REPORT

OF

THE BOSE INSTITUTE

FOR

1951 — 52

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Obituary

We have to record with deep sorrow the passing away of Lady Abala Bose, the widow of Acharya Jagadish Chandra Bose, on April 25, 1951 at the advanced age of 86. Her last appearance at a meeting took place on March 26, 1951, when in spite of increasing weakness she decided to attend the annual meeting of the Council of the Bose Institute.

Lady Bose associated herself actively in all her husband's dreams and projects for the revival of the spirit of free enquiry and scientific research in this country and which found culmination in the foundation of the Bose Institute in 1917. She was a foundation member of the Governing Body and of the Council of the Bose Institute and since the death of Acharya Jagadish Chandra, she often presided over the deliberations of these bodies. By her advice, by her presence at the meetings of the Council and Governing Body and by her readiness to contact and interest important personages in the affairs of the Bose Institute she contributed largely to the expansion and smooth working of the Institute.

An attractive personality with wide sympathies, Lady Abala Bose devoted herself to the cause of women's education and amelioration of their social and economic conditions. The *Nari Siksha Samiti*, of which she was the Founder and Secretary for over thirty years, will remain a monument to her untiring activities for the betterment of the lot of widows and distressed women of Bengal.

Governing Body

There were two meetings of the Governing Body of the Institute. Prof. S. K. Mitra, Ghosh Professor of Physics, Calcutta University, was elected a member of the Governing Body in the place of the late Prof. N. C. Nag.

The following members were nominated under sections 12(I) (a) and 14 of the Regulations as representatives of the Governing Body on the Council for a period of three years:

Messrs. S. C. Mukherjee, S. M. Bose, S. K. Mandal, B. M. Sen, K. N. Chatterjee, S. K. Mitra and A. N. Mitter.

Council

Two meetings of the Council were held during the year. The composition of the Council was renewed with effect from September, 1951, the names of the members of the new Council are given in the Appendix.

The anthropological instruments belonging to the recently abolished anthropological department of the Bose Institute were taken over by the Calcutta University at an agreed price.

A certain number of important books on anthropology belonging to the Institute Library were, on request, presented to the Calcutta University.

Capital and recurring grants

The following capital grants were received during this year:

Trustees of Sir J. C. Bose Trust Fund No. 1	Rs.	50,000/-
Government of India for building purposes	,,	20,000/-
Government of India for purchase of apparatus	,,	20,000/-

Out of the grant received from the Trustees Rs. 40,000/- was earmarked for building purposes, and Rs. 10,000/- for equipments.

The following recurring grants were received:

Government of India ...	Rs.	1,50,000/- (annual grant)
Government of India (for training in research) ...	,,	5,545/1/9
Other grants-in-aid ...	,,	96,229/-/9

Laboratory extensions

The new laboratory constructed on the top of the Institute hall has been fitted into a number of research rooms, all of which are now in use. The set of one-storied rooms to the south-west corner of the Institute quadrangle has been demolished and on the site a two-storied structure is under construction. The cost of erection has been estimated at Rs. 90,000/- for which grants amounting to Rs. 60,000/- have been received. The Government of India have been asked for an additional grant of Rs. 30,000/-.

At Mayapuri, Darjeeling, a laboratory and a glass house has been fitted up for investigations on potato virus disease and for soil microbiological investigations. Proximity of several Government potato seed farms and the co-operation of the authorities in their charge is facilitating the applied side of these investigations. It is proposed to station a team of cosmic ray investigators at Mayapuri when the

apparatus like pressure ionisation chamber, square Wilson chamber etc. at present being constructed and tested in Calcutta are ready for use.

Preliminary survey undertaken has shown the feasibility of erecting high altitude cosmic ray stations in the neighbourhood of Darjeeling within the reach of mechanical means for transport of necessary machineries and supplies.

The investigations which have been started in Darjeeling are of an exploratory nature, and have already yielded promising results. The Institute can take up other plant pathological investigations like the *furka* disease of cardamom which is one of the economic plants of the Darjeeling district.

The eastern Himalaya is the home of many medicinal plants. A great amount of valuable investigations on the seasonal variations in the alkaloid contents of different families of these plants and the most suitable methods of curing them for transport purposes can be undertaken from the Mayapuri Research Station. For putting the latter on a permanent footing will require additional grants both capital and recurring from authorities interested in these applied biological investigations. The present income of the Institute is being fully utilized for the maintenance and extension of the work being carried out in Calcutta and Falta.

Agricultural Experiment Station, Falta

In previous reports attention has been repeatedly drawn to the necessity of acquiring additional agricultural land for the Falta Experiment Station. The Government of West Bengal have recently agreed to acquire for the Bose Institute about fifty-eight bighas of *khasmahal* land near the Falta Fort area, at an estimated cost of about Rs. 48,000/-. The Government of West Bengal will contribute one-third of the cost of land acquisition, and the Trustees of Sir J. C. Bose Trust No. 1 have generously agreed to provide the balance of the sum necessary for the purpose.

Grant-in-aid Schemes

The list of schemes of investigations receiving grants-in-aid from different authorities is given in Appendix.

The negotiations carried out during the year with the ICAR and the Director of Agriculture, West Bengal, regarding the financing of a five years' scheme of investigations on weed-killers have been satisfactorily concluded. The Institute will receive a total grant of

Rs. 88,500/- extended over five years, of which payment of a sum of Rs. 17,000/- for the first year has been already approved.

Acharya Jagadish Chandra Bose Memorial Lecture

The thirteenth lecture of the series entitled "Statistical Methods in National Development" was delivered by Prof. P. C. Mahalanobis, F.R.S. on 30th November, 1951. The lecture has been printed along with the Director's Report presented to the 34th Anniversary meeting of the Bose Institute, at which Dr. H. C. Mookerjee, Governor of West Bengal, presided.

Other Lectures

Lectures were delivered in the Institute by Prof. H. J. Muller, N.L. of the Indiana University (U.S.A.) on "Mutation and its artificial production"; by Dr. J. H. Kane, Director of the Biochemical Research and Production Division, Chas, Pfizer & Co., Inc., U.S.A. on "Terramycin and other newer antibiotics" and by Mrs. J. B. S. Haldane on "Speciation in Salamanders".

A symposium on "Cosmic Rays" was held in which the delegates to the 39th Session of the Indian Science Congress participated.

Prof. Satio Hayakawa of the Osaka University, Japan, stayed in the Institute premises for 3 months as a Visiting Lecturer. He was invited by the University of Calcutta to deliver the "B. B. Roy Memorial Lectures" for 1951.

Visitors

H. E. Sri Mangaldas Pakvasa, Governor of Madhya Pradesh and party ; Prof. J. B. S. Haldane, Professor of Biometry, London University ; Dr. H. Kihara, Professor of Botany, Kyoto University, Japan ; Dr. E. Bullard, Director, National Physical Laboratory, London ; Dr. L. E. Howlett, Director of Applied Physics, National Research Council, Canada ; Mr. A. J. Philpot, Secretary, British Scientific Instrument and Research Association ; Mr. G. D. Clifford, General Secretary, British Institute of Radio Engineers ; Mr. Maurice Macmillan of Messrs. Macmillan & Co., Ltd. ; Mr. Percy Evans, Chief Geologist, Burma Oil Co., London ; Dr. O. A. Hoeg, Director, Birbal Sahni Institute of Paleobotany, Lucknow ; Dr. H. J. Bhabha, Director, Tata Institute of Fundamental Research, Bombay ; Dr. Eric Ashby, Vice-Chancellor, The Queens University, Belfast and other delegates to the Commonwealth Inter-University Conference, India ; members of the Chinese Cultural Delegation headed by Dr. Ting-Si-lin ; and delegates to the 39th Session of the Indian Science Congress held at Calcutta.

Staff Changes

Dr. J. P. Sircar, in charge of the workshop, retires on May, 2, 1952, from his post of Research Fellow in Physiology which he has been holding, barring for a break of few years, since the foundation of the Bose Institute in 1917. He was largely responsible for the construction of many apparatus and precision instruments recently turned out from the Institute workshop.

The Council has appointed Sri Mihirlal Chatterjee, Manager, Instrument Research Company, as Workshop Superintendent and Dr. J. P. Sircar has been appointed Special Officer for one year.

Dr. Amitabha Sen, M.SC., PH.D. (Leeds), Chemist, Bird & Co., was appointed Research Fellow in Physical Chemistry.

Dr. B. Banerjee, who was granted study leave as an Overseas Scholar of the Government of India, returned to India in October last, after a year's work at the Max Planck Institute at Heidelberg with Prof. Richard Kuhn and at the Freiberg University with Prof. G. Hesse.

Sri Sunanda Bose, Sir J. C. Bose Research Scholar resigned and joined the Institute of Genetics at Lund (Sweden) to work under Prof. A. Muntzing. Sri D. P. Burma of the Department of Chemistry has been awarded the D.Phil. degree of the Calcutta University.

Dr. Amalendu Ganguly was appointed an ICI Fellow of the National Institute of Sciences of India to work on virus investigations at Mayapuri, Darjeeling ; Sri Samir Kar was appointed a research assistant for this work.

The following appointments have been made under the Government of India grant for training in Scientific Research:

Sri R. K. Bose (Senior Scholar)—Chemistry ;

Sri C. R. Raha (Junior Scholar)—Chemistry ;

Sri Apurba Kumar Ghosh (Junior Scholar)—Botany ;

Sri Satyabrata Sarkar (Junior Scholar)—Botany (from August-December, 1951) ;

Sri Ajoy Kumar Guha (Junior Scholar)—Chemistry ;

Sri V. N. Gadgil (Junior Scholar)—Botany.

Sri Satyabrata Sarkar has been appointed Sir J. C. Bose Research Scholar in Botany.

Dr. B. Sarma was appointed Senior Scientific Assistant, National Chemical Laboratory, Poona.

Sri D. P. Dutta was appointed Senior Scientific Assistant, Fuel Research Institute, Digwadih (Dhanbad).

Sri B. C. Mukherjee is appointed Radiologist in the scheme for research on the "Effect of X-ray etc. on Jute Seeds" in place of Sri D. P. Dutta.

Sri J. M. Sarkar was appointed Senior Chemist, Sindri Fertilizer Factory, Sindri.

Sri A. C. Ghosh, Research Scholar, was appointed Research Assistant in the scheme on "Impregnation of jute fibres with suitable synthetic resins" in place of Sri J. M. Sarkar.

Sri S. P. Dutta resigned his appointment in the scheme under Board of Research on Atomic Energy and was permitted to continue his investigations as an attached honorary worker.

Prof. C. D. Allen (Chemistry) of Scottish Church College, Sri Radhabinode Mazumdar (Botany) of Vidyasagar College, Miss Madhuri Dutta (Botany) and Dr. (Mrs.) Santi Batra (Botany), of Lady Brabourne College, were permitted to work in the respective laboratories as attached honorary workers.

Miss Chinmoyee Das Gupta and Sri Anil Kundu worked in the Microbiology Section.

A. PHYSICS

A. 1. Measurement of Ultrasonic Power Output

The output of ultrasonic power of a quartz crystal of 6.25 sq. cms. in area and .287 cm. in thickness, excited under a given input of 0.9 kv. e.m. energy of frequency 1 megacycle/secs., was measured by calorimetric method. For this purpose a vessel containing about 8 litres of transformer oil is taken. The crystal transducer, a 500-watt immersion heater, a mechanical stirrer, and a Beckmann's thermometer, to read temperature to 1/100th of a degree, are dipped into the oil bath. The oil bath with all the above-mentioned elements is calibrated by varying the wattage supplied to the heater. The power is measured by means of sub-standard voltmeter and ammeter. For each set of power-input to the heater, the corresponding value of $\triangle T/\triangle t$ is noted where $\triangle T$ represents rise in temperature and $\triangle t$ represents time in seconds. A curve is drawn with power-input against $\triangle T/\triangle t$. The curve so obtained is a straight line passing through the origin. Now keeping all the elements same, the crystal is set into vibration and the value $\triangle T/\triangle t$ is noted. The value of $\triangle T/\triangle t$ for crystal was found to be .2. From the graph the corresponding value of the power for 0.2 ($\triangle T/\triangle t$) is noted, from which the ultrasonic power output of the crystal was found to be 150 watts. The experiment is being repeated taking further precautions.

A.1.1. A D.C. amplifier circuit with a photo-electric cell as receiver has been constructed, which will be used to study the following problems:

(a) the relative intensity of light diffracted in different orders in a liquid medium traversed by ultrasonic radiation,

(b) absorption of ultrasonic radiation in liquids,

(c) variation in width of diffracted lines with intensity of ultrasonic radiation.

A.1.2. The construction of a pulse generator of ultrasonic radiation is progressing. The following components have been constructed:

(a) A pushpull oscillator circuit of estimated output of 200 watts and frequency of 9 mc/s; by changing the self-inductance coils in the circuit, the frequency can be altered from 1 mc/s to 18 mc/s.

(b) Pulsing circuit to pulse the oscillator.

(c) Multivibrator to introduce necessary time delay in the transmitted pulse.

(d) Driver amplifier has been completed. The crystal-controlled master oscillator is under construction.

The following require to be assembled before the circuit is complete for investigation:

(e) A timing oscillator to synchronize the different parts.

(f) A receiving unit, which has been partly constructed.

A. 2. High frequency positive ray discharge tube

Investigations have been carried on during several years to develop a positive ray discharge tube in which a continuous flow of H_2 gas is maintained under conditions such that a maximum production of hydrogen atom ions takes place, and for the best focussing of the atom ion beam on a target placed at the further end of the discharge tube. The ultimate aim was to replace the hydrogen by heavy hydrogen and to suitably accelerate the deuteron ions on a heavy hydrogen containing compound on the target with a view to the production of neutrons. After experimenting with different arrangements recommended in various publications, it was found that the method of production of atom ions by means of high frequency discharge was the most satisfactory. A three-stage h.f. generator of power-output 200 watts at 20 mc/sec. has been used to circulate the discharge through a solenoid wound round the discharge tube. Using an extracting voltage further improvement of ion source has been recorded during the period under review. It was stated in the last report that 36% of atomic ions was obtainable

in a total beam current of 60 μ A. By further reducing the surface of metallic electrodes within the discharge tube and exposing a flat cathode surface for extraction of the ions the atomic ion percentage was increased to 60% in a total beam current of 174 μ A using 2.2 kv. as the probe extraction voltage. The ion beam after extraction from the h.f. generator tube is subject to a D.C. acceleration field and made to strike a heavy ice target.

A direct current voltage source for 60 kilovolts has been set up with a transformer, kenotron rectifier and a bank of condensers. The resulting voltage has a fluctuation of 3% for a current load of 200 microamperes. Arrangement for doubling this voltage source in a Cockroft Walton multiplier circuit has been planned and will be put into effect as soon as suitable condensers required for the purpose are available.

A double-walled Monel metal chamber has been designed and constructed for maintaining with the help of suitable refrigerants a heavy ice target for bombardment by the accelerated ions. This target holder is fixed to the end of the vacuum discharge tube.

A.2.1. High voltage generation with r.f. current : An experimental arrangement for the production of voltage multiplication using a r.f. source has been set up. The source of power is a valve circuit oscillating at 100 kc/sec. The circuit was designed to produce 50 kv. in 10 stages ; the high Q coils inducing 5 kv. and delivering 50 watts. At present a voltage of 20 kv. has been obtained. At this point several corona discharges have been found to occur. The coils are being re-wound to allow a better distribution of voltage to minimise losses. Necessary circuit changes are also being made for obtaining the power for filament heating of the rectifier tubes from the first tube output, rather than from the high voltage winding, to ensure more stable operation of the source.

A. 3. Cosmic ray investigations

A.3.1. Study of cosmic ray bursts : A new small (vol. = 1.9 litres approx.) pressure ionisation chamber has been assembled for the study of cosmic ray bursts. The chamber is filled with argon at a pressure of about 200 lbs. per sq. inch. It is intended to investigate along with air-showers the phenomenon of nuclear bursts. With this end in view, arrangements have been made to set up a G. M. counter telescope on the top and bottom of the chamber. From an analysis of the bursts as recorded both by the counter system and by the ionisation chamber, it will be possible to differentiate bursts produced by air showers originating outside the chamber from those originating within the material of the chamber wall or within the gas volume. At present

continuous record is being kept of the bursts produced, and the dependence of size frequency distribution of the two components resulting from extensive air-showers and cosmic-induced nuclear disintegration as function of barometric pressure is being studied.

