Bose Research Institute

ANNUAL REPORT

For the year 1947-1948

Report of the Bose Research Institute
for 1947-48

Council — Mr. Khitish Chandra Neogy a member of the Council was appointed Minister for Reconstruction and Rehabilitation during the year. There were four meetings of the Council during the year. Besides sanctioning the Budget Estimates for 1948-49, and passing the annual report and audited accounts for 1946-47, the Council considered drafts of Provident Fund Rules of the Bose Institute and of the rules governing the payment of Travelling Allowances. These have been referred to Sub-Committees, who have not yet submitted their reports.

Change of Regulation — The Council has also, with the consent of the Government of India, amended the Regulations to enable a representative of the Calcutta Corporation to have a seat on the Council.

Finance Committee — The Committee met twice during the year for scrutinizing the budget Estimates of the Institute and for recommending budgetary reappropriations, sanctioning of additional expenditure out of the Extraordinary Repair and Renewal fund, and from the Apparatus and Book Purchase Fund. Mr. Surendra Mohan Bose, Chairman of the Committee was granted leave of absence to enable him to visit Europe and the United States, when Mr. B. M. Sen was appointed to officiate in his place.

Building Committee — The Committee met once during the year to recommend certain items of extraordinary repairs and renewals, including the repair of the riverside embankment in the Director's quarters at Falta.

Proposals for Building Extensions — This Committee has also recommended the reconstruction of the one storied laboratory buildings in the west and south-west corner of the Institute quadrangle, to provide additional accommodation for laboratory, and workshop, and for the reconstruction of the menials' quarters. The Director has incorporated these recommendations in the various schemes prepared by him for consideration by the Ministry of Education, by the Scientific Man Power Committee and by the Reviewing Committee. The possibility of future expansion of the research and developmental work in the Institute will depend upon the provision of additional building accommodation. In connection with a scheme for expansion of agricultural investigations which has been submitted to the Government of West Bengal, a building grant has been asked for, for extension of staff quarters and of laboratory accommodation in the Falta Experimental Farm of the Institute.

Acharya Jagadish Chandra Bose Memorial Lecture — The ninth lecture of the series entitled 'Some Scientific and Practical Problems of Agriculture in India' was delivered on 30th November 1947 by Dr. L. N. Mukherjee

the Governor of West Bengal, Shri C. Rajagopalachari presided over the anniversary meeting. In his report presented to the meeting, the Director referred to the Founder of the Institute, as one of the group of artists, poets and scientists, who by their life long devotion and creative activities, have added a new significance and value to the ancient culture and civilization of this land.

Prof. M. S. Vallarta of the U.S.A. and Mexico gave a lecture on Cosmic Rays and held a *colloquium* on the subject during January 1948 in the Institute.

Visitors — Among the many visitors to the Institute, were the Scientific Delegation from Australia. Two of the Ministers, Shri K. P. Mukherji and Shri H. C. Naskar as well as many senior officers of the Department of Agriculture, Government of West Bengal, visited the Falta Experimental Farm of the Institute, to inspect the plant breeding experiments on Cotton and Jute, undertaken in the Farm.

Revision of scales of pay and of dearness allowances — The Director was in correspondence with the Government of India on the necessity of upgrading the scales of pay and of dearness allowances in the Institute to the level in force in other All-India Research Institutes. The Government have sanctioned the payment of the D.A. to the employees of the Institute on the scale recommended by the Pay Commission, and have deferred the revision of scale of pay pending the receipt of the recommendation of a Reviewing Committee which was recently appointed by them.

Research and Development Schemes — The Director has during the year under report submitted several schemes for extension of research and other activities of the Institute. These include (*a*) a scheme on agricultural research in Cotton, Jute, Rice and Pulses. The scheme was prepared at the suggestion of the Ministers of Agriculture and of Land Records who visited the Falta Experimental Farm in November 1947. A three years scheme has been submitted which includes proposals for (*i*) acquisition of another 40 bighas of agricultural land for the extension of the Institute farm, (*ii*) capital grants for building, development of agricultural land, and for laboratory equipment—of a total amount of Rs. 80,000, and (*iii*) a recurring grant of Rs. 75,000 for the first year. We understand that a plot of *Khasmahal* land of area about 50 bighas is being acquired for this purpose by the Land Acquisition Department of the Alipore Collectorate. The other parts of the scheme are still under consideration of the Government.

(*b*) Two schemes were also submitted during the course of the year to different departments of the Central Government. These include (A) a revised long range development scheme based on that submitted to the Department of Education (see last year's report); this includes schemes (*i*) for Cosmic Ray investigations, (*ii*) for extension of Sir J. C. Bose's

Bose Institute an All-India Centre for training and research in Biophysics, and (*iv*) for research in Nuclear Physics. The last named scheme has been referred to the Board of Research in Atomic Energy. At the same time the Scientific Man Power Committee circulated a questionnaire for assessing the different grades of scientific and technical man power requirements of the country and to make recommendations regarding actions to be taken during the next five years to meet these requirements.

(B) The scheme submitted by the Director to the Man Power Committee, contained an estimate of the immediate requirements of the Institute in the shape of building construction, laboratory equipment and staff extensions, necessary for providing facilities for training of an additional twenty research scholars. This short range scheme forms an integral part of the long range one submitted to the Ministry of Education.

So far no action has been taken by the Central Government on these two schemes. It appears probable that the latter instead of dealing with such schemes piecemeal will base their future action, if any, on the comprehensive report of the Reviewing Committee which they have appointd.

Reviewing Committee — A Committee of Enquiry was appointed by the Central Government in 1940 to review the work of the Bose Institute and to make recommendations on the future requirements of the Institute. Based on these recommendations the Central Government decided that certain alterations in the constitution of the Institute was necessary, and that a maximum annual deficit cover grant of Rs. 66,000 "was payable to the Institute for a period of five years or till one year after the termination of the war whichever happened to be earlier. The grant will be renewable on report of work after inspection of a Reviewing Committee, if in the opinion of the Central Government, the report justifies it".

