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REPORT NO. [redacted]

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The following scientific bulletins, published in Calcutta, have been received by the CIA Library, and are available upon request.

1. Silver Jubilee, published by the Indian Chemical Society.
2. Lists of Officers, Sectional Committees, and Ordinary Members in the Indian Science Congress Association.
3. Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science, November 1948.
4. The Indian Association for the Cultivation of Science, Calcutta.
5. Vijnan-Karmee, official organ of the Association of Scientific Workers of India, Vol. II, No. 6, June, 1950.
6. Association of Scientific Workers of India Memorandum on the Central College of Agriculture, Government of India, New Delhi.
7. Journal of the Indian Chemical Society, Vol. XXVII, No. 2, February, 1950.
8. Science and Culture, Vol. 15, No. 10, April, 1950.
9. Science and Culture, Vol. 15, No. 12, June, 1950.

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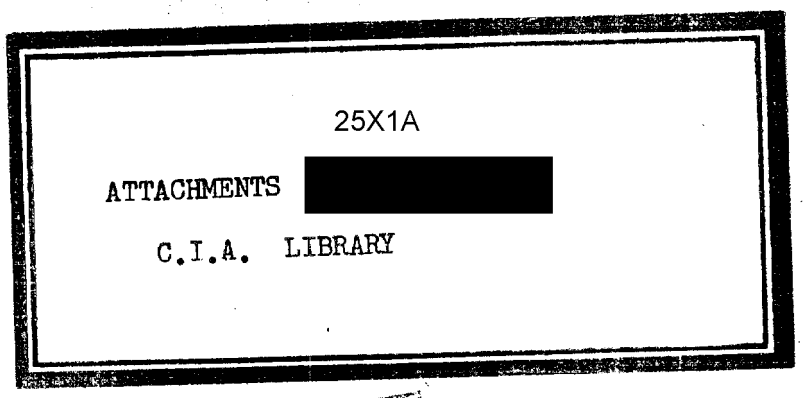

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INDIAN SCIENCE CONGRESS ASSOCIATION

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25X1C

THIRTYSEVENTH YEAR

1st February, 1949—31st January 1950.

NOTICES
LISTS OF OFFICERS, SECTIONAL COMMITTEES.
AND ORDINARY MEMBERS

[redacted]

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1, PARK STREET, CALCU

SEPTEMBER, 1949

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NOTE

The List of Members is printed in Part IV of the Proceedings which will be issued after the session by the middle of the following year.

Any inaccuracy or omission in the present list may kindly be reported to the General Secretary at 1, Park Street, Calcutta 16.

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INDIAN SCIENCE CONGRESS ASSOCIATION

THIRTY-SEVENTH ANNUAL MEETING, 1950

General Information

The Thirty-seventh Annual Meeting will be held at Poona from January 2nd to January 8th, 1950.

His Excellency Sir Maharaj Singh, the Governor of Bombay has kindly agreed to be the Patron of the Meeting.

Prof. P. C. Mohalanobis, F.R.S., will preside over the Meeting.

The names and addresses of the Sectional Presidents are given in the following pages.

Local Arrangements

All enquiries about accommodation and other local arrangements should be addressed to the Local Secretaries, 37th Indian Science Congress, University of Poona, Poona. Early intimation of the accommodation required should be sent to the Local Secretaries.

Membership Cards and Literature

Ordinary Membership cards have been forwarded to all Ordinary Members.

A detailed provisional programme of the Thirty-seventh Meeting of the Congress will be issued to all Ordinary Members in course of December of this year, together with a copy of Part III of the Proceedings containing Abstracts of the Paper accepted for reading at the different Sections.

Parts I (Official matters), II (Presidential Addresses) and IV (Discussions) of the proceedings will be issued by the middle of the following year.

THIRTY-ENGHTH ANNUAL MEETING, 1951.

Subscription notice will be sent out to all Ordinary Members on the register after the 1st February, 1950. This will be followed, after a suitable interval, by the Ordinary Membership cards for the year 1950-51 per V.P.P. for the amount of the subscription. Payment of the subscription fee of Rs. 12|- before the 15th July, 1949 will be only effective for continuance of Ordinary Membership during the ensuing year, covering the Thirty-eighth Annual Meeting.

Application for Membership

Application for new Ordinary Membership should furnish the following particulars. No form is necessary.

1. Name in full with degrees and titles.
2. Appointment, designation or profession.
3. Full address where correspondence is to be made.

This should reach the office of the Association at 1, Park Street, Calcutta 16, before the 15th July, 1950.

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INDIAN SCIENCE CONGRESS ASSOCIATION

THIRTY-SEVENTH YEAR: 1st FEBRUARY, 1949—31st January, 1950.

OFFICERS OF THE ASSOCIATION

PRESIDENT ELECT

Prof. P. C. Mahalanobis, F.R.S.

PRESIDENT

Sir K. S. Krishnan, F.R.S.

GENERAL SECRETARIES

Dr. B. Mukerji, D.Sc., M.B., M.P.S., F.A.Ph.S., F.N.I.
Dr. B. Sanjiva Rao, M.A., Ph.D., D.Sc., F.N.I.

TREASURER

Prof. K. N. Bagchi, F.R.I.C., F.N.I.

LOCAL SECRETARIES

Prof. S. V. Chandrasekhar Aiya, M.A. (Cantab), B.Sc., A.M.I.E.E., S.M.R.I.E.
Prof. B. V. Bhide, M.Sc., A.I.I.Sc.

EXECUTIVE COMMITTEE

1. Sir K. S. Krishnan, F.R.S. .. .. *President*
2. Prof. P. C. Mahalanobis, F.R.S. .. *President Elect.*
3. Dr. B. Mukerji, D.Sc., M.B., M.P.S., F.A.Ph.S., F.N.I. .. .. } *General Secretaries.*
4. Dr. B. Sanjiva Rao, M.A., Ph.D., D.Sc., F.N.I. .. .. }
5. [illegible], F.N.I.

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6.	Dr. U. P. Basu, D.Sc., F.N.I.	*Elected by the General Committee.*
7.	Dr. A. K. De, B.Sc., Ph.D.	
8.	Dr. B. C. Guha, D.Sc., Ph.D., F.N.I. ..	
9.	Dr. D. S. Kothari, Ph.D., F.N.I. ..	
10.	Dr. B. C. Kundu, M.A., Ph.D., F.L.S., F.N.I.	
11.	Prof. B. Narayana, M.Sc., M.B., Ph.D., F.R.S.E.	
12.	Dr. Baini Prasad, O.B.E., D.Sc., F.R.S.E., F.L.S., F.Z.S., F.R.A.S.B., F.N.I. ..	
13.	Prof. P. Ray, M.A., F.N.I.	
14.	Mr. B. K. Sarkar, M. I. Metal. ..	
15.	Dr. A. C. Ukil, M.B., M.S.P.E., F.S.M.F.B., F.N.I.	
16.	Prof. S. V. Chandrasekhar Aiya, M.A. (Cantab), B.Sc., A.M.I.E.E., S.M.R.I.E.	*Local Secretaries.*
17.	Prof. B. V. Bhide, M.Sc., A.I.I.Sc. ..	

COUNCIL

1—17(a) Members of the Executive Committee

(b) Past Presidents who are either Ordinary or Honorary Member

18. Sir M. Visvesvaraya, K.C.I.E., M.Inst.C.E., D.Sc.
19. Prof. J. L. Simonsen, D.Sc., F.I.C., F.R.S.
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22. Prof. M. N. Saha, D.Sc., F.R.S., F.R.A.S.B., F.N.I.
23. Dr. J. H. Hutton, C.I.E., M.A., D.Sc., F.R.A.S.B., F.N.I.
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25. Sir Jnan Chandra Ghosh, Kt., D.Sc., F.N.I.
26. Sir Ardeshir Dalal, Kt., I.C.S., (Retd.).
27. Dr. D. N. Wadia, M.A., D.Sc., F.G.S., F.R.A.S.B., F.N.I.
28. Prof. S. N. Bose, M.Sc., F.N.I.
29. Sir S. S. Bhatnagar, O.B.E., D.Sc., F.R.S., F. Inst.P., F.I.C., F.N.I., F.S.C.I. (Hon.).
30. Prof. M. Afzal Husain, M.A., M.Sc., F.N.I.
31. Jawharlal Nehru.
32. Col. Sir Ram Nath Chopra, Kt., C.I.E., M.A., M.D., Sc.D., F.R.A.S.B., F.N.I.

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20. Sir Chandrasekhara Venkata Raman, Kt., Nobel Laureate.
33. Prof. S. P. Agharkar, M.A., Ph.D., F.L.S., F.N.I.
34. Dr. W. D. West, M.A., Sc.D., F.N.I.
35. [illegible], C.B.E., D.Sc., F.R.A.S.B., F.N.I.

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36. Prof. P. Parija, O.B.E., M.A., I.E.S., F.N.I.
37. Prof. S. K. Mitra, M.B.E., D.Sc., F.N.I.
38. Prof. P. C. Mitter, Ph.D., F.N.I.,
2. Prof. P. C. Mahalanabis, F.R.S., F.N.I.

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20. Sir Chandrasekhara Venkata Raman, Kt., Noble Laureate.
12. Dr. Baini Prasad, O.B.E., D.Sc., F.L.S., F.Z.S., F.R.S.E., F.N.I.
39. Rai Bahadur Dr. S. L. Hora, D.Sc., F.L.S., F.Z.S., F.R.A.S.B., F.N.I.
35. Dr. J. N. Mukherjee, C.B.E., F.R.A.S.B., F.N.I.
13. Prof. P. Roy, M.A., F.N.I.

40—52(e) Sectional Presidents for the Session (see the following list.)

(f) Elected by General Committee.

53. Dr. R. C. Bose, M.A., D.Litt., F.N.I.
54. Dr. D. Chakravarti, D.Sc., F.N.I.
55. Mr. A. M. N. Ghosh, B.Sc., A.R.C.S.
56. Prof. S. N. Mathur, M.B., B.S., Ph.D.
57. Mr. S. N. Mukherjee.
58. Dr. J. S. Patel, M.Sc., Ph.D.
59. Dr. B. N. Prasad, D.Sc., Ph.D., F.N.I.

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Statistics—Dr. P. V. Sukhatme, Ph.D., D.Sc., F.N.I. *Statistical Adviser, Indian Agricultural Research Institute, New Delhi.*

Physics—Dr. R. N. Ghosh, D.Sc., F. Acoust. Soc., F.N.I. *Reader in Physics, Allahabad University, Allahabad.*

Chemistry—Dr. J. K. Chowdhury, Ph.D., *Head of the Dept. of Chemistry, Bose Research Institute, 93, Upper Circular Road, Calcutta.*

Geology & Geography—Mr. J. Coates, A.R.M.S., F.G.S., F.Inst.Pet., F.N.I., *Senior Geologist, B. O. C. (I.C.) Ltd. Burma-Shell House, Connaught Circus, New Delhi.*

Botany—Dr. Panchanan Maheswari, D.Sc., F.N.I., *Professor of Botany, Delhi University, Delhi.*

Zoology & Entomology—Dr. B. C. Basu, D.Sc., *Entomologist, Indian Veterinary Research Institute, Izatnagar, Bareilly (India).*

Anthropology & Archæology—Dr. C. Von Furer Haimendorf, Dr. Phil., *Adviser for Tribes & Backward Classes, Revenue Secretariat, Hyderabad (Deccan).*

Medical & Veterinary Sciences—Dr. M. V. Radhakrishna Rao, M.B.B.S., Ph.D., F.N.I. *Assistant Director, Haffkine Institute, Bombay 12.*

Agricultural Sciences—Mr. R. L. Sethi, I.A.S., *Agricultural Commissioner, Indian Council of Agricultural Research, P. Block, Raisina Road, New Delhi.*

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Statistics—Mr. K. C. Basak, B.A., *Director of Economic Research, Indian Central Jute Committee, 4, Hastings Street, Calcutta.*

Physics—Mr. Vikram A. Sarabhai, M.A., (Cantab), Post Box 28, *Ahmedabad.*

Chemistry—Dr. R. D. Desai, D.Sc., F.N.I., F.I.I.Sc., F.A.Sc., D.I.C., *Department of Chemical Technology, Matunga, Bombay.*

Geology & Geography—Mr. N. L. Sharma, M.Sc., *Officiating Professor of Geology, Indian School of Mines, Dhanbad.*

Botany—Mrs. E. Gonzalves, B.A., M.Sc., *Lecturer in Biology, Karnatak College, Dharwar.*

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Medical & Veterinary Sciences—Dr. C. R. Das Gupta, M.B., D.T.M., *Officer-in-Charge, Haematology Department, School of Tropical Medicine, Calcutta.*

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Engineering & Metallurgy—Mr. J. Dutt, B.A., C.E., A.M.I.E., *Dt. Engineer, The Concrete Association of India, Mithapur, Patna Junction.*

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Engineering & Metallurgy—Dr. J. N. Basu, M.I.E., M.A.E., Dr. Eng., *Prof of Mechanical Engineering, College of Engineering & Technology. P.O. Jadabpur College, 24-Parganas.*

LOCAL SECTIONAL SECRETARIES

Mathematics— Mr. G. L. Chandratreya M.A. *Prof. of Mathematics, Fergusson College, Poona,* 4.

Statistics—Mr. V. N. Dandekar, M.A., *Prof. of Statistics, Gokhale Institute of Politics & Economics, Poona* 4.

Physics—Mr. S. Basu, M.Sc., *Dy. Director General of Observatories, Poona* 5.

Chemistry—Dr. B. D. Laroia, *Asst. Director (Administration), National Chemical Laboratories, Poona*—3.

Geology & Geography—Mr. C. B. Joshi, M.A., (Cantab), *Prof. of Geography, N. Wadia College, Poona*—1.

Botany—Mr. V. V. Apte, M.Sc. *Prof. of Botany, Fergusson College, Poona* 4.

Zoology & Entomology—Mr. B. G. Shirole M.Sc., *Prof. of Zoology, Fergussoon College, Poona*—4.

Anthropology & Archaeology—Mr. H. D. Sankalia, M.A., Ph.D., *Prof. of Ancient Indian History, Deccan College Research Institute, Poona* 1.

Medical & Veterinary Sciences—Dr. P. G. Gollerkeri, M.D. (Bom.), *Prof. of Medicine, B. J. Medical College, Poona*—1.

Agricultural Science—Mr. L. S. S. Kumar, M.Sc. (Lond.), *Principal, College of Agriculture, Poona*—5.

Physiology—Mrs. R. Aiman, M.B., B.S., M.R.C.P. (Lond.), M.R.C.S., D.R.C.O.G., D.M.C.W., *Prof. of Pharmacology, B. J. Medical College, Poona* 1.

Psychology & Educational Science—Mr. B. V. Bapat, M.Sc., B.T., *Principal, Tilak College of Education, Tilak Road, Poona* 2.

Engineering & Metallurgy—Mr. A. Desouza, B.E., A.M.I.C.E., A.M.I., Struct. E., A.M.I.E., *Prof. of Engineering, College of Engineering, Poona* 5.

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SECTIONAL COMMITTEES.

(Names marked with * indicate that they were also Recorders of the respective Sections)

1. Mathematics—

Dr. N. M. Basu	*Convener.*
Dr. B. R. Seth	*Recorder*
Dr. S. K. Basu	*Sectional Correspondent*
Prof. G. L. Chandratreya ..	*Local Sectional Secretary.*
Dr. C. Racine	*Elected Members.*
Prof M. L. Misra	
Prof. N. R. Sen	*Past Presidents who are either Ordinary or Honorary Members.*
Prof. A. C. Banerji	
*Prof. M. R. Siddiqui ..	
Mr. B. M. Sen	
*Dr. B. N. Prasad	
*Dr. Ram Behari	
Dr. D. D. Kosambi	
Mr. S. Gupta	*Past Recorders who are either Ordinary or Honorary Members.*
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Dr. N. G. Shabde	
Prof. B. B. Sen	
Prof. P. N. Das Gupta ..	

2. Statistics—

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Mr. K. C. Basak	*Recorder*
Mr. T. P. Chaudhury ..	*Sectional Correspondent*
Prof. V. N. Dandekar ..	*Local Sectional Secretary*
Mrs. Chameli Bose	*Elected Members.*
Mr. K. R. Nair	
Prof. P. C. Mahalanobis ..	*Past President of the Mathematics and Statistics Section.*
Prof. K. B. Madhava ..	*Past Presidents of Statistics Section.*
*Dr. U. S. Nair	
Dr. P. K. Bose	*Past Recorder of the Statistics Section.*
Shree Sadashiv Sen Gupta ..	

3. Physics—

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Mr. Vikram A. Sarabhai ..	*Recorder*
Mr. P. C. Mukherjee	*Sectional Correspondent*
Mr. S. Basu	*Local Sectional Secretary.*
Mr. N. K. Saha	*Elected Members.*
Dr. S. R. Khastgir	

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Mr. T. P. Bhaskara Shastri	..	
Dr. S. K. Banerji	..	
Prof. M. N. Saha	..	
Dr. D. M. Bose	..	
Prof. S. N. Bose	..	
Prof. B. Venkatesachar	..	
Prof. S. K. Mitra	..	*Past Presidents who are either Ordinary or Honorary Members.*
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Diwan Bahadur K. R. Ramanathan		
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Dr. N. R. Tawde	..	
Dr. A. K. Dutta	..	

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Prof. P. C. Mitter	..	
Dr. K. G. Naik	..	
Prof. P. Ray	..	
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Prof. J. K. Chowdhury	..	
Dr. U. P. Basu	..	
Dr. Dukhaharan Chakravarti	..	

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Mr. N. L. Sharma	..	*Recorder*
Mr. S. C. Bose	..	*Sectional Correspondent*
Prof. C. B. Joshi	..	*Local Sectional Secretary*
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Mr. A. K. Roy	..	
Sir L. L. Fermor	..	*Past Presidents who are either Ordinary or Honorary Members.*
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Mr. P. Evans	..	
*Dr. M. S. Krishnan	..	
Dr. B. Rama Rao	..	
Dr. W. D. West	..	
*Prof. L. Rama Rao	..	
Dr. M. R. Sahni	..	
Dr. Rajnath	..	
*Dr. Shibaprasad Chatterjee	..	
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TAMHANE, R. V., Ph.D., Soil Survey Officer, Indian Agricultural Research Institute, New Delhi.

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TATA, Oil Mills Company Ltd., Tatapuram, Cochin, State.

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TAWDE, N. R. B.A., (Hons.), M.Sc., (Bom.), Ph.D., (Lond.), F.Inst.P., F.A.Sc., F.N.I., Professor of Physics, Spectorscopic Laboratories, Royal Institute of Science, Mayo Road, Bombay.

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VISWANATHAN, G. R., Veterinary Investigation Officer, Vepery Post, Madras.
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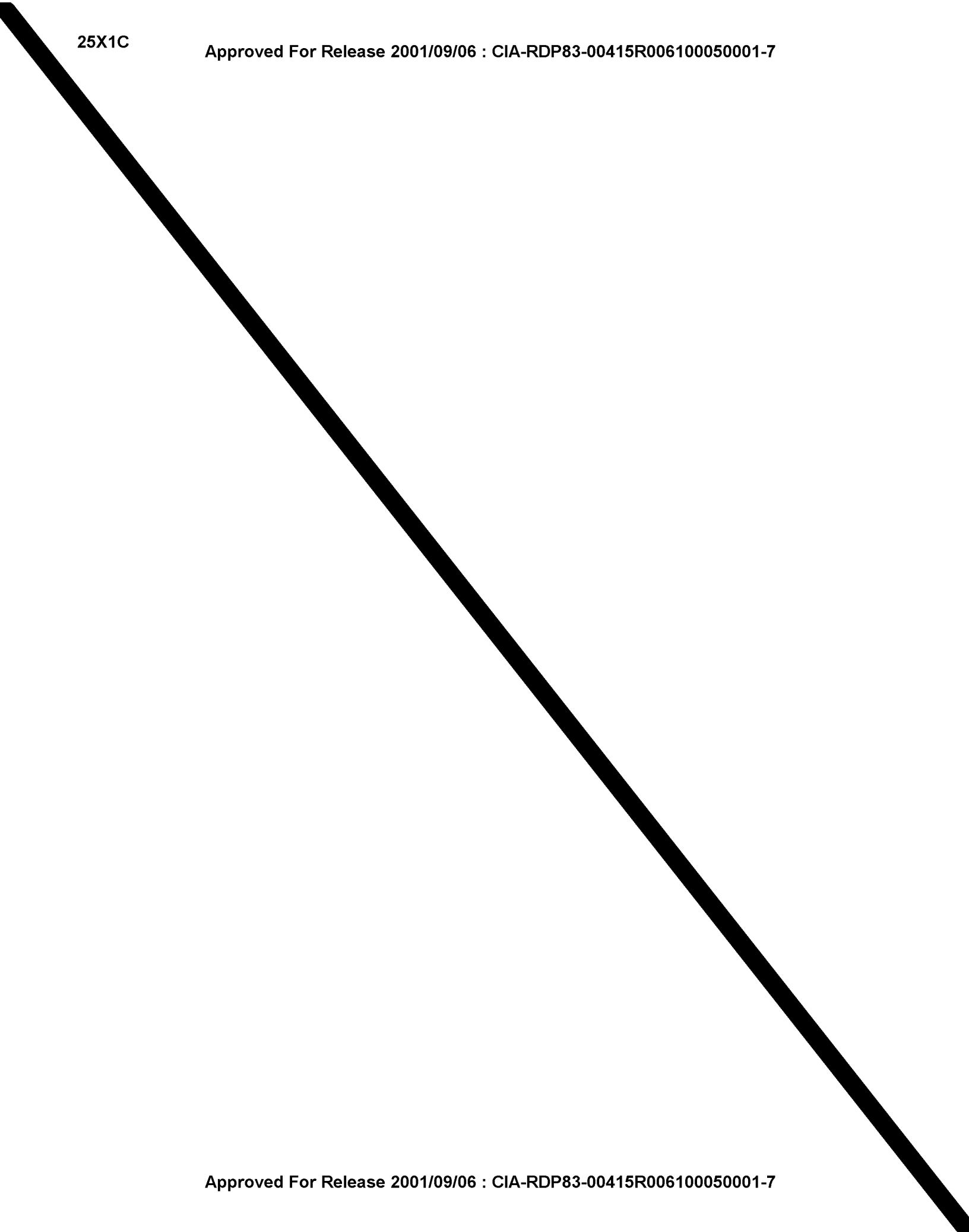

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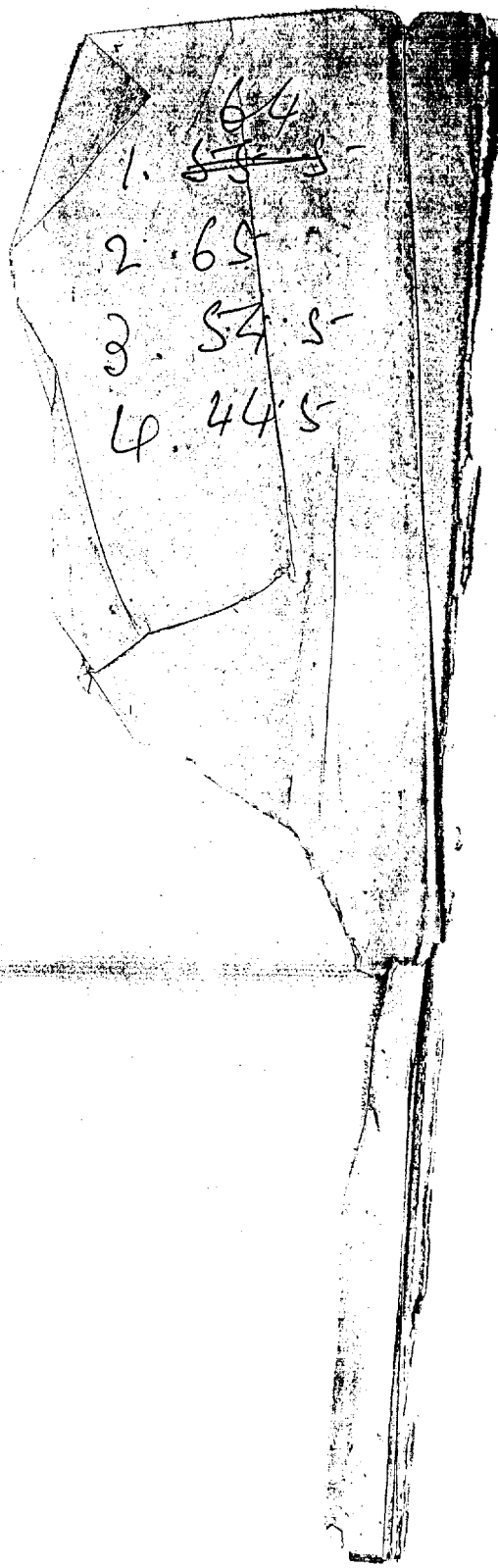

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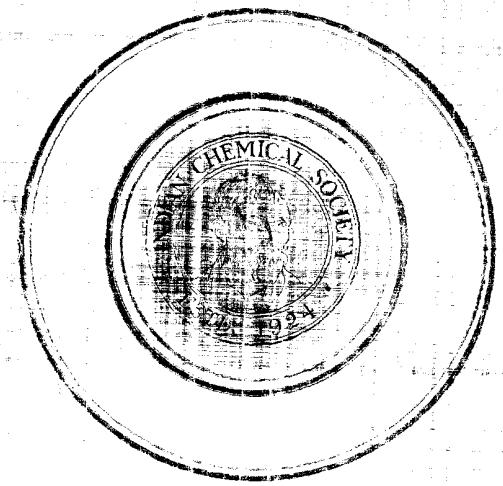
Silver Jubilee



1924—1948

INDIAN CHEMICAL SOCIETY

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INDIAN CHEMICAL SOCIETY

SILVER JUBILEE

1924–1948

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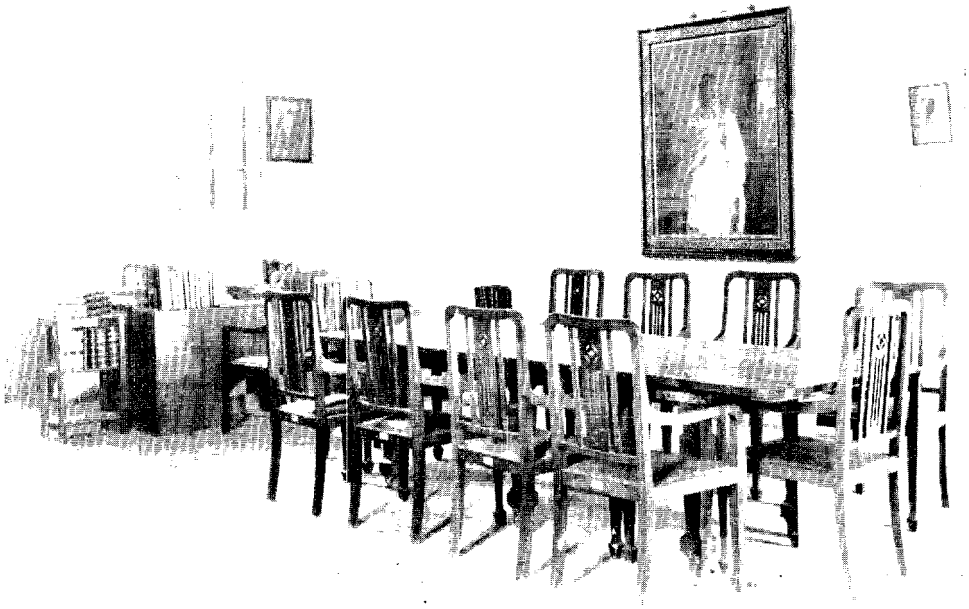

Council Room



Library

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EARLY HISTORY

Chemistry in the Nineteenth Century.

THE pursuit of chemistry in India in the nineteenth century was due to its applications in medicine. A limited group of research workers who studied the active principles of Indian medicinal plants belonged exclusively to the medical profession, of whom Dr. W.B.O' Shaugnessy, Professor of Chemistry, Medical College, Calcutta deserves special mention. He studied numerous herbs and drugs both chemically and physiologically, and incorporated the results in his "Bengal Pharmacopoea" (1840).

There is very little record of chemical researches in this country during the middle of the nineteenth century. James Prinsep of Geological Survey of India reported on an analysis of mineral water (1833) to the Asiatic Society of Bengal which was founded in 1784 for cultural and scientific studies. In the same year, Pearson communicated to the Society a method of preparation of strychnine, Stephenson gave an account of the efflorescence of the sulphate of soda found at Trihut (1834), and O' Shaugnessy wrote his experiences on arsenical poisons and on the effects of sea water on iron (1843). Piddington, the then Curator of Economic Geology in the Museum of Asiatic Society, described an apparatus for separating mercury by distillation from an amalgam of gold or silver (1852). D' Waldie determined the monthly changes in the quantity of salt held in suspension by the water of the river Hughly in Calcutta (1854) and also experimented on the chemical nature of the paraffins obtained from Burma (1860). In 1867, Dr. Kanai Lal Dey engaged himself in the investigation of the properties and constitution of some of the medicinal plants of Bengal, and worked up a method for detecting porphyroxin in Indian opium.

The beginning of modern school of chemistry india, however, may be said to date back to 1873, when Mr. Alexander Pedler (Later Sir Alexander) came to Presidency College, Calcutta, as Professor of Chemistry. He introduced a certain amount of practical work into the science course for the M.A. Degree. Soon after his arrival in this country, Mr. Pedler trained Mr. Chandrabhusan Bhaduri, his class-assistant, to chemical work and with his help examined and reported on the coal gas and water supplies of Calcutta. With the assistance of Babu Pulin Behari Soor, he began chemical investigations and published a paper on cobra venom in the Proceedings of the Royal Society of London and subsequently made some contributions on the action of light on chemical changes. Contemporaneously in 1876, Dr. Mahendra Lal Sircar founded the Indian Association for the Cultivation of Science, a research

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institution, which he desired, would combine the character, the scope and objects of the Royal Institution of London and the British Association for the Advancement of Science. But proper research work, both in physics and chemistry, could only be carried out at the Association after a long period of twenty six years. It was during this time that Major Waterhouse (1876) demonstrated to the Asiatic Society of Bengal, the action of eosin in extending the photographic action of solar spectrum on sensitive collodion plates. This reaction was used subsequently by French photographers for coloured objects.

During the last quarter of the nineteenth century the medicinal and poisonous plants of India were investigated chemically at the Medical College Laboratories. Warden and Wood isolated arbin, the poisonous principle of *Arbus precatorius;* Ram Chandra Dutta and Chuni Lal Bose assisted Warden in finding the chemical composition and empirical formulae of the active principles of various herbs and drugs, and also in compiling an authoritative book on Indian drugs, Pharmacographia Indica, in three volumes, edited by Dymock.

Nucleus of Modern School of Chemistry.

The credit of developing the teaching and modern researches in all branches of chemistry would certainly go to Dr. P. C. Ray (Later Sir Prafulla Chandra), who joined the Presidency College, Calcutta, as a Lecturer in Chemistry in 1889, on his return from Edinburgh, where he took his Degree of Doctor of Science working under Professor Crum Brown. Prior to this, it may be mentioned here, that Mr. Aghore Nath Chattopadhyaya also took his D.Sc. in chemistry from the same university in 1875 and was presumably the first Indian to receive such high academic distinction in chemical science. Since 1894 and onwards Dr. P. C. Ray was busily engaged in research, attracting a devoted band of workers around him and thus forming a nucleus of a school of chemistry. In 1896, he reported to the Asiatic Society of Bengal, the preparation of mercurous nitrite, a substance which had till then eluded isolation by several investigators. The Asiatic Society of Bengal was the only Society of its kind devoted to oriental studies and to a certain extent to botany and history of sciences. On the publication of this paper on mercurous nitrite *Nature* made the following comment, "The Journal of the Asiatic Society of Bengal can scarcely be said to have a place in our chemical libraries. The current number, however, contains a paper by Dr. P. C. Ray of the Presidency College, Calcutta, on mercurous nitrite, that is worthy of note."

Foundation of the Indian Science Congress.

Early in the present century it was recognised by those in authority that the standard of university education in India should be raised, and in 1904 the Curzon Commission on University Education was appointed; as a result of the recommendation of this Commission, Honours Courses were introduced in all different subjects and research work was

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encouraged in university colleges. Before this, research work was confined mainly to the various scientific services, such as the Botanical and Geological Surveys of India, and research in Presidency College by Dr. P. C. Ray and his pupils was perhaps the only example of research in educational institutions. In 1910, Professor MacMahon and Professor Simonsen, who were appointed to the newly created chairs of chemistry in the Canning College, Lucknow, and the Presidency College, Madras, felt the need for the establishment of a Scientific Association similar to the British Association with a view to stimulating research activities in India; their efforts finally led to the foundation of the Indian Science Congress in 1914.

