

Bose Research Institute

ANNUAL REPORT

For the year 1950-1951

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Report of Bose Institute for 1950-51

Governing Body—Two meetings of the Governing Body, the Board of Trustees of the Bose Institute, were held during the year, to pass the Audited Accounts for 1949-50 and the Budget Estimates for 1950-51.

Council—Two meetings of the Council were held to pass the Audited Accounts and Annual Report for 1949-50 and the Budget Estimates for 1951-52. The Council extended the tenure of office of the present Director, Dr. D. M. Bose by two years.

Obituary—The Bose Institute suffered a severe loss by the passing away on February 2, 1951 of Prof. N. C. Nag who served as Assistant Director of the Bose Institute for a period of twenty one years, from 1918 to 1939. During the life time of the first Director, Sir J. C. Bose, he was entrusted by the latter with the general administration of the Bose Institute. After his retirement in October 1939 he served as honorary Assistant Director of the Institute for a further period of five years. Prof. Nag was interested in a wide range of subjects, from inorganic and industrial chemistry to agricultural chemistry as well in plant physiology and plant chemistry, in each of these subjects he made some definite contribution. He was a member of the Governing Body of the Bose Institute since 1918 and of the Council since December 1946.

Government Grant—During the year under review the Bose Institute received the following grants from the Department of Scientific Research, Government of India

Recurring grant	...	...	Rs. 1,25,000/-
Special Recurring grant for training in research	...	...	Rs. 4,200/- (for a period of seven months)
Non-recurring grant for purchase of special apparatus	...	...	Rs. 30,000/-
Total	...	...	Rs. 1,59,200/-

The following instruments were either purchased or have been ordered:
Beckmann's Spectrophotometer,

Optical parts for an Electrophoresis Apparatus

Phillip's Conductivity Bridge

Marconi's Capacity Bridge, &c.

The Government of India has been approached for a further non-recurring grant of Rs. 30,000/- for the purchase of additional apparatus.

Building—The buildings of the Mayapuri Research Station, Darjeeling suffered some damage during the severe rain storm which occurred in Darjeeling during June, 1950. Severe land slides occurred in the Bankside Estate below the Mayapuri Station, belonging to the Sir J. C. Bose Trust No. 1. Only temporary repairs have been made; the final repairs will be undertaken after the rains in 1951-52, when it is expected the final consolidation of the hill sides, which suffered damage during June, 1950, will take place.

Construction of the laboratory erected over the lecture hall was finished during November 1950, and dedicated by Lady Abala Bose on November 30, 1950. In addition to two fair sized rooms 30'×20' and 20'×14' and lavatories on the western end of the main hall, the floor area of the latter is being fitted up into fourteen cubicles. Equipment of the main hall with gas, water and electric connections as well as with laboratory furniture is nearing completion. It is expected that the greater portion of the laboratory extension will be ready for occupation by August, 1951. The cost of construction of the laboratory as well of furnishing and equipment has come upto about Rs. 1,16,500/-.

Plans are being made to demolish the row of one storied rooms forming the western end of the southern block of Institute buildings, and erect in its place a two storied structure of area 126'×13.6' which will be in conformity with the eastern half of the southern block. It is proposed to accommodate in the ground floor the workshop and in the first floor the library of the Bose Institute; both of these two departments have outgrown their present accommodations. The rooms which will be vacated by the workshop will be taken over by the administration, while that vacated by the library will be utilized for the extension of the Botanical Laboratory.

It has been estimated that the cost of construction will come upto about Rs. 80,000/-. The Trustees of Sir J. C. Bose Trust No. 1 have sanctioned a grant of Rs. 40,000/- for the furtherance of the objects of the Bose Institute, which the Director recommends should be utilized for this purpose. The Government of India has been approached for a capital grant

Extension of Agricultural Experiment Station—To provide land for the urgently needed extension of the Experiment Station, about 10 bighas of good agricultural land has been taken on lease, for two years, from a garden house property at Bamangachi on the Jessore Road, about 17 miles to the north of Calcutta. Accommodation of the staff and land workers has been provided in the garden house and in the attached godowns.

The work of supervision of the two branches of the Experiment Station, situated at Falta and Bamangachi, about 32 miles and 17 miles to the south and north of Calcutta, has placed great strain on the supervisory staff. The attention of the Directorate of Agriculture, West Bengal is being constantly drawn to the desirability of acquiring for the Institute Experiment Station about 40 bighas of *Khas mahal* land near the Falta Fort area, not very far from the present Experiment Station at Falta. The Government of West Bengal, we understand have agreed on the principle of acquiring the plot at an estimated cost of Rs. 50,000/-, but no practical step has so far been taken by them.

Acharya Jagadish Chandra Bose Memorial Lecture—The twelfth lecture of the series entitled 'Rain-Making' was delivered on the 30th November 1950 by Dr. S. K. Banerjee, D. Sc., F.N.I., lately Director-General Observatories. The lecture has been published and circulated.

In his Annual Report the Director reviewed the different types of biological investigations undertaken at present in the Institute. In addition to plant biology and microbiology, a section of plant virus studies is being opened. The viruses represent the smallest units of living matter with properties lying in the borderland between the living and the non-living.

Visitors—A number of distinguished people visited the Bose Institute during the last year, including H. E. Raja Maharaj Sing, Governor of Bombay, Prof. Bernard Mouat Jones (lately Vice-Chancellor, Leeds University) and Mr. Mills of the British Council; a Chinese delegation of Botanists including Profs. Woon-Young Chun, C. Y. Wu and U.Y. Hou; Prof. Perrin, Chairman of the French Atomic Energy Commission and Prof. Amaldi of Rome.

Lectures were delivered in the Institute by Prof. A. Muntzing, Institute of Genetics, Lund University on 'Genetics and Plant Breeding' and 'Polyploidy in plants'; by Prof. Leprince Ringuet of College de France, Paris on some recent cosmic ray investigations; by Dr. E. G. Bowen, Chief of the Division of Radio Physics, Australia on 'Solar and Galactic radiation

BOSE RESEARCH INSTITUTE

Staff—Dr. P. Nandi, M.Sc., Ph. D. (London) has been appointed Research Fellow in Microbiology and Dr. S. K. Roy, M.Sc., Ph. D. (London) as Research Fellow in Plant Physiology. Miss Mridula Dutta, M.A. has been appointed Sir J. C. Bose Research Fellow of the Calcutta University; she will join later. Sunanda Bose, M.Sc. has been appointed J. C. Bose Research Scholar in Biology. Sri R. P. Chatterjee, M.Sc. has been appointed Research Assistant in the scheme 'Impregnation of bleached jute yarns with synthetic resins' and Sri Asok Das M.Sc. has been appointed a Research Assistant in the Oilseeds Scheme.

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

Dr. A. Ganguli, Ph.D. (Edin.)	Plant virus
Sri Gurupada Sen, M.Sc.	Microbiology
Sri K. N. R. Nair, M.Sc.	Plant Physiology
Sri R. K. Bose, M.Sc.	Retting of jute
Sri N. C. Das, M.Sc.	Nuclear Physics

Dr. P. K. Sen Choudhury, D.Phil., ICI Research Fellow has been appointed Professor of Physics, Presidency College, Calcutta. Sri Byomkesh Sarma, M.Sc. of the Department of Chemistry has been awarded the D. Phil. degree of the Calcutta University.

Dr. M. S. Sinha, Research Fellow in Physics has returned, after an eight months stay as guest worker in Prof. Rossi's Cosmic Ray Laboratory in the M.I.T., Cambridge. He spent a part of his time in the high altitude laboratory at Echo Lake, Colorado. On his way back he visited some of the important laboratories in England, France and Denmark where Cosmic Ray investigations are being carried out.

Dr. S. D. Chatterjee, another Research Fellow in Physics, after completing his one year's stay in Ottawa as National Research Council Fellow of Canada, spent some time in the National Bureau of Standards and Carnegie Institute in Washington and Bartol Foundation in Philadelphia. After visiting some laboratories in England and Germany he is now on his way back home.

Sri Tarini Chandra Bhadra and Sri Amalendunarayan Banerjee were sent for eight weeks training in the Army Radar Training Centre at Jalahalli, Bangalore and to the Army Technical and Electrical Workshop at Agra respectively for training in Radar and Microwave techniques.

Grant-in-aid schemes—The list of schemes of investigations receiving

The Indian Council of Agricultural Research has offered to finance a five years' scheme of investigation on Weedkillers. The amount sanctioned for this project appears to be insufficient for the purpose. A representation has been made to the Directorate of Agriculture, West Bengal to supplement the ICAR grant. The matter is under consideration.

Plant virus investigations—A new section for plant virus investigations has been started during the year. A portion of the glass house has been equipped for this purpose, which includes provision for ventilation by fans, fine wire masked aphid proof openings for air circulation. The room during the summer months becomes uncomfortably hot, and is not suited for the growth of the experimental plants. As it will be too expensive to air condition the entire room, a smaller glass house has been built inside it which will be kept at a temperature between 70°—85° F by means of a small refrigerating unit. It is proposed to carry on both basic and applied investigations in plant virus diseases. At present investigations will be carried on virus diseases of the following economic plants - potato, jute, mulberry and bhendi. Such investigations will be especially useful to the State of West Bengal.

RESEARCH ACTIVITIES

A. PHYSICS

1. *Ultrasonics*—In previous reports mention has been made of investigations being carried out with a fairly powerful ultrasonic generator. Using an oscillator valve MT 9 and rectifier valve MR4 and quartz crystal transducer of dimension 6.25 cm² × 0.29 cm thickness, ultrasonic waves of frequency 1 Mc/sec. have been obtained. Using a single quartz plate oscillator preliminary measurements have given the following power input and output figures.

A.C. input of power to the oscillator valve about 2 kw

High frequency power output from the oscillator valve—1 kw

Input of power to the crystal transducer —0.9 kw

Output of ultrasonic power about —25 W per cm²

In last year's report it was mentioned that ultrasonic radiation of 1 Mc/sec. frequency had definite lethal action on large micro-organisms like Spirogyra, Paramecium, Yeast, *B. coli* etc.; it was not effective in killing smaller bacteria *e.g.*, those belonging to the cocci group. Various

size of the cocci cells may be small compared to the wave lengths of u.s. radiation used. For investigation of this and other problems another ultrasonic generator whose frequency can be varied from 1 to 17 Mc/sec. is being constructed.

Morphological and other changes in plant tissues due to exposure to 1 Mc radiations are reported elsewhere in this report.

1.1 Ultrasonic pulse generator circuit—For many applied investigations, like measurement of transmission and absorption coefficients in solids, detection of flaws in castings, under water depth measurements etc., ultrasonic radiations are sent out in pulses and after transmission through a given medium, are observed in a double beam oscilloscope, simultaneously with a part of the original pulse. For this purpose the following units are required;

(i) A generator of u.s. waves of frequency 1 to 18 Mc/sec. and variable power out put upto 200 watts. This unit has been assembled.

(ii) Detector of the radiation attenuated after traversing an absorbing medium.

(iii) A timing oscillator to synchronize all the different units

(iv) A modulator by which the u.s. radiations are generated in short pulses and repeated at a given time intervals.

(v) A double beam oscilloscope—already purchased

(vi) A signal generator, to calibrate the pulses from the oscillator unit. This apparatus will require to be purchased.

2. X-rays—This radiation is used principally for plant irradiation investigations. A second continuously evacuated x-ray tube with demountable incandescent cathode has been constructed in the workshop. It can be run continuously at 40 kv, 30 mA output. Both these tubes are being daily used for irradiation of seeds of economic plants like jute, cotton, and oilseeds.

A x-ray diffraction camera for investigations of contractile tissues in plants is being set up. Recent investigations by Astbury *et. al.* have shown that some of the motile bacterial flagella give x-ray diffraction pattern similar to those given by unstretched and stretched keratin fibres, like fibrous muscles and hair. It is planned to study the x-ray diffraction pattern given by contractile tissues of plants like *Mimosa* and *Desmodium*.

