the endowments donated by Palit and Ghosh and began their work in science with whatever apparatus available in India and soon made their mark in their chosen fields. Palit Chairs in Physics and Chemistry and Ghosh Chairs in Physics, Chemistry, Applied Mathematics and Botany were soon filled up after the formal establishment of the University College of Science in March 1914. As stipulated in both the deeds executed by Palit and Ghosh, the incumbent should be “Indians (persons born of Indian parents as contradistinguished from persons who are called statutory natives of India) to be nominated by a Governing Body” consisting of the Vice-Chancellor, the DPI, Bengal, the Deans of the Faculties of Science and Engineering, four members of the Senate elected annually, four members of the founder nominated every three years and two representatives of the professorial staff to be elected annually from among themselves.¹²

ESTABLISHMENT OF CHAIRS IN CHEMISTRY, PURE AND APPLIED

The University College of Science started functioning with the appointment of P.C. Ray as Palit Professor of Chemistry in 1916. As we have seen, by 1916 Ray had already made outstanding contribution to Chemistry while working at the Presidency College, Calcutta. As Palit Professor of Chemistry, he rigorously pursued his research in the laboratory – the question of variability of valency attracted his attention. He studied the compositions and structures of a number of substances derived from organic sulphur components and chlorides of gold, platinum and iridium. His last few papers were on the subject of organic fluoro-compound. Till his last day in the laboratory, he carried out experiments with his own hands and won international recognition when in 1934 he was elected an Honorary Fellow of the Chemical Society of London and of the Deutsche Akademik of Munich. However, his activities were not confined to the laboratory only. He devoted a portion of his time and energy to public activities relating to education, health, reform and social service and economic uplift of the masses. He hardly participated in political activities, though he became an ardent advocate of spinning and weaving. After his retirement in 1936, he was made Emeritus Professor of the Calcutta University, which position he held till his death in June 1944. His *Life and Experiences of a Bengali Chemist* published before his retirement in 1936 and dedicated to the youth of India bears testimony to the zeal with which he ventured to explore the little known world of chemistry in India.¹³

Before Ray, systematic and sustained chemical research in India was practically unknown and Ray who with the help of his senior pupils had started his original investigations was able before his retirement to establish the nucleus of an Indian School of Chemistry. As Edward Thrope, the outstanding British Chemist, wrote about him "Acharya Parafulla Chandra has become many in his students and has made his heart alive in the hearts of many" like Saha and Bose. If he were "Acharya" to Rabindranath Tagore, he was a "great son of India" to Gandhi. And the British Crown gave him C.I.E. (Companion of the Indian Empire) in 1912 and Sir (Knighthood) in 1919 in spite of his being an active nationalist and dedicated patriot exposing the British exploitation in India.¹⁴

Profulla Chandra Ray was thus the father of Indian School of Chemistry – he put Indian Chemistry on a high pedestal by his hard work; so did one of his close students who joined as the first Rashbehary Ghosh Professor of Chemistry in 1914 after obtaining a doctorate in Chemistry from Berlin in 1912 under the guidance of Professor Carl Liebermanon. He was Profulla Chandra Mitter who held the post till 1937 when he retired. Mitter worked very hard in connection with the planning and construction of the building for the projected University College of Science. In his laboratory, he was engaged in the preparation of nitrogenous-compounds till 1927. Later, he started the project on the anthraquinones and made a contribution of fundamental importance on general properties and structure of natural anhraquinones, their classifications and synthesis¹⁵

Both Ray as Palit Professor and Mitter as Ghosh Professor worked on Pure Chemistry; in Applied Chemistry it was the work of Hemendra Kumar Sen who made outstanding contributions. The teaching of Applied Chemistry was inaugurated with a further donation of Rs 11,43,000 from Rasbehary Ghosh in 1919¹⁶ and in 1921 Hemendra Kumar Sen who began his career in 1908 as a personal research student of Ray and later obtained a doctorate from the London Imperial College of Science and Technology in 1915 joined as Ghosh Professor of Applied Chemistry. The course of study in Applied Chemistry gradually became so specialized and technical that it appeared necessary to develop Applied Chemistry as a separate department during 1934-36. It was in his department that Sen developed the first nucleus in India of a systematic survey of coals and their economic utilization. The low temperature carbonisation of coal was one of the problems to which he devoted many years of his work. The importance of the production of power alcohol from the waste cellulosic materials available in India was first screened by Sen at the Second World Power Conference in Berlin in 1920. As a matter of fact, a long range problem of research in his laboratory was the production of power alcohol by fermentation from a particular type of wood found in Sunderban. Sen, however, did not confine himself to any particular line of study – one special problem that particularly engaged his attention was the eradication and utilization of water hyacinth, an exotic ever-green aquatic plant of exuberant growth. Sen left the department after 15 years of service in 1937 to accept the post of Director of the Central Lac Research Institute of Ranchi¹⁷.