Formation of the Indian Chemical Society.

Within twenty years, since 1894, a school of chemistry was gradually built up in India, and the formation of a Society for the Chemists in India, the Indian Chemical Society, may be said to be one of the achievements of that school. As the Indian Science Congress was held only once a year, the research papers were published either in the Journal of the Asiatic Society of Bengal or in foreign journals. A search in the literature shows that till 1916, about one hundred and twenty six papers were contributed by the Indian workers to various journals abroad, like the Journal of the Chemical Society of London, Journal of the American Chemical Society, Zeitschrift für anorganische Chemie of Germany, and others. In 1910, Mr. Jnanchandra Ghosh (later Dr. and Sir Jnanchandra) and Mr. Jnanendranath Mukherjee (later Dr.), then Lecturer in Chemistry at the University College of Science and Technology, Calcutta, joined Professor Donnan's Laboratory at the University College of Science, London. There they came in contact with Mr. Shanti Swarup Bhatnagar (later Dr. and Sir) and discussed about the formation of an Indian Chemical Society with Dr. P. C. Ray as the Founder President. In 1922, a committee with Dr. E. R. Watson as the President, was formed to look into the possibility of organising a Chemical Society in India. It was found that the country was neither lacking in chemical talents, nor in original research papers which might come from different laboratories; and so the consideration obviously turned to the financial aspect of such an organisation. Dr. Watson circulated a letter to a large number of chemists, to the different universities and also to the Departments of different Governments of the Provinces and States. Replies from the Provincial Governments were not very encouraging, but the State of Baroda made a sympathetic response with a promise of an annual grant. The University of Calcutta, however, sounded a different but generous note, and agreed to publish the Journal of the proposed Society free of cost. The Universities of Dacca and Allahabad offered to make an annual contribution of Rs. 200/- each and the University of the Punjab Rs. 100/- a year. One hundred and seventy three persons replied intimating their willingness

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to join the Society and proposed that the membership fee should be fixed at Rs. 15/- per year.

Publication of the Journal of the Society.

The Committee reported in favour of the proposal to the Chemistry Section of the Indian Science Congress held at Madras in 1922. In the Indian Science Congress at Lucknow in 1923, a detailed scheme was drawn up, indicating the cost of publication of a Quarterly Journal and containing the rules and regulations framed for the purpose. The Society was registered on May 9, with Dr. P. C. Ray as its Founder President, and Dr. J. N. Mukherjee, as its Secretary. The constitution of the first Council of the Society is shown in the appendix. Warm support and encouragement were readily received from chemists all over India and by the end of December 1924, the Society had registered on its roll one hundred and one Fellows. In July 1924, invitations were issued to the Fellows of the Society for communicating papers for publication, and the first number of the Journal of the Society came out in November, 1924. The Society and its Journal were welcomed by different sister Societies abroad. Professor Wynne, President of the Chemical Society, London, cabled to Dr. P. C. Ray, "Hearty congratulations and warm wishes to the newly formed Indian Chemical Society". Dr. P. C. Ray in his reply to Professor Wynne expressed the reasons for founding a Chemical Society in India. "The Journal of the Chemical Society (of London) has hitherto been the only organ of chemists throughout the British Empire, and the Publication Committee had been hard put to it to find space for the ever-increasing number of communications and have often been under the necessity of appealing to authors of papers to abridge them as far as possible. This branch of science (chemistry) was zealously pursued in ancient India, and I have now the satisfaction of finding Chairs of chemistry in most universities of India filled by my own pupils, who have also been regular contributors to the Journal of the Chemical Society (London)".

The first number of the Journal of the Indian Chemical Society met with favourable criticism both at home and abroad. Professor Simonsen thought that "the first number of the Journal is a creditable production for a first issue."

Recognition of the Journal.

From the very beginning other sister organisations accorded their recognition to the Journal of the Society. The American Electrochemical Society, New York, and the Editor, Journal de Chimie-Physique, Paris, offered to exchange their Journals with that of the Society. The Secretary, American Chemical Society, forwarded the first number of the Journal to the Editor of the Chemical Abstract for notice and attention. The

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British Journals, too, did not fail in their appreciation. In January 31, 1925, a note appeared in *Nature* under the caption, 'Chemistry in India'. "The great work in chemistry which has occurred in the Indian Empire during the past ten years, has led to the establishment of an Indian Chemical Society;...the first number of the Quarterly Journal of the Society has now appeared. Hitherto chemical papers emanating from India have been published either in the Journal of the Chemical Societies of London or America, or in one or other of the larger continental publications. The disadvantages attaching to this procedure became more and more obvious as the volume of new work increased; because the older Journals are becoming over-burdened, and the need for economy of space necessitated frequent correspondence between authors and editors, entailing grave loss of time in the cases of countries so far distant as India.

"Apart, therefore, from the pleasure with which all British chemists will welcome this national effort on the part of India, there will be general agreement among them that the scheme of decentralisation of publications within the British Empire which it implies is the only one which can lead to the rapid and adequate publication of new knowledge and tend ultimately to the real advancement of chemistry.

"The new Journal is a welcome illustration of the development which has taken place in Indian chemistry during recent years. There are thirteen papers, and only one of these is published under English names. The remaining papers are published by Indians and come from all parts of the Indian Empire. Four of them emanate from the College of Science, Calcutta, and this is as it should be, because, for many years past, this Institution has been the back-bone of chemical research in India. The other communications come from Allahabad, Baroda, Dacca, Cuttack, Benares and Madras and constitute a series of which the organising committee and editor have every reason to be proud."

During the twenty five years of its existence the Society has made a steady progress in the number of its Fellows and subscribers, in its exchange relation with other journals, in the number of issues of its own organ and in other respects calculated to promote the chemical researches and study of chemistry in India. A reference to Table I will furnish an idea of its progress.

Activities of the Society.

The organ of the Society, which appeared as a quarterly journal for the first four years of its existence, was changed into a bi-monthly one in 1928 and into a monthly journal since 1930 in order to avoid undue delay in the publication of papers. Since 1937, in collaboration with the Institution of Chemists (India) an Industrial and News Edition of the journal has been added to meet the requirements of industrial chemists. This is published separately as a quarterly periodical.

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I. The Progress of the Society during 1924-48.

Year.	No. of Fellows.	No. of sub-scribers.	No. of exchange journals.	No. of Papers published.	Papers published in Industrial and News Edition.
1924	101	15	10	23	
1925	243	64	38	44	
1926	330	78	48	48	
1927	340	81	54	78	
1928	348	87	84	88	
1929	393	98	93	106	
1930	377	102	103	113	
1931	387	105	110	100	
1932	360	100	116	98	
1933	323	97	118	89	
1934	307	101	120	117	
1935	288	110	137	128	
1936	278	108	141	130	
1937	292	121	146	113	
1938	295	131	170	107	12
1939	296	148	180	118	15
1940	321	136	143	120	23
1941	320	135	103	107	30
1942	325	131	81	96	32
1943	359	150	76	99	23
1944	370	171	75	94	19
1945	389	202	91	90	25
1946	370	239	115	78	14
1947	399	233	123	145	22
1948 (Nov.)	448	289	128	107	26

Apart from the publication of its journal, the Society had published a Commemoration Volume on the occasion of the 70th birthday of Sir P. C. Ray in 1933. It contains articles form illustrious scientists from all parts of the world.

In 1929, the Society awarded research grants to workers in different laboratories, which have now been discontinued for financial stringency. To commemorate the 70th birthday of Sir P. C. Ray at the instance of Sir S. S. Bhatnagar, the Society awarded a gold medal for three years to the best research worker among the junior chemists in India. In memory of the late Mr. J. M. Das Gupta, a Fellow of the Society, the award of a second medal was arranged since 1934 through the generosity of Mr. S. M. Das Gupta, the brother of the late lamented Fellow.

Under the auspices of the Society Dr. B. B. Dey delivered H. K. Sen Memorial Lecture in 1946. The Society has also inaugurated a lecture-ship and a medal each year in memory of its Founder-President Sir P. C. Ray and the first lecture has been delivered by Prof. N. R. Dhar in 1948.

In recognition of its activities, the Society is represented at the All India Council of Technical Education, the Institution of Standards, the Central Drugs Technical Advisory Board and the Board of Examiners of Technical Education.

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Housing of the Society.

To begin with, the Society had no house of its own. Professor J. N. Mukherjee, who shouldered the burden of shaping and building the Society in its formative period, as its first Secretary, accommodated the office of the Society in his own sitting room at the University College of Science and Technology, 92, Upper Circular Road, Calcutta. On his being elected a Vice-President in 1929, the office of the Society was shifted to the sitting room of the late Professor H. K. Sen, who succeeded Professor Mukherjee as the Secretary of the Society. It was eventually located in the sectional library of the Department of Chemistry. The arrangement, to say the least, was far from satisfactory and more or less a precarious one, not to speak of the overcongestion and many other inevitable inconveniences associated with such uncertain and temporary habitation. The journals of various foreign societies were simply piled up for want of space and could not, therefore, be consulted by the Fellows of the Society. Sir P. C. Ray then came forward and made a generous gift of Rs. 10,350/- to the Society for building a house of its own.

After many unsuccessful attempts to secure a suitable plot of land as a gift either from the Government of Bengal or from the Corporation of Calcutta for building a house for the Society, the Council had a prolonged negotiation with the University of Calcutta. This happily resulted in 1933 in the construction of two large rooms, each of size 30 ft. × 20 ft., along with the verandah and side rooms in the third storey of the extension of the south wing at the University College of Science and Technology, Calcutta, at the cost of about Rs. 10,000/- for the use of the Society at a nominal token rent of Re. 1/- per month. The Society paid the cost of construction from its building fund.

Other active centres of chemical researches being at long distances from Calcutta, the headquarters of the Society, it is obviously not possible for Fellows from these centres, distributed all over India, to attend the meetings of the Society. Arrangements were, therefore, made for opening branches of the Society at those centres of research activities. Soon after the establishment of the Society in 1924, three such branches were opened, one in Lahore in 1925, one in Bombay in 1926 and another in Madras in 1927.

Financial Assistance to the Society.

Apart from receiving a substantial help from the University of Calcutta in the form of printing annually 1000 pages of the Society's Journal free of cost and being provided with accommodation for its office, the Society has also been supported by other Indian and State universities, as also by many research organisations through annual or occasional grants; of these mention may be made here of the Universities of Dacca (now in

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Pakistan), Madras, Bombay, the Punjab (now in Pakistan), Allahabad, Lucknow, Nagpur, Patna, Annamalai, Aligarh, Mysore, Travancore, Baroda and Osmania (Hyderabad), the Indian Institute of Science at Bangalore and Sir Dorabjee Tata Institute. The Society has also received occasionally financial help from the Government of India and from the Provincial Governments of Burma (now an Independent State), Bengal and Madras, as also from the States of Baroda and Hyderabad. Substantial contributions have also been received from time to time from many chemical firms, of which the Alembic Chemical Works, Bengal Chemical and Pharmaceutical Works, and the Calcutta Chemical Works deserve particular mention. For the last few years the Society is receiving financial assistance also from the Rockefeller Grant and the Government of India, through the National Institute of Sciences of India, towards its publication cost. The Council takes this opportunity of expressing its grateful thanks to all the benefactors, supporters and patrons whose munificient contributions have enabled the Society to grow and prosper.

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CHEMICAL RESEARCHES IN INDIA

§ 1. Inorganic Chemistry.

Research work in Inorganic Chemistry in India has been confined to only a few laboratories, notable among which lie in Calcutta, Bangalore, Patna, Lahore and Bombay. The earliest publications date back to 1890, when Alexander Pedler, Professor of Chemistry at the Presidency College, Calcutta, reported some investigations on the action of light on phosphorus, chlorine and chlorine acids, and attempted a chemical analysis of some sulphurous gases.

Earnest endeavour in this direction might, however, be said to have been started since P. C. Ray joined the Presidency College, Calcutta, in 1889. His amazing activity and inspiring example, no less than the discovery of mercurous nitrite and mercury hyponitrite in 1896, attracted scores of young and untiring workers for over thirty years, and it is a delightful chapter in the history of chemical research of the land to follow how gradually and successfully he knit them closely together into a new and vigorous school, in which may be reckoned the names of many of the distinguished scientists of India today. His work was both comprehensive and varied in nature extending from an exhaustive study of inorganic and organic nitrites and hyponitrites to compounds of noble and rare metals with numerous organic sulphides. From among a large number of workers who associated with him in these researches, mention may here be made of J. N. Sen, P. Neogi, A. C. Ganguly, A. C. Ghosh, J. N. Rakshit, H. K. Sen, R. L. Dutta, N. R. Dhar, N. N. Ghosh, N. Adhikary, S. C. Sen Gupta, S. Banerjee, N. Ray, and D. C. Sen. In addition, the publication of the "History of Hindu Chemistry" in 1902 and the foundation of the Indian Chemical Society in 1924 through his patronage and guidance constitute two other outstanding contributions made by him to the cause of science in India.

The Tatas founded the Institute of Science at Bangalore in 1906 and appointed M. W. Travers as its first Director. Travers published a paper in 1912 on borohydrates with one of the first batch of his students of the Institute, R. C. Ray, who later extended the study into a series of elegant and careful investigations during the uninterrupted years of his professorship at the Patna Science College. After the retirement of Travers, H. E. Watson led an active group at Bangalore in his work on electrical discharges in gases and radioactivity of minerals. K. R. Krishnaswamy developed the technique of high precision chemical analysis and redetermined the atomic weights of antimony and tantalum.

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The inauguration of the first Science Congress at Calcutta in 1915 is associated with the name of P. S. Macmahon whose investigation "on the action of light on silver chloride" was published in this country in the Proceedings of the (Royal) Asiatic Society of Bengal. His recent publications on the photochemical action of oxalates and the question of active oxalic acid from Lucknow University bear testimony to his unflagging interest in the subject.

An active school of inorganic chemistry grew up gradually at the University of Calcutta with the close association of P. Ray and P. B. Sarkar. The study of complex compounds of metals and development of analytical methods have become the most sustaining and fruitful lines of investigation as a result thereof.

Ray's contributions to Inorganic Chemistry has been manifold. Among his publications on analytical chemistry, the most widely known are those on rubeanic acid as a spot-test reagent, hexamine as an analytical reagent and quinaldinic acid as a macro and micro-specific reagent for the estimation of zinc, and dimercaptothiodiazole as an analytical reagent. R. M. Ray, A. K. Chattopadhyaya, M. K. Bose and J. Gupta were associated with him in these investigations. Some of his laborious researches on the magnetic susceptibility of complex compounds in collaboration with H. Bhar, H. Sahu, S. K. Siddhanta and D. N. Sen, attracted considerable notice in the literature. His works on the substituted cyanocobaltiates with S. Maulik, S. Chakravarty and N. K. Dutt, and isomerism of thiosulphuric acid with S. Maulik are distinct contributions to the chemistry of co-ordination complexes. The later period of his activity has been mainly devoted to an exhaustive study of the extraordinarily varied compounds of simple and suitably substituted biguanides with metals of the transitional series, in which H. Saha, H. P. Bhattacharya, N. K. Dutt, K. R. Chakravarty, S. P. Ghosh, S. K. Siddhanta, A. Bhaduri and A. N. Majumdar also participated. This led not infrequently to interesting and illuminating conclusions on problems of valency and the structure of chemical compounds. Particular reference may here he made of his work on the silver-ethylenedibiguanide complex with tripositive silver (with K. R. Chakravarty) and of alkali nickel periodates with tetrapositive nickel (with B. Sarma).

Among the earlier activities of P. B. Sarkar, his publications on the complexes of chromium and molybdenum with B. K. Pal and on the volumetric estimation of manganese may be especially mentioned. Since his return to India after a brilliant study on rare earths in general and on scandium in particular at Paris, he has established an active centre of research on the complex chemistry of the rare earths, the only one yet of its kind in India. His concepts of chemical analogy among elements

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and radicles led to establish the analogy between fluoberyllates and sulphates, nitrites and formates, to the isolation of fluocarbonic ester and incidentally to the application of thallous fluoride as a fluorinating agent. Of those who joined him in these works mention may be made of N. Ray, B. C. Ray, H. C. Goswami and A. C. Ray. His persistence and imagination have been largely responsible in introducing newer methods of analysis of trace elements in complex rocks and minerals and for the ever-increasing application of physico-chemical methods to a variety of chemical problems, especially the study of imperfect complexes, with N. K. Dutt, B. C. Purkayastha and B. Halder. Purkayastha has also studied the mechanism of uranium fission on the basis of yield mass curve.

The manifold activities of Ray and Sarkar have been followed up in recent years by a promising band of workers at and outside the University, particularly in the domains of physico-chemical methods and their applications, analytical chemistry and the chemistry of the rare earths. A method for the quantitative separation of nickel from cobalt was worked out by D. C. Sen. A number of methods for the estimation of bismuth, especially one using phenyl arsonic acid as the precipitating agent, have been worked out and a critical study of the application of quinaldinic acid and its isomer, quinoline 8-carboxylic acid, in the estimation of copper has been made by A. K. Majumdar.

At the Presidency College, Cal., P. Neogi kept up an active centre of research till only lately. His early work related to compounds and reaction mechanisms of certain oxyacids of nitrogen and phosphorus. Later he directed his activity to problems of stereochemistry and to a systematic study of compounds of rare metals, especially of gallium with N. K. Dutt and S. K. Nandi. Chemistry of co-ordination compounds also received some attention from K. Mondal, as also the formation and isolation of polyhalogen compounds of hydrogen from S. K. Ray.

Important work was being done at Lahore by H. B. Dunnicliff and his associates over a number of years. Dunnicliff's phase rule studies of some sulphate systems with A. L. Aggarwal, R. C. Hoon, and I. S. Sikka have been of lasting value. His numerous publications on the action of sulphuretted hydrogen towards different oxidizing solutions, carried out in association with G. S. Kotwani, S. Mohammad, J. Kishen, S. D. Nijhwan and C. L. Goni, have unfolded the mechanism of rather complicated reactions. An interesting gravimetric method for estimating some alkali metals using zirconium sulphate was worked out by N. A. Yajnik.

At the Science College at Patna R. C. Ray, besides continuing his previous line of research on borohydrates as stated before, made a critical

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study of the composition and nature of the hydrides of cobalt, nickel and iron in collaboration with R. B. N. Sahai. Stability of the perchlorates of metallic ammines also constituted another interesting branch of his study in collaboration with P. Sinha.

Among the group of workers at and around Bombay, the names of M. S. Shah and his associate T. M. Oza deserve special mention for their work on some oxides and oxyacids of nitrogen and the thermal decomposition of nitrites and hyponitrites.

The work of B. Sanjiva Rao and A. Rao at Bangalore on some unstable oxygen and halogen compounds of sulphur is noteworthy. A new and the lowest oxide of sulphur, S_2O, was isolated and characterized, while the existence of sulphur moniodide and thionyl iodide was confirmed in non-aqueous solutions and their hydrolysis studied.

A small but active centre was maintained at Dacca since the days of the revered Dr. E. R. Watson thirty years ago. J. C. Ghosh and his co-workers made valuable contributions to the development of Fischer-Tropsch synthesis by discovering cheap and active oxide catalysts. Publications on physico-chemical studies of complex acid, such as the complex formation between molybdic acid and tartaric acid etc. were also made from the same laboratory. R. L. De worked on radioactivity and the study of some phenomena in hydrogen tubes. P. C. Banerjee's more recent work on the use of vanadous sulphate as a volumetric reagent is particularly interesting.

Isolated pieces of work, none the less interesting, was done by R. K. Bahl from Lahore on chlorine and periodic acids, by H. Krall from Agra on the tautomerism of carbamides, and by others.

J. G.

§ 2. Organic Chemistry.

A considerable amount of research work in different branches of organic chemistry has been published by workers all over India and it is not possible to include in this short review the varied types of work undertaken. An attempt has, however, been made to indicate the main lines of work pursued by different investigators.

1. *Terpenes.*—Research in this branch of organic chemistry was initiated by Simonsen and valuable work was carried out by him at Madras and Bangalore. A thorough investigation of a number of Indian essential oils has been made and a large number of terpenes has been

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isolated in the pure state and their constitutions settled. Synthetic work in this field has also claimed considerable attention of Indian chemists, and in recent years successful syntheses of a number of natural terpenes and their degradation products, e.g. £- and β-santalol, thujone, zingiberine, etc. have been achieved. Mention should be made here of the contributions of P. C. Guha and collaborators, J. C. Bardhan, S. M. Mukherjee, P. C. Dutta, D. K. Banerjee, N. C. Ganguly, S. K. Bhattacharyya, P. L. Narashima Rao, R. N. Chakravarti, P. C. Mukherjee, M. L. Joshi, Bharatbhusan, B. K. Bhattacharyya and others.

2. *Steroids and Related Problems.*—Study on these important problems has been pursued with considerable zeal at Calcutta by a number of workers. The investigations have been mostly directed towards the synthesis of the natural products or their analogues and of the degradation products of the natural steroid bodies. A number of different methods has been developed for the ultimate synthesis of these important biological products and some fruitful results have been obtained. Notable contributions in this field have been made by J. C. Bardhan, D. K. Banerjee, P.C. Dutta and P. C. Mukherjee.

A closely related problem, the chemistry of phenanthrenes, has also received a good deal of attention. A number of routes for the syntheses of phenanthrenes and hydrophenanthrenes has been described by J. C. Bardhan and S. C. Sen Gupta, N. N. Chatterjee, R. Ghosh, N. C. Ganguly, B. K. Bhattacharyya, S. H. Zaheer and S. A. Faseeh. The dehydrogenation of hydrophenanthrenes by S. C. Sen Gupta has provided much valuable information on this subject. M. C. Nath has determined the constitution of a steroid ketone, artostenone, and has made some useful study on the colour reactions of sterols.

3. *Synthetic Dyestuff.*—Investigations in this line were first initiated by E. R. Watson at Dacca and followed up by A. C. Sarkar, S. B. Dutta and others. Besides describing synthetic dyes, they have published a large number of papers on the relation between colour and chemical constitution. R. N. Sen and his collaborators at Calcutta have also done much important work in this field. A large number of dyes of the indigo, indazine and azine series has been prepared by P. C. Dutta and S. K. Guha. K. Venkataraman's work on the practical application of the synthetic dyes is of considerable interest. M. Q. Doja has studied a number of new cyanine dyes with interesting results. P. C. Mitter and co-workers have synthesised a number of naturally occurring anthraquinones.

4. *Synthetic Drugs.*—Notable contribution in this field was made by U. N. Brahmachari and his colleagues, particularly in the field of

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antimonial drugs. S. C. Niyogy has studied a number of organo-arsenical and antimonial compounds. The preparation of synthetic organic compounds of potential therapeutic value has been actively pursued in different laboratories. P. C. Guha and his collaborators, K. Ganapati, J. N. Ray and co-workers, H. N. Das Gupta, U. P. Basu, T. N. Ghosh, P. K. Das Gupta and others have published a large number of papers on anti-malarials, sulfonamides, sulphones, thiazoles, acridines, amidines, etc.

5. *Sulphur Compounds.*—Different types of organic sulphur compounds have been prepared by P. C. Ray and his school at the University College of Science, Calcutta. The syntheses of long-chain sulphur compounds (P. C. Guha), heterocyclic compounds containing sulphur (P. K. Bose), thio-camphor and its derivatives (D. C. Sen), thio-aldehydes, thioketones and thioketonic esters (S. K. Mitra) are of interest.

6. *Heterocyclic Compounds.*—P. C. Guha and collaborators, S. C. De, T. N. Ghosh, and others have prepared a large number of heterocyclic compounds containing nitrogen, oxygen and sulphur, by a variety of condensation reactions. H. K. Sen and his co-warkers, U. P. Basu and C. R. Barat have synthesised a number of pyridine, quinoline and isoquinoline derivatives from oxymethylene ketones, β-diketones and cyanacetamide.

J. N. Ray and co-workers have made valuable experiments on the synthesis of oxy-quinazolines, phthalazines, etc.

Recently B. B. Dey and co-workers have published a number of interesting papers on the isoquinoline ring systems.

R. C. Shah has synthesised a number of quinoline derivatives and benzamidines. S. C. De and co-workers have made extensive studies on pyrazolones, thiazoles, thio-diazoles, triazoles, etc. The chemistry of the pyrones has been studied by R. Kaushal and S. S. Deshapande.

Coumarins, Chromones and Related Compounds.—The chemistry of the coumarins and chromones has received considerable attention at the hands of a large number of workers. Many papers have been published on the synthesis of coumarin derivatives, e.g. hydroxy-coumarins, alkylated coumarins, naphthapyrones, furo-coumarins, coumarin-acetic acids, etc.

Mention may be made of the notable contributions of B. B. Dey, D. Chakravarti, J. N. Ray, T. S. Wheeler, R. C. Shah, N. M. Shah, T. R. Seshadri, S. M. Sethna, R. D. Desai, K. Venkataraman, D. B.

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Limaye and others on the chemistry of coumarins and chromones with particular reference to their synthesis and hydrolysis. Pechmann's reaction, Simonis' reaction and Kostanecki's reaction have been thoroughly investigated with interesting results.

A large number of papers has been published on the isolation and the constitution of pyrone derivatives, occurring in Indian plants, e.g. coumarins (particularly furo-coumarins), flavones, flavonols and isoflavones. In some cases the products isolated have been identified with the known compounds previously described and in many others the constitution of these compounds has been established by their degradation and synthesis. The work of B. B. Dey, K. Venkataraman, J. N. Ray, T. R. Seshadri, B. L. Manjunath, R. C. Shah, P. K. Bose, Mrs. A. Chatterjee, D. Chakravarti and C. N. Bhar may be referred to in this connection.

7. *Investigation of Indian Plants.*—The investigation of the Indian medicinal plants by a number of workers has led to fruitful results. R. N. Chopra and S. Ghosh have investigated the plants which are reputed to be of medicinal value in the Ayurvedic and Unani systems of medicine. Groups of workers at different research centres have isolated several glucosides and other bitter principles, essential and fixed oils. B. B. Dey, J. N. Ray, S. N. Chakravarti, S. Siddiqui, R. Chatterjee, R. H. Siddiqui, S. B. Dutta, Mrs. A. Chatterjee, and B. L. Manjunath have published a number of papers on the isolation and constitution of alkaloids and allied subjects.

A large number of fatty oils has been investigated by Watson, Sudborough, B. S. Rao, T. Katti, S. Krishna, S. V. Puntambekar, S. B. Dutta, B. L. Manjunath, N. N. Godbole, N. L. Vidvarthi, and K. N. Menon. The physical and chemical constants of the oils have been determined; in many cases the glyceride components of the fatty oils, and in some cases the unsaponifiable matter have been examined and phytosterols of known and unknown types have been characterized.

A large number of Indian plants has been investigated by S. B. Dutta and their colouring matters have been isolated; in some cases an investigation of the constitution of these compounds has also been made.

Active principles from plants have also been isolated by S. S. Guha Sircar, N. K. Sen, and S. Krishna; and a considerable amount of work has also been done on the elucidation of the structure of these compounds.

8. *Miscellaneous.*—In this group mention should be made of the studies of P. Neogi and his co-workers on the action of nitrous acid on amines and the preparation of aliphatic nitro-compounds. Organo-metallic

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compounds have been prepared by P. Neogi, M. N. Goswami, H. N. Das Gupta, R. Chatterjee, D. Chakravarti, and others.

Much work has been carried out by B. K. Singh, Mohan Singh, and others on the dependence of optical rotatory power on the chemical constitution. They have also described some products of exceptionally high rotation.

The stereochemistry of the cyclohexane ring has been studied by M. O. Khuda and R. D. Desai with interesting results. Khuda, and N. N. Chatterjee have also studied a number of spiro-compounds.

The problem of orientation in the benzene ring has also been studied by a number of workers. R. L. Dutta and P. S. Varma have studied thoroughly the halogenation of aromatic compounds.

The condensation of malonic acid with various aldehydes has been very extensively studied by K. C. Pandya and his co-workers. S. B. Dutta has described the use of rare metals in the synthesis of organic compounds. A. B. Sen has published several papers on the synthesis of dinitrophenyl ketones and acetic acids.

Mention may also be made of the formation of alicyclic bridge compounds (P. C. Guha), the studies on the heterocyclic compounds (R. D. Desai), condensation of chloral with amides, urethanes, urea, etc. (A. N. Meldrum and co-workers), reaction of nitrophenols and related compounds (S. M. Sane and co-workers), studies on the activity of the substituted malonic and acetoacetic esters (K. G. Naik and co-workers), relation between chemical activity and absorption in the ultra-violet of certain organic molecules (K. G. Naik and co-workers, R. K. Trivedi, and others), studies in γ-ketonic acids (P. C. Mitter and co-workers), synthesis of long-chain acids of the type of aleuritic acid (P. C. Mitter and co-workers), and studies on phenylthiocarbamides (Hans Krall, R. Sahasrabudhey and co-workers).

D. C.

§ 3. Physical Chemistry and Soil Science.

Researches in physical chemistry in India originated with the work of N. R. Dhar on induced reactions and a notable contribution was made by J. C. Ghosh in 1918 on the theory of strong electrolytes. But researches in a systematic manner might be said to have been started in about 1919 by N. R. Dhar at the Allahabad University. Extensive studies were made on the problems of coagulation, hydration,

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and gelation of colloidal systems. Later on, an active school of workers was created for the study of photochemistry and some practical aspects of photonitrification in tropical soils. The use of molasses as a cheap source of energy-rich material for heightening the nitrogen status of the soil was suggested from these experiments. Useful contributions were made in these investigations by P. B. Ganguli, Gopala Rao, A. Bhattacharya, Atmaram, S. K. Mukherjee and others.

The investigations on colloids initiated at the Calcutta University by J. N. Mukherjee were designed to understand, besides the various properties including coagulation, stability and surface characteristics of colloids, the very complicated system of colloids, or more truly, the electrolytic colloids constituted of clays and clay minerals. For the study of these heterogeneous systems a fundamental approach was made starting from simple substances. Mainly electrochemical, viscous, x-ray, and optical studies were undertaken. As a result of these researches unequivocal and satisfactory answers were obtained to such little understood processes like base exchange reactions, soil acidity and other colloid chemical reactions, on the basis of the theory of the electrical double layer postulated by Mukherjee. Notable contributions have been made by a number of his co-workers; mention may be made of S. G. Chowdhuri, B. N. Ghosh, S. P. Ray Chowdhury, R. P. Mitra, S. N. Mukherjee, S. Mukherjee, B. Chatterjee, H. K. Acharya, N. C. Sen Gupta, B. R. Mazumdar, S. K. Mukherjee, S. N. Bagchi, N. P. Dutta and M. K. Indra.

The work on the electrochemistry of clay and other clay minerals and on ionic exchange properties of such systems is now being pursued by R. P. Mitra at the Delhi University and by S. K. Mukherjee at the Calcutta University.

At the Dacca University interest centred round the molecular or ionic properties in solution under the guidance of J. C. Ghosh. Ghosh's earlier contribution on electrolytic conductance was followed by researches on ionic aggregate formation in solutions by means of the study of fluorescence bands. Suitable and sensitive methods were devised and developed to study the fluorescence bands as also to measure the life period of molecules excited by radiation. Colloidal solutions of tungstic and vanadic acids and ceric borate were prepared, which, when allowed to mature under the influence of circularly polarised dextro-light, were found to be circularly dichroic. The utilisation of these dichroic suspensions as specific catalysts for one type of optically active transformations will be considered as a great step forward. Of those who associated with J. C. Ghosh in these investigations mention may be made of R. M. Purkayastha, K. P. Basu, S. K. Bhattacharya, T. Banerjee, B. C. Kar, S. B. Sengupta, P. B. Bhattacharya and T. K. L. Rangacharya.

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Kinetics of reaction in solution including photochemical reactions, the mechanism of such reactions, and kinetic salt effect have been investigated by J. C. Ghosh and A. N. Kappanna.

Colloidal gels form an important branch of study in the domain of colloids. The work in this field has been mainly carried out by Mata Prasad at the Bombay University and Satyaprakash and others at the Allahabad University. The chief lines of research included the problems of preparation and stabilisation of gels, sol-gel transformation or thixotropy etc. The investigations by Mata Prasad, Mathur, Hattiangadi, Desai, Parmar, Mehta, Subba Rao and others on the time of setting of gels and its dependence on various factors, specially viscosity, elasticity and also the optical properties have thrown considerable light on the mechanism of gelation and gel structure. The work on the colloidal behaviour of drilling mud including thixotropy, swelling, etc., initiated at the Calcutta University by J. N. Mukherjee, N. C. Sen Gupta, M. K. Indra and others has been found to be very helpful from the practical point of view.