2-1. Dosimetry—During the last year a x-ray dosimeter was construct-

amplifying circuit. The latter consisted of a RCA 954 tube with a second triode valve amplifier and gave a reading of $100\mu\text{A}$, when a 1 mg Ra source was placed at a distance of 5 cm from the ionisation chamber. The RCA 954 valve is being replaced by an electrometer tube, Phillips 4060, with a view to making the arrangement more sensitive as well as portable. This Dosimeter is at present too sensitive for use in measuring the x-ray intensities employed in the seed irradiation experiments. Recently the electronic amplifying system has been replaced by a string electrometer and preliminary measurements have shown that at 10 mA x-ray current normally employed for irradiation of seeds contained in a capsule placed at a distance of 35 cm from x-ray tube, the energy flux is about 100 roentgen per hour. The arrangement is being further tested and modified.

3. *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 in which a maximum production of Hydrogen atom ions take 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. In the last year's report it was mentioned that such discharge maintained between electrodes placed outside the glass discharge tube, gave an appreciable yield of atom ions which could be increased by placing the discharge tube inside a magnetising solenoid. The focussing condition of the beam was found to depend on the ratio of V_1 to V_2 where V_1 is the extraction voltage and V_2 the accelerating voltage, and not on their absolute values. Last year a pushpull circuit of two 826 valves was used for generation of h.f. current of frequency 40 Mc/c.

This year it was found that the above arrangement of valves could not maintain the discharge current satisfactorily. A new three stage h.f. power generator of power output 200 watts at frequency 20 Mc/sec. has been assembled to give higher output of current. Following recent results obtained in other h.f. laboratories, the electrodes placed outside the discharge tube has been replaced by a solenoid wound over the tube through which the h.f. current circulates. This is reported to give a better yield of atom ions. An additional axial magnetic field is then not necessary.

has been found to be about $60\mu\text{A}$. It has been magnetically analyzed by placing the discharge, in the field free space of the positive ray tube, in a variable magnetic field due to a Helmholtz coil receiving the deflected beam on a Faraday cylinder connected to earth through a microammeter. It was found that about 37 per cent of the beam current is carried by atom ions. By varying the conditions of discharge, and at the same time increasing the value of the extraction voltage, a higher discharge current and a larger yield of atom ions will be obtained. With such a strength of atom ion current and with an accelerating voltage of about 200 kv, other investigators, using a D-D. reaction, have obtained a yield of neutron equivalent to that due to a 2 gm Ra-Be source.

3-1. *Voltage multiplication arrangement*—For the second part of the investigation, a Cockroft-Walton arrangement suitably modified, is to be employed; the aim is to reduce the size and therefore the cost of the condensers and rectifying valves and use those employed in radio industry. For this purpose an initial high frequency voltage, which may be of the order of 0.5 Mc/sec., is necessary. One of the difficulties to be overcome is the heating of the rectifying valve cathodes under conditions of high insulation. Different methods have been employed in other places, like application of radiofrequency induction heating of cathode, or by using a cascade of ring shaped heating transformers, whose cores are made of high insulation ferrite materials. A third arrangement which have been tried is to employ selenium cell rectifiers. This last is the most convenient arrangement, but it is not yet known to what frequency a selenium rectifier will retain its property of rectification. A pilot plant is being set up to generate 50 kv by multiplication in ten steps. The r.f. (100 k.c.) voltage (5 kv) developed across a high Q coil of the final tank circuit, of a two stage oscillator, is inductively coupled to the multiplication circuit. The difficulty encountered at present is to obtain locally, suitable condensers. It is proposed to heat inductively the cathodes of the rectifier tubes.

4. *Cosmic ray measurements*—Continuous measurements of cosmic ray intensity by means of a pressure ionisation chamber, as described in previous reports, is being continued. Only two variations in cosmic ray intensity of some significance have been noted during this period. The first one occurred during the period 7th to 11th August 1950. In addition to the usual decrease in intensity associated with magnetic storms, there was an increase in intensity on 8th August, almost 24 hours before the commencement of magnetic storm, when the earth's horizontal intensity was well below normal. This occurrence is probably due to the solar

the period February 26 to March 2, 1951, and was accompanied by the usual magnetic disturbances. The latter was not of the sudden commencement type, and during the period from February 27 to March 2, the cosmic ray intensity remained below normal.

A large pressure ionisation chamber of volume 28 liters and capable of standing a pressure of 80 atmospheric is under construction. With such large chambers, variations in the record of cosmic ray intensity due to fluctuation effects will be largely eliminated, and it will be possible to record minor variations in cosmic ray intensity due to barometric pressure variations, diurnal effect etc.

A counter telescope consisting of 2 layers each of two G.M. counters, of length 40 cm and 4 cm diameter, connected in parallel is under construction. For continuous recording, a scaling circuit with accessories is being assembled.

4.1 *Wilson Chamber*—Production of mixed showers, containing both electrons and mesons, due to close nuclear interactions with penetrating cosmic ray particles is being continued with the arrangement described in the previous report, viz., a four fold coincidence counter system, with two counters above and two counters below, used to trigger a Wilson chamber, above which different thickness of lead upto 20 cms are placed. Inside the chamber are put three lead plates of total thickness 4 cms which serve to distinguish the nature of the particles constituting the showers.

A new cloud chamber, rectangular in shape and of dimension $24'' \times 24'' \times 12''$ is under construction. There will be space in it to insert 14 plates of thickness $\frac{1}{4}''$ which can be either of lead or aluminium. With this chamber a better discrimination will be possible between the different kinds of particles emitted during nuclear interactions with high energy primary cosmic ray particles.

A small cloud chamber of diameter 6" and depth up to 4" has been constructed, which can be placed between the pole pieces of an electromagnet, with yoke 8" diameter and adjustable gap between 4" to 8", and in which a magnetic field from eight to ten thousand gauss can be maintained. The electromagnet components are under construction.

The apparatus will be used for the study of delayed emission of charged particles like pi or mu mesons undergoing disintegration inside the small Wilson chamber. From momentum loss in a plate placed inside the chamber and the curvature of this tracks in the magnetic field the mass of the disintegrating particles will be determined. A CR delay circuit is under

4.2 *Nuclear emulsion plate*—Recent trend in the application of nuclear emulsion plates for cosmic ray research is to send the plates to altitudes of the order of 100,000 ft., by means of balloons and to use the newer plates like Ilfords G5 which record tracks of fast minimal ionizing particles. These plates, being extremely sensitive to β -ray tracks arising from radioactive contamination, can not be stored at altitudes of say 12000 ft. (Sandakphu) for any length of time like Ilford C₂ plates, without being considerably fogged. A trial attempt was made to send these plates in aeroplane which undertake journeys at altitudes upto 14,000 ft. for a period of three weeks. The plates when developed showed great deal of blackening.

Recently arrangements have been made, through the courtesy of the Director of the Regional Meteorological Observatories with head quarters at Alipore, to send up small batches of plates in pilot balloons which carry radio sonde arrangements for recording from the ground station, the altitude, temperature and humidity. Such balloons reach altitudes upto 40,000 ft. after which they usually burst. The recording instruments enclosed in light bamboo cage are often recovered; the finder being offered a suitable reward. An additional reward has been offered to the finders of cages in which packets of plates have been attached.

5. *Nuclear Physics*—Investigations on the absorption cross section of uranium oxide for neutrons as described in the previous report is being continued. The value for the thermal neutron absorption cross section for uranium has been found to be $30 \times 10^{-24} \text{cm}^2$ as compared to the values of $15 \times 10^{-24} \text{cm}^2$ given in the declassified documents of the USA and the Canadian A.E.C. The much larger value found here is probably due to one or more of the following factors: (i) impurity of the sample of uranium oxide employed. The sample is being repurified; (ii) lack of efficiency and good geometry of the neutron detector employed. The latter consisted of a G.M. counter with a thin silver anode, which after exposure to the neutrons transmitted through a spherical uranium oxide absorber, had to be taken to another place for counting the emission of β -particles. The neutron source of 160 mc Ra-Be is a strong emitter of γ -rays which makes it impossible to count *in situ* the emission of β -particles from the silver anode counter.

5.1 *Photomultiplier arrangement for the counting of charged and uncharged nuclear radiations*—The phosphorescence emitted by certain transparent organic and inorganic crystals, under impact of different kinds of nuclear radiation, and detected by a photomultiplier arrangement, is a very

is very small, the counting rate is fast, and the geometry is good, as the area of the surface exposed to radiation can be made very small. By admixture of a substance like boron or lithium to the detecting crystal, it is possible to use the arrangement for neutron detection.

A wide band high gain amplifier, a discriminator, and a scaler of 64 counts have already been constructed. Counting of dark current pulses of a 981A photomultiplier tube has already been undertaken. By means of the discriminator circuit, this background count can be reduced to any desired level. The arrangement is being tested for the detection of β -particles and γ -photons. For the present an anthracene crystal is being used as detector.

5.2 Low pressure Wilson Chamber—The construction of this chamber filled with hydrogen at 20 cm pressure has been described in a previous report. Using as a neutron source (160 mC Ra-Be) placed above the chamber and a thin film of uranium oxide inside the chamber, a large number of photographs have been taken. Under the conditions prevailing in the chamber, secondary β -particle tracks due to γ -rays are eliminated, and those due to α -particles from uranium are minimized. A few probable fission tracks have been observed in hydrogen. One of the surest method of detection of fission particles is by the observation of recoil delta particles produced by them. The operation of the chamber not being fast, the delta particles are not clearly visible in the photographs. In order to increase the efficiency of the counter a blue print of an expansion valve, arrangement as used in Prof. Bohr's laboratory, has been obtained, and a similar one is being made here. Attempt is being made to prepare Ethyl borate, a volatile compound of boron, which when introduced in the cloud chamber, will by the production of α -particles from neutron absorbed in Boron 10, give amongst other results an estimate of the neutron flux in the cloud chamber and consequently of the fission cross section of uranium and other elements for slow neutrons.

5.3 Radioactive Tracer—Radioactive phosphorus P_{32} , by irradiation of CS_2 with neutron from a 100 mc Ra-Be source has been isolated and its β -ray activity was measured with a gold leaf electroscope, which had been standardised with a known source of UX_2 whose β -ray energy spectrum is similar to that of the β -rays from P_{32} . The total activity of the radioactive phosphorus precipitated, was found to be equal to $0.082 \mu C$ —a quantity too small for use in tracer technique, taking into consideration the sensitivity of the β -ray detectors available in the laboratories.

The recently assembled photomultiplier counting circuit has been found

of P_{32} . Experiments have been started to follow the path of ascent of P_{32} nutrient salt in the plant when supplied to the roots.

Arrangements are being made to use radio active C_{14} for tracer work in connection with photosynthesis, in chlorophyll containing plants. 5 mc of C_{14} in the shape of $BaCO_3$ is being imported from the Radiochemical Centre at Amersham, England. Attempt is being made to make β -ray counters with mica end window thin enough ($2-3 \text{ mg cm}^2$) to count the soft β -rays emitted from C_{14} . Enquiries have been sent to England for the purchase of such counters manufactured by the G.E.C., England. At the same time it is being investigated whether the photomultiplier detector can be used for the detection of soft β -radiation.

5.4 *Paper Chromatography method of separation of U and Th from rare earths*—The following solvents were tried:

(i) Butyl alcohol saturated with HCl (ii) Cyclohexane with 8N HNO_3 (iii) Amyl alcohol saturated with water (iv) 50 per cent chloroform in alcohol with 5NHCl resp. 8NHNO₃ (v) Propyl alcohol with 5NHCl (vi) Ethylacetate with 8.5N acetic acid.

The filter paper was sprayed with $K_4Fe(CN)_6$ resp. with alcoholic solution of Alizarine, to develop the U and Th spots. From the R_F values for U, Th and the rare earths obtained, it is concluded that these metals are easily separable by the different solvents used when two dimensional chromatography is used. Only with solvent (vi) Ethyl acetate + 8.5N acetic acid, such separation is possible using one dimensional method.