In implementation of this decision, the Government of India recently appointed a Reviewing Committee, consisting of Prof. M. S. Vallarta (Chairman), Dr. J. N. Mukherji and Dr. S. P. Agharkar. The Committee visited the Bose Institute on March 20, 21 and 22, 1948 and have submitted their report and recommendations.

The Director prepared a Memorandum for the use of the Committee, which contained a short account of the work of the Institute since the visit of the last Committee of Enquiry, and a scheme for expansion of the activities of the Institute. The latter included proposals for augmenting the staff of the Institute, for improvement of the scale of pay of its staff and for expansion of research activities.

The suggestion was made in the Memorandum that the Institute should be developed as an All-India Institute for research in Plant Science, specially in Plant Physiology and Plant Genetics. The study of the sciences of Biophysics, Biochemistry, Microbiology and Animal Physiology should be considered as ancilliaries to the main purposes of the Institute, which

At the same time the methods and apparatus introduced by Sir J. C. Bose for physical and plant physiological investigations were to be further developed and utilized for the study of 'the nascent science which includes both Life and Non-life'.

The scheme as prepared by the Director involves Capital Grants (*i*) for building Rs. 1,70,000 (*ii*) for equipment of workshop and laboratories Rs. 2,50,000 and (*iii*) for the purchase of apparatus Rs. 3,00,000, and Recurring Grants (*i*) Rs. 2,00,000 for staff salaries and (*ii*) Rs. 1,00,000 for other items of recurring expenditure.

The Report of the Reviewing Committee is at present under the consideration of the Ministry of Education of the Government of India.

Grant-in-aid Schemes—A list of grand-in-aid investigations is given below. Those marked asterisks have been transferred from the Dacca University to the Bose Institute, since the appointment of Prof. J. K. Chowdhury of Dacca University as head of the Department of Chemistry.

Board of Research on Atomic Energy — (*i*) Transuranic Elements (*ii*) Study of nuclear fission in Uranium and other heavy elements, by double ionisation chamber and by Wilson chamber (*iii*) Study of scattering and absorption cross sections for neutrons in Thorium and Uranium.

B. S. I. R. — (*i*) Setting up of a powerful Ultrasonic Generator (*ii*) Setting up of a medium voltage positive ray apparatus for neutron production (*iii*) Desulphurisation of Coal.*

Government of Bengal — (*i*) Investigations on disease resistant long stapled cotton (*ii*) Investigations on bioelectric potential developed in germinating seeds etc.

Indian Central Jute Committee — (*i*) Effect of different kinds of radiation in inducing favourable mutation in jute seeds (*ii*) Impregnation of Jute Yarns with suitable Synthetic Resins.*

Government of India—Ministry of Health — (*i*) Physiological investigation on Cinchona (*ii*) Cytological investigation on Cinchona.

Guest Workers — (*i*) Accommodation has been provided for the laboratory of the Principal Quinine Officer to the Government of India. A pilot plant has been set up and is being used for investigating the economic feasibility of extracting quinine from the woody portion of Cinchona trees. (*ii*) The Microbiologist to the Government of West Bengal, Directorate of Agriculture, and staff are carrying on investigations on nitrogen fixing soil bacteria.

Staff — Mr. Dwijes Chandra Chakraborti was appointed Registrar to the Bose Institute last year and joined on 1st May, 1947. Dr. B. K. Kar, Research Fellow in Plant Physiology, has returned from leave and joined on 1st February, 1948. Mr. Sasanka Sekhar Sarkar, M.Sc. Research Fellow in Anthropology has resigned, on his appointment as officer in the Anthropological Survey of India. Mr. Sushil Kumar Mukherji, B.A. was appointed

services of a young man of great promise. Mr. Amiya Kumar Rai Chaudhury, M.Sc., Research Scholar in Chemistry Department of the Institute and Dr. J. K. Chowdhury, Ph.D., a former Fellow of the Institute have been awarded P. R. Studentships for 1946, for investigations carried out in the Institute.

REPAIRS AND NEW INSTALLATIONS

A. C. Generator — Last year it was reported that work in the physics department was hampered due to the breakdown of the large 50 K.W. 110 V. A.C. generating set, and no electrical engineering firm of good standing could be induced to undertake its repair. After exploring different alternative sources of supply of A.C. current, it was decided to purchase a 7.5 K.W. rotary convertor. The machine has been installed. At the same time with the technical assistance of a neighbouring electrical engineering firm, the large generator has been repaired in the Institute and put in running order. It is now possible to supply A.C. currents at 110 and 220 volts to the northern block of buildings. The rotary convertor is used for the normal A.C. supply, and the motor generator is used only when there is a heavy demand.

Air-conditioned Glass House — The long projected air-conditioned glass house, for physiological investigations in cinchona and other temperate region plants, has at last been completed and is now in running order. A large number of young cinchona plants have now been accommodated in it, and investigation on root respiration and nutritional requirements of cinchona plants have been started in the glass house, and now can be continued through the hot weather.

Further equipments for the Glass House are necessary, to enable an independent control of temperature and humidity in the glass house. It is proposed to construct another air-conditioned completely light tight room, which can be illuminated artificially by fluorescent lamps. When this is completed, the Institute will possess a set of chambers in which the physiological study of plant growth under controlled conditions of light, temperature and humidity will be possible. Many lines of investigations can either be started or renewed, like the artificial culture of plant tissue and organs which had to be stopped for want of an air-conditioned room.