N. A. Yajnik, D. Bhalla and others studied the stability of several organo-metallic sols and gels. They also worked on the adsorptive properties of charcoal and some physical properties like vapour pressure, surface tension and viscosity of binary liquid mixtures.

B. Sanjiva Rao and co-workers published several papers from the Bangalore Central College dealing with adsorptive properties of silica gel and kinetics of reactions in solution.

A careful study of the coagulation of colloids both in the slow and rapid regions was made by S. S. Joshi in collaboration with S. J. Rao and P. V. J. Rao, Pannikkar, Viswanath, Menon, Kulkarni, Purushottam, Prabhu, Narayana and others at the Benares University resulting in the observation of the "wall" and "zonal" effects in coagulation, and in the elucidation of the experimental data on the kinetics of coagulation. The periodic variations similar to those shown by the micellar reaction were also observed in the molecular systems under the influence of electrical discharge. Important researches have been made by Joshi, Narasimhan, Sirsikar, Deshmukh, Deo and Singh on the mechanism of chemical reactions under electrical discharge. A continuation of this work led to the discovery of a new light effect, now known as the Joshi effect. It was observed that subjected to ionisation by collision by alternating electric fields, the conductivity in chlorine or similar gases diminishes immediately on irradiation. This finding has been variously confirmed and is also being theoretically tackled.

Important studies on the preparation and physical and physicochemical properties, like stability, inversion, etc., of emulsions have been

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made by S. S. Bhatnagar, Mata Prasad and others at the Lahore University. It was observed that the electrical factor determines the stability of emulsions rather than their interfacial tensions. In this work, B. Ahmed, N. G. Mitra, Shrivastava and M. Singh collaborated with Bhatnagar.

Researches on magneto-chemistry and molecular structure have been actively pursued by Bhatnagar, Mathur, Kapur, Nevgi and Jain at the Lahore University, where an interferometer balance (Bhatnagar-Mathur balance), a very sensitive instrument for the measurement of magnetic susceptibility was designed and perfected. A series of investigations on the Raman effect and molecular structure of inorganic and organic compounds at different states and temperatures and of ions in solution were carried out by J. Gupta and co-workers. Mata Prasad and co-workers have investigated the effect of colloidalisation on the magnetic susceptibilities of substances.

The dielectric properties of liquids are being systematically studied at the Bangalore Institute of Sciences by S. K. K. Jatkar, C. T. Abichandani and others and interesting information has been obtained of the structures of many liquids. A study of parachor in relation to the chemical constitution of organic substances was made by S. K. Ray at the Presidency College, Calcutta, and by W. V. Bhagwat and co-workers at Indore. The latter workers have also made use of rheochor determination for the same purpose. Valuable work in the field of technical gas reactions including high pressure gas reactions has been undertaken at the Bangalore Institute of Sciences under the direction of J. C. Ghosh in continuation of his earlier work at Dacca in the same line. They found cheap and at the same time efficient catalysts for the Fischer-Tröpsch synthesis.

The physicochemical properties of the shellac solutions including viscosity, solubility, osmotic pressure etc., studied by S. R. Palit and S. Basu at the Indian Lac Research Institute, Ranchi, have thrown considerable light on the structural characteristics of these systems.

The viscosities of liquids and of electrolytic solutions and their variations with temperature have been thoroughly studied by B. Prasad at the Ravenshaw College, Cuttack. He has also critically examined a number of existing relationships between viscosity and temperature. At the Bombay University K. S. G. Doss made a theoretical as well as experimental approach to several problems dealing with surface tension of solutions.

Physicochemical methods of studying the formation of complex compounds have been developed and satisfactorily employed at the Calcutta University by P. B. Sarkar, N. K. Dutt and B. C. Halder and at the Agra University by A. K. Bhattacharya and co-workers.

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A useful application of some of the principles of physical chemistry has been made by J. N. Mukherjee and co-workers at the Calcutta University for the study of the problems of soil acidity and ionic exchange reactions in soils, humus, clay and other minerals.

At the Dacca University a comprehensive investigation has been made by A. T. Sen, S. P. Ray Chowdhuri, J. N. Chakravarty, B. C. Deb, M. K. Mukherjee and others of the physical, physicochemical and electrochemical properties of an important group of Indian soils, viz., the laterite soils. D. V. Bal, K. Ramiah, B. Viswanath, J. K. Basu, P. G. Krishna and others studied the profile characters of the black and black-cotton soils of India. B. Viswanath, A. C. Ukil, S. Das, S. K. Mukherjee, A. Sen, N. D. Vyas and others of the Indian Agricultural Research Institute published a comprehensive analysis of the examination of typical profiles of Indian soils and attempted a broad classification of these soils. The nature of the interaction between the phosphates and the soil is significant in many respects but is a very complicated affair owing to the heterogeneous character of the soil. Results of interest have been obtained from the studies made by S. L. Das at the Indian Agricultural Research Institute, by S. P. Ray Chaudhury and M. K. Mukherjee at the Dacca University and Dalip Singh at the Punjab University.

An extensive study from the physicochemical standpoint has been made by A. N. Puri, Uppal, R. C. Hoon and others and also by Shukla and Nayar on various practical aspects of soil science including soil acidity, base exchange properties, mechanical and physical properties of soils.

Soil survey as an important branch of soil science is full of promise so far as its practical utility is concerned, but it is still undeveloped in India. Co-ordinated surveys on a large scale are yet to be begun, but small scale surveys undertaken by the Provincial and State Departments of Agriculture have already made good progress. An essential aim of soil survey is to have a comprehensive soil map. The soil survey section of the Indian Agricultural Research Institute is working on this objective under the direction of Dr. J. N. Mukherjee.

The basic physical and physicochemical principles underlying the processes of soil erosion and conservation and those of reclamation of saline and alkaline soils are now well understood. In the Punjab, Bombay, the United Provinces, Hyderabad (Deccan) and a few other places practical applications of these principles have been successfully made. A co-ordinated plan to attack these vital problems has recently been given effect to by the Government of India.

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§ 4. Biochemistry.

It is not possible to present in the brief space of a few pages anything but a bare outline of the researches so far done in India in biochemistry. Therefore, only those subjects in which a considerable amount of work has been done will be dealt with, viz., enzymes, vitamins, food and nutrition.

Researches in biochemistry were started in India at the Indian Institute of science, Bangalore, by G. J. Fowler. Notable among those who received their first training in biochemical researches at Bangalore are V. Subrahmanyan, B. Banerjee, M. Damodaran, S. P. Niyogi, M. Sreenivasaya, K. V. Giri, V. N. Patwardhan, Miss K. Bhagvat, M. Srinivasan, N. K. Iyengar, and B. N. Acharya.

1. *Enzyme Action.*—Fermentative production of acetone from *jowar,* of power alcohol from waste cellulose matter, bacterial oxidation of alcohol to acetic acid and the retting of coconut husk, are some of the subjects which received the attention of Fowler and co-workers. The production of solvents like acetone, butyl alcohol, iso-propyl alcohol by the fermentation of molasses with micro-organisms was investigated recently in Calcutta by B. C. Guha, Das Gupta, J. K. Roy and Paul. Guha and Deb Sarma investigated retting of jute and isolated some very active jute-retting micro-organisms. Citric and gluconic acids were also obtained by the fermentation of molasses with *Aspergillus niger* by Das Gupta, Bose and Das. Giri and co-workers carried out extensive investigation on the phosphatases of animal and vegetable origin. The presence of alkaline phosphatase in erythrocytes was reported by Patwardhan. The alkaline phosphatase content of serum in patients with bone tumour was investigated by Chitre.

Guha and Das dicovered a new enzyme *Ionositol dehydrogenase* in the brain and kidney tissues of rats. In the seeds of *Phaseolus mungo* and *P. radiatus* succinic dehydrogenase has been reported to occur by Ramaswamy and Venkatesam; active aldose dehydrogenase by Rudra, which was also found by him in the small intestines of the animals; and from germinated seeds Basu and Kurkun isolated glucose dehydrogenase, and they also detected succinic dehydrogenase in cucumber. M. Damodaran and co-workers suggested that succinic acid is the source of asparagine in plants. According to Das and Sen Gupta the activity of both succinic dehydrogenase and fumarase is necessary to carry on the intense respiration and to help the formation of asparagine during germination. Shukla was able to isolate an amylase from Kaseru having the optimum *p*H between 5.8 to 6.2 From Sweet Cassava (*Manihot palmata*), Murty isolated an amylase whose optimum *p*H was found to be 6.5 A proteolytic enzyme like papain was detected by K. P. Basu and M. C. Nath in the milky juice of *Calotropis gigantea.* B. N. Ghosh and co-workers

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reported the presence of trypsin, polypeptidases and choline-esterase in the venoms of some Indian snakes. Ghosh and S. De isolated haemolysin (lecithinase) from the venoms of cobra (Naja) and *Crotalus terrificus*. De succeeded in crystallizing haemolysin from cobra venom. Choline-esterase from cobra venom was isolated in a pure state by Chowdhury.

The identity of Schardinger enzyme and xanthine-oxidase of milk was established by K. P. Basu and S. P. Mukherjee. Basu, Nath and Chakravarty also reported the presence of certain oxidising enzymes in betel leaves. Methods for the estimation of peroxidase activity were developed by B. B. Dey and also by Srinivasan and co-workers.

2. *Vitamins.*—An extensive search for a potent and cheap source of vitamin A was undertaken by Guha and co-workers, Basu and co-workers, Seshadri, Mazumdar, Rajagopal, Niyogi, and Braganca and co-workers. Guha and co-workers found that some of the Indian fish-liver oils are richer than cod-liver oil in vitamin A though less potent than halibut-liver oils. Wilson and Ahmed studied the metabolism of carotene and the absorption of carotene and vitamin A in the human subject. Similar experiments were also carried out by De. The problem of the preservation of vitamin A in ghee and oils was investigated by Banerjee and Basu.

Guha and co-workers isolated a flavine from ox-kidney and their work threw considerable light on the multiple nature of vitamin B_2. Swaminathan devised a chemical method for the estimation of nicotinic acid and of vitamin B_6. He with Shourie showed that rats could synthesise nicotinic acid.

Vitamin C content of a large number of Indian foodstuffs was estimated by Chakravarty and Ahmed. The investigations of Guha, Chakravarty and Paul showed that plant tissues contain a precursor of ascorbic acid. The dissociation constant of pure ascorbic acid was determined by J. C. Ghosh and Rakshit. Ghosh and co-workers also studied the redox potential of the system ascorbic acid and dehydroascorbic acid under conditions in which the last trace of oxygen was eliminated. The biosynthesis of vitamin C received considerable attention. Of the common sugars, mannose was found to produce ascorbic acid in rat tissues both in *vivo* and in *vitro* (Guha and co-workers). Ray and Guha also investigated the biosynthesis of ascorbic acid by rats under narcotized conditions. They found that the stimulating effect of chloretone on the urinary excretion of ascorbic acid by the rats could be suppressed almost completely, if the animals were made deficient either in thiamine or riboflavine. Roy suggested that the site of action of the narcotic was in all probability a flavoprotein resembling that of Hass Cytochrome-c-

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reductase. B. Banerjee observed certain interesting relation between vitamin C and carbohydrate metabolism. He noticed that pancreatectomized animals receiving vitamin C showed higher sugar tolerance than those without supplements.

Analysis of body and liver oils of fresh water fishes and other marine animals with respect to their vitamin D content was carried out by Basu and co-workers, Ranganathan, Braganca and Niyogi. Compared to cod-liver oil, oils from fresh water fishes were found to contain only small quantities of vitamin D. Patwardhan studied the absorption of calcium salts from the intestines of albino rats. No evidence of the influence of vitamin D on the absorption of calcium salt was noticed.

3. *Food and Nutrition.*—McCarrison undertook a diet survey of the different provinces in India.

Rice and pulses, which form two important constituents of Indian food, received considerable attention. Researches at Coonoor indicated that the quality of rice is dependent to an appreciable extent on the environmental conditions at the period of growth. The changes taking place in rice through storage, influence of season, and through parboiling were studied at Bangalore. It was shown by Srinivasan and also by Basu and co-workers as well as by Sanjiva Rao that the nutritive value of parboiled rice was better than raw rice in many respects. In *vitro* digestibility, by enzymes, of starch, of different varieties of rice was the subject of investigation by Basu, Sirkar and Mookerji and also by Srinivasan. The biological value of proteins of different varieties of rice was also investigated by Basu and co-workers.

The proteins of pulses were also studied by a number of workers. The alcohol-soluble protein of Ragi (*Elensine coracana*) was analysed by Narayana and Norris. Narayana extracted and analysed the globulin of Bengal and horse gram. Miss K. Bhagvat studied the globulins of cow pea and of the aconite bean. She also estimated the non-protein nitrogen of different pulses. Basu, Nath, Ghani, Mookerji and Basak studied the biological value of the proteins of different foodstuffs. Acharya, Niogy and Patwardhan determined the effect of perching on the digestibility and biological value of proteins of certain cereals.

The biological value of milk proteins was determined by K. Mitra and H. C. Mitra. Per unit weight of protein intake the growth promoting capacity of goat's milk has been found to be inferior to that of cow and buffalo. Anantakrishnan and Lahiri found that casein of ass's milk contains a larger percentage of phosphorus than the milk casein of other mammalian species.

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The preparation of a milk substitute from soyabean engaged the attention of Guha, De and Subrahmanyan. De investigated the problem in detail and succeeded in obtaining a milk-like preparation almost free from the unpleasant taste and odour.

Investigations on the biological value of fish proteins were carried out by K. C. Saha and also by Basu and Gupta. The effect of boiling and frying on the enzymic hydrolysis of fish was also investigated by Saha. Roy and Sen estimated cysteine, tyrosine and tryptophan contents of certain varieties of Bengal fish. Saha estimated the available iron in different varieties of fish. His results show that part of the iron exists in a very stable combination in the form of iron-copper nucleoprotein complex. The complex is reported to possess marked haemoglobin regenerating power.

B. G.

§ 5. Applied Chemistry.

Researches in applied chemistry, carried out during the last quarter of a century, cover almost every important aspect of national economy. During the last great war such researches were also directed to foster war efforts, but the results were not, as a rule, published. Results of investigations carried out under the auspices of industrial concerns, or of various research organisations, are also not usually available to the public. In the following brief review, information has been collected mainly from publications in the journal of the Society. It is to be regretted that the short space does not permit adequate notice being taken of a number of investigations which have been published elsewhere.

1. *Coal.*—The chemical composition of certain Indian coals has been investigated by Bhattacharjee and by Mahadevan. Dutta Ray has studied the action of solvents on coal. Chowdhury and co-workers have studied the selective oxidation of Assam tertiary coal by chlorine peroxide, followed by successive extraction with different solvents. They have also studied the mild aerial oxidation of coal at ordinary temperatures. Mineral matters in coal have been investigated by Dutta Ray, while Farmer has studied the relation of specific gravity and ash content. He has also supplied analytical data for a number of coal samples from different areas. Cleaning of Indian coals has been studied by Bose and Gupta, while Randal used the Forth Flotation process for the purpose and concluded that Indian coals, as a rule, did not respond to such washing. Forester and co-workers have recently examined the washability of a large number of samples of Indian coals from different areas. They conclude that Jharia coals below No.10 seam are quite amenable to washing, but Assam coals with high sulphur and low ash contents do not respond to the treatment. Low temperature carbonisation of coal has

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been studied by a number of workers, such as, Stanley, Farmer, Sen, Guha and others. Guha and co-workers have shown that the yield of tar and quality of coke can be improved by mixing the coal with tar previous to carbonisation. The yield of primary tar decreased with rise in the ash content. Sen and co-workers have improved the proportion of neutral oil in primary tar by adding iron filings and sodium carbonate in low temperature carbonisation. By this method they obtained a tar with low phenol ratio, which was found suitable for internal combustion engines. Ray and co-workers have been able to obtain a good quality coke by blending non-coking inferior coals with good coking coal and pitch and also by pressure carbonisation. The coal blending and coking sub-committee working at Jamsedpore is reported to have obtained good metallurgical cokes by blending 33% coking coal with 67% inferior grade coals. P. C. Guha and co-workers have fractionated coal tar obtained by high temperature carbonisation of coal and have been able to isolate a number of constituents including some new ones.

2. *Gaseous fuel.*—J. C. Ghosh and K. M. Chakravarty have studied the formation of methane from carbon monoxide and hydrogen in presence of various catalysts. Ghosh, Sen and co-workers have synthesised higher paraffins from the same ingredients by using special catalysts.

Chakravarty and Sarkar have been able to prepare highly active nickel-alumina catalyst for the reduction of carbon monoxide in water gas in the presence of moisture. Chakravarty and co-workers have also studied the Fischer-Tröpsch reaction using nickel catalysts in place of cobalt and obtained highly encouraging results.

3. *Adsorbents.*—Chowdhury and co-workers have prepared mixed adsorbents consisting of alumina and silica gels in varying proportions, and have used them for a number of technical purposes, such as, recovery of benzol from coke-oven gases and decolourisation of vegetable oils. Chowdhury and Datta have also used mixed alumina-iron oxide adsorbents as catalysts for oxidation of sulphuretted hydrogen to elementary sulphur. Bhatnagar and co-workers have prepared active haematite and successfully applied it as an adsorbent for colloidal suspensions. S. P. Rai Chowdhury has prepared active charcoal suitable for industrial purposes. Mukherjee, Bose and Das Gupta produced activated carbon by subjecting cane-sugar molasses to destructive distillation and studied its activation in detail. Rao and Rao have investigated the preparation of activated decolourising carbon from different raw materials, e.g. bagasse, paddy husk, coconut shell, etc. M. Goswami and co-workers have also studied the above raw materials for the production of active carbon. Chowdhury and co-workers have prepared activated carbon from rice husk by impregnation with zinc chloride, ammonium phosphate or boric acid before carbonisation and also by activating the primary carbon with carbon dioxide, steam and other gases.

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4. *Lac and Shellac.*—A number of investigators from the Lac Research Institute at Ranchi have studied the chemical and physical properties of lac and shellac. Sen has made interesting studies in the methods of washing stick lac with a view to producing high grade seedlac. Bleaching of lac, recovery of refuse lac, and separation of the lac-resin from shellac have received attention from a number of investigators. Sen and co-workers have successfully used shellac and seedlac as a moulding powder and have improved the technique of producing these moulded goods by the incorporation of various ingredients.

5. *Other Plastics.*—Bhatnagar and co-workers have used horn powder for the production of plastics by incorporating it with urea or phenol plastics. Chowdhury and Banerjee have studied physicochemical properties of horn and have successfully used horn-wastes for the production of moulded articles. Sreenivasaya and Sharma have studied lac-urea complexes and obtained interesting results. Goswami and co-workers have used a number of vegetable oils for the production of plastics. Guha and co-workers have treated jute-waste with acids under high pressures and obtained a powder suitable for the plastic industry. Ghosh and co-workers have made a detailed study of electrodeposition of rubber and produced rubber-lined equipments suitable for the chemical industry. Ghosh has also made an interesting study in the catalytic dimerization of acetylene to mono-vinyl acetylene at medium high pressures.

6. *Wood and Cellulose.*—A number of workers in the Forest Research Institute at Dehra Dun have studied the problem of impregnation of wood with preservatives. Pearson, Warr, Pophan and Kamesam have obtained promising results. Special mention may be made of a preservative containing chromium and arsenic developed by Kamesam who claims that the impregnated timber can replace iron for structural purposes. Raitt's work on suitability of bamboo for paper pulp has opened a new source for the raw material in the paper industry. Sudborough, Simonsen and others have studied the tars obtained by the distillation of various woods.

Saccharification of wood and other ligno-celluloses, with a view to manufacture power alcohol, has been studied by a number of workers. Sen and co-workers have studied Gangwa wood and water-haycinth for the purpose, while Deshpande has studied the suitability of rice-straw as a raw material for the power alcohol industry. Fowler and Banerjee have paid special attention to bagasse with the same object. Acetylation of cellulose and the solubility of the products in different solvents have been studied by Goswami and co-workers in some details. Sen and Das Gupta have isolated two new spore-forming organisms which can attack cellulosic substances without previous saccharification.

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7. *Jute.*—Conditions for the removal of lignin from jute without affecting other constituents of the fibre were studied in detail by Chowdhury and co-workers who found chlorine peroxide an ideal reagent for the purpose. They investigated the problem of improving the wet strength by impregnation with suitable synthetic resins. Bagchi obtained nitro-cellulose from jute in a stable form, suitable for lacquer industry owing to its greater solubility and lower viscosity than cotton nitro-cellulose. The molecular size of jute cellulose was investigated by Chowdhury and co-workers who concluded that the jute molecule had, on an average, a smaller length than the molecules of cotton cellulose. Chemical constitution of jute lignin was studied in detail by P.B. Sarkar. Sarkar and co-workers have successfully used treatment with sodium chlorite for removal of lignin without affecting the hollow-cellulose. They have also tried to correlate the spinning quality of jute fibre with its fat, nitrogen and other constituents. The colour of jute fibre has been attributed to the iron content of the retting water. S. C. Sarkar has been able to impart the properties of wool to jute fibre by treatment with concentrated alkali. Jute-shellac combination has been found to be a suitable plastic for use as a substitute for leather in the manufacture of suitcases and similar products. Guha and co-workers have been able to evolve a jute plastic by treating jute-wastes with acids under high pressure. Dry retting of jute has been carried out by Barua with the help of 'Hiperol', which, it is claimed, yields a better and stronger fibre.

8. *Molasses.*—Recovery of sucrose from cane molasses has been tried by Watson. Sen and co-workers have produced acetic acid and some alcohol from molasses by bacterial action. Guha and co-workers have studied the action of micro-organisms on molasses for the production of citric acid and oxalic acid under varied conditions. The role of phosphates in alcoholic fermentation has been studied by Chinoy and Chopra. Dhar used molasses and a mixture of molasses and press-mud for the reclamation of "usar" soil. He also claims considerable improvement of the nitrogen status of molass-treated soils and consequent improvement in the yield of crops.

9. *Tanning.*—B. M. Das and Guthrie have examined tanning waters and traced the causes of different kinds of stains in hides and skins. Biswas has developed improved methods for isolating tannin in pure state.

10. *Oils and Fats.*—Detection of impurities in butter fat has been studied by Godbole and other workers. Hydrogenation of oils and fats has received attention from Patel and Mukherjee. The composition of certain fish oils has been studied by Chowdhury, Dutta and by Goswami. Goswami's synthesis of ring glycerides of dibasic acids with a view to elucidating the constitution of various oils is of considerable interest. Rancidity of oils and methods for preventing such rancidity have been

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studied by Goswami and co-workers, who have also paid considerable attention to boiled oils. Dehydration of castor oil for use as a drying oil, either alone or in admixture with linseed oil has been studied by Goswami and co-workers. Goswami and his pupils have also studied the preparations of plastics from oils and have evolved the hypochlorous acid value as an analytical constant for furnishing a quick and reliable method for the simultaneous determination of unsaturation and saponification values of an oil. Polymerisation of the unsaturated fatty acids and their glycerides have been studied by Chowdhury and co-workers. Cracking of vegetable oils has received attention from Dulal and Mehta who used different catalysts for the purpose. They have studied the pressure distillation of the cracked oil with a view to obtaining different petroleum products. The cracking of vegetable oils has also received attention from Goswami, and Chowdhury and their pupils.

11. *Soaps.*—Suitability of vegetable oils for the soap industry has been studied by Dutta and co-workers, Duke, Sen and others. The cause of sweating of soaps in tropical countries has received attention from Chatterjee. Chatterjee has shown that Mahua oil is easily saponified in the cold by concentrated alkali and advocates its use in the manufacture of cold process soap.

12. *Essential oils.*—Sudborough and Rao have elucidated the constitution of several essential oils and estimated the essential oil contents of various natural products. Watson and Mulany and Guha have done valuable work in estimating the pinene content in Indian turpentine oils. Preparation of camphor from pinene has also been investigated by them. Sadgopal has made a survey of raw materials in India for the manufacture of essential oils.

13. *Sulphur.*—Extraction of sulphur in elementary form from pyrites has been studied by Chowdhury and Hussain. Chowdhury and co-workers have obtained elementary sulphur from sulphuretted hydrogen by aerial oxidation in the presence of mixed catalysts. Das-Gupta and co-workers have obtained elementary sulphur from sulphurretted hydrogen by treatment with oxides of nitrogen in gaseous state. The possibility of obtaining elementary sulphur from sulphurous coals of Assam has been investigated by Chowdhury and Dutta.

14. *Chemicals.*—Tamarind has been found to be a suitable raw material for the manufacture of tartaric acid and lime for citric acid by Marsden. Chowdhury and co-workers investigated optimum conditions for the catalytic oxidation of toluene and naphthalene in the vapour phase to obtain benzoic acid and phthalic acid respectively. Ghosh and Bakshi have studied the catalytic dehydrogenation of methyl alcohol and the effects of promoters and retardants on the same.

J. K. C.
P. B. D.

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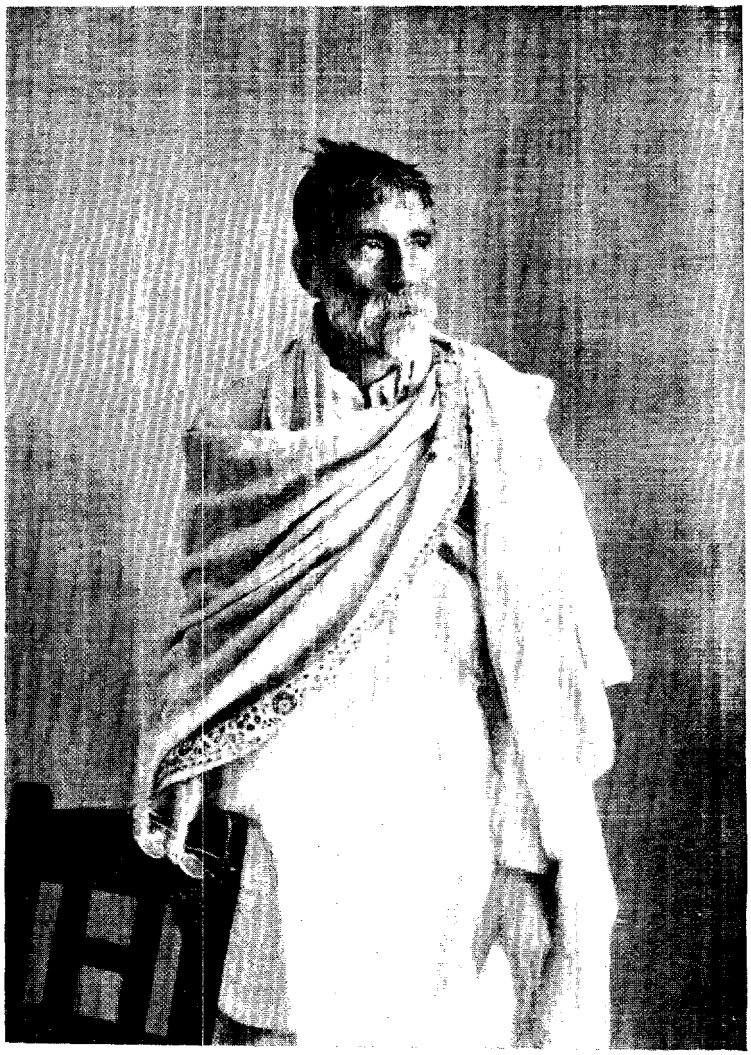

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PAST PRESIDENTS

Prafulla Chandra Ray 1924-26; 1929-30

Born at Khulna, Bengal, 1861. Early education at village school, Khulna; later Hare School, Calcutta, 1870; Albert School, 1876; Metropolitan Institution, 1879; Gilchrist Scholar, 1882. B.Sc., Edinburgh University, 1885. D.Sc. in Inorganic Chemistry, under Professor Crum Brown, Edinburgh University, 1888. Hope Prizeman, 1888. Assistant Professor of Chemistry, Presidency College, Calcutta, 1889-1916. Palit Professor and Head of the Department of Chemistry, University College of Science and Technology, Calcutta, 1916-1937. Visited Europe on deputation by Government of Bengal, 1904, and as a representative of the University of Calcutta to the Empire University Congress, 1912. C.I.E., 1911; Knighted in 1917. President Chemistry Section, Indian Science Congress, 1915. General President, Indian Science Congress, 1920. Last visit to Europe, 1926, as a Delegate to the Empire University Congress. Honorary Fellow of the Chemical Society, London, 1931. Honorary Member, Deutsche Akademie, Munich. Author of a large number of papers on the formation and stability of metallic nitrites and hyponitrites, including the preparation of mercurous nitrite; the action of nitric acid on metals and as well as on organometallic complexes, especially the organic thio-compounds of gold, platinum and iridium. Founder of Bengal Chemical and Pharmaceutical Works Ltd. Author of the History of Hindu Chemistry. Died in 1944.

Gilbert John Fowler 1927—1928



Born in Paris in 1868. Educated at the Quaker School, Sidcot, Somersetshire, and at the University of Manchester. B.Sc., 1886. Demonstrator and Lecturer, 1886-95. Studied organic chemistry and crystallography in Heidelberg, Germany and metallurgy in Sheffield and Freiburg. Chemist and later Superintendent of the Municipal Sewage Works, Manchester Corporation, 1896. Published a report on the treatment of sewage entering New York harbour, 1912. Developed a process for the activated sludge. Consultant in the treatment of sewage in Cairo, Shanghai, Hanghai and Federated Malaya States. Came to India in 1906 for the purification of sewage from the population connected with the jute mills; then again in 1909, in connection with a new process for the extraction of shellac from raw materials and in 1915, as Professor of Applied Chemistry at the Indian Institute of Science, Bangalore. Served also as Professor of Biochemistry, 1916-21, in the same Institute. Principal, Harcourt Butler Technological Institute, Cawnpore, 1927-29. Honorary Corresponding Secretary for India of the Royal Institute of Chemistry of Great Britain and Ireland. Has settled in India.

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Bawa Kartar Singh

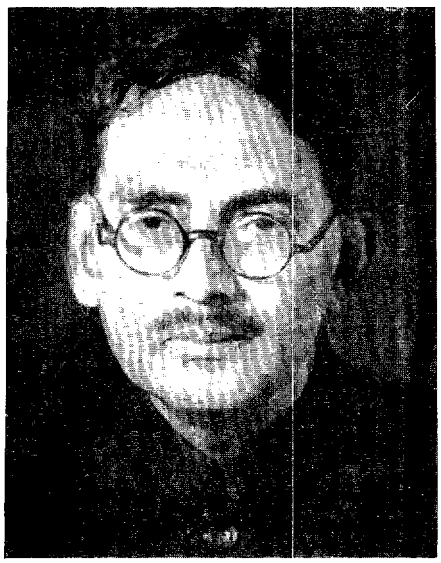
1931—1932



Born in Amritsar, 1886. Early education in Amritsar, Lahore, Calcutta and Rangoon. Later joined Downing College, Cambridge, 1903. Natural Science Tripos, Cambridge, 1906. Sc.D., Cambridge and Dublin. F.R.I.C. Professor of Chemistry, Dacca, 1910-18; of Lahore, 1918-21; of Patna and Cuttack, 1921-40; of Allahabad, 1940-46. President, Chemistry Section, Indian Science Congress, 1920. President of the Philosophical Society, Lahore, 1920. Additional Vice-President of National Institute of Sciences of India, 1934-37 and 1940-46. Member, Research Committee, Government of United Provinces, 1947. Honorary Research Professor, Benares Hindu University, 1948. Main contribution in the field of Organic Chemistry dealing with rotatory dispersion of organic compounds.

Nil Ratan Dhar

1933—1934



Born in Jessore, 1892. Educated in Calcutta. M.Sc. with physical chemistry as the special subject, 1913. Griffith Memorial Prizeman in Science, 1914; Elliot Prizeman and Medalist in chemistry of the Asiatic Society of Bengal, 1914. Lecturer in Physical Chemistry, University of Calcutta, 1913. State Scholar, 1915. Studied in England and France. D.Sc., University of London, 1917. Dr. es Sc. University of Paris, 1919. F.R.I.C., 1919. Professor of Physical Chemistry, Muir Central College, Allahabad, 1919. Director of Public Instruction, United Provinces, 1944. Professor and Head of the Department of Chemistry, University of Allahabad since 1946. Member, International Agricultural Congress, 1937. President, Chemistry Section, Indian Science Congress, 1922. Main activity in the field of Physical Chemistry dealing with problems of photochemical reactions, colloids, biochemistry and agricultural chemistry.