5.5 *Separation of U and Th using microphoretic method*—This method has been recently applied by some investigators for the separation of some ions of the first transition group of elements. Fifty experiments were performed for the separation of Th from U. No clear separation of the U and Th cations could be obtained. Each cation leaves a diffuse tail, the corresponding sprayed band appears to extend over a few cm. length. The method is not satisfactory.

5.6 *Analysis of a black sand collected from seashore near Puri*—The following results were obtained:

Loss on ignition	1.59%	U_3O_8	0.0022%
Silica	35.64%	ThO ₂	0.09%
Fe_2O_3	30.46%		
Al_2O_3	15.39%	rare earth oxide	0.30%

From the analysis it is concluded that the sample is a mixture of silica, Ilmenite, Bauxite, and Monazite (approximately 1 per cent).

B. CHEMISTRY

A special room has been fitted up with instruments required for investigations in physical chemistry. Instruments already purchased include a pH meter, a Pulfrich Colorimeter, a Conductometer, a Polarimeter, and a Microbalance; a Beckmann's Spectrophotometer has been ordered as well as the optical components of a Tiselius Electrophoresis apparatus. Most of these apparatus required for columnar and paper chromatographic work have been assembled. The latest addition being an apparatus for the desalting of solutions before subjecting them to paper chromatographic analysis.

1. *Chromatography*—The physicochemical aspects of the mechanism underlying paper chromatography have been studied in detail, including the influences of water content, quality of paper, distance, supply of solvent, quantity of the solute, extraneous substances, temperature etc. It has been established that the cellulose does not play a completely inert role as was assumed by the pioneers of the technique. There is some amount of adsorption on the filter paper.

The technique has been applied to determine the free amino acids present in the leaves of *Mimosa pudica* and *M. spegazzini*. A fair number of amino acids have been found to be present in the leaves, of which aspartic acid, glutamic acid, glycine, alanine, valine, tryptophan etc. occur prominently.

A similar investigation has been undertaken in collaboration with the Microbiology Department, to separate and identify the free amino acids present in the nodules and roots of certain leguminous plants. The identities of some of the amino acids have been established. The work is being continued. This technique is being also applied to the study of the enzymatic breakdown of pectin and of pectin like substances supposed to be present in jute.

Columnar method of chromatography is being applied to the isolation and purification of estrogenic hormones and their intermediaries using a column of Brockman's alumina. An apparatus for continuous circulation of effluent is being set up. This will make the columnar chromatography process automatic.

2. *Herbicides*—Two new methods of preparation of 2,4-D have been worked and published. A new herbicide 2-Methyl-4-Dichlorophenoxyacetic acid has been prepared.

phenoxy acetic acid has been prepared, starting from a coal tar derivative, a chlorinated products of carvanrol (2-4-5-D). This substance is a white crystalline solid, which when applied at concentration of 1 per cent in benzene and kerosene solution showed toxic effect, while at the lower concentration of 0.1 per cent only a physiological effect viz. cell elongation. The minimum dose for toxic effect within 48 hours was found to be 0.2 per cent, and for cell elongation .01 per cent. A comparative study was made by spraying on leaves of water hyacinth, 0.5 per cent solution of 2-4-D resp. 2-4-5-D. Within 7 days in the former case the leaves, stems, as well the roots decayed completely, but with the latter compound only leaves and stems were affected; within seven days fresh budding took place. The difference in toxic effect was attributed to the difficulty of translocation of the new herbicides to the roots.

3. *Impregnation of Bleached Jute Yarns with suitable Synthetic Resins*

—Previous experiments indicated that sodium chlorite bleaching of jute yarn gave stronger wet strength after impregnation than with bleaching powder, which is the cheaper process. Present year's investigation shows that if jute is extracted with alcoholic pyridine, the bleaching powder method gave equally good result.

Bleached impregnated jute is stiffer than textile fibres. Experiments were carried out to investigate the effect of certain technical softening agents *e.g.*, Velan P.R. and Ceresol. Results obtained are hopeful.

4. *Biochemistry of jute retting*—The purpose of the present investigation is (i) to isolate the different strains of bacteria, cultured from jute retting water. Three aerobic strains have been isolated, which have been found active in retting. Further three anaerobic strains have been isolated and their retting activities are being studied. (ii) The biochemical process underlying retting is being studied. The problem is to find out the nature of the pectin like matter in jute and of their cleavage products during retting. The action of pectinase on pure citrus pectin was investigated with the help of paper chromatography. Taka diastase, in contrast with other pectinases, gives galacturonic acid without the formation of any other intermediate compounds. Pure galacturonic acid was prepared in the laboratory by the acid hydrolysis of citrus pectin. The product in the two cases were found to be identical on the paper chromatogram. The pectin matter from the dried jute stems has been isolated. The action of different pectinases on this substance is under investigation.

Chemical analysis of other constituents of jute stems have also

C. PLANT SCIENCES

C.1. PLANT PHYSIOLOGY

Studies on the mode of production and the physiological role of the auxin B Indole acetic acid (IAA) in plants.

1.1 *Biosynthesis of IAA in Avena*—Investigation by Wildmann, Bonner, Gordon and others make it probable that both in spinach and in *Avena*, IAA is produced by enzymatic breakdown of tryptophan. The present investigation aims at a detailed study of the mechanism of conversion of tryptophan to IAA and of the enzymes involved in the process.

Preliminary to this it was necessary to standardise the quantitative production of IAA. For the purpose, the colorimetric method devised by Salkowski's was adopted. By this method the variation in concentration of IAA from 1 part in 50,000 to 1 in 600,000 could be measured. For the bioassay of auxin, a test similar to 'pea test' of Overbeck and Went, but employing lettuce instead as test plant (Lacey), was adopted. The test worked satisfactorily for IAA concentration varying from 1 in 10,000 to 1 part in two millions.

The enzyme preparation required for conversion of tryptophan to IAA was isolated from decapitated tips of *Avena* coleoptiles following the usual technique. dl tryptophan hydrochloride solution in phosphate buffer, was incubated with the enzyme. After the usual procedure, the final extract containing the auxin, and the Salkowski method of colorimetric test gave a weak coloration, showing the conversion of tryptophan to IAA by enzymes isolated from *Avena* coleoptile tips. Attempts will be made to purify and fractionate the enzymes extracted from the tips.

1.2 *Effect of IAA on plant respiration*—Recent investigations on the role of the auxin IAA on plant metabolism have made it probable that this auxin acts as prosthetic group in the respiratory enzymatic processes involved in pyruvic acid metabolism and also of adenylic acid arginine metabolism. It is proposed to study the influence of this auxin on other respiratory systems like oxidases, dehydrogenases, deaminases, transaminases etc. which probably have important influence on cell growth and proliferation. As a first step, the old Warburg Manometer, made in the Institute Workshop, has been altered and reconditioned and made up to date of recent models. The flasks of 50 ml capacity were found to be too large, reducing the manometer sensitivity. They have been replaced by smaller flasks each of 15 ml capacity. The calibration of the flasks and the volume content of each manometer has been

coleoptile segments under varying conditions and with different substrates is being studied.

1.3 *Effect of indoleacetic acid on the the growth of plants*—Studying the effect IAA on the growth of plants, experiments were conducted with tomato and tobacco plants. Seedlings from the same stock in each case were grown in different groups on soil in pots. One group was left as untreated control. In other groups they were treated with IAA. For application of the growth regulator, IAA was used in concentration of 0.005% and 0.01% in solution, and was applied by spraying on the leaves in one set, and by spraying on the soil in the other. The treatment was meted out only during the early part of the growth

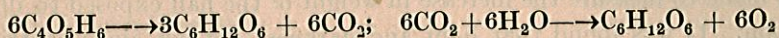
In tomato, apparently there was small differences in sizes of the plants of the different groups. However, the groups receiving 0.005% of IAA produced earliest flowers and earliest fruits. In these groups, the fruits were also largest in size. The groups receiving 0.01% of IAA also flowered and fruited before the control group. They also produced the largest number of fruits. There was practically little difference between groups receiving the same concentration of IAA, but under different treatments namely in soil or on leaves.

In tobacco, the plants in groups receiving auxin treatment grew much better and produced leaves which were distinctly larger in size and number than the untreated plants. Among the auxin treated plants the group receiving 0.005% IAA on leaves produced the best leaves both from the point of size and number. In groups receiving 0.01% of IAA, the leaves although larger in size than untreated controls, were not so encouraging as the leaves in 0.005% group. The tobacco leaves have been harvested and are being dried prior to their analysis for nicotine content and other chemicals like sugar content, nitrogen content etc.

The tomatoes are awaiting harvesting, when they will be analysed for seed content and sugar, nitrogen, and vitamin contents.

1.4 *Investigations on photosynthesis in plant*—It was shown by Sir J. C. Bose that organic acids can serve directly as a substitute for CO_2 in photosynthesis of plants. He found remarkable resemblance in photosynthetic reactions under increasing concentrations of CO_2 and of malic acid. Previous to him, Gerber and Aubert suggested that under the influence of light the organic acid is split up into sugar and CO_2 . When the photosynthesis is dependent on an organic acid, it can be assumed that a part of the organic acid is fixed in the plant directly as glucose,

the other part of the acid is fixed again in the plant by ordinary process of photosynthesis. When malic acid is the photosynthetic substrate the overall reaction can be assumed to be as



which shows that from the splitting up of malate, three parts are converted into carbohydrate by the direct action of light on the acid, and one part of carbohydrate is constituted from the CO_2 evolved, by way of normal photosynthesis. Assuming this, when the CO_2 concentration of an aqueous solution is equivalent to the CO_2 released from a malic acid solution, the increase of weight after photosynthesis of a plant in a malic acid solution will be four times that in the CO_2 solution. The problem was to test this assumption experimentally by a quantitative study. For this purpose it was thought that the torsion balance method described by Sir J. C. Bose in his monograph 'Photosynthesis' would be most suitable. *Hydrilla* plant being used by Bose in all his experiments, was similarly used for the present one.

Arrangements were also made to analyze the evolved gas due to photosynthesis. It was found that both in the malic acid solution as well as in water charged with CO_2 the percentage of oxygen in the collected gas varied from 60 to 80 per cent.

The increase in weight of two similar *Hydrilla* twigs, which under photosynthesis evolved the same volume of O_2 gas was determined when (i) one of the twig was immersed in CO_2 water and (ii) the second in an equivalent concentration of malic acid. According to the assumptions given above on the mode of conversion of malic acid into glucose, the relative increase in weight in the two cases would be 4 to 1. If the ratio came out otherwise, then it would be necessary to derive an alternative hypothesis on the mode of utilization of malic acid by *Hydrilla*. A great deal of time and ingenuity were spent in constructing a sensitive torsion balance and also in devising precautions for obtaining concordant weighings. Two sets of difficulties were encountered (i) that the gas evolution from the twigs immersed in water varied in an uncontrollable way and (ii) slight changes in the position of the leaflets (from vertical to horizontal), result in changes of weight as indicated by the torsion balance.

For these and other reasons, it was concluded that determination of increase in weight of a plant immersed in water due to photosynthesis would not give reliable results.

Next an attempt was made to determine the increase in weight of a

Thankuni leaf, divided into equal halves by cutting through the mid rib and petiole, were suspended from two arms of a torsion balance; they were enclosed in glass vessels kept saturated with water vapour. Attempt was made to measure the increase in weight of the half exposed to illumination. It was found that light and darkness did not alone contribute to increase in weight resulting from photosynthesis. Respiration, transpiration, and dark fixation of CO_2 were some of the variable factors which contributed to anomalous increases in weight of one or other of the two halves of the leaf suspended from the two arms of the torsion balance.

The conclusion was reached that estimation of carbohydrate formation by the weighing method was not feasible. The investigation was for the present discontinued.

1.5 Investigation on the Relation between Transpiration and Diametric Growth—In previously reported investigations on Growth, no definite correlation could be found between longitudinal and diametric growth. An investigation was begun to find out whether any definite correlation exists between transpiration and change in diameter of the stem. Transpiration affects the cell turgidity, and it may be assumed, that thereby, it may induce changes in diameter.

