BOSE RESEARCH INSTITUTE

ANNUAL REPORT

For the year 1946-47

Report of the Council of the Bose Research Institute for 1946–47

The most important event which took place during the year under review, was the constitution of the Council of the Institute as provided in the new Regulations and Bylaws, which came into effect from the 1st April 1946. According to the old Regulations, the Governing Body which has been in existence since the foundation of the Institute in 1917 was vested with the dual function of being the Trustees of the properties and investments of the Institute, as well as of managing its affairs. During the interim period from April, 1946 till December 18, 1946 when the first meeting of the newly oonstituted Council took place, the Governing Body continued to exercise its dual function. It met on two occasions, on July 16 and September 6, 1946. This body now functions solely as Trustees of the properties and investments of the Institute.

Council—Two meetings of the Council took place during the year, the first on December 18, 1946 and the second on March 30, 1947. At its first meeting the Council, on the recommendations of duly constituted Selection Committees, made the following appointments :

Head of Department of Botany—Dr. K. T. Jacob, M. A. Ph. D., Reader and Head of Department of Botany, Andhra University.

Head of the Department of Chemistry—Dr. J. K. Chowdhury, Ph. D. (Ber.), Professor and Head of Department of Chemistry, Dacca University.

Research Fellows :

Chemistry—Dr. Basudeb Banerjee, Ph. D. (Mun.) at present Sir J. C. Bose Research Fellow of the Calcutta University.

Microbiology—Dr. Nepal Ch. De, M. B.

Physics—Mr. S. R. Das, M. Sc.

Mr. A. N. Mitter, Superintendent was appointed temporary Registrar, pending the appointment of a permanent incumbent. A Building Committee was formed, consisting of the Director, and one representative each of the Council and of the Governing Body. The function of this Committee will be to make recommendations to the Council and to the Governing Body regarding questions of large scale repair, reconstruction of existing buildings and construction of new buildings. At the second meeting, the Council appointed Mr. Dwijes Chandra Chakraworti, M. Sc., as Registrar of the Institute. It also passed the Budget Estimates for 1947-48.

Revision of scale of pay—At the time of meeting of the Selection Committee, attention was drawn by the expert members of the Committee to the inadequacy of the scales of pay offered to the Heads of Departments, Research Fellows and Scholars of the Institute which in their views were not sufficient to attract to and retain the services of persons of the desired qualifications on the Institute

of Education to consider the question of training, remuneration and conditions and service of teachers in Universities etc. The Director is preparing a revised scale of salaries.

Finance Committee—Mr. G. Rajagopal, Accountant General, Bengal, has been appointed representative of the Central Government on the Finance Committee. The first meeting of the Committee took place on March 16, 1947. It scrutinized the Budget Estimates of the Institute for 1947-48 and forwarded them to the Council with its recommendations.

Sir J. C. Bose Memorial Lecture—The eighth lecture of the series was given by Prof. S. K. Mitra of the Calcutta University, on the 30th November 1946. The subject of his lecture was 'Micro wave-Pioneer work in India Half a Century Ago" ; in course of which the lecturer recalled the pioneer researches on micro radio waves of less than 10cm in wavelength, conducted by Sir J. C. Bose over half a century ago. The novel experiments of Sir Jagadish illustrating the optical properties of micro waves—their reflection, refraction, polarization and diffraction, were demonstrated with the help of the original apparatus used by him for his lecture before the Royal Institution in 1896.

After enumerating how Bose had foreshadowed several of the apparatus now used with radar microwave technique, and how he had anticipated many of the results recently obtained, on the co-efficient of absorption of microwaves by the important constituents of the atmosphere, Prof. Mitra remarked 'with his keen imagination and experimental skill, Sir Jagadish could rightly be regarded as the Faraday of India'.

Other lectures—Prof. P. M. S. Blackett F. R. S. of the Manchester University delivered a lecture on Cosmic Rays and Prof. E. Newton Harvey of the Princeton University on 'Animal Light', in the hall of the Bose Institute during the third week of January.

Several foreign delegates to the Indian Science Congress, including Dr W. Hanna, Senior Plant Pathologist, Government of Canada, Dr. T. S. Tanton, Senior Geologist, Géological Survey of Canada, Prof. A. F. Blakeslee of Smith's College, Massachussetts, Dr. D. E. Deming, Bureau of Budget, Washington and Prof. L. J. Mordell, Sadlerien, Professor of Pure Mathematics, Cambridge University, visited the Bose Institute

Grant-in-Aid-Schemes-Atomic Research Project—Along with the Tata Institute for Fundamental Research, the Palit Research Laboratory Calcutta University, the Bose Institute has been recognized as one of the Institutes to which grant-in-aid will be given by the Council of the Scientific and Industrial Research, for Atomic Research. The, grant sanctioned for 1946-47 for this purpose was Rs. 22,400./- Recently a letter has been received from the Secretary, C. S. I. R. inviting the Director to submit a long term programme of Atomic Research which can be carried out in the Bose Insiitute. It was mentioned in the covering letter that the Department of Education, Government of India, has been approached for grants-in-aid for such long term schemes. The department has expressed their willingness to consider such schemes.

The Director has recently forwarded both to the Department of

Other grants received from the C. S. I. R. were (i) Setting up of a powerful ultrasonic generator and (ii) Setting up of a medium voltage positive ray apparatus for neutron production.

Bengal Immunity Grant—Investigations on production of desirable strains of yeast by selection and by hybridization.

Bengal Government grant—(i) Investigations on the breeding of longstapled disease resistant cotton (ii) Investigations on bioelectric potentials developed in germinating plant seeds etc.

Indian Central Jute Committee—(i) Effect of ionizing radiations on the production of new mutants of jute.

Department of Health, Government of India—(i) Physiological investigations on cinchona (ii) Cytological investigations on cinchona. Accomodations have been provided for the laboratory of the Principal Quinine officer to the Government of India, for pilot plant investigations on the recovery of cinchona from the different portions of the cinchona plant.