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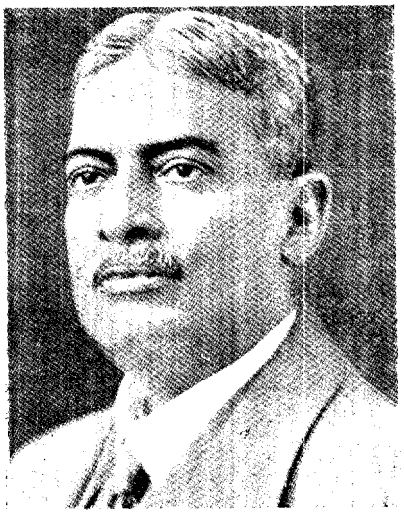
Upendra Nath Brahmachari 1935—1936



Born, 1873. Educated at Hooghly, and Calcutta. M.Sc. in chemistry, 1894; M.B., 1898. Teacher of Pathology and Materia Medica, Dacca Medical School, 1898. M.D., University of Calcutta, 1902; Ph.D. in physiology, 1904. Teacher of Medicine, Campbell Medical School, Calcutta, 1905-1923. Honorary Professor of Tropical Medicine, Carmichael Medical College, Calcutta; Honorary Professor of Biochemistry, University of Calcutta. General President, Indian Science Congress, 1930. Foundation Fellow of the National Institute of Sciences of India. Knighted in 1933. His contributions lay in the discovery of urea-stibamine, a specific in the treatment of kala-azar; in the discovery of a skin manifestation of Leishmanoid; and the chemotherapy of quinoline and acridine compounds. Author of "Kala-azar—its Treatment", and "Gleanings from my Researches". An article on infantile biliary cirrhosis in India was contributed to the British Encyclopaedia of Medical Practice. Died in 1946.

Jnan Chandra Ghosh 1937—1938



Born in 1894. Educated at Presidency College, Calcutta. Premchand Roychand Scholar, 1918. D.Sc., 1918. Lecturer in Chemistry, University of Calcutta, 1918-1921. Deputed for advanced scientific studies in Europe, 1918. Professor and Head of the Department of Chemistry, University of Dacca, 1921-39. Director, Indian Institute of Science, Bangalore, 1939-47. Knighted in 1943. Director General of Industries and Supplies, Government of the Indian Union, since 1947. President, Chemistry Section of the Indian Science Congress, 1925. General President, Indian Science Congress, 1939. President, National Institute of Sciences of India, 1942-44. Member, Council of Scientific and Industrial Research. Member, Indian Scientific Mission to U.K. and U.S.A., 1945. Contributions on photochemistry, kinetics of reactions, photosynthesis, electrochemistry and high pressure gas reactions. With scientific attainments he combines administrative ability and has been able to open several new departments in various branches of science at the Indian Institute of Science, Bangalore.

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Hemendra Kumar Sen 1939—1940



Born at Faridpur, Bengal, 1888. Educated at Brahmanbaria, Tipperah; subsequently at Calcutta; M.A., University of Calcutta, 1911. Premchand Roychand Scholar, 1912. Lecturer in City College, Calcutta, 1912. Joined the Imperial College of Science and Technology, London, 1912. D.Sc., London, 1915. Chemist, Tata Iron Works, Jamshedpur, 1916; Chief Chemist, Jamal Brothers, Burmah; and later of De Souza and Co., Burma. Professor of Applied Chemistry, University College of Science, Calcutta, 1920-36. Educational tour in Europe as a Ghosh Travelling Fellow, 1922 and 1930. Director, Lac Research Institute, Ranchi, 1936-41. Director of Industries, Bihar, 1941-45. President, Chemistry Section, Indian Science Congress, 1927. President, Institution of Chemists, India, 1930-1932 and 1935-36. Foundation Fellow, National Institute of Sciences of India. Chairman, Fuel Research Committee, 1943. Chairman, Heavy Chemical Industries Committee, 1944. His work was spread over problems in organic, applied and bio-chemistry. Author of "High Temperature Flames and Their Thermodynamics." Died in 1945.

Shanti Swarup Bhatnagar 1941—1942



Educated at Lahore. Demonstrator of Physics, Forman Christian College, Lahore. Joined the University of London as Dayal Singh College Trust Scholar, 1919. Senior Scholar of the Department of Scientific and Industrial Research, London. D.Sc., University of London, 1921. Professor of Chemistry, Benares Hindu University, 1921-24. Delegate to the annual session of the British Association for the Advancement of Science, Liverpool, 1922. Professor and Director of the University Chemical Laboratories, Lahore, 1924-40. Knighted in 1940. Director of Scientific and Industrial Research, Government of India, 1940. Elected Fellow of the Royal Society, London, 1943. Honorary Fellow and later a Vice-President of the Society of Chemical Industry, 1945. Honorary D.Sc., Universities of Patna, Allahabad, Delhi and Oxford. President of the Chemistry Section, Indian Science Congress, 1928 and 1938 and General President of the Indian Science Congress, 1944. President, National Institute of Sciences, India, 1947-48. Chairman, Indian Scientific Mission to U.K. and U.S.A., 1945. Contributions in the field of colloids, surface chemistry, photochemistry, and especially in magneto-chemistry. Devised the Magnetic Interference Balance. Author of "Principles and Applications of Magneto-Chemistry". Secretary to the Ministry of Scientific Research, Government of Indian Union, 1948.

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Biman Behari Dey 1943—1944



Born in Calcutta, 1889. Educated in Calcutta, City Collegiate School, 1899-1906. B.Sc. with Honours in Chemistry and Botany, 1908; M.Sc. with inorganic chemistry as the special subject, 1910. Premchand Roychand Scholar and Mouat Medalist. Further post-graduate studies at the Imperial College, Royal College of Science, London, 1911-15. D.I.C., 1912. A.R.I.C., 1913. D.Sc., 1915. Professor of Chemistry, Presidency College, Calcutta, 1916-1920. Professor of Chemistry, Presidency College, Madras, 1920-1938. Principal, Presidency College, Madras, 1938. Director of Public Instruction, Madras, 1944. President, Chemistry Section, Indian Science Congress, 1926. Education tour in Europe, 1928. Director of Researches, Council of Scientific and Industrial Research, Government of India. Director, Biochemistry Department, University of Madras, since 1948. Contributions on synthetic coumarins, plant alkaloids, isoquinoline ring system, enzyme peroxidases, glandular products and electro-synthesis of dye intermediates.

Jnanendra Nath Mukherjee 1945–1946



Born in 1893. Educated at Presidency College, Calcutta. M.Sc., 1915. Premchand Roychand Scholar and Mouat Medalist. Assistant Lecturer and Lecturer in Physical Chemistry, University of Calcutta, 1915-19. Palit Travelling Fellow, 1919, for higher studies in colloid chemistry; D.Sc., University of London, 1921. Professor of Chemistry, University of Calcutta, 1921-1945. Director, Indian Agricultural Research Institute, Delhi, since 1945. C.B.E., 1944. Foundation Secretary and subsequently Treasurer and Vice-President, Indian Chemical Society. Chairman, Committee on Social Conservation and Afforestation, National Planning Committee, Indian National Congress. Member, Indian Scientific Delegation, Royal Society Empire Scientific Conference; Member, the British Commonwealth Official Scientific Conference; Leader, Indian Delegation, Imperial Bureau Review Conference, 1946; Leader, Indian Delegation, Commonwealth Conference of Social Scientists, London, 1948. President, Chemistry Section, Indian Science Congress, 1929. Chief contributions are in colloid chemistry, electro-chemistry of clays and soil science. Founder of the colloid research laboratory, University of Calcutta.

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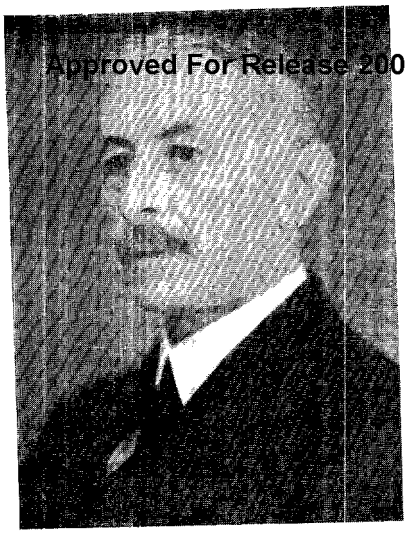

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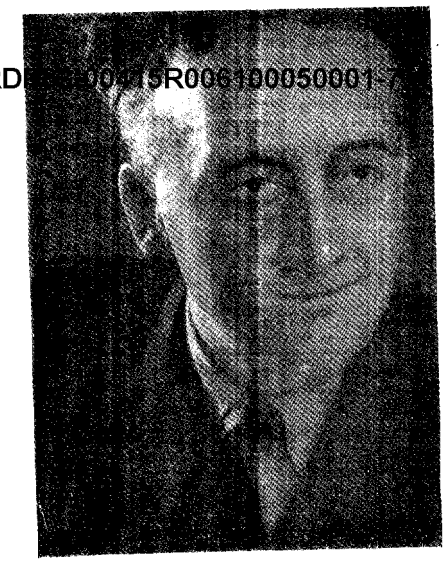

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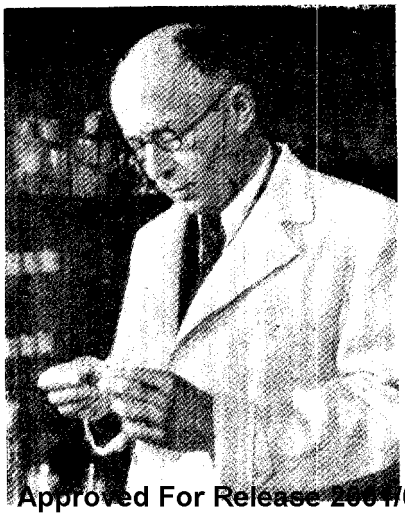

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ACHARYA PRAFULLA CHANDRA MEMORIAL FUND

AN APPEAL

The Society has opened a Memorial Fund in the name of its Founder-President, the late Acharya Prafulla Chandra Ray, a pioneer of chemical industries and researches in India. In order to perpetuate the memory of his services to India, in several fields of science, industry and philanthrophy and national movement, the Society has opened this memorial fund with a target of Rs. 2,00,000/- from the interest of which the Society proposes (i) to arrange for an annual Memorial Lecture by a distinguished scientist on suitable remuneration and the award of a Souvenir Medal, (ii) to grant scholarships to meritorious post-graduate students of chemistry all over India and (iii) to award the annual P. C. Ray Memorial Prize to the best Indian Research worker in chemistry.

The Society has already raised a sum of Rs. 51,000/- and has inaugurated since 1948 an annual memorial lecture. But the rest of the programme cannot be given effect to without further collection reaching near about the target figure. The Government of West Bengal has kindly promised to make a contribution of 25% of the total collection of Rs. 2 lakhs, provided the balance of 75% is raised by us from other sources. The West Bengal Government has also agreed to grant Rs. 25,000/- as soon as we can raise a fund of Rs. 75,000/-

We, therefore, appeal to the benevolent and generous public and the representatives of wealth and industry of the country to contribute their quota to perpetuate the memory of the great savant, who devoted his whole life for the development of chemistry and industry, for the cause of education, for social and economic welfare, and for all-round progress of our country.

INDIAN CHEMICAL SOCIETY
ESTD. 1924

J. N. RAY
President

D. CHAKRAVARTI
Hony. Secretary

We whole-heartedly support the appeal.

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Minister, Industries & Supplies Government of India	*Director-General, Industries & Supplies Government of India*	*Premier, Government of West Bengal*	*Ex-Premier, Government of West Bengal.*

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Extract of the letter of Prof. Dr. E. Pietsch, Gmelin-Institut

" I request you and all the Indian colleagues to help us by procuring the Indian reports whereby we can evaluate the knowledge of Indian colleagues. The scope of the work includes—Inorganic Chemistry, Physical Chemistry, Analytical Chemistry, Electro Chemistry, Colloid Chemistry, Corrosion and Passivity, Chemistry of Heterogeneous Equilibrium, Chemical Technology, Mineralogy, Crystallography, Geology and Mining, Geo-Chemistry, Economic Metallurgy, Metallography, Iron & Steel, Non-ferrous metals, Light metals, Experimental Physics, Nucleur & Atomic Physics, Radioactivity, Mechanical, Thermal, Optical, Electrical and Magnetic properties of matter and History of Chemistry.

We shall be thankful if you can supply us for the preparation of our Handbuch the specialised Indian Journal on those subjects. We shall also be further thankful if we can receive the larger proportion of the reprints of the publications of our Indian colleagues in a large number of foreign Journals. There has already appeared an invitation for the collection of reprints for Gmelin's Handbuch for insertion in Swiss Journal " Experientia."

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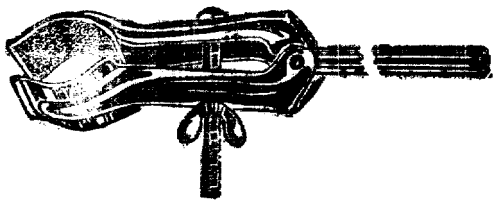

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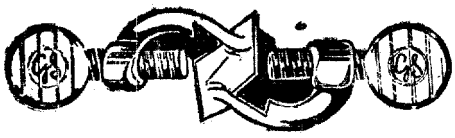

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INDUSTRIAL DEVELOPMENT OF INDIA—PRESENT AND FUTURE*

By J. N. Ray

It is customary for the President of the Society to select for his annual address a topic in which he is a specialist. I would make a slight departure from the accepted practice and would like to talk on a subject which is uppermost in the minds of all chemists in this country, namely, "Industrial Development of India—present and future". This topic would be in harmony with the aims and objects of the Society, which are primarily to encourage and foster the spirit of enquiry and original research, to protect and develop scientific life in this country and to promote the growth of cultural fellowship among chemists in general.

Under the Government of India Act 1935, the development of industries was a Provincial subject, but it was open to the Central Government to declare by law that the development of certain industries under Central control was expedient in the public interest. On such a declaration being made, the development of such industries could become a Central subject. No such action was, however, taken with the result that at the outbreak of hostilities in 1939, the development of industries remained wholly a provincial subject. The war necessitated central control and direction over industries, as India was the supply base for the armies in the Middle East and the Far East. The Eastern Group Supply Council, which was formed as a result, placed on India all demands which could be met from India. The Central Government naturally took upon themselves the responsibility for the supply of entire requirements of the Indian army, both at home and abroad. To discharge this onerous responsibility, it was found necessary to create the Department of Supply which was responsible not only for all the procurement activities of the Government but also for developing new capacity. A large number of scientific men were thus mobilised for discharging these responsibilities. How well this duty was performed could be gauged from the fact that during the years 1942-1946, 106 crores of rupees worth of chemicals, paints, gases and petroleum products were procured. The purchases on account of leather and tanned materials amounted to 23 crores of rupees, that of rubber items to 10 crores, and so on.

With the cessation of hostilities, the Government of India felt that this development which had taken place during the war should be stabilised and put on a firm basis. It was recognised that India's industrial development would have to be the result of conscious and deliberate planning and should not be left to haphazard and unco-ordinated efforts of private industrialists. In 1945, the Government of India made an important statement of India's industrial policy. In this, it was recognised that positive steps to encourage and promote the rapid industrialisation of the country to the fullest possible extent were an inescapable responsibility of the Government. A number of

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Panels were set up to report on the existing position of various industries. The general directive to the Panels was on the following lines :—

(i) The panels should report on the scope and extent of development including the types of products which should be taken up for development either by private enterprise or by the State ;

(ii) The extent to which technical advice from abroad may be necessary ;

(iii) The availability and future requirements of technical personnel ;

(iv) The manner and degree of co-operation with foreign firms considered necessary and desirable ;

(v) Location of the industry and assistance required from Government in the development of industries, and the

(vi) Stages in which industry should be developed.

The recommendations submitted by the Panels were considered by the Government of India in consultation with the Provincial authorities, and certain targets of production and expansion of capacity were accepted.

In the meantime, with the cessation of hostilities, the Department of Supply was amalgamated with the Department of Industries & Civil Supplies, and the new Department of Industry & Supply was created. The executive responsibility for carrying out the accepted recommendations of the various Panels was transferred to this new Department of Industry & Supply.

It will now be worthwhile to make a brief survey of the various developments that have taken place in the field of industry and also to indicate those that remain to be done.

The chemical industry occupies a key position in the economy of every country. Its products are used in a number of other industries such as Textiles, Paper, Leather, Soap, Glass, Ceramics, Paints, Plastics, Rayon, etc. The chemical industry, in India, in its modern form, really began after World War I (1914-18), although the oldest chemical factories were established in the middle of the last century. It was during World War I that real development took place. In 1921, there were 14 large chemical works employing 2500 workers. By 1939, the number of works rose to 38 employing about 8000 people. At present there are 200 firms employing 25,000 men.

Sulphuric acid.— There are now 40 firms, which can produce about 150,000 tons of sulphuric acid in 43 units. Of these, 11 are contact process units, mostly installed in the postwar period. The following table shows the consumption of sulphuric acid industry-wise :—

Chemicals	40%
Fertilisers	40
Metals	5
Cotton textile	5
Mineral oil	2
Leather	1
Engineering & other industries	7
	100

Four units are under erection, which would give an additional capacity of another 30,000 tons.

Superphosphate.—The production of superphosphate was negligible before

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the war. At present, capacity exists for the production of 90,000 tons of superphosphate per annum and with the expansion schemes now in hand, it is expected that by the end of 1950, the production would reach the target figure of 100,000 tons per annum. The Government now purchases all superphosphate at a fixed price. This has helped considerably in increasing indigenous production.

Ammonium sulphate.—The Government of India decided that ammonium sulphate should be produced by the State on a large scale. A Commission was appointed in 1945 to report on the possibility of manufacture of ammonium sulphate in India. As a result of the recommendations made by this Commission, it was decided to start the production of ammonium sulphate at Sindhri with a capacity of 350,000 tons per annum. This factory is nearing completion and will be one of the biggest units in the world. There are two other units producing synthetic ammonia, one at Mysore and the other at Travancore, with an aggregate capacity of 56,000 tons per annum. The production of sulphate from the ammoniacal liquors of the coke ovens is 22,000 tons.

Bichromates.—India's production capacity now is 3000 tons per annum and the domestic consumption is only 1000 tons. We have a large exportable surplus and considerable quantities have been exported abroad.

Soda ash.—India's requirements of soda ash are about 120,000 tons per annum for her various industries.

Glass industry	...	...	30,000 tons
Silicates	...	...	15,000
Textiles	...	...	9,000
Paper	...	...	5,000
Chemical industry	...	...	6,000
Misc. requirements	...	...	10,000
Washing	...	...	45,000
		Total	120,000

The present installed capacity is 54,000 tons. The chief difficulty in bridging this gap between production and domestic consumption is that of obtaining industrial salt at a reasonable price. The ideal location for the soda ash industry is naturally the coalfields which are situated a long way off from the Western coast, where cheap sea salt is available or from the salt-beds of Rajputana. The cost of transport is the principal limiting factor in the development of the soda ash industry.

Caustic soda.—India's requirements of caustic soda are 70,000 tons per annum, of which the soap industry consumes 31,500 tons, the textile industry, 19,250 tons, the paper industry 10,500 tons and other miscellaneous industries, 8,700 tons. The present installed capacity is 13,500 tons. There are certain units which are producing their own requirements of caustic soda and this capacity would come to another 3000 tons. At present, 3 units are under erection, which will give an additional capacity of 10,000 tons.

Liquid chlorine.— India has an installed capacity of 6,400 tons for the production of liquid chlorine. This is more than sufficient to meet all internal demands, but the difficulty is transport. Long distances involved stand in the way of free transport of liquid chlorine from the factories to places of consumption. Recently, a firm has planned the production of high test hypochlorite.

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Bleaching powder.— India produces 5,160 tons of bleaching powder and plans for expanding the capacity are in hand.

Bromides.— From the bitterns in the manufacture of salt, India has now established a capacity for the manufacture of 200 tons of bromides. The internal consumption has been computed to be 60 tons. There is ample scope for catering to the export market.

Magnesium chloride.— Another by-product in the manufacture of salt is magnesium chloride. India is not only able to meet her internal demands but has been exporting magnesium chloride to various countries including U.K.

Magnesium sulphate, alum, etc.—The demands for these chemicals are being fully met. There is also some export trade in these chemicals.

Potassium chlorate.—The match industry in India has expanded phenomenally during the last few years. At present, the country's aggregate capacity for the production of matches is 40 million gross boxes. We are also having a flourishing export trade in matches. To cater to the needs of the match industry we require a production of 2,000 tons of potassium chlorate. We are now mostly able to meet all internal demands for potassium chlorate.

Fine chemicals and pharmaceuticals.—The war found India totally unprepared to meet the growing needs of the Army. The procurement of medical stores for Government hospitals and the Army was the responsibility of the Director-General (I. M. S.), who was the head of the Medical Stores Department. The Medical Stores Department functioned primarily to supply the Army with all its medical and veterinary stores such as drugs, dressings, surgical instruments, etc. In addition to supplying the needs of the Army, the Medical Stores Department also provided for the needs of most of the Provincial Government and semi-Government hospitals, certain railways, mission hospitals, municipal institutions and other local bodies. The Medical Store Depots in India were the biggest importers of drugs and other medical stores and they were also manufacturers of drugs and dressings. There were five medical store depots maintained in five large centres in India. Two medical store depots had factories attached to them where certain preparations were made. These factories were at first located at Lahore and Calcutta but later on they were shifted to Madras and Bombay. At the outbreak of World War II, it was quickly realised that owing to shipping restrictions, these medical store depots would have to play a very large part in supplying to the growing needs of the Army, both at home and abroad. The organisation of the Director-General (I. M. S.) was strengthened by the recruitment of two officers, who were placed in charge of the production of Drugs and Dressings and Surgical Instruments and Appliances respectively. The result of intensive effort to increase production of medical stores was that the value of medical stores purchased in India (exclusive of depot manufactured articles) rose from Rs. 15.8 lakhs in 1938-39 to Rs. 3.48 crores in 1942-43.

Drugs and accessories needed for the Army could be roughly classified under the following headings.

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(*i*) Galenicals
(*ii*) Drugs of natural origin
(*iii*) Vitamins and hormones
(*iv*) Synthetic drugs
(*v*) Purified basic chemicals
(*vi*) Laboratory stains and chemicals
(*vii*) Special type of glassware.
(*viii*) Rubber goods
(*ix*) Surgical dressings
(*x*) Ligatures
(*xi*) Vaccines and sera
(*xii*) Anti-biotics.

India's requirements of galenicals were entirely met from indigenous sources. Surgical dressings, vaccines and sera, rubber goods, laboratory stains and chemicals were produced on a large scale. Of the drugs of natural origin, Morphine, Codeine, Strychnine, Caffeine, Ephedrine, Santonin, Quinine were produced in sufficient quantities not only for meeting internal demands, but, in some cases, for purposes of export. India's position regarding synthetic drugs was unsatisfactory, because the basic intermediates were in most cases unavailable. It was, however, possible to produce synthetically a very large number of drugs. A number of antiseptics and disinfectants, purgatives, uric acid solvents, vaso-constrictors, vaso-dilators, antipyretics, analgesics, narcotics, general anaesthetics and local anaesthetics were successfully produced. It can be said that given the equipment and the intermediate chemicals, there is not a single synthetic drug which is beyond the ability of an Indian chemist to produce.

During the war, an attempt was made to obtain intermediate chemicals. India is now able to produce 2 million gallons of benzene and 1 million gallons of toluene per annum at a cost which compares favourably with that prevailing in other countries. Recently, the manufacture of nitrobenzene at the Ordnance Factories has been established and it is now possible for the Indian industry to obtain about 100 tons of nitrobenzene at a price of Rs. 94/- per cwt. India produced very large quantities of T. N. T. during the war and, in fact, was one of the best sources of supply of this high explosive. It has not been difficult to establish the production of mono-nitrotoluenes which are now obtainable at a reasonable price. Manufacture was established for the production of 1000 tons of acetone from alcohol which is also now available for industrial purposes. During the war, it was felt necessary that the production of power alcohol should be taken in hand. At present, we have a capacity for the production of 14 million gallons of power alcohol in this country. Considerable quantities of butyl and amyl alcohol are also obtainable as by-products in this industry. The Indian coal is generally carbonised at a fairly high temperature with the result that the percentage of naphthalene hydrocarbons is rather high in the distillate. The production of naphthalene has been developed and we have now a capacity of 2000 tons of naphthalene per annum, which is capable of further expansion at a short notice. A certain amount of phthalic acid is also produced. The production of other basic chemicals such as Aniline, Hydroquinol, etc., has also been developed.

The development of the intermediate chemicals industry is closely bound up with the development of finished products. If this vicious circle is to be broken, then it occurs to me that it is necessary that a start should be made at the finished product end. I would not completely rule out a start being made by small units producing intermediate chemicals to feed the concerns producing finished products. It has been

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said that the day of small business is over. This is not entirely correct. In the U. S. A., it has been found that a mass production concern is not equipped to handle small order and special jobs. These can be adequately handled by a small outfit which also supplies the needs of the big manufacturers. Even in the field of automobile industry, it has been noticed that a big manufacturer buys nearly 1,100 different items from 400 small firms. In the most specialised industry, namely, the Petroleum Industry, the five largest refining companies in the U. S. A. account for only 40% of the capacity. There are 170 small concerns who have been able to hold their own against the competition of the bigger manufacturers. Similarly 7 big chemical manufacturers depend on 120 small-size firms for many of their requirements. Bigger size does not necessarily mean the greater efficiency.

This was amply borne out during the war, when a small firm produced *para*-aminoacetanilide and supplied successfully all the big manufacturers of organo-arsenicals and organo-antimonials based on *para*-aminoacetanilide. The manufacture of certain types of fine chemical intermediates can easily be undertaken by our chemistry graduates with adequate research experience even on a very small scale. During the war, large quantities of imported commercial dyes were purified and converted into bacteriological stains. In fact, the entire demands for these laboratory stains were met from the supplies made by very small manufacturers.

Following is a list of important drugs which cover the whole field of chemotherapy. Items produced in India are marked with an asterisk.

Antiseptics and Disinfectants

*1. Phenol
2. Salol
3. Resorcinol
4. Guiacol, Guiacol carbonate, Guiacol potassium sulphate
*5. Thymol
6. β-Naphthol
*7. Tribromophenol
8. Iodoform
*9. Formaldehyde
*10. Hexamine
*11. Chloramine T
12. Acriflavine
13. Dermatol
*14. Protargol
†15. Methyl violet
†16. Crystal violet
17. Auramine
18. Rivanol
19. Rhodamine
20. Chinisol
†21. Brilliant Green
†22. Malachite Green
23. Trypan Red
24. Trypan Blue
25. Mercurochrome
*26. Cresol
*27. Chlorinated xylenols
*28. D. D. T.

Purgatives and Aperitives

1. Phenolphthalein
2. Orexin (Phenyldihydroquinazoline)

Diuretics and uric acid solvents

†1. Caffeine
2. Piperazine
*3. Atophan
4. Salyrgan
5. Theophylline
6. Theobromine

* Are produced in India; in many cases, in insufficient quantities
† From imported intermediates.

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Vaso-constrictors

*1. Adrenaline
*2. Ephedrine
3. Benzidine
4. Alkaloids of Ergot: Ergotoxin, Ergotamine, Ergometrin, Ergotinine, Tyramine.

Vaso-dilators

*1. Amyl nitrite
2. Ethyl nitrite
*3. Nitroglycerine
4 Octyl nitrite

Antipyretics and analgesics

*1. Aetanilide
*2. Phenacetin
3. Benzoic acid
4. Salicylic acid
5. Aspirin
6. Antipyrine
7. Pyramidone

Narcotics and General Anaesthetics

1. Cyclopropane
*2. Ether
*3. Para-aldehyde
4. Acetophenone
*5. Chloroform
6 Urethane
7. Adaline
*8. Chloral hydrate
*9. Chloretone
10. Avertine
11. Veronal
*12. Luminal
13. Sulphonal
14. Trional
15. Tetronal

Local Anaesthetics

*1. Ethyl chloride
2. Anaesthesine
3. Novocaine
*4. Cocaine
5. Eucaine
6. Pentothal sodium

Antiprotozol and Antibacterial Drugs

*1. Atoxyl
*2 Tryparsamide
*3. Carbarsone
*4. Neo-salvarsan
5. Stovarsal
*6. Sulpharsphenamine
7. Solusalvarsan
8. Mapharside
*9. Urea Stibamine
10. Neostibosan
11. Neocardyl
12. Mercurochrome
13. Merthiolate
*14. Emetine
15. Yatren
16. Vioform
17. Sulpha drugs (detailed below).

Anti-malarials

1. Euqinine
2. Aristoquinine
3. Pamaquin
4. Mepacrine
5. Paludrine
6. Chloroquin.

* Are produced in India; in many cases, in insufficient quantities.

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Sulphanilamide group of Drugs (Sulpha drugs)

*1. Sulphanilamide	8. Albucid
2. Prontosil	9. Dagenan
3. Prontosil sol	10. Sulphaguanidine
4. Proseptazine	11. Sulphathiazole
5. Soluseptazine	12. Sulphapyridine
6. Rhodiloue	13 Sulphadiazine, sulphamerazine
*7 Uleron	14. *pp'*-Diaminodiphenylsulphone.

Anti-biotics

1. Penicillin	3. Chloromycetin
2. Streptomycin	4. Aureomycin

Miscellaneous Drugs

*1. Camphor	8. Sulphoform
*2 Ethyl ester of nicotinic acid (coramines)	9. Solganol
	10. Mandelic acid
*3. Glycerophosphates and choline	11. S. V. P. 36
4. Cardiazole	*12. Iodohydroxyquinoline
5. Cantharidine	*13. Kurchi bismuth iodide
*6. Calcium gluconate	*14. Emetine (from natural
7. Aulinogen	*15. Santonine sources.

* Are produced in India: in many cases, in insufficient quantities.

It will be seen that there is a considerable scope for developing many items of manufacture which are at present not produced in India.

Development Plans in hand

We have been considering the question of production of Penicillin and other antibiotics for a long time. In 1945, the Director-General of Supply financed an investigation for the production of Penicillin on a laboratory scale. Workers at the Institute of Science, Bangalore, and the Haffkine Institute, Bombay, have also been experimenting on the production of Penicillin. In March 1945, advantage was taken of the presence in England of Professor B. C. Guha, then an officer of the Department of Food, and a survey was undertaken by him on behalf of the Department of Supply of manufacture both in the U. K. and the U.S.A. The Department of Planning and Development sent out a team consisting of General Sir Saheb S. Sokhey and Dr. K. Ganapathy to investigate the possibility of manufacturing Penicillin in India. They submitted their report and certain investigations were made on the lines suggested in the Report. It was, however, felt that further investigations were necessary before a decision could be taken. Consequently, the Government of India sent out a second team consisting of General Sokhey, Dr. Ganapathy and Dr. Sankaran for the purpose. It has now been decided that the manufacture of Penicillin would be undertaken as a State enterprise in collaboration with a foreign firm. It is proposed to produce 1200 billion units per annum with a provision to increase it to 3600 billion units, if necessary. In the same factory, it is also proposed to manufacture certain sulpha drugs and synthetic antimalarials.

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of salicylaldehyde in alcoholic solution for over 4 hours, the disalicylidene derivative separated out in fine yellow-orange needles, m.p. 268-70°.

In the preparation of 4:4′-diaminodiphenylsulphone Raiziss's method (*J. Amer Chem. Soc.*, 1939, **61**, 2763) was slightly modified and this has been described in the experimental part of the paper.

Experimental

The method is a slight modification of the procedure adopted by Raiziss *et al.* (*loc. cit.*). 4-Nitro-4′-acetylaminodiphenylsulphone was prepared according to the method of Raiziss *et al.* in their preparation of 4-amino-4′-hydroxydiphenylsulphone; but this was, however, simultaneously reduced and deacetylated by tin and hydrochloric acid to yield 4:4′-diaminodiphenylsulphone.

4-Nitro-4′-acetylaminodiphenylsulphone (90 g.) was suspended in a mixture of concentrated hydrochloric acid (675 c.c.) and water (270 c.c.) and heated to boiling. To this solution was added tin turnings (100 g.) from time to time, and after the addition was complete, the solution was heated for a further period of 2 hours. The mixture was treated with charcoal and filtered hot. The filtrate was cooled and basified with the addition of a concentrated solution of caustic soda (50%). The 4:4′-diaminodiphenylsulphone separated out on cooling as a crystalline, curdy precipitate and was purified by crystallisation from alcohol, m.p. 175°, yield 40 g.