For observing transpiration the plant was placed in one arm of a U-tube containing a culture solution. A suitable hollow glass tube with its lower end closed was introduced in the thinner arm of the U-tube and connected with the recording lever. The water surfaces of both the arms of the tube were covered with thin layers of oil in order to prevent surface evaporation. Thus the lowering of the water level indicated transpiration which was recorded on the smoked glass plate. The plant-sphygmograph was suitably attached at a convenient place on the stem and connected to a second lever for recording on the same smoked glass plate changes in diameter.

Series of records were taken with a number of plants. The diametric growth curve was seldom found to be correlated with the transpiration curve. In some cases, however, the growth was found to increase in the evening when there was sharp fall in the transpiration curve.

1.6. Determination of the diametrical growth of a region on the stem in a plant—The usual method of determination of growth in thickness is by means of a sphygmograph devised by Bose. With this method the growth changes, limited to a particular point, could only be studied. It is difficult by this method to get a picture of the growth in thickness of

at different points at the same time. If the growth changes of a certain region containing many such points, could be studied as a whole, the nature of changes will certainly be better understood. Moreover, in the study of longitudinal growth, the observation is not limited to a point; a certain length of the stem or the entire plant is brought under study. When both the growth processes are compared it will be more appropriate if the growth in thickness of a particular region is taken into account.

In attempting to record the growth in thickness the following device was adopted: A glass tube, half an inch in diameter and two inches in length having both ends open, had a bent side tube one-fourth inch in diameter fused to it, with its open arm parallel to the wide tube. The wide tube is longitudinally slit by grinding, so that the stem of the plant could be introduced through this slit portion and secured in place with the help of some plasticine and a piece of plane glass. The interspace of the tube was filled up with mercury which also flowed into the side tube. A suitable iron float introduced into the side tube was attached to a recording lever. Any change in thickness of the stem brings about rise and fall of the mercury level, and is recorded by the lever on the smoked glass plate. The growth changes in thickness of a particular region can be quantitatively determined from the volume of mercury displaced.

In working out the device it was found that young and soft plant stems cannot withstand the pressure of mercury and wither in a few days. The method can be suitably used with mature stems whose growth changes can be consequently measured. The mercury could not be substituted by lighter liquids, like oil or water, which would have been desirable on account of their lower densities, on account of the change of their absorption by the stem. The investigation is being continued.

1.7. *Investigation on the rhythmicity of growth*—In investigations reported previously on the periodicity of growth, the diurnal growth in most cases were found to proceed in a pulsatory manner. In order to obtain more information on the subject further work has been undertaken. Growth is being studied under controlled conditions of light, temperature and humidity. The growth curve obtained under such conditions has no diurnal variation, but the curve is found to proceed in a rhythmic way. Further work is being continued for obtaining additional data on this rhythmic phenomenon in growth.

C.2 PLANT PATHOLOGY

2.1. *The 'die back' disease in Jute*. In course of investigations on inte

kept in open, it was first noticed in 1940 that many of the plants developed characteristic symptoms which later on was named as die-back disease. Many and varied causes for the disease have been put forward. Here in this Institute attempts were made to eliminate the disease by application of boron in different concentration, keeping all other nutrient elements intact; but to no effect. Secondly, as the disease appears in the middle of July during the period of drought, experiments were conducted in pots which were always saturated with moisture from an outer vessel, the height of water in the latter being maintained constant. In this case also the disease came almost at the same period with equal virulence. Thirdly, suspecting that as the disease appears when there was comparative drought and less rainfall, it was supposed that the original concentration of nutrient was changed by absorption by plant roots or rather the pH of the solution had gone more to the acid side thereby interfering with the supply of nutrients to the root. To test this point experiments were conducted with different pH cultures. But even then the disease came over the plants at the same time. Finally it was thought worthwhile to alter the ratios of N.P.K. in the nutrient solutions. With this end in view 8 different concentrations of P in the nutrient solution was tried.

Jute seeds were sown on 24.7.50 in sand and irrigated with tap water. On 8.8.50 seedlings were transplanted in earthenware pots containing sterilized sand. Pots marked A,B,C,D,E,F,G,H received different concentrations of PO_4 ions varying from 0, .05, .1, .5, 1, 2, 5, and 136 ppm respectively. Each series contains 15 plants grown in 5 pots, thus each pot contains 3 plants. The nutrient used were Hoagland's solution. The trace elements used being H_3BO_4 , MnCl_2 , ZnSO_4 plus a little of iron applied occasionally. Measurements of height of plants were recorded from 15.8, and continued upto 24.9, after which date the majority of the plants suffered from the die-back disease and finally died. The average growth measurements of plants in the course of 32 days beginning from 15.8 to 17.8 are given in the following Table:

Series of specimens	Concentration of PO_4 ion in ppm.	Transferred 8.8.50	Heights on	
			15.8.50	16.9.50
A	0		3.8 cms.	13.1 cms.
B	.05		3.6	13.2
C	.1		3.2	12.7
D	.5		3.0	11.2
E	1.0		3.5	12.9
F	2.0		2.9	9.7
G	5.0		2.8	10.5
H	136		2.8	10.5

It is to be noted that during one month the plants grew more or less unaffected. The plants marked A,B and C which received respective concentrations of 0, .05 and .1 ppm of PO_4 ion practically showed no symptoms of the disease, in the other five series of specimens however marked D, E,F,G and H receiving respectively .1, 1, 2, 5 and 136 ppm of PO_4 ion, on an average of 4 out of 15 plants were attacked with the die-back disease. Special mention may be made that the plants marked H, receiving 136 ppm., that is molar concentration of phosphate showed the highest growth and also suffered most. It is concluded that different PO_4 concentration had no effect in preventing the die-back disease.

It appears that the 'die-back disease' in jute may not be of physiological origin. Similar investigation carried out on mulberry plants has made it probable that the disease 'die-back' in them also is probably not of physiological origin. Plants grown in the plains under different manurial conditions show the effect, while in Kalimpong or in Mysore, at comparatively higher altitudes the disease does not appear. It seems probable that in both the plants the disease may be of a virus origin.

Experiments were started late in the season to test this hypothesis. From amongst the survivors of the jute plants from the above investigations, on February 5, 1951 some of the top most leaves were rubbed on leaves of healthy 5 days old transplanted tobacco plants. The tobacco plant leaves at first showed a few lesions characteristic of virus infection. Transfusion of sap to another set of healthy plants did not show the characteristic effects. Probably the conditions were not favourable to the optimum growth of virus. The investigations will be continued next year.

2.2 INVESTIGATIONS ON VIRUS DISEASES IN PLANTS

Potato—An insect proof glass house being an essential requirement for virus research work, arrangements were made to repair the existing glass house. The glass house and the other accessories for the laboratory were ready by the end of December 1950. Hence the research work could not be started before the beginning of January 1951.

To obtain a general idea about the viruses in the potato varieties *e.g.*, Red Round and White Round, twenty apparently healthy tubers and twenty diseased tubers from each variety were planted in pots. The diseased and the apparently healthy tubers were respectively obtained from the Special Officer (Potatoes), Government of West Bengal and from some

The following are the results obtained

TABLE

Variety	No. of tubers	Healthy	Mild mosaic	Severe mosaic	Leaf-roll
Red Round (healthy)	20	8	8	2	2
Red round (diseased)	20	2	8	4	6
White Round (healthy)	20	12	5	3	0
White Round (diseased)	20	7	9	4	0

The above mentioned results are based on the symptoms observed on the plants themselves.

To identify and separate the viruses, White Burley tobacco plants were inoculated with the sap obtained from the potato plants showing symptoms. Tobacco plants infected with sap from the potato plants showing mild mosaic symptoms produced necrotic local lesions on the inoculated leaves. Some of the tobacco plants infected with sap from the potato plants showing severe mosaic, also produced local lesions on the inoculated leaves. Those local lesion symptoms were followed by typical potato virus 'X' symptoms. Different types of mottling were also observed on those tobacco plants giving an indication of the presence of different strains of virus 'X' in those plants.

In some cases virus 'X' seemed to be mixed with virus 'Y' or some other viruses. Hence to purify the virus, *Datura* plants were infected with the sap from those tobacco plants showing symptoms. Attempts were also made to separate the virus and its strains by mono-lesion technique. But further work was not possible due to the unfavourable conditions of the glass house. The temperature of the glass house went upto 106°F which is unfavourable for virus work.

Hence another glass chamber with cooling arrangements inside the glass house is being constructed.

Attempts were also made to transfer virus 'Y' from the potato plants showing severe mosaic symptoms to white Burley plants with the help of aphides. Some of the tobacco plants showed definite vein banding symptoms. But this work also could not be carried out due to the unfavourable conditions of the glass house.

From the Table it seems that White Round is more resistant to Leaf-

deal of importance in breeding leaf-roll resistant potato varieties. Hence this resistance quality in White Round potatoes should be investigated.

It may also be mentioned here that more than 60% of the white Burley tobacco seeds germinated and plants grown under insect proof condition showed symptoms of tobacco necrosis. It seems that the virus is carried through the seeds. The question of seed transmission of tobacco mosaic virus is still a controversial problem. But upto now there seems to be no evidence for the transmission of this virus through tobacco seeds. The present investigation of this problem will be of great importance.

The virus worker went on tour to Darjeeling to obtain a general idea about the extent of virus infection in the seed growing fields. A visit to the Bhanjang farm (Government of West Bengal) gave the worker an opportunity to make comparative study of the occurrences of virus diseases in different varieties of potatoes. Arrangements have also been made with the Field Officer, Potato, Government of West Bengal, to obtain samples of different virus infected potato plants for investigation.

C.3 PLANT BREEDING & CYTOGENETICS

3.1 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 sixth year of investigation, during the year under report.

The year under report was favourable for the growth of cotton plants, with the result that the yield obtained during three months of this season equalled the total yield for the previous year.

During this year, 401 strains were grown at the Breeding station at Falta, as against 757 of the previous year. Thus a number of strains which were either late, or poor yielders were discarded for the time being, although some of them may have given favourable results under different environmental conditions. This could not be tested due to lack of facilities. This reduction in number of strains helped in the growing of more plants of the selected types, so as to get a better idea of the yield.

The strains consisted of 29 parent types, 308 hybrids from the F_2 to the F_8 generations, the rest being reciprocal, cyclic and multiple crosses from the hybrids. The Parbhani—American type, distributed by the Department of Agriculture, W. Bengal, was also grown along with our

ning percentage than many of our strains. The Sea Island cotton was also grown for the second year. This type has a lint length of 50.5 mm with a ginning percentage of 26.5 under the environmental conditions at Falta. But this type was found to be best suited for growing under the shades of other trees, and can form a suitable 'cover crop' in coconut and other plantations, giving a subsidiary income. Moreover, the seeds of this are fuzzless and hence easier for ginning.

The above strains were studied in the field for their adaptation to the environment, resistance to pests and diseases, date of flowering, lint length, ginning percentage and the number of bolls per plant. The following table (Table I) gives in details some of the above data on 27 strains, including some of the parent types.

TABLE I

Serial No.	Name of Types	No. of day required for the first flush	Lint length in mm	Ginning percentage
1.	CO ¹	69	32.5	36.0
2.	4F	87	34.0	36.2
3.	920	86	32.0	37.2
4.	LSS	76	33.5	35.5
5.	Co ²	92	34.5	35.0
6.	7682	74	34.5	36.0
7.	7682-18B	75	36.5	35.5
8.	CO ⁴ -B ₂ O-21	101	34.5	36.7
9.	CO ² -41	94	34.5	36.6
10.	7682-21 × CO ⁴ × (SG × S ₁) × 4456	89	34.8	35.5
11.	7733D-32-E ¹ × (CO ² × CO ⁴)Rush. Ash × SG. Ash	74	35.5	35.0
12.	Parbhani American	91	30.5	33.7
13.	Sea Island	—	50.5	26.5
14.	Iss-4F(F ₈)	72	35.5	35.0
15.	920-4F(F ₈)	80	34.5	37.4
16.	920-CO ² (F ₈)	82	33.5	35.0
17.	CO ⁴ -LSS(F ₈)	67	32.5	36.0
18.	CO ² -4F(F ₈)	65	34.2	37.5
19.	76251-LSS(F ₇)	86	35.5	37.5
20.	7727G ₂ -5286BUI(F ₇)	78	34.5	35.0
21.	CO ² -4F(F ₇)	70	33.0	35.5
22.	(CO ₂ × 4463)-(CO ₄ -LSS) (M ₂)	81	33.0	32.6
23.	6113F ₂ -LSS(F ₅)	92	35.5	32.0
24.	7733-8-7727G ₂ (F ₅)	138	34.5	34.0
25.	7733-8-5286BUI(F ₅)	141	32.0	32.5
26.	7733-8-289(F ₅)	119	32.5	35.5
	124			
27.	7733-8-7625-1 (F ₅)	105	32.0	34.0

It will be seen from the above table that the good lint length and the ginning percentages of many of the types are being maintained. The Parbhani-American, supplied by the Agricultural Department has a lint length of 30.5 mm only, which is the lowest recorded in the above

other types with greater values. Moreover this is a late type, giving the first flush in 91 days, while other strains of ours are much earlier, the earliest being 65 days in CO₂-4F (F₈).