The Biochemist, Lac Research Institute, has been deputed to the Institute for X-ray investigations of the different components of lac and of the modificatiens which are produced in them during the process of polymerisation.

Staff—Mention has been made in a previous para of the new appointments which have been made by the Council in December 1946.

Dr. K. T. Jacob, Ph.D., Research Fellow in Cytogenetics, was granted one year's leave from July 1946 to enable him to join the Andhra University as Reader and Head of the Department of Botany. He has since then been appointed Head of the Department of Botany of the Institute, and has come back in March 1947.

Dr. B. K. Kar, Ph.D., Research Fellow in Plant Physiology, has been granted one year's leave from February 1947, to enable him to join the Kabul University as Professor and Head of the Department of Botany.

Messrs. S. D. Chatterjee and M. S. Sinha have been awarded the D.Sc. degrees in Physics of the Calcutta University, for investigations in Nuclear Physics and Cosmic Rays.

Mr. Banbehari Ghosh, M. Sc., Assistant Engineer, All India Radio, has been awarded the P. R. Studentship in Physics of the Calcutta University, for investigations carried out by him as research scholar in the Bose Institute.

Research Activities

During the year under review the work of the Institute has been carried on under great difficulties. During and after the August disturbances the work was on several occasions interrupted, and at other times carried on with depleted staff, due to the difficulty which the staff found in coming to the Institute. which is situated in a disturbed area. The boundary walls of the Institute have been raised and other protective measures have been taken.

The 50 kw A. C. Generating Set has suffered from breakdown on

Attempt has been made to obtain a temporary supply of A. C. current from the A. C. Distribution Board of the University College of Science at 92 Upper Circular Road. After a good deal of correspondence and negotiations, consent of the different authorities concerned were obtained, but the scheme has not been carried out due to the inability of the firm, entrusted with the laying down of cable between the Science College and the Institute premises, to obtain the necessary special type of cables. At present it has been decided to purchase a new 7. 5. kw motor generator set. Several investigations were much hampered, due to lack of an adequate supply of A, C. current.

The equipment of the proposed air conditioned glass house, about which reference was made in the previous report, has not been completed. A 4 H. P. refrigerating unit for cooling the glass house was delivered in January this year, but the work of assembling the compressor and installing the cooling unit in the glass house has not been commenced by firm entrusted with the work. As a result, a valuable set of young cinchona plants which were being used for plant physiological investigations have perished, with the coming of hot weather towards the end of March.

Four bighas of land, adjoining the experimental farm at Falta, were taken on lease last year for the growing of experimental jute plants. It was found that the lands were flooded during the rains to an extent which made it unsuited for cultivation of lowland jute. The land is being used for the growing of different varieties of rice. The effect of using different fertilizers in increasing the production of rice both in high land and water logged areas is under investigation.

A. 1. Physics.

(a) *Nuclear Physics.*—The Institute received from the C. S. I. R. a grant of Rs. 22,400/- for atomic research. Further it has been invited to submit a long term scheme for atomic research. It is proposed to confine for the present such atomic investigations to the fissionable properties of nuclei of the heaviest atoms like Uranium, Thorium etc., with a view to the utilization of the energy released in atomic piles built up of fissionable metals, for the purpose of industrial development ; also it is proposed to utilize the radioactive fission products as trace elements for biological investigations. The proposed scheme of investigation involves (a) provision for large source of neutron current (b) the supply of large quantities of uranium and thorium containing minerals, with arrangement for the separation and purification of their essential constituents (c) investigations of conditions under which a self maintained atomic pile can be built up using uranium as fissionable material (d) the isolation of transuranic elements which may occur either in old uranium and thorium containing minerals or can be produced in uranium and thorium by irradiation with neutron.

(a. 1.) *Neutron Generators*—The construction of a positive ray medium voltage generator is being continued. The method used is to accelerate deuterons in a medium voltage positive ray tube

For detecting the emission of neutrons a Geiger Muller tube with an outer silver foil cathode tube was constructed, along with its appropriate high voltage, amplyfying, and counting circuits. The efficiency of the counter was tested by exposing it to a neutron source of a Ra Be tube containing 66 mg. of Radium. The positive ray discharge tube being in a proper working condition, was circulated with heavy hydrogen gas and a positive particle current of 250 μ A, supposed to contain only deuterons, was accelerated through a p.d. of 77 kv to strike against the $DP0_3$ target. No detectable amount of neutron emission was observed by the G. M. Counter. This may be due either (i) that the positive ray beam is made up largely of molecule ions like D_2^+ and only a small fraction of atom ion D^+ or (ii) the target $DP0_3$ as prepared by us was not suitably made, so that only a negligible number of D atoms in the target is exposed to D^+ bombardment. To test (i) a large Helmholtz coil has been built round the target end of the discharge tube. With the resulting magnetic field produced it will be possible to analyze the composition of the positive ray beam, and find out what fraction of it consists of D^+ particle. If this is found to be low, the arc discharge arrangement in which D_2 molecules are converted to D^+ ions will be modified. (ii) We are preparing an alternative target of heavy water ice to replace the $DP0_3$ target, to find out if thereby the efficiency of neutron production can be enhanced.

High voltage Electrostatic generator—The neutron yield from a positive ray tube can be considerably increased, if the accelerating voltage can be increased from 77 kv to the order of a million volt. The accelerated deuteron beam in this arrangement is made to strike a target; a comparatively simple arrangement for the purpose is a Li or B target.

Vander Graaf generator—A preliminary attempt to build up such a generator was made in 1939-40, but due to the non-availability of certain essential parts, it had to be discontinued. With the cessation of war we are now making another attempt to construct such a machine. The component parts are being made in the Institute and other workshops.

We are making arrangement to purchase locally and also to indent from abroad the required quantities of uranium minerals. A chemist is being appointed under the C. S. I. R. scheme to investigate the methods of separating and purifying the uranium oxides from it.