Preparation of 4-Arylidene-amino-4′-cinnamylidene-aminodiphenylsulphone.—The 4-benzylidene-amino- and 4-*p*-methoxybenzylidene-amino-4′-aminodiphenylsulphones were prepared according to Buttle *et al.* (*loc. cit.*) and the 4-salicylidene-amino-4′-aminodiphenylsulphone was prepared by heating an alcoholic solution of 4:4′-diaminodiphenylsulphone with molar amount of salicylaldehyde for about 20 minutes. The mixture was cooled and the orange-yellow solid separating, was collected. This was washed with ether, and found to melt at 225-26°. Jain *et al.* (*loc. cit.*) recorded the melting point of this derivative as 172°.

All the above mono-arylidene derivatives were mixed with an alcoholic solution of cinnamic aldehyde (1.12 mole) and refluxed for 2 to 3 hours. The mixture was concentrated and diluted with ether. The diarylidene derivatives separated. These were filtered and washed with ether.

The 4′-amino group of the above 4-arylidene-amino-4′-aminodiphenylsulphone could not be condensed with benzaldehyde or anisaldehyde. But the same of salicylidene-amino derivative readily condensed with acetaldehyde, glucose, and even salicyldehyde when heated under reflux in alcoholic solution as usual. In the case of glucose, a trace of ammonium chloride was added to bring about the reaction. From the ease of reaction it appeared that cinnamic aldehyde behaved as an aliphatic one and had been found to react easily with 4′-amino group of the 4-arylidene-amino-4′-aminodiphenylsulphones.

Preparation of 4-Acetylamino-4′-arylidene-aminodiphenylsulphone.— Although the monoarylidene-aminodiphenylsulphone did not react so readily with a second molecule

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of an aromatic aldehyde, the 4-acetylamino-4′-aminodiphenylsulphone, however, reacted with cinnamic aldehyde as well as with salicyldehyde when refluxed in alcoholic solution as usual.

The characteristics of the compounds are recorded in the table below.

TABLE I

General formula : $R=N\ (4)\cdot C_6H_4SO_2\cdot C_6H_4\ N\ (4')=R'$.

Compound						
	R=	R′=	General appearance.	Formula and Mol. Wt	Nitrogen % Found.	calc.
1.	Salicylidene	H_2	Yellow needles, m.p. 225-26°	$C_{19}H_{16}O_3N_2S$ (352)	7.47	7.97
2.	Salicylidene	Cinnamylidene	Yellow needles, m.p. 154-55°	$C_{28}H_{22}O_3N_2S$ (466)	5.72	6.0
3.	Benzylidene	Cinnamylidene	Yellow powder, m.p. 173-74°	$C_{28}H_{22}O_2N_2S$ (450)	6.4	6.22
4.	Anisylidene	Cinnamylidene	Yellow powder, m.p. 177-78°	$C_{29}H_{24}O_3N_2S$ (480)	5.96	5.83
5.	Salicylidene	Ethylidene	White needles, m.p. 162-63°	$C_{21}H_{18}O_3N_2S$ (378)	7.42	7.41
6.	Salicylidene	2:3:4:5:6-Pentahydroxyhexylidene	White powder, m.p. 243-45°	$C_{25}H_{26}O_8N_2S$ (514)	5.92	5.44
7.	Acetyl	Cinnamylidene	Yellow needles, m.p. 319-20°	$C_{23}H_{20}O_3N_2S$ (404)	6.95	6.93
8.	Acetyl	Salicylidene	Orange crystals, m.p. 343-44°	$C_{21}H_{18}O_4N_2S$ (394)	7.28	7.1

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STUDIES IN THE NATURE OF HYDRATED FERRIC OXIDE. PART I. INFLUENCE OF TEMPERATURE AND CONCENTRATION ON THE NATURE OF THE PRECIPITATE OBTAINED BY THE INTERACTION OF SOLUTIONS OF FERRIC CHLORIDE AND SODIUM HYDROXIDE

By Arun K. Dey and Satyeshwar Ghosh

Ferric oxides of different physical properties and chemical character have been prepared for the first time by the precipitation from ferric chloride employing different quantities of sodium hydroxide and by carrying on the precipitation at different temperatures. The variation in the properties has been ascribed to the amphoteric nature of the oxide and a mechanism to explain the behaviour of ferric hydroxide has been suggested. The hypothesis has been supported by quantitative studies on the adsorption of the various ions in the system, during the precipitation of hydrated ferric oxide. The conductometric study of the precipitation has also been made.

Two varieties of ferric oxide are well known ; Tommasi in 1882 (vide Weiser, "Hydrous Oxides", 1926, p. 364) recorded the existence of yellow and brown oxides, which were regarded by him as isomers. It was noted by Davies (*loc. cit.*) that the yellow variety, prepared by the oxidation of ferrous oxide or the carbonate, was denser and the solubility of this type of oxide in acids was very little. Weiser and Milligan (*J. Phys. Chem.*, 1935, **39**, 25 ; 1940, **44**, 1081) observe that the freshly precipitated oxide is amorphous, but on ageing it gradually transforms from α-Fe_2O_3 to β-FeOOH. The yellow β-oxide is also the product of the slow hydrolysis of ferric chloride (*J. Amer. Chem. Soc.*, 1935, **57**, 238). Thiessen and Köppen (*Z. anorg. Chem.*, 1930, **189**, 113 ; 1936, **228**, 57) opine that brown ferric oxide yields eight hydrates on isothermal dehydration, but their view has been challenged by Weiser and co-workers (*J. Phys. Chem.*, 1939, **43**, 1104). Not much work seems to have been done on the yellow oxide, and nothing is on record regarding the preparation of both of these oxides from the same reagents. It has, however, been observed by Banerji and Ghosh (*Nat. Acad. Sci., India*, Abstracts, 1942) that hydrated ferric oxide, when allowed to age gradually, becomes insoluble in mineral acids. They also observed remarkable variation in the peptisability of the oxide by hydrochloric and other acids with age. In the present investigation we have been able to prepare hydrated ferric oxides of varying colour beginning from deep brown to yellow by regulating the temperature and the concentrations of the reactants in the reaction between ferric chloride and sodium hydroxide solutions. We have also observed that in all the cases precipitation is complete even before the theoretical quantity of alkali is added. The same phenomenon has been recorded by Britton (*Ann. Rep.*, 1943, **40**, 44) who studied the precipitation of various oxides by the E. M. F. method. A similar observation has been made by Dey and Ghosh (this *Journal*, 1947, **24**, 181) during the study of the precipitation of cupric hydroxide from cupric sulphate solution when the quantity of alkali required was 14% less than the theoretical amount. We have in this study made a quantitative investigation of the precipitation of ferric hydroxide by analytical and conductometric methods.

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EXPERIMENTAL

A solution of AnalaR ferric chloride was prepared and both iron and chlorine were estimated volumetrically and gravimetrically and were in the proportion required by the formula $FeCl_3$. At the outset, to 10 c.c. of ferric chloride solution were added different quantities of a standard solution of sodium hydroxide (total volume 40 c.c.) and the quantity required for just complete precipitation was noted. After filtration the filtrate was tested and was found to be acidic when smaller volumes of alkali solution were employed. The volume of alkali solution needed to yield a just alkaline filtrate was also noted. The observations were repeated at several temperatures.

TABLE I

Ferric chloride soln. $= 0.575M$. Sodium hydroxide soln. $= 1.9418M$. Theoretically 10 c.c. of ferric chloride solution $\equiv$ 8.88 c.c. of alkali for precipitation of $Fe(OH)_3$.

	Volume of NaOH solution at temperature of				
	25°.	40°.	50°.	60°.	80°.
For complete precipitation	8.30 c.c.	8.30 c.c.	8.50 c.c.	8.30 c.c.	8.30 c.c.
For a neutral filtrate	9.00	9.00	9.00	8.90	8.90

The effect of dilution was studied by diluting both the solutions of ferric chloride and sodium hydroxide ten times and similar observations were repeated ; the results are shown in Table II.

TABLE II

Ferric chloride soln. $= 0.0575M$. Sodium hydroxide soln. $= 0.1942M$. Theoretically 10 c.c. of ferric chloride solution should require 8.88 c.c. of sodium hydroxide for precipitating $Fe(OH)_3$.

	Volume of NaOH solution at temperature of		
	25°.	50°.	80°.
For complete precipitation	8.50 c.c.	8.60 c.c.	8.60 c.c.
For a neutral filtrate	9.10	9.00	8.90

We thus find that on dilution the precipitation value approximates the theoretical values, and on raising the temperature, the values undergo negligible change. It was further observed that the samples of solid precipitates were readily soluble in hydrochloric and nitric acids, when precipitated with alkalis less than the theoretical amounts. The colour of hydrated ferric oxide in all these cases were dark brown. When the amount of alkali was increased the precipitate became more and more insoluble in acids. When the alkali was in great excess, the precipitate became more yellow in colour and when 10 c.c. of alkali were employed for precipitation, the colour of the oxide was deep yellow and a fair portion of the precipitate remained undissolved in even hot and concentrated hydrochloric and nitric acids, leaving a yellow residue. This insolubility was more pronounced when the precipitation was carried out at higher temperatures.

Now to 10 c.c. of ferric chloride solution, taken in several 100 c.c. flasks kept at constant temperature, were added different volumes of alkali solution, total volume

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was raised to 100 c.c. and they were maintained at constant temperature for an hour. The amount of iron, sodium and chlorine ions, and also hydrogen or hydroxyl ions in the supernatant liquid were determined accurately using a microburette, by the usual methods. Knowing the amounts of the different ions taken, the amounts of ions associated with the precipitate were calculated. The results obtained at different temperatures are recorded in the following tables.

Ferric chloride solution = 0.575*M*
Iron = 0.575 g. ions per litre
Chlorine = 1.725 g. ions per litre

NaOH solution = 1.9418*M*
Hydroxyl = 1.9418 g. ions per litre
Sodium = 1.9418 g. ions per liter

TABLE III

Temperature = 25°

Mg. ions taken.			Mg. ions available in supernatant liquid.				Mg ions associated with ppt.	
Fe.	Cl.	NaOH.	H or OH.	Cl.	Na.	Fe.	Na.	Cl.
5.75	17.25	14.56	1.84 H	6.76	—	2.15	—	10.49
5.75	17.25	15.53	0.76	5.14	—	2.00	—	12.11
5.75	17.25	16.12	0.45	15.17	16.12	Nil	Nil	1.78
5.75	17.25	16.89	0.05	15.95	16.77	,,	0.12	1.30
5 75	17.25	17.28	0.07 OH	16.49	17.14	,,	0.14	0.76
5.75	17.25	19.42	1.67	17.24	19.17	,,	0.25	0.01

TABLE IV

Temperature = 50°.

Mg. ions taken.			Mg. ions available in supernatant liquid.				Mg. ions associated with ppt.	
Fe.	Cl.	NaOH.	H or OH.	Cl.	Na.	Fe.	Na.	Cl.
5.75	17.25	15.53	0.665 H	11.01	—	4.05	—	6.21
5.75	17.25	16.12	0.041	15.29	16.12	Nil	Nil	1.96
5.75	17.25	16.50	0.016	16.64	16.50	,,	,,	0.61
5.75	17.25	16.89	0.010	16.88	16.77	,,	0.12	0.39
5.75	17.25	17.28	0.078 OH	17.10	17.12	,,	0.16	0.15
5.75	17.25	19.42	1.598	17.13	19.04	,,	0.38	0.12

TABLE V

Temperature = 80°.

Mg. ions taken.			Mg. ions available in supernatant liquid.				Mg. ions associated with ppt.	
Na.	Cl.	NaOH.	H or OH.	Cl.	Na	Fe	Na.	Cl.
5.75	17.25	15.53	0.700 H	15.45	—	0.90	—	1.80
5.75	17.25	16.12	0.214	15.09	16.12	Nil	Nil	1.16
5.75	17.25	16.50	0.011	13.89	16.50	,,	,,	3.36
5.75	17.25	16 89	0.009	14.07	16.75	,,	0.14	3.18
5.75	17.25	17.28	0.074 OH	15.76	17.11	,,	0.17	1.49
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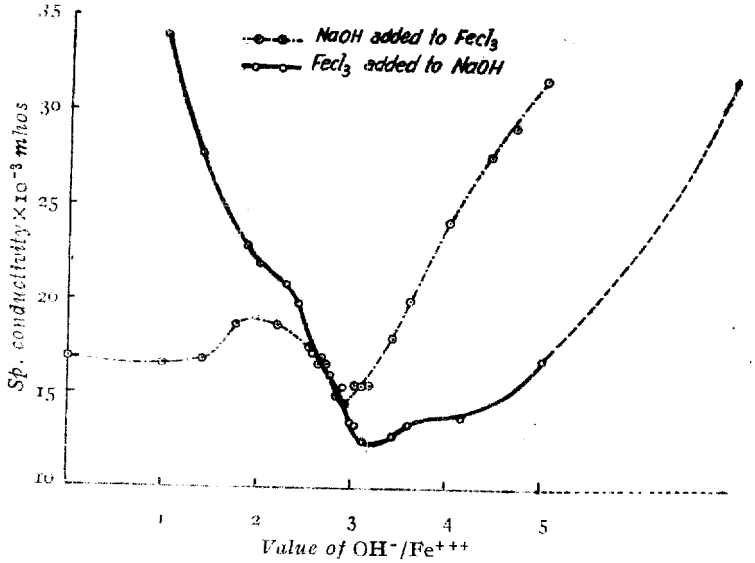
The precipitation was also studied by noting the electrical conductivities of the supernatant liquid in the different cases when varying proportions of ferric and alkali solutions were used. For conductometric measurements a great accuracy and precision was maintained. Instead of the cell constant, the calibration constant at different positions of the bridge wire was determined by the method of Wark (*J. Phys. Chem.*, 1930, **34**, 885), and these values were employed for the calculations.

To 5 c.c. of $M/10$ ferric chloride solution were added different volumes of $M/2$ sodium hydroxide solution, total volume kept at 10 c.c. and the precipitate allowed to settle for an hour at 30°. It was centrifuged at 2500 r.p.m. for five minutes and the electrical conductivity of the supernatant liquid was determined at 30°.

In another set, the concentration of alkali was kept constant and varying amounts of ferric chloride solution were added to it. The concentration chosen was $M/4$ for both the reactants, so that at the equivalence point Fe : OH = 1 : 3, the concentration of the respective constituents in both the sets was almost the same.

From the conductivity results the adjoining graph has been plotted showing the variation of specific conductivity with the increase in Fe : OH ratio (Fig. 1).

FIG. 1



DISCUSSION

Our results on the precipitation of hydrated ferric oxide from ferric chloride solution show that similar to the observation of Britton (*Ann. Rep.*, 1943, **40**, 43) with various hydroxides, the amount of alkali needed for complete removal of the metal from solution is always less than the theoretical amount. In all such cases there are two possible reactions, which would result to such an observation.

(1) Increased tendency of hydrolysis with increased concentration of the alkali, according to the following scheme :

$$FeCl_3 \longrightarrow Fe(OH)Cl_2 \longrightarrow Fe(OH)_2Cl \longrightarrow Fe(OH)_3$$

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The above will be more marked with increasing insolubility of the respective hydroxides and their strength as a base.

(2) Hydrolytic adsorption of the anion, Cl-by the basic oxide, producing free alkali :

$$Fe(OH)_3 + NaCl + H_2O \longrightarrow [Fe(OH)_3]_xCl_y + NaOH + \ldots$$

In the first case the formation of ferric hydroxide takes place in stages, yielding various intermediate basic compounds, which ultimately with a definite excess of alkali would result in the formation of $Fe(OH)_3$. In the second case, the quantity of alkali added precipitates the equivalent quantity of ferric hydroxide, which on adsorbing chlorine ions from the system liberates an equivalent quantity of OH^- ions, which precipitate more and more of the hydroxide. Our experimental results, as recorded in Tables III, IV and V, show that when the amount of alkali is deficient, the adsorption of chloride ion is high and this goes on decreasing as the quantity of alkali added is raised.

It is interesting to observe in Tables I and II that complete precipitation occurs when the supernatant liquid is slightly acidic. We find that in all the cases quoted in the aforesaid tables, the amount of alkali needed to yield a neutral filtrate is always greater than the volume needed for complete precipitation. This observation is contradictory to the case of precipitation of cupric hydroxide as observed by us (*loc. cit.*), where the filtrate becomes alkaline with complete precipitation. It may therefore appear to be anomalous, but keeping in view that ferric hydroxide is far more insoluble than cupric hydroxide, complete precipitation occurs at a lower OH^- ion concentration, so that the filtrate may remain slightly acidic even though complete precipitation has been effected.

If we regard the precipitate to be a basic salt in accordance to equation (1), shown above, it is obvious that earlier precipitation should be favoured by dilution and also by rise of temperature, as both of these are favourable for hydrolysis. A perusal of Table I shows that the amount of alkali needed for complete precipitation is not markedly affected by rise of temperature. From Table II it will be seen that with dilution precipitation occurs with the amount of alkali approaching theoretical values.

Considering the analytical data for adsorption, as presented in Tables III, IV and V, we find that the adsorption of sodium and chlorine ions varies remarkably with the amount of alkali used for precipitation. The adsorption of chlorine in general decreases, whilst the amount of sodium associated with the precipitate increases with increasing quantities of alkali added. These observations are easily explainable, when we remember that ferric oxide has an amphoteric character and the tendency of the adsorption of ions by such oxides is always governed by the hydrogen ion concentration of the medium in which the adsorption is taking place (Dey and Ghosh, *Proc. Nat. Acad. Sci., India*, 1946, **15A**, 143). Naturally when the OH^- ion concentration is low, the adsorption of Cl^- ions will be more prominent, while under such circumstances Na^+ ions will not be adsorbed. Thus, we find that at 25° (vide Table III) when the medium is prominently acidic containing 0.45 mg. *M* of acid, the adsorption of chlorine is 1.78 mg. ions, whereas the adsorption of sodium is nil. Now, as the medium becomes alkaline,

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containing 1.67 mg. *M* of alkali, the adsorption of chlorine falls to 0.01 mg. ions, whereas the amount of sodium associated is 0.25 mg. ions.

Increase of temperature favours the association of sodium with the precipitate, whereas the adsorption of chlorine is diminished. The latter is, however, not rigidly followed by changes in temperature, as the phenomenon of hydrolysis at higher temperatures plays an important role. The association of sodium ions with the precipitate goes on increasing steadily with rise of temperature. Thus, when 19.42 mg. *M* of alkali are added to ferric chloride solution containing 5.75 mg. ions of ferric iron, the amount of sodium associated with the precipitate is 0.25, 0.38 and 0.78 mg. ions at 25°, 50° and 80° respectively.

Ferric oxide with sodium hydroxide has a tendency to form sodium ferrite, and this will naturally be more prominent at a high temperature. Van Bemmelen in 1892 (vide Weiser, "Hydrous Oxides") prepared the yellow variety of ferric oxide by the reaction between sodium ferrite and water. We are of opinion that at higher temperatures sodium is found to be associated in larger amounts in alkaline media, as direct chemical interaction results to form some sodium ferrite.

It is interesting to point out that ferric hydroxide, obtained at higher temperature with excess of alkali, was definitely found to be of yellow colour and was highly resistant towards acids. This confirms our contention that a fair portion of the ferric hydroxide undergoes a chemical transformation to form ferric ferrite, which has lost its basic properties to be acted upon by an acid, according to the following scheme :

$$Fe(OH)_3 \rightleftharpoons Fe(OH)_2^+ + OH^- \quad \ldots (1)$$

$$Fe(OH)_3 \rightleftharpoons FeO(OH)_2^- + H^+ \quad \ldots (2)$$

$$Fe(OH)_2^+ + FeO(OH)_2^- \rightleftharpoons Fe_2O_3 + 2H_2O \quad \ldots (3)$$

In equation (1) ferric hydroxide acts as a proton acceptor, *i. e.* as a base and in equation (2) it donates a proton, and behaves as an acid. The chemical interaction between the acidic and the basic properties of the hydroxide in the above manner results in the formation of Fe_2O_3, which becomes chemically inert either as an acid or a base.

The conductometric study of the precipitation of ferric hydroxide shows that though complete precipitation of iron as hydrated oxide takes place with a little lesser amount of alkali, yet the minima of the conductometric graph occurs ,when Fe : OH ratio is 1 : 3.2 when ferric chloride is added to the alkali, whilst it is 2.9 when alkali is added to ferric chloride. In neither case the minima correspond to the observed ratio for complete precipitation. We are of opinion that this divergency of the results occurs due to the adsorption of the electrolytes present, and hence no accurate information can be obtained regarding the complete precipitation from these curves. We therefore suggest that Britton's data on the precipitation of different insoluble hydroxides using the E. M. F. method (*loc. cit.*) is also beset with similar difficulties and hence fails to convey a true idea of the conditions of precipitation.

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was raised to 100 c.c. and they were maintained at constant temperature for an hour. The amount of iron, sodium and chlorine ions, and also hydrogen or hydroxyl ions in the supernatant liquid were determined accurately using a microburette, by the usual methods. Knowing the amounts of the different ions taken, the amounts of ions associated with the precipitate were calculated. The results obtained at different temperatures are recorded in the following tables.

Ferric chloride solution = 0.575*M*
Iron = 0.575 g. ions per litre
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Hydroxyl = 1.9418 g. ions per litre
Sodium = 1.9418 g. ions per liter

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Temperature = 25°

Mg. ions taken.			Mg. ions available in supernatant liquid.				Mg ions associated with ppt.	
Fe.	Cl.	NaOH.	H or OH.	Cl.	Na.	Fe.	Na.	Cl.
5.75	17.25	14.56	1.84 H	6.76	—	2.15	—	10.49
5.75	17.25	15.53	0.76	5.14	—	2.00	—	12.11
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5.75	17.25	19.42	1.67	17.24	19.17	,,	0.25	0.01

TABLE IV

Temperature = 50°.

Mg. ions taken.			Mg. ions available in supernatant liquid.				Mg. ions associated with ppt.	
Fe.	Cl.	NaOH.	H or OH.	Cl.	Na.	Fe.	Na.	Cl.
5.75	17.25	15.53	0.665 H	11.01	—	4.05	—	6.21
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Temperature = 80°.

Mg. ions taken.			Mg. ions available in supernatant liquid.				Mg. ions associated with ppt.	
Na.	Cl.	NaOH.	H or OH.	Cl.	Na	Fe	Na.	Cl.
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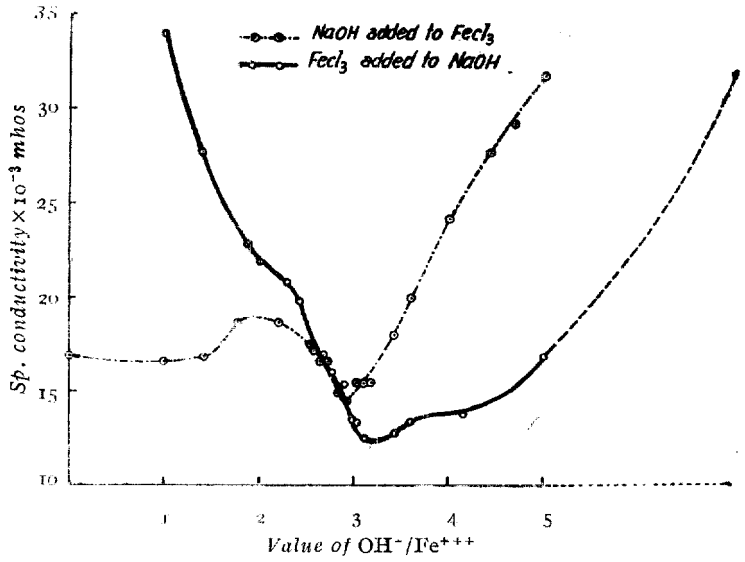
FIG. 1



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STUDIES IN THE NATURE OF HYDRATED FERRIC OXIDE. PART I. INFLUENCE OF TEMPERATURE AND CONCENTRATION ON THE NATURE OF THE PRECIPITATE OBTAINED BY THE INTERACTION OF SOLUTIONS OF FERRIC CHLORIDE AND SODIUM HYDROXIDE

By Arun K. Dey and Satyeshwar Ghosh

Ferric oxides of different physical properties and chemical character have been prepared for the first time by the precipitation from ferric chloride employing different quantities of sodium hydroxide and by carrying on the precipitation at different temperatures. The variation in the properties has been ascribed to the amphoteric nature of the oxide and a mechanism to explain the behaviour of ferric hydroxide has been suggested. The hypothesis has been supported by quantitative studies on the adsorption of the various ions in the system, during the precipitation of hydrated ferric oxide. The conductometric study of the precipitation has also been made.

Two varieties of ferric oxide are well known ; Tommasi in 1882 (vide Weiser, "Hydrous Oxides", 1926, p. 364) recorded the existence of yellow and brown oxides, which were regarded by him as isomers. It was noted by Davies (*loc. cit.*) that the yellow variety, prepared by the oxidation of ferrous oxide or the carbonate, was denser and the solubility of this type of oxide in acids was very little. Weiser and Milligan (*J. Phys. Chem.*, 1935, **39**, 25 ; 1940, **44**, 1081) observe that the freshly precipitated oxide is amorphous, but on ageing it gradually transforms from α-Fe_2O_3 to β-FeOOH. The yellow β-oxide is also the product of the slow hydrolysis of ferric chloride (*J. Amer. Chem. Soc.*, 1935, **57**, 238). Thiessen and Köppen (*Z. anorg. Chem.*, 1930, **189**. 113 ; 1936, **228**, 57) opine that brown ferric oxide yields eight hydrates on isothermal dehydration, but their view has been challenged by Weiser and co-workers (*J. Phys. Chem.*, 1939, **43**, 1104). Not much work seems to have been done on the yellow oxide, and nothing is on record regarding the preparation of both of these oxides from the same reagents. It has, however, been observed by Banerji and Ghosh (*Nat. Acad. Sci., India*, Abstracts, 1942) that hydrated ferric oxide, when allowed to age gradually, becomes insoluble in mineral acids. They also observed remarkable variation in the peptisability of the oxide by hydrochloric and other acids with age. In the present investigation we have been able to prepare hydrated ferric oxides of varying colour beginning from deep brown to yellow by regulating the temperature and the concentrations of the reactants in the reaction between ferric chloride and sodium hydroxide solutions. We have also observed that in all the cases precipitation is complete even before the theoretical quantity of alkali is added. The same phenomenon has been recorded by Britton (*Ann. Rep.*, 1943, **40**, 44) who studied the precipitation of various oxides by the E. M. F. method. A similar observation has been made by Dey and Ghosh (this *Journal*, 1947, **24**, 181) during the study of the precipitation of cupric hydroxide from cupric sulphate solution when the quantity of alkali required was 14% less than the theoretical amount. We have in this study made a quantitative investigation of the precipitation of ferric hydroxide by analytical and conductometric methods.

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EXPERIMENTAL

A solution of AnalaR ferric chloride was prepared and both iron and chlorine were estimated volumetrically and gravimetrically and were in the proportion required by the formula $FeCl_3$. At the outset, to 10 c.c. of ferric chloride solution were added different quantities of a standard solution of sodium hydroxide (total volume 40 c.c.) and the quantity required for just complete precipitation was noted. After filtration the filtrate was tested and was found to be acidic when smaller volumes of alkali solution were employed. The volume of alkali solution needed to yield a just alkaline filtrate was also noted. The observations were repeated at several temperatures.

TABLE I

Ferric chloride soln. = 0.575*M*. Sodium hydroxide soln. = 1.9418*M*. Theoretically 10 c.c. of ferric chloride solution ≡ 8.88 c.c. of alkali for precipitation of $Fe(OH)_3$.

	Volume of NaOH solution at temperature of				
	25°.	40°.	50°.	60°.	80°.
For complete precipitation	8.30 c.c.	8.30 c.c.	8.50 c.c.	8.30 c.c.	8.30 c.c.
For a neutral filtrate	9.00	9.00	9.00	8.90	8.90

The effect of dilution was studied by diluting both the solutions of ferric chloride and sodium hydroxide ten times and similar observations were repeated ; the results are shown in Table II.

TABLE II

Ferric chloride soln. = 0.0575*M*. Sodium hydroxide soln. = 0.1942*M*. Theoretically 10 c.c. of ferric chloride solution should require 8.88 c.c. of sodium hydroxide for precipitating $Fe(OH)_3$.

	Volume of NaOH solution at temperature of		
	25°.	50°.	80°.
For complete precipitation	8.50 c.c.	8.60 c.c.	8.60 c.c.
For a neutral filtrate	9.10	9.00	8.90

We thus find that on dilution the precipitation value approximates the theoretical values, and on raising the temperature, the values undergo negligible change. It was further observed that the samples of solid precipitates were readily soluble in hydrochloric and nitric acids, when precipitated with alkalis less than the theoretical amounts. The colour of hydrated ferric oxide in all these cases were dark brown. When the amount of alkali was increased the precipitate became more and more insoluble in acids. When the alkali was in great excess, the precipitate became more yellow in colour and when 10 c.c. of alkali were employed for precipitation, the colour of the oxide was deep yellow and a fair portion of the precipitate remained undissolved in even hot and concentrated hydrochloric and nitric acids, leaving a yellow residue. This insolubility was more pronounced when the precipitation was carried out at higher temperatures.

Now to 10 c.c. of ferric chloride solution, taken in several 100 c.c. flasks kept at constant temperatures were added different volumes of alkali solution, total volume

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of an aromatic aldehyde, the 4-acetylamino-4′-aminodiphenylsulphone, however, reacted with cinnamic aldehyde as well as with salicyldehyde when refluxed in alcoholic solution as usual.

The characteristics of the compounds are recorded in the table below.

TABLE I

General formula : $R=N\ (4)\cdot C_6H_4SO_2.C_6H_4\ N\ (4')=R'$.

Compound R=	R′=	General appearance.	Formula and Mol. Wt	Nitrogen % Found.	calc.
1. Salicylidene	H_2	Yellow needles, m.p. 225-26°	$C_{19}H_{16}O_3N_2S$ (352)	7.47	7.97
2. Salicylidene	Cinnamylidene	Yellow needles, m.p. 154-55°	$C_{28}H_{22}O_3N_2S$ (466)	5.72	6.0
3. Benzylidene	Cinnamylidene	Yellow powder, m.p. 173-74°	$C_{28}H_{22}O_2N_2S$ (450)	6.4	6.22
4. Anisylidene	Cinnamylidene	Yellow powder, m.p. 177-78°	$C_{29}H_{24}O_3N_2S$ (480)	5.96	5.83
5. Salicylidene	Ethylidene	White needles, m.p. 162-63°	$C_{21}H_{18}O_3N_2S$ (378)	7.42	7.41
6. Salicylidene	2:3:4:5:6-Pentahydroxyhexylidene	White powder, m.p. 243-45°	$C_{25}H_{26}O_8N_2S$ (514)	5.92	5.44
7. Acetyl	Cinnamylidene	Yellow needles, m.p. 219-20°	$C_{23}H_{20}O_3N_2S$ (404)	6.95	6.93
8. Acetyl	Salicylidene	Orange crystals, m.p. 243-44°	$C_{21}H_{18}O_4N_2S$ (394)	7.28	7.1

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of salicylaldehyde in alcoholic solution for over 4 hours, the disalicylidene derivative separated out in fine yellow-orange needles, m.p. 268-70°.

In the preparation of 4:4′-diaminodiphenylsulphone Raiziss's method (*J. Amer Chem. Soc.*, 1939, **61**, 2763) was slightly modified and this has been described in the experimental part of the paper.

EXPERIMENTAL

The method is a slight modification of the procedure adopted by Raiziss *et al.* (*loc. cit.*). 4-Nitro-4′-acetylaminodiphenylsulphone was prepared according to the method of Raiziss *et al.* in their preparation of 4-amino-4′-hydroxydiphenylsulphone; but this was, however, simultaneously reduced and deacetylated by tin and hydrochloric acid to yield 4:4′-diaminodiphenylsulphone.

4-Nitro-4′-acetylaminodiphenylsulphone (90 g.) was suspended in a mixture of concentrated hydrochloric acid (675 c.c.) and water (270 c.c.) and heated to boiling. To this solution was added tin turnings (100 g.) from time to time, and after the addition was complete, the solution was heated for a further period of 2 hours. The mixture was treated with charcoal and filtered hot. The filtrate was cooled and basified with the addition of a concentrated solution of caustic soda (50%). The 4:4′-diaminodiphenylsulphone separated out on cooling as a crystalline, curdy precipitate and was purified by crystallisation from alcohol, m.p. 175°, yield 40 g.