A.3.2. Continuous cosmic ray intensity measurements at sea level : In order to study variations in cosmic ray intensities of low magnitude, which includes diurnal variations, a 40 litre ionisation chamber which will be filled with pure argon at 800 lbs. pressure, has been constructed and is at present being tested for leak and insulations. A Lindemann electrometer will be used with it for continuous record of ionisation ; with the pressure ionisation chamber used previously, variations only up to 2 per cent could be detected. With the new chamber, statistical fluctuations in ionisation current intensity will be reduced below 0·25% and thus it will be possible to detect variations in cosmic ray intensity of the order of 0·5%.

A scaling circuit (scale of 64) has been constructed for use with a counter telescope arrangement for measurement of cosmic ray intensity.

A.3.3. Construction of an electromagnet for cosmic ray investigations : This has been found essential for all quantitative work. An electromagnet has been designed mainly along lines similar to those employed in the M.I.T. (Cambridge). The electromagnet will consist of six coils, each of 200 turns. They will be wound on two brass frames, three coils on each frame. All the coils will be demountable and will work independently of each other. The pole-pieces will consist of two conical pieces of soft iron the distance between which can be adjusted from 4″ to 8″. One of these will be made hollow, to allow for photography. The copper tapes for the coils have already been rolled from 99·5% pure copper. The brass frames have been completed with water-flowing arrangement. When completed this magnet will give a field of 8,000 to 10,000 gauss in a space of 8″ in diameter and 6″ deep, consuming electrical power of about 25 kilowatt. The magnet will be used with a small cloud chamber for the study of energy spectrum of decay electrons.

A.3.4. The study of rare phenomena in cosmic rays requires the use of a large cloud chamber. For this a square cloud chamber has been constructed in the workshop and at present being tested. This chamber will be used for the study of nuclear interaction of cosmic rays and will be fitted with an assembly of 12 lead plates of ¼″ thickness. A new stereoscopic camera has been built for this large chamber. The design of this camera is such that both views can be photographed in a single film, by which reprojection is made easy.

A paper containing some calculations on the momentum loss of low energy mesons in lead have been completed and will soon appear in the *Transactions of the Bose Research Institute*.

An electronic circuit to control the big square chamber has been wired up. The circuit has a fourfold function. It

(1) makes a fast expansion of the chamber by discharging a large capacity through the L.R. coil by means of a SN_4 tube.

(2) produces the light flash with a desired delay adjustable from 10 milliseconds to 100 milliseconds with respect to the expansion.

(3) makes the sweeping field off for 5 seconds.

(4) switches the camera motor on with the help of a relay.

A stabilised power giving a current of 200 ma. necessary for the above-mentioned circuit has also been constructed.

The control circuit has been put to test and found to work satisfactorily. The flash lamp power and triggering circuit has also been constructed.

A scaling circuit (scale of 32) with a built in power supply is under construction, and a four channel coincidence and an addition-circuit is being designed.

B. CHEMISTRY

B. 1. Chromatography

The techniques of column chromatography and paper chromatography which have been fully developed in these laboratories have been applied with success in various fields of plant biochemistry and inorganic chemistry.

B.1.1. Application of the technique of paper chromatography in the study of nitrogenous substances in the Rhizobium-legume symbiosis:

The technique of two-dimensional paper chromatography has been standardised and suitably modified for application in investigations on nitrogen-metabolism of plants. This technique has been successfully applied to the qualitative separation of the nitrogenous substances in the nodules, roots (of nodulated plants) and sterile roots of plants grown on nitrate-N. The following amino-acids have been detected—aspartic acid, glutamic acid, serine, threonine, tyrosine, glycine, asparagine, γ-alanine, β-alanine, γ-aminobutyric acid, valine tryptophan and leucine. There is at least one unknown substance present only in the nodules with a very high R_F value with phenol-water and low R_F value with benzyl alcohol-acetic acid-water. An unidentified substance was also present in both roots and nodules. The occurrence of γ-aminobutyric acid not known to occur in plants until recently and of β-alanine, is interesting at least in view of their relationship with glutamine, and aspartic acid respectively. The occurrence of both aspartic and glutamic acids in the nodules and the greater concentration of the latter than the former (as it appears from more intense spots) may indicate glutamic acid being the primary amino-acid synthesised and consequently ammonia as the key intermediate in the N-fixation process, with α-ketoglutaric acid acting as the acceptor. The similarity of amino acids in the nodules and roots of plants having different sources of nitrogen indicate a common path-way of synthesis of amino acids though initial products may be different. In the roots of plants grown on nitrate-N the concentration of the amino acids is greater than those having molecular-N as the nitrogen source. This may possibly be due to the amino acids being more quickly metabolised to protein in the case of plants utilising molecular-N or the variation in conditions obtaining in experiments with plants grown in water-cultures and those in field conditions.

B.1.2. Paper chromatography in the study of sugar-constituents of jute hemicellulose:

The sugar-constituents of polyuronide hemicellulose of jute have been determined by the technique of paper chromatography.

The method of extraction of polyuronide hemicellulose from jute was as follows. Since ordinary jute and delignified jute produced identical chromatograms, delignification before the extraction seemed unnecessary. Jute bast was separated mechanically from the stem and cut into small pieces. These were boiled with 5% ammonium oxalate solution for about 8-10 hours to remove pectic substances. The residue was washed, dried and then mixed thoroughly with 5% NaOH solution (about 10 times its volume) in a mortar, the paste filtered and the filtrate acidified with glacial acetic acid. Hemicellulose was precipitated with alcohol from the acidified solution. The polyuronide hemicellulose so obtained was refluxed with 2·5% H_2SO_4 at 100°C for 6-8 hours on an oil bath. The hydrolysate was neutralised with $BaCO_3$, $BaSO_4$ removed by filtration and the solution evaporated to dryness in vacuo. The residue was extracted with minimum quantity of pyridine to remove salts etc., centrifuged and the pyridine-extract chromatographed on paper, ·02-·04 c.c. of the solution sufficing for each chromatogram.

One way descending chromatography was carried out with phenol-water, butanol-acetic acid-water, benzyl alcohol-acetic acid-water in specially constructed chambers. Aniline hydrogen phthalate as well as benzidine were used as spraying agents. The sugars were identified from their R_F values ; standard sugars were run side by side as well as along with the hemicellulose-hydrolysate to confirm their identities. The following sugars have been detected: glucose, fructose, arabinose, galactose, xylose, rhamnose and probably mannose. Two unidentified spots of low R_F values with phenol (·05 & ·22) have been obtained by application of considerable amount of hydrolysate on filter paper. Two-dimensional chromatography is in progress.

Peculiarly enough, no spot corresponding either to galacturonic acid or glucuronic acid has been detected, neither in the pyridine-extract nor in the aqueous extract. This is perhaps due to their decarboxylation and subsequent conversion to arabinose and xylose during hydrolysis. Their isolation and subsequent detection on the paper chromatogram are in progress.

B.1.3. Separation of a mixture of lithium, sodium and potassium hydroxides by chromatography :

The technique of column as well as paper chromatography has been successfully applied for the separation of alkali hydroxides (LiOH, NaOH, and KOH).

'Whatman cellulose ashless powder' was found to be a suitable adsorbent for column chromatography and ethyl alcohol containing 15-20% water as the developing solvent. Since the chromatographed substances were colourless, fractional elution as well as indicator additional methods were employed for ascertaining the positions of the bands. According to the former the eluate was collected in various fractions and each fraction examined both with an alkali indicator (phenol red or bromthymol blue) as also a special reagent for each. According to the latter a suitable alkali indicator was added to the developing solvent so as to indicate the positions by coloured bands. A more or less uniform packing of cellulose powder into the glass column was effected by pouring a thick slurry of the cellulose powder in ether and removing the ether under suction. For a satisfactory separation 0·1 c.c. of the mixture in which the strength of each alkali is approximately 0·1 N was used. The cellulose column was 6·5 cm. long and 1 cm. in diameter. On developing the column with about 30 c.c. of alcohol (containing 15-20% water) the mixture separated into three distinct bands, the uppermost band was constituted of lithium hydroxide, the middle one of potassium hydroxide and the lowest diffuse band of sodium hydroxide.

The separation of alkali chlorides has already been effected by means of paper chromatography, but the R_F values of the hydroxides of the alkali metals on paper chromatogram with ordinary solvents were found to be too low and close to each other (*e.g.*, with alcohol containing 10% water R_F's of LiOH, NaOH and KOH are 0, 0·3 and 0·3 respectively) to be of any practical use for their separation. An increase in water-content of the solvents no doubt increased the R_F values but those of potassium and sodium hydroxides were still too close. The method of continuous development for long hours was, therefore, adopted and found to be expedient, following the descending way on Whatman No. 1 filter paper and using alcohol containing 15% water. For the purpose of indication the dried filter paper was sprayed with a suitable indicator (phenolphthalein for higher concentrations of the alkalis and phenol red or bromothymol blue for lower concentrations). With phenolphthalein the alkali hydroxides were visible as red spots and with phenol red they appeared as orange spots and with bromothymol blue as greenish blue spots, both on yellow background. After 24 hours' development the alkali hydroxides were found to just separate, lithium hydroxide moving little, potassium hydroxide about 3 to 5 cm. and sodium hydroxide about 6 to 8 cm.; in 36-48 hours' time all the three were found to be fairly well separated from each other. In the absence of solvent-boundary the R_F values could not be measured ; further, the distance travelled by each greatly depended on the original concentration of the solution used.

The diffuse character of the spots on the filter paper and the dependence of their rates of movement on the concentrations of the alkalis is evidently due to the adsorptive property of cellulose of the filter paper. It is clearly so in the case of column chromatography when cellulose powder has been used. The significance of the adsorptive capacity of cellulose has been emphasised by us as well as by other workers.

B.1.4. Separation of Uranium, Thorium and Rare earth by filter paper chromatography :

The investigations reported last year has been continued. About 11 different solvents were tried. With the following three, U, Th and Rare earth, ions can be completely separated from one another.

(*i*) Ethyl acetate + 8·5 N acetic acid (1:3)
(*ii*) Amyl alcohol + 8·5 N acetic acid
(*iii*) Ether and glacial acetic acid
(*iv*) Ether + concentrated nitric acid

All these four solvents can be employed for separation of these three groups (Th, U, Rare earths) by one-dimensional paper chromatography. The aim of this investigation is to employ the columnar chromatography method for separating Thorium and Uranium from Rare earths present in an extraction from Monazite sand. As the worker in charge has left the Institute ; the results obtained so far is being published in the *Transactions of the Bose Research Institute*.

B.1.5. Application of Microphoretic technique for the separation of uranium and thorium:

Application of this method to the separation of U from Th of which a preliminary account was given in the last report, was continued. About 50 experiments were performed but no clear separation between the traces of the two cations on the filter paper could be obtained. There is always a diffuse band left by each extending over a few cm. in length. The method was not found suitable and has been abandoned.

B. 2. Exploration of plant materials to find physiologically active products

Natural sources particularly plants, in which India is so very rich, can provide us with suitable chemical intermediates which may be converted into important physiologically active compounds. Cortisone and other biologically active steroidal compounds have been obtained from sapogenins isolated from plants belonging to the families of Dioscoreaceae, Scrophulariaceae, Apocynaceae, Amaryllidaceae, Papilionaceae, Liliaceae, etc.

In an attempt to obtain such important steroidal sapogenins, common onion, was used as the starting material. Onion bulbs were minced to pieces and was dried in enamel trays for a period of 10-15 days. The volatile matters were thereby mostly removed. The solid which remained behind was introduced into flasks and was left covered with petrol ether to remove fatty matters. The ether was decanted off and the residual solid was extracted thoroughly and exhaustively with rectified spirit. Seven to ten extractions were necessary for completion of the extraction. The residue was rejected. The filtrates were concentrated under vacuum and was cooled in a refrigerator. Solids separated out. This was washed with ether. The mother liquor yielded practically no more solids.

INVESTIGATIONS OF THE ISOLATED SOLID:

The solid :

(*i*) melts at 150°-160°C in the crude state.
(*ii*) does not effervesce with $NaHCO_3$ solution.

(*iii*) is soluble in dilute hydrochloric acid.
(*iv*) gives positive tests for glycosides.
(*v*) gives precipitates with alkaloid reagents.

Purification of the solid isolated above.—

The solid was dissolved in the minimum of water and was treated with lead acetate to remove pectins, tannins, proteins etc. The small amount of precipitate formed was removed by filtration. This precipitate is under chemical investigation. The filtered liquid was deleaded by hydrogen sulphide, filtered and the filtrate which gave no further precipitate with hydrogen sulphide was concentrated under vacuum to yield a white solid.

Physiological tests .—

This substance

(*i*) is active against *Staphylococcus aureus*.
(*ii*) has inhibitory action on frog's heart in a concentration of 0·4% solution.

B. 3. Chemistry and Microbiological studies of jute fibres

B.3.1. Microbiological investigation on the retting of jute:

Retting of jute being essentially a microbiological process, efforts were made to isolate various strains of bacteria and fungi both from the retting water and the retted plants. Retting water was collected from various places at different intervals of time. Dilution up to 10^6 was done of the retting water thus collected. Successive agar platings in different media were then made from higher dilutions. By repeating the process more than once several pure cultures of bacteria and fungi were isolated. They were then studied individually for their activities on jute plants in aseptic condition.

Nutrient agar and nutrient agar with jute extract were used for aerobic bacteria and the same media together with glucose were used for anaerobic bacteria. Potato-dextrose agar and Czapek-Dox agar media were used for fungi. Aseptic media for studying the activity of the isolated strains were made with jute stems sterilised at low steam pressure in very dilute solution (0·1%) of ammonium sulphate.

Eighteen different strains of bacteria and six strains of fungi were isolated in pure condition of which six strains of bacteria and one of fungi were found to be active in retting jute. In particular, the strain of fungus was the most active.

Attempts are being made to isolate more of the active strains and also to characterise the micro-organisms already isolated.

B.3.2. Biochemical studies on the breakdown products of the different constituents of jute fibres:

The retting process causes the breakdown of the different constituents binding the fibres in jute by the micro-organisms which help in separating the jute fibre from the bast. Attempts were made first to isolate different constituents from jute plants and then to study the effect of different hydrolysing agents on them.

Extraction of pectin from jute bark.—

The washed dried jute bark was extracted with 5% ammonium oxalate at 110°-112°C for 12 hours. The pale yellow extract was concentrated to a small volume and poured in excess of alcohol acidified with hydrochloric acid when a pale gelatinous precipitate slowly separates out. After standing for 24 hours, it was filtered and washed with graded strengths of alcohols acidified with hydrochloric acid and finally with ether. By repeated solution in water and precipitation with acidified alcohol it was obtained as almost white gel.

Extraction of hemicellulose from jute.—

This substance was obtained from fibre separated from jute bark by purely mechanical means without previous retting. Pectic substances were removed from the bark by repeated extractions with boiling ammonium oxalate (5%) solution. The residue after washing with water and ethanol was extracted twice with 5% sodium hydroxide solution. The filtered extract was acidified with glacial acetic acid and the hemicellulose was precipitated with ethanol. The precipitate was well washed and dried from ethanol.

Preparation of pectinase from active strains of retting fungus.—

The pectinase preparatives from the active strains of fungus isolated in our laboratory were made from dried bran cultures of the same. Samples of the cultures were extracted with distilled water adjusted to *p*H 5·6. The enzyme was precipitated either by the addition of 5 vol. of 95% aqueous ethanol or 70% ammonium sulphate per 100 ml. of the extract.

The precipitate obtained on addition of ethanol was collected by centrifuging and then taken up in small quantity and filtered. The precipitate was taken in a minimum quantity of water to a dialysing sac and dialysed overnight against tap water to remove the ammonium sulphate. The sac contents were then filtered and used directly, since attempts to prepare an active dried preparation were not successful. Of these two methods, precipitation with ammonium sulphate usually gave the more active preparation.

In our work pectin from jute and citrus pectin were treated with enzyme preparations. The degraded products were then subjected to paper chromatography techniques for their identification. In case of both the pectins, galacturonic acid has been found to be the final product. Jute pectin, in addition to galacturonic acid, gave another substance, the identification of which is at present being investigated.

Polyuronide cellulose isolated from jute by the above method was hydrolysed with normal sulphuric acid and the resulting sugars were identified by the method of chromatography. Jute hemi-cellulose was found to contain arabinose, xylose, galactose, glucose, mannose and rhamnose together with traces of two other substances, the nature of which is under investigation.

The degraded products of other constituents (both enzymatic and chemical) of jute are being studied (*vide B.1.2.*)

*B.3.3. Analysis of R. 26 (Control) and Tall Mutant Jute fibre**:

The mutant plants were obtained from X-ray irradiated jute seeds of R.26 strain. A comparative study is being made on the nature and chemical composition of the retted fibres from sets of control and mutant plants.

About 1½ feet from the lowest part of jute and some 3-4 feet from the upper part were rejected. The fibres freed from woody matter were cut into small pieces and defatted with alcohol-benzene and dried. Lignin, holo-cellulose and α- cellulose were estimated.