The purchase of a jeep car and a trailer have facilitated the transport of staff members and of materials to the Falta Farm. A large portion of the money accumulated in the Repair and Renewal Fund and in the Apparatus Purchase Fund have been spent in building and embankment repair and in the purchase of some essential laboratory and workshop appliances. There is still much room for improving the accommodation and equipments of the different laboratories and workshops of the Institute.

RESEARCH ACTIVITIES

A. 1. PHYSICS

Atomic Research — Out of a capital grant received from the Board of Research on Atomic Energy, the following radio-active preparations, minerals and accessory substances have been purchased from Canada (*i*) 100m Curie of Radium Beryllium (source of neutron) (*ii*) 1 mC of Radium Bromide—for calibrating weak radio-active minerals and spring waters (*iii*) 3 mC of Radiolead (*iv*) 5 mC of Polonium (*v*) 3 lbs of Pitch blende and (*vi*) 25 gms of Beryllium.

The Institute has now about 160 mC of Ra Be neutron source. The neutrons so obtained will be used,

(*i*) for measuring the various absorption and scattering cross sections for neutrons of different velocities in the nuclei of fissile elements like Uranium and Thorium. This preliminary work is necessary for the study of chain reactions in atomic piles. Different kinds of neutron detector tubes are being prepared. Also different neutron absorber materials are being ordered from abroad.

(*ii*) for the preparation of radio-active tracer elements to be used in connection with investigations on plant metabolism and of transport of nutrients in plants.

Transuranic elements — Plutonium 239 with half life of 25,000 years is expected to occur in traces in very old uranium containing ore. It was reported last year that a minute quantity of such transuranic compounds have been separated by chemical method from a small quantity of Uraninite obtained from Indian sources. To establish that the precipitate contains Plutonium, which is an α -ray emitter, it is necessary to measure either the energy or range in air of the α -particles emitted, in terms of those of the α -particles emitted by Polonium. The α -ray characteristics of these three elements are as follows :

Polonium	Po (210),	Pu (238),	Pu (239)
Particle Energy Me V	5.298	5.137	5.496
Range in air in cm.	3.84	3.68	4.08

The source was so feeble that measurement of the range of particles in photographic emulsion did not prove feasible. The precipitate as well as a Po source were therefore introduced in Wilson Chamber of large sensitive time, and the tracks of α -particles were photographed by a pair of stereoscopic objectives. The number of tracks obtained were too few to make accurate measurement of track characteristics possible. It is now proposed to separate the transuranic elements from the recently purchased pitch blende.

Separation of Uranium from Thorium containing ores — Though India is rich in Thorium containing minerals like Monazite, which can be used as fuel after being bred in an Atomic Pile started with Uranium, the latter

estimation of small concentrations of Uranium in the presence of other metals—a colorimetric method has been devised for the purpose. At the same time different chemical methods are being tested for economically separating Uranium present in small concentration in Monazite, where the ratio of Uranium to Thorium is about 2 per cent. Chemical methods of separation, as well as the recently developed method of separation by selective absorption on synthetic resins and their subsequent elution by citrate solutions of controlled *p*H values, are being tried.

Study of nuclear fission and disintegration — It has been previously reported that spontaneous fission of Uranium nuclei has been studied in the Institute and the life time measured by means of a single ionisation chamber connected to a fast recording galvanometer. To find the energy distribution amongst the fission pairs, it is necesary to use a double ionisation chamber, each half of which is connected to a fast recording galvanometer. The Uranium mineral is sputtered on a very thin support like mica or aluminium, with small stopping power for the energetic fission particles emitted during fission. The foil is mounted on a frame separating the two ionisation chambers.

The difficult technique of depositing by sputtering uranium metal has been mastered and thin sputtered films have been obtained. The amplifying circuit for use with the second recording galvanometer is being assembled.

Later it is proposed to study by means of a low pressure Wilson chamber the tracks of pairs of fission particles emitted from such foils of sputtered Uranium.

Studies with Photographic Emulsion — Pioneer investigations on the determination of mesotron mass by exposing Ilford new halftone plates to cosmic rays was carried out in this Institute. Recently these emulsions have been very much improved, and the Bristol workers have obtained important results connected with the disintegration of atomic nuclei by cosmic rays, resulting in production of long range mesotrons ; they have also made plausible that some of the heavy mesotrons are transformed into light mesotrons. This type of investigation, in which detailed scanning of developed plates under high powered microscopes, is time consuming and involves considerable eyestrain. At present this investigation has been started again as part time work of a college lecturer, and some very interesting enlargement photographs of nuclear disintegrations have already been obtained. The Atomic Research Board have recommended the sanction of a grant for the appointment of a whole time worker and two student assistants for this work.

Wilson Chamber — Nuclear fission and disintegration : Investigations are also being undertaken with a low pressure Wilson Chamber filled with metallo organic vapours like Lead Tetraethyl etc. Such a chamber has been

The performance of the chamber when filled with Lead Tetraethyl is being tested.

Another counter controlled chamber is being used for the study of noncoulombian scattering of penetrating particles in lead sheets. Several thin sheets of lead have been introduced in the Wilson chamber for the purpose.

The same apparatus with some modification is being used to investigate whether electrons are emitted from lead sheets in which mesotrons have been stopped. Among many photographs of stoppage of penetrating particles in lead sheets, only in one photograph the emission of an electron from the absorbing sheet has been observed. In view of the controversy over the ultimate fate of mesotrons slowed down in absorbers, this line of investigation is important.

Pressure ionization chamber for the study of cosmic rays — Two duraliminium vessels, one large and the other small, have been filled with argon gas at 10 atmosphere pressure. The former is connected to a recording string electrometer, and will be used for the continuous study of atmospheric shower and burst production. The latter connected through an amplifying circuit to a recording string galvonometer will be used for the study of burst production in absorbers surrounding the chamber.

