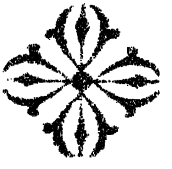
JAGADIS CHANDRA BOSE 1922

ACHARYA
JAGADIS CHANDRA BOSE

BIRTH CENTENARY



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CONTENTS

TEXT

The Editor thankfully acknowledges the help he has received from Sree K. P. Biswas and Sree H. K. Deb in preparing this life-story.

PLATES

It was a woman in the Vedic times, who when asked to take her choice of the wealth that would be hers for the asking, inquired whether that would win for her deathlessness. What would she do with it if it did not raise her above death? This has always been the cry of the soul of India, not for addition of material bondage, but to work out through struggle her self-chosen destiny and win immortality. Many a nation had risen in the past and won the empire of the world. A few broken fragments are all that remain as memorials of the great dynasties that wielded the temporal power. There is, however, another element which finds its incarnation in matter, yet transcends its transmutation and apparent destruction: that is the burning flame born of thought which has been handed down through fleeting generations.

JAGADIS CHANDRA BOSE

THE weakling who has refused the conflict, having acquired nothing, has nothing to renounce. He alone who has striven and conquered can enrich the world by the generous bestowing of the fruits of his victorious experience. In India such examples of constant realisation of ideals through work have resulted in the formation of a continuous living tradition. And by her latent power of rejuvenescence she has readjusted herself through infinite transformations. Thus while the soul of Babylon and the Nile Valley has transmigrated, ours still remains vital and with capacity of absorbing what the time has brought, and making it one with itself.

JAGADIS CHANDRA BOSE

JAGADIS CHANDRA BOSE 1901

Jagadis Chandra Bose

The Story of his Life

THE twentieth century had just dawned. An Indian scientist was addressing leading British scientists at the Royal Institution, London. The subject of the Friday Evening Discourse of May 10, 1901 was novel. While engaged in his researches with a wireless receiver in Calcutta earlier, the speaker of the evening had noted that the uncertainty of his receiver was brought about by fatigue and that the curve of fatigue of his instrument resembled the fatigue-curve of an animal. He was, therefore, giving a discourse on the general phenomena of response.

But the bold Indian scientist did not end his discourse on a strictly conservative note. "I have shown you this evening", he said, "autographic records of the history of stress and strain in the living and the non-living. How similar are the writings. So similar indeed that you cannot tell one apart from the other. We have watched the responsive pulse wax and wane in the one as in the other. We have seen response sinking under fatigue, becoming exalted under stimulants and being killed by poisons, in the non-living as in the living. Amongst such phenomena, how can we draw a line of demarcation and say, here the physical ends, and there the physiological begins? Such absolute barriers do not exist". He asked: "Do not these records tell us of some property of matter common and persistent? Do they not show us that the responsive processes, seen in life, have been foreshadowed in non-life? . . . . that the physiological is related to the physico-chemical? . . . . that there is no abrupt break, but a uniform and continuous march of law"?

The Message of India

Disregarding the demarcation line that is so often drawn between precise enquiry that science demands and bold thinking that philosophy favours, the youthful scientist fell back upon the age-old message of his motherland that there is an underlying unity amidst apparent diversities.

In bringing the discourse to a close, the Indian scientist observed: "When I came upon the mute witness of these self-made records, and perceived in them one phase of a pervading unity that bears within it all things . . . . the mote that quivers in ripples of light, the teeming life upon earth, and the radiant suns that shine upon us . . . . it was then that I understood for the first time a little of that message proclaimed by my ancestors on the banks of the Ganges thirty centuries ago—'They who see but one in all the changing manifoldness of this universe, unto them belongs Eternal Truth . . . . unto none else, unto none else'."

By repeating this eternal message of India from a platform jealously guarded as a close preserve for science and science alone, the Indian scientist, Jagadis Chandra Bose, proclaimed the mission of his scientific life. But more than one scientist in the West challenged the results of his enquiry. Persistent attacks hurled against him were sometimes hard and often uncharitable. Nevertheless, the "militant" Indian manfully met the challenge. He bravely accepted, confronted and dominated all opposition.

The life-history of this man is the story of a voyager who had sensed his destination and whom no storm, no breakers nor bar could turn back. Like a true *kshatriya,* he fought his way through with a courage and chivalry that derived inspiration from the immemorial traditions of India; and when he reached the cherished goal, only after waging a relentless war, he gave all that he had, again, as a worthy descendant of his ancestors. He dedicated "not merely a laboratory but a temple" to his country, whose name he had, once more, after centuries of silence, made to reverberate through the long corridors of world-achievements.

BIRTH AND PARENTAGE

THE ancestral home of Jagadis Chandra was in the village of Rarikhal in Vikrampur (Dacca)—an ancient seat of Hindu and Buddhist learning and culture—the home of Atisa Srijnana, who carried, centuries back, the message of the Buddha to China. Vikrampur has given to India many worthy children who have helped to contribute to the heritage of the land and make her richer and greater at home and abroad. Of them the names of Aghornath Chattopadhyaya, Monomohan and Lalmohan Ghose, Chittaranjan Das and Sarojini Naidu stand out.

Jagadis Chandra Bose was, however, born in Mymensingh where his father Bhagaban Chandra Bose was a Deputy Magistrate. Later, Bhagaban Chandra's brother, Iswar Chandra Bose, became Headmaster of the Government School at Mymensingh. In this school, when Iswar Chandra was at its head, another famous Indian, a future President of the Indian National Congress and the first Wrangler of India, Ananda Mohan Bose, was a student. Ananda Mohan married a daughter of Bhagaban Chandra.

A Remarkable Father

Bhagaban Chandra Bose was in many respects a remarkable man. Much of his attention was devoted to questions of social welfare, industrial and technical schools. He was one of the first Indians to start the tea industry along with Ananda Mohan Bose and Durga Mohan Das, an uncle of Deshabandhu Chittaranjan Das. The concern, called the National Tea Company, was established with the main object of enabling young middle class Bengalis to work in the field. He founded a 'Peoples' Bank'—the forerunner of later Co-operative Societies. He staked all his savings on starting weaving mills. He promoted one even in Bombay. These pioneering efforts for the industrial progress of the country did not prosper. In some, success came too late for him to enjoy the fruits. So far as Bhagaban Chandra Bose was concerned, he acquired only a burden of heavy debts. "He had come before the country was ready, and it happened to him as it must happen to all pioneers", was the apt comment of the son made in an estimate of his father's work and worth. "And it is on the wreck of a life like his and of many such lives that will be built the greater India yet to be. We do not know why it should be so, but we do know that the Earth Mother is hungry for sacrifice".

The father's character and example, so full of varied activities and initiatives, was a great impulse and inspiration throughout the son's life. When Bhagaban Chandra was posted as Deputy Magistrate at Faridpur, it was time for sending the boy to school. Here too was a High English School. Only boys of the upper class families read there. Bhagaban Chandra had started a Vernacular School—as primary schools teaching through the medium of the mother tongue were then known—for the education of the children of those who could not afford expensive education. He surprised everybody by getting his son admitted in the Vernacular School instead of the High English School. Jagadis Chandra said once in a reminiscent mood: "I now realise the object

of my father in sending me to the Vernacular School, where I was to learn my own language, to think my own thoughts and to receive the heritage of our national culture through the medium of our own literature. I was thus to consider myself one with the people and never to place myself in an equivocal position of assumed superiority".

Early Associates and Traits

Recalling his early association with the children of fishermen and cultivators, who were his comrades at school, no less than their stories of strange creatures living in mighty rivers like the Padma ; his frequent visits, accompanied by them, to the river-banks, where he would be catching fish ; delighting, always in their company, in the joyous performances of *jatra*-players and witnessing the worship of Visvakarma by artisans, he said: "From them I drew my love of nature". Feeding his young and imaginative mind with the stories of the *Mahabharata* and *Ramayana*, and of the fearful adventures of a released dacoit, in the employ of his father, who carried him on his shoulders to school and back ; later on, at Burdwan, where Bhagaban Chandra had become an Assistant Commissioner, interesting himself in general metal work and even in a brass foundry ; daily tiring out his busy father with endless interesting and intelligent questions ; and, on the family visits to the village-home, musing on the moving waters of the river on which it stood, the boy Jagadis Chandra came gradually to imbibe an imaginative insight, a speculative bent of mind, and, lastly, a scientific curiosity—the most formative element in the character of a future

Education in Calcutta

When Jagadis Chandra was hardly eleven (1869), he was admitted in Hare School in Calcutta. Soon afterwards he went to St. Xavier's School, meant almost exclusively for European and Anglo-Indian boys. Here, on the very first day after the school hours, he was challenged to fight the champion boxer of the class. To quote Bose's own words: "I then knew nothing about boxing ; nevertheless, I accepted the challenge and got the severest punishment. Still I persisted and ultimately won victory through determination never to yield against odds however great". "This attitude", commented Jagadis, "helped me in my later intellectual contests".

At sixteen Jagadis passed the Entrance Examination of Calcutta

University (1875) with a scholarship and entered St. Xavier's College. Here he took the science course and thus came under the influence of a teacher who greatly moulded his career as a scientist. This was Father Lafont, a name that Jagadis Chandra always remembered with reverence and gratitude. He attracted Bose more to Physics than to Natural History for which his pupil had shown a taste earlier. Jagadis Chandra passed the First Arts and B.A. examinations in 1877 and 1879. In the certificate signed by the Rector of St. Xavier's College it is stated that he had taken up Latin as Second Language and was also proficient in Sanskrit.

A crisis faced young Jagadis when, after passing the B.A. examination of Calcutta University, he wanted to proceed to England for higher studies. His father was by then almost a ruined man because of his failure in industrial ventures. Jagadis Chandra wanted to qualify himself for the I.C.S. in order to relieve his father's burden of debts. But the father had his own ideas about the future career of his son. He opposed the proposal. As Jagadis Chandra said later, his father's refusal as regards that particular career was absolute: "I was to rule nobody but myself, I was to be a scholar, not an administrator". He then thought of Medicine ; and the father, who had vetoed both the Civil Service and the Bar, gave his consent. His mother, a conservative Hindu lady, with horrors of sea-voyage imprinted on her mind, did not at first look favourably upon the son's going to England. But when she saw that the son had set his heart on higher studies abroad, not only acquiesced despite the risk involved but offered her jewellery and some money she had as her own. This was not, however, needed, and Jagadis Chandra sailed for England in 1880.

Education in England

The preliminary scientific examination for admission to the medical course in London he passed without difficulty. The first year of his medical studies began with a preliminary course of training in Zoology under Ray Lankester, as also in Botany and Anatomy. But the Kala-azar fever Jagadis had contracted in the jungles of Assam while on a hunting expedition with a friend of his did not prove amenable to treatment in England. He was advised to give up his medical studies, and he decided to take science at Cambridge. He secured a scholarship for natural science studies at Christ's College, which he joined in 1881. Among the first three Indians to be admitted in Cambridge University and received as students at Christ's

College was Ananda Mohan Bose, and it was through his recommendation that Jagadis secured his admission.

Perplexity vexed him now as to his course of studies. What should be the precise line for him to follow he was at a loss to determine. To resolve his doubts, he decided to attend lectures on as many subjects as possible and also to visit laboratories. By the middle of the second year he could settle down to regular work in Physics, Chemistry and Botany. Most decisive for his future career as a physicist was the teaching of Lord Rayleigh, whose patient and careful experimentation and explanation of things made an abiding impression on young Bose's mind. After Father Lafont at St. Xavier's College, Calcutta, it was Lord Rayleigh at Christ's College, Cambridge, who contributed most towards making a scientist of him. He succeeded in establishing a rare mental tuning between himself and Lord Rayleigh as well as Prof. Vines of the Botany Department—a relationship which was instrumental in bringing out their old pupil to the front rank of scientific investigators and also sustained him when blows, hard and relentless, fell upon him at a later period. Jagadis Chandra passed the Natural Science Tripos of Cambridge University as well as the B.Sc. examination of London University at about the same time.

Appointment At Presidency College

Armed thus with two British degrees, Jagadis Chandra returned home in 1885 with a letter of introduction from Prof. Fawcett, the economist, to the Viceroy of India, Lord Ripon, who personally wrote to the Director of Public Instruction, Sir Alfred Croft, to find an appointment for Bose. A place in the Provincial Educational Service was offered but Jagadis Chandra declined it. Again, the Viceroy intervened and he was appointed officiating Professor of Physics at the Presidency College, Calcutta, the Principal, Mr. C. H. Tawney, himself protesting.

The prejudice that an Indian was not competent to teach science was then widespread, and it operated against Prof. Bose. He also suffered from the invidious distinction between an English and an Indian teacher in respect of salaries. His pay was fixed at two-thirds of the permanent British incumbent's. Added to this was also the provision that because the appointment was a temporary one, Prof. Bose was to receive one-third of the pay normally attached to the post. Prof. Bose took to heart both these anomalies and decided on a new form of protest. He resolved not to accept

the cheque for his monthly salary and continued doing so for three long years. And this he did at a period when the fortune of the Bose family was at its lowest ebb.

During the first nine years of service as Professor of Physics, Jagadis Chandra was engaged in organising his laboratory and a course of lecture-demonstrations for which he later became justly famous. Scientific hobbies like photography, recording of voices with one of the earliest models of Edison's phonographs were amongst them.

Son Pays off Father's Debts

To relieve his father of the debts contracted for his industrial and agricultural ventures, Prof. Bose now took matters in his own hands, disposed of his ancestral house and family property and succeeded in clearing half of the liabilities. He then approached his mother, who had once volunteered all her ornaments for defraying his expenses abroad, to make a gift of them to him to pay off the debt. Another quarter of the debts could be cleared by the sale of the jewellery. The creditors were amazed at Prof. Bose's determination and offered to wipe off the balance from their records. But Jagadis Chandra Bose had a different view in the matter. He was happy only when, after a few years, he could pay off the remaining portion of his father's debts out of his own earnings. For, after full three years of Bose's service at the Presidency College, both the Principal and the Director of Public Instruction came to realise the value of his work, and by a special order of the Government made his appointment permanent with retrospective effect. He thus got a lump sum on account of arrears of pay, and the first thing he did was to make it available to his father's creditors. After the discharge of the debt, his father lived only for a year and his mother two years more.

A Birthday Resolve

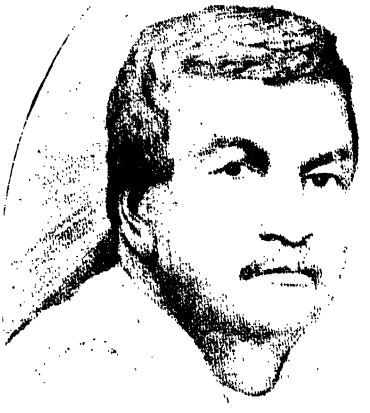
But the great turn of his life was yet to come—but not in the line of his professorial activities. On his 35th birthday on the 30th November, 1894, Jagadis Chandra resolved that his best efforts henceforth would be dedicated to the furtherance of new knowledge by unravelling the mysteries of nature. But there were hurdles in his way. Firstly, he had to snatch odd hours from his duties as a professor for this purpose, and, secondly, he had to build his laboratory out of nothing for this work. Recalling the early days of his research work at the Presidency College, Prof. Bose once

observed: "There was no laboratory and no instrument maker. Everyone said that original scientific work was impossible in India. But it came to me as a flash that it was not for man to quarrel with circumstances but bravely to accept, to confront and dominate over them, and we belonged to a race which had accomplished great things with simple means".

Today when spacious and fully equipped laboratories are offered to research scholars for carrying on their work, it is worthwhile to pay a visit to the small room 20 feet square in the Presidency College and realise how within that ludicrously limited space the first original scientific work in India was undertaken by Acharya Jagadis Chandra Bose. The conditions under which he had to carry on his researches were most depressing. The Education Department of those days held the view that the duty of a professor lay wholly in the teaching of the classes—research in its view involving neglect of this work. Lecture hours were long—as many as twentysix being the weekly average. The only time Jagadis Chandra could find for his investigations was after the day's grind—carrying them on far into the night. There was no grant for research, and he had to spend quite a fair amount out of his own slender income on equipment and assistance. For making apparatus and appliances he employed an illiterate tin-smith of the city whom he trained up. And with such equipment and personnel the Presidency College came to earn a name in all the scientific centres of the world in course of two years. The mechanic soon proved himself an adept in making instruments of extreme delicacy.

EARLY RESEARCHES IN PHYSICS:
ELECTRIC WAVES

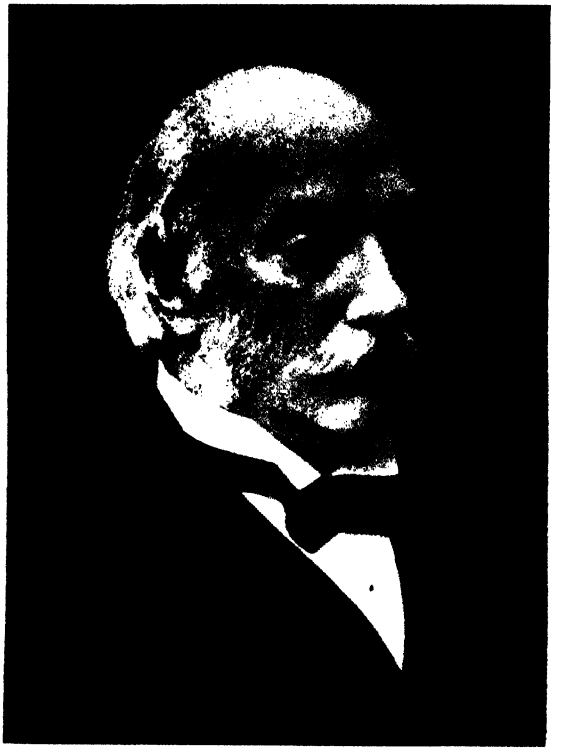
BUILDING on the experimental work of Faraday, Clarke Maxwell had predicted mathematically that light-waves are of electro-magnetic nature, a prediction brilliantly verified by Hertz (1887). Construction of new instruments and original work thus got a good start. The work which at once drew the attention of scientists was Prof. Bose's researches in "Hertzian waves", which then most prominently held the field of scientific investigation abroad. Prof. Bose used to demonstrate successfully to his students the Hertzian experiments which absorbed his attention. Able physicists took up the Hertzian line of investigation and extended it in new directions. In this field of activity Sir Oliver Lodge, Prof. Branly, Righi and others



BHAGABAN CHANDRA BOSE

BAMASUNDARI BOSE

ANANDA MOHAN BOSE



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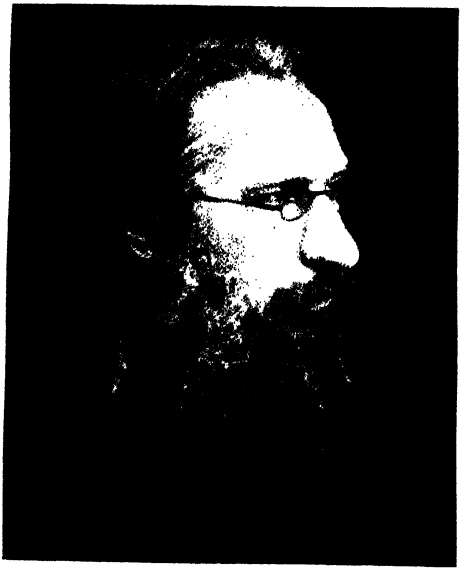
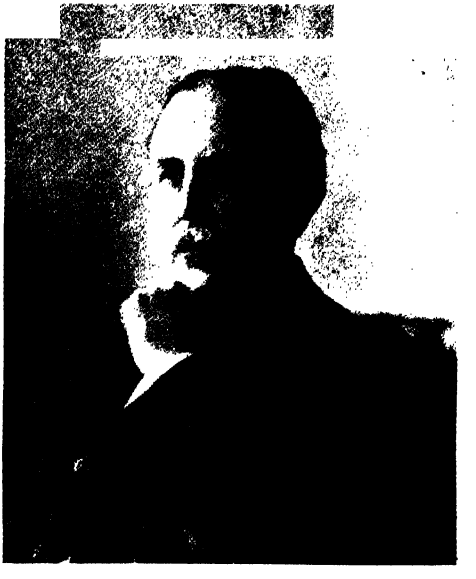


FATHER LAFONT



PROF. VINES

came to occupy the front rank where Bose also had a place. His success was two-fold ; firstly, he produced extremely short waves and, secondly, he effected considerable improvement upon Hertz's detector of electric waves. Branly's detector was a simple device (improved later by Lodge)—a slender tube of metal filings, which was no doubt an improvement on Hertz. But Bose's receiver represented a great advance. Bose was also successful in inventing other types of receivers in some of which there was actual increase of resistance after reception of electromagnetic waves, instead of the usually observed decrease. This fact militated against Lodge's coherence idea. He was the first to employ a semi-conductor crystal like galena as a self-recovering detector of electric rays (1901). Bose succeeded in evolving a small and compact set which could stand conveniently at one end of a writing table and could be packed into a suitcase and carried for exhibition to any audience. It was found to be a suitable apparatus for study of quasi-optical properties of electric waves and has been described as such in text books and encyclopaedia articles by J. J. Thomson, Poincaré and others.