(b) *Transuranic elements*—From an old uranium containing mineral, attempt has been made to separate the transuranic element Pu_{94}. There are two isotopes of this element known of half period of 50 and 25000 years, both of which emit α particles. A Wilson Chamber of large sensitive time has been constructed, and a stereoscopic lens arrangement for photographing the tracks of α particles, emitted by the precipitate containing Pu is nearing completion.

(c) *Photographic emulsion method*—This method was extensively used by Miss Chowdhury for the study of emission of secondary cosmic ray particles at high altitudes. With her departure the work was discontinued. Recently many new types of photographic emulsions have been prepared and are finding important applications in nuclear

(d) *Study of nuclear fission*—Arrangement is being made to sputter uranium metal on a very thin support, whose absorption of the fission products will be negligible. With such a source the energy distribution in the fission products will be studied by a double ionization counter arrangement and by Wilson Chamber. The photographic emulsion method will also be used for such investigations.

(e) *Cosmic Rays*—Large and small pressure ionization chambers connected with suitable automatic recording arrangements are being constructed for the study of extended cosmic ray air showers and bursts. The apparatus when found working satisfactorily will be installed at Mayapuri, Darjeeling, where the cosmic ray intensity is 2-3 times greater than at Calcutta.

The study of penetrating secondary particles produced by cosmic rays in lead and iron is being continued. The Wilson Chamber has been rebuilt with three lead plates inside it. The Chamber, operated by a coincidence circuit arrangement, is working satisfactorily. Large number of photographs of penetrating particles as well as of multiples have already been obtained

A low pressure Wilson Chamber is under construction for the study of fission products of heavy nuclei present as vapours of organo metallic compounds, under action of cosmic rays.

(f) *Micro radio waves*—The suitability of the coherer used by Sir J. C. Bose in his electric wave apparatus, for the detection of short electromagnetic waves emitted by the sun during the recent sun spot cycle was investigated. The coherer with the spiral spring contract arrangement has not been found to be sufficiently sensitive for the purpose. It is proposed to further modify the coherer to make it better suited for such investigations.

(g) *Ultrasonic wave generator*—The investigation was considerably handicapped by the break down of the A. C Motor Generator set. The scheme is being kept in abeyance, pending fresh arrangements being made for the supply of A. C. Current. In the mean time orders have been placed for the purchase of permanently evacuated glass triode valves 10 kv and 200 mA output, which will replace the demountable valves at present being used. Also fresh quartz oscillator plates are being imported from abroad, with which the performances of quartz plates prepared in our workshop will be compared. A fresh attempt will then be made to construct powerful mosaic plate generators of ultrasonic waves.

A. 2. Biophysics

(a) *Bioelectric potentials*—As reported last year a valve tube arrangement for the amplification and detection of feeble bioelectric potential has been constructed. The arrangement has been reconstructed according to a recent design of circuit proposed by Burr. The bioelectric potentials devoloped in germinating maize seeds have been measured, and the results obtained are in general agreement with those of other investigators, viz., the first deflection of the recording galvanometer is a measure of the viability of the germinating seeds, while the steady galvanometer deflection is a measure of the hybrid vigour of the seeds. Investigations with germinated cotton seed will be taken up now.

(b) *Membrane potential*—In a paper which is appearing in Vol. XVI of the Transactions of the Bose Research Institute, attention has been directed to the underlying similarity in the mechanism of trans-

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mission of excitation in *Mimosa pudica* and in nerve muscle unit. In both cases chemical substances act as essential mediators in the transmission processes which in the case of nerves are identified with acetyl choline, while in Mimosa a tannin like body is believed to play an analogous role. Acetyl choline which is released at the nerve surface membrane when traversed by an excitation current, is supposed to depolarize the membrane. This assumption has been tested by Beutner by means of an artificial oil membrane which reproduces many of the properties of the lipoid surface membrane of living cells. A difference of potential is found to develop between two different concentrations of the same electrolyte separated by an oil layer made up of a solution of oleic acid in guiacole. It has been found by Beutner that introduction of an alkaloid like atropine, strychnine etc. at concentrations of 10^{-6} produce marked depression of the membrane potential ; acetyl choline produces a similar effect at the still lower concentrations of 10^{-8}. It is proposed to study the effect of introducing dilute plant irritability substances in one of the interfaces of the oil electrolytic combination.

(c) *X-ray investigations*—A X-ray tube for irradiating germinating jute and other seeds as well as an ionization current dosimeter for measurement of the total irradiation, as measured in roentgen units, have been constructed in the workshop and are in operation.

An arrangement for the X-ray method of structure determination of large molecular crystalline groups has been set up. Preliminary measurement of the structure of egg albumin molecules has been made.

Mr. B. Bose of the Lac Research Institute has been deputed to undertake the X-ray investigations of the different constituents of lac and of the structural change introduced in them during polymerisation under different treatments.

B. Chemistry

Biochemistry—In last year's report it was mentioned that a new theory has been proposed to explain the nature of the enzymatic activity in producing chemical changes in subtrate molecules. It is known that in all biological oxidation processes which are accompanied by release of free energy, the substrate molecule has to pass through an intermediate state of activation associated with a high potential barrier. In living cells the function of the enzymes is to lower the potential barrier. The nature of the activation process has been the subject of many interpretations. In the proposed theory no actual contact between the enzyme molecule and the substrate is assumed but it is supposed that in the long range field of force due to the former, the latter is activated by some resonance excitation process. This assumption of a finite distance intervening between the enzyme and substrate molecules is supported by recent experimental investigations of Rothen. The mathematical formula based upon the differential catalysis of the reversible phosphorylase system as deduced in the previous paper, has been used to determine the reactive chain length of starch (amylose) synthesised by muscle phosphorylase. The study of the effect of very small currents on enzyme activity is being continued. Preliminary investigations have shown that it is possible

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In plant physiological investigations, the glucose-1-phosphate so prepared has not turned out satisfactorily. Attempt is now being made to make it diretly from glucose. So far the required quantity of α-penta acetyl glucose has been prepared.