Neutron Generator — A positive ray medium voltage discharge tube generator of neutrons has been under construction during the last two years. Deuterons ($D+$) produced in an arc fed with a stream of heavy hydrogen molecules (D_2) are accelerated through 80 kV in a high vacuum tube and made to strike against a target containing a heavy hydrogen compound, thereby neutrons are produced according to the reaction $D^2_1 + D^2_1 \longrightarrow He^3_2 + n^1_0$. The construction of the discharge tube is complete ; at present attempts are being made to improve the efficiency of the arrangement, which depend upon (*i*) increasing the fraction of deuterons produced in the arc (*ii*) focussing of the ion beam striking the target and (*iii*) the nature of heavy hydrogen compound used as target.

An alternative arrangement which allows a very high percentage conversion of D_2 molecules into atom ions ($D+$) is being set up. In this arrangement a very high frequency current is sent through a tube in which D_2 is circulated at low pressure, and the tube is placed in a uniform magnetic field.

Ultrasonic generator — The construction of the generator was kept in abeyance pending the restoration of the A.C. supply, the procurement of quartz plates and of permanently evacuated valve tubes. Now that the A.C. circuit has been repaired and the necessary materials procured it is proposed to begin work with the arrangement for the production of ultrasonic waves of large energy output.

A. 2. BIOPHYSICS

favourable mutations by means of X-rays and Ultraviolet radiation has been continued this year. Physiological and genetic modifications have been studied and are reported in a subsequent section (Jute-irradiation experiments).

This year a hot cathode X-ray tube has been constructed, specially suited for irradiation work. The current obtainable in the X-ray tube is 15 mA, as against 6 mA in the gas filled tube. While the latter requires a kenotron valve to rectify the high voltage current, the new tube is self-rectifying. The X-ray beam comes out through a much wider aperture from the tube, and is directed in a vertically downward direction. The specimens to be irradiated can be placed in horizontal dishes under the tube and can be more conveniently handled. For irradiation work, the present tube is 8-10 times more efficient than the previous one. A dosimeter has been constructed, the ionisation current produced in it by incident X-rays is measured by a String Electrometer. Some difficulty is being encountered in replacing the thin Wollaston fibre mounted in the electrometer.

The structural study of biological substances with large molecules like proteins etc. has been started. Powder diagrams of egg albumin and milk casein have been obtained, the results obtained are in agreement with those published recently by other investigators. The work on the structure of shellac, in its various physical modifications, was interrupted, due to an unexpected breakdown of the gas filled X-ray tube. It will be taken up when the conditions are favourable. Difficulty is being met with in using the same X-ray transformer both for irradiation and for structure determination work.

Bioelectric potential developed in germinating seeds — An investigation has been recently published by Burr, in which he has shown that the bioelectric potential developed in germinating seeds of pure and hybrid strains of maize can be correlated with (*i*) vigour of growth of plants raised from such seeds and (*ii*) in the case of hybrid strains of maize with hybrid vigour. From (*ii*) it was concluded that the method could also be used to determine, whether in seeds produced from cross fertilized pollen grains, hybridisation has actually taken place or not.

A grant was received for a proposed investigation with cotton seeds from the Government of Bengal about two years ago. The first year was spent in building up a suitable push pull valve amplification circuit for accurate determination of bioelectric potentials and for repeating some of Burr's investigations with maize.

In the year under report, bioelectric potentials in germinating cotton seeds were measured. The seeds belonged to the varieties Co_2, Co_3 and Co_4; the last one is a recent hybrid between Co_2 and C_3. The seeds were obtained from the Institute Experimental Farm at Falta. Unlike the results obtained by Burr *viz.* that the bioelectric potentials, for a given strain of maize, were

Starch iodine compounds — It is known that iodine reacts on starch molecules and on some of its breakdown products like Glycogen etc., each showing a characteristic colour. X-ray and other investigations have shown that starch occurs in several modifications of which the A and B forms consists of linear molecular configurations, which are convertible to a helical configuration V. It has also been shown that the blue colour reaction with iodine only occurs with the V configuration of starch. The chemical nature of the interaction between starch and iodine is being studied in this laboratory. The tentative conclusions arrived at are (*i*) iodine is attached to starch by some residual or secondary valency and (*ii*) in starch iodide complex iodine occurs as I_3.

B. 2. *Plant Products and their Synthesis—Soluble salts of Quinine Febrifuge* — After Quinine has been extracted from the treated bark as sulphate, an insoluble residue of alkaloids is left containing about 80 per cent of cinchona alkaloids other than Quinine. The production of the Febrifuge amounted to 62,355 lbs in 1944-45. It represents a cheap antimalarial drug, but due to its slight solubility in water, it has only a limited scope of application.

The present investigation was undertaken for the purpose of producing soluble salts of the Febrifuge alkaloids. The aims in view were (*i*) the cost of production must be kept low to enable it to compete with Paludrine (*ii*) the finished product must have an alkaloid content which should not vary beyond a certain small limit (*iii*) it must possess a high antimalarial activity.

Hydrochloride, hydrobromide and sulphate salts have been prepared as solid powder which are all highly soluble in water ; the solutions have *p*H of range 5 — 5.3, so that their oral administration is permissible.

Of these three salts the sulphate is the cheapest to prepare. Further investigations are necessary to determine the antimalarial activity of these salts by tests carried out in hospitals; also certain technical investigations are necessary for vacuum concentration of the salts from solution, and for reducing the hygroscopicity of the tablets prepared.

Synthesis of Penicilin amine — Mischer in Basel is reported to have synthesised this salt ; there is no mention of the yield, which is probably very poor. The synthesis of this compound is of great importance, as it represents an intermediate stage in the synthesis of different Penicilin molecules. Further it is possible that by condensation of sulphonamide groups to penicilin amide, drugs of great bacterostatic or bactricidal properties may be obtained.