First Scientific Paper

Prior to these mechanical achievements, Bose had communicated his new results in a paper "On the Polarisation of the Electric Ray" to the Physical Section of the Asiatic Society of Bengal, the first learned society of Asia in modern times, in May, 1895. The paper claimed to prove that the electric beam when transmitted through crystal are parallelised. In that pioneer paper, accompanied by demonstration, one could see the dawn of modern physical science in India. Great difficulty was at first experienced in constructing an apparatus for the generation of electric waves having short wave-lengths and a suitable receiver, but this was overcome. We also learn from the annual address of the President of the Asiatic Society (1896) that the apparatus used was of the size of only a six-inch cube, much smaller than the ordinary optical lanterns used for the corresponding experiments on light. A flash of radiation was produced by pressing a key ; the waves were only about half an inch in length ; while the receiver was so sensitive that it responded to the feeblest electric reaction.

First Paper to Royal Society

Jagadis Chandra sent his second paper to his former professor Lord Rayleigh. The English journal *Electrician,* published it in December, 1895,

The third paper was again sent, soon after the second, to Lord Rayleigh, who forwarded it to the Royal Society. The Society accepted the paper, published it in its journal and offered help from its Parliamentary grant for the continuation of Bose's researches. This paper was considered useful for electric signalling apparatus in place of ordinary light-houses, which were ineffective in foggy weather. One of the leading scientific journals devoted to electrical researches was much impressed by the new researches of Prof. Bose. It suggested that practically minded men might find it remunerative 'to devise a practicable system of electrical equivalent to the human eyes'. The now-defunct Calcutta daily, *The Englishman*, expressed the hope that in case Prof. Bose could perfect his system and patent his Coherer, the whole system of coast-lighting throughout the navigable world would be revolutionised.

"As a practical outcome of my theory", writes Jagadis Chandra, "the head of a great firm working on wireless telegraphy told me that the advantage he derived from the suggestions contained in that paper was beyond anything he could have dreamt of. About my further ideas on the subject he begged me not to make things public but allow him to take out patents. He told me he could make great things out of my ideas. But I cannot find heart to give any part of my life for money-making purposes. . . ." We may be sure that it was the firm of Messrs. Muirhead & Co., patentees of the well-known system of wireless telegraphy. They wrote to him on the 13th November, 1900 that they had discussed with him some of his results bearing on "certain practical points in the manufacture of wireless telegraphic apparatus", adding, "we have already benefited by your work in the construction of the most important part of such apparatus".

Refusal to Patent Discovery

His refusal to patent his discovery may seem quixotic to many, but to him it was not. It appeared puzzling even to his friends. *The Electric Engineer* of London expressed 'surprise that no secret was at any time made as to its construction, so that it has been open to all the world to adopt it for practical and possibly money-making purpose'. Bose's priority in the line would never have been established, had not two of his friends, an Irish woman and another an American woman, taken out patents on his behalf of his "Galena Receiver" in both England and America after some time. These were Sister Nivedita (Miss Margaret Noble) and Mrs. Ole Bull. They got his gadget patented. But Jagadis Chandra would not use his rights,

and allowed the patents to lapse. He was determined from the first not to make any profit from his inventions. His English biographer, Patrick Geddes, writes: "His child-memory had been impressed by the pure white flowers offered in Indian worship; and it came early to him that whatever offerings his life could make should be untainted by any considerations of personal advantage".

Practical Application of Bose's Researches

The technique of micro-wave production and detection found its practical application during the last war (1939-45) when the radar was used to detect and destroy enemy aeroplanes. In this connection it is interesting to note a review by Ramsay published in the *Proceedings of the Institute of Radio Engineers* (Feb., 1958) on micro-wave techniques developed before 1900. Special importance has been assigned there to Bose's quasi-optical investigations of the structure of crystals and of models made by him from paper-sheets, jute-fibres etc. in which Ramsay sees the beginnings of Analog Physics in which micro-waves are employed to investigate microscopic models of the structure of matter.

It is not possible in this short sketch to narrate how Prof. Bose made sustained efforts to make these early researches of his known to people at home. As early as 1895, at the Presidency College of Calcutta, he demonstrated the possibility of signalling, by ether waves, messages to a distance. In the Calcutta Town Hall also, before a large gathering, he transmitted waves through the body of the chairman of the meeting, the Lieutenant Governor of Bengal, and then through a solid wall, displacing a heavy weight, ringing a bell and exploding a mine placed in a closed room.

London Confers Doctorate

Prof. Bose now submitted a paper on the Electric wave-length measurements to London University, which was duly accepted; and the degree of D.Sc. was conferred on him without his having to be present at any examination, testifying to the high merit of his thesis (1896). Lord Kelvin was "literally filled with wonder and admiration" for it and M. Cornu, President of the French Academy of Science, acknowledged in handsome terms Bose's "power of furthering the progress of science".

The Government at home was roused to consciousness by these honours abroad, conferred upon a young professor in its service. The Lieutenant-

Governor of Bengal, Sir Alexander Mackenzie, realised the difficulties under which Jagadis Chandra was labouring, and the Government of Bengal, after words and cross-words, sanctioned an annual grant of Rs. 2,500 towards the outlay for his future research carried on at the Presidency College.

FIRST SCIENTIFIC MISSION TO EUROPE

THE success of his scientific researches and appreciation abroad convinced Jagadis Chandra that he should go to Europe again to keep himself abreast of the latest trend of scientific work. When his former teacher Lord Rayleigh was on a visit to Calcutta he was invited by Bose to pay a visit to his laboratory. Lord Rayleigh gladly accepted the invitation and was impressed by the work done. He suggested to Prof. Bose that he should go to Europe again to acquaint himself with similar work that was being carried on there. But this was by no means easy. He had not the means to undertake such a mission on his own. His approach to Government met with no response. He was told that the Imperial Government would never sanction a deputation on a matter which was merely educational. But the Lieutenant Governor of Bengal again came to his assistance. On his own responsibility he decided to send Jagadis Chandra to England as "he attached the greatest importance to Prof. Bose's visiting Europe and conferring with the leaders of scientific enquiry there".

AT THE BRITISH ASSOCIATION

The first scientific mission to Europe, thus arranged and undertaken from India by an Indian, was a great success. His name had preceded his visit. His first appearance in England was at the Liverpool meeting of the British Association (1896) where he read a paper on "Electric Waves". An account of the reaction that this paper had on the scientists present at the meeting is available. Lord Kelvin, who had already had occasion to express his admiration for Prof. Bose's work, not only spoke in the warmest language after his address but limped upstairs in the Ladies' gallery and shook Mrs. Bose by both hands. Later he wrote to the Secretary of State for India: "I believe it will be conducive to the credit of India and to scientific education in Calcutta, if a well-equipped physical laboratory is added to the resources of the University of Calcutta in connection with the professorship held by Dr. Bose".

The British Press took note of the paper. *The Times* came out with appreciative comments. "The originality of the achievement", it said, "is enhanced by the fact that Dr. Bose had to do work in addition to his duties as a Professor of physical science in Calcutta and with apparatus and appliances which in this country would be deemed altogether inadequate". Enthusiastic comments came from other newspapers and magazines also.

At The Royal Institution

Before he could leave London for the continent Prof. Bose was invited to address the Before-Easter Session of the Royal Institution. This Friday Evening Discourse was equally welcomed by the press and the public. The *Spectator,* which had always been critical towards India, came out with a comment which is worth quoting. Referring to Bose's discourse it said: "There is, however, to our thinking, something of rare interest in the spectacle there presented of a Bengalee of the purest descent lecturing in London to an audience of appreciative savants upon one of the most recondite branches of modern physical science". Years later the same journal wrote: "The culture of thirty centuries has blossomed into a scientific brain of an order which we cannot quite duplicate in the West. He is a prince among physiological research workers and a prophet of his age, which has brought so many new powers of life".

Appreciation of His Work

One good result of his visit to England was that Englishmen, hitherto fed on prejudices against the capacity of Indians for scientific research work, were enlightened. Jagadis Chandra had succeeded in breaking through what had so long seemed a closed door, thus opening the highway to active and productive science for his countrymen. For the first time it came to be recognised by the West that the Eastern mind was equally capable of making great scientific discoveries and producing experimentalists as eminent as it had. Leading British scientists expressed their appreciation of the value of his work in a practical way. They made a representation to the Secretary of State for India urging the establishment of a central laboratory for advanced teaching and researches in physical science at Presidency College. The representation was made in a memorial signed by almost all the leading scientists of England and included such names as Lord Lister,

then President of the Royal Society, Lord Kelvin, Prof. Clifton, Prof. Fitzgerald, Dr. Gladstone, Prof. Poynting, Sir William Ramsay, Sir Gabriel Stokes, Prof. Sylvanus Thompson, Sir William Rücker. The Secretary of State accepted the suggestion, and ultimately the Government of India recommended the establishment of such a laboratory at an initial cost of £40,000/-. This, however, did not materialize for reasons unknown. But for his research work, Prof. Bose began to receive an annual grant of Rs. 2,000 from the Central Government added to the sum of Rs. 2,500 from the Government of Bengal to which reference has already been made.

In The Continent

Before we take note of the work of Prof. Bose on return home, we have to follow him in his journey to the different scientific centres of Europe. His lecture-demonstration on the 9th March, 1897 in Paris at the Sorbonne roused so much interest that he had to repeat his experiments before the Société de Physique. Many French savants were present at this lecture. M. Cornu, President of the Academie des Sciences, presided over the meeting. In offering his congratulations to Jagadis Chandra he said: "You should try to revive the great traditions of your race, which bore aloft the torch-light of science and art and was the leader of civilisation, two thousand years ago. We in France applaud you and wish you every success." Bose was soon after made an honorary Member of the Société de Physique.

From Paris the journey was for Berlin. Here the discourse was given to the Academy of Sciences before leading physicists of Berlin and in other scientific centres of Germany. Everywhere the compactness of his apparatus, which incorporated some new principles, and the large number of new experimental results he had obtained were received with applause. After visiting the principal laboratories and lecturing at centres like Kiel, Prof. Bose turned homeward and sailed for India. In this first mission of his, Jagadis Chandra could put the name of India on the scientific map of the world. His experiments and his results also soon passed into current science text books both in England and the continent. Many years later when Jagadis Chandra visited Sweden, Prof. Carl Benedicke, President of the Physical Society of Stockholm, recalled in his welcome to Prof. Bose that "some days ago I looked up my old text books of Physics and I found underlined by myself a passage telling that you had shown that an ordinary book has the remarkable property of acting as an excellent polarisation prism for electric waves".

FROM PHYSICS TO PHYSIOLOGY:
PLANT RESPONSE

ON return home Prof. Bose resumed his work vigorously and succeeded in completing paper after paper on his subject and submitting them to the Royal Society. But the most interesting turn of his career as a scientist was not long in coming. When experimenting on his electrical researches he noticed a novel phenomenon which heralded a departure from Physics to Physiology. This happened in 1899 in connection with the responsive phenomena in the parallelisms between the response of what is called "inorganic" matter and the response of "living" substances. He found that the curve of fatigue of his instrument closely resembled the fatigue-curve of an animal tissue. He was able to remove the "tiredness" of his receiver by the application of rest and of suitable stimulants. He was thus, as he said later, unconsciously led to the border region of Physics and Physiology and was amazed to find the boundary lines vanishing and points of contact emerging between the realms of the living and non-living. In his investigation of "life"-phenomena Prof Bose was also led to the study of the response of plants, the half-way house between inorganic matter and highly complex animal life. A universal reaction appeared to bring together metal, plant and animal under a common law.

At The Paris Congress

Jagadis Chandra was anxious to lay this discovery before the scientists of Europe and sought the opportunity to go abroad once again. And soon it came in the invitation from the International Congress of Physicists arranged in connection with the Paris Exhibition of 1900—one of the earliest world-gatherings of scientists held in Europe. Here he first announced the results of his new experiments in the response of inorganic and living matter. In the paper read there, he said that "continuity was found not broken. It is difficult to draw a line and say here the physical phenomenon ends and the physiological begins"; and he concluded by saying that a "fundamental unity amidst the apparent diversity" ruled the world. The effect of this lecture and the experiment with which it was demonstrated on the assembled scientists has been described as electric. The paper was accepted as most important, and duly published in the Transactions of the Congress.

Swami Vivekananda's Tribute

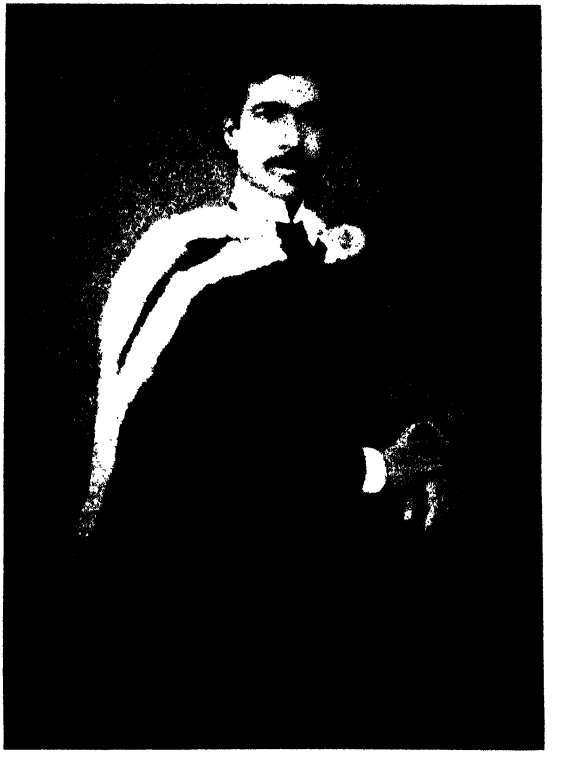
By a fortuitous concourse of affairs, there was present at that Congress another representative of India returning home after giving voice to her eternal message to the West. When Bose brought the lecture to a close by repeating the Vedic pronouncement that a fundamental unity existed amidst apparent diversities, Swami Vivekananda was beside himself with joy. He wrote home: "Here in Paris have assembled the great of every land, each to proclaim the glory of his country. Savants will be acclaimed here ; and its reverberation will glorify their countries. Among these peerless men gathered from all parts of the world, where is thy representative, O Thou, the country of my birth? Out of the vast assembly a young man stood for Thee, one of Thy heroic sons, whose words have electrified the audience, and will thrill all his countrymen. Blessed be this heroic son ; blessed be his devoted and peerless helpmate who stands by him always." Seven years ago Chicago had listened to an Indian monk, and now Paris listened to an Indian scientist equipped with results obtained in the laboratory and through a process which Europe could readily understand and appreciate.

At British Association Again

From Paris Prof. Bose went to England and read a similar paper before the British Association in September, 1900. "The reading of my paper at the Bradford meeting'", says Bose in a letter, "was a grand success. One of the leading Physicists brought round his friends to see my apparatus and they were full of warmest congratulations. . . . They all wondered the many years I must have taken before obtaining clue to this great generalisation. I dared not tell them how naturally it came to me in connection with my studies on the molecular change induced by the shock of electric waves. It came most naturally and now I fully realise the endless prospect and the years of persistent efforts which will henceforth be mine. I wonder whether I shall live long enough to carry it through". He again writes: "I was asked to meet several distinguished electricians. They told me that my paper at the British Association on 'Response of Inorganic Matter' came to them as a revelation. They could never remember anything which had produced such a sensation among original investigators".

Prof. Bose's paper was published in the *Electrician,* which said: "It is several years since Prof. J. C. Bose of Calcutta University delighted and

CHRIST'S COLLEGE : CAMBRIDGE



IN CAMBRIDGE GRADUATE'S GOWN : 1885

AT THE ROYAL INSTITUTION, LONDON, 1897
FIRST FRIDAY EVENING DISCOURSE

surprised English physicists, at a meeting of the British Association, by an exhibition of the neat and compact Hertzian wave apparatus, which he had designed and by his rehearsal of the principal experiments in optics with Hertzian waves. What investigators in Europe had been attempting with crude and clumsy apparatus, Prof. Bose had accomplished in his laboratory in Calcutta, with a pretty little set of instruments occupying no more space than an ordinary optical bench. "Viewed in the light of Prof. Bose's researches, recent and of earlier date", the *Electrician* concluded, "Physics and Chemistry, even, perhaps, Biology, appear to be on the eve of a generalisation of unusual importance".

His Findings Challenged

All this praise did not, however, go unchallenged. Sir William Crookes invited Jagadis Chandra to deliver a lecture on those or kindred subjects of research before the Royal Society. Prof. Bose accepted the invitation. But while the Physicists hailed his paper, the Physiologists who were present at the meeting on invitation—as is the custom when "boundary questions" in science are raised—looked puzzled and were unwilling to fall in with his line of work. They objected that they did not as physiologists understand the method of conductivity variation which Prof. Bose was then using. Nor was Hertzian radiation generally used as a stimulating agent. The method of detection employed by them was that of electromotive variation. Jagadis Chandra had anticipated this objection and experimented tentatively by the latter method also. He had published the results in one of his papers communicated to the Royal Society. He, however, accepted the challenge of physiologists and wanted to meet it.

Meanwhile, he fell seriously ill and had to be in hospital for about two months. But he could not forget the challenge. While convalescing he devised some experiments on lines familiar to physiologists, and when restored to health he began to work in the Davy Faraday Laboratory of the Royal Institution as advised by his old teachers, Lord Rayleigh and Sir James Dewar. And he worked there "like a man haunted by the fear that if he failed at any point his people would be held to have no right to education". While fighting against death in hospital, he told a friend: "Everyone knows we Indians have brilliant imagination, but I have to prove that we have accuracy and dogged persistence besides". And Jagadis Chandra did prove it.

A Memorable Day

What then happened is best told by the Professor himself. The memorable day was February 22, 1901. "I went out yesterday afternoon", says Prof. Bose, "and in an evil hour stopped to look in at a second-hand shop of discarded sets of instruments. The stimulus of sight of these broken things evoked a complex set of molecular thrills in that detector which they call the 'brain'; and standing there the vision of a new apparatus suddenly appeared complete in all details. I at once went to my instrument-maker and explained to him the new apparatus and that youngman was so excited that he burst into his broadest Yorkshire brogue. This new apparatus will, at a single winding, take automatically a series of uninterrupted observations, about 5000 or more; the whole apparatus could be carried in one's pocket. Do I sleep? Do I dream? But it is quite maddening. Like a child with a new plaything, I can hardly keep my mind from the fascination of it".

CHALLENGE AT EVERY STEP

By the middle of April, 1901, Prof. Bose was ready, and it was announced that he would give a Friday Evening Discourse at the Royal Institution on the general phenomena of Response. The day fixed was May 10, 1901. In the meantime he had sent on request records of his results to Sir Michael Foster of the Royal Society, who was so interested in his work that he offered a special arrangement by which the results could be received by the Society without prejudice to the lecture which he was scheduled to deliver before the Royal Institution. This was designed only to ensure his priority claim. The Royal Society received Prof. Bose's communication on May 7, containing a synopsis of the results.

A Momentous Meeting

It was a momentous meeting so far as Prof. Bose was concerned. He had anticipated that physiologists, who were not prepared to accept his results, would challenge him at every step. He, therefore, moved in a thoroughgoing fashion marshalling all the data obtained by him and demonstrating them by experiments. His historic concluding observations form the introduction to this biographical sketch. He repeated with

emphasis what he had said at the Paris Congress as also at an earlier meeting of the Royal Society, that there was no absolute barrier existing between Physics and Physiology, that there was no abrupt break but a uniform and continuous march of law. To his great surprise, his views thus expressed at this meeting went unchallenged.

The Storm Bursts

But a storm was gathering elsewhere. An indication of that storm was given to him by an eminent scientist, a Fellow of the Royal Society, Raphel Meldola, who came to see Bose and lodged a complaint. The complaint was, to quote Bose's own words, that "I should have sprung upon unsuspecting scientists such a 'tremendous surprise'. He himself is much impressed, but warned me that if I meant to convert people, I must work persistently for some years."

The full blast of that storm burst at the meeting of the Royal Society on June 6, 1901. Here, again, while the physicists were full of admiration for totally unexpected revelations, he found that he had unwittingly strayed into the domain of a new and unfamiliar caste-system and offended its etiquette. The physiologists present at the meeting strongly assailed his results. "I read my paper", writes Jagadis Chandra referring to this meeting, "and showed experiments which went remarkably well and evoked applause. Burdon Sanderson then rose and spoke very highly of the novel and remarkable physical phenomena which I was able to exhibit and which would be of great interest to physicists, but though apparently similar they had nothing but superficial similarity to the wonderful physiological phenomena. As regards electric response of ordinary plants it was simply impossible, for he had tried it himself but never found it. He did not say a word in criticism of my experiments. Then Dr. Waller got up; he was evidently greatly excited and my paper which he had in his hand, was full of his notes. He again trotted out the objection of variation of contact of air and water, which might produce the electric current. I had him there; and when the time for answer came I showed the utter absurdity of his contention. I said that that was the only thing which required a scientific answer. The dogmatic assertion that there could be nothing common to physical and physiological phenomena required no answer". Jagadis Chandra, however, looked upon this opposition as "perfectly normal". He knew and maintained that knowledge could only be established by questioning—*'pariprasnena'*—and truth, by test.

The direct result of the opposition by no less a person than Sir John Burdon Sanderson—the doyen of British physiologists—and Prof. A. D. Waller was that Prof. Bose's paper submitted to the Royal Society prior to his lecture-demonstration at the Royal Institution and even printed by the Society was not released. Jagadis Chandra, to use political terminology, was boycotted and kept isolated.