The synthesis of two other compounds of plant and animal origins is being attempted. The drug ergot consists of alkaloid compounds each of which on hydrolysis gives Lysergic acid. Attempt is being made to synthesise Lysergic acid. The other compounds whose synthesis is being attempted is Civetone, the odiferous principle of civet.

The synthesis of another compound, Mimosin, which has been isolated from the sap of Mimosa plant is being tried. Haberlandt and Jenny Renz believed it to be the active principle responsible for the transmission of excitation in Mimosa. Mimosin is believed to be made up of a pyridine ring to which two hydroxyl groups and an alanin residue are attached. Mimosin has been isolated in a pure form from the sap of Mimosa by Haberlandt and its structure has been determined by Jeny Renz and by Nienburg and Taubock and is given as dioxy-pyridil-alanin. It is optically active and its synthesis has not been attempted yet. Leucinol, to which a structure very similar to Mimosin has been ascribed is inactive. Attempt is being made to synthesise the basic structure of Mimosin, which has not so far been attempted.

C. Plant Physiology

(a) *Chemical Mediator in the transmission of excitation in Mimosa.*

As mentioned in last year's report, a large number of investigations have been carried out on the nature of the chemical mediator in the transmission of excitation in Mimosa, which plays a role analogous to that of acetyl choline in nerve transmission of excitation. This substance, contrary to the findings of Jenny Renz and Haberlandt, is not Mimosin. Different chemical methods have led to the isolation of two different groups of substances from Mimosa, both of which give irritability test. The one contains an α-amino acid group, a phenolic hydroxy group and a free carboxalic acid group. The other substance separated contains a tannin associated with a glucoside. These extracts, when introduced in a Mimosa leaf stem unit, produce vigorous closure of the leaflets and contraction of the pulvini. These extracts are being purified and so far possible the active principles isolated. It is proposed to study the effect of such irritability substances in producing depolarization, when introduced in the oil water interface of artificial oil membranes as described in the Biophysics section.

There are interesting observations by Muralt and Babsky, on the effect of flow of a steady electric current through certain animal nerves, in increasing the acetyl choline concentration in the cathode region and in diminishing it in the anodic one. We are undertaking simiilar observations with Mimosa plants, to find out if when two pulvini of M. pudica are connected in series, and a steady current flows through them, there is any relative change in the concentration of the irritability substance in the cathodic resp. the anodic regions.

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Intimately connected with this observation, is the question as to the form in which acetyl choline is present in quiescent nerves ; is it inactivated or is its concentration reduced ? According to Babsky the effect of the constant current is to change the activity of the choline esterase which deactivates acetyl choline ; the former's activity is diminished in the cathodic region and is increased in the anodic region'

thereby causing opposite changes in the concentration of acetyl choline at these two regions. We are undertaking similar investigations with Mimosa to find if there is an enzymatic substance present in its tissue which can deactivate the irritability substance.

(b) *Control of Water Hyacinth by Auxin treatment*—The problem of devising means of eradicating water hyacinth has from time to time, engaged the attention of the workers of the Bose Institute. In 1921 the Government of Bengal appointed a commission under the chairmanship of Sir J. C Bose "to enquire into the subject of the spread of water hyacinth which had already become an acute economic danger." Certain preliminary investigations were carried out in the Bose Institute, on the efficacy of the methods employed in different countries to check the spread of the pest. It was found that while steam kills the portion of the plant above water, the submerged portion of the plant remains alive and thus brings about its rapid propagation; poisonous solutions applied to the roots travel up the stem with the ascent of sap, and thus kill the plant throughout its whole length. Application of poisonous solutions by means of spray cause only local death of the upper portion of the plant. The poison is thus not carried downwards to the root system; spraying is therefore ineffective in the destruction of the plant.

Recently substances have been found which are specifically poisonous to certain kinds of weeds, without affecting the cereal crops growing along with them. These physiologically active substances belonging to the class of heteroauxins, can be divided into two groups (i) those which cause cell elongation, and initiate the growth of adventitious roots and (ii) those which modify the patterns of leaves and of other organs. The herbicides belong to the latter group and the most active of them are (i) the 2, 4 dichlorophenoxy acetic acid (2-4-D) developed in the U S.A. and methoxone developed by the Imperial Chemical Industries in England.

At the suggestion of the I.C.I. we have undertaken to test the efficacy of methoxone as an eradicator of waterhyacinth and other weeds like *Lemna*, *Pistia* and *Salvinia*. Its action on waterhyacinth is specific and can be effective over a wide range of dilutions. A 0.01 per cent solution when sprayed once on a leaf gradually disorganizes and kills the plant within 20 days. In higher dilutions methoxone is effective in producing morphogenetic changes but is not lethal to the plant. The mode of action of inorganic poisons and of methoxone on waterhyacinth appears to be different. The former is effective in killing the whole plant when introduced through the roots, while the latter is far more effective when sprayed on the leaf. At present the mode of transmission from the sprayed leaf to the rest of the stem and root system of the plant is under investigation. Due to the Calcutta disturbances it was not possible to undertake field trials. Arrangements are being made to commence this work on a small scale at Falta.

(c) *Influenee of auxins on the bud development and fruit setting in Mulberry cuttings.*

A number of Mulberry cuttings were brought to Calcutta from Kalimpong in the middle of December and early in January. The tree from which the cuttings were taken at Kalimpong was in a resting

also planted. Under indole acetic acid treatment the largest number of inflorescence buds burst open and berries numbering from two to four came out from each bud within two to four weeks of planting. In the controls also the inflorescence buds opened within three to six weeks but their percentage was less than those under indole acetic acid treatment. Under indole butyric acid treatment only a small number of inflorescence buds gave out fruits after eight weeks. This shows that the indole butyric acid induces an inhibiting effect on the development and bursting of the inflorescence bud. It should be mentioned here that some of the inflorescence buds did not produce berries on bursting ; there were only inflorescence leaves which were of different size and shape as compared to foliage leaves. In a number of budless stumps, both treated and untreated, foliage buds appeared within two weeks of treatment from which branches ultimately developed.