Starting with Acetone and Acetoacetate, a Benzyl derivative of penicilin amine has been obtained. The next step in the reaction, associated with the replacement of a carboxyl group by NH_2 (Schmidt's reaction), involves a difficult experimental technique.

Synthesis of B-Selenine — The constitution of this compound, a sesqui-

of the several reagents necessary for this synthesis is being carried out in the laboratory.

Synthesis of 2, 4, dichlorophenoxy acetic acid (2, 4, D) and its other derivatives — The work of Zimmerman and his fellow workers in the Boyce Thomson Institute has shown the usefulness of this and other related compounds for regulating and modifying the growth of plants and plant organs. Recent investigations have shown that 2, 4, D and a similar compound called Methoxone prepared by I. C. I. are powerful herbicides. Investigations were recently carried out in the Institute on the use of dilute Methoxone as eradicator of Water Hyacinth.

The present investigation was undertaken with a view to investigate the possibility of manufacture of herbicides like 2, 4, D from raw materials available in this country, and also to study the effect of replacing or introducing different groups and elements, on the auxin like properties of the substance. The starting material for the synthesis of 2, 4, D is 2, 4, dichlorophenol, which is not available in the local market. As a first step, different methods of producing this compound, from raw materials available in this country, were investigated. The method which was found successful was (*i*) preparation of 2, 4, dinitrophenol from phenol, (*ii*) reduction of the latter into 2, 4,—diaminophenol (hydrochloride) and finally its conversion into 2, 4, dichlorophenol. From this 2, 4, D was finally prepared by one of the standard methods.

Attempts are being made to try other methods of synthesis with a view to simplifying the procedure.

B. 3. *Applied Chemistry* — Two schemes of grant in aid research were brought over from the Dacca University by Prof. J. K. Chowdhury.

Impregnation of Jute Fibre — Naturally occurring jute fibre is rather coarse and hard, due to the presence of lignin in it, which therefore does not find much use in the textile industry. If lignin is removed by bleaching, the colour and grip improves, but the fibre loses its strength when it comes in contact with water. The present work was undertaken with the idea of introducing some water resistant synthetic resin in place of the lignin removed and thus to improve the wet strength of jute yarns.

Promising results have been obtained by introducing (*a*) urea formaldehyde, (*b*) melamine—aldehyde and (*c*) melamine urea formaldehyde resins in the bleached fibre. The wet strength is improved and if bleaching is not too drastic, the strength approaches that of the original unbleached yarn, while the colour and softness remains satisfactory. Melamine amins have proved more satisfactory and are resistant to soap washing. If the investigation turns out successful such treated yarns could be dyed and used for knitting or for admixture with wool or cotton.

Desulphurisation of coal — Coal samples obtained from different localities in Assam are found to contain sulphur of concentration from 2.7 to 7.8 per

content and thus improve its utility and further to recover the sulphur products preferably as elementary sulphur.

Two methods have been evolved for the purpose—one consists in treating the coal with sodium bicarbonate and then subjecting it to carbonisation at 750°-800°C, and the other consists in heating coal to 750°-800°C and passing ammonia gas at the same time. About 80-85 per cent of sulphur are removed from coal by these processes.

Certain equipments necessary for the work had to be left at Dacca, including a specially made furnace ; a similar one is being made in Calcutta. Bicarbonate method is being used with different samples of coal, and the following reduction in sulphur content has been obtained: Ledo II (83.07%), Namdong (77.06%), Cherapunji (56.07%).

It has been further observed that longer period of heating is detrimental to desulphurisation, as sulphurous products then react with coal and form organic S-compounds.

C. 1. Plant Physiology

Transmission of Excitation in Mimosa — It is now generally accepted that the transmission of excitation in Mimosa, as in nerve muscle units, is a physicochemical process. Hesse has claimed to have isolated from a hot water extract of Mimosa leaves, an irritability substance of such potency that in concentration of in 10^8 it can induce collapse of the leaves, when such solution is introduced at the cut end of Mimosa branch (Mimosa test).

An alternative physiological method of testing the potency of solutions containing irritability substances was tried. A fine incision is made in the petiole of a Mimosa leaf, a little away from the pulvinus. After the leaf system has recovered, a minute drop of a dilute aqueous extract of Mimosa leaves is introduced by a small pipette in the incision, which results in an immediate collapse of the pulvinus. It was found that the system reacted up to a dilution of 1 in 10^6 of the original extract—which gave a much higher order of potency for the irritability substance found in the extract, than that claimed by Hesse.

As control, the effect of introducing pure distilled water to the incision by means of a pipette was tested, and an identical dropping of the pulvinus was observed. While the liquid drop is still hanging, the pulvinus recovers and in this state the addition of a fresh drop does not induce any response. But if the liquid dries up, placing of a fresh drop of water will cause the pulvinus to fall. This is probably a wound effect ; the proposed method cannot therefore replace the Mimosa test method developed by Fitting, Umrath, and others. For further experiments with irritability substances, the latter method will be followed.

The electric disturbance accompanying the transmission of excitation by solutions containing irritability substance has been investigated. An inci-

is introduced between the incision and the pulvinus. A drop from an extract of irritability substance is placed on the incision—it is found that a monophasic current of galvanometric negativity accompanies the fall of the pulvinus. Without the use of a fast recording galvanometer, it will not be possible to establish whether the electrical disturbance precedes or follows the mechanical response—the interpretation will be different, according to one or other of the above alternatives is observed.

Mechanism of transport of synthetic auxins in leaves of plants — It has been observed that the auxin 2, 4, dichlorophenoxy acetic acid (2, 4, D) which is both a growth regulator and a herbicide ; when introduced at the tip of the leaf of a young bean plant, produces after sometime a bending of the stem, to which the leaf is attached, in a direction away from the leaf. The velocity of translocation of the substance has been found to be retarded, if the leaf is deprived of facility for synthesis of carbohydrates either by keeping the leaf in darkness or by circulating over the leaf air from which CO_2 has been removed.