Poet Comes To Scientist's Aid

Bose rightly realised that this boycott move would imperil the facilities granted to him by the Government of India for his scientific mission. Actually an extension of his deputation was refused. But he decided to remain at his post to resume further experiments at the Royal Institution. Such an indefinite stay in England on the leave due to him, however, meant a considerable amount of money. And where was he to get it from? He scanned the horizon which was bleak. But he had a friend in India, Rabindranath Tagore, to whom the work of Jagadis Chandra Bose was service to their motherland. They often wrote to each other. The poet poured out in his letters to his scientist friend cheering light when all around him was darkness. These letters, instinct with love and warmth and no less inspired by a rare patriotic fervour and unfaltering faith in his friend, sustained Jagadis Chandra in his trials—reviving his drooping spirits as nothing else, perhaps, could or did.

What Rabindranath Tagore did for Jagadis Chandra Bose at this crisis was revealed for the first time by Tagore when Bose was no longer in the land of the living. "My unfaltering belief in Jagadis Chandra's success added strength, I am sure", said Rabindranath, "to his own strength, to his own conviction as to the reality of the goal of his quest. So far for the first chapter. In the next, our Professor, accompanied by his worthy helpmate, went off on an expedition over the seas to announce the truth he had gathered and offer them to the scrutiny of expert criticism. Thus was my mind filled with a rapturous foretaste of the glory that awaited our motherland in the appreciation of this mission of her gifted son in foreign lands. And acute was my distress when I learnt that financial difficulties were standing in the way of Jagadis' expected victory; for had I not my own bitter experience of how sadly achievements could be frustrated by mere lack of material resources? For that very reason my own means, at the time, did not permit my coming to his aid personally; so I had to cast our burden on a friend . . . . . a wonderful friend, whose noble, unosten-

tatious generosity I have the melancholy pleasure here to make public. This friend was the late Maharaja of Tippera, Radhakishore Manikya, and the deep affection and high regard which he happened to entertain for me, has remained a mysterious marvel throughout my life. At that juncture the wedding of his son was about to be celebrated in right royal style. I seized the opportunity to tell him that I was suppliant for a favour worthy of the occasion. He smiled when I set forth the nature of my request. 'I do not know', said he, 'nor am I competent to judge the work of Jagadis Chandra Bose. But to you I can refuse nothing and I am not concerned to enquire what you will do with my gift'. Saying this he handed me a cheque for Rs. 15,000/-. That gift I dedicated to pave the way for the triumphal march of my friend."

At The Linnean Society

Prof. Bose entered the laboratory of the Royal Institution for carrying on his experiments to meet all the criticisms directed against his experimental technique. Meanwhile, his uncompromising courage in the face of opposition had so impressed the Secretary of State for India that he took the responsibility of granting him an extension over the Government of India. Heartened by this he went to work anew. While engaged in his work he received a visit from his old teacher Prof. Vines, who came to see his work in the company of Prof. Howes, the successor of Huxley at South Kensington. Both the scientists were so impressed by his work that they assured him that if the Royal Society closed its door to him, the Linnean Society would accept it for publication after a lecture-demonstration.

Prof. Bose accepted the invitation and the lecture was given on March 21, 1902. The Linnean Society, as was the custom, invited the physiologists including his opponents, Sanderson and Waller. After the lecture was over the President thrice invited comments from the audience. There were indeed comments but they were all in favour of Prof. Bose. The Society accepted the paper and published it in their Transactions. Prof. Vines told Prof. Bose how his results were misrepresented even to him as also to other scientists, stating that what Prof. Bose demonstrated was an accidental current due to the rusting of the wire. Prof. Vines could not ignore Sanderson's assertion and it was to ascertain how far Sanderson was right that he and Prof. Howes had come to his laboratory. And both were convinced.

Royal Society Closes Its Doors

After his success at the Linnean Society it was expected that the propaganda against him would cease and that the Royal Society would again welcome Prof. Bose back and agree to release his paper rusting in its archives. But when the question of releasing it came up before the Committee of the Society in charge of publication a fresh complaint was lodged by his opponents that a similar paper containing similar results had already found a place in the *Journal of the Physiological Society* and without any acknowledgment to Prof. Bose. The author of the paper, who had been present at Prof. Bose's lecture before the Society, had taken ample notes on the occasion and later challenged his results. It was a most unexpected blow, a hit below the belt. But the absolute priority of Bose was established beyond doubt by the enquiry committee, for both Vines and Howes had seen proofs of Bose's paper five months before the communication now claiming priority.

The Royal Society, however, did not or could not throw its doors open to him. His paper could not be released. Prof. Bose was satisfied that the traditional method of submitting papers for publication to scientific societies alone did not suffice as the only means for self-expression. He decided to write books embodying his researches.

His First Book Published

The first book of Jagadis Chandra recounting the results of his investigations was published by Longmans, Green & Co., under the title *Response in the Living and Non-Living* (1902). It received widespread welcome from scientific circles. Before leaving for home Prof. Bose addressed meetings of the British Association at Belfast, the Botanical Society and the Royal Photographic Society. He was also invited by the University of Bonn, and the Société de Physique, Paris, to which he had contributed a paper. He could rouse interest in the scientific world of Europe despite hostility in certain quarters.

On return home Prof. Bose once again devoted himself to the study of plant-life and the results of these extended investigations were communicated in December, 1903, again to the Royal Society for publication. The Publication Committee recommended for publication his seven papers in its *Philosophical Transactions*. But, again, at the last moment, because of opposition from the same quarters, this publication was withheld. The

Society informed him that judgment on these papers had to be reserved until the plants themselves could record their answers to questions put to them. Prof. Bose took the hint and was determined to see that plants did record their own answers in language intelligible to all.

NEW DOMAIN OF INVESTIGATIONS

HENCEFORWARD, Prof. Bose's researches were to be carried on entirely in a new domain—the world of responding plants. He wanted to demonstrate that all the characteristics of the response exhibited by animal tissues were also found in those of the plant. Detailed descriptions of his experimental methods and the results of his researches in the new realm were for the first time embodied in his *Plant Response* (1906) and *Comparative Electro-Physiology* (1907). The desire was now widely expressed that Prof. Bose should prove his results with practical demonstrations, and the Government of India, in response, sent him on his third scientific deputation to England and America in 1907-8. After a short sojourn in England he went to the United States—for the first time—visited laboratories and lectured before select but appreciative audiences in different American universities. It is interesting to recall that the suggestion for his visiting U.S.A. first came from the eminent Indian politician—Gopal Krishna Gokhale, a life-long friend and admirer of Jagadis Chandra Bose.

NEW APPARATUS INVENTED

On return to India Prof. Bose concentrated his attention on the invention of a complete set of apparatus by which the experimental plant would be automatically excited at definite intervals of time by successive uniform stimuli and make its own records without any assistance at any point from the observer. This effort on his part brought into existence the 'Oscillating Recorder,' whose magnifying power was raised to 10,000 times. The new series of apparatus was designed to confirm and verify the results obtained by him previously and to demonstrate the transmission of nervous excitation in plants against the generally accepted view that there was nothing in the plant comparable to the nervous system in animals. Results of one of these new investigations were communicated to the Royal Society and published in its *Philosophical Transactions* in 1913.

His next book, *Researches on Irritability of Plants,* published in the same year, roused so much interest in his work that he was invited by several important scientific societies of Europe to lecture before them.

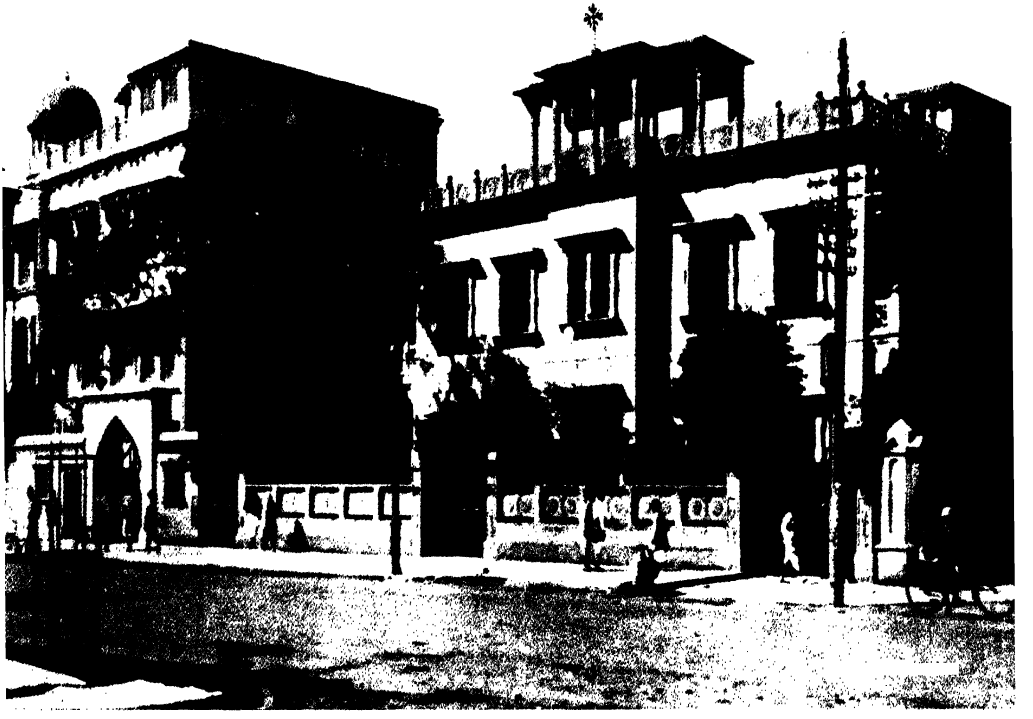
Fourth Scientific Mission Abroad

In 1914 Acharya Jagadis Chandra Bose set forth on his fourth scientific mission abroad. This time he carried with him not only his delicate instruments but also his plant specimens—mimosa and telegraph plant —*desmodium gyrans*—for his lecture-demonstrations in Europe. Only half the plants survived the voyage. On reaching England he got them housed in a tropical greenhouse. He also set up a laboratory, to which Sir William Crookes paid a surprise visit. Sir William was then President of the Royal Society. After seeing Prof. Bose's work he asked if he knew whose casting vote prevented the publication of his papers on Plant Response by the Royal Society. Bose was taken aback. Sir William burst out laughing and replied to his own query: "I am that person", adding, "I could not believe that such things were possible and thought your oriental imagination had led you astray. Now I fully confess that you have all along been right". Prof. Bose felt happy over this 'voluntary confession' by the President of the Royal Society. A cloud was lifted.

Lectures At British Universities

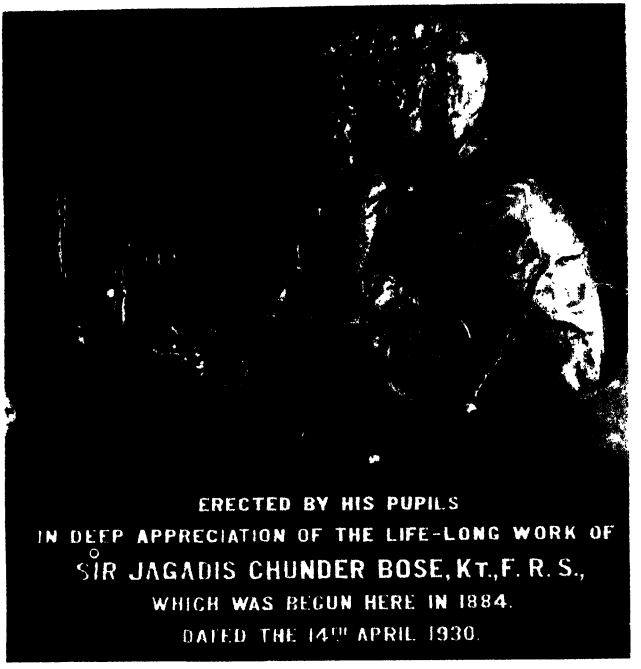
Bose now commenced his lecture-tour of British universities beginning with Oxford. Sir Francis Darwin presided over his lecture at Cambridge. The next lecture was delivered before the Royal College of Medicine, London, to be followed by another lecture before the Royal Institution.

In his lecture before the Royal Institution his demonstrations with the apparatus made in Calcutta led his learned audience from marvel to marvel. His 'Resonant Recorder' registered the speed of transmission of excitatory impulse; the 'Oscillating Recorder' traced the throbbing pulsations of the telegraph plant and revealed their striking similarity with the pulse-beat of the animal heart; and, finally, the 'Death Recorder' indicated the death-throes of the plant. As in 1909, so in 1914, Jagadis Chandra did not limit himself only to the language of science for conveying his thoughts to the assembly. Referring to plants, he said: 'These mute companions, silently growing beside our door, have now told us the tale of their life, tremulousness and their death spasm in script that is as inarticulate as they are".



THE BOSE INSTITUTE, CALCUTTA, WITH JAGADIS CHANDRA'S HOUSE

THE LECTURE-HALL : A PARTIAL VIEW



A MEMORIAL PLAQUE
At the Physics Laboratory of the Presidency College, Calcutta.

WITH SOME OF HIS PUPILS : 1928
Sitting from left to right—Meghnad Saha, Acharya Jagadis, J. C. Ghosh.
Standing from left to right—S. Datta, S. N. Bose, D. M. Bose, N. R. Sen, J. N. Mukherjee, N. C. Nag.

At his lecture before the Royal Society of Medicine, London, Sir Lauder Brunton, a collaborator of Darwin, said that fifty years ago he himself made some experiments on the action of poison on plants. But since those days Physiology had become a new science and his old work crude in contrast. In the intervening period Sir Jas Sampson and Sir John Burdon Sanderson had conducted some such experiments, but Prof. Bose had gone far deeper and more fully than any other worker. In a letter to Prof. Bose Sir Lauder further said: "Darwin made some experiments on digestion in insectivorous plants. All the experiments I have yet seen are crude in comparison with yours in which you show what a marvellous resemblance there is between the reactions of plants and animals".

Unhappy Bernard Shaw

On arriving at London Jagadis Chandra had set up a private laboratory at Maida Vale, which soon became a meeting place not only for leading men of science but for distinguished men of letters, politicians and journalists. Arthur James Balfour, the philosopher-statesman, was impressed by the psychological significance of the Indian scientist's discoveries. George Bernard Shaw, a confirmed vegetarian, felt extremely unhappy when he saw a piece of cabbage, which formed part of his daily lunch, was thrown into violent death paroxysms when 'roasted'. Massingham of *The Nation* wrote of "the unfortunate carrot strapped to the table of an unlicensed vivisector" and of the "feelings of so stolid a vegetable" when the electric shudder of pain was passed through it by Bose's apparatus.

Lectures In The Continent

Prof. Bose next went to Vienna, an important centre of biological researches where he addressed a meeting attended by many scientists of Austria and Germany who paid the singular tribute that 'Calcutta was far ahead of them in these new lines of investigation'. Invitations came to him from different German universities for a series of lectures. But before undertaking his trip to Germany Prof. Bose came to Paris where too he received a cordial welcome. After fulfilling his Paris engagements, when Bose was on his way to Bonn to deliver lectures at the University, the first world war broke out (August, 1914), and Prof. Bose could barely retrace his steps and escape internment. Not so fortunate, however, were his two nephews, then pursuing their studies there. One of them is now the head of the Institute their uncle founded later.

In The United States Again

He then went to America and lectured before American universities, giving demonstrations of his experiments. At Washington he addressed the State Department and the Bureau of Agriculture. The *Scientific American,* referring to the application of his results in practical agriculture wrote: "What is the tale of Aladin and his wonderful lamp compared with the possibilities of Dr. Bose's Crescograph. In less than a quarter of an hour the action of fertilisers, foods, electric currents and various stimulants can be fully determined." At Harvard Jagadis Chandra spoke before the Departments of Philosophy and Psychology, and also before Clark University, whose President, the well-known psychologist, Dr. Stanley Hall, had always evinced great interest in his work, in fact, from his earliest publications. On his way back home he visited Japan where he met Prof. Koketsu of the Imperial University, who was carrying on investigations on Bose's lines, which tended to confirm some of Bose's important results in course of time.

THE BOSE RESEARCH INSTITUTE

Jagadis Chandra retired in 1915, when the Presidency College, which he had served for upwards of thirty years, appointed him Professor Emeritus, thus securing his permanent connection with the Institution whose renown he had so remarkably enhanced. He was knighted in 1917.

Although retired from the Indian Educational Service by virtue of a conventional age-limit, which in his case, however, was extended by a couple of years, Bose was far from being tired in his continued service to the cause of science. From 1915 to 1917, he cloistered himself on the top floor of his residence in Calcutta, or at his riverside retreat at little-known Sijberia on the Rupnarain, or the Himalayan heights of Darjeeling. There he meditated on an ideal he had long cherished as a dream. For experiments on plants under field conditions he founded at Falta on the Hooghly a research-station ; and, as if unwilling to let the Himalayas feel hurt at his neglect, he laid out a laboratory in his Darjeeling summer-home where the May-flowers might seem to hold out recurring prospects of beautiful efflorescence as an artistic counterpart to a scientific study of plants.

"Not Merely a Laboratory But A Temple"

But the peak-point of Bose's wakeful dream-life was attained on his fifty-ninth birthday, November 30, 1917, when he inaugurated his Research Institute by the side of his Calcutta residence. "I dedicate to-day", said Sir Jagadis in his inaugural address, reproduced elsewhere, "this Institute—not merely a Laboratory but a Temple". And a temple it certainly is, even as a pure piece of architecture from floor to ceiling, reminiscent of Ajanta, the focal point being occupied by a relievo-representation of the sun-god rising in his chariot to dispel darkness and to instil life. One of Nandalal Bose's masterpieces will be found here on a frieze symbolising alliance between Intellect and Imagination—the two constituents of a scientific mind in quest of undiscovered Reality. Here is an auditorium, scientifically constructed in accordance with accoustic laws, where 1,500 persons can be seated for listening to lectures in comfort and confidence that the words emanating from the rostrum are words of wisdom capable of demonstration to the satisfaction of our senses, requiring no intuitive insight in the hearer. Yet the dedicatory address of its founder bears witness to his own appraisal of the traditional intuition of ancient Indian sages, as well as to the deep impression made on his mind by Nalanda and Taxila as ancient University centres whereto were welcomed scholars from foreign lands out in search of truth. And he made provision for such visitors to the Institute he founded.

An Inspired Utterance

Acharya Jagadis Chandra's dedicatory address is an inspired utterance. What strikes one most on the centenary of his birth is his insistence, more than half a century ago, that discoveries of science can be applied in two ways, good and evil—one for construction, another for destruction. This divergence in applied science was keenly felt by his sensitive soul, and, as the first world war was on, he deplored the feverish rush for exploiting scientific knowledge for destruction. Civilisation seemed to be on the brink of ruin, and the saving grace remained unseen. Today, the world is once again face to face with a situation calling for caution lest the atomic energy with its proved power for good and evil is diverted to devastating war—a war this time on millions of men, women and children engaged in peaceful pursuits. Science can make their happy homes happier, with clear conscience as guide. But if the game be in wrong hands, disaster

is sure to ensue. It is, therefore, well for us to recall the words of Acharya Jagadis Chandra Bose uttered in 1917 emphasising the ideal of "giving, of enriching, in fine, of self-renunciation in response to the highest call of humanity".

Complete Renunciation

As symbols of self-sacrifice, the artist in Jagadis Chandra chose the *Vajra* (Thunderbolt) and half of an *Amlaki* fruit, harking back to two ancient stories, the one pre-Vedic, the other post-Asokan. According to a story related in the *Rig Veda,* the Rishi Dadhichi—the pure and blameless—embraced death so that out of his bones might be fashioned the Thunderbolt as the only weapon by which evil could be smitten. And according to Buddhist accounts, King Asoka gave up all his empire as ransom for the world—all but half of an *Amlaki* fruit; and of this last possession he made his final gift with an anguished cry.

The spirit of complete renunciation of earthly possessions which actuated Jagadis Chandra in the foundation of his Research Institute was made manifest in the fact that he devoted whatever he had saved from his earnings towards building the Institute. Inadequate as that capital was, its potentiality lay in attracting contributions from the generous public as well as from the Government. Bose's power to elicit response in this field also was proved to demonstration.

Donations and Bequests

Jagadis Chandra was able to collect for the Institute donations amounting to over Rs. 11 lakhs from the public and secured also an annual grant of Rs. one lakh from the Government of India, which in view of the condition then prevailing might be considered very handsome. He created during his life-time Trust Funds amounting at present to Rs. 12 lakhs for support of researches conducted in the Institute and for foreign scholarships. After his death his widow Abala Bose constituted out of his residual properties another Trust amounting to over Rs. 3·5 lakhs. Several scientific and social activities are maintained by this Trust.

An Active Centre of Research

Results of researches carried on under the auspices of the Institute were designed for publication in its *Transactions,* modelled on the Royal

Society, thus ensuring that the discoveries made might be public property, the right—and the duty—of publication being vested in the Government. These *Transactions* soon acquired an international reputation. *The Times,* in its issue of November 24, 1923 observed: "The function of the Bose Institute differs from that of mere college education whereby large classes may be taught on known facts by a small staff of teachers. Only by long and arduous training are the scholars made competent to undertake original investigation. In such conditions it needs a master mind to waken up, by character and enthusiasm, the latent powers in others. At present there are almost a dozen scholars under the personal training of the Founder. They are called to devote themselves to the pursuit of research undisturbed by any distraction, for Sir Jagadis cherishes the ancient Indian faith that the vision of truth is vouchsafed when sources of distraction are absent and when the mind has reached the point of rest".