I. Estimation of Lignin

Table I

Estimation of Lignin

Expt. No.	Variety	Wt. of dry and defatted jute (gm.)	Wt. of lignin (gm.)	% of lignin on dry and defatted jute	
1	Tall mutant	.9989	.1077	10.78	10.90 (mean)
2	Tall mutant	.9925	.1091	10.99	
3	Tall mutant	.7501	.0822	10.95	
4	R.26 Control	.9995	.1062	10.61	10.81 (mean)
5	R.26 Control	.9906	.1122	11.32	
6	R.26 Control	.9954	.1048	10.52	

* For details regarding the field performances of the Tall mutant and R.26, see Section *C.2.2.1* pp. 33-36.

II. Estimation of Holo-cellulose

Table II

Estimation of Holo-cellulose

Expt. No.	Variety	Wt. of jute taken (dried and defatted)	Wt. of delignified fibre	% of holo-cellulose on dried and defatted jute		% of lignin on dry and defatted jute (by difference)
1	Tall mutant	1.000 gm	89.41	89.41	89.45 (mean)	10.59
2	-do-	1.000 gm	89.43	89.43		10.57
3	-do-	1.000 gm	89.65	89.65		10.35
4	R.26 Control	1.000 gm	89.62	89.62	89.49 (mean)	10.38
5	-do-	1.000 gm	89.64	89.64		10.36
6	-do-	1.000 gm	89.11	89.11		10.89

III. Estimation of α-Cellulose

Table III

Estimation of α-cellulose

Expt. No.	Variety	Wt. of holo-cellulose	Wt. of α-cellulose	% α-cellulose on holo-cellulose	% α-cellulose on dried and defatted jute	
1	R.26 Control	.3986	.2684	67.33	60.22	60.45 (mean)
2	-do-	.4233	.2872	67.84	60.68	
3	Tall mutant	.8640	.5897	68.25	61.07	61.35 (mean)
4	-do-	.3813	.2626	68.88	61.64	

IV. Estimation of Hemi-cellulose

Table IV

Estimation of Hemi-cellulose

Expt. No.	Variety	Wt. of holo-cellulose	Wt. of α-cellulose	Wt. of hemi-cellulose	% hemi-cellulose on holo-cellulose	% hemicellulose on dried and defatted jute	
1	R.26 Control	.3986	.2684	.1302	32.66	29.21	28.98 (mean)
2	-do-	.4233	.2872	.1361	32.15	28.75	
3	Tall mutant	.8640	.5879	.2743	31.74	28.46	28.12 (mean)
4	-do-	.3813	.2616	.1187	31.13	27.85	

V. Estimation of Moisture

Table V

Estimation of Moisture

Expt. No.	Variety	Wt. of moist jute (in gms)	Wt. of dried jute (in gms)	% of moisture		Average
1	Tall mutant	.8058	.7233	10.23		10.24
2	-do-	.5859	.5258	10.25		
3	R.26 Control	.8707	.7794	10.48		10.42
4	-do-	.6587	.5904	10.36		

VI. Estimation of Ash

Table VI

Estimation of Ash

Expt. No.	Variety	Wt. of dry jute (in gms)	Wt. of ash (in gms)	Wt. of ash on dry jute	Average
1	R.26 Control	.8884	.0080	.90	.915
2	-do-	.3943	.0037	.93	
3	Tall mutant	.8987	.0076	.84	.825
4	-do-	.8992	.0073	.81	

The analytical studies of R.26 control and Tall mutant jute fibres given in the above tables can be summarized as follows:

(i) The lignin content of Tall mutant was found to be very slightly higher (about .09%) than that of R.26 control sample.

(ii) The difference between the holo-cellulose contents of the two samples was negligible. The value of the Tall mutant was .04% higher than that of R.26 control.

(iii) The α-cellulose content of Tall mutant was found to be higher (about .09%) than that of R.26 control

(iv) The hemi-cellulose content of Tall mutant sample was found to be lower (.86%) than that of R.26 control.

Though the differences as shown above are very small yet they appear to be systematic.

B.3.4. The impregnation of bleached jute yarns with suitable synthetic resins:

Methods for the impregnation of jute yarns with suitable synthetic resins with a view to improving its wet strength have been described in previous reports. It has been stated therein that best results are obtained with melamine-formaldehyde resins. A brief report of further progress is given below.

The degree of bleaching and removal of lignin have, generally speaking, profound influence on impregnation. Initial experiments (done in previous years) showed that bleaching with sodium chlorite gave better improvements in wet-strength. But sodium chlorite is a costly and difficultly available reagent, hence we are using bleaching powder in two or three stages, with and without pre-treatment, so as to get maximum improvement in wet-tensile strength after resin impregnation. We are collecting more data with a view to evolving appropriate bleaching and impregnation methods. We are also on the search of new and more water-resistant types of resin *e.g.*, Silanes, Amino-silanes, Ethylene-immine besides Melamine-formaldehyde as impregnating agents. Considerable improvements in wet-strength have been achieved with Amino-silanes used in conjunction with Urea-formaldehyde resin.

The effect of pre-treatment and the degree of bleaching on the wet-strength of treated yarns are being investigated. The residual lignin in the bleached fibre is estimated by standard methods while the amount of resins in the impregnated yarns has been estimated by the determination of nitrogen. We are also trying to simplify the technique and processes involved. In this connection, it may be stated that the process of preparing melamine resins has been somewhat simplified by using melamine-formaldehyde resin aged for 48 hours without the use of curing agent $(NH_4)_2HPO_4$. The results obtained are shown in the following table (p. 21).

The mode of resin deposition in the fibre and its possible chemical combination with the constituents of yarns are being investigated by microscopic examination of transverse sections.

General yarn Ref. No.	Pre-treatment	Bleaching agents employed	Special yarn Ref. No.	Impregnating agents	Curing agents	Single-thread strength
C's of B_3S_4	2% alcoholic-pyridine	Bleaching powder in two stages	C	Unbleached control	X	9.9±0.24
			C'	Bleached control	X	3.0±0.26
			C'a	4.5% M.F. after 24 hrs.	$NH_4H_2PO_4$	5.6±0.30
			C'b	4.5% M.F. after 48 hrs.	X	6.0±0.28
			C'd	4% U.F. + Amine Silane (1%)	X	5.2±5.21
C's of B_1S_4	Without pre-treatment	Bleaching powder in two stages	C''	Bleached control	X	4.4±0.21
			C''a	4.5% M.F. after 24 hrs.	$(NH_4)_2HPO_4$	5.8±0.15
			C''b	4.5% M.F. after 48 hrs.	X	6.0±0.23
			C''d	4% U.F. + 1% Amino Silane	X	5.2±0.27

* U.F. = Urea formaldehyde resin.
M.F. = Melamine formaldehyde resin.

C. BOTANY

C. 1. Plant Physiology

C.1.1. Effect of Auxins on Respiratory Systems of Avena Coleoptile :

In last year's report it was pointed out that the constant volume Warburg respirometer was constructed and the calibration of the different manometric systems prior to final work was well under way. During the year under review the calibration of the instruments with the old large flasks was completed and flask constants for each set of manometer at different temperatures varying from 30°C to 40°C was determined.

Experiments were then undertaken to study the respiration of avena coleoptile tips under normal and variable experimental conditions. Avena coleoptiles were selected as being the material fairly sensitive to external application of auxins, a property which has made it a natural choice in most of the work connected with auxin type of plant hormones.

At the onset it was necessary to establish the standard conditions under which the oxygen uptake by the coleoptile tissue would represent the true respiration of the tissue, and be independent of any mechanical factor like rate of shaking, quantity of respiring tissue and the rate of diffusion of oxygen in the suspending fluid. Experiments were, therefore, conducted with different quantities of avena coleoptile tips and at different rates of shaking. It was found that the combinations given in TABLE I were satisfactory as being free from any mechanical effect (see p. 27).

The rate of shaking varied from 90 strokes per minute to 130 strokes per minute and it was found that within the range up to a maximum of 40 tips per flask corresponding to about 9-10.5 mg. of dry matter respired satisfactorily. The oxygen uptake was not affected by the rate of shaking or by the length of strokes and thus indicating its independence of diffusion of the gases in the suspending fluid. With progressive increase in the quantity of tissue the oxygen uptake per hour varied from 67 µl for 20 tips to about 85 µl for 40 tips as indicated in TABLE II (see p. 27).

The figures in Table II represent an average of about 30 determinations and a variation in the length of strokes within the above-noted limits did not seem to have any significant effect upon them. (A smaller length of stroke, however, appeared to have a little adverse effect on oxygen uptake).

The medium used for suspending the respiring tissue was either an M/100 solution of KH_2PO_4 or an equal part mixture of M/100 solutions of KH_2PO_4, $MgSO_4$, and $Ca(NO_3)_2$ adjusted to *p*H 6.4. Either of the media was found to be equally effective under these conditions.

For the study of the effect of Indole-acetic acid on the endogenous oxygen uptake by avena coleoptiles, the generally adopted condition was to study with 30 tips of 72 hours old coleoptile, each having a length about 10 mm. respiring at a temperature of 30°C. The flasks were shaken at the rate of 120 strokes per minute. The tissue was suspended in 4.0 ml. of M/100 KH_2PO_4 solution. Suitable quantities of an 1 in 10,000 solution of IAA was taken in the side arm and at the end of an hour, when the rate of oxygen uptake by the tissue was found to compare favourably with normal respiration, the IAA solution was mixed with the main solution. The quantity of IAA solution used to be such as on mixing the suspending solution had an IAA concentration of 1 in 50,000, 1 in 100,000 or 1 in 500,000. Normal controls were run under identical conditions for comparison.

The IAA in all cases was found to stimulate the rate of endogenous oxygen uptake of the coleoptile tissue. Some typical figures are given in TABLE III (see p. 27). It may be noticed from the Table that IAA in all the concentrations studied did stimulate the respiration, and the increase in oxygen uptake in an unit period of 15 minutes varied from 28.4% with an IAA concentration of 1 in 500,000 to 34.9% with 1 in 50,000.

The flasks that were used so far were of fairly large volume and consequently the pressure change due to a small quantity of gas exchange was not sufficient. It was, therefore, desired to work with smaller flasks so that the sensitivity of the system increased. Warburg flasks of smaller sizes has since then been blown and fitted up with standard manometers. These have been calibrated and their flask constants at different temperatures have also been worked out. Preliminary experiments with these new sets of respirometers have been conducted and found to confirm the trend of previous findings though the values are somewhat different quantitatively.

During the current year it is contemplated to study the effect of IAA and other heteroauxins on the oxidative enzyme systems of avena coleoptile and also on the oxidative-deaminase systems. For precise study a scheme has been prepared to obtain the different enzymes in more or less purified state and thus to study them under conditions free from the interfering influence of others and also in different combinations and permutations. Some work has already been reported on the effect of auxins on a few dehydrogenase systems and although, of late, plant biochemical literature contains valuable contribution on the enzyme systems in avena coleoptile and their sensitivity to different respiratory inhibitors like, azide or fluoride,

little work has so far been done to correlate the auxin metabolism with respiration. Moreover, oxidative deamination seems to form an important step in the biosynthesis of IAA from tryptophan and successful isolation of these enzymes and their study is likely to throw new lights on the question of the origin and role of IAA in plants.

C.1.2. Study of Phosphate Compounds and Associated Enzymes in Plants :

The role of different organic phospho-esters in energy transfer as different intermediates in the process of glycolysis is now a well-emphasized and carefully studied subject in animal biochemistry. It is generally believed that more or less similar reactions take place in plants as well. This idea is corroborated by the existence of different phospho-intermediates of glycolysis in plants. Recently attention has been drawn to the importance of phosphates in plant biochemistry through the work of Umbreit and others and also of the Bonner school of workers, who have made a careful study of the relationship existing between organic and inorganic phosphates in plants during the early stages of growth. Considering the special significance of organic and inorganic phosphate compounds in systems requiring a supply of high level of energy, it is worthwhile to take up the study of different organic and inorganic phosphate compounds in plants and the enzyme systems associated with them. The role of compounds like ATP in the muscular contraction has been well elucidated and from the postulated analogy in the two systems, study of phospho-compounds is likely to yield important information about the mechanism of energy transfer in plants like *Mimosa* and *Desmodium*.

With this object in view a study of phosphate compounds in plants has been taken up. Considering the delicate nature of the problem and the small quantity in which phosphate compounds are encountered in natural plant material, prime consideration was centred round standardising the methods of separation and estimation of the different intermediate organic phospho-compounds which are likely to be involved in the series of study. This part of the work has been taken up. Work on this section has been greatly benefitted and stepped up with the acquirement of the new 'Beckman Spectrophotometer' which has been set up and standardized. The method of estimation of total phosphorus, inorganic phosphorus and organic phosphorus in plant materials has been standardized and at the time of writing this report work is on way to standardize the method of separation, identification and estimation of the different organic phospho-compounds in plants. As a study material avena coleoptile is being used at the moment.

A standard method for the different estimations is likely to be established soon and it is contemplated to take up a detailed study of the different phospho-compounds in growing plant materials like avena coleoptiles, pea-embryo, excised root tip tissue and also in plant materials like the active pulvini of *Mimosa* etc.

C.1.3. Studies on the Growth of Excised Plant Tissue :

Excised plant tissues like root-tip, stem-tip or embryo, growing in isolation from the rest of the plant offer a simple and complete physiological system, comparatively free from external interference and thus form suitable test materials for the study of many problems associated with growth, proliferation and metabolism. With this bearing in mind, the study of carbohydrate and amino-acid metabolism has been taken up using excised root tip, stem-tip and embryo tissue. Similarly, a scheme is being drawn for the study of abnormal non-differentiated growth in plants using gall tumour tissue as test materials.

The study of excised root tip tissue has been successfully taken up. Early attempts were made to establish the standard conditions for the growth of such tissue. For this purpose work was started with three different varieties of tomato of which two proved to be quite satisfactory.

The different conditions conducive to the growth of excised root tip tissue through successive stages of transfer have been studied and a procedure has been standardized with which it has now been possible to grow the excised root tips through stages. In all cases the growing tissue is always found to be healthy and vigorous. A number of clones have been obtained from which further growing tissue can be produced. It has been noted that for proper growth the nutritive solution should have an initial p_H of 5.0 and the culture must be maintained at a temperature of $25^{\circ}C \pm 1^{\circ}C$. With one set of the tissue, studies in amino-acid metabolism has been taken up.

It is contemplated to take up later the problem of growing excised stem tips and excised embryo tissue. The problem of growing gall tissue is being taken up. Preliminary study of literature relevant to the problem is being made and in the meantime gall-producing plants like Bryophyllum, *Vinca rosea* and Sunflower are being grown.

C.1.4. Effect of Concentration and Mode of Application of β-Indole-acetic acid on Tobacco and Tomato :

Repeating the work done last year to find out the effect of external supply of the naturally occurring plant hormone, β-indole-acetic acid, on the growth and metabolism of tomato and tobacco, seeds of three

varieties of tomato and two varieties of tobacco were sown in seed beds in the middle of November, 1951, and transplanted in the field during the 3rd week of December. When the plants were found to have adapted to the transplantation, they were divided into five different groups for different treatments. Two different concentrations of IAA (0.005% and 0.01%) were used and sprayed on the leaf surface (avoiding the stem tip) in one series and on the soil around the base of the plants (root region) in another series. In each variety, there was a series of plants as untreated controls. Spraying was started about one month after transplanting and was done four times each at intervals of one week. Growth of the tomato plants, their vigour, flowering, fruiting, nature of the fruits etc., were studied. The moisture content of the ripe tomato fruits was determined by drying portions of the fruit in an air-oven set at a temperature of 105° ± 1°C till constant weight. The sugar content, expressed as dextrose, was determined by S. W. Cole's ferricyanide-methylene-blue method. The ascorbic acid content was determined by the usual method of titration against a standard solution of 2-6 dichlorophenol indophenol.

From a study of their performance there appears to be some significant increase in growth and vigour of the tomato plants treated with IAA. In two varieties of tomato early flowering and early maturation of fruits have been obtained. As regards the contents of moisture, free sugars and ascorbic acid in the fruits there does not appear to be any significant differences, but the application of IAA seems to increase the total yield of fruits as regards their number and total fresh-weight.

The tobacco were sprayed at the 3-5 leaved stage in the end of January with the same two concentrations of IAA, some on leaves and some on the soil. Spraying was done four times each at intervals of one week.

The plants were harvested in April and the lengths of their stems and roots, the total leaf-area as well as their dry weights were determined. The nicotine and sugar content of the dry leaves are under analysis.