Preparation of 4-Arylidene-amino-4′-cinnamylidene-aminodiphenylsulphone.—The 4-benzylidene-amino- and 4-*p*-methoxybenzylidene-amino-4′-aminodiphenylsulphones were prepared according to Buttle *et al.* (*loc. cit.*) and the 4-salicylidene-amino-4′-aminodiphenylsulphone was prepared by heating an alcoholic solution of 4:4′-diaminodiphenylsulphone with molar amount of salicylaldehyde for about 20 minutes. The mixture was cooled and the orange-yellow solid separating, was collected. This was washed with ether, and found to melt at 225-26°. Jain *et al.* (*loc. cit.*) recorded the melting point of this derivative as 172°.

All the above mono-arylidene derivatives were mixed with an alcoholic solution of cinnamic aldehyde (1.12 mole) and refluxed for 2 to 3 hours. The mixture was concentrated and diluted with ether. The diarylidene derivatives separated. These were filtered and washed with ether.

The 4′-amino group of the above 4-arylidene-amino-4′-aminodiphenylsulphone could not be condensed with benzaldehyde or anisaldehyde. But the same of salicylidene-amino derivative readily condensed with acetaldehyde, glucose, and even salicylaldehyde when heated under reflux in alcoholic solution as usual. In the case of glucose, a trace of ammonium chloride was added to bring about the reaction. From the ease of reaction it appeared that cinnamic aldehyde behaved as an aliphatic one and had been found to react easily with 4′-amino group of the 4-arylidene-amino-4′-aminodiphenylsulphones.

Preparation of 4-Acetylamino-4′-arylidene-aminodiphenylsulphone.— Although the monoarylidene-a minodiphenylsulphone did not react so readily with a second molecule

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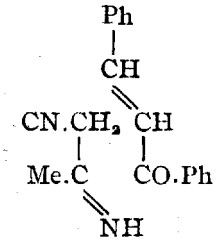
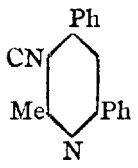
MEYER'S SYNTHESIS OF PYRIDINES FROM AMINOACRYLONITRILES : VERIFICATION IN THE LIGHT OF GASTALDI'S OBJECTIONS

By Nirmalananda Palit

The reactions of dinitriles have been extensively studied by V. Meyer and have proved to be a fruitful source for the preparation of pyridines. A typical member of the series has been obtained by Gastaldi from the corresponding pyrilium salt and has been found to be different. This questions the correctness of the structure of Meyer's compounds. In the present investigation it has been shown that the structures of Meyer's compounds as a class are not incorrect, but so far as the particular member is concerned, Gastaldi's contension probably holds good and Meyer's compound may have to be represented differently.

Meyer has developed a method for the synthesis of pyridines. β-Amino-β-methylacrylonitrile was condensed with benzylidene-acetophenone in presence of sodium ethoxide to yield 3-cyano-2: 4-diphenyl-6-methylpyridine (I). The cyano group was hydrolysed with concentrated HCl at 260° to the carboxy derivative (II) which, when heated with lime, lost carbon dioxide and gave 2: 4-diphenyl-6-methylpyridine (III), m.p. 156°. The compound (II) on oxidation with permanganate gave 2 : 4-diphenylpyridine-5:6-dicarboxylic acid (IV), m.p. 185° (V. Meyer and Irmscher, *Chem. Zentrl.*, 1908, II, 594).





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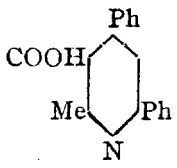

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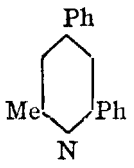

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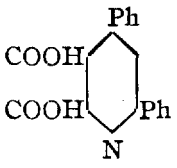

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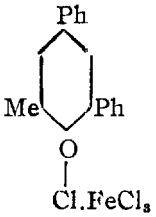

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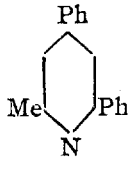

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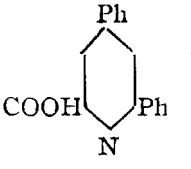

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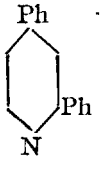

(VIII)

Gastaldi has thrown considerable doubt on this reaction. He has obtained (VI) from acetophenone or dypnone by the action of acetic anhydride in presence of ferric

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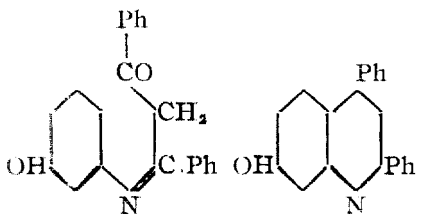
chloride and treating the resulting pyrilium salt (V) with ammonia and found it to be different from (III), m.p. 73°. Oxidation of (VI) with permanganate in 5% sulphuric acid gave an acid (VII), the sodium salt of which on heating with lime at 400° formed 2: 4-diphenylpyridine (VIII) (cf. *Chem. Zentrl.*, 1922, III, 778 ; 1923, I, 759).

The author while studying a reaction, similar to that of Meyer (this *Journal*, 1937, **14**, 355), obtained products which were assigned structures based on certain experiments which definitely proved the constitution of the dicarboxypyridine compound (IV) and indicated that Meyer's mode of representing the reaction as a class is not incorrect. Those experiments form the subject matter of the present communication.

In the light of Gastaldi's research it became necessary to investigate Meyer's reaction more critically and for this purpose, in the first instance, the reaction was slightly modified in such a way that any chance of ambiguity was very much restricted. Thus, β-amino-β-phenylacrylonitrile was condensed with *O*-ethyl ether of dibenzoylmethane, a substance which can hardly be expected to react in any abnormal way. The product formed was identical with 3-cyano-*sym*-triphenylpyridine, obtained by Meyer from the same aminonitrile and benzylidene acetophenone (*loc. cit.*). This reaction can scarcely be regarded as capable of taking any other course. Moreover, this cyanopyridine derivative on hydrolysis lost carbon dioxide and gave *sym*-triphenylpyridine, identical with that previously obtained by Newman from the monoxime of benzaldiacetophenone by passing dry HCl in benzene solution (*Annalen*, 1898, **302**, 240). This identity with Newman's compound, formed by an entirely different method, lends support to the correctness of Meyer's compounds.

In the second instance, (IV) has also been obtained by an equally different method. Dibenzoylmethane reacts with *m*-amidophenol to form an anil (IX) which with dry HCl in glacial acetic acid solution closes up the ring to form 2: 4-diphenyl-7-oxyquinoline (X) (Bulow and Issler, *Ber.*, 1903, **36**, 4017). It has now been obtained more conveniently by boiling *m*-amidophenol and benzylidene-acetophenone in alcoholic solution with a trace of alkali as the condensing agent. Permanganate oxidises the oxyquinoline to give 2: 4-dipnenylpyridine-5: 6-dicarboxylic acid, identical with Meyer's compound (IV).



(IX) (X)

These evidences therefore establish the fact that Meyer's reaction is generally correct, and if there is any doubt, it must be with the individual member (III), and to settle this issue it was thought desirable to synthesise it in such a way as would definitely prove its constitution. Ethyl β-aminocorotonate, which reacts with ethyl acetylpyruvate

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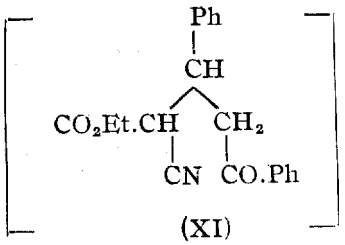
vigorously even at 0° (Mumm and Hüneke, *Ber.*, 1917, **50**, 1568), failed to react with dibenzoylmethane with alkaline condensing agents or when heated with zinc chloride under suction. The 1: 5-diketone from styrylphenyl ketone and acetoacetic ester (Knoevenagel, *ibid.*, 1902, **35**, 397) when treated with ammonia suffers intramolecular ring-closure before it can react with the latter. Next the synthesis was attempted from dypnone and acetamide by heating them together with zinc chloride in a sealed tube at 340° for 48 hours according to the method of Pictet and Stchelin (*Compt. rend.*, 1916, **162**, 876) but the analysis of the products did not agree with the pyridine in question. The following scheme was more successful.



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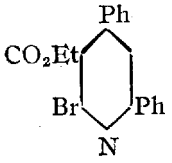

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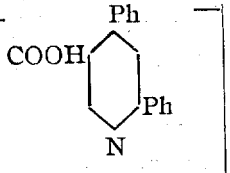

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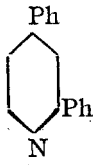

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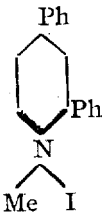

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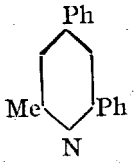

(XVI)

Using methyl cyanoacetate the course of the above reaction was followed up to the bromo-ester corresponding to (XII) by Kohler, Graustein and Merril (*J. Amer. Chem. Soc.*, 1922, **44**, 2536). With the more common ethyl ester, it was noticed that the formation of (XI) did not proceed to completion unless the mixture was maintained just alkaline throughout the reaction by occasional additions of drops of sodium methoxide solution. Bromine in glacial acetic acid converted the open-chain nitrile into the bromopyridine derivative (XII). This was reduced with HI and the product obtained (XIII) on dry distillation with excess of barium hydroxide lost carbon dioxide and gave 2: 4-diphenylpyridine, identical with Gastaldi's compound (VIII). This energetically combined with methyl iodide on a water-bath and the methiodide at 300° (Ladenburg, *Ber.*, 1883, **16**, 1410, 2059 ; Lange, *ibid.*, 1885, **18**, 3438 ; Koenigs and Hoffmann, *ibid.*, 1915, **58**, 194) formed a mixture the major component of which was diphenylpyridine, but it also contained (V, m.p. 73°) which was identified by its picrate. Meyer's compound (III, m. p. 156°) was not formed. The very small amount of material at hand and the unsatisfactory yields obtained by this process precluded any further study here and the work has been taken up again with a different line of approach which will be duly communicated.

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EXPERIMENTAL

3-Cyano-2: 4: 6-triphenylpyridine (I, Ph *in place of* Me).—β-Amino-β-phenylacrylonitrile (2.8 g.) (Holtzwart, *J. prakt. Chem.*, 1889, *ii*, **39**, 242) and dibenzoylmethane-*O*-ethyl ether (5 g.) (Ruheman and Watson, *J. Chem. Soc.*, 1904, **85**, 462) were dissolved in absolute alcohol and introduced into alcoholic sodium ethoxide (Na, 0.46 g.). The liquid immediately assumed a deep red tint. Within half an hour it set to a semi-solid mass. Next day it was filtered at the pump and repeatedly washed with alcohol till perfectly white, yield 2 g. It was crystallised from a large volume of alcohol, m.p. 220° (Meyer, m.p. 220°). (Found : C, 86.4 ; H, 5.2 ; N, 8.5. $C_{24}H_{16}N_2$ requires C, 86.7; H, 4.8 ; N, 8.4 per cent).

Hydrolysis : sym-*Triphenylpyridine*.—The hydrolysis was effected by heating the cyano compound with fuming HCl in a sealed tube at 260° for 4 hours. On adding water a flocculent white precipitate was obtained which did not dissolve in NaOH solution. It crystallises in needles from ethyl acetate, acetone, alcohol and is least soluble in the last, m.p. 136-37° (Found : N, 4.7. $C_{23}H_{17}N$ requires N, 4.56 per cent). A mixed melting point determination with the compound obtained by Newman's method showed no depression.

7-Hydroxy-2:4-diphenylquinoline (X).—*m*-Amidophenol (2.5 g.) and styrylphenyl ketone (5 g.) were dissolved in absolute alcohol (40 c c.) and boiled under reflux for 7 hours with the addition of a few drops of alcoholic potash. The solution turned red and on cooling set to a crystalline mass. This was collected and crystallised from benzene, yield 2 g. Unlike the crude product it no longer tarnished in air and light, m.p. 273° (turns brown). The alcoholic mother-liquor on concentration gave a further yield of 1 g. (Found: C, 85.21 ; H, 5.23 ; N, 4.67. $C_{21}H_{15}ON$ requires C, 84.84 ; H, 5.05 ; N, 4.71 per cent). Picrate, shining orange-yellow flakes, m.p. 246-47°. (Found: N, 10.8. $C_{21}H_{15}NO.C_6H_3O_7N_3$ requires N, 10.6 per cent).

Oxidation of the Quinoline Compound: 2: 4-*Diphenyl*-5: 6-*dicarboxylic Acid* (IV).—The oxyquinoline derivative (3 g.) was dissolved in aqueous KOH (conc., 3 g. excess was used to prevent hydrolysis on dilution) and then diluted with warm water to 450 c.c. The solution was heated on a water-bath. 5%$KMnO_4$ (Tech., 9 g.) was very slowly added to it with stirring till the mixture became permanently pink ; excess of $KMnO_4$ was decomposed with SO_2, filtered hot and the precipitated oxide extracted with hot water. The filtrate was concentrated with occasional neutralisation with dilute H_2SO_4 to a small bulk when copious gelatinous inorganic matter separated. This was filtered off and the filtrate with copper sulphate solution precipitated a greenish blue copper derivative which was collected, washed, suspended in water and decomposed with H_2S. The gummy precipitate was extracted with warm dilute caustic soda and acidified, when a spongy mass was produced. The whole thing was extracted with ether, dried with calcium chloride and the solvent evaporated. The residue was crystallised from absolute alcohol, m.p. 185° (gas evolution), yield too poor. (Found : C, 71.2 ; H, 4.4 ; N, 4.7. $C_{19}H_{13}O_4N$ requires C, 71.5 ; H, 4.1 ; N, 4.4 per cent).

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Condensation of Ethyl Cyanoacetate with Benzylidene-acetophenone (XI).—The condensation did not proceed satisfactorily unless very pure chemicals were used in absolutely dry condition. The ketone (20 g.) and the ester (14 g.) were dissolved in carefully dehydrated methyl alcohol (30 g.) and to the warm solution sodium methoxide (5% soln.) was added dropwise till distinctly alkaline. The temperature of the reaction mixture shot up and the liquid began to boil. It was then refluxed for 2 hours with repeated additions of the condensing agent (2 drops, each time) to keep it alkaline throughout. After standing overnight the solvent was removed, the residue taken up in ether, washed with sodium carbonate, dried ($CaCl_2$) and finally distilled. At 10 mm. pressure a few drops of cyano-ester passed off below 100° and then the temperature began to rise till at 200° tendency to decomposition was noticed. It was a very thick, viscous, transparent mass not solidifying even on keeping in ice for several days nor could it be crystallised from any solvent, yield 28 g.

Action of HBr *on above Open-chain Addition Product : Formation of Ethyl 2-Keto-4 :6-diphenyltetrahydropyridine-3-carboxylate.*—The above light brown mass was dissolved in warm carbon tetrachloride and saturated with dry HBr. The solution on keeping in an ice chest solidified completely. On rubbing with methyl alcohol shining white flakes were obtained, m.p. 150-55°, yield 22 g. It was crystallised from alcohol, m.p. 160°. (Found : C, 74.3 ; H, 6.1 ; N, 4.7. $C_{20}H_{19}O_3N$ requires C, 74.76 ; H, 5.91 ; N, 4.4 per cent). Hydrolysis of this ester gave the acid identical with Kohler's product (*loc. cit.*).

Action of Bromine : Formation of Ethyl 2-Bromo-4: 6-diphenylpyridine-3-carboxylate (XII).—The open-chain compound (XI) was treated with bromine in hot glacial acetic acid. Copious HBr was evolved and towards the end a very slight white granular precipitate appeared which was identified to be ammonium bromide, suggesting hydrolysis of a part of the material. This was filtered off, the filtrate distilled under suction and the acid fumes removed in a vacuum desiccator over solid KOH. The residual thick brownish mass was boiled with water when it became nearly semi-solid but separated from solvents as an oil. The mass was next treated with hot caustic soda solution which dissolved a considerable portion of it to form a red solution from which a quantity of the ketotetrahydropyridine ester, described above, was recovered. The residue was a hard, red, impure solid which was repeatedly crystallised from alcohol with the addition of animal charcoal and kieselghur as oblong plates, m.p. 133-35°, yield very poor. (Found : Br, 20.97. $C_{20}H_{16}O_2NBr$ requires Br, 20.94 per cent).

Reduction of the Bromopyridine Ester.—The bromo-ester (XII, 5 g.) was mixed with red phosphorus (1 g.) and hydriodic acid (*d* 1.94, 12 c.c.) and heated in a sealed tube at 175°-180° for 24 hours. With the disappearance of iodine vapours a colorless liquid with large crystals were obtained. The crystals turned violet on exposure to air and were soluble in warm water. These were treated with boiling potash solution and concentrated. On cooling the potassium salt separated as a rose-red solid, freely soluble in water. Acidification precipitated the acid (XIII) in an impure condition, m.p. 200-205°. The crude reduction product was refluxed with powdered barium hydroxide and a little water for 2 hours, cooled, filtered and dried.

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Removal of the Carboxyl group : Formation of 2: 4-Diphenylpyridine (XIV).—The dry material was well mixed with a little more barium hydroxide and heated gently with a small free flame in a pyrex test tube fitted with a delivery tube dipping in cold water. Decomposition started with frothing and very soon an oily distillate condensed on the cooler parts of the test tube. This solidified to a pale brown solid, yield 0.5 g. from 1 g. of the crude crystals obtained in the previous operation, m.p. 68° (pure) (Gastaldi, *loc. cit.*, m.p. 69°). (Found : N, 6.2. $C_{17}H_{13}N$ requires N, 6.0 per cent). Picric acid in alcohol produced a deep yellow picrate, m.p. 189° (Gastaldi, m.p. 187°).

2: 4-*Diphenylpyridine Methiodide* (XV).—This pyridine (1 g.) and methyl iodide (1.5 g.) were refluxed on a carbon lamp. Within an hour a red paste was formed which set to a glassy red solid on cooling. This was rubbed with warm rectified spirit when a yellow solid separated, m.p. 206-208°. It was recrystallised from alcohol, m.p. 210°. (Found : I, 34.1. $C_{18}H_{16}NI$ requires I, 34.0 per cent).

2: 4-*Diphenyl-6-methylpyridine*.—The methiodide (4 g.) was heated in a sealed tube at 300°-315° for 2 hours affording a black transparent soft mass which was taken up in hot water, treated with concentrated NaOH solution and distilled in steam. A slightly milky liquid passed over. Extraction of the distillate with ether, followed by removal of the solvent, gave a yellow oil having a strong odour of essential oil, but on keeping this votatile portion passed away leaving a very small amount brown solid which formed a picrate, m.p. 184-87°. This was probably diphenylpyridine.

The residue after steam-distillation was mixed with enough ether. Most of the black mass went into solution having a deep brownish green fluorescence. This was separated, filtered from the slight brown precipitate formed, solvent removed and the residue crystallised from ligroin. Impure crystals separated melting at about 60°, which energetically formed picrate. This was again mostly diphenylpyridine as the recrystallised picrate melted sharply at 169°. The mother-liquor (ligroin) was evaporated off, residue taken up in a little benzene, a few drops of petrol added and allowed to concentrate in air. Some crystals separated which were removed and washed with a little petrol. These melted at 69-72° and formed a picrate melting at 212°. The exceedingly poor yield of this compound and its admixture with diphenylpyridine, which is so close to it both in solubility in different solvents and melting point, indicated the unsuitability of this method.

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CHEMICAL EXAMINATION OF THE WOOD OF *CEDRELA TOONA*, ROXB. ISOLATION OF A LACTONE, AN ESSENTIAL OIL AND A COLOURING MATTER

By Dharam Bal Parihar and Sikhibhushan Dutt

From the wood of *Cedrela toona*, a lactone (m.p. 204°), an essential oil, and a colouring matter (m.p. 256°) have been obtained in yields of 0.40, 0.17 and 0.25% respectively.

The lactone, Cedrelone, has a molecular formula $C_{25}H_{30}O_5$. It contains one ethylenic double bond, one phenolic hydroxyl, one ketonic group and a lactone ring in the molecule.

Several derivatives of Cedrelone have been prepared and analysed.

Cedrela toona, commonly known as *Tun* in Hindi, is a tall handsome tree, about 50 to 60 feet high, belonging to the natural order of Meliaceae. It is found in abundance in the sub-Himalyan tract from the Indus eastwards, Chittagong, Assam, Burma, Chota Nagpur, Western Ghats of Bombay to the Nilgris and other hills of the Indian Peninsula.

The wood, which is of a brownish red colour, has a faintly aromatic odour, mainly due to the presence of a golden yellow essential oil, and a lactone. The wood is very light and is largely used in making light furniture and musical instruments. Mell (*Text. Col.*, 1931, **53**, 68) found the wood to be an interesting source of a natural dyestuff.

Besides the commercial aspects, the plant enjoys a great repute in medicine. The bark of the plant is a powerful astringent and has been used with success in chronic infantile dysentery, and as a local astringent application in various forms of ulcerations (Kirtikar and Basu, "Indian Medicinal Plants", Vol. I, pp. 562-564). The infusion of the bark is given in intermittant fevers and blood complaints in Indo-China. The seeds have similar therapeutic value. The flowers are considered emmenagogue in Bombay, and are given in disordered menstruation.

The essential oil from the wood was analysed by Pillai and Sanjiva Rao (*J. Soc. Chem. Ind.*, 1931, **50**, 220T). By steam-distillation of the powdered wood a golden yellow pleasant smelling essential oil (yield 0.44%) was obtained. The oil was found to consist of a tricylic sesquiterpene, *l*-copaene (35%), and bicyclic hydrocarbons identified as cadinene. The sesquiterpene alcohol fraction consisted mainly of *l*-cadinol (13 %).

Apart from the essential oil, no systematic work on the wood of the plant has been done by any previous worker, and in view of the great medicinal importance of the plant, the present work was undertaken to find out the active principles present and to study their constitutions.

The authors while working on the wood of the plant have isolated a pleasant smelling, heavy, essential oil, a reddish yellow colouring matter (m.p. 256°) and a lactone (m.p. 204°), in yields of 0.17%, 0.25% and 0.40% respectively on the dry wood. The systematic chemical examination of the essential oil and the colouring matter will be

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the subject of separate communications; while in the present one the lactone has been studied in detail.

The lactone, which has been named as "Cedrelone" by the authors, crystallises in colorless, glistening, rhombic needles and large hexagonal plates from benzene, melting sharply at 204°. It has a molecular formula of $C_{25}H_{30}O_5$, and contains one ethylenic double bond, one phenolic hydroxyl and one ketonic groups. Several derivatives of the compound were prepared and analysed and are described in the experimental part of the paper.

EXPERIMENTAL

For preliminary examination the powdered dry wood (25 g.) was taken in a sohxlet's apparatus and extracted with different solvents in the hot each time, for about an hour and the solvent distilled off. The following are the percentages of the extracts obtained in each case:

Water	7.47 %	$CHCl_3$	1.49 %
MeOH	17.96	CCl_4	1.08
EtOH	11.74	Benzene	1.18
Acetone	8.90	Ether	1.38
Ethyl acetate	6.06	Petrol ether	1.09

The wood on complete ignition left 2.55% of a white ash.

The air-dried, powdered wood of the plant (10.2 kg.) was extracted with hot benzene under reflux in lots of 2 kilos at a time. The extracts were filtered hot, the solvent distilled off and the viscous reddish concentrate was allowed to stand for one week, when large colorless crystals settled down. These were filtered off through a Buchner funnel and rapidly washed with ether. The mother-liquor and the washings were collected. These on concentration gave three more crops of the same crystalline compound with identical melting points. The ultimate mother-liquor was completely freed from benzene by heating on a water-bath under reduced pressure in an atmosphere of carbon dioxide, thus affording a very thick red coloured oily stuff, which was found to be the solution of the lactone in essential oil. This was treated with alcoholic potassium hydroxide on the water-bath, excess of alcohol distilled off, the mixture after cooling diluted with water, and extracted with ether. The ethereal extract on recovery of the solvent gave a heavy, pleasant smelling essential oil (yield, 0.17 %). The alkaline solution on acidification with dilute hydrochloric acid precipitated the lactone, which had the same melting point as that of the original lactone, confirmed by mixed melting point when no change was noticed. The systematic work on the essential oil will be the matter of a separate communication.

The wood after extraction with benzene was further extracted with hot alcohol under reflux and the solvent distilled off when a syrupy residue was obtained. After removal of traces of the solvent by evaporation on the water-bath, the residue was extracted with hot acetone, the extract concentrated and the colouring matter precipitated with chloroform. The compound on drying was found to shrink at 215° and

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melt at 254-56°. This was recrystallised from boiling glacial acetic acid in reddish yellow needles melting at 256°. On further crystallisations the melting point of the compound did not rise. Thus, 25.5 g. of the colouring matter were obtained in an yield of 0.25% on the weight of the dry wood. The colouring matter is soluble in water, alcohol, ethyl acetate and acetone, but insoluble in chloroform, petroleum ether and benzene. It dissolves in alcoholic KOH with a yellow coloration and turns red with concentrated sulphuric acid. To alcoholic ferric chloride it imparts a greenish brown coloration and with an alcoholic solution of lead acetate, a yellow precipitate is produced. Ordinarily it has got no action on Fehling's solution but only reduces it after hydrolysis, thus showing it to be a glucoside. On reduction with magnesium and methyl alcoholic hydrochloric acid it turns red, thus indicating the presence of a pyrone nucleus in the molecule. It was found to contain no methoxy groups.

The various crops of the colorless crystalline matter, mentioned above, were mixed together and recrystallised from the least amount of hot benzene after treatment with animal charcoal when the compound was obtained in fine, colorless, rhombic needles and hexagonal plates melting sharply at 204°, which even after repeated crystallisation of the compound did not rise any further. Thus, 41 g. of the crystalline compound were obtained in an yield of 0.40% on the weight of the dried wood.

Cedrelone possesses a characteristic faint odour. It is soluble in benzene, chloroform, petroleum ether and acetic acid, while insoluble in cold and hot water and alcohol. It is insoluble in aqueous caustic soda and gives no coloration either on heating or prolonged standing. It is not volatile in steam and does not sublime. It dissolves in sulphuric acid (conc.) giving a deep red coloration, but on the addition of water the colour disappears and the original compound is reprecipitated. The compound gives deep yellow coloration with alcoholic caustic potash, thus definitely indicating the presence of a lactonic ring. From the alkaline solution acid precipitates the original compound. With alcoholic ferric chloride the compound gives a violet coloration showing the presence of a phenolic hydroxyl group. It fails to give Liebermann-Burchard reaction. The lactone neither gives any test with alkaline sodium nitroprusside nor reduces Tollen's reagent, a property mainly shown by $\beta\gamma$-unsaturated lactones. The compound is unsaturated and adds on bromine in benzene or acetic acid. The compound indicated the precence of no methoxyl group as found by Zeisel's method. [Found: C, 73. 52; H, 7.21; M.W. (cryoscopic in phenol), 412, 415; M.W. (Rast's camphor method), 410. $C_{25}H_{30}O_5$ requires C, 73.17; H, 7.31 per cent. M.W., 410].

Repeated attempts to prepare the silver, lead and copper salts of the compound were unsuccessful.

Cedrelone Dibromide.—The compound (1.5 g.) was dissolved in dry benzene (10 c.c.) and the mixture kept in a freezing mixture. To this was added an 1% solution of bromine in the same solvent in small amounts during the period of about half an hour till the bromine was in slight excess. During the addition the temperature was not allowed to rise above 0°. The mixture was kept overnight in the refregerator, and the solvent and the exeess of the bromine distilled off on the water-bath. The syrupy residue was dissolved in the minimum quantity of alcohol and a few drops of water added to the solution, when fine glistening orange needles settled down. The product was filtered,

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washed with water and recrystallised from alcohol in beautiful yellow needles, m.p. 116°, yield 1.4 g. The compound is soluble in methyl and ethyl alcohols, ethyl acetate and benzene, but insoluble in hot or cold water. (Found: Br, 26.4, 28.09. $C_{25}H_{30}O_5Br_2$ requires Br, 28.07 per cent).

Acetylcedrelone.—The compound (2 g.) was dissolved in acetic anhydride (10 c.c.), anhydrous sodium acetate (1 g.) added and the mixture gently refluxed in a boiling tube on a sand-bath for about 2 hours. After that the mixture was poured into cold water, well stirred and kept in the refrigerator for about 4 hours, when the acetyl derivative crystallised out in shining crystals. It was filtered and thoroughly washed with water and recrystallised from 80% alcohol in small colorless needles and plates, m.p. 148°, yield 2.01 g. The compound is soluble in alcohol, acetone, ethyl acetate, benzene, ether and petrol ether, but insoluble in water. (Found: acetyl, 11.4, 10.9. $C_{25}H_{29}O_5.COCH_3$ requires acetyl, 9.51 per cent).

Cedrelone Phenylurethane.—Cedrelone (1 g.), dissolved in 5 c.c. of anhydrous benzene, was treated with phenyl *iso*cyanate (2 g.), dissolved in 5 c.c. of the same solvent; the mixture was refluxed on the sand-bath for about 2 hours and then the solvent distilled off. The residue was allowed to cool when it became a syrup. This was dissolved in absolute alcohol and allowed to stand for some time when shining long needles melting at 232° were obtained. The compound is soluble in alcohol, benzene, ether and petrol-ether but insoluble in water. (Found: N, 2.32. $C_{25}H_{29}O_4$-$OCONHC_6H_5$ requires N, 2.64 per cent).

Cedrelone Monoxime.—Hydroxylamine hydrochloride (1.5 g.) and anhydrous sodium acetate (3 g.) were thoroughly mixed together in a mortar and the mixture was taken in 25 c.c. of glacial acetic acid and heated for about half an hour on the sand-bath. To this was added cedrelone (8 g.) and the mixture was refluxed in a boiling tube for about an hour on a sand-bath. The mixture while hot was poured into cold water, when a crystalline mass settled down. It was filtered, thoroughly washed with water, dried and recrystallised from hot alcohol in shining colorless prisms and needles, m.p. 258°, yield 1.46 g. The compound is soluble in alcohol, acetone, ethyl acetate, but insoluble in water, ether and petrol-ether. (Found: N, 3.18. $C_{25}H_{30}O_4.NOH$ requires N, 3.29 per cent).

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THORIUM : ITS SEPARATION FROM CERITE EARTHS AND ESTIMATION

By M. Venkataramaniah, T. K. Satyanarayanamurthy and Bh. S. V. Raghava Rao

Detailed procedures have been described for the separation of thorium from cerite earth mixtures in proportions approximately from 1 : 1 up to 1 : 10 using the reagents : trimethylgallic acid, phenoxyacetic acid, veratric acid, benzoic acid, ammonium benzoate and tannic acid. Thorium in monazite has also been successfully estimated employing these reagents

The separation of thorium from the rare earths, particularly from the cerite earths, is one of the principle problems of thorium chemistry, since on the ease and effectiveness of this separation depends the commercial utilization of the element. Several methods have been suggested, but few have been investigated in any detail (Moeller *et al.*, *Chem. Rev.*, 1948, **42**, 63). In the following pages are presented results of systematic investigations on a number of reagents, many of which are now reported for the first time.

Experimental

Each reagent was tried first on a solution of pure thorium, next on made-up mixtures of thorium and cerite earths, and finally on a sample of Travancore monazite.

The thorium solution was obtained by further purification of high grade thorium nitrate as follows. The thorium was twice precipitated with sebacic acid, and then with hydrogen peroxide. The oxide was dissolved in nitric acid, evaporated to dryness on a water-bath and finally dried to a constant weight in an air-oven at 100° to 120°. The thorium content of the sample was variously estimated with sebacic acid (Mitchel and Ward, "Modern Methods in Quantitative Chemical Analysis", 1932, p. 149), oxalic acid (Scott, "Standard Methods of Chemical Analysis", 1937, Vol. I, 5th Ed., p. 946) and potassium iodate in nitric acid (Meyer and Speter, *Chem. Ztg.*, 1910, **34**, 306). All procedures yielded results agreeing within 0.2%.

The cerite earth solution was prepared from monazite from which all thorium and the yttrium earths had been very carefully removed. The earth content was estimated by precipitation from an aliquot part with oxalic acid and weighing the ignited residue as oxides. No attempt was made to determine the proportion of the individual members n the group, neither would it serve any purpose in this investigation.

For the estimation of thorium in monazite, a sample from Travancore was digested according to the usual practice with sulphuric acid and taken up in ice-cold water. Oxalic acid in sufficient excess was next added and the oxalate precipitate was dissolved in fuming nitric acid and evaporated to dryness on a water-bath. The residue was taken up in water, made up to a definite volume, and aliquot portions were pipetted

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out for each determination. It may be mentioned that attention was focussed not on an accurate analysis of monazite, but on the efficiency of the reagent as a means of separation of thorium from the rare earths.