Some of the types in F₇, F₆ and F₅ generations have also been found to be earlier this year than in the previous year. These will be studied during the next season to find out their behaviour.

Irradiation experiments, which gave promising results in 4 out of the 15 strains the previous year, were continued in greater detail on 18 strains during the year under report; the X-radiations given being 6, 10, and 14 m.a.H. in each of the strains. In addition, the progenies of the previous year were also sown during this year.

It was observed that doses up to 10 m.a.H. gave the best results while the 14 m.a.H. was found to be too high. So during the next season, a greater number of doses from 4 to 10 m.a.H. will be tried. It is also seen that nearly all the strains which responded to X-radiation during the previous season, gave favourable results this year also. The results of the two years indicate that these experiments, if continued further, will lead to favourable results.

The behaviour of the fuzzless mutants obtained from crosses between CO₂ and 4F, 920 and LSS, have been studied during the year under report.

3.2 JUTE

(a) IRRADIATION EXPERIMENTS

This is a scheme financed by the Indian Central Jute Committee and is in the 6th year of investigation, during the year under report.

During this year the following species and varieties of Jute were irradiated for 28, 36, 42, and 48 m.a.H.

<i>Corchorus capsularis</i> var.	D.	154
" " "	D.	386
" <i>olitorius</i> "	C.	G.
" " "	R.	26

(i) Germination & growth

The irradiated seeds were sown in replications at the Experimental Station of the Rose Research Institute, Falta, with a spacing of 1 ft.

The plants were examined from time to time in the field, and peculiarities if any, were noted.

During the season, due to the heavy storm in June '50, the growing points of the stems in nearly all the plants were affected and broken in some cases. But many of these continued to grow, and in the latter stages the only visible effect of the storm was a deformity (zigzag) of the stem. This affected growth of the plants to a certain extent.

(ii) *Heights and basal diameters*

The following table (Table 2) gives the average measurements of the heights and basal diameters of 50 plants taken from seven replications, in the controls, the various treatments and in the progeny of the tall mutant.

TABLE 2
Average Measurements of 50 Plants from 7 replications.

Vaierity & Treatment			Height	Basal diameter	
D	154	-Control	13'	6.4"	1.034"
"	"	28 m.a.H.	13'	5.22"	1.064"
"	"	36 m.a.H.	13'	2.36"	0.974"
"	"	42 m.a.H.	13'	7.04"	1.58"
"	"	48 m.a.H.	12'	0.04"	0.832"
D	386	-Control	13'	3.38"	1.008"
"	"	28 m.a.H.	12'	5.74"	0.88"
"	"	36 m.a.H.	13'	0.32"	0.956"
"	"	42 m.a.H.	13'	3.76"	1.04"
"	"	48 m.a.H.	12'	6.62"	0.902"
Chinsura	Green	Control	12'	5.9"	0.608"
"	"	28 m.a.H.	12'	11"	0.63"
"	"	36 m.a.H.	11'	7.8"	0.578"
"	"	42 m.a.H.	12'	6.54"	0.67"
"	"	48 m.a.H.	11'	2.24"	0.6"
R	26	Control	13'	4.7"	0.724"
"	"	28 m.a.H.	12'	10.6"	0.604"
"	"	36 m.a.H.	13'	4.48"	0.622"
"	"	42 m.a.H.	13'	1.5"	0.634"
"	"	46 m.a.H.	12'	5.68"	0.614"
Tall Mutant			17'	0.36"	0.764"

It will be seen from the above table, that while there is not much difference between the controls and the various treatments of the year under report, the progenies of the tall mutant attained a greater height.

Table 3 gives the weight of the dry fibres in 50 plants selected at random from 5 rows, both in the control and the progenies of the tall mutant. The

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TABLE 3

R 26 Control			Tall Mutant		
Row No.	No. of plants in the row (taken at random)	Dry weight of the fibre	Row No.	No. of plants in the row (taken at random)	Dry weight of the fibre
R 80	10 Plants	112 gms.	R 55	10 Plants	145.5 gms.
R 79	"	98 "	R 50	"	138.7 "
R 77	"	77 "	R 58	"	145 "
R 78	"	72.5 gms.	R 56	"	141 "
R 90	"	83 "	R 53	"	109.4 "
Total weight of the fibre of 50 plants		442.5 gms.	Total weight of the fibre of 50 plants		680 gms.
		88.5 ± 14.57			136.1 ± 13.65
		88.5 ± 14.6 approx.			136.1 ± 13.7 approx.

Table 4, gives the time taken by the plants to flower, in the controls and the various treatments. It will be seen that in D. 154, D. 386 and G.G. there is very little difference in the time of flowering but in R. 26, the 42 M.A.H. treatments flowered in 61 days as against 85 days in the control. During the year, one plant in the progeny of the tall mutant flowered in 42 days, which attained a height of 14 ft. 8" with 0.8" basal diameter. The seeds of this plant have been collected separately and will be grown during the next season, to find out if this earliness is being maintained.

TABLE 4

Variety & Treatment			Date of Sowing	Date of 1st flower	Age of the plant at the time of 1st flower
I.	Chinsura Green	Control	19.5.50	19.7.50	61 days
(a)	"	28 m.a.H.	19.5.50	19.7.50	61 days
(b)	"	36 m.a.H.	19.5.50	21.7.50	63 days
(c)	"	42 m.a.H.	19.5.50	23.7.50	65 days
(d)	"	48 m.a.H.	19.5.50	19.7.50	61 days
II.	R 26	Control	19.5.50	12.8.50	85 days
(a)	"	28 m.a.H.	19.5.50	14.8.50	87 days
(b)	"	36 m.a.H.	19.5.50	28.7.50	70 days
(c)	"	42 m.a.H.	19.5.50	19.7.50	61 days
(d)	"	48 m.a.H.	19.5.50	26.7.50	68 days
III.	D 154	Control	4.5.50	17.8.50	105 days
(a)	"	28 m.a.H.	2.5.50	12.8.50	102 days
(b)	"	36 m.a.H.	2.5.50	10.8.50	100 days
(c)	"	42 m.a.H.	4.5.50	12.8.50	100 days

TABLE 4 (contd.)

Variety & Treatment				Date of Sowing	Date of 1st flower	Age of the plant at the time of 1st flower
IV.	D	386	Control	2.5.50	14.8.50	104 days
(a)	"	"	28 m.a.H.	2.5.50	13.8.50	103 days
(b)	"	"	36 m.a.H.	3.5.50	15.8.50	104 days
(c)	"	"	42 m.a.H.	2.5.50	15.8.50	105 days
(d)	"	"	48 m.a.H.	2.5.50	12.8.50	102 days
V.	Tall Mutant's progeny (1 plant),			25.4.50	6.6.50	42 days

Table 5 shows the performance of the selections for earliness made during the seasons 1947 and 1948, are carried forward without any further treatment.

TABLE 5

Serial No.	Variety	Age at the time of the 1st flower in days
1.	R. 26 Control	85 days
2.	34/73	60 "
3.	23/58	77 "
4.	24/6	65 "
5.	21/21	44 "

Thus it will be seen from the above table that in some of the selections for earliness, this character is being maintained.

The average length and the breadth of the pollen grains in μ in the control and the various treatments were studied, (average of 100 counts). It was seen in R 26, that with increase in dosage there is increase in the size of the pollen grains. The same is true for D 386, except in the last dose. But the pollen grains of the tall mutant, unlike the previous year, are smaller than the controls. This may mean that this strain is getting more and more stabilised, but as will be seen from Table 2 there is not only an increase on the dimensions of the plants, but the yield is also much higher (Table 3).

Table 6 gives the percentage of fertile and sterile pollen grains (average of 1000 counts) in the control, the tall mutant and in the various treatments. In general, it will be seen that the sterility is least in the control. In the case of the tall mutant, it is 4.16% as against 7.534% of the previous year. This is an additional proof to show that this type (tall

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TABLE 6

Variety & Treatment				Pollen Counts (average of 1000 counts)			Percentage	
				Total	Fertile	Sterile	Fertile	Sterile
I.	D	154	Control	1240	1185	55	95.57%	4.43%
"	"	"	28 m.a.H.	1198	1125	73	95.9 %	6.1 %
"	"	"	36 m.a.H.	1116	1000	116	89.6 %	10.4 %
"	"	"	42 m.a.H.	1436	1313	123	91.44%	8.56%
"	"	"	48 m.a.H.	1564	1449	115	92.65%	7.35%
II.	D	386	Control	1423	1370	53	96.28%	3.72%
"	"	"	28 m.a.H.	1476	1281	195	88.15%	11.85%
"	"	"	36 m.a.H.	1241	1134	107	91.38%	8.62%
"	"	"	42 m.a.H.	1118	896	222	80%	20%
"	"	"	48 m.a.H.	1276	929	347	72.8 %	27.2 %
III.	Chinsura	Green	Control	1168	1144	24	97.95%	2.05%
"	"	"	28 m.a.H.	1132	1044	88	92.47%	7.63%
"	"	"	36 m.a.H.	1023	972	51	95.00%	5.00%
"	"	"	42 m.a.H.	1174	1088	86	92.68%	7.32%
"	"	"	48 m.a.H.	1091	1035	56	94.87%	5.13%
IV.	R	26	Control	1391	1359	32	97.70%	2.30%
"	"	"	28 m.a.H.	1193	1142	51	95.73%	4.27%
"	"	"	36 m.a.H.	1138	1083	55	95.17%	4.83%
"	"	"	42 m.a.H.	1154	1095	59	94.89%	5.11%
"	"	"	48 m.a.H.	1118	1025	93	91.69%	8.31%
V.	Tall Mutant			1466	1405	61	95.84%	4.16%

The percentage of bifurcation were studied in the controls and the various treatments. Here, certain differences were observed from the previous year's data. During the previous season, in D 154, only the 28 m. a.H. showed a small percentage of bifurcations, while there were none in D 386 unlike the present season. But C. G. in both the years showed the maximum numbers of bifurcations, and it appears that this is the chief visible effect of X-radiation in this type.

(iii) *Other morphological peculiarities.*

In *C. capsularis*, the following morphological peculiarities were noticed during the year under report:

(1) Several plants having a number of branches, the maximum being 9.

(2) One plant with the main stem bearing irregular leaves, the side branches being normal.

(3) In a few instances, the serrations of margins of the leaves were irregular, and the two halves of the leaves were unequal.

(4) Plants with variegated leaves, due to the unequal distribution

- (5) One plant having leaves only on one side.

In *C. olitorius*, several abnormal plants were noticed, with the leaves partly normal and partly abnormal, or all leaves abnormal.

(iv) *Cytological Observations.* The irregularities noticed during this season were similar to the one reported during the previous season viz., cytomixis, unequal number of chromosomes at the different poles, lagging bivalents and univalents at anaphase I & II, restitution nucleus, meiotic bridges etc.