The experiment was repeated in the Institute using in place of 2 4 D, Methoxone, a methyl substitution product of the former. A mechanical recorder was used to find the exact time and extent of bending of the leaf. In general the decrease of the velocity of translocation was observed when the experimental leaf was kept in darkness. It was however observed that the bending of the stem was not always in the expected direction, which made its mechanical recording difficult.

Electric correlate to geotropic response in plants — It is known that when a growing plant is placed horizontally, the stem bends upwards (negative geotropism) while the root tip bends downwards (positive geotropism). It has further been observed that an electric field is always associated with the curvature, so that the convex side is always negative to the concave side. Since J. C. Bose investigated these phenomena, it has further been discovered that if the tip of the growing plant is removed the geotropic response is absent, though, as Shrank has observed, the electric field is still present. With an intact plant Shrank has observed that while the electric field is set up within five minutes of the plant being placed horizontally, the mechanical bending occurs about 20 to 30 minutes later.

The fact that the electrical field is not dependent on the presence of the growth substance, shows that it is not caused by the latter. It suggests the possibility of the geotropic effect being classed under the general laws of response to stimulation in plant and animal organisms *viz.* that there is a perceptive organ which converts the stimulation into an electric excitation, and a chemical reaction is either activated or its concentration is selectively altered in the electric field, which produces the resulting mechanical response.

Shrank's investigations are being repeated to test the validity of the above hypothesis. Both the electric and the mechanical responses are being

Growth phenomena in Cinchona plants — A grant-in-aid has been received for investigations on the physiology of young cinchona plants, specially for the study of the nutritional and environmental factors on which the growth of young cinchona plants depend. As cinchona grows best in a temperate climate, an air conditioned glass house has been constructed for the purpose, and is in operation since the beginning of March. Previous to that such investigations could only be carried out during the winter months. Investigations on the following topics have been planned, some of which are now being carried out

(*i*) Measurement with automatic recorders of both the longitudinal and diametric growth in young cinchona plants raised in ordinary garden soil.

(*ii*) Influence of temperature on growth *e.g.* when the temperature is kept constant in the glass house say at 75°F, and when there is a day and night difference in temperature of about 10°F.

(*iii*) To study the nutritional requirements of the plants, when grown in culture solutions.

(*iv*) The effect of *p*H of the culture solution and of its aeration on growth.

(*v*) Chemical analysis of the leaf materials, taken from plants grown in garden soils and in different culture solutions. This will give indication of the factors on which the mineral uptake by cinchona plants depend, when grown on soil and in culture solution.

(*vi*) Spectroscopic determinations of trace elements in cinchona plants. Later on by introducing these trace elements in different concentrations to culture solutions, to investigate their influence on growth.

Periodicity in growth phenomena — During the last two seasons continuous record of both longitudinal and diametric growth in cinchona plants have been kept, using J. C. Bose's automatic longitudinal and diametric growth recorders. It has been found that there is a long range growth periodicity in cinchona plants, associated with the opening of the apical bud. During this period there is an appreciable increase in the lengths of the first two internodes. It is probable that a growth stimulating auxin is produced in the terminal bud, which when the bud opens is released for diffusion into the lower regions, where growth is then stimulated. This growth ceases after a few days and is revived when a new apical bud opens. Attempt was made to verify this assumption, by making an aqueous extract from a macerated apical bud and applying it with lanoline paste to an internodal region where growth has temporarily ceased. The experiment was inconclusive, and will be repeated under better experimental conditions. Similar long range periodicity in growth has been recorded with two annual plants,

being most pronounced during night followed by either cessation of growth or actual contraction during day light. In the latter case growth appears to take place in pulsations.

Diametric growth has also a diurnal periodicity which is not pronounced ; the diametric expansion at night is followed by a daylight contraction. There is no correlation between the periods of maximum longitudinal extension and diametric contraction. Diametric growth is a very slow process. Growth is associated with the transference of nutrient solutions through the root system to the stem of the growing plant. This translocation usually takes place against the ionic concentration gradient, and requires performance of work by the root system of the plant ; this will be associated with an increase in the rate of root respiration. To test this assumption, an apparatus has been constructed, in which the total CO_2 evolved from the roots of a cinchona plant immersed in a nutrient solution, during 12 periods of each of two hours, is measured. CO_2 free air is bubbled through the nutrient solution, and passed through a battery of 12-Pettenkofer's tubes containing Baryta water. The connections with successive tubes are made at two hours interval by a gas commutator driven by clock work. The apparatus assembled will also be used to measure the effect of varying the degree of root respiration on the growth of cinchona plants.

C. 2. Plant Breeding

Cotton Breeding investigations — This is a scheme financed by the Government of Bengal for 3 years, for evolving long stapled disease resistant types of cotton suitable for cultivation in the deltaic areas of Bengal. This report is for the third year.

During the year, the types grown and studied at Falta total 491, including 22 parent types collected from Lyallpur and Coimbatore ; their crosses, reciprocal, cyclic and multiples, in the F_1, F_2, F_3, F_4 and F_5 generations. The following table gives the lint length, ginning percentage and flowering period of some of our selections from the parent types and their hybrids.

No.	Type	Ginning percentage	Lint length in m.m.	No. of days required for the first flush
1	CO_2	36.8	32.6	82
2	4F	37.5	34.1	79
3	920	34.6	32.1	82
4	LSS	35.0	33.0	67
5	CO_4	35.2	34.0	73
6	CO_2-4F(F_5)	37.5	34.1	57
7	920-4F(F_5)	36.2	35.2	77
8	LSS-4F(F_5)	34.4	32.2	70
9	CO_4-LSS(F_5)	33.2	33.1	66

A comparison with the last year's table shows that in the case of the types like Co_2 and 920, due to further selection, an increase in lint length, ginning percentage and earliness were obtained during the year under report. In addition, one type Co_2-4F(F_5) showed remarkable earliness, *i.e.* it flowered on the 57th day, while the parents took 82 and 79 days respectively. But the yield in this type is not very satisfactory and efforts are being made to increase this factor, by suitable back crossing.