Trimethylgallic Acid.—Neish (*Chem. News*, 1904, **90**, 196) made the observation that gallic acid in *alcoholic* solution precipitated thorium as a flocculent, slimy mass while holding other cerite earths in solution, but the subject was not further investigated. Some preliminary experiments conducted by us showed that while the precipitation of thorium was incomplete in both alcoholic and aqueous solutions, large amounts of the cerite earths were simultaneously carried down. On the other hand, trimethylgallic acid in neutral or faintly acid medium proved highly satisfactory. Neither ammonium gallate nor ammonium trimethylgallate, however, proved of any value.

The thorium solution was made just neutral to Congo red and diluted to 150 c.c. Solid ammonium chloride (20-25 g.) was then added and the solution heated to boiling. To this was added with constant stirring a slight excess of a boiling 2% solution of the reagent (i. e. about 100 c.c. of the precipitant for every 0.1 g. of the oxide). A gelatinous precipitate resulted which settled down rapidly. After about 15 minutes on a water-bath, the precipitate was filtered hot through Whatman No. 41, washed with a boiling 0.2% (approximately) solution of the reagent to which a few grams of ammonium chloride had also been added, *partially dried*, and ignited to the oxide. When the quantity of the cerite earths is rather large, the precipitate carries small quantities of these and a second precipitation, as described below, is necessary. The washed precipitate was returned to the original beaker, dissolved in the minimum of hot dilute hydrochloric acid, and dilute ammonia was very carefully added till the liquid reacted but faintly acid to Congo red. Precipitation, washing and ignition were repeated. Some representative results are shown in the following table.

TABLE I

ThO_2 taken.	Cerite earths R_2O_3 added.	Wt. of ThO_2 obtained in single pptn.	Double pptn.
0.1180 g.	—	0.1181 g.	—
0.1180	—	0.1178	—
0.2360	—	0.2362	—
0.1180	0.1405 g.	0.1183	0.1181 g.
		0.1184	0.1182
0.1180	0.4580	0.1182 } slightly 0.1180 } coloured	0.1178 0.1182
0.1180	0.5620	0.1185 } slightly 0.1183 } coloured	0.1179 0.1180
0.1180	1.1450	0.1200 } 0.1208 } coloured	0.1180 0.1183
{ Monazite 0.0900 }	0.4708	—	0.0900 0.0898

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Phenoxyacetic Acid.—Pratt and James (*J. Amer. Chem. Soc.*, 1911, **33**, 1330) recorded that precipitation of thorium by phenoxyacetic acid in neutral solution was almost quantitative, while Smith and James (*ibid.*, 1912, **34**, 281) opined that the thorium salt was slightly soluble in water. A more detailed investigation appeared desirable. The following procedure yields good results.

The thorium solution, which should react neutral to Congo red, is diluted to 100 c.c. and heated to boiling. To the boiling solution is added slowly and with constant stirring a slight excess (100 c.c. for every 0.1 g. of ThO_2 will be sufficient) of a hot 2% solution of phenoxyacetic acid. The liquid is now once again brought to boiling, and set aside to cool. The cooled precipitate is filtered through Whatman No. 41 and washed with a cold 0.2% (approx.) solution of phenoxyacetic acid. The washed precipitate is now returned to the original beaker and dissolved in the minimum of hot diluted (1: 2) hydrochloric acid. The solution is diluted to about 100 c.c. and very carefully neutralised by dropping dilute ammonia until it is but faintly acid to Congo red. The thorium is reprecipitated, washed and ignited to the oxide. Some results are shown in the following table.

TABLE II

ThO_2 taken.	Cerite earths R_2O_3 added.	ThO_2 obtained.	ThO_2 taken.	Cerite earths R_2O_3 added.	ThO_2 obtained.
0.1140 g.	——	0.1143 g.	0.1180 g.	0.5610 g.	0.1183 g.
0.1140	——	0.1140	0.1140	0.5712	0.1144
0.1180	——	0.1178	0.1140	0.5712	0.1146
0.1180	——	0.1181	0.1140	1.1424	0.1143
0.1180	0.1402 g.	0.1181	0.1140	1.1424	0.1145
0.1140	0.2805	0.1138			
0.1140	0.2805	0.1143	{Monazite	0.4708	0.0902
0.1140	0.4580	0.1138	0.0900}		0.0901

Veratric Acid.—This reagent or any of its analogues has not been mentioned in literature. The thorium solution which should be nearly neutral to Congo red, is diluted to 100 c.c., solid ammonium chloride (15-20 g.) added and heated to boiling. To the boiling solution is added, with constant stirring, a saturated boiling solution of veratric acid. The resulting gelatinous precipitate is allowed to settle, filtered through Whatman No. 41 filter, washed with hot dilute veratric acid in 5% ammonium chloride, transferred to the original beaker, dissolved in dilute hydrochloric acid, diluted and reprecipitated. After complete washing the precipitate is ignited and weighed as oxide. Representative results are shown in Table III.

Benzoic Acid.—Benzoic acid was suggested by both Kolb and Ahrle (*Z. angew. Chem.*, 1905, **18**, 92) and Neish (*loc. cit.*). Apparently without further investigation the reagent was pronounced unsatisfactory and rejected in favour of *m*-nitrobenzoic acid, a rather expensive reagent. The following procedure adopted by us has yielded results which compare favourably with any known method.

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TABLE III

ThO_2 taken.	Cerite earths R_2O_3 added.	ThO_2 obtained.
0.1180 g.	——	0.1186 g. 0.1186
0.1180	1.1450 g.	0.1182 0.1179
{Monazite 0.0900}	0.4708	0.0904 0.0907

To the thorium solution, if strongly acid, dilute ammonia is added dropwise until the solution reacts but faintly acid to *methyl red*. It is then diluted to 100 c.c. and heated to boiling. Hot 1% benzoic acid solution (100 c.c.) is added with vigorous stirring followed by 5% ammonium acetate until the liquid reacts at this stage just neutral. A precipitate results which settles quickly. This is filtered through Whatman No. 41. After washing with hot 0.25% benzoic acid the precipitate is returned to the original beaker and dissolved in hot dilute nitric acid and precipitation is repeated. The second precipitate after complete washing is ignited and weighed as the dioxide. The results are shown in the following table.

TABLE IV

ThO_2 taken.	Cerite earths added.	ThO_2 obtained.
0.1140 g.	——	{0.1142 g. 0.1141
0.1140	0.4580 g.	{0.1141 0.1142
0.1140	0.5712	{0.1145 0.1148
0.1140	1.1424	{0.1148 0.1146
{Monazite 0.0900}	0.4708	{0.0.0900 0 0.0904

Ammonium Benzoate.—This reagent has not been referred to previously.

The nearly neutral solution is diluted to 200 c.c., acidified with 2 c c. of glacial acetic acid and cold 3% ammonium benzoate is run in a thin stream with constant stirring until about 100 c.c. have been added for every 0.1 g. of thorium dioxide supposed to be present. The precipitate is now left on a water-bath and after it has settled (usually 30 minutes) as much of the supernatant liquid as possible is poured through a Whatman No. 41 filter, without disturbing the precipitate. It is now stirred up with hot 0.5% benzoic acid, filterd, and washed with the same reagent. The washed precipitate is transferred back to the original beaker and dissolved in a minimum of dilute hydrochloric acid. The solution is diluted to 150 c.c. and dilute ammonia is

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run down from a burette until slight turbidity results. Precipitation is completed by adding a slight excess of ammonium benzoate reagent. The precipitate is next filtered, washed with hot 0.5% benzoic acid, and ignited to the oxide. The following table shows the results obtained.

TABLE V

ThO_2 taken.	Cerite earths R_2O_3 added.	ThO_2 obtained.
0.1140 g.	——	0.1142 g. 0.1141
0.1140	0.4580 g.	0.1141
0.1140	0.5712	0.1145 0.1148
0.1140	1.1424	0.1148 0.1146
Monazite 0.0900	0.4708	0.0900 0.0904
0.0900	0.4708	0.0897 0.0900

Tannic Acid.— This reagent which has found such extensive use in the separation of columbium and tantalum does not seem to have attracted attention in this field. Neish (*loc. cit.*) refers to it only passingly.

The neutral solution is diluted to 200 c.c. after addition of 10 g. to 15 g. of ammonium chloride. Dilute acetic acid is then added dropwise until a drop of the solution just turns Congo red paper blue. Mineral acids should not be used for this acidification. The solution is heated just to boiling (it should not actually boil), and hot 5% tannic acid solution at the rate of 100 c.c. per 0.1 g. of thorium oxide is added slowly with constant stirring. The precipitate is left on a water-bath for 2 hours after which it is filtered through Whatman No 41 and washed with 2% tannic acid solution to which a

TABLE VI

ThO_2 taken.	Cerite earths added.	ThO_2 obtd.	ThO_2 taken.	Cerite earths added.	ThO_2 obtd.
0.0570 g.	——	0.0572 g.	0.1140 g.	1.1424 g.	0.1143 g.
0.0570	0.4580 g.	0.0573	0.1140	1.1424	0.1140
0.0570	0.4580	0.0574	0.1180	——	0.1183
0.1140	——	0.1139	0.1180	0.1402	0.1183
0.1140	0.4580	0.1142			
0.1140	0.5712	0.1148	Monazite 0.0900	0.4708	0.0897 0.0900

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little ammonium nitrate or chloride has been added. The precipitate with the filtered paper is transferred to the original beaker and boiled with about 40 c.c. of dilute HCl (1:2) to dissolve the precipitate. Nitric acid should not be used. After thorough digestion dilute ammonia is added until the liquid reacts just neutral to Congo red. Precipitation and washing are repeated and the washed precipitate is ignited to the oxide. The results are given in Table VI.

In all cases, however, zirconium and quadrivalent cerium, if present, are simultaneously precipitated, a disadvantage that is shared by many reagents for thorium. It is thus necessary that cerium is reduced to the trivalent stage and zirconium is removed earlier by a simple precipitation with oxalic acid.

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DETERMINATION OF PEROXIDE VALUE OF RANCID FATS. A MODIFIED PROCEDURE

By S. Mukherjee

Peroxide value of the butter-fat has been determined by combining the method of Wheeler and Lea.

Peroxide value is by far the most extensively used index for evaluating rancidity of fats and oils. A number of different iodimetric procedures, viz., those of Lea (*Proc. Roy. Soc.*, 1931, **108B**, 175), Wheeler (*Oil & Soap*, 1932, **9**, 89) and Taffel and Revis (*J. Soc. Chem. Ind.*, 1931, **50**, 87T) are available for making such determinations, and although all these methods are presumed to react quantitatively and may do under most conditions, results by the different methods are not always reliable. The experience of the present investigator with peroxide determination using the three methods is that Lea's method gives lower values than Wheeler's and still lower values are obtained with the Taffel-Revis's method. The results were found to differ depending on the following factors : (*i*) the atmosphere in which the estimation is carried out, (*ii*) the temperature, (*iii*) the time of reaction and (*iv*) weight of fat used in the estimation.

For this reason all the methods were subjected to re-examination using different weights of fat, different reaction period and using different temperatures, as also determinations were made both in presence of oxygen and in inert atmospheres. The experimental results with a sample of rancid butter-fat are tabulated below.

Table I

Determination of peroxide value by different methods.

Wt. of fat.	Time of reaction.	Temp.	Atmosphere.	Peroxide value.
		1. Lea's method.		
1.008 g.	3 minutes	98.8°	Nitrogen	95.80
2.100	,,	,,	,,	95.10
0.5020	,,	,,	,,	95.88
0.2510	,,	,,	,,	95.93
10.1000	,,	,,	,,	93.05
		2. Wheeler's method.		
5.5025 g.	1 minute	36-37°	Air	103.6
3.5163	,,	,,	,,	104.7
7.8203	,,	,,	,,	101.9
1.0035	,,	,,	,,	104.5
10.0	,,	,,	,,	98.0
		3. Taffel-Revis method.		
1.0 g.	2-3 minutes	98.8°	CO_2	91.81
2.0	,,	,,	,,	89.62
5.0	,,	,,	,,	88.01
10.0	,,	,,	,,	86.82

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From the results in Table I it is evident that the Wheeler method always gives higher values than the Lea or Taffel-Revis method. This can be explained firstly as due to the inert atmospheres maintained in the other two methods, whereas in the Wheeler method the atmospheric oxygen liberates a certain amount of iodine from the KI solution. The lower values in Lea's method may, however, be due to the fact that there is a possible chance of partial decomposition of the peroxides at the high temperature employed. The still lower values obtained with the Taffel-Revis method are probably due to the incomplete extraction of the peroxides with the acetic acid alone. The use of chloroform is a probable advantage with the Lea or Wheeler method. Thus a point of considerable importance in the peroxide determination is the *atmosphere* in which the reaction is conducted, as also the *temperature* of the reaction.

The Effect of Weight of Fat.—The next variable studied was the weight of fat used in the experiment, using a temperature of 36°-37° (Wheeler), an atmosphere of CO_2 (Taffel-Revis) and a reaction period of 2-3 minutes (Lea) and Table II shows the effect of sample size on the peroxide value.

TABLE II

Peroxide value and sample size.

Wt. of fat. (butter-fat).	Peroxide value.	Wt. of fat. (butter-fat).	Peroxide vlaue.
0.1025	97.22	1.5129	96.83
0.2050	97.22	2.0100	96.02
0.4110	97.03	5.1035	93.0
1.0030	96.84	9.9877	92.85

TABLE III

Effect of sample size on peroxide value.

Coconut oil		Groundnut oil		Linseed oil	
Wt. of fat.	Peroxide value.	Wt. of fat.	Peroxide value.	Wt. of fat.	Peroxide value.
0.1230 g.	9.2	0.1532 g.	26.0	0.1028 g.	27.2
0.2526	9.2	0.3185	25.3	0.2550	25.9
1.0297	8.9	0.8241	23.5	0.7574	23.4
2.0512	8.8	1.5656	22.2	1.2022	20.2
5.0	8.1	2.9400	20.4	2.5110	18.2
		5.0	17.8	5.0	15.0

Comparison of the results obtained by Lea's method in Table I with those obtained in Table II clearly shows that in the original method of Lea there is a slight decomposition of the peroxide at the high temperature (about 1-2%). The peroxide value of a particular sample of oxidised fat is moreover found to vary considerably with the weight of the fat. This is probably due to the re-absorption of the liberated iodine at the unsaturated centres of the fat. This is more fully illustrated by the results in Table III where

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similar experiments have been conducted with rancid coconut, groundnut, and linseed oils, the re-absorption of iodine by the oils being least with coconut and maximum with the linseed oil as the sample size is varied from 0.1 to 5.0 g. The error due to this source may be reduced by restricting the weight of the fat to the lower value employed in the Lea's method, viz. 1 g.

Effect of Reaction Time.—The next object was to study the effect of time factor on the peroxide value determinations. The following table (Table IV) records the results of such investigations using different reaction periods in the dark including those used by previous workers. In order to keep the weight of the fat constant and thus to minimise the effect due to this factor, nearly 1.0 g. of fat was used in these experiments, by taking the same measured volume of a chloroform solution containing a definite weight of the oxidised butter-fat.

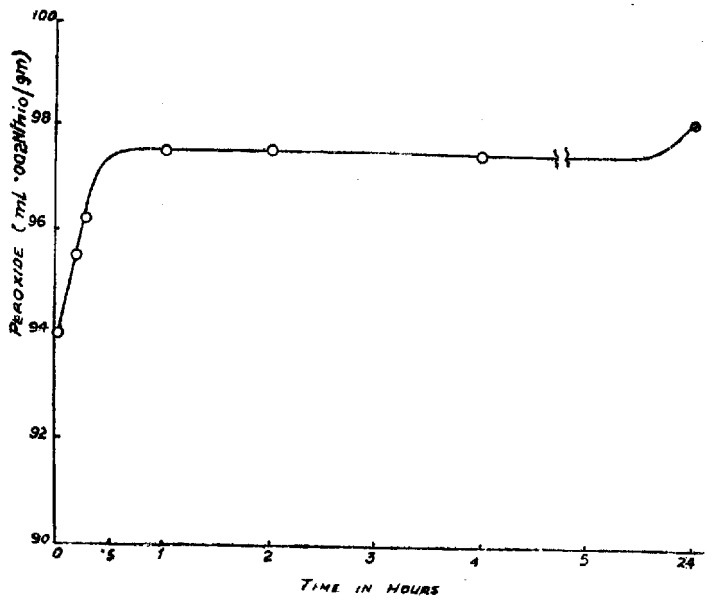
TABLE IV

Peroxide values vs time.

In CO_2 atmosphere at 37°.

Wt. of fat.	Time.	Peroxide value.	Wt. of fat.	Time.	Peroxide value.
1.0244	3-5 mins.	95.0	1.0460	2 hours	97.5
1.0460	10	95.5	,,	4	97.5
,,	15	96.2	,,	6	97.5
,,	30	97.3	,,	12	97.7
,,	45	97.5	,,	24	98.2
,,	60	97.5	,,	48	98.93

Fig. 1



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From the results in the above table it appears that almost 98% of the peroxide react within 3 to 5 minutes. For complete reaction of the peroxides with KI, it is better to allow one hour reaction time in the dark, as a safe measure. This is quite evident from the flat portion of the curve in Fig. 1 relating peroxide value and time factor.

Recommended Procedure.—For accurate determination of the peroxide the following procedure may therefore be used with advantage. About 1 g. of the oil or fat is weighed into a 750 c.c. glass-stoppered iodine bottle from which air has previously been excluded by flushing with carbon dioxide for 3 to 5 minutes, and 10 c.c. of a solvent comprising 40 parts of $CHCl_3$ and 60 parts of acetic acid (glacial, A.R.) are added to dissolve the fat. The solvent mixture must previously be flushed with CO_2 for 5 to 10 minutes before use to exclude any dissolved air ; 2 c.c. of a saturated solution of KI is next added and the stopper, moistened with KI solution, is carefully put in place and the whole kept in the dark for one hour (at 36°-37°) after which the liberated iodine is titrated with $N/200$- thiosulphate solution after diluting the reaction mixture with oxygen-free distilled water. Lea's procedure for carrying out the titration in a dark room illuminated by a tungsten lamp is definitely an advantage in determining the end-point with the starch indicator. The result is expressed as ml. 0.002N- thiosulphate per g. of fat.

The method combines the essential features of the Wheeler's and Lea's method in that an inert atmosphere as used by Lea has been employed, the temperature used being that of Wheeler's, viz. 36°-37°, at which the chance of decomposition of peroxide is nil and the weight of the fat has been confined to that used by Lea, viz. 1 g. to minimise the effect of re-absorption of iodine which will necessarily entail greater error when larger amount of fat is used, as in the original Wheeler's process. The results obtained by the modified method approach most closely to those obtained by Lea's method.

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KINETICS OF THE REACTION BETWEEN CHLORAL HYDRATE AND BROMINE

By A. N. Kappanna and Bhanu Ramchandra Deoras

The kinetics of the oxidation of chloral hydrate by bromine in aqueous solutions has been studied at 30° and 40°. The reaction has been found to take place according to the equation

$$CCl_3CH(OH)O^- + Br_2 \rightarrow CCl_3COO^- + 2H^+ + 2Br^-.$$

The retarding influences of hydrogen and bromine ions on the velocity of reaction have been quantitatively studied. The energy of activation of the reaction has been found to be 15830 calories.

Bromine oxidises acetaldehyde to acetic acid in neutral solutions. In acid solutions, however, the reaction results in halogen substitution through a prototropic mechanism (Dawson, Burton and Ark, *J. Chem. Soc.*, 1914, **105**, 1275). Trichloroacetaldehyde which exists in aqueous solution exclusively as chloral hydrate, does not offer any scope for substitution. The compound chloral hydrate is itself acidic in character and in acid solutions the only possible reaction with bromine is oxidation. Ogialoro (*Ber.*, 1874, **7**, 1461) reported that chloral, when heated with bromine, formed the acid bromide, CCl_3COBr. Chlorine and bromine have been shown to react photochemically with chloral, yielding a number of oxidation products (Schumacher *et al.*, *Z. physikal. Chem.*, 1939, **B44**, 57; 1940, **B47**, 67). Kolthoff (*Pharm. Weekblad*, 1923, **60**, 2) mentions that bromine does not oxidise chloral in acid solutions. It is well known that chloral hydrate molecule is stable only either in neutral or acid solutions and that alkaline solutions decompose rapidly (Enklaar, *Rec. trav. chim.*, 1905, **24**, 419). Attempts to oxidise this compound keeping both the carbon atoms in tact should therefore be made only in neutral or acid solutions. Preliminary experiments carried out in this laboratory showed that chloral hydrate reacted with bromine at measurable speeds at ordinary temperature and in equimolecular proportions. The quantity of acid formed, when decolorisation of a known quantity of bromine in presence of excess of chloral hydrate took place, was found on estimation to be equal to what should be expected if the reaction had taken place quantitatively according to the equation

$$CCl_3CH(OH)_2 + Br_2 \rightarrow CCl_3COOH + 2\,HBr.$$

The quantity of bromine taken up by a given quantity of chloral hydrate was likewise found to conform to the above equation. That trichloroacetic acid was formed was further proved by the decomposition of the resulting solution on boiling, yielding chloroform and carbon dioxide. We have studied the kinetics of the reaction and the results are reported in this paper.

Experimental

Chemicals employed in this investigation were all of extra pure quality. The solutions were all prepared in redistilled water.

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The reaction vessels were kept in an electrically regulated thermostat for all kinetic measurements. The reaction was followed by withdrawing definite volumes of reaction mixtures and estimating the unreacted bromine iodometrically.

Table I contains the results of an experiment carried out with a mixture containing 0.25 M chloral hydrate and 0.0054N bromine. The reaction mixture (10 c.c.) was titrated each time, after the addition of potassium iodide against $N/200$-thiosulphate.

TABLE I

Temp. = 30°.

Time.	Thio	$k_{uni.}$	Time.	Thio.	$k_{uni.}$
0 min.	11.90 c.c.				
		0.01440	72	5.50 c.c.	0.01069
15	9.30				
		0.01320	91	4.60	0.01042
30	8.00				
		0.01221	121	3.80	0.009407
50	6.45				
			160	3.00	0.00853

It will be seen that the unimolecular velocity constant falls off as the reaction progresses, more rapidly at the initial stages than at the later stages. This may be due, as is known in other cases of aqueous bromine oxidations, to the accumulation in the system of hydrogen and bromide ions and the retarding influence they exert. Tables II and III contain results of two experiments carried out to test the influence of each one of these two ions on the velocity of the reaction. Potassium bromide was added in one case and hydrochloric acid in the other, in such quantities that the concentrations of the bromine and the hydrogen ions in the respective mixtures could be regarded as constant through the course of the reaction. The concentrations of chloral hydrate and bromine were the same as in the previous experiment.

TABLE II

Temp. = 30°. KBr = 0.05M.

t.	Thio.	$k_{uni.}$
0 min.	10.90 c.c.	...
30	6.90	0.00907
46	7.40	0.008395
63	6.70	0.007705
87	6.70	0.007429
115	5.10	0.006578
188	3.60	0.005865

TABLE III

Temp. = 30°. Conc of HCl = 0.05M.

t.	Thio.	$k_{uni.}$
0 min.	13.50 c.c.	...
43	12.20	0.001736
85	11.45	0.001626
145	10.50	0.001548
234	9.20	0.001522
325	8.10	0.001488
455	6.85	0.001431

These results indicate that each of the ions, bromine and hydrogen, exerts powerful retarding influence, the effect of the hydrogen ion being more powerful. Each by itself is not sufficient to exert a steadying influence on the rate. The effect of the initial addition of sufficient excess of both potassium bromide and hydrochloric acid was next tried. The results are contained in Table IV.

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TABLE IV

Temp. = 30° Chloral hydrate = 0.20 *M*. Bromine = 0.002854 *N*. HCl (initial) = 0.008 *N*. KBr (initial) = 0.0377 *M*. 25 c.c. titrated each time against *N*/400-thiosulphate.

t.	Thio.	$k_{uni.}$
0 min.	24.00 c.c.	
30	18.90	0.007951
45	16.70	0.008050
60	14.60	0.008027
75	13.15	0 008015
90	11.70	0.008000
121	9.20	0.007912
		Mean 0.007993

The steady value of the velocity constant at the different stages of the reaction indicates clearly the role of the hydrogen and the bromine ions. The retarding influence of hydrogen ion is obviously due to the suppression of the ionisation of chloral hydrate and the consequent diminution of the effective concentration of the anion which appears to be the real reactant, in accordance with the equation,

$$CCl_3CH=(OH)_2 \rightleftharpoons H^+ + CCl_3CH\begin{matrix}OH\\O^-\end{matrix}$$

Similarly, the bromine ion diminishes the effective concentration of free bromine by forming the tribromide ion according to the equation,

$$Br_2 + Br^- \rightleftharpoons Br_3^-$$

The order of the reaction with respect to chloral hydrate was determined by a set of experiments in which the initial concentration of this constituent was altered, while those of others were kept constant. Table V shows the variation of the velocity constant with increase in the concentration of chloral hydrate.

TABLE V

HCl = 0.01*N*. KBr = 0.02 *M*. Bromine = 0.002 *N*.

Chloral hydrate (*M*) ...	0.05	0.10	0.15	0.20	0.25
$k \times 10^4$ ...	10.42	21.42	31.05	39.15	49.45

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These results indicate, considering that it is the ion of chloral hydrate that is involved, the unimolecularity of the process with respect to chloral hydrate. The reaction can therefore be represented by the equation,

$$CCl_3.CH\langle^{OH}_{O^-} + Br_2 \longrightarrow CCl_3COO^- + 2H^+ + 2Br^-$$

Influence of Hydrogen-ion Concentration

We chose sulphuric acid for the addition of hydrogen ion in all subsequent experiments as the addition of hydrochloric acid might introduce a complication by the formation of chloro-dibromide ion (Ray, this *Journal*, 1934, **11**, 117).

Table VI contains results of a detailed study of the retarding influence of hydrogen ion.

TABLE VI

Chloral hydrate = 0.25 *M*. KBr = 0.10 *M*. Bromine = 0.0025*N*.

Equiv. of H_2SO_4 per litre	0.008	0.01	0.02	0.03	0.04	0.05	0.06
$k \times 10^4$	30.21	27.40	15.64	11.10	9.20	7.52	6.36

There is a progressive diminution in the velocity constant, as is to be expected if the anion is the reactant, with increase in the initial concentration of hydrochloric acid.

The concentration of the anion could be reckoned on the assumption that chloral hydrate behaves like a weak acid, HA, in the following way

$$K_a.HA \rightleftharpoons H^+ \times A^-$$

where K_a represents the dissociation constant of the acid and HA, the concentration of the unionised acid. From which we can deduce

$$A^- = \frac{K_a.(HA)}{K_a + H^+}, \text{ where (HA) is the total concentration of chloral hydrate.}$$

Introducing this in the kinetic expression,

$$\frac{dx}{dt} = k.C_{A^-} \times C_{Br_2} = \frac{k.K_a.(HA)}{H^+ + K_a} \times C_{Br_2}$$

$= k_{obs} \times C_{Br_2}$ for concentrations (HA) large in comparison with C_{Br_2}

k_{obs}, the observed unimolecular velocity constant being equal to

$$\frac{k.(A)\ .K_a}{H^+ + K_a} = \frac{k'.K_a}{H^+ + K_a} \qquad \text{or} \qquad \frac{1}{k_{obs}} = \frac{1}{k'} + \frac{H^+}{k' \times K_a}$$

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This equation demands that we should get a straight line if we plot $1/k_{obs}$ against $H^+[H_2SO_4/2]$. Actually we get a very good straight line with an intercept on the $1/k_{obs}$ axis which should be equal to $1/k'$. $1/k' = 1.20 \times 10^2$ and the slope of the line $1/k'.K_a = 2.416 \times 10^4$ from which K_a comes out to be equal to 4.96×10^{-3}.

This value for the Ostwald constant for chloral hydrate would mean that chloral hydrate is a fairly strong acid. Chloral hydrate, even on very careful purification is definitely acidic in its reaction towards litmus and should be expected to be so by virtue of the two hydroxyl groups attached to the same carbon atom. But one could hardly believe that it could be as strong as monochloroacetic acid ($K = 1.53 \times 10^{-3}$).

The molecular conductivity of chloral hydrate in 0.01 *M* solution is just 0.60 (Enklaar, *loc. cit.*) and it is a little difficult to reconcile this low conductivity with the high dissociation constant we arrive at on the basis of our kinetic study. We are investigating this matter further but we have to content ourselves at present by recording the observation we have made.

Influence of Bromine Ion on the Reaction Rate

The velocity of reaction, as observed before, is affected very considerably by the presence of bromide ion. This is obviously due to the removal of bromine from its free state by the formation of tribromide ion. The results of the experiments carried out at 30° and 40° with different concentrations of potassium bromide in the reaction mixtures are given in Table VII.

TABLE VII

Chloral hydrate = 0.20*M*. H_2SO_4 = 0.01*N*. Bromine = 0.0025*N*.

KBr.	$k_{30°} \times 10^3$.	$k_{40°} \times 10^3$.	$k_{40°}/k_{20°}$.	$\left[k_{obs\ 30°} \times \frac{k_{30°}+Br}{k_{30°}}\right]$.	$\left[k_{obs\ 40°} \times \frac{k_{40°}+Br}{k_{40°}}\right]$.
0.025 *M*	4.439	10.56	2.38	5.944	13.20
0.050	3.496	5.72	2.445	5.870	13.09
0.075	2.921	7.61	2.606	5.890	13.31
0.100	2.530	6.76	2.671	5.961	13.51
0.125	2.127	5.96	2.800	5.731	13.41
				Mean 5.879	13.304
				From graph k' = 5.888	13.510

The velocity constant falls off with increase in concentration of bromide ion. The equilibrium equation

$$K = \frac{(Br_2)_{free} \times Br^-}{Br_3^-}$$ leads to the equation

$$Br_{2\ free} = \frac{K}{K+Br} \times Br_{2\ total}$$ expressing $Br_{2\ total} = Br_{2\ free} + Br_3^-$.

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The rate of reaction is proportional to the concentration of free bromine. Substituting this value for free bromine in the differential equation, we get

$$\frac{dx}{dt} = k.C_{A^-} \times C_{Br_2\ free}$$

$$= k.C_{A^-} \times \frac{K}{K + Br^-} \times C_{Br_2\ total}$$

$$k'' \cdot \frac{K}{K + Br^-} \times C_{Br_2\ total} \quad \text{where } k'' = K.C_{A^-} \ (C_{A^-} \text{ being in large excess}).$$

$k$obs. $C_{Br_2\ total}$ (k_{obs} being the observed unimolecular constant) therefore

$$k_{obs} = k''. \frac{K}{K + Br^-} \quad \text{and}$$

$$\frac{1}{k_{obs}} = \frac{1}{k''} + \frac{Br^-}{k''.K}$$

As should be expected from this equation we get very good straight lines on plotting $1/k_{obs}$ against Br^- (KBr) at both the temperatures.

We get this inspite of the fact that we have employed concentrations of potassium bromide instead of activities of bromide ion. The intercept $1/k''$ at 30° has a value of 1.70×10^4 or $k'' = 5.888 \times 10^5$ and the slope $1/k''.K_{30°} = 23.0 \times 10^4$ from which we get $K_{30°} = 0.07380$. Similarly $1/k''$ at 40° gives 0.74×10^4 or $k'' = 13.510 \times 10^{-5}$ and $1/k''.K_{40°} = 0.74 \times 10^5$ from which $K_{40°} = 0.100$.

The values for K appear to be somewhat higher than what should be expected from the figures given by Linhart (*J. Amer. Chem. Soc.*, 1918, **40**, 158). The values for $k'' = k\text{obs}. \frac{K + Br^-}{K}$ calculated from the observed velocity constants at different concentrations of potassium bromide are included in the 5th and 6th vertical columns of Table VII. The constancy at both temperatures is good and the average values agree very well with the intercepts from graphs.

Temperature Coefficient of the Reaction Rate

Attention might here be drawn to the ratios $k'(obs)_{40°}/k(obs)_{30°}$ given in the 4th column of Table VII which show a steadly rise with increase in the concentration of the retardant. This increase in temperature coefficient, signifying increase in energy of activation (which should be considered apparent energy of activation) is understandable as we know that the observed velocity constant involves the variable, concentration of bromide ion. The correct basis for the calculation of temperature coefficient is the value of k''.

$$\frac{k''_{40°}}{k''_{30°}} = \frac{13.510}{5.888} = 2.294.$$

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The energy of activation calculated from this value of temperature coefficient comes out to be 15830 cals. Similarly, the temperature coefficient of the equilibrium constant for the reaction

$$Br_2 + Br^- \rightleftarrows Br_3^-,$$

from the values of K, deduced from our measurements, leads to the value 5786 calories for the heat of reaction.