From an analysis of the data it appears that there is some definite increase in the vigour and yield of tobacco with external supply of IAA. The differences in response due to the two different concentrations and the two modes of application do not entirely agree with previous year's findings although there seems to be a close similarity in the trend. It is, however, worth noting that the growth of the plants was not so satisfactory as in the last year. This might be due

to the soil condition of the plot. A careful repetition of the study next year may be as desirable before the results could be published.

Results of the experiments in an abridged form are appended in Tables IV-VII (see pp. 28-29).

Table I

Conditions for the Respiration of Avena Coleoptile Tips

Temp.	Vol. of suspending liquid/flask	Max. Quantity of tissue/flask	Rate of shaking Stroke/minute	Length of Strokes
25°C-40°C	4.0 ml-5.0 ml	No. Dry wt. 40 10.5 mg.	90-130	20 mm.-40 mm.

Table II

Respiration of Avena Coleoptile with different mass of tissue and at different time

No. of Tips	Dry wt. in mg.	μl of O_2 taken up in		
		60 minutes	120 minutes	180 minutes
20	5.6	67.0	134.0	202.0
30	8.0	80.0	157.0	240.0
40	10.5	85.0	166.0	252.0

Table III

Effect of I.A.A. on the Respiration of Avena Coleoptile Tips

Coleoptile tips		I.A.A. conc.	μl of O_2 absorbed at different times						
			Time in minutes						
No.	Dry wt.		30	60	75	90	120	150	180
A									
30	8.2	1-in 50,000	47	90	99	129	187	245	303
30	8.1	,, ,,	47	87	103	126	167	208	251
B									
30	7.6	,, 100,000	45	92	110	142	199	251	288
30	7.9	,, ,,	44	84	107	128	167	205	239
C									
30	8.3	,, 500,000	36	70	80	113	157	203	243
30	7.8	,, ,,	35	68	84	103	134	169	202

Table IV

HARVEST DATA OF TOMATO VAR. SUTTON'S "BEST OF ALL"

Treatments	Total number of plants in the treatment	Date of flowering in 50% of the plants	Total number of plants bearing fruits	Total number of fruits	Total fresh wt. of all the fruits	Average fresh wt. of a single fruit
0·005% I.A.A. on leaves	10	16.2.52	5	13	272·7	20·9
0·005% I.A.A. on soil	10	9.2.52	5	14	350·5	25·0
0·01% I.A.A. on leaves	9	9.2.52	7	10	198·0	19·8
0·01% I.A.A. on soil	10	9.2.52	5	6	122·8	20·4
Untreated Control	10	26.2.52	1	2	43·7	21·8

Table V

HARVEST-DATA OF TOMATO VAR. SUTTON'S "HARBINGER"

Treatments	Total number of plants in the treatment	Date of flowering in 50% of the plants	Total number of plants bearing fruits	Total number of fruits	Total fresh wt. of all the fruits	Average fresh wt. of a single fruit
0·005% I.A.A. on leaves	10	9.2.52	6	18	284·4	15·8
0·005% I.A.A. on soil	8	23.2.52	3	7	74·6	10·7
0·01% I.A.A. on leaves	8	16.2.52	5	11	106·3	9·6
0·01% I.A.A. on soil	9	23.2.52	4	8	110·5	13·8
Untreated Control	9	23.2.52	4	3	58·0	19·3

Table VI

YIELD-DATA OF TOBACCO VAR. "HARRISON'S SPECIAL" (1952)

Treatments	Total number of plants in the treatment	Average leaf number per plant	Average leaf-area per plant	Average fresh wt. of leaves per plant in gms.	Average dry wt. of leaves per plant
0·005% I.A.A. on leaves	6	11	102·6	22·9	2·74
0·005% I.A.A. on soil	5	11	115·4	30·3	3·06
0·01% I.A.A. on leaves	4	16·5	221·0	53·3	6·15
0·01% I.A.A. on soil	2	17·5	256·2	69·3	6·93
Untreated Control	4	7	26·5	6·6	0·92

Table VII

TOBACCO—WHITE BURLEY

	Total number of plants in the treatment	Average leaf-number per plant	Average leaf area	Average fresh wt.	Average dry wt.
A	3	13·3	562·0	133·7	12·5
B	3	11·7	501·5	125·7	11·5
C	3	10·0	312·9	73·8	6·7
D	3	8·7	247·9	57·6	5·5
Control	3	10·3	382·7	89·7	8·4

C.1.5. Turgor variation in the pulvinus of Mimosa pudica due to contractile response :

A device has been made by which the expulsion of sap due to contractile response of *Mimosa pudica* can be observed with a micro-potometer. The mechanical response and the expulsion of sap has been simultaneously recorded on a smoked glass plate. It has been possible for the first time to demonstrate practically the expulsion of sap from the pulvinus of Mimosa due to its contractile response, though it has previously been suggested by different workers to be due to turgidity variation. By this method it will also be possible to estimate quantitatively the amount of water expelled by pulvinar contraction.

C.1.6. Autonomous Pulsatory Movement of the Leaflet of Oxalis acetosella :

The autonomous pulsatory movement of the leaflet of *Oxalis acetosella* was automatically recorded with a single lever oscillating plate diurnal recorder. A full-grown mature leaflet was found to produce about eight pulses during twenty-four hours without any stoppage at night, whereas, a young one stopped pulsating at night and resumed at day. Similar to previous observation made on *Desmodium* the nocturnal stoppage of pulsation of the young leaflet of *Oxalis acetosella* disappeared by application of 1% glucose and reappeared with the withdrawal of the same. The conclusion arrived at is that the young leaflet stops pulsating because of its incapability of building sufficient carbohydrate reserve for the supply of energy at night ; this insufficiency can be supplemented by direct application of glucose.

C.1.7. Protein Metabolism in the Excised Leaf :

In a previous communication on the 'Energy mechanism of the pulsatory activity of Desmodium', it was shown that energy of pulsation is derived from photosynthesis, and in an excised leaf under normal variation of light, the depletion of photosynthetic energy at night can be fully compensated by the supply of glucose. In a condition of continued darkness, however, the photosynthetic activity of daylight could not be fully replaced by glucose. This inadequacy of glucose could not be previously properly explained. In the present communication an attempt has been made to interpret it from an analysis of the observations of different workers on protein synthesis in the excised leaf. It has been suggested as an explanation of the particular behaviour of the leaflet in continued darkness, that a rapid depletion of protein occurs in darkness, as evidenced by the yellowing of the leaf, and that light energy is essential in the mechanism of protein synthesis besides that of carbohydrate production. It has also been shown that the conclusion of Chibnall and others that the leaf in the excised condition is not capable of synthesizing protein and that some hormone formed in other part of the plant is necessary, is not applicable in the case of the young leaflet of *Desmodium*.

C.1.8 Experiments on Growth and root Respiration in Cinchona :

Investigations were undertaken with a specimen of *Cinchona ledgeriana* to ascertain the relation between (I) the variation of growth in length of stem and (II) that of respiration of roots of the same specimen.

(I) The diurnal curves of growth were recorded by utilising Sir J. C. Bose's automatic growth recorder for the period 30.6.48 to 28.9.48. The records of growth that have been obtained show that in the majority of cases a higher rate of growth occurred at night and that at daytime there was very little growth.

It has been found further that the rate of growth was not a continuous process but of a pulsatory nature.

(II) Records of respiration were determined simultaneously with that of growth by an apparatus designed and constructed at this Institute. From the observed records of respiration beginning from 30.6.48 to 28.9.48 covering the same period of 90 days as in the case of growth, the amount of respiration is greater at night, *i.e.*, during the period 6 p.m. to 6 a.m. and that during daytime it is less.

It was also found that during the entire period of its growth, the CO_2 evolution as the end product of root respiration was of a periodic nature like that of growth. It was noticed that during the period of

TABLE I

Serial No.	Types	Name of type	Lint length in mm.			Ginning percentage			Average No. of bolls harvested per plant from Jan. to Mar. in each year		
			In 1951	In 1952	Difference from 1951 in 1952	In 1951	In 1952	Difference from 1951 in 1952	1951	1952	Difference from 1951 in 1952
1.	Parent	7682	34·5	33·0	−1·5	36·0	32·8	−3·8	4·8	3·0	−1·8
2.	,,	7682—18i3	36·5	35·5	−1·0	35·5	34·0	−1·5	5·0	5·0	±0
3.	,,	7682—21 × [CO¹ × (SG × S₁)] × 1456	34·8	33·0	−1·8	35·5	36·0	+0·5	4·4	5·6	+1·2
4.	,,	7733D3264 × (CO³ × CO¹) × Russ. Ash × SG. Ash	35·5	33·5	−2·0	35·0	33·8	−1·2	5·0	4·0	−1·0
5.	,,	LSS	33·5	31·5	−2·0	35·5	34·0	−1·5	4·0	5·0	+1·0
6.	,,	4F	34·0	33·5	−0·5	36·2	33·0	−3·2	4·5	5·0	+0·5
7.	,,	920	32·5	31·5	−0·5	37·2	34·8	−2·4	4·0	5·0	+1·0
8.	,,	CO¹	34·5	32·0	−0·5	36	30·0	−6·0	4·5	5·2	+0·7
9.	,,	CO¹ — B40 — 21	34·5	34·5	±0	36·7	32·4	+4·3	3·0	5·2	+1·2
10.	,,	CO³ — 41	34·5	33·5	−1·0	36·6	30·8	−5·8	5·8	6·9	+1·1
11.	,,	CO²	34·5	33·5	−1·0	35·0	32·8	−2·2	5·0	4·5	−0·5
12.	,,	F9	34·5	33·5	−1·0	37·4	36·0	−1·4	4·5	4·5	±0
13.	,,	920 — 4F	35·5	34·0	−1·5	35·0	32·8	−2·2	5·4	5·3	−0·1
14.	,,	LSS — 4F	33·5	30·5	−3·0	35·0	32·4	−2·6	4·1	4·7	+0·6
15.	,,	CO₂ — 4F	32·5	33·0	+0·5	36·0	34·8	−1·2	4·5	3·0	−1·5
16.	,,	7625 — 1 — LSS	34·2	33·5	−0·7	37·5	34·0	−3·5	5·2	5·5	+0·3
17.	F8	7727G3 — 5286 BUL	35·5	34·0	−1·5	37·5	34·0	−3·5	3·3	4·0	+0·7
18.	,,	CO² — 4F	34·5	34·0	−0·5	35·0	34·0	−1·0	3·5	3·7	+0·2
19.	F7	7733 — 8 — 5286 BUL	33·0	32·5	−0·5	35·5	35·2	+0·7	4·0	4·2	+0·2
20.	F6	7733 — 8 — 7625 — 1	32·0	32·5	+0·5	32·5	33·0	+2·5	3·5	4·4	+0·9
21.	,,	7733 — 8 . 7625 — 1	32·0	33·0	+1·0	34·0	31·0	−3·0	3·5	4·1	+0·6
22.	,,	7733 — 8 . 7727G3	34·5	32·0	−2·5	34·0	36·4	+2·4	3·0	3·6	+0·6
23.	,,	6113E₂ . LSS	35·5	33·0	−2·5	32·0	38·6	+6·0	4·6	5·2	+0·6
24.	,,	7733 — 8 . 289F	32·5	30·0	−2·5	35·5	30·0	−5·5	3·5	4·2	+0·7
25.	M_7	(CO² × 4463) . (CO¹ — LSS) 124	33·0	32·5	−0·5	32·6	31·6	+2·0	4·0	4·2	+0·2
26.	Parent	Parbhani-American	30·5	30·0	−0·5	33·7	32·4	−1·3	2·3	3·5	+1·2
27.	,,	Sea Island	30·5	48·5	−2·0	26·5	25·0	−1·5	3·6	1·0	−2·6

measurement covering a period of 90 days there were 5 pulses approximately coinciding with those in the longitudinal growth of the cinchona plants.

C. 2. Plant Breeding and Cytogenetics

C.2.1. Cotton Breeding Investigations :

This is a scheme financed by the Government of West Bengal for evolving long stapled cotton types, suitable for cultivation in the deltaic areas of West Bengal and is in the seventh year of investigation, during the year under report.

During the year, a major portion of the 401 strains grown during the previous season were allowed to continue in the fields for the second year in succession to find how they compare with the first year's crop as regards their (1) lint length, (2) ginning percentage, (3) yield (number of bolls harvested), and (4) incidence of pests and diseases and the results of 27 of the better types (including those of Parbhani-American recommended for cultivation by the State Agricultural Department) are contained in Table I (see p. 31).

It will be observed from the above table that in some of the strains, the number of bolls collected during 1952 were slightly more than in 1951. But this apparent slight increase in the number of bolls in 1952 was offset by the smaller size of the bolls and the tarnished and dirty lint, with the result that the yield in terms of lint was lower. Also the lint length and ginning percentage in most of the types were lower in 1952. In addition, many of the plants were affected with the cotton leaf worm, boll-worm, aphids and stem borers, which generally do not make their appearance if the plants are pulled out after one season. The only advantage in allowing the plants to continue for the second year is the saving in the cost of preparing the field and planting the seeds. But in view of the facts mentioned earlier, it is not advisable to do so, as when the pests and diseases (leaving alone the other factors like lower yield, lint length and ginning percentage) take hold of the crop and are allowed to continue on the plants during the second year, they may establish themselves and prove to be a lasting menace. In this connection, it will be useful to recall that in some States where cotton is cultivated on an extensive scale, in some years the "pest act" is promulgated by which it is an offence to allow the same cotton plants to continue in the field during the second year also.

Attention may also be drawn to the Parbhani-American type which has been recommended to be cultivated in 7,000 acres in West Bengal during the year 1952-53 and listed under No. 26 in the above

table. It will be seen that many of the types detailed earlier have greater lint lengths and higher ginning percentages, in addition to increased yield. From our experience in growing and breeding cotton for over 12 years at our Experimental Farms, we feel that some of our types which have proved superior to Parbhani-American in all respects, should be multiplied and grown in West Bengal. After all, best results can be obtained in cotton cultivation in West Bengal only by breeding types suitable for our soil conditions rather than by importing types which were bred for different environmental conditions.

During the year under report, 39 types were resown in October —about 2½ months later than our usual sowing time—to find out the effects on the flowering and yield etc. in late sowings. These consisted of 23 parent types, 14 hybrids from the F^6 to the F^9 generations and 2 reciprocal and multiple crosses of the hybrid types. It was found that these plants flowered much later.

The 17 irradiated types sown in 1951 were also allowed to continue in the fields in 1952, to study their behaviour and it was found that here also the lint lengths and the ginning percentages were lower in 1952 than in 1951. But compared to the controls, those irradiated types which gave higher lint lengths and ginning percentages continued to do so in the second year also.

During the year under report, fresh irradiations were given to selected types and were sown in the field during the 3rd week in September. At the time of writing up this report (26-4-1952) it has not been possible to analyse the yield and other data fully, but it has been generally noticed that some of the irradiated types appeared to be more vigorous, with bigger bolls etc.

The hybrid types evolved between the tree cottons and the economic types such as 920, 4F, L.S.S. which were in the F^3 generation during the year under report were found to withstand to a greater degree the harmful effects of pests and diseases, when the same plants were allowed to continue during the second year in the fields. Moreover their yields also increased by as much as double in the second year. But the only disadvantage is that their lints were coarser than in the economic types such as 920, 4F and L.S.S. In order to improve this, back crosses have been attempted during the year under report and the results are awaited.

C.2.2. Jute :

C.2.2.1. Irradiation Experiments :

This is a scheme financed by the Indian Central Jute Committee and is in the seventh year of investigation, during the year under report.

(a) Sowing Season of 1951

During this year, the following species and varieties of jute seeds were irradiated in the dry state for 28, 36, 42, 48 and 60 m.a.H., the last being an additional high dose, not attempted earlier. In addition, the seeds of the tall mutant were also irradiated to find out if any better plants could be isolated from the X-rayed progeny.

Corchorus capsularis var.	... D. 154
,, ,, ,,	... D. 386
,, *olitorius*	... C. G.
,, ,,	... R. 26
,, ,,	... Tall Mutant (T. M.)

(b) Germination and Growth

The irradiated seeds were sown in replications at the Experimental Station of the Bose Research Institute, Falta. The spacings given were 1 ft. between rows and 6″ between plants.

Soon after sowing, by the third week in April, 1951, there was a heavy drought which delayed the germination. Then the fields were artificially flooded to a depth of about 4″, when it was found that the germination was very good, in fact much better than in any of the previous years. This method will be tried hereafter, whenever necessary.

During the season, due to the heavy storm in May, 1951, nearly all the tall plants fell down. These could be raised up only two days afterwards due to the muddy nature of the soil. By this time their growing points had already bent, and after raising they bent again and continued their growth, resulting in a zigzag course. This retarded their growth to a certain extent, as in the previous season.