As the Research Institute was being planned, Bose completed many important lines of research, the results being communicated to the Royal Society. In these papers, afterwards published in the *Transactions of the Bose Research Institute* for 1918 and 1919, he reveals that the plant-world as a whole was not passive but fully responsive, thus dispelling all misunderstandings that only plants like mimosa record response.

FELLOWSHIP OF ROYAL SOCIETY

THE World War ended in 1918, leaving behind a terrible aftermath, psychological and economic, even in victorious Britain. Prof. Bose chose such a time to go again to England to acquaint his friends with the results obtained by him in the meantime and also to give demonstrations of the delicate instruments recently invented by him. He reached England in the middle of November, 1919, determined to convince, fully and finally, the scientific world of the importance of the modern Indian contribution to science.

WARM WELCOME IN ENGLAND

Contrary to pessimistic forecasts and friendly misgivings, he was received in England with more than usual warmth. Scientists and statesmen alike gave overflowing evidence of the most eager and widespread interest

in his work and its significance. Every door, as it were, was flung wide open to him. It was a complete welcome. Patrick Geddes writes: "It was as though the entire British world had been prepared, by every sort of experience, to receive and acclaim the discoveries which, in previous years, had seemed to be problematical and remote".

A distinguished and highly representative gathering of leading thinkers of Britain came to hear him at the India Office, at the invitation of Edwin Samuel Montagu, Secretary of State for India. Arthur James Balfour took the chair at the meeting. Jagadis Chandra showed a remarkable series of experiments, demonstrating the powers of his 'Magnetic Crescograph', revealing the ever-widening realm of science unifying reason and experiment by imaginative insight.

'To the Benefit of Mankind'

The interest roused by the lecture was so great that extensive summaries of the lecture were cabled to the Continent and America. The British Press—even its popular section—published long reports and appreciative leading articles. Even so staid a paper as *The Times* was stirred. It wrote: "Whilst we in Europe were still steeped in the rude empiricism of barbaric life, the subtle Eastern had swept the whole universe into a synthesis and had seen the *one* in all its changing manifestations . . . . He is pursuing science not only for itself but for its application to the benefit of mankind".

That this was no mere journalistic effusion remained to be corroborated by no less a man of science than Professor J. Arthur Thomson. He wrote in the *New Statesman*: "It is in accordance with the genius of India that the investigator should press further towards unity than we have yet hinted at, should seek to correlate responses and memory impressions in the living with their analogues in organic matter, and should see in anticipation the lines of physics, of physiology and of psychology converging and meeting. These are questionings of a prince of experimenters whom we are proud to welcome in our midst to-day".

Prof. Bose was again invited to lecture before the universities of Oxford, Cambridge, London and the Royal Institution. He was awarded the honorary degree of L.L.D. by Aberdeen University.

A Pleasant Surprise

The road was now smooth for his election to the Fellowship of the Royal Society (1920). The honour came as a pleasant surprise to him. It had

its dramatic element too. For many of his earlier opponents were later found to be his supporters.

The Times in a leading article observed on the occasion: "The Royal Society will formally admit to its Fellowship to-day Sir Jagadis Chandra Bose, the first Indian to attain this distinction for scientific, as distinct from mathematical, work. The previous admission was made in 1917, when the Fellowship was conferred on Mr. Srinivasa Ramanujam, the holder of the Cambridge mathematical research degree. It is nineteen years ago since Sir Jagadis Bose communicated to the Royal Society his first results in plant response, and his paper was rejected. They have been years of persistent and unswerving labour devoted to the working out of new methods of enquiry. The prolonged delay in the crowning of his work by the Royal Society cannot be attributed to any question of race; in the discussions over the nature and final value of his discoveries there has been no suggestion of misunderstanding or conflict between East and West".

Prof. Bose himself said gracefully that "the Royal Society had shown deliberation in recognising his discoveries. This was as it should be, because unless all discoveries were critically examined science and superstition would be inextricably mixed together".

A Challenge Met Again

The unstinted praise accorded to Prof. Bose's work by the British Press and the Fellowship of the Royal Society again brought his old opponent Prof. Waller to the fore. In a letter to *The Times* he doubted the accuracy of Prof. Bose's results and challenged him to give a demonstration of his apparatus of the growth-records by his Crescograph in a laboratory other than his own. Prof. Bose at first ignored the challenge but when he found that Prof. Waller was supported by another scientist, he accepted it.

The demonstration was given at the London University laboratory. Distinguished professors were invited to the lecture fixed for the 23rd April, 1920. It was a complete success. After the demonstration was over, Lord Rayleigh and Professors Bayliss, W. S. Blackman, A. J. Clark, W. C. Clinton and F. G. Donnan in a letter to *The Times* said: "We are satisfied that the growth of plant tissues is correctly recorded by this instrument and at a magnification of from one million to ten million times". Sir W. H. Bragg and Prof. F. W. Oliver, who saw similar demonstrations elsewhere, agreed with the above views and wrote to *The Times* giving their opinion on the point. In a dignified letter Prof. Bose wrote to *The Times*:

"Criticism which transgresses the limit of fairness must inevitably hinder the progress of knowledge. My special investigations have by their nature presented extraordinary difficulties. I regret to say that during a period of twenty years these difficulties have been greatly aggravated by misrepresentation and worse. The obstacles deliberately placed in my path I can now ignore and forget. If the result of my work, by upsetting any particular theory, has roused the hostility here and there of an individual, I can take comfort in the warm welcome which has been extended to me by the great body of scientific men of this country".

A German Hurdle Overcome

Yet another hurdle Jagadis Chandra had to overcome in Europe before he could establish himself squarely. In Berlin he had to accept the challenge of the leading scientific men, specially of the most eminent of them, the plant physiologist Prof. Haberlandt, whose theory had been upset by Prof. Bose's work. He was alone amongst scores of eminent German scientists. He sensed a coldness in the reception accorded to him on arrival. He gave his lecture-demonstration before the scientists without provoking any reaction. The next day it was the turn of Prof. Haberlandt himself. "Yesterday evening", said he, "we experienced a scientific treat of quite an unusual kind. The Indian savant and investigator laid before us lucidly and with the enthusiasm of the discoverer, the results of his researches on the physiology of irritability, which he had been able to attain by means of his highly developed methods of investigation". "We saw", he proceeded, "that there is a sleep of plants in the true sense of the term ; and finally realised that a man of genius can not only *hear* the corn grow, but also *see* it. It is no more an accident that it should have been an Indian investigator who has in high a measure perfected the methods of the physiology of irritability. In Prof. Bose there lives and moves that ancient Indian spirit, which sees in every living organism a perceptive being endowed with sensitiveness. It is remarkable that the same old Indian spirit which has carried to its utmost limits metaphysical speculation and introspection wholly withdrawn from the world of sense . . . that this same spirit should have brought to light on its modern representative, who is our guest to-day, such an extraordinarily developed faculty for observation and such an ecstasy in scientific experimentation. We Germans feel ourselves to be allied in this spirit with the Indian people. Long we have philosophised and speculated with marked enthusiasm,

and at the same time have assiduously fostered the feeling and the love for the direct observation of Nature. For this it has been a double pleasure to welcome Prof. Bose in the capital of the German Empire".

REVEALER OF A NEW WORLD

An excellent biography of Acharya Bose by Prof. Patrick Geddes was published by Longmans in 1920, indebtedness to which in preparing this life-story is acknowledged here.

In 1923, Jagadis Chandra made his sixth visit to Europe. Again he spoke before a distinguished gathering at the India Office. From London he went to Paris. *Le Matin*, a leading French daily, came out with a long editorial, commenting in characteristic French fashion: "After his discovery we begin to have misgivings, when we strike a woman with a blossom, which of them suffers more—the woman or the flower".

His sixth book, *The Nervous Mechanism in Plants*, was published in 1925. He invented the Magnetic Sphygmograph, which revealed the unseen waxings and wanings of the plant's life, confirming his view that the life-mechanism is the same in plants as in animals. The book attracted admiring and wide interest in England, France, Germany, Russia and America.

At The League of Nations

Acharya Jagadis Chandra was at this time nominated to the League of Nations Committee on Intellectual Co-operation. In anticipation of his proceeding to Europe to attend the League Committee meeting he was invited by many scientific centres and continental universities to give discourses on his new discoveries (1926).

While he was in London, to relieve Jagadis Chandra of his anxiety about the future of his Research Institute, eminent British scientists and statesmen submitted a joint memorial to the Governor-General of India requesting him to extend further help to the Institute to expand its activities. This remarkable document was signed, among others, by Sir Charles Sherrington, President of Royal Society ; Lord Grey of Fallodon, Secretary of State for Foreign Affairs ; Sir R. A. Gregory, Editor of *Nature ;* C. P.

Scott, Editor of the *Manchester Guardian*. Seldom has a memorial been so influentially sponsored.

Honours In Belgium

Jagadis Chandra met the great French philosopher Henri Bergson in Paris. "The dumb plants", he said, "had by Bose's marvellous inventions been rendered the most eloquent witness of their hitherto unexpressed life-story. Nature has at last been forced to yield her most jealously guarded secrets". The King of the Belgians, who had during his tour in India visited the Bose Institute, invited Jagadis Chandra to give a lecture-demonstration at Brussels. The King himself presided. For the lecturer's experiments plants were grown in his palace garden. The decoration of *Commandeur Ordre de Leopold* was conferred by the King on Bose.

Presides Over Indian Science Congress

After six months' stay abroad, Bose returned to India in October, 1926. In January, 1927 he presided over the Indian Science Congress at Lahore. The Punjab Government made a present to him of the beautiful wooden gateway now adorning the entrance to the Bose Institute.

Guest of Romain Rolland

In April 1927, Jagadis Chandra sailed again for Europe. Romain Rolland, the famous author of *Jean Christophe,* was his host at Paris, and he presented a copy of his book to Bose superscribed by him: "To the Revealer of a New World". From Paris he went to London where Aldous Huxley, recalling his visit to the Bose Institute, observed: "Bose has given us new eyes to look at the world of living things: we owe him a debt of gratitude". From London he came to Geneva to attend the session of the League of Nations Committee on Intellectual Co-operation. His presence personified the link between the Orient and the Occident. And he had as his colleagues on the Committee—Einstein, Lorentz and Gilbert Murray.

The honours and reception in Europe, the joint memorial submitted by scientists and others in England, the unanimous support accorded to it and his personal appeal to Lord Irwin bore fruit. Shortly before his visit to Europe in 1929, Jagadis Chandra was informed that the Government had sanctioned an extra grant for the extension of the laboratories of the Bose Institute.

From Triumph To Triumph

Jagadis Chandra's last and tenth visit to Europe was a march from triumph to triumph. Wherever he went and spoke—whether at the British Association or at the universities of Vienna and Munich—he was greeted with one voice as a savant who ranked among the great. His work had its appeal not only for scientists but for philosophers and litterateurs alike. Bernard Shaw, after seeing Bose's demonstrations in London, presented him with a special edition of his collected works bearing the inscription "From the least to the greatest biologist". The Editor of the *Spectator* of London gave a lunch in his honour to which came, keen on meeting him, John Galsworthy, Alfred Noyes, Norman Angel, Rebeca West, Yeats-Brown and others. Some of them spoke offering their esteem to "one who had in so eminent a degree enriched human thought", while others asked him about the aspirations of India and the influences which had contributed to her renascence. Along with Tagore, Bose was looked upon as a cultural ambassador from India.

Septuagenary Celebrations

On November 30, 1928, Jagadis Chandra completed the seventieth year of his life. Rabindranath Tagore gave the lead for celebrating the event, and with him were associated some of Prof. Bose's foremost former pupils. Celebrations were held on December 1 in the festive grounds of the Bose Institute, when universities and learned societies at home and abroad either presented addresses or offered tributes and felicitations. Rabindranath commemorated the occasion with a dedicatory poem to his friend in words of singular depth and beauty recalling his early struggles crowned with triumph at the end and his faith in him that never faltered.

Eminent men of science and letters in the West sent their greetings. Sir Richard Gregory, Editor of *Nature,* spoke of his "lifting the veil which had previously enshrouded the analogous workings of plant and animal life" ; Sir John Farmer of the Imperial College of Science, London, referred to his "wonderful apparatus" that had "given a new organon to those who pursue exact methods of physiological and physical investigations" ; Prof. Hans Molisch, one of the greatest plant-physiologists of modern times and a former Rector of the University of Vienna, then a great centre of biological science in Europe, who had come out on the occasion as a visiting professor to the Bose Institute, paid—in the course of an article contributed to the special number brought out by the civic organ of Calcutta in honour

of Jagadis Chandra—a tribute to "a vibrant figure, a fighter and also a dreamer, an inventor more subtle in mind and hand than others . . . . a man who sees the world as one and who proclaims the unity of science." Prof. Goebel, the eminent plant-physiologist of Munich University, paid a tribute to his work that had "made a deep impression not only upon the minds of specialists, but also upon all those who are interested in the intellectual and moral progress of humanity". Bernard Shaw spoke in the same strain wishing him "many more years of splendid service to humanity"; while Romain Rolland acclaimed him as "the Seer", who "by the light of his poetic and spiritual insight has penetrated into the very heart of Nature".

CLOSING YEARS

EARLY in 1931, the Corporation of Calcutta—the accredited representatives of the city which had been the place of his work and struggles for more than forty years, and where the watching of a weed by the roadside had led to the extension of his work from the realm of the inorganic to the great mystery that underlies all organised life—headed by the Mayor, Subhas Chandra Bose, presented Jagadis Chandra with a civic address which paid a tribute to "a great teacher", who had "inspired the youth of our country with a lofty idealism" and by his "utterances and exhortations quickened the renascence of this ancient land". The Acharya, in a characteristic reply, speaking of the honoured place India had succeeded in winning in the federation of nations by her intellectual achievements in many fields, paid a tribute to the valuable work of Sir Chandra Sekhar Venkata Raman on physical science, "which has everywhere been received with high appreciation".

The Bose Institute, by this time, came to be recognised as one of the leading scientific centres of the world where fundamental researches were being conducted. In 1931 Dr. Magnus Hirschfeld visited the Institute to see some physiological experiments on plants. Another distinguished visitor to the Institute was Dr. George C. Ward, President of the Department of Botany of the Brooklyn Institute of Arts and Science.

Early in 1933 Sir Richard Gregory, Editor of *Nature* and a life-long friend of Acharya Jagadis, visited the Bose Institute "to witness the advanced researches carried out in its departments".

Death At Giridih

The years were now closing fast on Acharya Jagadis Chandra Bose. Diabetes was a long-standing malady with him and he had also developed high blood pressure. The annual summer rest that he could take at his Mayapuri Research Station at Darjeeling had to be denied because of the blood pressure. Instead he chose Giridih in south Bihar for the annual change during winter. He gradually withdrew from active participation in research work in his Institute and confined himself more to a critical supervision of the work of the research staff there.

The 30th November of 1937 was fast drawing near and Acharya Jagadis was preparing to return from Giridih to take part at the anniversary meeting of the Bose Institute. On the 20th November, he had passed the final proof sheets of the *Transactions* of the Institute, of which he was Editor to the last. On the evening of the 22nd he had given instructions to the Superintendent of the Bose Institute as to the disposal of his residuary properties, worth several lakhs, to endow research and social work. On the 23rd November, he was having his usual bath at about half past eight in the morning, when his heart suddenly failed, the heart that had sustained him for over thirty years to wage a war singlehanded to establish truth. Sreematee Abala Bose was preparing to celebrate befittingly the eightieth birthday of her husband, seven days later. They were to return to Calcutta together, but she alone returned with the last remains of her life's companion for half-a-century, to be cremated in Calcutta—a city plunged in grief and which rose to a man to honour the illustrious dead.

ABALA BOSE

The fairy godmother who presided at the birth of Jagadis Chandra endowed him with many gifts but, perhaps, the greatest gift was the life-companion he was blessed with. *Grihini sachiva sakhi*—mistress of the household, counsellor and comrade—not many wives had filled all the three rôles as Abala Bose did. If Jagadis Chandra was indebted to any single person for contributing to his success and achievements, it was surely the lady he took as his wife soon after his appointment in the Presidency College.

Single-minded Devotion

Miss Abala Das—her maiden name—then a student of the fourth year class of the Madras Medical College, was the daughter of the well-known

Calcutta lawyer Durgamohan Das and was thus a cousin of Deshbandhu Chittaranjan Das. Durgamohan, a famous Brahmo leader, took a prominent part in many social and political activities of his time. Abala Bose's rôle in life was to smoothen the path that her husband chose for himself. With single-minded devotion, with no thought other than the convenience and comfort of her consort, she completely identified herself with the life-mission of her husband. It was not for nothing that Swami Vivekananda spoke of his friend's wife as he did . . . . 'and blessed be his devoted and peerless helpmate who stands by him always' (1900). Years later the editor of the London *Spectator*, in a striking article on Jagadis Chandra in the *Fortnightly Review*, described Lady Bose as 'a type of all that is bravest and most beautiful in Indian womanhood'. But no finer tribute was, perhaps, paid to her than the one the biographer of her husband, Patrick Geddes, did (1920). It will bear repetition:

> Hers has been no simple housewife's life, but one full of active culture-interests also, not only appreciating her husband's many scientific problems and tasks, and hospitality to his students and friends, but sharing all his cares and difficulties, and so lightening them not a little. For his impassioned temperament—in younger days doubtless fiery, and still excitable enough—her strong serenity and persistently cheerful courage have been an invaluable and ever active support, like the fly-wheel steadily maintaining and regulating the throbbing energies of the steam-engine. Pilgrimages in India and visits to Europe and America have been made always together, and their one great common sorrow—the loss of their only babe in early infancy—has made them more completely at one. Alike for physical health, on the whole well maintained, yet once and again nursed back from danger, and for steadiness of intellectual output, for consolation in times of trial, difficulty and lightening of long years of poverty and self-denial—which cannot but press more closely upon a wife than on a husband—Bose has indeed been rarely fortunate in such a helpmeet; and no friend or biographer could fail to recognise the greatness of her share in his life's productivity and success.

In later life, when Prof. Bose had retired, Abala Devi interested herself and took a leading part in spreading women's education and in establishing Nari Siksha Samiti, built on an incentive she brought from Japan. Its main object is "spreading of education—general and technical—among

girls and women in Bengal so as to make them good wives and mothers and devoted social workers". The Vidyasagar Bani Bhavan in Calcutta, which she could build through the generosity of three Hindu ladies, was to be a home for helpless Hindu widows, devoted to the work of providing them with such education as would not only instil in them a sense of self-respect, but would also enable them to earn their livelihood. Jagadis Chandra had complete sympathy for all these activities of his wife and he bequeathed a generous gift to the Samiti for the creation of a permanent fund.

ANANDA MOHAN BOSE

AMONG his relations the person to whom he owed most was his brother-in-law—Ananda Mohan Bose. It was he who secured for him admission in Cambridge, and it was he, again, who procured for him a letter of introduction to Lord Ripon leading to his appointment in the Indian Educational Service. This, however, any relation would do if he had the influence the first Indian Wrangler possessed. But Ananda Mohan did something more. He inspired Jagadis Chandra with the same love of his country which filled his own soul. Only its expression was different. While Ananda Mohan joined hands with Surendranath Banerjea in founding the Indian Association in 1876—the precursor of the Indian National Congress over which he presided in 1898—Jagadis Chandra chose as the field of his work where he could advance his country most. The patriotic fervour, the lofty idealism and the saintly character of Ananda Mohan exercised the most profound influence in shaping his life and career. Next only to his parents he placed Ananda Mohan in his esteem and affection, and to Ananda Mohan he was more than a brother.

It was from Jagadis Chandra's Calcutta residence at Parsibagan that Ananda Mohan was carried, rising almost from his deathbed, to the ground opposite, when, on October 16, 1905, he laid the foundation-stone of the Federation Hall—a symbol of the unity of Bengal which Curzon had cleaved into two—and delivered the magnificent address, of which Surendranath Banerjea writes in his Reminiscences—'one of the noblest orations to which it has been one's privilege to listen'. And it was at Jagadis Chandra's residence that he passed away ten months later—one of the noblest sons of India. Near and around are hallowed grounds on which stand the houses Rammohun, Keshub Chunder and Vidyasagar built and lived in—at Manik-tala, Mechuabazar and Badurbagan respectively.