After about three months, the cuttings were taken out of the soil to study their root formation. It was found that the stumps containing inflorescence buds had no root formation, both under treated and untreated conditions. But in the budless stumps which gave out foliage buds afterwards, there was profuse root formation. From the examination of the above results the following points are found to be of significance.

(i) Induced shortening of the dormant period in the cuttings indicated by the early flowering and bud development in them ; this may be due to transference of the cuttings from lower to higher temperature environment.

(ii) Indole butyric acid inhibits the development and bursting of the inflorescence buds.

(iii) Inflorescence buds or leaves appear not to produce root forming substances.

This is however a preliminary investigation ; further experiments will be undertaken this year with cuttings from Falta and Kalimpong, for elucidation of the above points.

(d) *Investigations on cinchona*—Since last year, investigations have been undertaken, to study the effect of environmental factors and of nutrients, on the growth of young cinchona plants. The former refers to the influences of temperature, humidity, light, and soil texture on the growth of the young plants, and the latter to the study of the inorganic nutrient requirements of the plant and on the effect of P_H of the nutrient solutions on the growth of the plant. As mentioned before, the installation of an air conditioning unit in the glass house could not be completed before the onset of the warm weather in March. As a consequence most of the young plants brought from the Cinchona Plantations, Mungpoo, did not survive the hot weather. It is interesting to note that only two plants planted in garden soil, one in a shaded portion of the garden and the other in a pot kept in the glass house, have survived the hot weather. The factors on which the survival of the plant depend viz. the effect of shading from the sun's heat and light radiations, influence of air temperature and humidity, and also of the soil temperature and moisture, require to be separately investigated.

Preliminary investigations showed that the plants are very susceptible to water logging and to the effect of chlorine present in tap water. A batch of plants which became submerged in water for a few hours due to flooding on one day in September perished. In nutrient solutions made up with tap water, the young plants did not survive more than three to four weeks, which was contrary to our experience of growing sunflower plants in sand culture with such

solutions. When distilled water was substituted for tap water the cinchona plants thrived well.

(d 1) *Nutrient experiments with Cinchona ledgeriana*—The first batch of 12 plants were received on 3. 12. 46 and a second batch of 24 plants were received on 25. 12. 46. The former arrived in fresh and healthy conditions, while the latter were in very poor condition.

Both sand and water culture methods were tried using the same complete nutrient. Plants survived longer in water culture than in sand culture. It may be that the sand used was not of the required degree of coarseness, which hampered free root respiration, though special efforts were made to aerate the sandy soil on which the plants grew.

Two typical reports of the growth characteristics of plants grown by water resp. sand culture method is given below.

Water Culture

Dates of observation	Height in cm.	Basal diameter in mm.	No. of leaves	Temperature in F°	
				maximum	minimum
20. 2.46	8.0	3.0	10	80	54
22. 1.47	9.0	3.0	6	80	54
21. 2.47	10.5	3.2	6	94	64
21. 3.47	2.0	2.2	7	100	74
15. 4.47	12.0	3.2	4	102	82
*Sand Culture**					
20.12.46	10.0	5.1	13	80	54
21. 1.47	11.0	5.1	10	80	54
21. 2.47	12.0	5.4	8	90	64

*The specimen died in the 1st week of *March 1947*.

The records are typical of several plants grown. It shows that the growth conditions were best maintained from end of December to end of February when the temperature varied between 94°—84° and 64°—54° F.

These results are generally supported by observations made on individual plants with Crescograph (longitudinal growth apparatus) and Sphygmograph (diametric expansion apparatus). The results obtained so far with these apparatus are given below.

(i) Growth of young cinchona plants has a diurnal periodicity ; it increases at night and slows down during the day or sometimes actual contraction takes place.

(ii) This actual contraction in a radial organ, taking place during the process of growth, has been observed previously. For further confirmation of this observation in the growth phenomenon of other plants, the diurnal growth of *Dahlia* was also studied. In it also there was alternate contraction and expansion more or less of a pulsatory nature, in the growth process during the rapidly growing phase.

(iii) In addition to this diurnal periodicity there is another periodicity in the growth of the plant, which is associated with the opening of the apical bud. The growth of the lower internodes which gradually slows down with time, is temporarily accelerated during the opening of the apical bud. When however the apical internode first starts growing at a fast rate, the revived growth of lower internodes again subsides. This periodic increase and decrease was also observed

in the total growth phase of *Dahlia*. In *Dahlia*, however, there being no stipule enclosing the bud, this bud opening phenomenon is not conspicuous.

(iv) Higher temperature condition appears to retard the time of opening of the apical bud.

(v) The maxium rate of growth in Cinchona was found to occur in early February. With the advent of hot weather in March the growth rate was found to diminish gradually with the rise of temperature.

(vi) By recording both the longitudinal and diametric growth simultaneously on the same plant, it has been found that the variation in the diametric growth is more or less similar to that of the longitudinal growth. More work requires to be done to establish a correlation between the two growth components. An arrangement has been made to study both factors of growth simultaneously on the same plant grown in culture solution. The work could not be continued due to the advent of hot weather. It will be resumed after the rain has set in.

(e) *Breaking the dormancy of potato tuber*,—The study of this problem was undertaken with the object of utilizing freshly harvested potatoes for seed purpose. As there is a difference in the seasons for cultivation in the hills and in the plains, freshly harvested tubers can be procured from the hills to be used as seeds for cultivation in the plains and vice versa. Preservation of potato as seed entails huge wastage and expenditure and so the cost of seed potato becomes very high and often cultivation suffers due to scarcity of the same. So if the freshly harvested potato can be utilised as seed, without preserving it for such a long time, a difficult problem in potato cultivation may be solved. This investigation has been continued for the last three years and some interesting data have been collected which will be published in detail in course of this year.