ESTABLISHMENT OF CHAIRS IN PHYSICS, PURE AND APPLIED

The Physics Department of the University College of Science was inaugurated with the appointment of C.V. Raman as Palit Professor in 1917. Before his appointment to the Chair, Raman had been since 1907 a member of the Indian Finance Service of the Government of India at Calcutta where during his spare hours he used to carry on original investigations in the laboratory of the Indian Association for the Cultivation of Science founded in 1876 by Mahendralal Sircar, a great scholar, physician, scientist and educationist¹⁸. His investigations on the molecular scattering of light led to the discovery of "Raman Effect" in 1923 for which he was awarded the Noble Prize in 1930 and brought lustre to Calcutta University and Science in India. His discovery made it possible to map out the levels of possible energy gains of the molecules and atoms of the substance and infer the detail of molecular and atomic structure. By substituting measurement of colour modifications of visible X-rays the alternative to Infra-Red Spectroscopy, that is, Raman Spectroscopy, provided a superbly easy experimental technique. Raman left Calcutta University College of Science in 1934 to become Director of the Indian Institute of Science, Bangalore and later in 1943 founded at the same place Raman Research Institute¹⁹.

Raman was succeeded by Meghnad Saha as Palit Professor of Physics in 1938. Saha had joined Department of Mathematics as Lecturer in 1916 but found it irksome to get on with Professor Ganesh Prasad and got a transfer to the Department of Physics in 1917. In 1919, he was awarded Premchand Roychand Scholarship, visited Europe for two years and on his return in 1921 was appointed Khaira Professor of Physics, one of the five Chairs created with the gift of Kumar Guruprasad Singh of Khaira in 1920-21. But two years later in 1923, he left Calcutta to join the University of Allahabad as the Professor and Head of the Department of Physics and stayed there for 15 years till his return to Calcutta as the Palit Professor in 1938.

It was at the young age of barely 26 in 1917 that Saha earned world-wide recognition for his theory of thermal ionization. If heat is added to matter, its general effect is to loosen its component parts; a solid, when heated, turns into a liquid, and the liquid on heating becomes vapour consisting of discrete molecules. On further heating, the molecules in the vapour break up into their constituent atoms. Saha argued that if the addition of heat be continued still further, then electrons, being one of the constituents of the atoms, will be detached from the atoms and the atoms will be positively charged or ionized. Saha thus conceived the idea of applying what is known as the law of reversible action in chemistry to a hot mass of gas consisting of molecules, dissociated atoms – neutral and ionized – and electrons. With the help of the formula so obtained, he could calculate the percentage concentrations of the 'dissociated' components as a function of the temperature and pressure of the hot mass of gas. The application of this so-called Theory of Thermal Ionization to the spectra of celestial bodies immediately brought order in a host of uncorrelated data of the molecular and atomic spectra. For this work, Saha was admitted to the Fellowship of the Royal Society of London in 1927 at the young age of 34. A great organizer, Saha was

associated with the establishment of U.P. Academy of Sciences, National Institute of Sciences of India, the Indian Physical Society and in Calcutta he expanded the Indian Association for the Cultivation of Science and established the Institute of Nuclear Physics in April 1948, attached to the Calcutta University.

In 1920, Phanindranath Ghosh was appointed the first Ghosh Professor of Applied Physics. In 1914, he started his career as a Lecturer in Physics and obtained his doctorate in Optics in the same year from Calcutta University, when he was appointed Ghosh Professor of Applied Physics. He developed post-graduate courses suitable for students in the industrial application of physics. In 1925, when the post -graduate course in Applied Physics was opened, Ghosh was offered a single room and a few antiquated measuring instruments and two 1(H.P.) D.C. motors for giving instruction in Electro Technology. By his untiring perseverance and relentless efforts he developed the Department. He conducted investigations on molecular spectroscopy, dielectrics and design of electrical measuring instruments. His spectroscopic laboratory was one of the best in Asia²¹.