- (v) *Sowing season of 1951*

During this season, in addition to the usual 4 varieties that were tried last year, the tall mutant was also irradiated; the exposures in all being 28, 36, 42, 48, and 60 m.a.H. Thus during this season, there is a very high dose (60 m.a.H.) not tried previously as it was felt that still stronger doses are necessary to break up the genetic stability, for inducing greater variations.

(b) SALINE WATER EXPERIMENTS

As in the previous year, the seeds of *C. Capsularis* (D. 154 and D 386) and *C. Olitrius* (C. G. and R 26), which were collected from the previous years treated plots, were used in these experiments. The same treatment that were given last year were also given this year.

Treatment I. The seeds of the four varieties from the same treatment were soaked in 5% common salt solution 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.

In *C. Capsularis* types, about 50% of the seeds germinated, out of which about 75% survived after the second saline irrigation. In *C. Olitorius* types, about 30% germinated, out of which about 25% survived the second saline irrigation.

Treatment II. The seeds collected from the similar experiments of the previous year were soaked in pond water for 3 hours and sown. The plots were irrigated with saline water from the Ganges, 30 days after sowing.

The germination in both the species were between 80 to 90%, but after irrigation with saline water, 80% of the *Capsularis* types and 50% of *Olitrius* types survived.

As in the previous year, it was found that *Capsularis* types were better

3.3 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*).

The following are some of the important results obtained during this year:

3.31 TIL (*Sesamum*)

The following types have been received from the various States in the Indian Union and we take this opportunity to express our gratitude to the Directors of Agriculture and to those Officers who responded to our request and supplied us with the necessary seeds and other information, in most cases free of cost.

Variety		Locality
1.	T M V 1	(Tindivanam, Madras)
2.	T M V 2	" "
3.	T M V 3	" "
4.	No. 10	(Berhampore, W. Bengal)
5.	No. 12	" "
6.	No. 16	" "
7.	No. 20	" "
8.	T— 85	(Nasik, Bombay)
9.	N 41	(Nagpur, C.P.)
10.	N 128	(Nagpur, C.P.)
11.	T 10	(Kanpur, U.P.)
12.	N.P. 3	(Pusa)
13.	N. P. 7	"
14.	N. P. 29	"

Preliminary experiments were conducted during March—April 1950, to find out the germination percentages of these types under the local conditions, and trial doses of X-rays were administered and the germination percentages tested. From the results of those experiments all the above types excepting N. 128 from Nagpur were selected for trials, the exposures given being, 36 m.a.H. and 50 m.a.H. These were sown in small compact replicated plots with controls, at the Experimental Station of the Bose Research Institute at Falta, during the months of May, June and July 1950. The sowing was spread over two months with the idea to find out the best sowing time also.

The following table (Table 7), gives the data regarding the locality, the types, treatments, data of sowing, date of the flowering, the age of the plant at the time of flowering, and the earliness, if any. It will be seen from the above table, that in all the types except in T 10 (Kanpur) there

seeds of these been collected separately and will be sown without any further treatment, to find out if further selections can be made.

TABLE 7

Locality	Types	Control & Treatment	Date of Sowing	Date of 1st flowering	Age of the plant at the time of flowering	Earliness in days
Berhampore (Bengal)	No. 10	Control	5.6.50	23.7.50	48 days	
		36 m.a.H.	"	18.7.50	43 days	5
		50 m.a.H.	"	17.7.50	42 "	6
"	No. 12	Control	26.5.50	14.7.50	49 days	
		36 m.a.H.	"	11.7.50	46 "	3
		50 m.a.H.	"	11.7.50	46 "	3
"	No. 16	Control	27.5.50	19.7.50	53 days	
		36 m.a.H.	"	11.7.50	45 days	8
		50 m.a.H.	26.5.50	11.7.50	46 days	7
"	No. 20		A B	A B	A B	A B
		Control	19.6.50 9.7.50	8.8.50 26.8.50	50 days 48 days	
		36 m.a.H.	19.6.50 9.7.50	6.8.50 20.8.50	48 days 42 days	2 6
"	No. 20	50 m.a.H.	19.6.50 9.7.50	6.8.50 18.8.50	48 days 40 days	2 8
Madras	T M V I	Control	10.7.50	24.8.50	45 days	
		36 m.a.H.	"	19.8.50	40 days	5
		50 m.a.H.	10.7.50	22.8.50	43 days	2
"	T M V 2	control	26.5.50	20.7.50	55 days	
		36 m.a.H.	"	15.7.50	50 days	5
		50 m.a.H.	"	15.7.50	50 days	5
"	T M V 3	Control	27.5.50	19.7.50	53 days	
		36 m.a.H.	"	14.7.50	48 days	5
		50 m.a.H.	26.5.50	14.7.50	49 days	4
Pusa	N.P. 3	Control	10.7.50	19.8.50	40 days	
		36 m.a.H.	"	16.8.50	37 days	3
		50 m.a.H.	"	11.8.50	32 days	8
Bombay	T 85	Control	10.7.50	20.8.50	41 days	
		36 m.a.H.	10.7.50	19.8.50	40 days	1
		50 m.a.H.	10.7.50	17.8.50	38 days	3
"	T 85	Control	9.7.50	19.8.50	41 days	
		36 m.a.H.	9.7.50	14.8.50	36 days	5
Nagpur	N 41	Control	9.7.55	19.8.90	41 days	
		36 m.a.H.	9.7.50	15.8.50	37 days	4
		50 m.a.H.	9.7.50	14.8.50	36 days	5
Kanpur	T 10	Control	27.7.50	1.9.50	36 days	
		36 m.a.H.	"	2.9.50	37 days delayed by 1day	
		50 m.a.H.	"	5.9.50	40 days delayed by 5days	

of 500 seeds. For these observations, only the mature good seeds were selected. It will be seen from this table that in the first two types listed, 36 m.a.H. gave a highest yield, and in the first 4 types, 36 m.a.H. gave a higher yield than 50 m.a.H. In the last two types, 50 m.a.H. gave a higher yield than 36 m.a.H. but the controls in both were the best. In many of these treatments, certain individual plants gave a high yield; these are selected for further trials. As regards the weight of the seeds, some of the treatments gave a higher figure. It is now necessary to find out the oil content of these seeds, both in the treatments and control, but that is not possible now, unless the Indian Oilseeds Committee is prepared to sanction the post of a chemist in the grade Rs. 160-10-330, plus the usual allowances.

TABLE 8

Locality	Variety	Control & Treatments	Yield per 10 best plants in grams	Weight of 500 seeds in grams.
Bengal (Berhampur)	Type No. 12	Control	131.275	1.26
		36 m.a.H.	169.01	1.29
		50 m.a.H.	92.535	1.31
" "	Type No. 16	Control	84.050	1.12
		36 m.a.H.	98.575	1.165
		50 m.a.H.	85.145	1.112
" "	Type No. 20	Control	103.455	1.105
		36 m.a.H.	71.090	1.175
		50 m.a.H.	57.440	1.16
Madras	T. M V 1	Control	9.360	1.032
		36 m.a.H.	3.675	.845
		50 m.a.H.	1.377	.79
Madras	T M V 2	Control	28.395	1.14
		36 m.a.H.	17.725	1.29
		50 m.a.H.	28.125	1.425
Pusa	N.P. 3	Control	11.550	.945
		36 m.a.H.	5.832	.82
		50 m.a.H.	7.190	1.05

Table 9, gives the average size of pollen grains from one hundred measurements in the controls and the two treatments in 8 types. It will be

size. But the above results indicate that much greater doses of X-rays are necessary to induce sufficient variation for purposes of selection.

TABLE 9

Locality	Variety	Control & treatments	Pollen Measurement in μ (average of 100)
Berhampur (Bengal)	No. 10	Control	26.610
		36 m.a.H.	29.031
		50 m.a.H.	27.894
"	No. 12	Control	27.934
		36 m.a.H.	25.424
		50 m.a.H.	27.821
Madras	T M V 2	Control	23.679
		36 m.a.H.	27.695
		50 m.a.H.	25.624
"	T M V 3	Control	25.875
		36 m.a.H.	27.045
		50 m.a.H.	27.760
Pusa	N.P. 3	Control	23.38
		36 m.a.H.	29.180
		50 m.a.H.	28.252
"	N. P. 7	Control	27.214
		36 m.a.H.	30.736
		50 m.a.H.	27.577
"	N.P. 29	Control	27.566
		36 m.a.H.	27.255
Nagpur	N 41	Control	26.030
		36 m.a.H.	27.263
		50 m.a.H.	26.565

Table 10, gives the pollen sterility in seven types of control and the treatments. It will be seen that in three types, there is an increase in the pollen sterility, with increase in dosage. But in the other four types, there is a decrease in sterility with increase in dosage, which is against the usual expectation. This table also indicates that greater doses of X-rays are necessary for inducing greater differences, and the next years programme

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TABLE 10

Locality	Variety	Control & Treatment	% of pollen Sterility
Berhampur (Bengal)	No. 10	Control	3.25%
		36 m.a.H.	6.75%
		50 m.a.H.	11.79%
"	No. 12	Control	8.51%
		36 m.a.H.	3.39%
		50 m.a.H.	3.66%
Madras	T M V 2	Control	2.95%
		36 m.a.H.	19.00%
		50 m.a.H.	4.91%
"	T M V 3	Control	4.64%
		36 m.a.H.	5.61%
		50 m.a.H.	1.88%
Pusa	N.P. 29	Control	2.01%
		36 m.a.H.	4.63%
		50 m.a.H.	3.63%
Bombay	T 85	Control	7.42%
		36 m.a.H.	6.69%
		50 m.a.H.	8.03%
Nagpur	N 41	Control	2.88%
		36 m.a.H.	7.26%
		50 m.a.H.	7.79%

Cytological investigations were carried out in the different types of sesamum. It was found that $2n$ was 26 in every case.

Meiotic studies on the flower buds of the plants grown from the X-rayed seeds did not reveal many irregularities. This is an additional evidence to show that higher doses are necessary for upsetting the genetic stability and inducing chromosome aberrations. In all the types excepting in N.P. 7, the nucleolus was found to persist at metaphase.

In one plant of N 41 from Nagpur, irradiated for 50 m.a.H., the petals were sepaloid with rudimentary anthers. This did not set seeds. The flowers and the growing points were fixed for further cytological and anatomical studies to determine the cause for the changes.

3.32. RAPE AND MUSTARD (*Brassica*)

The following types have been received from the various States and were experimented with:

Locality	Variety
1) Bengal (Berhampur)	Rai No. 5

3)	U. P. (Kanpur)	.....	Maghi Lahi
4)	" "	.....	R. T. 11
5)	East Punjab	.....	R. L. 9
6)	" "	.....	R. L. 18
7)	" "	.....	R. L. 19
8)	" "	.....	Brown Sarson 'A'
9)	" "	.....	R. Type 11
10)	Bihar (Sabour)	.....	Mustard 36
11)	" "	.....	Mustard 40
12)	Bihar (Sabour)	.....	Mustard 325

As the land available at the Falta Farm was not sufficient for all the experiments, 10 bighas of land were rented at Bamangachi, 18 miles to the north of Calcutta, where the experiments were laid out. Due to very many preliminary difficulties in setting up a new experimental Station, the sowing of mustard was unfortunately late.

As in the case of *Sesamum* several doses of X-radiations were given and the seeds were sown in replications with a control in each plot. Data similar to those of sesamum were also collected for mustard, but for the sake of brevity, are not included here.

C.4 BIOLOGICAL EFFECT OF ULTRASONIC (U.S.) RADIATION

I. *Effect on plant root system*—Cytological observations were made on the effect of ultrasonic on the root tips of four species of plants viz., *Allium cepa*, *Vicia faba*, *Hodeum vulgare* and *Ciccer arietinum*. Despite a marked difference in chromosome and nuclear sizes, no significant differences in the effect due to u.s. radiation were found, between the types studied. Except for the fact that no breakage of chromosomes was observed in any of the types studied, results were in agreement with those of Newcomer and Wallace. The change observed are mainly due to mechanical action. The differences between the results reported here and those of the previous investigators appear mainly to be due to the much higher frequency and intensity used, as well as to the exposure of the root tip cells to the region of maximum agitation in the water exposed to u. s. radiation.