Some chemicals, such as ethylene chlorhydrin and sodium, potassium and ammonium thiocyanate, react readily in breaking the dormancy of mature cut tubers of Nainital and Darjeeling red varieties, and sprouting follows within two to three weeks after treatment, whereas in controls sprouting does not start before two months. In some gas mixtures too containing high percentages of Co_2 the resting period was much shortened. Cut tubers have been found to be more readily affected by this treatment than whole tubers. In the very early stage of tuber formation, the resting period appears to be almost absent The resting period is progressively lengthened with increasing maturity of the tuber. In all stages there was a difference in sprouting time between the cut and the whole tuber; the former sprouted comparatively early.

It is interesting to note that the early tubers, in which the resting period is very short or nil, do not sprout under soil when attached to the mother plant. The cause of this may be due to some inhibiting substance or hormone transmitted from the mother plant. When the latter dies or the immature tuber is detached from the plant, there is some possibility of its sprouting, if left under ground. There are reports of cases where some potatoes are found to have sprouted during harvesting.

(f) *Storage of vegetable seeds*—Expensive vegetable seeds such as cabbage, cauliflower etc., have to be imported every year; the surplus stock of seeds of such vegetables that remain are ordinarily thrown away because they fail to germinate next year. The study of this problem was therefore undertaken with the object of discovering a suitable and simple method of storage by which the life of the seeds could be prolonged. The experiment is being continued for the last two years. The seeds of cauliflower, cabbage, knolkhol, and carrot

were stored, under normal and different dehydrated conditions. Under low moisture conditions the seeds have maintained their normal viability even to this day, and they promise to continue in this state for a much longer time. Storage under relatively higher moisture condition results in a considerable loss of viability.

D. Plant Breeding and Cytogenetics

(a) *Breeding Investigations in long-staple Cotton*—This scheme is financed by the Government of Bengal for a period of three years, with a view to the breeding of disease resistant varieties obtained by hybridization and pure-line selection, which can possibly be grown in Bengal soil specially as a subsequent crop in rotation with Aus paddy. The scheme started in August 1945.

Detailed study of one year's life cycle of the plants has been completed. Particular attention was given to the following points :

(i) best season for the sowing of seeds, so as to obtain seed production with the least vegetative growth (ii) earliness in flowering period (iii) character of infections to which the plants and its bolls are subject (iv) measurement of lint length and determination of ginning percentage. Leaf index is also being measured to determine the specificity of types.

Selfing and crossing were made from selected plants of proved economic values, to evolve further useful types of plants.

During the year (1946-47) number of types including parent types and wild ones have reached 460, as against 103 in the last year, of which 22 are parent types, 4 wild, 12-F_4, 28-F_3, 24-F_2, 195-F_1 ; 1 multiple cross of F_2 and the rest belong to the cyclic crosses from $F_1F_2F_3$ and multiple cross varieties. This number also consists of 3 new Coimbatore and 3 wild types introduced this year. Out of the hybrid types evolved two are found to be more promising in comparison to their respective ancestors. Both are F_4 crosses, one being of Co_2 and 4F, and the other of 920 and 4F.

A comparison of the characters of these two cross types with those of their ancestors, as regards ginning percentage lint length earliness in flowering shows (Table 1) that the cross between Co_2 and 4F having ginning percentage 35.4 lint length 33.3 mm, and number of days required for flowering 69, has got a higher ginning percentage than Co_2 by 3. 6 but a lower one than that of 4F by 3.5 a greater lint length than Co_2 by 1 mm, but is smaller than that of 4F by 1 mm, while the earliness in flowering over Co_2 is 25 days and that over 4F is 9 days. The other cross with the ginning percentrge 36.7, lint length 31.8 mm, and period of flowering 78 days has got a higher ginning percentage than 920 by 4.0, but lower than that of 4F by 2.2, greater lint length than that of 920 by 1.7 mm but smaller than that of 4F by 2.5 mm, with flowering period earlier than that of 920 by 2 days and the same as that of 4F.

Name of Types	Ginning percentage	Lint length	No. of days required For flowering
Co_2	31.8	32.3	94
4F	38.9	34.3	78
920	32.1	30.1	90
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A few other F_2 and F_3 cross types are also showing some promising character.

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A few other F_2 and F_3 cross types are also showing some promising character.

One fuzzless mutant evolved out of F_3 cross between Co_2 and 4F during last year was earmarked and the seeds from it were sown in a separate row. Sixteen plants have come out and five plants from amongst those have so far been found to be fuzzless again. This character has added to this cross type an important economic value in addition to other useful characters to make the type a specially advantageous one for the growers.

(b) *X-ray Irradiation of Jute*—In the report for 1945-46 it was stated that the aim of the investigation is to induce desirable hereditary changes (mutations) in the seeds of jute plants by subjecting them to different kinds of ionizing radiation, like X rays, gamma rays and neutrons. Different physical and chemical agents can also be used for accelerating the rate of mutations. One of the most convenient method is to subject the plants or respectively the germinated seeds to different doses of X-rays. The plan of investigation is (i) to irradiate the seeds, seedlings, pollen grains of the plant (ii) to grow the irradiated specimens in trial plots, along with nonirradiated specimens in adjoining plots as controls, (iii) to study the changes produced and to collect the seeds from the plants grown from irradiated seeds which show the most prominent changes (iv) to breed for three generations the seeds of the selected plants to find out whether they breed true (v) to find out if the new mutants have desirable economic properties and (vi) to make a comparative study of the chromosome characteristics of the normal plant and of the mutants—to find out whether any alteration in the chromosome characteristics can be associated with the mutation produced.