The progenies of a fuzzless mutant obtained during the previous year were studied this year. It was observed that there was a grading of the fuzz character and detailed investigations are being undertaken to determine the number of genes involved.

Paddy—Manurial experiments — Manurial experiments in paddy were laid out in 5 replications in the Experimental Station, Falta, and in an adjacent plot rented for the purpose. The effects of $(NH_4)_2\ SO_4$, K_2SO_4 and superphosphate were studied on the variety *Bhasamanik*, at the rate of 80 lbs., 40 lbs., 20 lbs., and 10 lbs., each chemical, mixed together.

The following are the results :

No.	Quantity of manure	Yield per acre in the Experimental Station plot			Yield per acre in the rented plot		
		Mds.	Srs.	Chhts.	Mds.	Srs.	Chhts.
1	80 lbs.	41	34	10	36	30	13
2	40 lbs.	43	28	5	34	19	10
3	20 lbs.	43	21	9	34	12	9
4	10 lbs.	39	25	9	34	13	7
5	no manure	40	1	2	32	21	13

It may be mentioned that the cultivator's yield in the locality is from 30 — 32 mds. per acre. The difference in yields obtained from the experimental and rented plots, either without manuring or with equal amount of manuring, is probably due to the fact that in previous years manurial trials were undertaken in the former and which had left some residual effects. The negative correlation between yield and degree of manuring in experimental plot 4 and 5 may be due to statistical fluctuations associated with small sample trials. Further investigations are planned for next year, which will include a soil analysis of the different experimental plots.

Jute—irradiation experiments

(1) *X-raying of the dry seeds* — This is a scheme financed by the Indian Central Jute Committee and the work under report is for the 3rd year.

As in the previous year, the seeds of the four economic types of jute, *viz.* D.154 and D.386 of *Corchorus capsularis* and C.G. and R.26 of *C. olitorius* were irradiated in the dry state, each type X-rayed for 4, 6 and

at the Experimental Station at Falta. Field data was taken of the germination percentage from day to day, the vigor of the plants in the field and the maximum heights and basal diameters attained by the plants.

The following table gives the maximum heights and basal diameters in the control and the treatments in all the replications. It may be mentioned here that in all the cases listed below, the same plant does not combine the maximum height and basal diameter. It was also observed that the germination continued upto 14 days after sowing, which may be attributed to the abnormal climatic conditions during the sowing period of 1947.

Variety	Treatment in hours	Maximum heights (in feet and inches)	Maximum basal diameter (in inches
D. 154	Control	12′ 11″	2.4″
D. 154	4	13′ 6″	2.0″
D. 154	6	13′ 2″	2.5″
D. 154	8	12′ 11″	2.8″
D. 386	Control	12′ 2″	1.4″
D. 386	4	12′ 6″	1.2″
D. 386	6	12′ 4″	1.3″
D. 386	8	12′ 6″	1.4″
C.G.	Control	17′ 9″	1.2″
C.G.	4	17′ 4″	1.3″
C.G.	6	16′ 9″	1.2″
C.G.	8	17′ 3″	1.9″
R. 26	Control	19′ 5″	1.7″
R. 26	4	22′ 6″	1.8″
R. 26	6	19′ 6″	2.2″
R. 26	8	20′ 5″	1.9″

It will be seen from the above table that some of the irradiated plants gave a greater height and basal diameter than the controls. Their performances during the X_2 and X_3 generations will have to be studied.

It may be mentioned that 5 of treated plants in R.26, flowered and were ready for retting at the end of the 7th week, while the controls took 15 to 16 weeks. The seeds from these plants will again be grown in the X_2 generation to study their behaviour.

Two plants in the C.G. treated lots also flowered much earlier *i.e.* at the end of the 11th week, while the controls took the usual time of 15-16 weeks.

The following additional morphological peculiarities are worth mentioning :

(*a*) In one irradiated plant of D.154 one branch of a bifurcation had

while the other branch was normal. This is suspected to be a haploid branch and the buds were fixed for cytological study. The flower did not open or set seeds.

(*b*) The usual types of branching mentioned in the earlier report, were observed again.

(*c*) In one treated plant of C.G. a lateral branch flowered very early (about the 7th week) while the main stem continued its vegetative activity.

(2) *Cytological studies* of the flower buds of the selected plants are being continued. In general, the following meiotic abnormalities were noted (*a*) unequal number of chromosomes at the different poles (*b*) lagging bivalents and univalents at I and II Anaphase (*c*) restitution nucleus (*d*) meiotic bridges involving 1, 2, 3, or 4 chromosomes or chromatids at anaphase I and II and (*e*) cytomisis.

(3) *Ultra-violet treatment* — Preliminary experiments were conducted during the year, using a mercury arc lamp as the source. All the four types mentioned earlier were germinated in pots and the seedlings exposed to the rays for 10, 15, 20, 30 and 45 minutes daily for 3 consecutive days.

There was no effect on the seedlings when the exposures were below 15 minutes, but above this dose the margins of the leaves curled inwards. In the lower doses, especially, where the exposures were not continued, some of these leaves regained their original shapes. But in others these leaves dropped off and the growing points of the stems also appeared to be affected. These curled leaves were fixed for anatomical studies to find out the nature of the changes involved.

A number of such seedlings were planted in the ground and their final heights and basal diameters were measured. These are being tabulated, but it seems that there is a positive effect in certain treatments.