C.5. PALEOBOTANY

The microflora from the Cambrians and post-Cambrians of India and its bearing on the age of the Saline Series, Salt Range, Punjab.

The occurrence of vascular microflora in the Cambrian of the Punjab Salt Range, has already been reported (See Annual Report of the Bose Research Institute 1949-50). The results of analysis made in quest of traces of life in other Cambrian strata of India (Kashmir and Spiti)

grant-in-aid (second instalment) received from the Burmah Oil Company (India Concessions) Ltd.

Altogether four specimens of Vindhya (infra-Cambrian or Cambrian) rocks, two specimens of Cambrian (Kashmir and Spiti) two specimens of Mandi Salt (post-Cambrian) and eight specimens of Permian (Salt Range) samples have been examined during the year under review.

VINDHYAS (INFRA-CAMBRIAN OR CAMBRIAN)

Sample Nos. (i) G.S.I. 927 B*

G.S.I. 926 A**

(ii) G.S.I. 925 B*

G.S.I. 924 A**

Localities— (i) Dalla W. of Camp; (ii) Chopan W. of Camp

Description—Kajrhat Limestone

Horizon—Basal Stage, Semri Series (Lower Vindhya)

From (i) non-winged spores of various forms and size, winged spores, carbonized bordered pitted wood elements and very few semi-carbonized scalariform tracheids have been recorded. The microflora recovered from (ii) consist of fungal hyphae and spores, algal thallus, sporangia like bodies, hairs and various dubious organic remains. This occurrence of vascular and non-vascular microflora in different rocks of the same stage presents an interesting data and further work is necessary. It is well to note that surface samples (A**) are more rich in microflora than the deeper ones (B*).

It may be noted that remnants of vascular microflora have already been recorded from the Lower Vindhya in this laboratory from two samples of Olive Shales (Semri Series; Kheinjua Stage) bearing the G.S.I numbers 58/918A and 58/919B (see Annual Report for 1949-50).

CAMBRIAN OF KASHMIR

Sample No. G.S.I. K 32/248

Locality Hundwara Tahsil, Kashmir

Description Compact olive green. Phyllitic state containing *Toukinnella* and other trilobites & *Obolus* like brachiopods,

Horizon Middle—Upper Cambrian

** A indicates samples from the surface

The microflora recovered from this specimen consist mainly of bordered pitted tracheids. Two winged and a few non-winged spores are also recorded.

CAMBRIAN OF SPITI

Sample No.	G. S.I. K 14/884
Locality	Parahio River, Spiti
Horizon	Upper Cambrian.

A preliminary examination yielded negative results and a re-examination is needed.

MANDI SALT BELT (*post-Cambrian*)

Samples Nos.	(i) G.S.I. 58/1032 (ii) G.S.I. 58/1033
Locality	31°45'55" Maigal Stream, Section near road bridge, Mandi Dt., Himachal Pradesh.
Description	Lignite
Horizon	Mandi Salt Belt

Microflora consist principally of pteridophytic, pteridospermous and gymnospermous spores. Good many of the spores recall those of *Pityosporites*, *Spencerites* and *Lebachia*. Carbonized bordered pitted tracheids also do occur.

PERMIAN OF THE SALT RANGE

Eight specimens of rocks from Lower, Middle and Upper Productus Stage received from the B.O.C. (I.C.) Ltd. have been re-examined. Besides different forms of bordered pitted wood elements, about sixty different types of spores have been recovered. Moreover some of the spores are new records on the Permian of the Salt Range.

D. MICROBIOLOGY

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

1. *Further studies on the occurrence of new antibiotic producing micro-organisms (fungi and actinomycetes) from the soils of West Bengal and other provinces of India.*

Investigations on the occurrence of newer antibiotic-producing micro-organisms from soils of West Bengal and neighbouring provinces (Orissa, Bihar and Madras) have been continued in the year under review. The collected samples of soil were partially dried and plated out in different

ding to the method reported last year. The cultures were isolated in their respective media and the antibiotic properties were tested against four test organisms *e.g.*, *Staph. aureus*, *E. coli*, *Eb. typhosa*, and *V. cholerae*. The results are given in Table I.

TABLE I

(Number of soil samples examined-55; West Bengal-38, Bihar-4, Orissa-10, Madras-3)

Test organisms	Total No. of fungi tested	No. of positive cultures	Percentage of positive cultures
<i>Staph. aureus</i>	225	39	17.4
<i>E. coli</i>	203	36	17.4
<i>Eb. typhosa</i>	74	21	28.4
<i>V. cholerae</i>	52	9	17.3

It was observed that the antibiotic-producing fungi are widely distributed in the cultivated soils of different parts of the country. A preliminary systematic study shows that most of the fungi belong to the genera *Penicillium*, *Aspergillus*, and a few genera of *Fungi Imperfecti*. The correlation between the predominance of the inhibitory organisms belonging to the two former genera and the limitation of growth of other micro-organisms in soil due to the possible antagonistic effect requires a thorough investigation of the problem. It appears from the results (Tables I and II) that the gram-negative organisms are affected to a lesser degree by antibiotics of fungal origin.

In view of the importance of the chemotherapeutic value of the antibiotics isolated from actinomycetes, greater attention was paid to the study of their inhibitory activity against human pathogens. Altogether 65 actinomycetes cultures were tested for their antibiotic activity. The results are given in Table II.

TABLE II

	Test organisms			
	<i>Staph. aureus</i>	<i>E. coli</i>	<i>Eb. typhosa</i>	<i>V. cholerae</i>
No. of actinomycetes positive	44	28	21	13
Percentage of positive cultures	67.7	43.1	32.3	20

It would appear from the antibiotic spectrum (Table II) that the inhibitory effect was more prominent in the case of gram-positive than gram-negative bacteria. However, the percentage of effective strains inhibitory against *Eb. typhosa* and *V. cholerae* was almost similar.

2. STUDIES ON THE ISOLATION AND CHEMICAL PURIFICATION OF ANTIBIOTIC PRINCIPLES OF 5 POTENT STRAINS OF SOIL MICRO-ORGANISMS

Of the soil microbes of West Bengal isolated in this laboratory five potent strains were selected for further study with special reference to biochemical activities, chemical purification and isolation of the antibiotic principles. A brief report of the investigation is given below:

A. 136—Special attention was paid to this strain of *Penicillium* due to its high potency against both gram-positive and gram-negative organisms. The ether-eluate gave a gummy substance from which needle-shaped crystals were obtained after treatment with dry chloroform. Further investigation into chemical purification and identification is under progress.

B. F_3 (83)—This strain of *Fungi Imperfecti* was selected for its pronounced activity against both gram-positive and gram-negative organisms. The active principle can be best eluted from charcoal with 80% acetone. On evaporation a crude substance has been obtained. Attempts to isolate the purified product and identify the compound is under progress.

C. FX_1 (68)—This strain also belongs to *Fungi Imperfecti*. Method of purification was the same as before except that the active principle is best eluted at an alkaline pH with 80% chloroform.

D. & E. AC_1 (46) & AC_7 (8)—These two strains of *Streptomyces* sp. were selected for their antibiotic action against gram-negative organisms. One of them, AC_1 (46) was also found to be highly fungistatic. Of the different media tried, straw-glucose-agar, potato-starch-tryptone-agar, and molasses-agar deserve special mention. Both in potato media and molasses media growth was rapid and sporulation plenty. The active principles are best eluted with methanol-acetic acid or methanol-HCl mixture at a pH of 4.6-4.8 for AC_7 (8) and near the acid side of neutrality for AC_1 (46). Further investigations into their biochemical activities and chemical purification are under progress.

The antibacterial spectrum of the strains studied are given below:

Name of micro-organism	Lysed Zone diameter (in mm.)				
	<i>S. aureus</i>	<i>E. coli</i>	<i>E. typhosa</i>	<i>V. cholerae</i>	<i>K. pneumoniae</i>
AC_1 (46)	18.0	10.5	20.0	15.0	0
AC_7 (8)	17.0	16.0	26.0	20.0	26.0
F_3 (83)	27.0	23.0	19.0	25.0	21.0
FX_1 (68)	15.0	15.0	21.5	0.0	—
123	26.0	27.0	30.0	27.0	25.0

3. STUDIES ON THE INHIBITION OF NITROGEN-FIXING ORGANISMS

e.g. Rhizobium AND *Azotobacter* by (i) CULTURES OF SOIL ACTINOMYCETES, (ii) PURE ANTIBIOTICS, (iii) SULPHA COMPOUNDS

(i) INHIBITION BY SOIL ACTINOMYCETES

A considerable number of antibiotic substances have been isolated from soil micro-organisms in recent years. With a view to ascertaining how far these inhibitory substances influence the lives of such useful soil micro-organisms as *Rhizobium* and *Azotobacter* which are known to fix atmospheric N, the antagonistic action of several actinomycetes isolated from the soils of W. Bengal against 6 strains each of *Rhizobium* and *Azotobacter* (also isolated from the legumes and soils of W. Bengal) have been studied. The cross-streak method of assay was followed.

Of the 6 strains of *Rhizobium* (Gram, Lentil, Phaseolus, Cajanus, Lathyrus and Soyabean) tested, the Soyabean strain was the most resistant, followed by Cajanus. 64% of the Actinomycetes inhibited at least one strain and 18% all the six. 55% of the Actinomycetes tested against the 6 strains of *Azotobacter* inhibited at least one but none could inhibit all the six strains. The AZ(B) strain was the most resistant.

(ii) EFFECT OF PURE ANTIBIOTICS

The inhibitory effects of 3 antibiotic substances, Penicillin, Streptomycin and Chloromycetin against the 6 strains each of *Rhizobium* and *Azotobacter* mentioned above have been tested by the agar-cup method. Penicillin seemed to have no appreciable effect on Rhizobia but produced some bacteriostatic action on 2 strains of *Azotobacter*. Streptomycin and Chloromycetin inhibited 4 strains of Rhizobia and 2 strains of *Azotobacter*.

(iii) EFFECT OF SULPHA COMPOUNDS

The inhibitory effects of six sulpha compounds—Sulphadiazine, Sulphamezathine, Sulphaguanidine, Sulphapyridine, Sulphathiazole and Sulphanilamide were tested by the agar-cup method. The sulpha compounds appear to have some bacteriostatic action on certain strains of *Rhizobium* and *Azotobacter*. Among the Rhizobia—Gram, Lathyrus and Cajanus and among the Azotobacters all but AZ(F) are affected. All the sulpha compounds used except sulphadiazine have been found to be

An examination of Woods and Fildes (1940) 'essential metabolite inhibition' hypothesis for the antibacterial action of the sulphha compounds, using these organisms which are autotrophic regarding their Nitrogen nutrition, may bring to light some interesting informations.

4. ANTIBIOTICS FROM PTERIDOPHYTES

Most of the antibiotic substances known so far owe, their origin to the lower Cryptogams or the higher plants, but little or no attention has been paid to the plant groups in-between *i.e.*, the Bryophytes and the Pteridophytes. An attempt was made to investigate the existence of antibiotic properties in the aqueous extracts of 13 members of Pteridophytes growing in and around Calcutta. The agar-cup method of assay was used with *Staph. aureus* and *E. coli* as the test or organisms.

The antibiotic substances when present was usually inhibitory to *Staph. aureus*, the gram-positive test organism, except in the case of underground parts of *Equisetum* sp., when *E. coli* was inhibited. The antibiotic property was most remarkable in the Polypodiaceous Ferns and almost negligible among the Water Ferns. Aqueous extracts of the pinnae of *Adiantum peruvianum* Kl., *Nephrolepis cordifolia* Presl., *Polypodium scolopendria* Burm. and the rhizomes of *Drynaria quercifolia* (L) J. Sm. growing on soil produced inhibition zones of 20 mm or more. The inhibitory properties are dependent on: (a) the season of collection (b) habitat (c) the part of the plant used and (d) the method of extraction.

5. EXPERIMENTS ON BACTERISATION

Pre-sowing treatment of seeds of legumes with suitable strains of the nodule organism *Rhizobium* has become a common agricultural practice in various parts of the world. How far this treatment may prove useful under Indian conditions is the object of the investigation reported below.