(c) Heights and Basal Diameters

During the year under report the heights of the tallest plants with their basal diameters were measured with special reference to the Tall mutant and its X-rayed progenies. One plant out of the 60 m.a.H. treated population of the Tall mutant attained a height of 21′-7″ as against 20′-9″ in the control and a basal diameter of 1.3″, as against 1.2″; but these differences do not appear to be very marked. The lower doses, on the other hand, resulted in slightly lesser heights with practically the same basal diameter. It appears that for obtaining significantly higher values both in the heights and basal diameters, doses over 60 m.a.H. are necessary and the irradiation programme of the 1952 season has been altered accordingly.

The X2 progenies of these will be grown during the next season to select out the mutants, if any, having desirable qualities.

The average heights of 50 of the tallest plants both in the Control (R. 26) and T. M. were 18′ and 19′-6″ respectively.

It may be mentioned that the average of 50 plants of the tall mutant was only 17 ft. during the previous season, while it is 19 ft. 6 inches during this season—an increase of 2 ft. 6 inches. But the controls also increased from 13 ft. 4 inches to 18 ft.—an increase of 4 ft. 8 inches,—which proportion is greater than in the T. M. This may be due to the fact that while the progenies of the T. M. grown during this season were from selfed seeds, the controls were from N. F. seeds in which there may have been a certain percentage of naturally crossed seeds and these may exhibit greater vegetative activity due to heterosis.

Table II

Variety and Treatment	Flowering period in days (from the first to the last plant to flower in the population)
T. M. Control	107
T. M. 28 m.a.H.	60
T. M. 36 ,, ...	92
T. M. 42 ,, ...	68
T. M. 48 ,, ...	84
T. M. 60 ,, ...	68
R. 26 Control	100
,, 28 m.a.H.	86
,, 36 ,, ...	65
,, 42 ,, ...	84
,, 48 ,, ...	79
,, 60 ,, ...	63
C. G. Control	83
,, 28 m.a.H.	85
,, 36 ,, ...	90
,, 42 ,, ...	83
,, 48 ,, ...	102
,, 60 ,, ...	76
D. 154 Control	45
,, 28 m.a.H.	45
,, 36 ,, ...	41
,, 42 ,, ...	38
,, 48 ,, ...	39
,, 60 ,, ...	39
D. 386 Control	42
,, 28 m.a.H.	46
,, 36 ,, ...	37
,, 42 ,, ...	40
,, 48 ,, ...	41
,, 60 ,, ...	46

During the season, an analysis was made of the flowering period (the number of days that elapse between the earliest flowering plant and the latest flowering plant in a particular replication) of the controls and the treatments to find out if X-radiation has any effect on this factor and the results are contained in Table II (see p. 35).

It will be seen from the above table that both in T. M. and R. 26, the controls take the maximum number of days from the first plant to flower to the last, while in the various treatments the period is much less. If all the plants flower more or less at the same time, or as near to each other as possible, it has a definite advantage in that they mature and are ready for cutting, more or less at the same time. But it will have to be seen how they behave in the subsequent generations before their practical utility can be assessed.

The progenies of the Tall mutant which flowered earlier during the previous season were sown again during this season without any further treatment, when it was found that two of those were later by 9 and 6 days and one earlier by 11 days.

The behaviour of the early types selected during the 1947 and 1948 seasons and carried forward without any further treatments were studied when it was seen that not only these continued to be early but showed improved performances.

As in the previous seasons, the percentage of bifurcated plants both in the controls and the various treatments were again studied during the season under review. The X-rayed progenies of the T. M. exhibited bifurcations like all the other treated *olitorius* varieties. The maximum number of such plants were found in the 48 m.a.H. treatment, where the percentage was 5.69. In R. 26, the highest percentage of bifurcated plants (7.66) was in a lower dose—*viz.* 36 m.a.H. Unlike the previous season, the R. 26 treated plants showed a greater number of bifurcations during this year. In general, the percentage of bifurcations increased with increase in dosage, especially in C. G., where the controls did not show any bifurcations, while the treatments had varying percentages up to 6.64.

In general, the *capsularis* types showed a lesser number of bifurcations than the *olitorius* types.

The percentages of sterile and fertile pollen grains were studied in all the varieties and their treatments, the details of which have been included in the annual report to the Indian Central Jute Committee.

C.2.2.2. Saline Water Experiments :

The acclimatization of Jute to saline water conditions have again been carried out and the year under report is the fourth year for these

experiments. The seeds used in these experiments were those of D. 154 and D. 386 of *C. capsularis* and C. G. and R. 26 of *C. olitorius* and were collected from the controls and the saline water treated plots of the previous season. The following were the treatments given.

Treatment I.—The same as that of last year, *i.e.*, the seeds of the above four varieties from the same treatment of the previous year, were soaked in 5% common salt solution for 3 hours and sown in plots which were previously irrigated with saline water from the Ganges. A second irrigation with saline water was given on the 30th day after sowing.

In D. 154 about 85% and in D. 386, 71% of the seeds germinated, out of which 57% and 41% respectively survived after the second saline irrigation. The initial germination percentage appears to be much better than that of the previous year, when only 50% of the seeds germinated. In C. G. and R. 26, 42% of the seeds germinated, which is slightly better than the previous year's record of 30%. But the survivals after the second saline irrigation were 15% and 18% only.

The flowering and fruiting in the *capsularis* types were normal while they were scanty in the *olitorius* types and the maximum heights attained by the plants in all the treatments and controls are contained in Table III.

TABLE III

MAXIMUM HEIGHT RECORDED IN FT. AND INCHES.

Variety	Control	Treatment I	Treatment II	Treatment III
D. 154	8′ 3″	5′ 4″	6′ 9″	6′ 4″
D. 386	9′ 0″	6′ 2″	8′10″	7′ 8″
C. G.	9′ 0″	4′10″	6′ 0″	5′ 7″
R. 26	7′ 7″	3′ 0″	7′ 1″	6′ 2″

Treatment II.—(Same as that of last year). The seeds collected from the similar experiments of the previous year were soaked in pond water for 3 hours and then sown, the plots being irrigated with saline water from the Ganges 30 days after sowing.

The germination percentages in D. 154, D. 386, C. G. and R. 26 were 94, 90, 75 and 80 respectively as against 90, 88, 70 and 75 in the controls. But the survival percentages in the above types after irrigation with saline water were 75, 80, 30 and 35 as against the controls having 75, 76, 55 and 60%. The flowering and the fruiting were much better than for the similar experiment of the previous season.

Treatment III.—This is a new treatment. In this, the seeds of the above types collected from the 2nd treatment of the previous year,

were soaked in pond water for 3 hours and sown in plots previously irrigated with saline water from the Ganges. A second irrigation with saline water was given 30 days after sowing.

Here, both in D. 154 and D. 386, 76 and 75% respectively of the seeds germinated, out of which 44 and 32% of the plants survived after the second irrigation with saline water. In C. G. and R. 26, 29 and 31% germinated, out of which only 5 and 7% survived the second irrigation. The flowering and fruiting were far below the controls, but the *capsularis* types fared better than the *olitorius* types.

Treatment IV.—Control.

The higher rate of mortality and the lower heights attained by the plants this season as against the previous season, may be due to the droughty conditions which existed during the sowing period. But the general behaviour of the plants in all the types were better than that of the previous year and it was evident that the seeds are getting more and more acclimatized to saline conditions of the soil.

As in the previous season, it has been found that the *capsularis* types are better suited to saline conditions than the *olitorius* types. This may also be due to the fact that normally the former being a low-land type can withstand the effects of water-logging to a greater extent than the latter, which is a high-land type.

C.2.3. Oil-seeds (Sesamum and Brassica):

This is a scheme financed by the Indian Central Oilseeds Committee for inducing mutants with economic characters in Til (*Sesamum*) and Rape and Mustard (*Brassica*) and is in the second year during the year under report.

C.2.3.1. Til (Sesamum):

During the previous season 14 types were X-rayed and grown in the field, out of which 8 types did not grow well and so were discarded. The 6 remaining types found suitable are listed in Table IV. Each type was given three doses of X-rays, *viz.*, 36, 50 and 100 m.a.H. and grown in both the Field Stations of the Bose Institute, at Bamangachi and at Falta, in replicated plots with a control in each plot towards the end of May.

The selected plants from the X-rayed progenies of the previous season were also sown in compact blocks without any further treatments, to study their behaviour in the X2 generation together with their controls.

The percentage of germinations in the various treatments and controls, the growth, the flowering and fruiting data etc., were collected from time to time.

The following table (Table IV) gives the maximum number of fruits collected from the best plants in the controls and treatments, from the various fields:

TABLE IV

Locality	Type	Control & Treatments	Field No. 2	Field No. 7
Berhampore (West Bengal)	No. 10	Control	186	94
		36 m.a.H.	272	154
		50 ,,	302	150
		100 ,,	198	202
Berhampore (West Bengal)	No. 12	Control	71	98
		36 m.a.H.	92	172
		50 ,,	135	120
		100 ,,	85	173
Berhampore (West Bengal)	No. 16	Control	118	57
		36 m.a.H.	178	212
		50 ,,	122	107
		100 ,,	141	62
Berhampore (West Bengal)	No. 20	Control	150	76
		36 m.a.H.	225	204
		50 ,,	163	135
		100 ,,	245	100
Madras	T.M.V. 1	Control	205	
		36 m.a.H.	281	
		50 ,,	601	
		100 ,,	243	
Madras	T.M.V. 2	Control	70	
		36 m.a.H.	80	
		50 ,,	124	
		100 ,,	93	

It will be seen from the above table that the yield (number of fruits) in many of the X-rayed progenies are much greater than in the controls. For example, in Berhampore (Bengal) Type No. 10, in field No. 2, the best control plant produced 186 fruits while one plant in 50 m.a.H. treatment had 302 fruits. In field No. 7, the control had 94 fruits, while a 100 m.a.H. plant had 202 fruits. In Berhampore

No. 12, from field No. 2, the best plant in the control had 71 fruits, against 135 fruits in a 50 m.a.H. treated plant and from field No. 7, the control had only 98 fruits as against 173 fruits in a 100 m.a.H. treated plant. In Type No. 16, from field No. 2, the number of fruits were 118 in the control against 178 in a 36 m.a.H. treated plant and from field No. 7, 57 against 212 also in the same treatment. In Type No. 20 the corresponding figures in field No. 2 and 7 were 150 against 245 and 76 against 204. In the T. M. V. 1, from Madras, one plant from the 50 m.a.H. population gave 601 fruits as against 205 in the control, which is remarkable. This particular plant had a number of branches emanating from the base and bearing fruits. In this particular treatment, there were several other similarly branched plants having a much greater number of fruits than the controls. In T. M. V. 2, the relative figures were 70 in the control against 124 in the 50 m.a.H. treatment.

In general, all the plants listed above from the X-rayed population gave more fruits than the controls and if these continue to behave like this in the subsequent generations without any further treatment, it will be a good achievement.

The yield (the number of fruits) from the X2 population of 1951 (seeds collected from the higher yielding plants of the X1 of 1950 and sown without further treatments and their controls) in Berhampore No. 16 and No. 12 were studied when it was seen that the higher yielding plants of the X1 population of the 1950 season continued to give higher yield in the X2 season of 1951.

As in the previous season, an attempt was made to isolate the plants which flowered early both in the controls and in the various treatments. It was observed that in T. M. V. 1, one plant in the 36 m.a.H. group flowered in 44 days, an earliness of 6 days over the control. In the other two treatments, the earliness is only by two days, which is not significant. But in T. M. V. 2 the two treatments were later this year unlike the previous year when they were earlier by 5 days. But in all the Berhampore types, all the treatments flowered early, the range being from 3 days to 9 days. These will be grown during the next season as X2's without further treatment, to find out if this character is being maintained.

As in the case of the yield data, the early X1 types of the 1950 season were sown in 1951 (X2) without further treatments and their behaviour studied. It was seen that the earliness in many of the types, especially in Type No. 16 from Berhampore was being maintained. It was also observed that in general, the plants flowered earlier in 1951 than in 1950, which may be due to the fact that in 1950, they were sown during the last week of May and first week of June,

TABLE V

Locality	Types	Control and Treatments	Date of sowing	Date on which the first plant flowered	Date on which the last plant flowered	No. of days in between
Berhampore (West Bengal)	No. 12	Control	25-5-1951	15-7-1951	29-7-1951	15 days
		36 m.a.H.	,,	18-7-1951	25-7-1951	8 ,,
		50 ,,	,,	12-7-1951	24-7-1951	13 ,,
		100 ,,	,,	15-7-1951	25-7-1951	11 ,,
Berhampore (West Bengal)	No. 16	Control	25-5-1951	16-7-1951	28-7-1951	13 days
		36 m.a.H.	,,	14-7-1951	22-7-1951	9 ,,
		50 ,,	,,	16-7-1951	23-7-1951	8 ,,
		100 ,,	,,	15-7-1951	23-7-1951	9 ,,
Berhampore (West Bengal)	No. 10	Control	25-5-1951	19-7-1951	25-7-1951	7 days
		36 m.a.H.	,,	18-7-1951	22-7-1951	5 ,,
		50 ,,	,,	17-7-1951	23-7-1951	7 ,,
		100 ,,	,,	16-7-1951	23-7-1951	8 ,,
Berhampore (West Bengal)	No. 20	Control	25-5-1951	16-7-1951	27-7-1951	12 days
		36 m.a.H.	,,	18-7-1951	25-7-1951	8 ,,
		50 ,,	,,	15-7-1951	23-7-1951	9 ,,
		100 ,,	,,	17-7-1951	25-7-1951	9 ,,
Madras	T.M.V. 1	Control	27-5-1951	16-7-1951	5-8-1951	21 days
		36 m.a.H.	,,	10-7-1951	30-7-1951	21 ,,
		50 ,,	,,	14-7-1951	29-7-1951	16 ,,
		100 ,,	,,	14-7-1951	29-7-1951	16 ,,
Madras	T.M.V. 2	Control	27-5-1951	16-7-1951	17-8-1951	33 days
		36 m.a.H.	,,	20-7-1951	11-8-1951	23 ,,
		50 ,,	,,	15-7-1951	7-8-1951	24 ,,
		100 ,,	,,	20-7-1951	5-8-1951	17 ,,

while in 1951 they were sown by the middle of May. These experiments will be continued during the next season.

As the duration of the flowering the number of days between the first and the last plant to flower in a population has a definite economic bearing, a comparative study of this factor was made in the controls and the treatments and the results are contained in Table V (set p. 41). The lesser the number of days between the first plant to flower and the last, the earlier the crop can be removed from the field, thus minimizing the cultural expenses. Moreover in such cases, the field can be used for other crops also at an earlier date.

The pollen sterility in the controls and various treatments were studied. It was observed that the percentage of sterility was lowest in the controls and in general, increases with increase in dosage. In types No. 12 and 16 from Berhampore, 50 m.a.H. gave the highest sterility, while in three of the remaining types, the highest dose gave the highest sterility.

As in the previous season, the average diameter of the pollen grains from one hundred measurements were taken, both in the controls and the various treatments when it was noted that in general the controls had the smallest pollen grains, while in the treatments they were bigger. If this will result in bigger and heavier seeds with greater oil content, then it will have a distinct advantage.

The weight of 1000 seeds in the control and the treatments were taken. It was noticed that in many of the treatments the seed weight was higher than in the controls. This probably can be correlated with the bigger size of the pollen grains mentioned earlier.

As a greater oil content is one of the most important factors in breeding better types of *Sesamum*, an attempt is being made to estimate the oil contents of definite quantities of seeds by extraction with the "soxhlet" apparatus, and these results will be included in the next annual report.

C.2.3.2. Rape and Mustard (Brassica):

Out of the 12 types grown last year, some did not thrive well under the climatic and soil conditions of our Experimental Farm and hence were discarded. So during this season only the four following types were grown, Rai, No. 5 and Tori, No. 7, of West Bengal, Mustard 325 from Sabour (Bihar), R. L. 9 from East Punjab and a variety from Jashpur (M. P.). The last is a new variety which was not tried during the previous season, as it was received late. But this did not thrive well under our environmental conditions. As even the

maximum dose administered last year (65 m.a.H.) was found to be insufficient for inducing sufficient variations, much higher doses were given this year the doses being 50, 65, 100 and 140 m.a.H. The plants were grown in small compact blocks with a control in each block, in replications. The percentage of germination of the seeds in the controls and the treatments, the growth and vigour, the date of flowering and the number of fruits obtained from the selected plants were recorded and the following (Table VI) gives the number of fruits in

TABLE VI

Locality	Field	Types	Treatments	Maximum No. of fruits
Sabour	6	Mustard 325	Control	108
			50 m.a.H.	175
			65 ,,	155
			100 ,,	264
Malda (West Bengal)	6	Rai No. 5	Control	480
			50 m.a.H.	774
			65 ,,	560
			100 ,,	820
			140 ,,	620
Malda (West Bengal)	7	Rai No. 5	Control	560
			50 m.a.H.	745
			65 ,,	650
			100 ,,	708
			140 ,,	753
Gurgaon (E. Punjab)	8	R. L. 9	Control	495
			50 m.a.H.	367
			65 ,,	705
			100 ,,	650
			140 ,,	822
Gurgaon (E. Punjab)	7		Control	220
			50 m.a.H.	230
			65 ,,	408
			100 ,,	325
			140 ,,	505
Gurgaon (E. Punjab)	8	R. L. 9	Control	250
			50 m.a.H.	400
			65 ,,	275
			100 ,,	525
			140 ,,	270
Malda (West Bengal)	7	Tori No. 7	Control	95
			50 m.a.H.	190
			65 ,,	185
			100 ,,	125
Malda (West Bengal)	6	Tori No. 7	Control	145
			50 m.a.H.	200
			65 ,,	150
			100 ,,	310

the best plant in the control and the various treatments from the several fields.