ACHARYA BOSE'S CONTRIBUTION TO SCIENCE

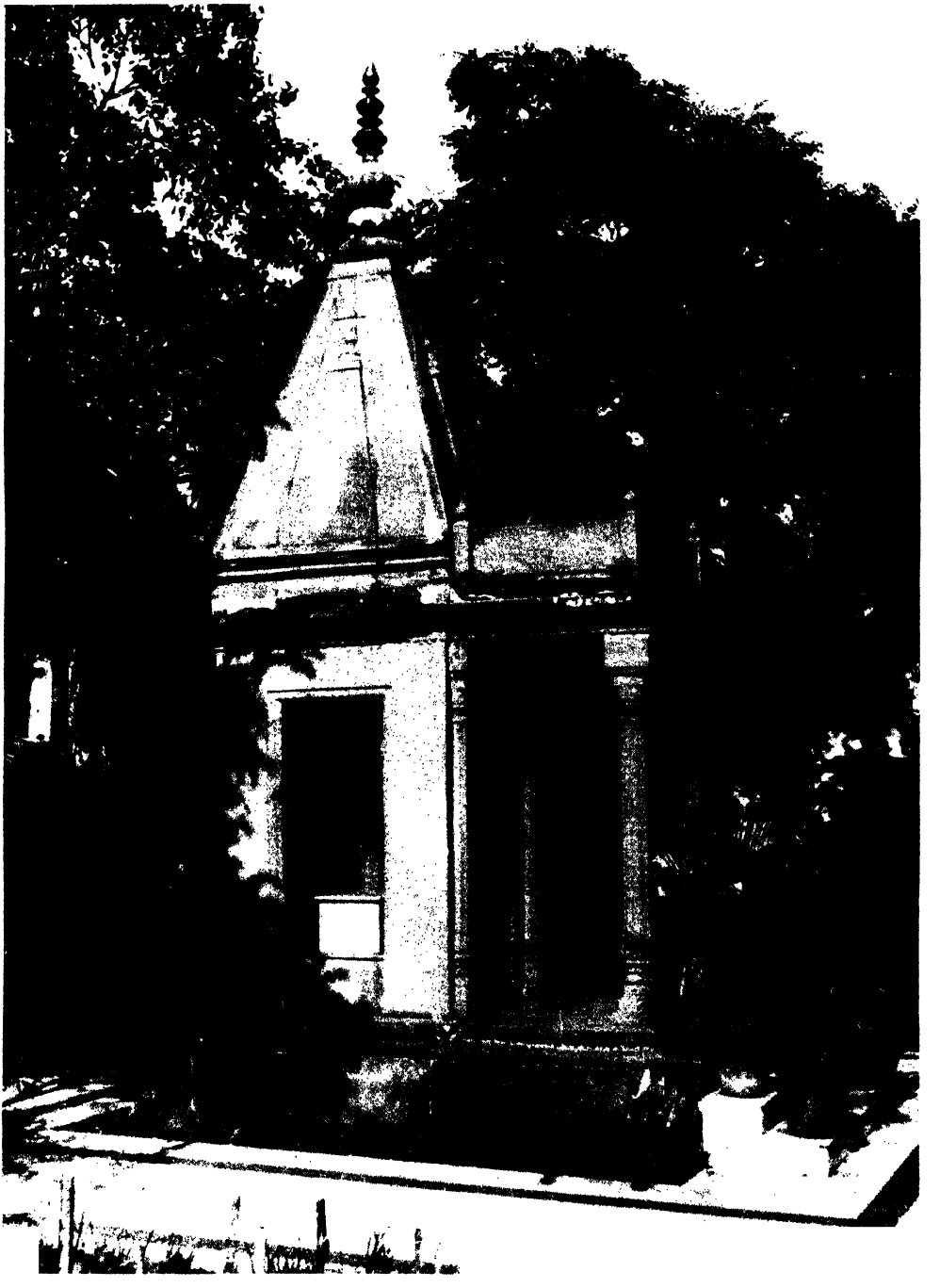
THREE STAGES

ACHARYA JAGADIS CHANDRA BOSE'S active scientific researches extended from 1894 till his seventieth year, 1928. This long period of thirty-three years of his researches could be broadly divided into three stages.

FIRST STAGE

They began with investigations into short electromagnetic waves and continued between 1895 and 1899. Hertz in 1880 verified Maxwell's prediction. The shortest wave-length obtained by Hertz was 5 meters ; for measuring the optical properties of these wave reflection, refraction, polarisation etc., Hertz had to use a very large apparatus. Prof. Bose communicated his first paper on the polarisation of electric waves by double refraction in May, 1895. The wave-length used by him was 5 mm, *i.e.*, one thousandth of that used by Hertz. Bose also carried out signalling through space by means of his apparatus. Marconi, Lodge and Muirhead were using long electric waves of wave-lengths of the order of hundred meters for transmission of messages without wires. Commercial application of transmission of radio messages developed by Marconi employed electric waves of wave-lengths of hundreds of meters. Only recently, after the last world war, in the radar, television etc., the centimeter radio waves investigated by Prof. Bose have come into commercial use. The wave-length region studied by Bose is finding a new application in the study of properties of matter. Competent scientists have regretted that Jagadis Chandra did not continue this line of physical research in which he was undoubtedly a pioneer. But he was cast in a somewhat different mould. For those who have a synthetic vision it is not enough that a discovery is made. Where it fits itself in the cosmic scheme appears to be a more important subject for them to follow. Jagadis Chandra's reasoning and his imagination did not rest until he noted the underlying relationship that enabled him to link an isolated fact with another and still another. Like Darwin he could take ten thousand apparently unrelated facts and show that they were but manifestations of some universal law. Hence his scientific hypothesis, based on the facts that he had painstakingly gathered, had an epic sweep foreign to the narrow interpretation of the mere analyst.

ABALA BOSE 1926



WHERE THEIR ASHES REST

The ashes of the parents of Jagadis Chandra, his own and his wife's are enshrined in the garden of the Bose Institute.

Second Stage

The second stage of his investigations began with the observation of the similarity of electrical responses in the living and non-living substances—from 1899 to 1904. Nearly half a century later, during the last war, a large number of electronically controlled machinery were invented like radar, guided missiles, electron-computing machine, whose behaviour could be described in terms of another set of physiological terms like receptor of messages, a central exchange and an effector-mechanism. For these types of similar behaviour in animals and machines, Nobert Wiener coined the term 'Cybernetics'. Jagadis Chandra may well be considered as a precursor of this new science of Cybernetics.

Third and Last Stage

These electrical researches were, however, no irrelevancies in the major work of his life, because they led him to investigate the responses of organic and inorganic matter with whose measurement began what may truly be called a Columbus voyage of scientific discovery. When making use of the receivers of his electric waves, he had noticed in them obvious signs of fatigue, which would only pass away after a period of rest. This curious phenomenon prompted him to look into the responses of inorganic matter, which he first explained before the International Congress of Physicists in Paris in 1900. An enquiry into the response of plants was only a step removed from this, and by advancing further along this path he was enabled to discover the identity of physiological reactions in plants and animals and the velocity of nervous impulses in plants. This was his third or last group of investigations, which started in 1905 and continued till 1928. His first conclusions on the subject, embodied in his book *Plant Response* published in 1906, he elaborated with the help of a marvellous series of instruments, whose invention and manipulation was not the least part of his genius. He met the stoutest opposition in this field of work from physiologists. No man had to work harder to arrive at the laws and for the recognition of these laws by keen and often unreasonable and at times hostile critics. It took Acharya Jagadis Chandra Bose more than twenty years of unremitted labour to overcome all objections and opposition to get his discoveries accepted by the world of science.

This was due above all to the fact that Jagadis Chandra was the first Indian of modern times to do not only distinguished but pioneer work in science. The West was quite accustomed to the metaphysical speculations

of the East, but it believed exact science to be a branch of knowledge for which orientals had no aptitude. The Acharya was to demonstrate that science is neither of the West nor of the East but international in its universality. He was no less a pioneer in science for rehabilitating the name of India in the study of positive science than he was for conquering unknown world for plant physiology.

JAGADIS CHANDRA—THE MAN

JAGADIS CHANDRA BOSE was by choice a man of science. But he was more. The scientist in him is not difficult of assessment—for there are estimates of his contribution to science made both by critics and by admirers—but his poetic temperament, philosophical outlook; keen sense of beauty, aesthetic appreciation, outstanding literary abilities are not so well known.

The personality of Jagadis Chandra Bose is not likely to be fully revealed if the generally accepted yard-stick is applied to gauge his achievement. A distinguished European writer touched on this key-point of Jagadis Chandra's life when he remarked: "In the European scientist the steeling of the mind to the interpretation of Nature has often been accompanied by a withering of the feeling for beauty. Darwin bitterly lamented the fact that his research in Biology had completely atrophied his appreciation of poetry. With Bose it is otherwise. Science has but enhanced his emotional reaction".

SOUL OF AN ARTIST

In Jagadis Chandra actually reason and emotion were completely integrated. He had the insight of a scientist with the soul of an artist. His analytical faculties were quickened by his emotional impulses. Because he saw one order running through the universe in all its diverse manifestations, he could see life as a whole. And this life was not nurtured in laboratories alone but nourished in art and letters, music and drama to give it a rhythm and balance. Jagadis Chandra attained this harmony as few of his contemporaries in the East and the West did. The precision of his scientific mind he carried to and imprinted on everything around him. He could stand nothing in disarray, nothing out of focus. His daily life

was ordered in a remarkable manner. He could never be slipshod. Unlike many well-known scientists he dressed with care. Though by no means a gourmand, he liked good food well served. Poetry stirred him, music moved him, and flowers were his passion. Nature affected him deeply.

Eye for Beauty

Endowed with an eye for beauty, he was an excellent judge of sculpture and paintings. His Calcutta house alongside the Research Institute he founded has grafted on its walls Buddha images, miniature Buddhist *stupas* and some specimens from Harappa; his drawing room is decorated with murals of episodes from the *Mahabharata* executed by Nandalal Bose. The Institute itself—an architectural landmark in the 'city of palaces'—with its striking gateway, its bas-reliefs and plaques, its well-laid gardens speak the deep and abiding love of beauty that Acharya Jagadis Chandra cherished throughout his life-long quest for truth.

Literary Abilities

His acquaintance with literature was extensive. Tagore once remarked that if his friend took to literature he could without difficulty occupy the front rank. In fact, the few writings in Bengali he has left behind entitle him to an assured place among those who have used their mother tongue to give expression to their thought. A selection from these has been brought out under the title *Abyakta* (The Unmanifest)—scientific and imaginary writings and tales of his pilgrimages. Curiously enough, he once wrote a short story which brought him the first prize in a competition—a story with a scientific background, perhaps, the first of its kind in Bengali. It was not only well-written but well-told with a lively touch of humour. His presidential address, recounting his researches and findings, at the Mymensingh session of the *Bangiya Sahitya Sammelan*—Bengali Literary Conference—was a masterpiece. And it was not for nothing that the *Bangiya Sahitya Parishad*—Academy of Bengali Letters—made him its president for two successive terms, a rare honour for a scientist in any country.

Warm-hearted Affection

Though a strong element of combativeness and an impassioned temperament went into the making of Jagadis Chandra's character—and these alone

could give him the strenuous and persistent courage to confront and overcome difficulties and obstacles, natural and man-made—yet these did not make him aggressive by any means. Nor was he ever bitter about the hostility he had to face. He could even be amusing about it when recounting the story of his struggles.

Jagadis Chandra had no brother or children. A younger brother died while quite young, and his only child while a babe in arms. But a more warm-hearted and affectionate brother to five sisters and an uncle to numerous nephews and nieces and their children could hardly be found. He counted among his friends world celebrities, but he had many, unknown to fame. He could move equally well among kings and commoners, for he had that touch which could knit them together.

Keen Sense of Humour

Jagadis Chandra had a wonderful fund of interesting stories, some very amusing of the many lands he had visited and the personalities he had met. He could go on telling them for hours together, and no one would ever get tired of listening to him, for he could always make the most trivial things fascinating, and he had a keen and refreshing sense of humour.

An Ideal Teacher

As a teacher his relation with his pupils was abiding. He inspired not a few of them to high endeavour. And he commanded a respect bordering almost on worship. The ancient Indian ideal of *guru* and *shisya* bound them with a bond rare in these days. Of his numerous students he thus spoke in one of his addresses: "Perhaps as a reward for years of effort, I find all over India those who have been my pupils occupying positions of the highest trust and responsibility in different walks of life. I do not merely count those who have won fame and success, but I also claim many others who have taken up the burden of life manfully and whose life of purity and unselfishness has brought gleams of joy into suffering lives".

Pride in His Heritage

Jagadis Chandra Bose was an ardent patriot, proud of his heritage. The realization of India's greatness came to him not only from his acquaintance with her scriptures, epics and history, but it also grew from the

travels he undertook to almost all her ancient and historic sites. The earliest of such travels, always in the company of his wife, was made in the early nineties of the last century when travelling facilities were few. The two vacations at college, the Bose couple invariably utilized 'to see and know India'. He always carried a full-plate camera with him, and whatever struck him he took photograph of. The few which have been preserved indicate what was the Indian heritage that fascinated him most.

Travels in India

Jagadis Chandra's travels covered entire India—sacred or secular—beginning broadly in historic order with old centres and shrines before later ones. One of his first journeys was to the Sanchi tope built by Asoka's queen over a relic of Buddha. Buddhist lores and legends had always an appeal for the Hindu scientist. Bodh Gaya, Rajgir and Nalanda—visited in the company of Rabindranath Tagore, Sister Nivedita and Jadunath Sarkar—the caves of Ajanta and the ruins of Pataliputra made a deep and abiding impression on him. It was at Taxila and Nalanda—the two great centres of Buddhist learning—that the vision of the Institute he founded first awoke in him. The temple of Mandhata at the confluence of the Nerbudda and Tapti and the adjacent temple-ruins which legends link with the heroes of the *Mahabharata;* the centres of Rajput chivalry; the magnificent Mogul cities of northern India; the golden Sikh city of Amritsar; the temples of Bhubaneswar, Puri and Konark; the great cathedral cities of the south—about which he wrote a memorable article in the *Modern Review* (March, 1919)—Ceylon with its ancient Buddhist temples and, of course, the rock-temple of Ellora and the cave-temples of Elephanta, Karli and Kenhari, followed by a visit to Maharastra with its heroic associations of Chhatrapati Sivaji formed over a period of years his Indian itinerary. And nothing helped him more in forming a profound conception of the unity of Indian cultures which put such a characteristic stamp on his utterances through the succeeding period of his creative life.

The Call of the Himalayas

But the greatest attraction for Jagadis Chandra was the Himalayas. One of his earliest journeys was to the Pindari Glacier undertaken from Nainital. A hair-breadth escape for guide and self proved only stimulating; so the next year, starting by way of Almora, he piloted his wife and some friends

to the glacier again, exploring the sources of the mighty Ganges, the tail-end of which had cast such a deep spell on him in his childhood days in East Bengal. Several visits were made to the Kumaons with a stay with the sannyasins of the Ramkrishna Mission at Mayavati, and as he came in close touch with the people inhabiting the hills, the pervading spirit of Indian mythology he had imbibed in his boyhood was revealed to him in the simple life of the denizens of that distant corner of the sub-continent.

The journey that enthralled Jagadis Chandra most was his pilgrimage to Badrinath and Kedarnath—accompanied by his wife and Sister Nivedita. Three weeks' uphill journey from the railway terminus was needed to reach there. In the rugged terrain all around men and women, young and old, from all parts of India were joyously proceeding to the same destination braving all physical hardships. Often the stillness of the majestic gorges would be rent by the cries of *'jais'* raised in chorus in obeisance to Kedarnath.

This human scene deeply moved Jagadis Chandra, revealing to him, as nothing else could, the fountain head of the spiritual heritage of his compatriots. In a reminiscent mood later he remarked: "With all these experiences India has made me and kept me as her son. I feel her life and unity deep below all". He never suffered from any doubt about the fundamental unity of India and the pervading cultural atmosphere breathed by the people whether they hailed from the Himalayan recesses or the places where the Indian soil reaches the Arabian Sea and the Indian Ocean. A cosmopolitan in the best and widest sense of the term, his fundamental attitude to life, his cultural sympathy and outlook were primarily Indian. His roots were in India and he fully realized her old values with the best of the new culture of the West contributing not a little to his intellect and personality. But to him India was first.

Not A Parochial Nationalist

Yet it would be wrong to take Jagadis Chandra Bose as a parochial 'nationalist'. His nationalism never enclosed his outlook within the borders of his own country. It was in no sense narrow. One incident he used to refer to very often, and that showed how he could take a balanced view even of the great past of his country. "After taking my degree here, when I went to London and Cambridge about forty years ago", he said once to his students, "even then I was filled with patriotic fervour. I was soon

to learn to discriminate between effective and emotional patriotism. I believed like you that our ancestors knew everything and that we had nothing to learn from people of yesterday. I did not know anything about our ancient history, but that made me the more dogmatic. I was working hard at the British Museum and looked very ill. One of my neighbours, who, I learnt later, was a great man of science, came to me, and invited me to take a long drive in the country in a hansom cab. During the drive I fully utilised the time to preach India to him, and made the most extravagant claims about what India had done for civilizing the rest of the world, and dwelt specially on our sympathy and compassion for the sufferings of animal life. My friend inquired that I must then be a strict vegetarian, which I was not. I had not at that time discovered the sufferings of the plant-life. I was, however, not to be taken aback, and said that some of us were compelled to take animal food but even then our innate spirit of chivalry made discrimination in favour of female animals; thus we might take the meat of a he-goat but never that of a she-goat. My friend appeared to be greatly impressed, and invited me to dinner next day when he explained that the meat served was that of a he-cock and not that of a she-cock. About the sex of the fish served, he was not certain, but he hoped that they were all males. I then realized that true patriotism was not a matter of outward show but of inner attitude and that it was vulgar to brag about our past. I could not help realising that we had the start of other nations by thirty centuries but there had crept in some weakness that had arrested our advance. True patriotism required that we should throw off this fatal paralysis. By our present deeds only we could justify our great ancestry. The golden age belonged not in the past but in our immediate future".

Deeply impressed though he was by the achievements of ancient India, he had the unshaken belief 'that the past shall yet be reborn in a nobler future through the efforts of their lives'.

SOME FRIENDS OF JAGADIS CHANDRA:

RABINDRANATH TAGORE

Of Jagadis Chandra's friends, Rabindranath, of course, occupied the place of honour. Of their friendship over many years the poet had spoken at more than one place and as only he could speak. The collection of Rabindranath's letters to Jagadis bears abiding testimony to the deep

attachment between the poet and the scientist. It was mutual. Tagore's love and warmth was fully reciprocated by Bose. What drew them together was, as Tagore once said, the love they shared for their motherland. But there was something more. The 'militant exuberance of youthfulness' with which Jagadis Chandra was 'contemptuously defying all obstacles in the progress of his endeavour' infected Rabindranath, and he resolutely stood by him, offering hope and rendering help, at a time when Jagadis Chandra needed them most. How much it meant to the scientist would be evident from the letters he wrote to the poet which are being collected and published on the occasion of the Centenary. Tagore left no stone unturned to raise funds for the undisturbed continuance of Bose's work. He begged. He borrowed. And he helped in keeping his friend abroad so that he might completely vindicate his scientific claims challenged by hostile critics.

Tagore rightly believed that a part of his nature was logical, which 'not only enjoyed making playthings of facts' but, to quote his own words, 'sought pleasure in an analytical view of objective reality'. Bose often assured his friend that he 'only lacked the opportunity of training to be a scientist, but not the temperament'. It is indeed remarkable that it was Tagore who, for the first time, wrote in Bengali, for a periodical he then edited, a most lucid account of Bose's lecture before the Royal Institution in 1901 on the response of inorganic matter to mechanical and electrical stimuli. The message of an all-pervading unity binding together all things—with which Rabindranath had been familiar from his early life through the utterances of the *Upanishads*—found at once a responsive echo in the poet's mind.

How intimate the relationship between Jagadis Chandra and Rabindranath was will be best illustrated by an episode recorded by his biographer, Patrick Geddes. On the occasion of Bose's return from his successful visit to Europe in 1896, Tagore called to congratulate him and, not finding him at home, left on the work-table a great blossom of magnolia, as a fitting and characteristic message of regard. The poet's favourite resort then at Shilaidah in East Bengal on the mighty Padma was often visited by the Bose couple when a most delightful time was spent.

These visits are vividly described by the poet's son in his reminiscences recently published. He writes: "Jagadis Chandra Bose loved to spend the week-ends with us on the river. He had travelled far and wide, but he used to say that no health or pleasure resort in the world could rival the *chars* of the Padma. He taught me how to trace the footprints of the turtles and

SISTER NIVEDITA

THE LADY OF THE LAMP

NIVEDITA MEMORIAL AT THE BOSE INSTITUTE

discover the eggs that were carefully hidden under the sand. I had to bring him turtle eggs every day for his breakfast. He would be more delighted when a live turtle was caught, for he relished the tender meat. Jagadis Chandra had another hobby; he would make all of us dig pits in the sand and with wet towels round our heads lie down in them to sun-bath, and then when the roasting process had gone far enough jump into the cool water for a change".

Of his father's relation with Jagadis Chandra, Rathindranath Tagore writes: "The attachment of the scientist and the poet was much more than just friendship. They would constantly exchange ideas. One would talk of the next story to be written and the other of the remarkable results obtained from experiments carried on in his laboratory. They would not only appreciate each other's criticism but derive inspiration from their discussions. Every week-end that Jagadis came to Shilaidah he would make Father read out to him the short story that he had written the previous week and get a promise from him to have another ready the next week-end . . . . His constant demand from his friend made Father write so many short stories at this period".

Tagore was not then known in Europe and Bose keenly felt that the West had not the opportunity of realising his friend's greatness. So during his second visit to Europe in 1900 he had one of his stories, 'Kabuliwala', translated into English and submitted it to *Harper's Magazine* for publication. The Russian scientist and Nihilist leader, Prince Kropotkin, a noted critic in letters and science declared it to be the most pathetic story that he had ever read and the theme reminded him of the greatest writers among his countrymen. But the magazine declined to publish the story on the ground that the West was not sufficiently interested in Oriental life. When during Bose's visit to America in 1915—Tagore's fame was then reaching its meridian in the West—Harper saw him for one of his articles, he did not fail to avail himself of the opportunity to remind Harper of his earlier views.