ESTABLISHMENT OF CHAIR IN APPLIED MATHEMATICS

In 1916, the Department of Applied Mathematics started functioning with the appointment of Ganesh Prasad as the first Ghosh Professor of Applied Mathematics, a post which he held with credit till 1918. In 1923, after retirement of Professor Cullis, Prasad was invited by Mookerjee to occupy the Hardinge Chair of Pure Mathematics started in 1912 with financial support from the Government of India. He held this post till 1935, when he died. Prasad who started his work at Cambridge and finished it at Gottingen was mainly concerned with the potenticis of ellipsoids of variable densities and attracted a number of talented students from different parts of India to do research specially in the Theory of Functions of a real variable²²

N.R. Sen was appointed Ghosh Professor of Applied Mathematics in 1924. Young people animated by the spirit of quest gathered round him and soon Calcutta became an active centre for fundamental research in various disciplines of mathematical studies, such as Relativity, Astrophysics, Geophysics, Quantum Mechanics, Statistical Mechanics, Hydromagnetics, Fluid Dynamics, Elasticity and Ballistics. In 1936, Sen made an improvement in his Department by the addition of a Mathematical laboratory. The Computation laboratory and also the Hydrodynamic Laboratories are monuments of Sen's vision – rightly he had since been described as “the Father of Applied Mathematics in India.”²³

ESTABLISHMENT OF CHAIRS IN LIFE SCIENCE

The Department of Zoology was opened in 1919 with a museum attached to it and with one student, Durgadas Mukherjee, who later jointed his Department as a teacher. However, not until 1933, when Himadri Kumar Mookherjee became the Professor of Zoology (named Nilratan Sirkar Chair of Zoology in 1944) that interest in Zoological

studies in Bengal could be created. Mookherjee with his determined efforts popularised the study of Zoology, introduced Biology as a subject in undergraduate courses, while introducing Fishery and Entomology as special subjects in the post-graduate courses and made important contributions to comparative embryology. His colleague, Harendranath Ray, worked on the bionomics and systematics of parasitic protozoa²⁴.

The Department of Botany, which was opened a year earlier than that of Zoology, became well-known two years later, when S.P. Agharkar was appointed Ghosh Professor of Botany in 1920. Agharkar who came from the Elphinstone College of Bombay held the post till 1946 and made outstanding contributions to botanical studies in India. He was a well-known morphologist who made critical observations on teratological phenomena in the plant kingdom. He recorded abnormalities on many flowers like *Musa Superba* based on the examination of 2618 flowers. His name is commemorated in two flower plants – *Dicrala Agharkaric* and *Musa Agharkarii*, one fungus – *Mitula Agharkarii* and one centipede (-) *cryphryptops Agharkarii*²⁵

ESTABLISHMENT OF CHAIRS: KEYS TO THE START OF OUTSTANDING RESEARCH IN SCIENCE IN CALCUTTA UNIVERSITY

The establishment of Chairs in Chemistry, Physics, Mathematics as well as in Zoology and Botany was the starting point of outstanding research and teaching by dedicated Indian scientists. Asutosh Mookerjee who became the first President of the first session of the Indian Science Congress at Calcutta, where nearly more than a hundred scientists met in January 1914²⁶, took great care to identify the right talent for the right post from different parts of India in science as in humanities and was able to attribute to the University College of Science a truly national character. No nation could live solely upon the achievements of its past or upon its borrowings from others, and , at the same time hoped to retain its place among the great people of the earth. Besides advancing the frontiers of knowledge in science, the work by the Indian scientists at the University College of Science not only helped in increasing the wealth of the country but also succeeded in drawing the attention of the scientific world. The dedication and devotion with which the Indian scientists at the University College of Science began their work to explain the many unknown phenomena can only remind us of the zeal and enthusiasm with which William Jones and his choice band of thirty elite Englishmen in 1783-84 had began their investigations into "the history and antiquities, arts, sciences and literature of Asia".²⁷