It will be noted from the above table that in all the types under investigation and in all the fields where they were grown, the best plants in the treatments had many more fruits than in the controls. For example, in Mustard 325 from Sabour, the best plant in the control had 108 fruits as against 264 fruits in one plant treated for 100 m.a.H. In Rai No. 5 from Malda (Bengal) the relative numbers are 480 in the control as against 820 also in 100 m.a.H. treatment. In another field for the same type, the best plant in control had 500 fruits against 753 in the 140 m.a.H. treatment. In R. L. 9 from Punjab, the relative figures were 495 in the control against 822 in 140 m.a.H. treatment. In the same field, in another replication, the figures were 250 against 525 in 100 m.a.H. treatment. In another field, the same type produced 220 fruits in the best control plant, while one plant in the 140 m.a.H. produced 505 fruits. In Tori No. 7 from Malda (Bengal) the best control had 95 fruits as against 190 in the 50 m.a.H. and in another field 145 against 310 in 100 m.a.H. In general, all the treated plants had more fruits than the controls but the higher doses (100 and 140 m.a.H) gave rise to plants with largest number of fruits. During the current season also, similar high doses will again be attempted on fresh seeds, in addition to growing the higher yielding X1 and X2 of the previous generations.

Other data such as earliness, duration of flowering, percentage of sterile pollens, pollen diameter, seed weight etc. have been collected, but are not included here for the sake of brevity. These details have been included in the annual report to the Indian Central Oil seeds Committee.

C. 3. Anatomy and Cytology

C.3.1. Jute :

Sections cut at three different levels in mature plants of the control (R. 26) and Tall Mutant (T.M.) of *Corchorus olitorius* have revealed that there were greater number of thinner fibres in the latter than in the former. A detailed study of the development of the fibres in the above two strains from the seedling stage to the mature plant has been undertaken.

C.3.2.1. Sections of the foliar ascidia in *Clerodendron infortunatum* have revealed that these terminal ascidia are composed of the upper pair of opposite and decussate leaves. The vascular bundles

are arranged in two rings in the ascidial stalk. The outer ring is normally oriented while the inner ring is inversely oriented.

C.3.2.2 Studies on the concentric vascular bundles in some ascidial stalks of *Clerodendron infortunatum* was undertaken and the origin of these bundles has been traced.

C.3.3. Cyto-morphological and Cyto-taxonomical studies in Leguminosae: Investigations have been undertaken in several varieties of *Glycine hispida, Cicer arietinum, Dolichos lablab, Pisum sativum, Lathyrus sativus, Lens esculenta,* etc. Detailed morphological studies of the chromosomes in such of those species and varieties where the individual chromosomes can be identified are being undertaken, with a view to evaluating their phylogeny and inter-relationships.

C.3.4.1. Mimosa speggazzini (*Leguminoseae*), *Biophytum sensitivum* and *Averrhoa carambola* (Oxalidaceae):—It was found that modifications of the motile organ the pulvinus, followed the same pattern as that previously reported in *Mimosa pudica*. The bulky cortex is aerenchymatous hence contractible, woody elements are spiralised and reduced to a minimum in area, and special cell inclusion similar to *M. pudica*, comprising a dark viscous gel and rhombohedra-shaped crystals probably of calcium oxalate are universally present. It was not possible to make the Safranin test on the viscous contents as the pure dye was not available. They showed the tannin reaction to ferric chloride.

The pulvini of the above plants, are longitudinally differentiated, bearing out the contention that the movement is the result of the interaction of the two halves.

C.3.4.2. Comparative anatomical and physiological studies of the autonomously moving pulvini of Desmodium gyrans (*Leguminoseae*) *and Oxalis acetosella* (*Oxalidaceæ*):—The movements of both these plants had been recorded by other workers. *Desmodium* is famous for its movements which are visible to the naked eye. *Oxalis* was found to follow the same pattern but its movements were much slower being from 4 to 6 revolutions per 24 hours. Similar to *Desmodium* there were no movements in very young leaves ; movement recorded only in the day time in more mature leaves and continuous gyrations in fully mature leaves. When kept in glucose solution the semi-mature leaves showed continuous movement. It was noticed that the gyrations were executed by the tip of the very long pulvini of the *Desmodium* leaflets. This is not so in the case of *Oxalis* which has very short pulvini. Longitudinal sections of both pulvini showed that the cortex is aerenchymatous, the xylem reduced and special contents are present. There is, however, no longitudinal difference between the two halves. In

Desmodium the tip showed some structural difference from the rest of the pulvinus. Here the aerenchyma is more pronounced and contents and crystals are very much more concentrated. The contents gave the tannin reaction to ferric chloride.

C.3.4.3. Effect of two new antibiotics as compared to penicillin on onion root tip chromosome: The effect of different concentrations of the crude filtrate of *Psalliota campestris* (psalliotrin) and *Polystictus sanguineus* (polyporin) kindly supplied by Prof. S. R. Bose was observed on the growing roots of onion by treating them in the same way as tried by Wilson, Ferreira, Levan and others with standard antibiotics including penicillin. This latter was repeated as control test and incidentally some new observations were made. The concentrations used 5 to 500 ppm. were not lethal. All three antibiotics had the same effect but that of penicillin was more pronounced and the treated material was attacked by bacteria later than in control.

Concentrations of 5 and 10 ppm were slightly inhibitory in action, there was some division in 50 ppm for two days before inhibition ; 100 ppm was near threshold and showed little deviation from normal while in 500 ppm there was a sharp rise above normal in the first two days then as sharp a fall ending in the cessation of further growth.

After growth had stopped the roots did not die but remained turgescent and living till the end of the week, when the experiment was discontinued. Swellings appeared behind the tip region and sometimes branches appeared on these swollen parts, similar to conditions found by Levan and Ferreira with other antibiotics.

Observations on division rate were made on microscopic sections in which the number of division figures per unit area were counted. As a result of the action of the antibiotic, nuclei were seen to assume a pre-division appearance neither progressing further nor reverting to resting stage. This condition is comparable to the "bacteriostatic" effect of antibiotics. Such nuclei are sometimes capable of recovery.

Experiments were carried out in the cold room of the Institute where the preparation remained bacteria-free longer than when kept at room temperature. Roots were fixed every 24 hours for a week, then sectioned in paraffin, stained, and observed for chromosome behaviour. Chromosomes were found to uncoil and shorten, resembling the C-mitotic effect, then later become clumped and thickened before entering the semi-resting stage.

C.3.4.4. Mode of development of coconut endosperm:—In an

attempt to find out whether the free nuclei present in the milk of coconut passed through division stages and whether such divisions continued after the fruit had been picked, 3 series of coconut fruits, starting from the pre-kernel forming stage were stored at the air-conditioned room temperature, and observed every 24 hours. The following observations were made:

(a) Fruits remain living and continue with development, when kept at 25°C but were stopped in the refrigerator (5°C).

(b) Young fruits are bacteria-free but do not remain so when once opened. Growth of other organisms is brisk one hour after the tiniest hole has been bored.

(c) In all fruits even when fresh from the tree the milk is thick with yeast once the 'meat' has fully formed.

(d) The endosperm grows from the embryo end downwards. The growing meristem is a syncitium with cytoplasm and dividing nuclei on the edge of the tissue, and walls are formed secondarily in tissue which has already been laid down.

(e) Free floating nuclei are not found in the water of fruit where the kernel has not been deposited. They probably become detached from the freely growing syncitium.

(f) The tissue as also the free nuclei grow by somatic division. Division has not been found in the morning but is present from 3 to 4 p.m. Chromosomes and 'spindles' are large and may be distinctly observed unstained with ordinary high power (x400).

(g) Nuclei differ in size and some are more than double that of others. The diploid number of the plant is $2n=32$. In the endosperm the triploid number is expected. In the present study nuclei (photograph taken) with 80 distinct chromosomes have beeen observed. There were larger nuclei than this in the tissue.

(h) Oil droplets and crystalline inclusions increase with the growth of the endosperm. Free nuclei are not seen in the fully-formed fruit, having been destroyed by bacteria and other growing organisms.

Cutter, Dube and Wilson have recently reported fully on the mode of development of the coconut fruit touching on the physiological and chemical processes involved. Present observations as noted are those in addition to their findings. Two of these, namely, the presence of free floating nuclei only after kernel deposition and regular somatic division in the tissue are contrary to their findings.

C. 4. Plant diseases

Potato Virus disease Investigation:

A general survey of the virus diseases in the potato varieties Red Round and White Round was carried out this year in the district of Darjeeling. The investigation was restricted mainly in the Government seed-growing field at 'Rungbull' and some of the general cultivator's field.

This work was possible due to the kind permission of the Department of Agriculture, Government of West Bengal, specially due to the very kind help and co-operation of the "Inspecting Officer, Potatoes", Government of West Bengal.

The following tables (I and II) give the general picture of the incidence of different virus diseases in the variety 'Red Round' both in the Government farm and in the general cultivator's fields. It may be

TABLE I

CULTIVATOR'S FIELDS

Fields:	Altitudes:	No. of Plants Examined:	Percentage of Mild Mosaic:	% age of Severe Mosaic:	% age of Leaf Roll:	% age of Total Plants Infected
No. 1	5000'-5500'	100	26.0	12.0	8.0	46.0
No. 2	4000'-4600'	100	28.0	19.0	17.0	64.0
No. 3	4500'-4800'	100	33.0	16.0	20.0	69.0

TABLE II

GOVT. FARM, RUNGBULL

Plots:	Altitudes:	No. of Plants Examined	% age of Mild Mosaic:	% age of Severe Mosaic:	% age of Leaf-Roll:	% age of Total Plants Infected
L_1	5500'-5800'	100	12.0	4.0	4.0	20.0
L_2	Do	100	18.0	8.0	8.0	34.0
M_1	5800'-6100'	100	14.0	4.0	8.0	26.0
M_2	Do	100	20.0	6.0	6.0	32.0
T_1	6100'-6500'	100	20.0	4.0	6.0	30.0
T_2	Do	100	16.0	6.0	10.0	32.0
Total	5500'-6500'	100	16.0	6.0	7.0	29.0

mentioned here that in the Government farm, only certified disease-free tubers of potatoes were grown under careful observation.

Diseased plants in the field were identified on the spot; but to check up the symptoms, samples from infected plants were tested in the laboratory.

Leaf Roll Virus was tested in the host plants *Physalis floridana* and *Physalis angulata*. Histopathological tests were also carried out to check up the symptoms of Leaf Roll infected plants. The results obtained from the laboratory tests confirmed the accuracy of the field observations. Leaf Roll Virus has also been transmitted successfully from the diseased to the healthy potato plants by 'Myzus persicae'. It goes without saying that the symptoms in *Physalis floridana* and *Physalis angulata* proved to be more efficient for the test of Leaf Roll Virus.

Symptoms of Mosaic disease in the field varied from very mild to severe mottling, sometimes accompanied by leaf curling and distortion of plants. For the convenience of the work the Mosaic symptoms were, however, classified into two major groups, *e.g.*, Mild Mosaic and Severe Mosaic.

Samples from plants showing Mosaic symptoms were tested in the laboratory. In most of the cases virus 'Y' was obtained. *Petunia*, *Solanum nodiflorum*, and *White Burley* tobacco plants were used to study the symptoms of virus 'Y'. At present virus 'Y' is being cultured in the laboratory in pure state for further study.

Virus 'X' was almost invariably present along with Virus 'Y'. Sometimes Virus 'X' alone was also obtained from the plants showing very mild Mosaic symptoms. *White Burley* tobacco, *Datura stramonium*, *Nicotiana glutinosa* and tomato were used as test plants for virus 'X'. Different types of symptom pictures were obtained with varying severity and patterns in the host plants infected with the different isolates of virus 'X', obtained from different sources of Red Round and White Round. Five different strains of virus 'X' have, however, been isolated and are being cultured for further study.

A number of Red Round and White Round potato tubers were also grown in the glass house for investigation, specially to find virus-free stock. The tubers were supplied by the 'Inspecting Officer, Potatoes', Government of West Bengal as virus-free certified seed tubers. These were tested by sap inoculation on different host plants and by graft-infection on different apparently healthy European potato varieties. Unfortunately, no plants were obtained completely free from

virus disease. From these plants also virus 'X' and virus 'Y' were mainly obtained. The results obtained on different host plants agree with the results obtained on the graft infected different European potato varieties. Virus 'A' could not be found from any of the plants of the variety Red Round so far tested. In one of the cases the presence of virus 'C' has been suspected in the variety Red Round. Potato varieties, 'Arran Consul', 'Majestic', 'President' have up-to-date reacted with hypersensitive reaction following graft infection with scions from that particular plant. Sap inoculation from that plant on 'White Burley', however, gave 'Vein clearing' symptoms. Further investigation in this connection is in progress.

Attempts are being made to investigate the possibilities of finding different resistance characters against virus diseases in both cultivated varieties of potatoes including 'Simla Hydrids' and in different South American wild species of potatoes. Major attention is being given on the character of 'field immunity', which claims importance as being of immediate value in breeding virus resistant potato varieties.

The variety Red Round has been found to be field immune from virus 'B'. The results from the other European varieties so far tested regarding field immunity agreed with the results obtained by Cockerham in 1943. Attempts are being made to carry out breeding work among the cultivated varieties of potatoes available.

Examination of the wild species of South America has revealed similar characters of field immunity in respect of not only viruses 'X', 'A', 'B' and 'C' but also of virus 'Y' which has not yet been reported in any cultivated varieties. The diploid ($2n=24$) species *Solanum simplicifolium* which is field immune from viruses 'A', 'Y' and 'C' and *Solanum brevimucronatum* which is field immune to virus 'X' are at present being used in breeding for resistant varieties. *Solanum Rybinu* ($2n=24$) which is susceptible to all these mosaic viruses is being used for recessive character. A number of progenies at different generations have already been raised with dominant genes controlling field immune characters in respect to these mosaic viruses. It is contemplated to breed some of these progenies with the hexaploid species *Solanum demissum* which is resistant to *Phytophthora infestans*, to raise tetraploid progenies with dominant genes in respect to those mosaic viruses and adding to it the resistance to *Phytophthora infestans*. These will then be back crossed with cultivated varieties (tetraploid, $2n=48$). This work is being carried out in continuation of the work done by one of the investigators in the Scottish Society for Research in Plant-breeding, Edinburgh.

Another wild potato species *Solanum polyadenium*, which has been reported to be resistant to aphides transmitting virus 'Y' is also under investigation with a view to utilise it in breeding work.

Last year it was reported that the variety 'White Round' showed a high degree of quantitative resistance to leaf-roll virus. This has also been confirmed this year. Special attentions are being given to the character of "quantitative resistance" or Klenducity leaf roll virus, available in the variety White Round and in other Indian and European varieties of potatoes.

Insect Population Count:

Counts of aphides infesting potato crop in the Government farm 'Rungbull' were made during this summer. Table III (see p. 52) shows the result of the count. For the convenience of the work the field was divided into three zones according to different altitudes. Each zone was again sub-divided into six sub-plots. Counts were taken in each sub-plot separately and according to different altitudes. The total counts of the field at different dates have only been recorded in this table.

It was planned to take the counts throughout the whole season ; but further counts after 4th May, 1952, were not possible in the field due to an epidemic of 'Blight' which destroyed most of the plants. It is, therefore, proposed to make a general survey of the aphides infestation in potato crop in the plains this year and in the hills again in the coming year.

Investigation on other Diseases:

Some tubers were obtained from the Inspecting Officer, Potatoes, Government of West Bengal, which showed black rings when cut into halves. Scrapings from these tubers were examined under microscope which revealed rod-shaped gram-ve bacteria. These were then cultured and purified. The isolated organisms were then inoculated into fresh healthy tubers which after 7-8 days showed similar symptom of black-rings. Organisms from the inoculated tuber when cultured gave identical organisms as found before.