With Tagore his artist-nephews Gaganendranath and Abanindranath as also their most distinguished disciple Nandalal Bose came in close contact with Jagadis, in whom they found an ardent admirer of the new Bengal school of painters contributing its share to Indian renascence.

Swami Vivekananda

Jagadis Chandra first met Vivekananda soon after his triumphant return home from Chicago. The Swami's enthusiasm for 'the heroic son

of India', first roused in Paris in 1900, never waned, and the contact then established between the monk and the scientist never lapsed. The editor of this brochure had more than once heard from Lady Bose how Swamiji, in between his sojourns abroad, would call on his friend in Calcutta and amuse him with stories of his many odd experiences abroad and regale himself with East Bengal dishes—hot curries—cooked specially for him by her—the hotter the better. One particular visit Lady Bose vividly remembered—the surprise the Swami gave by turning up late one winter evening in complete European attire, driving from Belur in a coach and pair.

Sister Nivedita

Speaking of his friend shortly after Jagadis Chandra's death, Rabindranath referred to Nivedita's friendship with Jagadis Chandra and said that in any record of his life the name of the Sister must be given a place of honour. Like her Master the noble Irish woman realized, early in her acquaintance with Jagadis Chandra, the great role he was destined to play in the field of science in general and for the promotion of scientific activities in India in particular. But the tie that knit them close was their intense love for India—reverence for her great past and faith in her future still greater. A vision of a resurgent India great in every way moved Nivedita. She felt that whatever she could do to help her friend in the mission he had made his own would contribute to that end. And she never spared herself. Her intellectual equipment and high idealism alike fitted her to appraise Jagadis Chandra's work. Writing to Rabindranath after the publication of Bose's book on *Response in the Living and Non-living* she said: "I want a far greater work such as only this Indian man of science is capable of writing on Molecular Physics—in which that same great Indian mind that surveyed all human knowledge in the era of the *Upanishads* and pronounced it one, shall again survey the vast accumulations of physical phenomena which the 19th Century has observed and collected and demonstrated to the empirical . . . West that these also are one—appearing as many". Sympathy and succour that was in her power to give, she gave to Jagadis Chandra in an unstinted measure. His difficulties she made her own and she fought his battles on her front, constantly inspiring him to "go out and fight your battles where the fire is hottest and labour most intense and the contest raging thickest" (quoted from her letter).

How deep was Sister Nivedita's admiration for and how great was

her expectation of Jagadis Chandra is revealed in the message she sent him on his birthday in 1910. She was then in Genoa. "When you receive this", she writes, "it will be *our* beloved 30th—the birthday of birthdays. May it be infinitely blessed . . . . May it be followed by many many of ever-increasing sweetness and blessedness. Outside there is the great statue of Christopher Columbus, and under his name only the words 'La Patrie', and I thought of the day to come when *such words* will be the speaking silence under *your name* . . . . how spiritually you are already reckoned with him and all those other great adventurers who have sailed trackless seas to bring their people good. Be a light unto the people and a lamp unto their feet and be filled with peace—you the great spiritual mariner who found new worlds". (Italics are Nivedita's.)

Her long-dreamt-of centre of research for Bose came to be established when Nivedita was no longer in the land of the living. She died at Darjeeling in 1911 under her friend's roof. But when the Bose Institute came into being, Acharya Jagadis Chandra erected to her memory a striking bas-relief in bronze of a woman carrying a lamp, placed above a lotus-pool at the entrance to the Institute, on the wall between his residence and the Lecture-hall. Lady Abala Bose once spoke of Nivedita: "As a woman, I knew her in everyday life, full of austerity and possessed with a longing for righteousness which shone round her like a pure flame. Others will know her as the great moral and intellectual force which comes to us in time of great national need".

Mrs. Ole Bull

The other woman from the West, who, like her friend Sister Nivedita, helped Jagadis Chandra in his mission in various ways was Mrs. Ole Bull, widow of the great Norwegian violinist, who inspired a generation of writers and musicians and won European eminence. She had heard of the scientific researches of Prof. Bose and during her visit to Calcutta in 1899 came to pay him a visit in his laboratory. A deep friendship grew between the two. During his second mission to Europe, first Prof. Bose and later Mrs. Bose fell seriously ill in London. Mrs. Ole Bull was then in the continent. She hurried to London, found for Jagadis Chandra an expert surgeon and helped to nurse him back to health. When the Boses went to America they found a home in Mrs. Ole Bull's house which Jagadis Chandra made his headquarters for his lectures at different American universities. During later visits to America in 1914, when Mrs. Ole Bull was dead, Prof. Bose

and his wife found an equally warm home in the house of Mr. I. G. Throp, an honoured citizen of Boston, a brother of Mrs. Ole Bull, who had married a daughter of the poet Longfellow.

Acharya Prafulla Chandra Ray

Acharya Prafulla Chandra Ray was another friend of Jagadis Chandra. On return to India with his doctorate from Edinburgh, the distinguished chemist found a welcome and a home at Bose's. He also faced the same prejudice of the appointing authorities of the Education Department as Jagadis Chandra did. But this time Bose himself managed to disarm the reluctance of the Department and get his friend appointed as the second Indian in the science professoriate of the Presidency College. And a close friendship grew up between them, labouring side by side for more than a quarter of a century, for the achievement of their common ideal—the propagation of science in India.

Brajendra Nath Seal

Among others, who were leaders in educational, social and political fields of India during the first quarter of the present century, Jagadis Chandra was on terms of closest friendship with the great savant Brajendra Nath Seal. It was natural that a kinship should grow between Dr. Seal and Prof. Bose, for Dr. Seal's quest after a great synthetic philosophy had a special attraction for Prof. Bose with his synthetic outlook on science.

Nilratan Sircar

Equally held in esteem by Jagadis Chandra was his life-long friend, the eminent physician, Dr. Nilratan Sircar, who had rendered distinguished service to education. Bose, who greatly admired the gifts and graces of his friend's intellect and character, owed his life on more than one occasion to his promptitude and skill. The excellent health he enjoyed for many years depended much on Sir Nilratan Sircar's care and vigilance which never relaxed.

Ramananda Chatterjee

The famous editor of the *Modern Review* and *Prabasi* was a pupil of Jagadis Chandra. And no pupil ever held a teacher in greater esteem

and no teacher admired a pupil more for his great qualities. He looked upon him as a friend whom he took into confidence and whose counsel he sought throughout an unbroken period of fifty years. No journals did more than those conducted by Ramananda Chatterjee in making known the work and achievements of Jagadis Chandra Bose.

Gokhale and Gandhi

Jagadis Chandra's relationship with Gokhale and Mahatma Gandhi, both of them politicians, was rather strange, particularly because throughout his life he avoided politics. Once, when he had retired from the educational service, a proposal was mooted that he should be called upon to become Vice-Chancellor of Calcutta University. He expressed his disinclination to accept the office because, in his view, it was becoming political. To him there was nothing else to nurse but his Institute to adolescence and full vigour.

But Jagadis Chandra all through his life kept himself abreast of public affairs and his mind alert to events around him. That alertness—greatly aided by Nivedita—brought him in contact with Gokhale. Gokhale, who, quite early in Bose's career, recognised his scientific talent, strongly urged upon the Government of the day to send Prof. Bose on a deputation to all the scientific centres of Euope, America and Japan. Shortly after the death of his illustrious friend Bose made it a point to visit Gokhale's home at Poona and pay homage to his memory.

Acharya Bose and Mahatma Gandhi met during one of the earliest visits of Gandhiji to Calcutta, and Jagadis Chandra came to entertain a high admiration for this great Indian since then. That Gandhiji in his turn was equally impressed is evident from the frequent tributes he paid to Jagadis Chandra and the support he gave him. After the foundation of the Bose Institute Gandhiji came and stayed with Jagadis Chandra for a few days, and when anxious to raise funds for it, Jagadis went to Bombay, Gandhiji, through his *Young India,* issued an earnest appeal to the public in support of the cause. "All Indians", the appeal said, "are proud to claim Sir Jagadis as a countryman because he is not only one of the greatest scientists of the world, but a time will come when his discoveries will revolutionize the industries of the world. The Bose Institute of Calcutta is destined to fill a great place in the world . . . . Now it is for the citizens of this great city to give the Indian scientist who has carried the fame of India all over the world such a welcome as will redound to the honour and glory of Bombay".

To

Jagadis Chandra Bose

From

Rabindranath Tagore

1901

Young image of what old Rishi of Ind
Art thou, O Arya savant, Jagadis?
What unseen hermitage hast thou raised up
From 'neath the dry dust of this city of stone?
Amidst the crowd's mad turmoil, whence hast thou
That peace in which thou in an instant stoodst
Alone at the deep centre of all things—
Where dwells the One alone in sun, moon, flowers,
In leaves, and beasts and birds, and dust and stones,
—Where still one sleepless Life on its own lap
Rocks all things with a wordless melody,
All things that move or that seem motionless!
While we were drunk with the remote and vain
Dead glories of our past,—in alien dress
Walking and talking in an alien tongue,
In the caricature of other men—
Their style, their bearing,—while we shouted, yell'd
Frog-like with swollen throat in our dark well,
O, in what vast remoteness wert thou then?
Where didst thou spread thy hush'd and lonely mat—
Thy mat of meditation? Thou, thy mind
Curdling into calm gravity, didst plunge
In thy great quest after the viewless ray,

RABINDRANATH TAGORE 1905

Beyond the utmost borders of this world
Of visible form, there where the Rishis old
Oped, and passed in beyond the lion-gates
Of the Manifold and stood before the One,
Silent in awe and wonder, with joined hands!
O Hermit, call thou in the authentic words
Of that old hymn called *Sama*: "Rise! Awake!'
Call to the man who boasts his Sastric lore
From vain pedantic wranglings profitless,
Call to that foolish braggart to come forth
Out on the face of Nature, this broad earth.
Send forth this call unto thy scholar band:
Together round thy sacrifice of fire
Let them all gather. So may our India,
Our ancient land, unto herself return
O once again return to steadfast work.
To duty and devotion, to her trance
Of earnest meditation ; let her sit
Once more unruffled, greedless, strifeless, pure
O once again upon her lofty seat
And platform, teacher of all other lands.

—*Translated from Bengali by*
PROF. MANMOHAN GHOSH.

The Voice of Life

by

Jagadis Chandra Bose

Inaugural Address delivered at the Bose Institute on November 30, 1917

I DEDICATE today this Institute—not merely a Laboratory but a Temple. The power of physical methods applies for the establishment of that truth which can be realised directly through our senses, or through the vast expansion of the perceptive range by means of artificially created organs. We still gather the tremulous messages when the note of the audible reaches the unheard. When human sight fails, we continue to explore the region of the invisible. The little that we can see is as nothing compared to the vastness of that which we cannot. Out of the very imperfection of his senses man has built himself a raft of thought by which he makes daring adventures on the great seas of the Unknown. But there are other truths which will remain beyond even the super-sensitive methods known to science. For these we require faith, tested not in a few years but by an entire life. And a temple is erected as a fit memorial for the establishment of that truth for which faith was needed. The personal, yet general, truth and faith whose establishment this Institute commemorates is this; that when one dedicates himself wholly for a great object, the closed doors shall open, and the seemingly impossible will become possible for him.

Thirty-two years ago I chose teaching of science as my vocation. It was held that by its very peculiar constitution, the Indian mind would always turn away from the study of Nature to metaphysical speculations. Even had the capacity for inquiry and accurate observation been assumed present, there were no opportunities for their employment; there were no well-equipped laboratories nor skilled mechanicians. This was all too true. It is for man not to quarrel with circumstances but bravely accept them; and we belong to that race and dynasty who had accomplished great things with simple means.

Failure and Success

This day twenty-three years ago, I resolved that as far as the whole-hearted devotion and faith of one man counted, that would not be wanting, and within six months it came about that some of the most difficult problems connected with Electric Waves found their solution in my Laboratory, and received high appreciation from Lord Kelvin, Lord Rayleigh and other leading physicists. The Royal Society honoured me by publishing my discoveries and offering, of their own accord, an appropriation from the special Parliamentary Grant for the advancement of knowledge. That day the closed gates suddenly opened and I hoped that the torch that was then lighted would continue to burn brighter and brighter. But man's faith and hope require repeated testing. For five years after this the progress was uninterrupted ; yet when the most generous and wide appreciation of my work had reached almost the highest point there came a sudden and unexpected change.

Living and Non-living

In the pursuit of my investigations I was unconsciously led into the border region of physics and physiology and was amazed to find boundary lines vanishing and points of contact emerge between the realms of the Living and Non-living. Inorganic matter was found anything but inert ; it also was a-thrill under the action of multitudinous forces that played on it. A universal reaction seemed to bring together metal, plant and animal under a common law. They all exhibited essentially the same phenomena of fatigue and depression, together with possibilities of recovery and of exaltation, yet also that of permanent irresponsiveness which is associated with death. I was filled with awe at this stupendous generalisation ; and it was with great hope that I announced my results before the Royal Society, results demonstrated by experiments. But the physiologists present advised me, after my address, to confine myself to physical investigations in which my success had been assured, rather than encroach on their preserve. I had thus unwittingly strayed into the domain of a new and unfamiliar caste system and so offended its etiquette. An unconscious theological bias was also present which confounds ignorance with faith. It is forgotten that He, who surrounded us with this ever-evolving mystery of creation, the ineffable wonder that lies hidden in the microcosm of the dust particle, enclosing within the intricacies of its atomic form all the mystery of the cosmos, has also implanted in us the desire to question and understand. To

the theological bias was added the misgivings about the inherent bent of the Indian mind towards mysticism and unchecked imagination. But in India this burning imagination which can extort new order out of a mass of apparently contradictory facts, is also held in check by the habit of mediation. It is this restraint which confers the power to hold the mind in pursuit of truth, in infinite patience, to wait, and reconsider, to experimentally test and repeatedly verify.

It is but natural that there should be prejudice, even in science, against all innovations; and I was prepared to wait till the first incredulity could be overcome by further cumulative evidence. Unfortunately there were other incidents and misrepresentations which it was impossible to remove from this isolating distance. Thus no conditions could have been more desperately hopeless than those which confronted me for the next twelve years. It is necessary to make this brief reference to this period of my life; for one who would devote himself to the search of truth must realise that for him there awaits no easy life, but one of unending struggle. It is for him to cast his life as an offering, regarding gain and loss, success and failure, as one. Yet in my case this long persisting gloom was suddenly lifted. My scientific deputation in 1914, from the Government of India, gave the opportunity of giving demonstrations of my discoveries before the leading scientific societies of the world. This led to the acceptance of my theories and results, and the recognition of the importance of the Indian contribution to the advancement of the world's science. My own experience told me how heavy, sometimes even crushing, are the difficulties which confront an inquirer here in India; yet it made me stronger in my determination, that I shall make the path of those who are to follow me less arduous, and that India is never to relinquish what has been won for her after years of struggle.

The Two Ideals

What is it that India is to win and maintain? Can anything small or circumscribed ever satisfy the mind of India? Has her own history and the teaching of the past prepared her for some temporary and quite subordinate gain? There are at this moment two complementary and not antagonistic ideals before the country. India is drawn into the vortex of international competition. She has to become efficient in every way,—through spread of education, through performance of civic duties and responsibilities, through activities both industrial and commercial. Neglect

of these essentials of national duty will imperil her very existence; and sufficient stimulus for these will be found in success and satisfaction of personal ambition.

But these alone do not ensure the life of a nation. Such material activities have brought in the West their fruit, in accession of power and wealth. There has been a feverish rush even in the realm of science, for exploiting applications of knowledge, not so often for saving as for destruction. In the absence of some power of restraint, civilisation is trembling in an unstable poise on the brink of ruin. Some complementary ideal there must be to save man from that mad rush which must end in disaster. He has followed the lure and excitement of some insatiable ambition, never pausing for a moment to think of the ultimate object for which success was to serve as a temporary incentive. He forgot that far more potent than competition was mutual help and co-operation in the scheme of life. And in this country through milleniums, there always have been some who, beyond the immediate and absorbing prize of the hour, sought for the realisation of the highest ideal of life—not through passive renunciation, but through active struggle. The weakling who has refused the conflict, having acquired nothing, has nothing to renounce. He alone who has striven and won, can enrich the world by giving away the fruits of his victorious experience. In India such examples of constant realisation of ideals through work have resulted in the formation of a continuous living tradition. And by her latent power of rejuvenescence she has readjusted herself through infinite transformations. Thus while the soul of Babylon and the Nile Valley have transmigrated, ours still remains vital and with capacity of absorbing what time has brought, and making it one with itself.

The ideal of giving, of enriching, in fine, of self-renunciation in response to the highest call of humanity is the other and complementary ideal. The motive power for this is not to be found in personal ambition but in the effacement of all littlenesses, and uprooting of that ignorance which regards anything as gain which is to be purchased at others' loss. This I know, that no vision of truth can come except in the absence of all sources of distraction, and when the mind has reached the point of rest.

Public life, and the various professions will be the appropriate spheres of activity for many aspiring young man. But for my disciples, I call on these very few, who, realising some inner call, will devote their whole life with strengthened character and determined purpose to take part in that infinite struggle to win knowledge for its own sake and see truth face to face.

Extended Regions of Enquiry

The work already carried out in my laboratory on the response of matter, and the unexpected revelations in plant life, foreshadowing the wonders of the highest animal life, have opened out very extended regions of inquiry in Physics, in Physiology, in Medicine, in Agriculture and even in Psychology, Problems, hitherto regarded as insoluble, have now been brought within the sphere of experimental investigation. These inquiries are obviously more extensive than those customary either among physicists or physiologists, since demanding interests and aptitudes hitherto more or less divided between them. In the study of Nature, there is a necessity of the dual view point, this alternating yet rhythmically unified inter-action of biological thought with physical studies, and physical thought with biological studies. The future worker with his freshened grasp of physics, his fuller conception of the inorganic world, as indeed thrilling with "the promise and potency of life" will redouble his former energies of work and thought. Thus he will be in a position to win now the old knowledge with finer seives, to re-search it with new enthusiasm and subtler instruments. And thus with thought and toil and time he may hope to bring fresher views into the old problems. His handling of these will be at once more vital and more kinetic, more comprehensive and unified. The further and fuller investigation of the many and ever-opening problems of the nascent science which includes both Life and Non-Life are among the main purposes of the Institute I am opening today ; in these fields I am already fortunate in having a devoted band of disciples, whom I have been training for the last ten years. Their number is very limited, but means may perhaps be forthcoming in the future to increase them. An enlarging field of young ability may thus be available, from which will emerge, with time and labour, individual originality of research, productive invention and some day even creative genius.

But high success is not to be obtained without corresponding experimental exactitude, and this is needed today more than ever, and to-morrow yet more again. Hence the long battery of super-sensitive instruments and apparatus, designed here, which stand before you in their cases in our entrance hall. They will tell you of the protracted struggle to get behind the deceptive seeming into the reality that remained unseen ;—of the continuous toil and persistence and of ingenuity called forth for overcoming human limitations. In these directions through the ever-increasing ingenuity of device for advancing science, I see at no distant future an advance

of skill and of invention among our workers; if this skill be assured, practical applications will not fail to follow in many fields of human activity.

ADVANCEMENT AND DIFFUSION OF KNOWLEDGE

The advance of science is the principal object of this Institute and also the diffusion of knowledge. We are here in the largest of all the many chambers of this House of Knowledge—its Lecture Room. In adding this feature, and on a scale hitherto unprecedented in a Research Institute, I have sought permanently to associate the advancement of knowledge with the widest possible civic and public diffusion of it; and this without any academic limitations, henceforth to all races and languages, to both men and women alike, and for all time coming.

The lectures given here will not be mere repetitions of second-hand knowledge. They will announce, to an audience of some fifteen hundred people, the new discoveries made here, which will be demonstrated for the first time before the public. We shall thus maintain continuously the highest aim of a great Seat of Learning by taking active part in the advancement and diffusion of knowledge. Through the regular publication of the Transactions of the Institute, these Indian contributions will reach the whole world. The discoveries made will thus become public property. No patents will ever be taken. The spirit of our national culture demands that we should for ever be free from the desecration of utilising knowledge for personal gain. Besides the regular staff there will be a selected number of scholars, who by their work have shown special aptitude, and who would devote their whole life to the pursuit of research. They will require personal training and their number must necessarily be limited. But it is not the quantity but quality that is of essential importance.

It is my further wish, that as far as the limited accommodation would permit, the facilities of this Institute should be available to workers from all countries. In this I am attempting to carry out the traditions of my country, which so far back as twenty-five centuries ago, welcomed all scholars from different parts of the world, within the precincts of its ancient seats of learning, at Nalanda and at Taxilla.

THE SURGE OF LIFE

With this widened outlook, we shall not only maintain the highest traditions of the past but also serve the world in nobler ways. We shall

be at one with it in feeling the common surgings of life, the common love for the good, the true and the beautiful. In this Institute, this Study and Garden of Life, the claim of art has not been forgotten, for the artist has been working with us, from foundation to pinnacle, and from floor to ceiling of this very Hall. And beyond that arch, the Laboratory merges imperceptibly into the garden, which is the true laboratory for the study of Life. There the creepers, the plants and the trees are played upon by their natural environments,—sunlight and wind, and the chill at midnight under the vault of starry space. There are other surroundings also, where they will be subjected to chromatic action of different lights, to invisible rays, to electrified ground or thunder-charged atmosphere. Everywhere they will transcribe in their own script the history of their experience. From his lofty point of observation, sheltered by the trees, the student will watch this panorama of life. Isolated from all distractions, he will learn to attune himself with Nature ; the obscuring veil be lifted and he will gradually come to see how community throughout the great ocean of life outweighs apparent dissimilarity. Out of discord he will realise the great harmony.