SCIENCE AT THE UNIVERSITY COLLEGE OF SCIENCE IN COLONIAL INDIA WAS NOT A "COLONIAL SCIENCE"

In 1929, in Britain support for scientific research was provided in the Colonial Development Act, which aimed not so much at helping the colonies but at easing unemployment in Britain. Between 1929 and 1934, scientific research expenditure was 4% of the total expenditure, which rose to 24% between 1934 and 1939. In all those years, India's share was extremely meagre-in the late 1920s it was hardly 1.1% when

it was 69.8% in Britain, 15.1% in the Dominions and 14.0% in the colonies²⁸. Nevertheless, with the meagre support provided by Britain in pre- and post-1929 years, scientific research which developed in India was tied to the apron strings of British imperialism²⁹. The British in India were quick to realise the role and importance of science in the process of empire-building, but they excluded Indians as a matter of policy from any effective participation in their scientific undertakings. The highly inquisitive and intelligent Indians began to look for a distinct identity in science which found its expression in the establishment of the Indian Association for the Cultivation of Science by Mahendralal Sircar in 1876³⁰

Asutosh Mookerjee almost achieved in 1914 what Mahendralal Sircar had set out to achieve in 1876 – to help India achieve her “share in the responsibilities with the civilised nations of the world... by means of science or positive knowledge of God’s works”³¹. During all these years between 1876 and 1914, Sircar’s “Association” had been a force to reckon with in the development of science by the Indians. It not only influenced the inaugural undergraduate courses in science in the Calcutta University but profoundly influenced the National Education Movement which emerged as a fallout of the Swadeshi Movement in the wake of Curzon’s passing of the Indian Universities Act of 1904-5 and the partition of Bengal in 1905. Both Palit and Ghosh who helped Asutosh Mookerjee with huge donations to found the University College of Science were ardent patriots, devoted nationalists and were intimately associated with the National Education Movement, which had a scientific overtone in Bengal³². In their deeds with the Calcutta University, they stipulated conditions whereby none but the Indians could hold the Chairs at the University College of Science. And the sole object of their gifts was for “the promotion and diffusion of scientific and technical education and the cultivation and advancement of science, pure and applied, amongst my countrymen, by and through indigenous agency”, as Ghosh made it clear in a letter to Asutosh Mookerjee on 8 August 1913.

Thus, the University College of Science did not emerge like some scientific departments and societies of British India to satisfy imperial needs and interests. Despite the fact that the College was a department of the Calcutta University set up as a part of the colonial educational system under the directions of the Education Despatch of 1854, there had been no substantial financial support from the British Raj to encourage the Indian scientists in their works presumably under the idea that Indian brains were not suitable for scientific research despite the great promise shown by Jagdish Chandra Bose and Profullachandra Ray at the Presidency College years before the foundation of the University College of Science. Of the total expenditure of Rs 18,13,959 of the University College of Science between March 1914 and March 1922, the Government of India’s contributions from public funds was a meagre Rs. 1,20,000/ - only³³.

And how did the scientists at the University College work? Many of the full-time teachers who could not look forward to any external source of income, voluntarily kept a substantial portion of their salaries in abeyance, while part-time lecturers ungrudgingly

continued their association with the University College of Science without any remuneration. They never left the College except in a very few cases where the scientists left it with better positions in imperial organizations, as in the case of Sen³⁴. The classic example is provided by Profulla Chandra Ray who when reappointed Palit Professor for 5 years after reaching the age of superannuation donated his full monthly salary for the entire period for the special benefit of his department which was "proud to acknowledge him as its leader"³⁵. Yet in spite of these financial constraints and difficulties, there had been "a steady output of original work rapidly increasing in volume and improving in quality" which emanated "not from one or two extraordinarily isolated or exceptionally gifted workers blessed with special advantages and facilities, but from a large body of able and devoted scholars"³⁶. Among those who left Calcutta University, there were indeed many who carried with them the devotion and dedication to investigation developed at Calcutta like S.N. Bose, who continued his work in the newly founded Dacca University after leaving Calcutta University's Department of Physics in 1921 and within three years in 1924 was able to make outstanding contributions to the new statistics with notes from Einstein indicating its importance³⁷. No doubt, the scientists at the University College of Science sowed the seeds of many a promising project which were to bear fruits in the post-independent years. The University College of Science was indeed an oasis of scientific research in India before 1947.