Cinchona—Cytogenetical investigations — In November 1947, nearly 50 lots of *Cinchona ledgeriana* and *C. succirubra*, both flower buds and root tips were fixed at Mungpoo after preliminary aceto-carmine smearing, for determining the time of division. These materials are being microtomed for cytological studies.

Miscellaneous — Investigations have been undertaken to study the nature of the nucleus, if any, in one of the unicellular nitrogen fixing organisms isolated from the soil by the Microbiologist to the Government of West Bengal. Different fixing, smearing and staining methods are being tried in this connection.

AUDITED ACCOUNTS

An analysis of the income expenditure accounts of the Institute for the

Income	1945-46	1946-47	1947-48
From Trust Fund	38,836 7 3	32,233 15 3	48,287 5 0
Central Government Grant	29,515 2 10	46,023 5 0	65,027 0 0
Central Government Grant for D.A.	6,820 0 0	9,894 0 0	22,335 9 9
Grants-in-aid	28,691 0 6	47,884 15 7	62,118 8 9
Expenditure (total)	1,34,187 0 6	1,51,892 13 9	2,14,901 3 0
Deficit	17,084 5 11	25,750 9 11	11,267 0 6

The deficit incurred during 1945-46 was recouped from the Government, according to the agreement to meet net deficit incurred any year upto a maximum of Rs. 66,000. According to the same agreement the Central Government has paid during 1947-48, Rs. 19,973 for deficit incurred during the previous year. As this deficit was partly due to the non-realisation of interest on securities due for 1946-47 within that year, the net deficit of Rs. 4,536-13-8 has been debited to the Trust Fund Account for 1947-48. The net deficit incurred during 1947-48, after deducting the advances made to the different grant-in-aid schemes of Rs. 4,305-2-3, is Rs. 11,267-0-6 ; it represents a normal increase in the working expenditure, and should be recouped by an additional grant from the Government.

Gm

APPENDIX

I. MEMBERS OF THE GOVERNING BODY :

LADY ABALA BOSE
DR. DEBENDRAMOHAN BOSE
MR. SUDHANSUMOHAN BOSE
MR. SURENDRAMOHAN BOSE
MR. SUDHIR KUMAR MANDAL
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. MANDAL
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, C.P.
DR. D. M. SEN, Ph.D., Educational Adviser to the
Government of India.

III. FINANCE COMMITTEE :

MR. B. M. SEN, Chairman (Offg.)
MR. SURENDRAMOHAN BOSE (on leave)
MR. G. RAJAGOPAL, Accountant General, West Bengal.
DR. D. M. BOSE, Director.

IV. BUILDING COMMITTEE :

DR. D. M. BOSE
MR. SURENDRAMOHAN BOSE (on leave)
MR. B. M. SEN (Representative of the Council)
MR. A. N. MITTER (Representative of the Governing Body)

V. STAFF :

DEPARTMENT OF PHYSICS :

Head of the Department—Director.
Research Fellow—S. R. DAS, M.Sc.
Research Scholar—N. K. GANGULY, M.Sc.
Attached workers—PROF. H. P. DE, M.Sc. P.R.S. (Vidyasagar College)
S. P. DUTT, M.Sc. (Vidyasagar College)

DEPARTMENT OF CHEMISTRY :

Head of the Department—PROF. J. K. CHOWDHURY, Ph.D. (Berlin)
Research Fellow—DR. B. BANERJEE, Ph.D. (Mun.)
Birla Scholar—AMIYA KUMAR ROY CHOWDHURY, M.Sc., P.R.S.
Research Scholar—ANIL CHANDRA GHOSH, M.Sc.

DEPARTMENT OF BOTANY :

Head of the Department—DR. K. T. JACOB, Ph.D. (Lond.)
Research Fellow—DR. B. K. KAR, Ph.D. (Leipzig)
Special Scholars—B. K. PALIT, B.Sc.
B. K. DUTTA, B.Sc.
A. T. GUHA THAKURTA

DEPARTMENT OF MICROBIOLOGY :

Research Fellow—vacant
Guest worker—DR. P. K. DE, Ph.D. (London)

DEPARTMENT OF PHYSIOLOGY AND ZOOLOGY :

Research Fellow—DR. J. P. SIRCAR, M.B., Ch.B. (Edin.) and also in charge of the workshop
Special Scholar—G. C. BHATTACHARYA

DEPARTMENT OF ANTHROPOLOGY :

Research Fellow—S. S. SARKAR, M.Sc.

Staff appointed under grant-in-aid schemes :

1. COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH—

(*a*) Ultrasonic generator—
INDRALAL CHAKRAVORTY, M.Sc.

(*b*) Positive Ray discharge apparatus—
A. N. BANERJEE, M.Sc.

(*c*) Atomic Research—
Senior Research Assistants—

Junior Research Assistant—
INDRALAL CHAKRAVORTY, M.Sc.
Analytical Chemist—
BYOMKESH SARMA, M.Sc.

(*d*) Desulphurisation of Coal—
PHANI BHUSAN DUTTA, M.Sc.
NIKHIL BHUSAN CHANDA, M.Sc.

2. INDIAN CENTRAL JUTE COMMITTEE—

(*a*) Production of suitable mutants in Jute by X-ray irradiation—
Cytologist—KANTILAL CHOWDHURY, M.Sc.
Radiologist—D. P. DUTTA, M.Sc.

(*b*) Impregnation of bleached jute yarns with suitable synthetic resins—
J. M. SARKAR, M.Sc.
H. C. NANDI, M.Sc.

3. COTTON COMMITTEE—

(*a*) In charge of plant breeding—
A. K. ADHIKARI, M.Sc.
Biophysicist—A. M. NAHA, M.Sc.

4. CINCHONA SCHEME—
Cytologist—MISS DIPTI GHOSH, M.Sc.
Chemist—RAM PRASAD CHATTERJEE, M.Sc.