The Outlook

These are the dreams that wove a network round my wakeful life for many years past. The outlook is endless, for the goal is at infinity. The realisation cannot be through one life or one fortune but through the co-operation of many lives and many fortunes. The possibility of a fuller expansion will depend on very large endowments. But a beginning must be made, and this is the genesis of the foundation of this Institute. I came with nothing and shall return as I came ; if something is accomplished in the interval, that would indeed be a privilege. What I have I will offer, and one who had shared with me the struggles and hardships that had to be faced, has wished to bequeath all that is here for the same object. In all my struggling efforts I have not been altogether solitary ; while the world doubted, there had been a few, now in the City of Silence, who never wavered in their trust.

Till a few weeks ago it seemed that I shall have to look to the future for securing the necessary expansion of scope and for permanence of the Institute. But response is being awakened in answer to the need. The Government have most generously intimated their desire to sanction grants towards placing the Institute on a permanent basis, the extent of which will be proportionate to the public interest in this national undertaking.

Out of many who would feel an interest in securing adequate Endowment, the very first donations have come from two of the merchant princes of Bombay, to whom I had been personally unknown.

A note that touched me deeply came from some girl-students of the Western Province, enclosing their little contribution "for the service of our common motherland". It is only the instinctive mother-heart that can truly realise the bond that draws together the nurselings of the common homeland. There can be no real misgiving for the future when at the country's call man offers the strength of his life and woman her active devotion; she most of all, who has the greater insight and larger faith because of her life of austerity and self-abnegation.

Even a solitary wayfarer in the Himalayas has remembered to send me a message of cheer and good hope. What is it that has bridged over the distance and blotted out all differences? That I will come gradually to know; till then it will remain enshrined as a feeling. And I go forward to my appointed task, undismayed by difficulties, companioned by the kind thoughts of my well-wishers, both far and near.

India's Special Aptitudes in Contribution to Science

The excessive specialisation of modern science in the West has led to the danger of losing sight of the fundamental fact that there can be but one truth, one science which includes all the branches of knowledge. How chaotic appear the happenings in Nature! Is nature a Cosmos, in which the human mind is some day to realise the uniform march of sequence, order and law? India through her habit of mind is peculiarly fitted to realise the idea of unity, and to see in the phenomenal world an orderly universe. This trend of thought led me unconsciously to the dividing frontiers of different sciences and shaped the course of my work in its constant alternations between the theoretical and the practical, from the investigation of the inorganic world to that of organised life and its multifarious activities of growth, of movement, and even of sensation. On looking over a hundred and fifty different lines of investigations carried on during the last twenty-three years, I now discover in them a natural sequence. The study of Electric Waves led to the devising of methods for the production of the shortest electric waves known and these bridged over the gulf between visible and invisible light; from this followed accurate investigation on the optical properties of invisible waves, the determination of the refractive powers of various opaque substances, the

discovery of effect of air film on total reflection and the polarising properties of strained rocks and of electric tourmalines. The invention of a new type of self-recovering electric receiver made of galena was the forerunner of application of crystal detectors for extending the range of wireless signals. In physical chemistry the detection of molecular change in matter under electric stimulation, led to a new theory of photographic action. The fruitful theory of stereo-chemistry was strengthened by the production of two kinds of artificial molecules, which like the two kinds of sugar, rotated the polarised electric wave either to the right or to the left. Again the 'fatigue' of my receivers led to the discovery of universal sensitiveness inherent in matter as shown by its electric response. It was next possible to study this response in its modification under changing environment, of which its exaltation under stimulants and its abolition under poisons are among the most astonishing outward manifestations. And as a single example of the many applications of this fruitful discovery, the characteristics of an artificial retina gave a clue to the unexpected discovery of "binocular alternation of vision" in man ;—each eye thus supplements its fellow by turns, instead of acting as a continuously yoked pair, as hitherto believed.

Plant Life and Animal Life

In natural sequence to the investigation of the response in 'inorganic' matter, has followed a prolonged study of the activities of plant-life as compared with the corresponding functioning of animal life. But since plants for the most part seem motionless and passive, and are indeed limited in their range of movement, special apparatus of extreme delicacy had to be invented, which should magnify the tremor of excitation and also measure the perception period of a plant to a thousandth part of a second. Ultra-microscopic movements were measured and recorded ; the length measured being often smaller than a fraction of a single wave-length of light. The secret of plant life was thus for the first time revealed by the autographs of the plant itself. This evidence of the plant's own script removed the long-standing error which divided the vegetable world into sensitive and insensitive. The remarkable performance of the Praying Palm Tree of Faridpore, which bows, as if to prostrate, itself, every evening, is only one of the latest instances which show that the supposed insensibility of plants and still more of rigid trees is to be ascribed to wrong theory and defective observation. My investigations show that all plants, even the

trees, are fully alive to changes of environment; they respond visibly to all stimuli, even to the slight fluctuations of light caused by a drifting cloud. This series of investigations has completely established the fundamental identity of life-reactions in plant and animal, as seen in a similar periodic insensibility in both, corresponding to what we call sleep; as seen in the death-spasm, which takes place in the plant as in the animal. This unity in organic life is also exhibited in that spontaneous pulsation which in the animal is heart-beat; it appears in the identical effects of stimulants, anaesthetics and of poisons in vegetable and animal tissues. This physiological identity in the effect of drugs is regarded by leading physicians as of great significance in the scientific advance of Medicine; since here we have a means of testing the effect of drugs under conditions far similar than those presented by the patient, far subtler too, as well as more humane than those of experiments on animals.

Growth of plants and its variations under different treatment is instantly recorded by my crescograph. Authorities expect this method of investigation will advance practical agriculture; since for the first time we are able to analyse and study separately the conditions which modify the rate of growth. Experiments which would have taken months and their results vitiated by unknown changes, can now be carried out in a few minutes.

Returning to pure science, no phenomena in plant life are so extremely varied or have yet been more incapable of generalisation than the "tropic" movements, such as the twining of tendrils, the heliotropic movements of some towards and of others away from light, and the opposite geotropic movements of the root and shoot, in the direction of gravitation or away from it. My latest investigations recently communicated to the Royal Society have established a single fundamental reaction which underlies all these effects so extremely diverse.

THE GREAT MYSTERY

Finally, I may say a word of that other new and unexpected chapter which is opening out from my demonstration of nervous impulse in plants. The speed with which the nervous impulse courses through the plant has been determined; its nervous excitability and the variation of that excitability have likewise been measured. The nervous impulse in plant and in man is found exalted or inhibited under identical conditions. We may even follow this parallelism in what may seem extreme cases. A plant

carefully protected under glass from outside shocks, looks sleek and flourishing; but its higher nervous function is then found to be atrophied. But when a succession of blows is rained on this effete and bloated specimen, the shocks themselves create nervous channels and arouse anew the deteriorated nature. And is it not shocks of adversity, and not cotton-wool protection, that evolve true manhood?

A question long perplexing physiologists and psychologists alike is that concerned with the great mystery that underlies memory. But now through certain experiments I have carried out, it is possible to trace "memory impressions" backwards even in inorganic matter, such latent impressions being capable of subsequent revival. Again, the tone of our sensation is determined by the intensity of nervous excitation that reaches the central perceiving organ. It would theoretically be possible to change the tone or quality of our sensation, if means could be discovered by which the nervous impulse would become modified during transit. Investigation on nervous impulse in plants has led to the discovery of a controlling method, which was found equally effective in regard to the nervous impulse in animal.

Thus the lines of physics, of physiology and of psychology converge and meet. And here will assemble those who would seek oneness amidst the manifold. Here it is that the genius of India should find its true blossoming.

The thrill in matter, the throb of life, the pulse of growth, the impulse coursing through the nerve and the resulting sensations, how diverse are these and yet how unified! How strange it is that the tremor of excitation in nervous matter should not merely be transmitted but transmuted and reflected like the image on a mirror, from a different plane of life, in sensation and in affection, in thought and in emotion. Of these which is more real, the material body or the image which is independent of it? Which of these is undecaying, and which of these is beyond the reach of death?

The Soul of India

It was a woman in the Vedic times, who when asked to take her choice of the wealth that would be hers for the asking inquired whether that would win for her deathlessness. What would she do with it, if it did not raise her above death? This has always been the cry of the soul of India, not for addition of material bondage, but to work out through struggle her

self-chosen destiny and win immortality. Many a nation had risen in the past and won the empire of the world. A few buried fragments are all that remain as memorials of the great dynasties that wielded the temporal power. There is, however, another element which finds its incarnation in matter yet transcends its transmutation and apparent destruction: that is the burning flame born of thought which has been handed down through fleeting generations.

Not in matter, but in thought, not in possessions or even in attainments but in ideals, are to be found the seed of immortality. Not through material acquisition but in generous diffusion of ideas and ideals can the true empire of humanity be established. Thus to Asoka to whom belonged this vast empire, bounded by the inviolate seas, after he had tried to ransom the world by giving away to the utmost, there came a time when he had nothing more to give, except one half of an Amlaki fruit. This was his last possession and his anguished cry was that since he had nothing more to give, let the half of the Amlaki be accepted as his final gift.

Asoka's emblem of the Amlaki will be seen on the cornices of the Institute, and towering above all is the symbol of the thunderbolt. It was the Rishi Dadhichi, the pure and blameless, who offered his life that the divine weapon, the thunderbolt, might be fashioned out of his bones to smite evil and exalt righteousness. It is but half of the Amlaki that we can offer now. But the past shall be reborn in a yet nobler future. We stand here today and resume work tomorrow so that by the efforts of our lives and our unshaken faith in the future we may all help to build the greater India yet to be.

DAWN OF THE NEW THOUGHT

An Eastern mind, seeing Nature whole, and working with the critical experimental science of the West, was needed and in the fulness of time was forthcoming when Indian genius found itself in full and practised possession of Cambridge scientific method in the person of Jagadis Bose, the Bengali physicist. Centuries hence men may point to Bose as a conveniently identifiable point from which to date the dawn of the new thought, just as to-day we put our finger on Socrates when we wish to focus our view of the beginning of that new thought which inspired the West for centuries, and to say: "Here is our landmark: here the new can be said to have been first recognizable as something that was characteristically different."

—COLLUM
in
"Life's Unity and Rhythm"

Jagadis Chandra Bose Memorial Address

by

Rabindranath Tagore

Delivered at the Bose Institute on November 30, 1938

WHEN by some fortunate chance I came into intimate contact with Sir Jagadis, he was in the prime of his youth and I was very nearly of his age. At that moment his mind seemed entranced with a vision of the living creatures' fundamental kinship with the world of the unconscious He was busy in employing his marvellous inventiveness in coaxing mute Nature to yield her hidden language. The response which he received through skilful questionings revealed to him glimpses of the mystery of an existence that concealed its meaning underneath a contradiction of its appearance. I had the rare privilege of sharing the daily delight of his constant surprises. I believe, poets inherit the primeval age in their temperament when things in their infant simplicity revealed a common feature. Somehow these lovers of *Maya* feel the joy of their being spread all over the creation, which makes them indulge in seeking the analogy of the living in things that appear lifeless. Such an attitude of mind may not in all cases be based upon any definite belief, animistic or pantheistic ; it may be merely a makebelieve, as we notice in children's play, which owes its origin to the lurking tendency in our sub-conscious mind to ascribe life-energy to all activities in the natural world. I was made familiar from my boyhood with the *Upanishad* which, in its primitive intuition, proclaims that whatever there is in this world vibrates with life, the life that is one in the infinite.

This might have been the reason of the eager enthusiasm with which I expected that the idea of the boundless community of life in the world was on the verge of a final sanction from the logic of scientific verification. Being allowed to follow the Master's footsteps in the privacy of his pursuit, even though as a mere picker of his casual hints, I had my daily feast of wonders. At this early stage of his adventure when obstacles were powerfully numerous and jealousy largely predominated over appreciation, friendly companionship and sympathy must have had some needful value

for him even from one, who, to maintain intellectual communion with him, lacked special competency. Yet I can proudly claim to have helped him in some of his immediate needs and occasional hours of despondency in those days of an inadequate recognition and feeble support that he received from the public.

Faith in His Greatness

In the background of that distant memory of mine, I find not the slightest gleam of a vision of the enormous success that could before long combine scientific renown with a vast material means adequate enough to build this Institute, one of the very few richly endowed mediums in India for bestowing the benediction of science upon his countrymen. In fact, it makes me laugh at myself today to read, in some of my old letters, my effort to encourage him with the likelihood of filling the gaps in his funds when my own resources were precariously limited to persuading friends who were foolish enough to have faith in me. Still it is comically sweet to think of the proud magnificence in my assurance fitfully accompanied by contribution absurdly poor compared to the ceaseless flow of tribute that, later on, he could attract by his own magnetic personality and also by the general confidence he widely aroused in his genius. But I repeat again, it was sweet to have dreamed impracticable dreams and to have done however little it was possible, as it proves a courage of joy in the faith in greatness which itself is a bounteous gift to one's own mind.

However ill-equipped I was by the deficiency in my training and by the poet's idiosyncrasy to be a fit companion to a man of science at a luminous period of his self-revelation, I was still accepted as his close friend and, possibly because of the contrariety in our natural vocations, I was able to offer some stimulation to his urge of fulfilment. Not having the necessary amount of vanity in my constitution, it had been the subject of constant wonder in my mind.

Since then time passed quickly, maturing the fruits of our expectation. During this period of his fast growing triumph, I was modest enough to feel less and less the urgency of my comradeship in his journey towards the goal, which was no longer arduous or beset with uncertainty. And yet I can rightfully claim the credit for strengthening in some measure his trust in his own destiny, by adding to it my own unwavering faith, at that painfully hesitant moment of fortune during the dubious dawn of his career, when even persons of meagre resources might have some important use.

An Image of Glory

Victory is the inalienable claim of all genuine power having the might of attraction that naturally exploits all kindred elements on its path and moulds them into an image of glory. And such an image is this Institute, which represents the Master's lifelong endeavour taking a permanent shape in the form of a centre for the inspiration of similar endeavours.

However, the early association of mine with the Master's first great challenge of genius to his fate, whose path at that time did not run smooth, belongs for me to a remote period of a history in which I feel myself hazily indistinct. And this made me seriously waver to accept the invitation for taking an honoured seat at a ceremonial meeting in this institution. The presumptuousness of youth made me absurdly proud to imagine that my companionship was growing into an organic part in the history that was being evolved before my eyes, and, in that belief I did try to hearten the hero, which was a part of my vanity. But foolish youth does not last for ever, and I have had time to come to realise my limitation. Anyhow it is quite obvious, that I am a mere poet carrying on my *sadhana* in the temple of language, the most capricious deity who is apt to ignore her responsibility to logic, often losing herself in the nebulous region of fantasy. Our oriental custom is to bring proper gifts to sacred shrines, but my gift of words for this occasion cannot but be out of place among the records of memorable proceedings of a learned society.

"I Offer My Salutation"

Fortunately there are some few men among us who can claim fellowship with the aristocracy in the realm of science, and can be expected to make splendid this ceremony with the wealth of their thoughts. I can only bless this institution from that obscure distance where the multitude of the uncared-for generations of this country have helplessly drifted to the pitiless toil of primitive land-tilling. I offer my salutation to the illustrious founder of this Institute, humbly sitting by those who are deprived of a sufficiency of that knowledge which only can save them from the desolating menace of scientific devilry and from the continual drainage of the resources of life, and I appeal to this Institute to bring our call to science herself to rescue the world from the clutches of the marauders who betray her noble mission into an unmitigated savagery.

From

Romain Rolland

to

Jagadis Chandra

A LETTER ON HIS SEVENTIETH BIRTHDAY

[*Translated from French*]

Dear Friend,

Allow me to associate myself with those who in India and in the world joyfully celebrate your seventieth birthday. I feel I must bring to you my fervent homage as well as of your friends in France.

Others more qualified will hail you as a Genius of Science. I hail the Seer ; he who by the light of his poetic and spiritual insight has penetrated into the very heart of Nature, beneath the veils of bark and stone wherein are enveloped her throbbings of life.

As Siegfried in the forest, conqueror of the dragon, finds the secret of the language of birds, so you have wrested from plants and stones the key of their enigma ; and you make us hear their incessant monologue, that perpetual stream of the soul, which flows through all beings from the humblest to the highest, the orgastic and tragic song of the universal life whose rhythm surges up in joy and sorrow.

It is not by mere chance that I evoke the name of a hero of the ancient Indo-Germanic epics. In you too I hail the hero of the mind, who, faithful to the virtues of his warrior caste, has been the conqueror of a continent of the unknown. In these days when an intellectual elite of your country truly awakens the memories of greater India, you have boldly added to the vast domain of Indian thought a hemisphere of the Being, which the intuition of your ancient sages had already recognised—these innumerable people of the vegetable and the mineral world who surround humanity—even as the world known to the ancients was a lost islet whose shores were beaten by the dark currents of an ocean of mystery where passed the ships of Barbarians. You have thrown open the gates of the empire of the Mind,

that world of Life, till yesterday held to be unconscious, dead, and buried in the night.

I hail you great magician! Forgive a poet greeting you in these images, ill suited to express the rigorous precision of science and her serene objectivity. In the years to come, it will not be your least claim to glory to have taught, or rather taught over again, to the spirit of the East those exact methods of the Sciences of the West. In your make will be seen in the course of this century that India without sacrificing anything of the richness of her profound soul, of that inner world which was bequeathed to her by centuries of thought, will add thereto the intellectual weapons of Europe, which will be given to her to make her perfect for the mastery of Nature and for the glory of the *Atman*.

ROMAIN ROLLAND

Villeneuve, November, 1928.

INDIA'S GIFT

Nothing can be more vulgar or more untrue than the ignorant assertion that the world owes its progress of knowledge to any particular race. The whole world is interdependent, and a constant stream of thought has throughout ages enriched the common heritage of mankind. It is the realisation of this mutual dependence that has kept the mighty human fabric bound together and ensured the continuity and permanence of civilization. Although science is neither of the East nor of the West, but international in its universality, yet India, by her habit of mind and inherited gifts handed down from generation to generation, is specially fitted to make great contributions in furtherance of knowledge. The burning Indian imagination which can extort new order out of a mass of apparently contradictory facts, can also be held in check by the habit of concentration; it is this restraint which confers the power to hold the mind in pursuit of truth in infinite patience. The true laboratory is the mind, where, behind all illusions, we catch glimpses of truth. In order to discover the life-mechanism in the interior of the tree, one has to become the tree, and feel the throbbings of its beating heart. This inner vision has, however, to be frequently tested by results of experimentation; for, otherwise it may lead to the wildest speculation subversive of all intellectual sanity. It is only by the contact of the hand with real things that the brain receives its stimulating message, and the answering impulse then gives the hand its cunning.

JAGADIS CHANDRA

—From the address given at the eighth anniversay meeting of the Bose Institute.

The Bose Institute Today

DURING the last decade of Acharya Jagadis Chandra's tenure as Director (1927-1937), the scope of investigations carried out in the Bose Institute was gradually extended to include—besides Plant Physiology, Plant Chemistry, Theoretical and Experimental Physics, Zoology and Anthropology.

After his death in 1937, the Government of India, according to an agreement previously entered with Sir J. C. Bose, appointed a Reviewing Committee, based upon whose recommendations certain changes in the existing Regulations were introduced. These cover provision for an enlarged Council, to include representation of scientists from outside Bengal, of the Central Legislature, and a nominee of the Central Government.

In addition to the basic researches 'on the ever-opening problems of the nascent sciences which includes both Life and Non-life' as outlined by the Founder, the Institute is also applying the results of such basic researches to the solution of the problems of Agriculture, Industry and Medicine.

Since 1940, the Institute has been receiving financial assistance from grant-in-aid bodies like the Department of Atomic Energy, the Indian Central Committees for Jute and Oilseeds, the ICAR, and the CSIR. After Independence, the Government of India is giving increasing grants, in support of pure and applied researches, to the National Laboratories, the Universities and Research Institutes. At present the income of the Bose Institute from different sources *viz.* grants from the Central Government, from the grant-in-aid bodies, and from its invested funds expressed in lakhs of rupees are approximately 6·5, 2·0 and 0·8 respectively. Out of the total grants received since 1949, about Rs. 10·7 lakhs has been spent in building construction, laboratory and workshop equipment, purchase of apparatus and library extension.

Investigations are carried on in the main laboratories at 93/1, Upper Circular Road, the Field Experiment Stations at Falta, Shamnagar, and at the high-altitude Mayapuri Research Station, Darjeeling (alt. 7200 ft.) In the last named place Cosmic Ray investigations, partly in co-operation with the IGY programme, are being undertaken. The main subjects of investigations carried on at the Institute are:

Physics: Ultrasonics, Microwave, Nuclear Physics, Cosmic Rays.

Chemistry: Organic and Plant Chemistry, Biochemistry, Radiation and Physical Chemistry.

Botany: Plant Physiology, including continuation of J. C. Bose's investigations, Weed Control, Cytology, Cytogenetics, Production of mutation in economic plants by chemical agents and by radiation; selection and breeding of mutants with improved economic character.

Microbiology: Chemical and radiation mutation of micro-organisms, isolation of new antibiotic substances from soil micro-organisms; pilot plant production of some new broad spectrum antibiotic substances.