Six major pulses of India were selected for study: Pea, Gram, Phaseolus, Lentil, Lathyrus and Cajanus. The seeds were immersed in a thick suspension of the bacteria (which were isolated from the nodules of these legumes last winter) and air-dried for 12 hrs. The bacteria adhered to the surface of the seed coat. Seeds were sown in small plots at the Experimental Farm at Bamangachi 17 miles away from Calcutta on Dec. 1, 1950. The control seeds were sown on another plot some 100 yards away.

Except in the case of Gram, nodules were formed on both the control

greater in number. Beneficial effect of the inoculation was expressed in the length of the plants one month after inoculation; the effect being more marked after two months, except in the case of *Lathyrus* where no appreciable difference was noticed. The increase in length is also accompanied by an increase in the fresh and dry weight of the plants and the nodules.

In the case of Gram in the treated plots nodules were formed only on plants at one side of the plot. Nodules when formed were remarkably large and many. In the 'Control' plots either there were no nodules or white nodules caused by ineffective strains. The cause of non-nodulation is difficult to explain. It is probably due to the presence in soil of some substance or substances inhibitory to the strain of *Rhizobium* which causes nodulation in the roots of Gram. The soil is now being subjected to a microbiological analysis for isolation of the organism or organisms which are antagonistic to this strain or *Rhizobium*, if the cause of the toxic condition is biological.

The results of the first year's experiments indicate the beneficial effect of bacterisation to Indian legumes. The whole experiment is to be repeated next year before final conclusions are drawn.

E. ZOOLOGY

Caste determination in Oecophylla smaragdina Fabr.—Nutritional experiments with the aggressive red-ants, *Oecophylla smaragdina* Fabr. are being continued. It is usually believed that the queen represents the typical female form of the species, and as there is a definite male form, the origin of sexual form can be easily understood. It is also believed that fertilization or non-fertilization of the egg of social Hymenopteron determines the sex of the prospective ants. If that is so, how then does the worker form originate? It is said that the fertile eggs give rise to females—either sexually immature females (workers) or true females. The worker is thus an aberrant organism. But the workers are the dominant creatures in their colony and occur frequently with morphogenic stability. They, therefore, represent the species. It will be admitted that such a stable and regular phase as that of the worker (cannot be an accidental deviation. It should be regarded as a typical or primary phase of the ants.

It has been observed that the sexual forms appear only for a short time and the fertilized queen gives birth to eggs which produce workers only and this power of reproduction lasts for a few months only after

the months of April-May) the dealated queen goes on laying enormous quantities of eggs; but till next February not a single larva of male or queen could be found in the nest. Only vigorous and mostly major workers come out of these eggs. It has been observed that the workers (so-called neuters), as a rule, reproduce frequently for the maintenance of the colony. It has also been observed that the eggs laid by the virgin queen (before the nuptial flight) gives rise to males only. From different observations it is inferred, that the appearance of bulky queen form might be a case of gigantism produced from the larva of worker's egg when it is fed with special diet containing some activating substances.

It has been established that the unfertilized egg of honey bee which develops into drone possesses only half the number of chromosomes of the fertilized egg. On the maturation of the sperm, the usual halving of chromosome number does not take place, since the cells already contain the reduced or haploid number. The females—queens and workers arise from fertilized eggs and contain the diploid number of chromosomes. The diploid eggs developed within the female undergo a reduction from diploid to haploid. If unfertilized they contain the haploid number and develop into drones; if fertilized by a haploid sperm they contain the diploid number and develop into females.

Recent work on Cytology of the honey-bee has confirmed that in the drone there are 16 chromosomes in all stages of the developing sperms. In queen there are 32 chromosomes in the oogonia and 16 in the reduced oocyte and polar nuclei. But in certain Hymenoptera, e.g., some saw-flies and gall-flies, males are unknown or exceedingly rare, and the eggs, being unfertilized, yield not males as in bee, but females. Parthenogenetic development of females is reported among different kinds of bees, wasp etc. It has been observed that the red-ants *Oecophylla smaragdina* are in similar conditions. So it seems probable that the sex heterozygote is in the female ant.

Eminent authors are of opinion that morphological differences displayed by queen and workers amongst bees are due to quantitative differences in food. Our observation shows that during summer months nursing workers collect nectarine secretions from flower-buds, aphides, mealy-bugs etc., and regurgitate these to some of the young larvae. Queens, though few in number, were obtained in artificial nests by supplying them with flower buddings etc. Diet without these nectarine secretions brings forth normal workers. From these results polymorphism,

Vitamin E and vitamin B, having failed, nutritional experiments with Follicular Hormone, Lutoeyelin, Ovocyelin etc. are being continued. No definite results have yet been obtained.

LIBRARY

The Library contains 2,941 volumes (1,482 books and 1,459 periodicals). During the year under report 105 volumes (47 books and 58 bound periodicals) were added to the stock as against 127 during the previous year. The total number of periodicals received was 78 (inland 15 and foreign 63) as against 61 in the previous year, out of which 38 (inland 7 and foreign 31) were purchased and the remaining 40 (inland 8 and foreign 32) were received in exchange of the Institute publication—"Transactions of the Bose Research Institute."

The total number of volumes issued out of the Library was over 1,000 and the volumes consulted in the Reading Room was more than 2,000.

Though the Library is primarily meant for use of the staff of the Bose Institute yet because of its efficient service and well arranged selected acquisitions, a great number of outside scholars were attracted to visit the Library for reference work. The average number of such visitors was more than 50 a month, while the average daily readers (including outsiders) was about 20.

To relieve the congestion of books in the Library, a new set of steel shelving racks has been installed which has accommodated about 500 volumes.

AUDITED ACCOUNTS

An approximate analysis of the income/expenditure account of the Bose Institute for the last three years is given below :

	1948-49	1949-50	1950-51
Trust Fund contribution :	50,000- 0-0	47,733- 0-0	47,566- 0-0
Central Government grant	1,00,000- 0-0	96,250- 0-0	1,25,000- 0-0
Special grant for reorganisation		25,000- 0-0	
Grant-in-aid	1,60,203-14-9	98,147-10-9	1,05,749-11-0
Expenditure (total)	2,50,825- 1-9	2,66,274- 4-8	2,78,315-11-1
Deficit Institute account	2,659- 5-9	6,054-15-1	7,534- 8-1
	(surplus)		
Deficit Grant-in-aid A/C	...	...	5,029-10-0

NON-RECURRING GRANT (1950-51)

For purchase of apparatus Rs. 30,000-0-0

APPENDIX

I. THE GOVERNING BODY :

LADY ABALA BOSE

DR. DEBENDRA MOHON BOSE

MR. SUDHANGSU MOHON BOSE

MR. SUDHIR KUMAR MANDAL

MR. ABANINATH MITTER

MR. SATISH CHANDRA MUKHERJEE, I.C.S. (Retd.)

PROF. NAGENDRA CHANDRA NAG*

MR. KSHITISH CHANDRA NEOGY, M.P.

MR. BHUPATI MOHON SEN, I.E.S. (Retd.)

MR. KEDARNATH CHATTERJEE

II. THE COUNCIL :

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MR. SUDHANGSU MOHON BOSE

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MR. B. M. SEN, M.A., I.E.S. (Retd.), F.N.I.

MR. KEDARNATH CHATTERJEE

DR. D. M. BOSE, Director (*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)

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.

} Elected by the
Governing Body

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).

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., F.G.S.

Special Officer—DR. J. P. SIRCAR, B.Sc., M.B., Ch.B. (Edin.) (also in charge of Workshop)

APPENDIX

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DEPARTMENT OF PHYSICS :

Head of the Department —Director

Research Scholar—T. C. Bhadra, M.Sc. (on deputation from 24.8.50
to 4.11.50)

Government of India Junior Scholar—Nakul Chandra Das, M.Sc.
(from 16.3.51)

Attached worker— PROF. H. P. DEY, M.Sc., P.R.S. (Vidyasagar
College, Calcutta)

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 from 1.10.50

Research Scholar—A. C. GHOSH, M.Sc.

Birla Scholar—D. P. BURMA, M.Sc.

Sir J. C. BOSE Scholar—R. P. CHATTERJEE, M.Sc. (upto 17.5.50)

Government of India Junior Scholar—R. K. BOSE, M.Sc.
(from 1.12.50)

Attached workers—N. N. BANDHYOPADHAYA, M.Sc. (Textile Insti-
tute, Srirampur).

S. K. DUTTA, M.Sc. (Gokhale Memorial Girls
College).

S. P. DHAR, M.Sc. (Vidyasagar College, Calcutta).

DEPARTMENT OF BOTANY :

Head of the Department—DR. K. T. JACOB, M.A., Ph.D. (London)

Research Fellow—DR. S. K. ROY, M.Sc., Ph.D. (London)

Special Scholars—B. K. PALIT, B.Sc.

B. K. DUTTA, B.Sc.

A. T. GUHA THAKURTA

Sir J. C. BOSE Scholar—SUNANDA BOSE, M.Sc. (from 1.7.50)

Government of India Senior Scholar—DR. A. Ganguly, Ph.D.
(Edin) (from 1.9.50)

Government of India Junior Scholar—K.N.R. NAIR, M.Sc. (from
(30.10.50)

Attached worker—D. K. CHAKRAVARTI, M.Sc. (R. G. Kar Medical
College, Calcutta).

DEPARTMENT OF MICROBIOLOGY :

Research Fellow—DR. P. NANDI, M.Sc. Ph.D. (London).

SIR J. C. BOSE Scholar—S. P. SEN, M.Sc.

Government of India Junior Scholar—GURUPADA SEN, M.Sc. (from
1.9.50)

Attached workers—S. K. MUKHERJEE, M.Sc. (Surendranath College,
Calcutta)

DR. D. N. NANDI, M.Sc., M.B., (Lumbini Park

DEPARTMENT OF PHYSIOLOGY AND ZOOLOGY :

Special Scholar—G. C. BHATTACHARYA.

Staff appointed under grant-in-aid schemes:

A. DEPARTMENT OF PHYSICS:

Board of Research on Atomic Energy:

DR. S. D. CHATTERJEE, D.Sc. (on leave)

DR. M. S. SINHA D.Sc. (on study leave from 1.6.50 to 28.2.51)

I. L. CHAKRAVARTY, M.Sc.

A. M. GHOSH, M.Sc.

N. K. GANGULY, M.Sc.

DR. B. SARMA, M.Sc., D.Phil.

S. P. DUTTA, M.Sc.

A. N. BANERJEE, M.Sc. (on deputation from 23.9.50 to 24.12.50)

H. RAHA (from 8.9.50)

*National Institute of Sciences of India:*Imperial Chemical Industries Fellow—DR. P. K. SEN CHOUDHURY,
M. Sc., D.Phil.

B. DEPARTMENT OF CHEMISTRY:

1. *Council of Scientific and Industrial Research :*

Desulphurisation of Coal—

S. P. SEN, M.Sc. (upto 29.4.50)

S. R. GHOSH, M. Sc. (upto 29.4.50)

2. *Indian Central Jute Committee :*

Impregnation of bleached jute yarns with suitable synthetic resins—

J. M. SARKAR, M.Sc.

R. P. CHATTERJEE, M.Sc. (from 18.5.50)

C. DEPARTMENT OF BOTANY:

1. *Indian Central Jute Committee :*

Production of suitable mutants in Jute by x-ray irradiation—

R. K. BASU, M.Sc.

D. P. DUTTA, M.Sc.

12. *Indian Central Oilseeds Committee :*Scheme for inducing mutants with economic characters in Til,
(*Sesamum*), Rape and Mustard (*Brassica*) by x-ray—

K.L. CHOUDHURY, M.Sc.

ASOKE DAS, M.Sc. (from 5.5.50)

13. *Government of West Bengal :*

Cotton Scheme—

A. K. ADHIKARI, M.Sc.

14. *Barma Oil Company (India Concessions) Ltd :*

Micropaleobotanical Investigations with special reference to the