

THE VOICE OF LIFE

*Sir Jagadis Chunder Bose's Inaugural address
dedicating the Bose Institute to the nation*

I DEDICATE to-day 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 message 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 mechanics. 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 investigation 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 meditation. 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 millenniums, 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 men. But for my disciples, I call on those 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.

Advancement and Diffusion of Knowledge

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 interaction 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 winnow the old knowledge with finer sieves, 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 purpose of the Institute I am opening to-day; 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 to-day more than ever, and to-morrow yet more again. Hence the long battery of supersensitive 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; and if this skill be assured, practical applications will not fail to follow in many fields of human activity.

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 child 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 this 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 will 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 hers 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 understanding. 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 mother-land." It is only the instinctive mother-heart that can truly realise the bond that draws together the nurselings of the common home-land. 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 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, accompanied 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 fore-runner 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 polarized 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. Ultramicroscopic 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 longstanding 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, anæsthetics 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 simpler 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 communi-cated to the Royal Society have established a single fundamental reaction which underlies all these effects so extremely diverse.

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 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 pshychologists 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 those is undecaying, and which of these is beyond the reach of death?

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, nor 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 thoughts 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 to-day 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.