Zoology: Chemical retardation of metamorphosis in tadpoles etc. Relation between nucleus and cytoplasm in amoeba.

Workshop: The tradition set up by the founder, of constructing special instruments for research in the workshop is being expanded. Amongst the apparatus recently constructed may be mentioned: —

(*i*) a large rectangular Cloud Chamber (36″ × 30″ × 16″)

(*ii*) a large 8 kw. electromagnet

(*iii*) cubical meson telescope and neutron monitor with automatic recorders for the IGY programme

(*iv*) a neutron generator with a maximum estimated neutron yield equivalent to that produced by a 50 curie Radium-Beryllium source; a small Cockroft Walton high-voltage generator, delivering 400 micro ampere current at 240 kilo volt

(*v*) a radio carbon dating apparatus

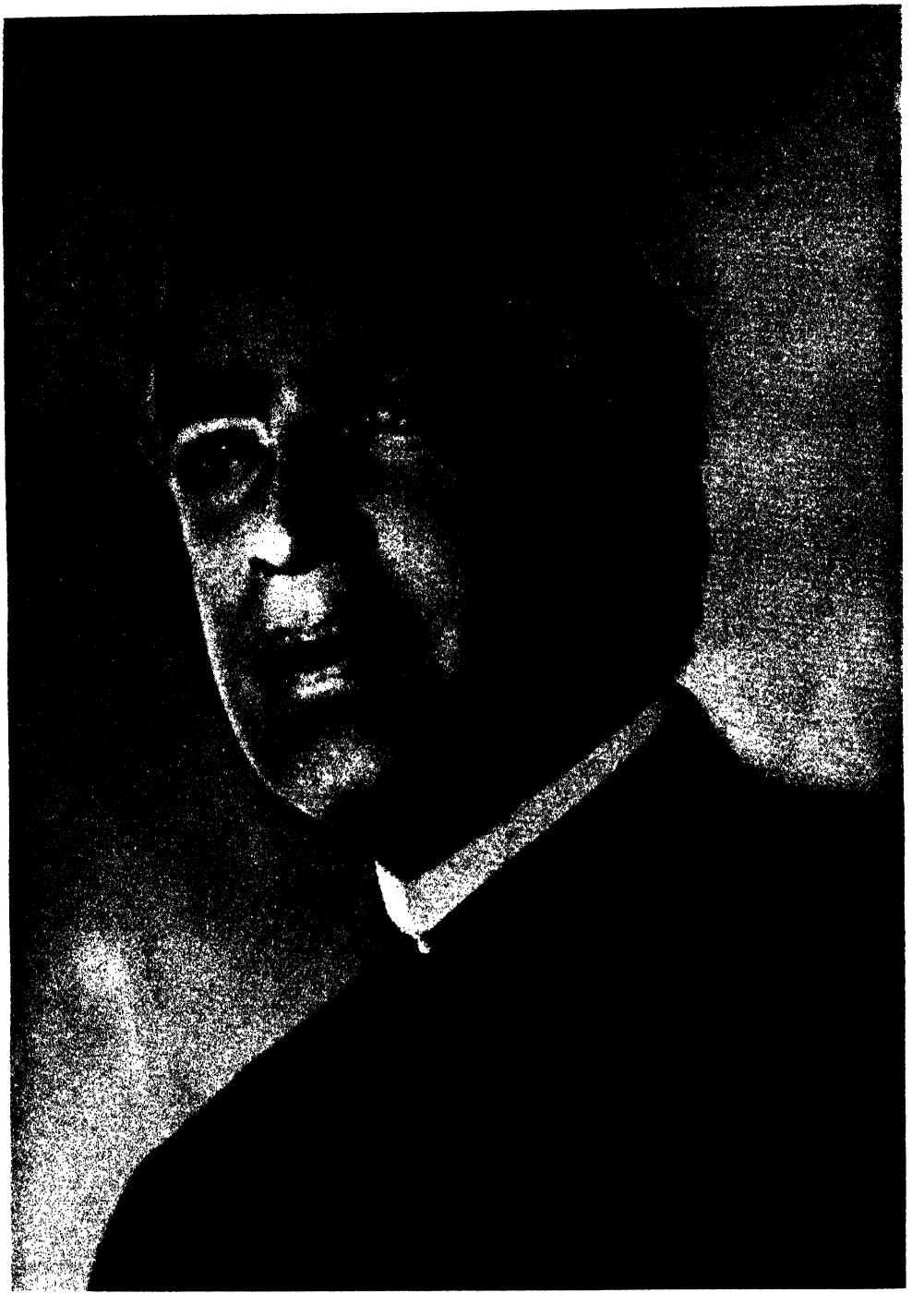
(*vi*) a large Tisellius electrophoresis apparatus and a gas chromatography apparatus.

Significant contributions have been made in all the branches of research undertaken at the Institute, which is now recognised as the leading Plant Science Institute in India. Specialists in different branches of science, while carrying on their particular lines of investigations, co-operate in the investigation of problems in which collaboration between different branches of sciences is necessary. This is one of the reasons for the successful outcome of many investigations undertaken in the Institute.

ACHARYA PRAFULLA CHANDRA RAY

NILRATAN SIRCAR

RAMANANDA CHATTERJEE



JAGADIS CHANDRA BOSE 1926

Jagadis Chandra Bose

A Chronology : 1858–1937

1858: November 30: Born at Mymensingh, East Bengal—son of Bhagaban Chandra Bose and Bamasundari Bose.

1870: Admitted in St. Xavier's School, Calcutta after receiving his elementary education in a Vernacular School at Faridpur, East Bengal.

1875: Passes the Entrance Examination of Calcutta University in the First Division with a scholarship—joins St. Xavier's College, Calcutta.

1877: Passes the First Arts Examination of Calcutta University.

1880: Passes the B.A. Examination of Calcutta University.—Leaves for England for higher studies.

1880-1881: Studies Medicine in London for a year.

1881: Enters Christ's College, Cambridge.

1884: Graduates from Cambridge (Natural Science Tripos) and passes the B.Sc. Examination of London University.

1885: Appointed officiating Professor of Physics in the Presidency College, Calcutta.

1887: Marries Abala Das, daughter of Durgamohan Das.

1888-1894: Made permanent in the Presidency College with retrospective effect.—Pursues scientific hobbies.

1894-1895: Gives a public lecture at the Calcutta Town Hall showing the possibility of signalling by short electric waves.

1895: Communicates to the Asiatic Society of Bengal *his first scientific paper* on "The Polarisation of Electric Ray by Crystals" published in its *Journal*—Communicates, through Lord Rayleigh, *his first paper to the Royal Society of London* "On the Determination of the Indices of Electric Refraction", published in its *Proceedings* (Vol. 59, 1895).

1896: Conferred the Doctorate of London University.

1896-1897: *First Scientific Deputation to Europe.*—Reads a paper before the British Association at Liverpool on "Complete Apparatus for studying the Properties of Electric Waves". — Delivers his first Friday Evening Discourse at the Royal Institution, London, on "The Polarisation of the Electric Ray". — Visits France and Germany and lectures before the Société de Physique in Paris and the Physikalische Institute of the University of Kiel.

'1897: Rabindranath calls on Jagadis Chandra on his return home to offer him his congratulations on his successful mission abroad.

1900-1901: *Second Scientific Deputation to Europe.*—Reads a paper before the International Congress of Physics at Paris (1900) on "De la Généralité des Phénoménes Moléculaires produits par l'Électricité sur la Matiére Inorganique et sur la Matiére Vivante".—Meets Swami Vivekananda in Paris.—Reads a paper before the British Association at Bradford on "The Similarity of Effect of Electric Stimulus on Inorganic and Living substances" and exhibits there and in the Royal Institute, London, an "Artificial Retina" (1900) —Demonstrates a new phenomenon on "Binocular Alteration of Vision" before the Physiological Society of London (1900)—Works in the Davy Faraday Research Laboratory for two terms (1901).—Reads a paper before the British Association at Glasgow (1901) on "The Change of Conductivity of Metallic particles under cyclic Electromotive Varation."—Delivers his second Friday Evening Discourse at the Royal Institution, London, on "The Response of Inorganic Matter to Mechanical and Electrical Stimulus".

1902: Gives a demonstration-lecture before a special meeting of the Linnean Society on "The Electric Response in ordinary Plants under Mechanical Stimulus". — Reads a paper before the Société de Physique, Paris, on "Sur la Reponse Electrique de la Matiére Vivante".—Elected Member of the Société Francaise de Physique.—Reads a paper on "Electric Response in Animal,

Vegetable and Metal" before the British Association at Bradford.

His *first book*, "Response in the Living and Non-living", published by Longmans, Green & Co., London.

1903: Companionship of the Indian Empire (C.I.E.) conferred on him.

1904: A series of five papers on Plant Response are not accepted for publication by the Royal Society. Decides to publish his investigations in form of monographs.

USA Letters Patent No. 758,840 issued for his Detector for Electrical Disturbances.

1904-1905: Devises a number of new apparatus revealing unsuspected phenomena in plant-life.

1906: His *second book*, "Plant Response as a Means of Physiological Investigation", published by Longmans, Green & Co., London.

1907: His *third book*, "Comparative Electrophysiology", published by Longmans, Green & Co., London.

1908-1909: *Third Scientific Deputation to Europe and America.*—Reads a paper on "Mechanical and Electrical Response in Plants" before the British Association, Dublin.—Visits America and delivers a series of lectures before the annual joint meeting of the American Association for the Advancement of Science and the Botanical Society of America at Baltimore, the Medical Society of Boston, the Chicago Academy of Sciences, the Torrey Botanical Club, the Western Society of Engineers at Chicago and at the universities of Illinois, Ann Arbor, Wisconsin and Chicago on Electrophysics and Plant Physiology.

1911: Presides over the Bengali Literary Conference at Mymensingh and delivers an address on his researches and findings.

1912: Companionship of the Star of India (C.S.I.) conferred on him.

Conferred D.Sc. (*Honoris causa*) by Calcutta University.

1913: His *fourth book*, "Researches on the Irritability of Plants", published by Longmans, Green & Co., London.—Delivers three lectures at the Punjab University.

1914-1915: *Fourth Scientific Deputation to Europe and*

America. Lectures before the universities of Oxford and Cambridge.—Delivers his third Friday Evening Discourse at the Royal Institution, London, on "Plant Autographs and their Revelations".—Visits Austria and lectures before a meeting of leading scientists in Vienna.—Visits Germany and lectures at several universities.—Lectures before the Royal Society of Medicine, London, on "The Action of Drugs on Plants".—Visits America and lectures at the principal universities ; addresses the American Association for the Advancement of Science and the Botanical Society of America at Philadelphia, the New York Academy of Sciences, the Washington Academy of Sciences and the Botanical Society of Washington, the American Philosophical Society, the Natural Science Auditorium of the Iowa City, and at the Twentieth Century Club. — Also gives a demonstration-lecture before the State Department officials in the Diplomatic Reception Room, Washington. —Visits Japan and delivers a public lecture at the Wasede University.

Retires from the Indian Educational Service (November, 1915) ; appointed *Emeritus* Professor of the Presidency College on full pay for five years.

1916: Delivers the inaugural address, entitled "From the Voiced to the Unvoiced" at the foundation of the Banaras Hindu University.

1917: Addresses the Faridpur Industrial Exhibition on the life of his father, Bhagaban Chandra Bose, who founded the exhibition fifty years ago.

Knighthood conferred on him.

Founds the Bose Institute in Calcutta, on the 30th November, his 59th Birthday, and delivers an inaugural address entitled "The Voice of Life" (printed elsewhere).

1918: Starts publishing regular research reports in the form of *Transactions of the Bose Research Institute,* Calcutta. The first volume appears under the title "Life Movements in Plants".—Delivers a lecture on "The Unity of Life" under the auspices of the Bombay University.—Lectures

at the Royal Opera House, Bombay, on "Invisible Light".

1919: Publishes "Life Movements in Plants", being Vol. II of the *Transactions of the Bose Research Institute*, Calcutta.

1919-1920: *Fifth Scientific Mission to Europe.* Gives a demonstration-lecture at the India Office under the presidentship of Arthur James Balfour. — Lectures before the universities of Cambridge, Oxford, Leeds, London.— Awarded the honorary degree of LL.D. by the Aberdeen University.

Elected Fellow of the Royal Society, London, (13th May, 1920)—Addresses the Royal Society of Medicine. — Demonstrates, before eminent scientists, "Magnetic Crescograph" at the Physical Laboratory of the University College, London.—Visits France and lectures at Paris before the Biological Society, Physiological Congress, and the Botanical Society.—Lectures at the Rothamstead Experimental Station, England.— Visits Sweden and lectures before the Physical Society of Stockholm.— Visits Germany and lectures at Berlin before eminent Plant Physiologists.

His biography, *Life and Work of Sir J. C. Bose,* by Prof. Patrick Geddes, is published by Longmans, Green & Co., London. — Publishes Vols. III & IV of the *Transactions of the Bose Research Institute* entitled, "Life Movements in Plants". — Publishes "Avyakta", a collection of writings in Bengali.

1923-1924: *Sixth Scientific Mission to Europe.*—Gives demonstration-lectures at the University College, London, University of Prague, at the Danish Botanical Society, the University of Copenhagen, before the Imperial College of Science, London and the Royal Society of Medicine, London, on "Assimilation and Circulation in Plants".—Speaks at the India Office, London, before a distinguished audience, including the Prime Minister (Mr. Ramsay Macdonald), Lord Hardinge (ex-Viceroy) and Mr. George Bernard Shaw, on the "Phenomenon of the Growth of Plants."— Publishes Vol. IV of the *Transactions of the Bose*

Research Institute, entitled "Physiology of the Ascent of Sap".

His *fifth book,* "The Physiology of Photosynthesis", is published by Longmans, Green & Co., London.—Visits France and lectures at the Natural History Museum and the University of Paris.—Nominated a member of the League of Nations Committee on Intellectual Co-operation. —Delivers the Convocation Address at the Punjab University, Lahore.

1925: Lectures on "Invisible Light" at the Bose Institute.—Delivers the Convocation Address at the Banaras Hindu University.

1926: His *sixth book,* "The Nervous Mechanism of Plants", is published by Longmans, Green & Co., London.

Seventh Scientific Mission to Europe.—Lectures before the University College, London, at the Royal Society of Medicine, the Royal Society of Arts and the British Association at Oxford.—Visits France and lectures at the Sorbonne and the Natural History Museum, Paris.—Visits Belgium and lectures before the Foundation Universitaire, Brussels, the King of the Belgians presiding over the meeting and conferring on him the Decoration of *Commandeur Ordre de Leopold.* — Attends the first meeting of the Committee on Intellectual Co-operation of the League of Nations at Geneva and lectures at the University of Geneva before a distinguished gathering of international scientists, including Professors Lorentz and Einstein.

1927: His *seventh book,* "Collected Physical Papers", is published by Longmans, Green & Co., London.—Presides over the Fourteenth Indian Science Congress at Lahore.

Eighth Scientific Mission to Europe.—Lectures at some of the southern universities of France.

His *eighth book,* "Plant Autograph and their Revelations", published by Longmans, Green & Co., London. — Speaks on "The Mechanism of Life" at the Kingsway Hall, London, in connection with the International Homeopathic Congress,

—Addresses the International Conference on Education at Locarno on way to attend the League of Nations meeting at Geneva. — Delivers the Convocation address at the University of Mysore. Lectures at the Madras University on "Invisible Light" and on "Surge of Life".

His *ninth book*, "Motor Mechanism of Plants", published by Longmans, Green & Co., London.

1928: *Ninth Scientific Mission to Europe.*—Lectures at the University of Vienna. —Delivers a series of lectures at the University of Munich.—Attends a meeting of the League of Nations Committee on Intellectual Co-operation. —Lectures at the Geneva School of International Studies on "The Plant as a Sentient Being".—Visits Egypt at the invitation of the Government of Egypt and lectures at the Royal Geographical Society of Egypt. — Delivers the Convocation Address at the University of Allahabad and conferred the honorary degree of D.Sc. —Addresses the All-India Medical Conference at the Bose Institute.

His Seventieth Birthday celebrated in Calcutta on November 30, 1928.—Prof. H. Molisch of Vienna comes as Visiting Professor to the Bose Institute.

Tenth and last Scientific Mission to Europe.—Gives a demonstration-lecture at the India Office on "The Revelations of the Unvoiced life of Plants" before scientists and politicians.—Attends a meeting of the League of Nations Committee on Intellectual Co-operation.

His *tenth book*, "Growth and Tropic Movements of Plants", published by Longmans, Green & Co.

Awarded "Shree Sayaji Rao Gaekwad Prize and Annuity" for three years. —Edits Vol. VI of the *Transactions of the Bose Research Institute* entitled "Life Movements in Plants".

Civic address presented by the Corporation of Calcutta, headed by Mayor Subhas Chandra Bose.

1933: Edits Vol. VII of the *Transactions of the Bose Research Institute* (1931-

32).—Visits Baroda and delivers a series of lectures on his researches and discoveries.—Conferred the honorary degree of D.Sc. by the Banaras Hindu University.

1934: Gives a discourse on "Indian Aspirations and Achievements" during the Golden Jubilee Celebration of the Gaekwad of Baroda.—Delivers the Convocation Address at the University of Nagpur.—Edits Vol. VIII of the *Transactions of the Bose Research Institute* (1932-33).

1935: Edits Vol. IX of the *Transactions of the Bose Research Institute* (1933-34).

Conferred the honorary degree of D.Sc. by the Dacca University.

Edits Vol. X (1934-35) and Vol. XI (1935-36) of the *Transactions of the Bose Research Institute.*

November 23: Dies at Giridih (South Bihar). —Funeral in Calcutta (Nov. 24).

Appendix

Acharya Jagadis Chandra Bose Endowment Fund

THE Centenary Committee has undertaken two important schemes to give a lasting shape to the Centenary celebrations and to provide a fitting memorial to Acarya Jagadis Chandra Bose, the first Indian scientist of modern times to win recognition in the international world of science. These are the Acharya Jagadis Chandra Bose Endowment Fund and the Acharya Jagadis Bose Science Talent Search Scheme. These Schemes will be administered by the Bose Institute.

The objects of this Fund will be to reintroduce the scheme of 'Visiting Professorship' to the Bose Institute, and to establish facilities for enabling the Institute to 'interpret science to the public'.

Visiting Professorship

Since its foundation in 1917, and during the lifetime of the Founder, the Bose Institute invited several eminent scientists—men like Prof. Patrick Geddes of Edinburgh and Aberdeen, Prof. Hans Molisch, famous Plant Physiologist and sometime Rector of the University of Vienna, to work and lecture at the Bose Institute. Such visits resulted in great mutual benefit—particularly to the workers of the Institute.

After the Founder's death in 1937, the 'Visiting Professorship' had to be discontinued for lack of funds. Today, when increasing international co-operation in science is becoming a pressing necessity, the need for reviving the 'Visiting Professorship' is being increasingly felt. Already, the Indian Statistical Institute and the Indian Association for the Cultivation of Science have introduced such schemes to the immense benefit of the general body of scientists in Calcutta and elsewhere.

The Centenary Committee proposes to create an Endowment of Rs. 5 lakhs to be known as Acharya Jagadis Chandra Bose Visiting Scientists' Fund. The annual income from this Endowment, amounting to Rs. 20,000, will be utilised for financing the visits of scientists to the Institute.

In selecting Visiting Professors, the Institute will take care to recruit rising young scientists of great promise who can train the Institute's workers into the latest techniques of scientific investigation. The course of lectures delivered by the Visiting Professors will eventually be published by the Institute in book form.

To the target of Rs. 5 lakhs, the Government of India has given a grant of Rs. 1 lakh to the Endowment Fund. It is hoped that the State Government, leading business and industrial houses, cultural associations and individual donors will help the Centenary Committee to raise the balance of Rs. 4 lakhs at an early date.

Interpretation of Science to the Public

In founding the Bose Institute in 1917, Acharya Jagadis Chandra modelled it after the Royal Institute, London, to carry out both original research and hold experimental lectures for the general public.

The Royal Institution, since the time of Davy and Faraday, has carried on a two-fold programme of furthering advancement of scientific knowledge through

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means, students with special or unusual aptitude for science and provide them with stipends and other forms of assistance to pursue their chosen career of science unhampered. The Westinghouse Educational Foundation runs such a scheme in the United States of America.

Initially, it is proposed to launch a 'pilot' scheme in West Bengal, which may be gradually extended to cover the other states.

B. C. Roy	S. K. Mitra	D. M. Bose
CHIEF MINISTER WEST BENGAL	EMERITUS PROFESSOR CALCUTTA UNIVERSITY	DIRECTOR, BOSE INSTITUTE CALCUTTA
President	*General Secretary*	*Treasurer*

ACHARYA JAGADIS CHANDRA BOSE BIRTH CENTENARY COMMITTEE

The Unseen Power

It is the resonance of strings woven of memory that affects us deeply. This city has been the place of my work for more than third of a century. It is the watching of a roadside weed in Calcutta that turned the entire trend of my thought from the study of the inorganic to that of organised life.

The [illegible] life is the supreme gift of a pl[illegible]. Who could be so base [illegible] all and the soil th[illegible] long the inhabitan[illegible] Some who came from [illegible] and found here the [illegible] home. The ever-[illegible]anifestation of the un[illegible] the city's de[illegible] is guiding [illegible]lden of this [illegible] with a burn[illegible]ndia's ancien[illegible]

J. C. Bose.

Message to the
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1934