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9. As quoted in A.Bose "The Indian Response to Scientific and Technical Education in the Colonial Era, 1820-1920" in Deepak Kumar ed., *Science and Empire* (Delhi, 1911), p.135.
10. *Hundred Years of the University of Calcutta, op.cit.* pp. 235-37.
11. N.K. Sinha, *Asutosh Mookerjee* (Calcutta, 1966), p-85, Mookerjee seemed to echo the sentiments of Dallhousie about the Presidency College he had set up after reforming the Hindu College in 1853 when he observed: "The time, I doubt not, will come when the Presidency College, having elevated itself by its reputation and scholarships will expand itself into something approaching to the dignity and proportions of an Indian university". See Suresh Chandra Ghosh, *Dalhousie in India, 1848-56* (Delhi, 1975), . p.12.
12. *Hundred Years of the University of Calcutta, op.cit.*, pp.232-33 and 236-37.
13. S. Mukherjee and P.K. Bose, ed., *op.cit.*, pp.29-31.
14. *Three Convocation Addresses of P.C. Ray* (Calcutta, 1989), Compiler's Note.
15. *Biographical Memoirs of Fellows of the Indian National Science Academy* (Delhi, 1966), Vol.1, pp.44-57. Also *Fellows of the Indian National Science Academy: Past and Present* (Delhi, 1984), p.2995 et seq.
16. *Hundred Years of the University of Calcutta, op cit.*, pp.270-71.

17. *Biographical Memoirs of Fellows of the Indian National Science Academy*, *op cit*, pp.88-89.
18. See an interesting article on Mahendralal Sircar in Deepak Kumar, ed., *op cit*, p.152 *et. seq.*
19. *Fellow of the Indian National Science Academy: Past and Present op.cit.pp.3799-80*. Also *Chamber's Biographical Encyclopedia of Scientists* (Edinburgh, 1981), p.419.
20. B. Mukherji and P.K. Bose, eds., *op cit.*, pp.61-63.
21. *Biographical Memoirs of Fellows of the Indian National Science Academy* (Delhi, 1970), vol.2, pp.5-6.
22. *Ibid.*, (Delhi, 1979), Vol.5, pp.40-44.
23. *Ibid.*, (Delhi, 1966), Vol.1, pp.128-135.
24. *Fellows of the Indian National Science Academy: Past and Present op. cit.*, p.299. Also *Hundred Years of the University of Calcutta*, *op cit.*, pp.185-86.
25. *Ibid.*, p.465.
26. B.V. Subbarayappa and Amit Das. "Growth of Science and Technology during the British period", in A. Rahaman and P.N. Chowdhury eds., *Science and Society* (Delhi, 1980),p.129.
27. For details, see Suresh Chandra Ghosh, *The Social condition of the British Community in Bengal, 1757-1800* (Leiden, 1971) p.166 *et.seq.*
28. Michael Worboys, "Science and the Colonial Empire, 1895-1940", in Deepak Kumar, ed., *op cit.*, p.20
29. A. Rahaman, R.N. Bhargava, M.A. Qureshi, Sudarshan Pruthi, eds., *Science and Technology in India* (Delhi, 1973), p.14.
30. Deepak Kumar, "Colonial Science: A look at the Indian Experience" in Deepak Kumar, ed., *op.cit*, pp.9-10.
31. Se Mahendra Lal Sircar's last letter to the Indian Association for the Cultivation of Science on 28 November 1903 as quoted in Chittabrata Palit, "Mahendralal Sircar, 1833-1904: The Quest for National Science" in *Ibid*, p.158.
32. For details about the National Education Movement in Bengal, se Haridas and Uma Mukherjee, *The Origins of the National Education Movement, 1905-1910* (Calcutta, 1957).
33. *Hundred Years of the University of Calcutta*, *op.cit* , p.284.
34. *Biographical Memoirs of Fellows of the Indian National Science Academy*, *op.cit.*, p.89.
35. *Hundred Years of the University of Calcutta*, *op.cit.*, p. 291.
36. *Ibid.*
37. Satyendra Nath Bose (better known as Satyen Bose) returned to the Calcutta University College of Science as Khaira Professor of Physics in 1945.