Although the causal organisms have been proved to be a rod-shaped gram-ve bacteria, yet no definite conclusion has been made regarding the identity of the bacteria, as other tests to identify the organism is not yet complete. It seems, however, that the disease is like that of 'Blackleg' or bacterial wilt of potato.

TABLE III

Insect Count

Date	TOP LEAF		MIDDLE LEAF			LOWER LEAF		
	Total No. of leaf examined	% age of leaf Infested	Total No. of Persicae	Total No. of leaf examined	% age of leaf Infested	Total No. of Persicae	Total No. of leaf examined	% age of leaf infested	Total No of Persicae
17 March 1952	900	11.1	130	300	12.0	48	300	21.3	82
2 April 1952	900	7.4	97	300	5.0	20	300	17.3	77
19 April 1952	900	9.4	129	300	9.0	37	300	17.3	86
4 May 1952	900	12.3	232	300	16.0	82	300	21.0	150

C. 5. Palaeobotany

Microfossil as an indicator of age :

Twenty rock specimens of different ages—infra-Cambrian or Cambrian to Recent—from different localities including one sample of Vindhyans (infra-Cambrian or Cambrian), 9 samples of Mandi Salt (Cambrian or post-Cambrian), 7 samples of Salt Range (Triassic), 2 samples of Assam Coal (Tertiary) and one sample of Calcutta peat (Recent) were examined during the year under review. A collection of a dozen North American Cambrian specimens were received from Prof. B. F. Howell, of Princeton University, U.S.A., late in the year and is under examination.

Vindhyans (infra-Cambrian or Cambrian) :

Sample No. G. S. I. K44/425.

Locality—Banjari, near Rohtasgarh, Sahabad Dt., Bihar.

Description—Calcareous shale or concretionary nodule.

Horizon—Rohtas Stage, Semri Series.

The specimen on maceration yielded only carbonized bright yellow, minute round bodies of unknown affinity. No identifiable plant remains have been found.

It may be recalled that remnants of non-vascular and vascular microflora have already been recorded from the Basal and Kheinjua Stages, Semri Series of the lower Vindhyans. (See Annual Reports for 1949-50 and 1950-51).

Mandi Salt Belt (Cambrian or post-Cambrian) :

The origin and age of the Mandi Salt is still a subject of debate. Geologists who consider the Mandi Salt bed as homotaxial with the Punjab Saline Series, claim it to be infra-Cambrian or Cambrian in age and there are others who advocate a Tertiary age.

With a view to find out the age of the Mandi Salts with the aid of microfossils—the solution of which may give a clue to the age controversy of the Punjab Saline Series—the following samples received from the G. S. I. were examined:

No.	*Regd. No.*	*Locality*	*Material*
1.	58/1015 A +	31°47′48″:76°57′, S. of Bhatog near 4565, Khalsa village	Limestone
2.	58/1016 B ×	Do.	Do.
3.	58/1021 A	31°58′20″: 76°51′10″, Guma; road section, mile 28½	Shaly limestone

\+ A indicate specimens from surface.
× B indicate specimens from depth.

No.	*Regd. No.*	*Locality*	*Materials*
4.	58/1022 B	31°58′20″: 76°51′10″, Guma; road section, mile 28½	Shaly limestone
5.	58/1040 A	31°45′42″: 76°57′12″	———
6.	58/1041 B	Do.	———
7.	58/1044 A	31°45′40″: 76°57′24″, Maigal stream, section	Lokam limestone salt sequence
8.	58/1045 B	Do.	Do.
9.	58/1046	Drang Salt mine	Salt

The specimens have been collected from Himachal Pradesh, Mandi Dt., Mandi Salt Belt by Mr. G. Kohli (of G.S.I.).

From the limestone specimens (1-8) a good number of spores of pteridophytic affinity while from the salt sample (9) vascular wood elements with 1-seriate bordered pits and with or without vascular rays, insect chitins, and various dubious organic remains have been found out. Spores are remarkably absent from the salt specimen.

Variation in microfloral types in limestone and salt is noteworthy although the microfossil data do not give any indication as to the exact age of the Salt bed.

Triassic of the Salt Range:

Three rock specimens from the Ceratite beds (Triassic) and 4 samples from the Kingriali Stage (Triassic or Triassic-lower Jurassic) obtained through the courtesy of the B.O.C. (I.C.) Ltd. have been examined. A more systematic classification of spores so far recorded from the Cambrian and post-Cambrian beds have been made on artificial grounds and altogether 59 spore types have been noted from the Triassic beds against 81 from the Permian and 16 from the Cambrians.

Assam Tertiary:

Coal samples received by the Department of Chemistry of the Institute for chemical analysis from Ropeway Manager of Cherrapunji (Assam) from Namdang were analysed. Numerous angiospermous pollens (*e.g.*, like that of Magnolia and Palm), various types of cuticles and wood fragments have been observed.

Calcutta peat:

A combustible peat (with water—50% and dry matter 50% of the fresh weight approximately) collected from 20 ft. below the surface from Vidyasagar Colony, Jadavpore was analysed and

numerous angiospermous pollens, wood elements and cuticles recovered.

D. MICROBIOLOGY

The following items of investigation were undertaken during the period under review:

1. Further studies on the occurrence of antibiotic-producing fungi and actinomycetes from the soils of West Bengal and Assam.
2. Further progress on the chemical purification of antibiotics produced by active strains of actinomycetes.
3. Studies on the inhibition of *Rhizobium* and *Azotobacter* by antagonistic soil fungi and actinomycetes.
4. Studies on the rate of inhibition of *Rhizobium* and *Azotobacter* by Penicillin and Streptomycin.
5. Studies on the beneficial effect of "Bacterisation."
6. Studies on the relation between strain specificity and citric acid production by strains of *Aspergillus niger*.
7. Soil Microbiological work at Mayapuri Research Station.

D.1. Investigations were continued on the survey of antibiotic-producing micro-organisms from the soils of West Bengal and Assam. The methods adopted in the following experiments for the isolation of fungi and actinomycetes were modified in order to obtain better results.

The soil samples were treated with readily utilisable organic matter *e.g.*, glucose, peptone and straw and kept for a few days prior to their use for soil plating. The above treatments activated the growth of the soil microflora in a changed nutritional condition and it was found (Table I) that the nature and composition of the soil organisms were modified with a great increase in number.

TABLE I

Treatment of soil	Total number of micro-organisms	Number of fungi	Number of actinomycetes
1. Soil + 0.5% glucose	*(N) 195	x	63
	*(Th) 133	2	38
2. Soil + Compost	(N) 93	x	6
	(Th) 159	1	14
3. Soil (control)	(N) 89	x	17
	(Th) 120	1	34

* (N)—Norris' medium ; (Th)—Thornton's medium.

Four different media were used for soil plating in order to study their comparative effects. From the results (Table IIA) it was observed that Norris' medium and Thornton's medium were most suitable for the development of both bacteria and actinomycetes colonies.

TABLE IIA

Media used	Number of micro-organisms	Number of fungi	Total number of actinomycetes
1. Straw Infusion	1	1	x
2. Potato medium	37	4	x
3. Norris' medium	176	0	65
4. Thornton's medium	128	1	36

The recommendation (Crook *et al*, 1950) for the use of Sodium propionate (0.1%—0.4%) incorporated in media for the development of actinomycetes was tried in this laboratory, but the results seem to indicate that it is of very little help for our purpose. Altogether 41 soil samples were analysed in the year under review and screening method was adapted for eliminating the ineffective cultures. Of the isolates, 98 fungi and 32 actinomycetes strains were selected for the study of their antibiotic-producing capacity. They were grown on modified Czapek Dox media and the filtrates assayed against the following 5 test organisms:—(*i*) *Staph. aureus*, (*ii*) *E. coli*, (*iii*) *Eb. typhosa*, (*iv*) *V. cholerae*, and (*v*) *K. pneumoniae*. From the results (Table IIB) it will be seen that *K. pneumoniae* is the least sensitive to antibiotics while *Staph. aureus* is inhibited by almost every antibiotic-producing micro-organism both fungi and actinomycetes. However, the latter group seem to possess a wide range of antibiotic spectrum.

TABLE IIB

ANTIBIOTIC SPECTRUM OF FUNGI AND ACTINOMYCETES ISOLATED FROM SOIL

Number of organisms tested	Test organisms				
	Staph. aureus	*E. coli*	*Eb. typhosa*	*V. cholerae*	*K. pneumoniae*
Fungi—98	82	10	1	0	0
Actinomycetes —32	24	17	8	5	1

D. 2. In continuation of the work reported earlier an attempt was made to isolate the active antibiotic principles elaborated by the following potent strains of *Streptomyces* (AC_1 46), AC_7 (8), AC_6(118) isolated in this laboratory from soils of different parts of West Bengal. Since none of them showed properties similar to those of the antibiotics already known, the purification involved the use of methods of a more refined character. The method of approach has been twofold. Attempt was made to increase the proportion of the antibiotic component in the culture fluid by modifying the composition of the medium and other cultural conditions. Secondly, various chemical and physico-chemical methods were adopted to isolate the active principle. The unit processes of extraction, adsorption and chromatography were employed for the removal of antibiotics from the culture media. Table III shows the antibiotic spectrum of different strains of *Streptomyces* grown in different media against *E. typhosa*:

TABLE III

Media	Lytic zone diam. in mm.		
	AC_1(46)	AC_7(8)	AC_6(118)
1. Straw agar	20.0	26.0	22.5
2. Straw-tryptone-potato-agar	18.0	27.5	20.0
3. Peptone-molasses agar	16.0	21.0	18.0
4. Peptone-nitrate asparagine-agar	13.0	21.0	17.0

Of the media employed the following deserves special mention. The addition of yeast extract did not improve the antibiotic titre to a considerable degree. Though growth was remarkable and sporulation was found to be plenty in straw-tryptone-potato-agar media the results (Table III) show that straw agar was best suited for this purpose.

Instead of a compact growth strains AC_1(46) and AC_7(8) were found to adhere to the sides of the wall of the glass container. This difficulty was overcome by the addition of "calsolene" (I.C.I. product) in different dilutions but with no marked improvement of the antibiotic titre. The change of titre with reference to the number of days of growth was next studied against *E. typhosa* (Table IV):

Table IV

Number of strains	Zone diam. in mm.		
	Number of days of growth		
	4	8	12
1. AC_1 (46) ...	—	19.0	17.0
2. AC_7 (8) ...	+	22.0	25.5
3. AC_6 (118) ...	—	22.0	17.0

St. AC_7(8).—The culture fluid was adsorbed on activated charcoal (carbonit) and was eluted successfully with a mixture of CH_3OH, CH_3COOH and H_2O (40:40:20). The eluted liquor was evaporated under vacuo at the room temp. 28°C and the product was dissolved in phosphate buffer (*p*H 7.0). To the solution thus obtained NaOH (N/10) was added when a buff-coloured precipitate was obtained. This was dissolved in (N/10) HCl and filtered, leaving a brown-coloured residue. After it was filtered, both the residue (I) and the filtrate (II) were further treated for chemical purification.

Treatment of residue (I).—This was dissolved in N/10 HCl and filtered, leaving a brown-coloured residue. The filtrate was neutralised with 5% $NaHCO_3$ solution when a colourless substance was precipitated down. This was filtered and to the filtrate was added phosphomolybdic acid when a yellow precipitate was obtained.

Treatment of filtrate (II)—Method A.—Attempt was made to isolate the active principle from the filtrate (II) by column chromatography on silica gel. The pigment was eluted by $CH_3OH:CH_3COOH$ and the liquid was evaporated to dryness, dissolved in phosphate buffer (*p*H 7.0) and was found to be active against *E. typhosa*.

Method B.—Here the experiment was designed to isolate the active principle by precipitation method ; the filtration (II) was concentrated and to the concentrate was added absolute alcohol when a second crop of buff-coloured ppt. was obtained (III). This was filtered and the filtrate was evaporated to dryness when a yellow hygroscopic mass was obtained which was treated with glacial acetic acid when colourless crystals were precipitated down. The ppt. was filtered and the filtrate was again evaporated to dryness when a red sticky mass was left.

The work on the study of antibacterial and physico-chemical properties of the various fractions obtained in different stages is in progress.

St. AC_6(118).—This species of actinomycetes was grown in straw-media and the culture fluid was adsorbed on "carbonit" and eluted with a mixture of $CHCl_3$-CH_3COOH-CH_3 (1:1). The solution was evaporated under vacuo and the resulting product was dissolved in the phosphate buffer (*p*H 7.0). Tests were performed with the product thus obtained in order to key the compound for identification. Since no confirmatory results were obtained, attempt was made to resolve this product by paper chromatography using methyl alcohol-acetic acid as a resolving solvent. Halo zones were observed along certain parts of the dried paper strips when placed on plates seeded with *S. aureus* and *E. typhosa* and R_f value of this substance with respect to the above-mentioned solvent was calculated. Attempts are now being made to study the substance extracted from relevant portions of the paper chromatogram where the same R_f value lies. Preliminary animal experiments (with mice) indicated the non-toxicity of the active compound. It was also found to be thermostable. Further study on the isolation of the active principle is in progress.

St. AC_1(46).—The antagonistic action of this strain was fungistatic and was studied with reference to several plant pathogens. The following results were obtained:

Table V

Name of plant pathogen	Activity*
1. *Curvularia* sp.	+
2. *Helminthosporium oryzae*	+++
3. *Cephalosporium saccharum*	+
4. *Fusarium* sp.	+
5. *Fusarium* sp.	+
6. *Alt. solani*	++

* + indicates slight activity, ++ moderate, and +++ strong inhibition.

D. 3. The inhibition of nitrogen-fixing bacteria *e.g., Rhizobium* and *Azotobacter* by other soil bacteria is reported by many workers but little is known about the antagonistic activity of antibiotic-producing fungi and bacteria. The following experiment deals with the antibiotic effect of fungi and actinomycetes and of substances of fungal and actinomycetal origin.

Fungi.—Of the various antibiotic-producing fungi isolated in this laboratory 70 were chosen for test of their antagonistic activities towards *Rhizobium* and *Azotobacter*. As there is a wide specificity of reaction, a large number of test organisms—8 strains each of *Rhizobium* and *Azotobacter* belonging to different spp. were used as test organisms. The cross streak method of assay was followed.

The isolation of the active substance of this strain of *Streptomyces* was reported earlier. The impure product is now being treated for separation of the components by chromatography.

Though all the 70 fungi were inhibitory to the pathogenic bacteria 35 of them inhibited any one of the Rhizobium strain, 33 inhibited both *Rhizobium* and *Azotobactor* and 47 inhibited any one of the *Azotobacter*. Among the Rhizobia, Gram and Lathyrus are the most sensitive strains while Pea and Lupin are the most resistant. Among the Azotobacters, *Az. chroococcum* is more sensitive than *Az. indicum*. In general *Azotobacters* are more susceptible than *Rhizobia*. Cultures of fungi inhibitory to Gram-negative pathogenic bacteria did not necessarily inhibit these organisms which all react negatively to Gram strain. *Penicillia* were more inhibitory than the *Aspergilli*. Strains of *Aspergillus niger*, which are habitually acid producers possibly exert their effect on the above test organisms by lowering the *p*H of the substrates.

Actinomycetes.—The inhibition of the nitrogen-fixing bacteria by actinomycetes was reported in Annual Report for 1950-51. The work was further extended and 50 strains of actinomycetes were tested against 16 test organisms. Of these 50 strains of antagonists, 18 and 22 inhibited any one of the *Azotobacters* and *Rhizobium* respectively. Gram nodule bacteria was the most sensitive while the bacteria of Lathyrus and Lens nodules were found to be resistant. Among Azotobacters, *Azotobacter chroococcum* (strain 128) was the most resistant and *Azotobacter indicum* (AZ. I) was seen to be somewhat resistant to the antibiotic action. Only 3 strains of actinomycetes were inhibitory to both *Rhizobium* and *Azotobacter* and none could inhibit all the test organisms.

All the strains of actinomycetes examined in the above experiment belong to the genus *Streptomyces* and they were found to be strongly inhibitory against both Gram-positive and Gram-negative test organisms.

D.4. Pure antibiotics: The antibiotic effect of penicillin and streptomycin on the rate of growth of *Azotobacter indicum* and *Rhizobium leguminosarum* have been studied. A concentration 1 µg/ml of streptomycin produces complete inhibition of *Azotobacter indicum* in less than 24 hour's time and 2.5 µg/ml brings about sterilization of the medium in 6 hours, with higher concentrations, the inhibitory effect being almost immediate in this case. The effect of penicillin is less pronounced. The growth rate is checked with a concentration of 10 units/ml but the inhibitory effect is overcome in 24 hours' time. However, with higher concentrations complete inhibition occurs in 6 hours' time.