The following varieties of jute were used for the investigations :—

C. capsularis	D154
	D386
C. olitorius	Chinsura Green

Exposures were given at a target distance of 8 cm from a X-ray tube, run at 30 kv and current of 4-5 mA. The irradiated seeds were sown along with controls during June-July 1946. Due to unavoidable reasons the sowing was rather delayed ; the plants grown under such condition did not mature satisfactorily. The exposure given varied from $\frac{1}{2}$ hour to a maximum of 7 hours. The effect of the irradiation expressed itself in the following manner : (i) the number of plants grown from irradiated seeds, which survive after three weeks of growth, decrease with increasing dosage from 2 to 7 hours. It is expected that the percentage of mutants induced in irradiated plants will increase with the increase in the lethal dose. The seeds from the surviving plants have been collected for sowing in the next season (April-May 1947) (ii) it is observed that under increasing irradiation, there is a general tendency of the plants grown towards increasing height, so that the frequency distribution curves against height are shifted as a whole towards increasing heights. This appears, in agreement with our previous results, to be a general effect of irradiation. As the increase in irradiation causes a decrease in the percentage of survival of the plants, the spacing between such plants is much larger than between the control plants. It is proposed to investigate next year, whether the average increase in height of the surviving plants is due to the increase in space made available to them or it is a real effect of irradiation.

Irradiation for next seasons sowing—From February to mid-April systematic X-ray irradiations of four varieties of Jute seeds, D154, D368, R26 and C.G. have been undertaken for the next season's sowing. Exposures have been confined to 3, 5 and 7 hours duration at 4 mA 32.5 kv rating.

X-ray irradiation of seedlings and pollen grains being rather difficult with our vertical X-ray tube, it is proposed to undertake ultraviolet irradiation of such specimens. As stated in the course of a discussion which took place at a meeting of the Jute Committee in January, ultraviolet irradiation is also effective in producing mutation, but its dosage cannot be evaluated in the usually adopted Roentgen units. Sowings will be started from mid-April.

Cytological investigations for the observation of meiotic abnormalties in the flower buds of the different varieties of jute grown from last year's irradiated seeds were undertaken since January 1947. No unusual abnormalties were noticed. Attention was directed to the finding out of the nature of secondary association of meiotic chromosomes in the metaphase of first division. A combination of 3:2:2 was mostly observed.

Sections made from fixed materials of irradiated flower buds (from plants sown in pots) were also studied under the microscope. Unfortunately in the few flower buds fixed, the desired stage was missing. The experiment will be repeated this year with flower buds and pollen grains subjected to ultraviolet irradiation.

E. Microbiology

(a) *Fibre retting substances*—The work on Hiparol and bacterial enzyme preparations is now being carried out on a large scale in a few Jute Mills, whereby jute root cuttings and long jute, without the roots being detached, are "cleaned and softened" within 12—34 hours and utilized in the production of sackings weft, sacking warp, hessian weft and hessian warp. Samples of yarn and cloth are being tested periodically to determine if this treatment has any deleterious effect on the tensile strength of the fibre; tensile strength and weight of the yarn and cloth are in no way impaired by the treatment. This process opens a new and very promising method in the processing of jute textiles, since the price of jute and the present manufacturing costs are both high. This work is now being carried out under the auspices of the Indian Jute Mills Association for general application in the mills.

Hiparol has also been applied successfully in the extraction of ramie, flax, coconut and sisal fibres and methods of processing these fibres on existing machinery are being worked out.

The chemistry of tamarind seed kernel is being investigated with a view to elucidate its chemical composition, so that a fuller exploitation of its technical possibilities can be made.

Diseases of tropical fruits and vegetables chiefly mango, pineapple, potato and tomato in storage are being investigated with especial reference to the physiology of parasitism of the diseases. The biological effects of temperature and humidity in storage life of certain food stuff are being investigated.

The extraction of alkaloids from cinchona bark by use of microbial enzymes is being investigated.

Antibiotic substances—Investigations on the isolation of antibiotic substances from different molds is being continued. The research worker in charge of penicillin production is now working on similar problems in the Bacteriological Department of the Imperial College of Science, London. Another worker was engaged for some time in the production and purification of Streptomycin. We are very much

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hampered in the successful completion of such investigations by the absence of a well balanced team of workers consisting of mycologists, biochemists and chemical engineers. Unless funds are made available for the recruitments of such a group of workers and for the purchase of necessary equipments, antibiotic investigations are bound to be of a spasmodic character.

F. Anthropology

During the year under review the following papers were published :

1. The frequency of multiple births in India—Trans. Bose Res. Inst. Vol. 16, 1944-46.
2. Rh factor in the old world peoples—Science & Culture ; Vol. 6, 1946.

The following papers are almost ready for publication :—

1. Blood Groups from Palamau—To be sent to the Journal of Genetics, England.
2. Muthuvan Blood groups—To be sent to Man in India
3. An abnormal hand in a polydactylous family—To be sent to Journal of heredity, U.S.A.

Researches—During this year intensive blood grouping investigations were carried out among the aborigines of Palamau district. So far about 450 persons of various tribes have been grouped. It has been found that the recessive O blood group is being lost rapidly under the pressure of the two dominant blood groups A and B. Further intensive work in this region is likely to yield important results regarding the mechanism of loss of genes. The above researches are substantiated by blood group pedigrees.

Twin investigations are being carried out according to our previous procedure though few twins could be brought in the laboratory due to riots in the city. Four pairs were, however, brought in January, 1947 in connection with the D. P. H. classes.

Lectures—The D. P. H. classes were extended this year owing to the increase in the number of students. The classes were held in December, 1946 and January 1947.

Accounts

During 1946-47, the total grant received from the Central Government was Rs. 62,475/- including Rs. 16,452/- due on account of deficit incurred in 1945-46. Out of this Rs. 10,000/- was paid in November, 1946 and the balance was received towards the end of March, 1946. This delayed payment of Government grant, which is calculated on the basis of the deficit incurred during the previous financial year, is causing a great deal of inconvenience. The opening deficit of Rs. 16,452/- on April 1946 was increased to a closing deficit of Rs. 25,750/- at the end of March 1947. To meet the consequent cash shortage incurred in the working of the Institute during the year, it was necessary to sell G P. Notes of face value of Rs. 20,000/- belonging to the Building Depreciation and Apparatus and Book Purchase Funds, and also to take a temporary loan of Rs. 30,000/- The Auditior has also drawn attention to the fact, that the amount received by the encashment of 5 per cent G. P. Notes of face value of Rs. 10.000/- which matured in 1944-45, has not yet been invested. This state will continue until the Institute is provided with a substantial opening balance in the Working Account.