The growth of *Rhizobium leguminosarum* a resistant strain of nodule bacteria was considerably slowed down at a concentration of

10 IU/ml. of penicillin but no complete inhibition occurred even after a duration of long exposures. There was a gradual reduction of the growth rate until there was no growth at 500 IU/ml. the effect lasting for 48 hours after which there was a rise.

From the results obtained above it appears that the soil fungi are usually more active inhibitors towards these useful micro-organisms than the actinomycetes. There is a wide specificity of reaction of antagonistic effects which is well considered by the nature of the substances excreted and the concentrations in which they may accumulate in soil to influence the life process of these organisms so vitally concerned with the nitrogen economy of the soil. Antibiotics of fungal origin are usually acidic and those of actinomycetal are basic in nature. The fungal antibiotics have been found to remain longer in soil and therefore the chances of inhibition of these organisms are greater with them. It was found in field experiments that *Rhizobium* strain of gram were much affected by the fungi and actinomycetes. The absence of nodules on this and other leguminous plants may well be due to the antibiotic effect of certain micro-organisms.

D.5. Bacterisation: The experiment regarding the beneficial effect of bacterisation on the growth of legume crops was repeated this year. Two plots (100′ × 50′) brought under cultivation for this purpose were reported to have remained fallow for at least 5 years after which jute was grown for the last two years. Treated and control plots were separated by a small buffer zone (10′ in width) of wheat to prevent the possible migration of *Rhizobium* from the treated to the control plots. The following legume seeds were sown for the experiment—gram, pea, lentil, Lathyrus and Phaseolus. It was noticed that the number of nodules were appreciably greater in the case of treated series while those in the control were smaller and their occurrence was irregular. There were certain peculiarities in the growth of gram specially in the treated plots. It is noticed that plants with and without nodules in their roots attained the same height and there was no appreciable difference in other respects.

The height and dry weight of the legumes were recorded at different times of their growth taking random samples over the plots. The total nitrogen of the dried samples will be estimated later for comparison.

From a review of literature on the work done regarding the improvement of legume crop by bacterisation with effective strains it is found that controversial results were obtained by many workers. It appears from our own findings that the beneficial effect of bacterisation depends on the following factors: (*i*) presence of effective strains

in the soil, (*ii*) pre-existing nitrogen balance of the soil, (*iii*) presence of toxic condition in the soil. However, pre-sowing bacterisation may be recommended as a useful precaution against the absence of effective strain of bacteria in soil and its competition in ineffective strains.

D.6. Citric acid production from strains of Aspergillus niger: Forty strains of *A. niger* were isolated from soil and decomposed food grains. They were grown in Sucrose—Ammon. sulphate medium (*p*H 1.8—2.0). The organism is known to produce citric acid in media with higher H-ion concentration. The results were recorded starting from the 4th day onwards up to the 10th day of incubation by estimating the total acid produced in media calculated from the value of titration with N/10 NaOH using phenolpthalin as an indicator.

Of the eight strains showing titres higher than 10 (in respect of N/10 NaOH) were further studied and the following estimations were made: (*i*) Variation of *p*H of the culture filtrate, (*ii*) Total acidity, (*iii*) Residual sugar, (*iv*) Dry wt. of the mycelium and (*v*) Amount of citric acid obtained after precipitation. The results show that the *p*H remaining steady for some period tends to decline while there is a continuous increase in acid production from the 4th day of incubation up to the end of the experiment.

Next the trace elements Mn, Zn, Fe, and Cu were used in media to study the increase in the acid production. Here the results show a remarkable improvement over the control. In some instances the acid titre went up as high as three times that of the control.

In order to study the rate of recovery of citric acid in the form of Calcium citrate, two highly potent cultures were selected, grown in media containing trace elements, and the citric acid was precipitated down as Calcium citrate. The ppt. was washed, dried and weighed. The recovery of pure citric acid from the precipitate obtained, is in progress.

D.7. Soil Microbiological Work: It is proposed to study the monthly variation of *Azotobacter* population and its relation with the variation of Nitrogen content of soil at different altitudes in the Darjeeling district.

As all the necessary equipments were not available at this laboratory until recently, the preliminary study regarding the problem had to be carried out at the Darjeeling Municipal Bacteriological laboratory with the kind permission of the authorities.

All the preliminary informations regarding the problem have been obtained and, it shows that the results will be of very high value. Necessary equipments having now been obtained, the work has been started systematically.

E. ZOOLOGY

Effect of antibiotics on the Metamorphosis of tadpoles of Rana tigrina:

During the last summer some feeding experiments with antibiotics were being conducted regarding induced polymorphism in aggressive red-ants, *OEcophylla smaragdina* Talr. while a few tadpoles of *Rana tigrina* were put into a vessel containing distilled water mixed with penicillin. It was in early May, 1951. There were some more tadpoles of the same brood in a bigger vessel containing fresh water. All those tadpoles were collected a few days before the experiment; within a week the fresh water tadpoles transformed into froglets; but the treated ones showed no signs of transformation even after two weeks of the last of the untreated one's metamorphosis. As the vessel with the tadpoles was destroyed accidentally, further observation was not possible. However, this delay in metamorphosis or inhibition of growth encouraged further investigation into the matter.

More than hundred tadpoles of *R. tigrina* of different sizes (some of them had their hind legs developed) were collected from a shallow ditch in the suburb of Calcutta, early in June, 1951. Out of them 70 specimens were equally distributed in ten vessels containing distilled water, and penicillin was added to them in different number of units. The rest of the tadpoles were set aside as control in three jars containing fresh water. No food was given either to the control or to the treated ones. Every three days the penicillin water was renewed. This treatment continued for different length of time varying from 15 to 30 days in different vessels. After this treatment tadpoles were removed to fresh water and supplied with foods.

Except for 5 or 6 deaths, all the tadpoles of the control transformed into froglets on different dates within 27th June, 1951. But not a single one in the experimental jars metamorphosed within this time. In most of the treated specimens metamorphosis was delayed for a considerable length of time, varying from two to four months. But the tadpoles in two vessels containing 50 and 80 units of penicillin respectively, showed no signs of metamorphosis until the end of January, 1952. In the middle of February, '52, two tadpoles of 50 units of penicillin metamorphosed and three died in the larval condition. Two more from the same jar also died by the middle of

March, 1952. The remaining one is still continuing its larval life. Two of the tadpoles in the vessel containing 80 units of penicillin died in February, 1952. By the end of February, 1952, an incomplete metamorphosis occurred in one of the remaining 5 specimens, that is one of the front legs did not emerge from the sternal pocket. Two more tadpoles died in the end of March, 1952. The remaining four, *i.e.*, two of 50 units and two of 80 units of penicillin, are still in their larval forms.

The tadpoles of *R. tigrina* generally metamorphose within three weeks or so after their emergence. But it is interesting that some of these penicillin treated tadpoles are retaining their larval forms for the last ten months. The external or internal cause is still unknown and its elucidation requires further investigation. It may be mentioned that a somewhat similar example is found in Mexican Axolok, which reaches adult size but retains the larval state through its life. It can be made to turn into a land salamander at will by a single dose of thyroid. Such a condition, a constant feature in Mexican Axolok, is known to occur in the British Smooth and Palmate Newts. It is called *neotony* and often turns up more than once in the same place. There might be something in these waters which encourages *neotony*. The cause of delay in metamorphosis in the penicillin-treated tadpoles might be, to a certain extent, similar to that of Mexican Axolok. Further investigations, will be started with fresh broods of tadpoles, which will be available during the next few months.

F. LIBRARY

The Library consists of 3,088 volumes (1,552 books and 1,536 periodicals). During the year under report 147 volumes (70 books and 77 bound periodicals) were added to the stock as against 105 during the previous year. The total number of periodicals received was 79 (inland 15 and foreign 64) as against 78 in the previous year, out of which 39 were purchased and the remaining 40 were received in exchange of the Institute publication—*Transactions of the Bose Research Institute*. The demand for exchange with our publication has been increasing gradually.

The Library is primarily meant for use of the staff of the Bose Institute. On account of its efficient service and well-arranged selected acquisitions, a great number of outside scholars are attracted to visit the Library for reference work. The average number of such visitors was about 60 a month during the year under report.

With the increase of research staff in the Institute, there has been a growing demand for books and journals in the Library. Due

to restriction of funds, however, it has not always been possible to meet their demands. It is felt that further additions of important books and journals are extremely necessary to meet the requirements of the staff as well as to build up an up-to-date Research Library.

G. PUBLICATIONS

Transactions of the Bose Research Institute and other Publications.—During the year under report the demand for *Transactions* (mostly on exchange basis) increased considerably. There has also been an appreciable increase in the sale of *Transactions*. Many important and popular works of Sir J. C. Bose, *viz.*, Response in the Living and Non-Living, Plant Response, Researches on Irritability of Plants, Plant Autographs and their Revelations, etc., have been out of print for a long time. Efforts are being made to reprint some of them in the near future and steps have already been taken to reprint "Plant Autographs and their Revelations". Other publications during the year under Report include (1) Annual Report for 1950-51 and (2) Sir J. C. Bose Memorial Lecture on 'Rain Making' by Dr. S. K. Banerji with director's report. Volume 18 of the *Transactions* (1948-51) is *in press*.

APPENDIX

I. The Governing Body :

Lady Abala Bose*
Dr. Debendramohan Bose
Mr. Sudhansumohan Bose
Mr. Sudhirkumar Mandal
Mr. Abaninath Mitter
Mr. Satish Chandra Mukherjee, I.C.S. (Retd.)
Mr. Kshitish Chandra Neogy
Mr. Bhupatimohan Sen, I.E.S. (Retd.)
Mr. Kedarnath Chatterjee
Prof. S. K. Mitra, D.SC., F.N.I.

II. The Council :

Lady Abala Bose*
Mr. Sudhansumohan Bose
Mr. S. K. Mandal
Mr. S. C. Mukherjee, I.C.S. (Retd.)
Mr. B. M. Sen, I.E.S. (Retd.)
Mr. Kedarnath Chatterjee
Prof. S. K. Mitra, D.SC., F.N.I.
Mr. A. N. Mitter
Dr. D. M. Bose (*Ex-officio*)
Dr. S. S. Bhatnagar, D.SC., F.R.S., F.N.I., Secretary, Ministry of Natural Resources and Scientific Research, Government of India (nominee of the Central Government)
Mr. K. C. Neogy, M.P. (representative of the Central Legislature (up to 25-7-51)
Mr. Jnani Ram, M.P. (from 26-7-51)
Dr. P. Parija, D.SC., O.B.E., F.N.I., Pro Vice-Chancellor, Hindu University, Banaras.
Dr. K. Krishnamurti, D.SC. (Lond.), Principal, Science College, Nagpur

III. Finance Committee :

Mr. B. M. Sen, *Chairman*
Accountant General, West Bengal
Dr. D. M. Bose (*Ex-officio*)

IV. Building Committee :

Dr. D. M. Bose
Mr. Kedarnath Chatterjee (representative of the Council)
Mr. A. N. Mitter (representative of the Governing Body)

* Died on 25-4-51.

V. Staff :

Director—Dr. D. M. Bose, M.A., PH.D., F.N.I.
Registrar—Mr. A. K. Ghosh, M.SC., M.M.G.I.
Special Officer—Dr. J. P. Sircar, B.SC., M.B., CH.B. (Edin.) also in charge of the Workshop.

Department of Physics :

Head of the Department—Director
Research Scholar—T. C. Bhadra, M.SC.
Government of India Junior Scholar—Nakul Chandra Das, M.SC. (up to May, 1951)
Sir J. C. Bose Scholar—Nakul Chandra Das, M.SC. (from June, 1951)
Attached Workers—Prof. H. P. De, M.SC., P.R.S. (Vidyasagar College, Calcutta)
S. P. Dutta, M.SC. (Vidyasagar College, Calcutta) from September, 1951.

Department of Chemistry :

Head of the Department—Dr. J. K. Chowdhury, M.SC., PH.D., F.N.I.
Research Fellow—Dr. B. Banerjee, PH.D. (Munich) on study leave to Germany up to October, 1951 and on leave from November, 1951.
Research Scholar—A. C. Ghosh, M.SC.
Birla Scholar—Dr. D. P. Burma, M.SC., D.Phil.
Government of India Junior Scholar—R. K. Bose, M.SC. (up to June, 1951)
Government of India Senior Scholar—R. K. Bose, M.SC., (from July, 1951)
Government of India Junior Scholar—C. R. Raha, M.SC. (from June, 1951)
Government of India Junior Scholar—Ajoy Kumar Guha, M.SC. (from January, 1952)
Attached workers—N. N. Bandyopadhaya, M.SC. (Textile Institute, Serampur)
Prof. C. D. Allen (Scottish Church College, Calcutta)

Department of Botany :

Head of the Department—Dr. K. T. Jacob, M.A., PH.D. (Lond.)
Research Fellow—Dr. S. K. Roy, M.SC., PH.D. (Lond.), D.I.C.
Special Scholars—B. K. Palit, B.SC.
B. K. Dutta, B.SC.
A. T. Guha Thakurta

Research Scholar—Satyabrata Sarkar, M.SC. (from January, 1952)

Research Assistant—Samir Kar, M.SC. (Ag.)

Government of India Senior Scholar—Dr. A. Ganguly, B.SC., PH.D. (Edin.) up to June, 1951

Government of India Junior Scholar—Satyabrata Sarkar, M.SC. (from August, 1951)

Government of India Junior Scholar—K. N. R. Nair, M.SC. (up to June, 1951)

Government of India Junior Scholar—Apurba Kumar Ghosh, M.SC. (from June, 1951)

Government of India Junior Scholar—V. N. Gadgil, B.SC. (on deputation from Nagpur University from February, 1952)

Attached workers—D. K. Chakraverty, M.SC. (R. G. Kar Medical College, Calcutta)
Atindriya Bose, M.A. (Ramakrishna Vidyamandir, Belur)
Radhabinode Mazumdar, M.SC. (Vidyasagar College, Calcutta)
Miss Madhuri Dutta, M.SC. (Lady Brabourne College, Calcutta)
Dr. (Mrs.) Santi Batra, M.A., PH.D. (Cornell), (Lady Brabourne College, Calcutta)

Department of Microbiology :

Research Fellow—Dr. P. Nandi, M.SC., PH.D. (Lond.), D.I.C.
Sir J. C. Bose Scholar—S. P. Sen, M.SC.
Government of India Junior Scholar—Gurupada Sen, M.SC.
Attached workers—S. K. Mukherjee, M.SC. (Surendranath College, Calcutta)
Miss Chinmoyee Das Gupta, M.SC.
Anil Kumar Kundu, M.SC.

Department of Physiology :

Special Scholar—G. C. Bhattacharya

STAFF APPOINTED UNDER GRANT-IN-AID SCHEMES:

A. Department of Physics :

Board of Research on Atomic Energy:

I. Transuranic elements and nuclear fission of heavy elements:
Dr. M. S. Sinha, D.SC.

Mr. J. L. Chakraverty, M.SC.
Dr. B. Sarma, M.SC., D.PHIL. (up to January, 1952)
Mr. A. M. Ghosh, M.SC.
Mr. N. K. Ganguly, M.SC.

II. Use of photographic plates for the study of nuclear disintegration:
Mr. S. P. Dutta, M.SC. (up to August, 1951).

III. Setting up of medium voltage positive ray discharge tube:
Mr. A. N. Banerjee, M.SC.
Mr. H. Raha

B. Department of Chemistry :

Indian Central Jute Committee:

Impregnation of bleached jute yarns with suitable synthetic resins:
Mr. J. M. Sarkar, M.SC. (up to 13-6-52)
Mr. R. P. Chatterjee, M.SC.
Mr. A. C. Ghosh, M.SC. (from December, 1951).

C. Department of Botany :

Indian Central Jute Committee:

Production of suitable mutants in jute by X-ray irradiation—
Mr. R. K. Basu, M.SC.
Mr. D. P. Dutta, M.SC. (up to December, 1951)
Mr. B. C. Mukherjee, M.SC. (from March, 1952)

Indian Central Oilseeds Committee:

Scheme for inducing mutants with economic characters in til (*Sesamum*), rape and mustard (*Brassica*) by X-ray:
Mr. K. L. Chowdhury, M.SC.
Mr. Asok DAS, M.SC.

Government of West Bengal—Cotton Scheme:

Mr. A. K. Adhikari, M.SC. (also in charge of the farm at Falta)

National Institute of Sciences of India I.C.I. Fellow—

Dr. A. Ganguly, B.SC., PH.D. (Edin.) from 29-6-52

Sir J. C. Bose Research Fellow (Calcutta University):

Miss Mridula Dutta, M.A. (from 1-8-51)