An analysis of the income expenditure account of the Institute for the last two years gives an idea of sources of income of the Institute and of expenditure.

Income	1945-46	1946-47
from Trust Funds	58,836-7- 3	32,233-15- 3
from Government Grant	29,575-2-10	46,023- 5- 0
from Grants-in-aid	28,691-0- 6	47,884-15- 7
Expenditure	1,34,187-0- 6	1,51,892-13- 9
Deficit	17,084-5-11	25,750- 9-11

It will be noticed that in spite of an increase in Government deficit cover grant by about Rs. 16,500/- the working deficit has increased by about Rs. 8,700/- This is partly due to an increase in expenditure by about Rs. 17,700/- and partly due to the fall in Institute income by Rs. 26,600/- Of this latter amount, about Rs. 8,000/- represent a permanent fall of income, due to the reduction in rate of interest payable on G. P. Notes from $3\frac{1}{2}\%$ to 3% The balance is due to the non-receipt of interest accruing on the G. P. Notes during the second half of the year, after their conversion.

APPENDIX

I. *Members of the Governing Body.*

Lady Abala Bose
Dr. Debendramohan Bose
Mr. Sudhansumohan Bose
Mr. Surendramohan Bose
Mr. Sudhir Kumar Mondal
Mr. Abaninath Mitter
Mr. Satish Chandra Mukherjee
Prof. Nagendra Chandra Nag
Mr. Kshitish Chandra Neogy
Mr. Bhupatimohan Sen

II. *Members of the Council.*

Lady Abala Bose
Mr. Surendramohan Bose
Mr. Sudhansumohan Bose
Mr. S. K. Mondal
Mr. S. C. Mukherjee I. C. S. (Retd.)
Prof. N. C Nag
Mr. B. M. Sen M. A., I. E. S (Retd.)
Dr. D. M. Bose, Director —Ex-Officio
Mr. K. C. Neogy M. L. A.
Representative of the Central Legislature
Dr. P. Parija D. Sc., Vice-Chancellor, Utkal University, Cuttack.
Dr. K. Krishnamurti D. Sc. (Lond.),
Principal, King Edward College, Amraoti.
Dr. D. M. Sen, Ph D.,
Educational Adviser to the Government of India

III. *Finance Committee*—Mr. Surendramohan Bose —Chairman
Mr. G. Rajagopal
—Accountant General, Bengal
Dr. D. M. Bose —Director

IV. *Building Committee*—Dr. D. M. Bose
Mr. Surendramohan Bose
Representative of the Council
Mr. A. N. Mitter
Representative of the Governing Body.

V. *Staff*—Director—Dr. D. M. Bose, M. A., Ph. D., F. N. I.,
Registrar—Mr. A. N. Mitter (Officiating),
Department of Physics—Head of the Department--Director.
Research Fellow—Mr. S. R. Das, M. Sc.,
Birla Scholar—Dr. S. D. Chatterjee, D. Sc.,
(till February 1947)
Research Scholar—Vacant
Attached workers—Prof. H. P. De, M. Sc.,
(Vidyasagar College)
Mr. S. P. Dutt, M. Sc., (Vidyasagar College)
Department of Chemistry—Head of the Department—
Prof. J. K. Chowdhury, Ph. D. (Berlin)
will join in July 1947.
Research Fellow—
Dr. B. Banerjee Ph. D. (Mun.)

Department of Botany—

Head of the Department—
Dr. K. T. Jacob, Ph. D., (Lond.) from 16th March 1947.
Research fellow—
Dr. K. T. Jacob, Ph. D. (Lond.) on leave from 1st July 1946.
Dr. B. K. Kar, Ph. D, (Leip.) on leave from 1stFebruary 1947.
Special Scholars—
Mr. B. K. Palit B. Sc,
Mr. B. K. Dutta B. Sc.
Mr. A. T. Guha Thakurta
Sir J. C. Bose Scholars in Botany—
Miss Mridula Dutt, M.A. (upto 31st October 1946)
Attached worker—
Dr. J. K. Chowdhury, Ph. D. (Lond.)—Bethune College

Department of Microbiology—

Research Fellow—Dr. N. Dey—on leave from 1st February 1947 and has not joined.
Scholar—vacant
Attached workers—Dr. H. K. Baruah Ph D. (Cantab.)
Mrs. Parukutty Baruah M. A (Ben.)—Brabourne College.

Department of Physiology and Zoology—

Research Fellow—Dr. J. P. Sircar, M. B, Ch. B., and also in charge of the workshop,
Special Scholar—Mr. G. C. Bhattacharya

Department of Anthropology—

Research Fellow—Mr. S. S. Sarkar, M. Sc.

Staff appointed under grant-in-aid schemes--

(1) *Council of Scientific and Industrial Researeh*
(a) Ultrasonic generator—Dr. M. S. Sinha D. Sc., (upto 28th Feb. 1947)
Mr. Indralal Chuckerverty, M. Sc.
(b) Positive ray discharge apparatus—Mr, A. N. Banerjee, M. Sc,
(c) Atomic Research—Senior Research Assistants—
Dr. S. D. Chatterjee, D.Sc., (from 1-3-47)
Dr. M. Sinha, D.Sc., (from 1-3-47)

(2) *Indian Central Jute Committee*—
(a) Cytologist—Mr. Kantilal Chowdhury, M.Sc.
(b) Radiologist—Mr. Sudhir Ranjan Das, M.Sc. (upto 31-3-47)

(3) *Cotton Committee*—
(a) In charge of Plant Breeding—Mr. A. K. Adhikary, M.Sc.
(b) Biophysicist—Mr. A. M. Naha, M.Sc.

(4) *Cinchona Scheme*—
(a) Cytologist—Mr. Sudhir Kumar Banerjee, M.Sc. (upto 31-10-46)
(b) Chemist—Mr. Ram Prosad Chatterjee, M.Sc.