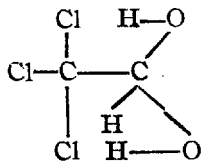
DISCUSSION

The results recorded in the paper indicate the reaction to be comparatively simple and straight forward. The equation

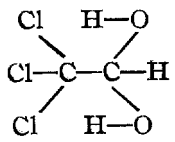
$$CCl_3.CH\begin{matrix}OH\\O^-\end{matrix} + Br_2 \longrightarrow CCl_3COO^- + 2H^+ + 2Br^-$$

correctly represents the reaction kinetically and stoichiometrically. The process of oxidation consists in the removal of two hydrogen atoms from the chloral hydrate ion, as hydrobromic acid.

One of the hydrogen atoms is the hydroxyl hydrogen, ordinarily somewhat remotely situated from the other hydrogen which is directly linked to the carbon atom. The point of interest therefore is to account for the simultaneous removal of these hydrogens by an activated collision with a bromine molecule. Such removal could be facilitated only in case where the two hydrogens are situated in sufficient proximity to one another in such a manner that a bromine molecule colliding in suitable orientation could contact both. It is interesting to recall in this context, the structure proposed for chloral hydrate by Werner long ago (*J. Chem. Soc.*, 1904, **85**, 1376) to account for the formation of chloroform and formic acid from this molecule



and compare it with the structure arrived at by Davies (*Trans. Faraday Soc.*, 1940, **36**, 333) on the basis of infra-red studies.



The only apparent difference between the two, as depicted on paper, is in regard to the disposition of the hydrogen atom directly attached to the carbon atom. The infra-red evidence is that the hydroxyl hydrogens are clamped towards the chlorines joined to the α- carbon atom. If we consider the actual locations of the three hydrogen atoms in space, it would be found that the

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distance between the directly linked hydrogen and any one of the two hydroxyl hydrogens is small enough to enable a bromine molecule getting in between them to contact both. Hence, in the chloral hydrate ion, in which there is only one hydroxyl hydrogen, the simultaneous removal of this and the directly linked hydrogen by a single energised collision with a bromine molecule is possible, provided that the energy conditions are satisfied.

The energy of activation is of the magnitude usually met with in simple bimolecular reactions, indicating the effectiveness of a good number of collisions and consequently the facility with which the reaction seems to proceed.

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CYSTINE AND METHIONINE IN THE PROTEIN FROM THE SEEDS OF CARILLA FRUIT

By J. W. Airan and N. D. Ghatge

Two sulphur-containing essential amino-acids, cystine and methionine, have been estimated in carilla fruit seed-cakes.

After the succesive extraction of the seeds of Carilla fruit (*Momordica Charantia*, N.O. Cucurbitaceae) with organic solvents like petroleum ether, benzene, chloroform and alcohol, the residue was found to contain nitrogen and sulphur. The albumin, isolated from this residue according to the method adopted by Basu, Nath, Ghani and Mukherjee (*Ind. J. Med. Res.*, 1937, **24**, 4, 1027), was subjected to van Slyke's process (*J. Biol. Chem.*, 1911-12, **10**, 15) as modified by Plimmer and Rosedale (*Biochem. J.*, 1925, **19**, 1015) for the study of nitrogen distribution on the one hand, and Callan and Toennies method (*Ind. Eng. Chem., Anal. Ed.*, 1941, **13**, 450) for cystine estimation, and to Horn, Jones and Blum's method (*J. Biol. Chem.*, 1946, **166**, 313) for methionine estimation on the other. It contained 0.967% total sulphur, out of which 0.3647% was accounted for by cystine, and 0.3132% by methionine. The percentages of these essential amino-acids were 1.37 for cystine and 1.56 for methionine.

Since these seeds are not discarded in most of the preparations where the Carilla fruit is used as vegetable, these figures have a significance, and hence they are put along with the figures for some of the common seed meals below, the data being taken from Block and Bolling ("The Amino-acid Composition of Proteins and Foods", 1945, p. 195).

	%Cystine.	%Methionine.
Peanut meal	1.6	0.9
Cottonseed ,,	2.0	1.6
Soyabean ,,	1.3	1.3
Carilla seedcakes (present work)	0.0841	0.0957

EXPERIMENTAL

Total Sulphur.—It was estimated by means of Parr's sulphur bomb; 0.2045 g. of protein yielded 0.01429 g. of barium sulphate which corresponded to 0.967% sulphur.

Cystine.—Protein (1 g.) and potassium permanganate (10 g.) were added to NaOH soultion (6.4 g. in 150 c.c. water). The mixture was refluxed on a water-bath for 48 hours, after which period the excess of the permanganate was destroyed with methyl alcohol. It was then acidified and the insoluble portion filtered off. The filtrate was boiled with bromine water, and then the sulphate ions were precipitated as barium sulphate, and treated in the usual manner. The precipitate weighed 0.0266 g. which corresponded to 0.3647% sulphur in the sample, and hence to 1.37% cystine.

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Methionine.—The protein (0.5594 g.) was refluxed on a sand-bath with 15 c.c. of 20% hydrochloric acid for 18 hours. After this period, the hydrolysate was concentrated to nearly 5 c.c. and then treated with a small quantity of vegetable charcoal, and filtered. The filtrate was then made to 100 c.c. and 50 c.c. of this solution were withdrawn and concentrated to 10 c.c. roughly. It was then filtered and made exactly to 10 c.c. and 2 c.c. of this taken for estimation. Three small glass bottles were taken ; one of these was taken for the "blank" experiment, one for the "unknown", and the third for the "standard". For this estimation, an authentic sample of methionine was obtained from the B.D.H.

Into each of these the following reagents were added in the order given below :

"Blank".	"Unknown".	"Standard".
2 c.c. soln.	2 c.c. soln.	2 c.c. soln.
3 c.c distilled water	3 c.c. distilled water	3 c.c. dist. water
	1 c.c. sodium nitro-prusside soln., 10%	1 c.c. sodium nitro-pruside soln., 10%.
1 c.c. 5*N*- NaOH soln.	0.1 c.c. 5*N*-NaOH soln.	0.1 c.c.5*N*-NaOH

After these additions were made, the three bottles were shaken for 10 minutes and then to each of these, 2 c.c. of 3% glycine solution were added and again shaken for 10 minutes, and finally 2 c.c. of phosphoric acid were added. The bottles were then shaken and kept aside for 5 minutes.

The bottle marked "blank" did not develop any colour. The solutions from the other two bottles were then taken for comparison of their colours. The readings with the Dubosq colorimeter were :

1.	22	"unknown"	9.4	"standard"
2.	32.2	,,	13.4	,,
3.	35.6	,,	15.2	,,

2 C.c. of the "standard" taken for comparison contained 0.002 g. of methionine, whence the amount of methionine in the sample taken for analysis was 0.5594 g. or 1.529% in the protein. This would account for 0.3741% of the total sulphur.

The albumin isolated was 6.135% of the seed-cake. Therefore the percentages of cystine and methionine in the seed-cakes work out to 0.0841 and 0.0957 respectively.

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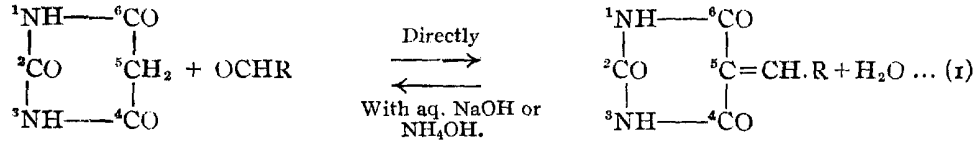
A STUDY OF MALONYLGUANIDINE AND ITS REACTIVE METHYLENE GROUP. PART I. CONDENSATION OF MALONYLGUANIDINE WITH AROMATIC ALDEHYDES UNDER STRONG ACIDIC CONDITIONS

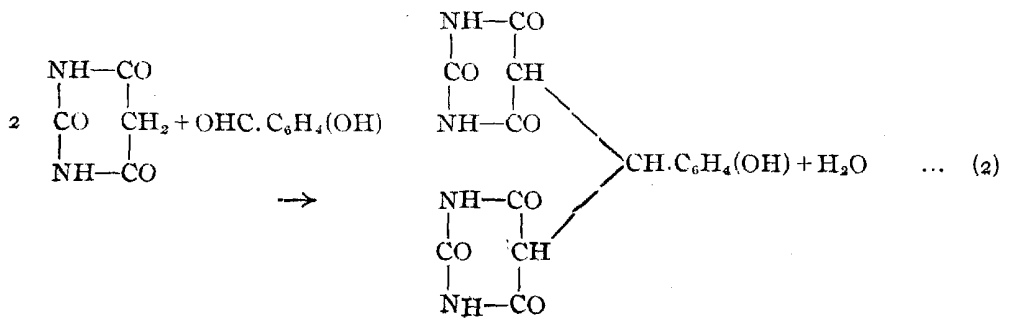
By Sunil Kumar Mukherjee and Kunj Behari Lal Mathur

Malonylguanidine condenses with aryl aldehydes in the presence of acetic acid-sulphuric acid mixture (ca. 4 :1) to give arylidene-malonylguanidine sulphates ArCH: $[(C_4H_3N_3O_2).H_2SO_4]$. In the presence of hydrogen chloride in saturation with absolute alcohol or acetic acid, the products are either an arylidene-malonylguanidine chloride ArCH : $[(C_4H_3N_3O_2).HCl]$ or compounds of the *bis*-type ArCH : $[(C_4H_4N_3O_2)\ HCl]_2$, depending upon the nature of the aldehydes.

Barbituric acid is known to give with aromatic aldehydes 5-arylidene-barbituric acids,



even by warming the ureide and the aldehyde in aqueous or alcoholic solutions and without the use of any condensing agent (Conrad and Reinback, *Ber.*, 1901, **34**, 1339 ; Weinschenk, *ibid.*, p. 1685). With thiobarbituric acid (Dox and Plaisance, *J. Amer. Chem. Soc.*, 1916, **38**, 2164) the 5-arylidene-2-thiobarbituric acids are smoothly obtained from aldehydes, but 12% hydrochloric acid is needed to effect condensation. Certain NN′-disubstituted barbituric acids and thiobarbituric acids (Whitley, *J. Chem. Soc.*, 1907, **91**, 1342 ; Akabori, *J. Chem. Soc., Japan*, 1931, **52**, 601 ; *Ber.*, 1933, **66B**, 139 ; Whitley and Mountain, *Proc. Chem. Soc.*, 1909, **25**, 121) can also be condensed more or less with the same ease as the parent ureides. It is remarkable that barbituric acid and salicylaldehyde upon direct condensation (Conrad and Reinback, *loc. cit.*, p. 1340) yield 5: 5′-salicyl-*bis*-barbituric acid :



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Condensation products from benzaldehyde and certain phenolic aldehydes in the presence of acetic acid are reported also to be of the *bis*-type (Pavoline, *Riv. Ital. essenze. Profumi*, 1933, **15**, 171). In the above cases the condensation products are generally coloured, though in the case of less substituted aldehydes colorless forms are also met with. The compounds from the barbituric acids are decomposed with aqueous caustic soda or ammonium hydroxide with the separation of the aldehyde in a way, perhaps, typical of the reversal of an aldol reaction (cf. equation 1).

In comparison of barbituric acid, thiobarbituric acid and malonylguanidine as a quantitative precipitant for furfural in very dilute solutions, Dox and Plaisance (*J. Amer. Chem. Soc.*, 1916, **38**, 2156) report incidentally the formation of furfurylidene-malonylguanidine $C_4H_3OCH : C_4H_3N_3O_2$ in the presence of 12% hydrochloric acid. Apart from the above meagre reference little is known so far about the reactivity of malonylguanidine. In the present investigation the results obtained by condensing malonylguanidine with various aldehydes in alcohol and acetic acid under strong acidic conditions are recorded.

When malonylguanidine is reacted with benzaldehyde in the presence of glacial acetic acid-sulphuric acid mixture (4: 1), a well defined crystalline product is obtained, which has the composition

$$[(C_4H_3N_3O_2) : CHC_6H_5].H_2SO_4,$$

the sulphuric acid remaining chemically bound to the condensation product. The acetic acid-sulphuric acid mixture serves also as a solvent for malonylguanidine which is difficult to dissolve in any other organic solvent except formic acid. Other aldehydes e. g., 4-chlorobenzaldehyde, anisaldehyde, salicylaldehyde, 3-hydroxybenzaldehyde, 4-nitrobenzaldehyde, β-resorcylic aldehyde, pyrogallol aldehyde and vanillin can be condensed with more or less equal ease giving products which are always coloured and contain combined acid. The latter is apparently released in cold water though by this treatment the solids invariably retain their original colour. On prolonged contact with water or upon heating, further decomposition occurs regenerating the malonylguanidine and the aldehyde. Decomposition is quicker with aqueous alkalis but is attended with the appearance of transient violet colorations in the case of phenolic compounds. All the products have the composition of an arylidene-malonylguanidine sulphate, formed thus,

$$C_4H_5N_3O_2 + OCH.R + H_2SO_4 = [(C_4H_3N_3O_2) : CHR].H_2SO_4 + H_2O \quad \ldots (3)$$

Reaction can occur also when hydrogen chloride gas, dissolved in absolute alcohol or glacial acetic acid, is used as the condensing agent. But the nature of the product seems to depend upon the aldehyde used. Vanillin, β-resorcylic aldehyde, pyrogallol aldehyde and furfural give an arylidene-malonylguanidine chloride

$$C_4H_5N_3O_2 + OCH.R + HCl = [(C_4H_3N_3O_2) : CHR]\,HCl + H_2O \quad \ldots (4)$$

in which curiously enough only one molecule of hydrochloric acid remains attached to the resulting product. On the other hand, benzaldehyde and 3-hydroxybenzaldehyde

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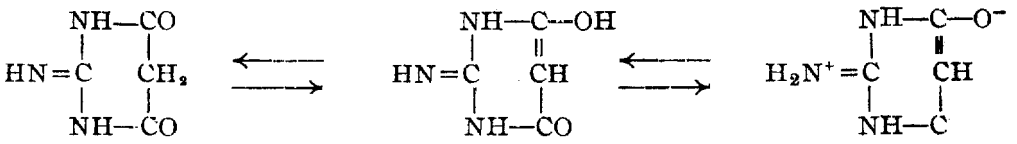
give compounds having the composition of a *bis*-malonylguanidine derivative

$$2C_4H_5N_3O_2 + OCH.R + 2HCl = [(C_4H_4N_3O_2)_2 : CHR].2HCl + H_2O \quad \ldots \quad (5)$$

The arylidene-malonylguanidine chlorides behave more or less like their sulphate analogues but the *bis*-type of compounds are very soluble in cold water, though they also are hydrolytically decomposed with equal ease. The latter salts are, however, faintly coloured compared to the arylidene sulphates or chlorides, some of which are highly coloured.

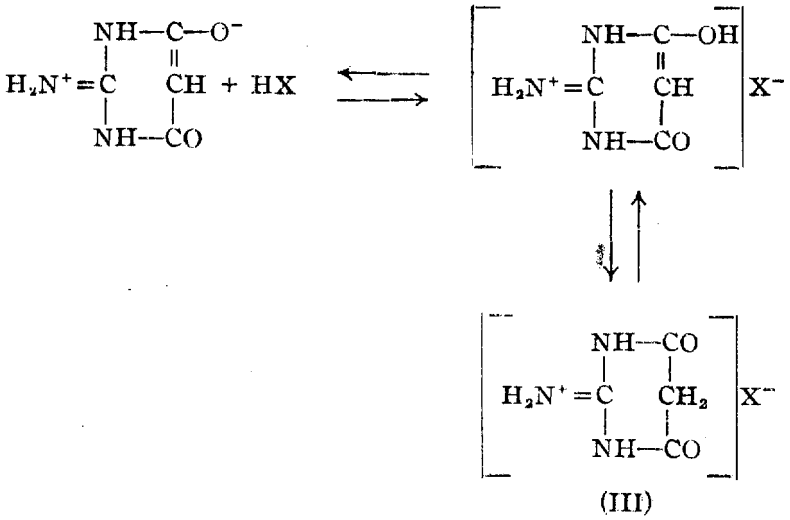
The analogous mode of the hydrolytic decomposition of the products from malonylguanidine and from barbitruic acid is suggestive of the reactive methylene group in malonylguanidine being involved in the reaction. The unsaturated character of the arylidene-malonylguanidine sulphates and chlorides is in accord with this view point.

The above reactions can be explained if we consider that malonylguanidine is a "zwitterion" such as (II).



(I) (II)

This internal salt-like arrangement is justified by the properties of malonylguanidine itself. As in the form (II) there is no incipiently ionised hydrogen atom, malonylguanidine is unable to condense with aldehydes directly like barbituric acid. However, in the presence of strong mineral acid, the zwitterion character is lost and a salt with the acid will be formed thus,



(III)

(X = Cl^- or HSO_4^-)

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the glacial acetic acid or the alcohol serving the purpose of a solvent for the salt (III). In this way the reactive methylene group is made available for condensation, as it is in barbituric acid, with the difference that here a cation, e. g., from (III) is the reactive entity, instead of a neutral molecule. On this basis, the products holding only one equivalent of sulphuric acid (vide equation 3) should be deemed as acid salts. In an analogous way the *bis*-type of the compounds may also be formulated.

EXPERIMENTAL

Preparation of Malonylguanidine.—It was best prepared and purified according to the method of Dass and Dutt (*Proc. Nat. Acad. Sci. India*, 1939, **9**, 93) from malonic ester and guanidine carbonate. In addition malonylguanidine was found to dissolve in warm (80°) formic acid from which it could be recrystallised ; it failed to dissolve in several other non-polar solvents tried.

Malonylguanidine did not condense with benzaldehyde in the presence of absolute alcohol. The addition of sodium ethoxide evolved ammonia on continued heating indicating the occurrence of secondary decompositions. The use of glacial acetic acid or acetic anhydride was equally ineffective. Also, in the bare solvents used the malonylguanidine had remained practically insoluble. Finally, the following acidic mixtures were found to give products of uniform composition and had the added advantage of serving as a solvent for malonylguanidine :

(*i*) Conc. sulphuric acid (25 c.c.) diluted to 100 c.c. with glacial acetic acid.

(*ii*) Absolute alcohol saturated with hydrogen chloride gas.

(*iii*) Glacial acetic acid saturated with hydrogen chloride gas.

Condensation of Malonylguanidine with Benzaldehyde in the presence of Glacial Acetic Acid-Sulphuric Acid Mixture.—The acid mixture (12.7 c.c.) was added quickly to malonylguanidine (1.27 g., 0.01 *M*) with vigorous stirring and slight warming on the water-bath, when all the guanidine practically went in solution. If the required amount of the solvent was not used at once, a part of the malonylguanidine tended to form a gelatinous product which failed to be redissolved in excess of the solvent. The clear liquid was decanted off from a few undissolved particles into a boiling tube containing a solution of benzaldehyde (1.6 g., 0.015 *M*) in glacial acetic acid (5 c.c.) and the mixture was heated on a water-bath at 80°-90° with occasional stirring. After 10 minutes, yellow feathery crystals began to appear, which increased considerably afterwards. Upon cooling, the whole crop of crystals was filtered, washed repeatedly with glacial acetic acid till the washings ceased to give any precipitate with aq. barium chloride. They were then further washed with carbon tetrachloride to remove acetic acid and dried at 90°. The product was pure enough but could be recrystallised from formic acid.

The compound was light yellow, showing leaflets under the microscope, m.p. 236-38° (decomp.). It decolorised quickly 1% potassium permanganate and bromine water in the cold. On boiling with water it decomposed to give a strong smell of

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benzaldehyde and the aqueous filtrate gave a precipitate with barium chloride. The latter test could also be obtained from a suspension of the compound in cold water. Dissolution occurred also in aqueous alkali and concentrated sulphuric acid ; it was followed by decomposition in the first case and colour change to golden yellow in the last case. {Found : N, 12.3 ; H_2SO_4 (after aq. decomp.), 30.21. $[C_6H_5CH : C_4H_3N_3O_2].H_2SO_4$ requires N, 13.41 ; H_2SO_4, 31.4 per cent). Yield 1.68 g. (56%).

Preparation of various Arylidene-malonylguanidine Sulphates.—Condensations were run, as in the previous experiment, with various aldehydes (0.015 to 0.02*M*). Of all the solvents tried formic acid had excellent solvent properties for the resulting products, which themselves had crystallised out from the reaction mixture more or less in the pure form. They were decomposed by hot water and aqueous alkalis, with the evolution of strong characteristic smell of the aldehyde, e. g., in the compounds with 4-chloro-, 4-methoxy-, 2-hydroxy-, 3-methoxy-, and 4-hydroxybenzaldehydes. Concentrated sulphuric acid dissolved them giving yellow-orange solutions. With phenolic compounds, however, aqueous alkali gave also transient violet colorations and concentrated sulphuric acid produced charring. The compounds from 3-hydroxy-, 4-methoxy-, 3-hydroxy-4-methoxybenzaldehydes were also slightly soluble in ether, chloroform and hot acetic acid. In every case the products decolorised 1% potassium permanganate. The test for unsaturation with bromine water, as applied to the non-phenolic compounds, was also given. Table I summarises the chief results obtained, those from benzaldehyde being also incorporated for the sake of completeness.

Condensation of Malonylguanidine with Benzaldehyde and 3-Hydroxybenzaldehyde in the presence of Absolute Alcohol saturated with Hydrogen Chloride.—The malonylguanidine (0.635 g., 0.005 *M*) was gradually dissolved in alcoholic hydrogen chloride (35 c.c.) and after filtration from a few undissolved particles, reacted with a solution of benzaldehyde (0.53 g., 0.005 *M*) in acetic acid (3 c.c.) in a boiling tube. The mixture was stirred and warmed at 40°-50° and kept overnight. The crystals that had separated were washed first with acetic acid and then repeatedly with chloroform till the washings ceased to give a precipitate with aqueous silver nitrate. They were then dried at 90°.

The compound had a faint yellow colour. It charred at 244° and decomposed with frothing at 256°. It was very soluble in cold water which deposited white granular mass on keeping. By this treatment also the aqueous liquid smelt freely of benzaldehyde. The aqueous filtrate gave a precipitate with aqueous silver nitrate, insoluble in nitric acid. Decomposition was quicker with aqueous alkalis. It dissolved in formic acid and concentrated sulphuric acid with evolution of hydrogen chloride in the latter case. {Found : N, 19.82 ; HCl (after alkaline decomposition and weighed as AgCl), 17.7. $C_6H_5CH : [C_4H_4N_3O_2.HCl]_2$ requires N, 20.24 ; HCl, 17.58 per cent}. Yield 0.7 g. (61.3%).

In a similar experiment with 3-hydroxybenzaldehyde (0.91 g., 0.075 *M*) crystals appeared after 1½ hours at room temperature and the reaction was completed by keeping overnight. The product has its properties like the compound with benzaldehyde, m.p. 242-46° (decomp.). {Found : N, 19.5 ; HCl, 17.1. $HO.C_6H_4CH : [(C_4H_4N_3O_2.HCl]_2$ requires N, 19.03 ; HCl, 16.93 per cent}. Yield 0.9 g. (67.1%).

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TABLE I

Ar-CHO & wt.	Formation of the compound.	Yield.		Colour, shape & decomp. point.	Arylidene-malonylguanidine sulphate. (Ar*CH : $C_4H_3N_3O_2.H_2SO_4$) Nitrogen		H_2SO_4	
					Found.	Calc.	Found.	Calc.
C_6H_5.CHO (Benzaldehyde 1.6 g., 0.015 *M*)	After 10 mins. heating	1.68 g.	56.0%	Yellow leaflets; decomp. 236-38°	12.30	13 41	30.21	31.40
(Cl).C_6H_4.CHO 4 1 (1.4 g, 0.01 *M*)	After 5 mins. heating.	2.20	63.1	Yellow star-like crystals; decomp. 251-52°	12 44	12.05	—	—
(CH_3O). C_6H_4.CHO 4 1 (Anisaldehyde, 2.04 g., 0.015 *M*)	After 10 mins. heating.	23.1	67.6	Golden yellow leaflets; charred 240°; decomp. 247°	12.02	12.24	28.71	28.57
(OH). C_6H_4.CHO (Salicylaldehyde, (2.84 g., 0.02 *M*)	Heated for 1 hr. & kept overnight.	1 90	55.1	Yellow feathery leaflets; charred 220°; decomp. 266°	12.71	12.76	30.34	29.80
(OH). C_6H_4.CHO 3 1 (1.84 g., 0.015 *M*)	After 20 mins. heating.	2.38	71 6	Yellowish green leaflets; charred 134°; decomp. 300°	12.84	12.76	28.81	29.80
(NO_2). C_6H_4.CHO 4 1 (2.27 g., 0.015 *M*)	Heated for 3 hrs. & kept for 3 hrs.	0.62	17.2	Pale yellow leaflets; decomp. 218°	16.70	15.64	27.09	27.30
$(OH)_2$. C_6H_3.CHO 2 : 4 1 (β-Resorcylic aldehyde**, 1 38 g., 0.01 *M*)	Heated for 2 hrs; ppted by Ac_2O (1 c.c.) & AcOH (10 c.c.) & warmed.	1.50	34.9	Dark red; charred 270°; soln. in hot ACOH, green flurescence	8.63	9.79	23.45	22.84
$(HO)_3$. C_6H_2.CHO 3 : 4 : 5 1 (Pyrogallol aldehyde)	After 40 mins. heating.	1.80	50.0	Tiny red plates; charred 220°	11.11	11.60	27.32	27.14
(CH_3O)(OH)C_6H_3.CHO 3 : 4 1 (Vanillin, 2.28 g., 0.015 *M*)	After 10 mins heating.	1.70	48.0	Yellow leaflets; charred 260°; decomp. 270°	11.54	11 69	27.80	27.30

Condensations of Malonylguanidine with 2:4-Dihydroxy-, 3:4:5-Trihydroxy-, 3-Methoxy-4-hydroxybenzaldehydes and with Furfural.—The condensations were run exactly as in the previous experiment, with malonylguanidine (0.635 g., 0.005 *M*). In the case of vanillin glacial acetic acid, saturated with hydrogen chloride, gave equally good result. All the products were decomposed by water giving the combined acid and the aldehyde back. Concentrated sulphuric acid and formic acid dissolved them with the evolution of hydrogen chloride in the former case and colour change to golden yellow in the latter case. Aqueous alkalis produced transient red-orange colorations in the case of the di- and tri- phenolic compounds. All the products had deeper colour than the *bis*-type of compounds and their composition tallied rather with an arylidene-malonylguanidine chloride. The results are summarised in the following table.

* This 'Ar' is the same as signified by that of the aldehyde used.

** The figures agreed with that of a diacetylated reaction product.

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TABLE II

Ar-CHO & wt.	Formation of the compound.	Yield		Colour, shape & charring point.	Arylidene-malonylguanidine chloride. (Ar*CH: $C_4H_3N_3O_2$.HCl) Nitrogen		HCl	
					Found.	Calc	Found.	Calc.
$(HO)_2C_6H_3.CHO$ 2:4 1 (β-Resorcylic aldehyde**, 1.035 g., 0.075 *M*)	After 1½ hrs. at room temp.	1.10 g.	77.40%	Deep yellow; charred 241-42°	15.01	14.81	12.30	12.87
$(HO)_3C_6H_2.CHO$ 3:4:5 1 (Pyrogallol aldehyde, 1.16 g., 0.075 *M*)	After 1½ hr. at 40°	1.10	73.3	Orange blocks; charred 202°	13.81	14.02	11.92	12.20
$(CH_3O)(OH)C_6H_3.CHO$ 3 4 1 (Vanillin, 0.76 g., 0.005 *M*)	Within ½ hr. at 60°	0.58	32.2	Tiny red plates; charred 221°	14.13	14.11	11 15	12.00
$C_4H_3O.CHO$ (Furfural, 0.72 g., 0 075 *M*)	Within 20 mins.	0.66	53.7	Carbonised; greenish black; infusible.	15.4	17.39	11.32	15.10

* This 'Ar' is the same as signified by that of the aldehyde used.

** Solution in formic acid of the product diluted with acetic acid gave bluish fluorescence.

Reactions in aqueous solutions under strong acidic conditions are proposed to be further investigated.

The authors' grateful thanks are due to Dr. S. Dutt for suggesting this piece of work and for his continued interest in it.

CHEMICAL LABORATORIES,
UNIVERSITY OF DELHI,
DELHI.

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REVIEWS

Die Thermodynamik des Warme – Und Stoffaustausches in der Verfahrenstechnik— Von Dr.-Ing. Werner Matz—Verlag Dr. Dietrich Steinkopff—Frankfurt (Main)—1949; pp. 355 + xii, Figs. 114. Price 30 D.M. (approximately).

This is a book on Thermodynamics of Exchange of Heat and Matter that take place in industrial processes, e. g., evaporation, distillation, absorption, adsorption, extraction, heating, cooling, etc. Exchange of heat and exchange of material between different parts of a system have been treated together. Scattered throughout the literature are to be found thermodynamic treatment of the processes mentioned before; but here, in one single volume, all these processes have been dealt with from the same point of view. The author has restricted himself only to the processes peculiar to chemical industries and has not touched on operations like expansion, compression, refrigeration, flow of fluids, etc., which form the subjects of most books on chemical engineering thermodynamics. Treatment of the subjects selected is thorough and rigorous. The author has laid special emphasis on the Law of Conservation of matter, the first two Laws of Thermodynamics, and Dimensional analysis. The Second Law has been applied with the help of extrophy-concept.

All lovers of thermodynamics will find the book interesting and instructive. It may specially be recommended to chemical engineers and industrial chemists who want to acquire more intimate knowledge of the processes they handle. Considering the excellence of the book it is expected that in near future an English translation will come out from America. H.L.R.

High Polymer Physics: A Symposium—Edited by Dr. Howard A. Robinson. Pp. 572 + xiii. Published under the auspices of the American Institute of Physics by the Chemical Publishing Co. Price $12.00.

High Polymer study has during recent years come into great lime light. The developments have been so rapid that it is very difficult for any investigator to keep abreast of the huge mass of informations on its various aspects that are accumulating in the scattered literature on the subject. Unlike the chemical substances having small molecules, macromolecular substances are of importance mainly for their physical characteristics. It has therefore been very opportune for the High Polymer Branch of the American Physical Society, of which Dr. Howard A. Robinson was the Chairman, to arrange a symposium on High Polymer Physics and to publish the papers contributed there on. The contributions are from most of the leading investigators in the various branches of high polymer in America and cover a wide range of aspects of the subject. Many of the articles were scattered over a large number of Journals, but they have been revised by the authors to take into account the developments in the intervening periods. This, therefore, serves as a quite handy collection of very useful informations to one desiring to pursue the subject. The twentythree papers that have been contributed are divided into four parts. The first part deals with Determination of the Molecular Structure of High Polymers and includes the uses of colour and

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Fluorescence indicators, applications of Infra-red methods and X-ray diffraction methods for determinations of structures. The articles on the physical properties of high polymers form the second and the largest part and deals with such topics as Mechanical properties, Equation of state, Viscometric investigations, Formation of ionised water films, Thermal behaviour, creep, permanent set and electrostatic properties. The third part deals with the Chemical Physics of the high polymers. The fourth part contains articles on the apparatus for the measurements of thermal diffusion and light scattering.

The articles are contributed by the leading investigators on high polymers in their own lines of research and as such they are in general very well presented and give a clear and up-to-date account of the aspects dealt with. Being reports of a symposium it cannot, however, be expected to give a connected account of the whole subject. Some of the articles presupposes a considerable amount of preliminary knowledge of the subject ; Eyering's paper on "The mechanical properties of textiles" may be particularly mentioned in this connection. On the whole, the book will prove to be an asset to workers on high polymers and Dr. Robinson may be congratulated for his bringing out such a useful volume.

K. B.

Gmelins Handbuch der Anorganischen Chemie.—8 Auflage (Edition). System Number 18, Antimon. Teil B 2. Pp. 496.

In this volume the treatment of the physical properties of antimony, not dealt with in the previous volume, has been concluded.

This comprises a part of the electrical properties of the metal ; addition and correction to the physical properties described in the previous volume ; chemical properties of the element; its detection and estimation ; the various compounds of antimony with hydrogen, oxygen, nitrogen, fluorine, chlorine, bromine and iodine.

All references to literature till the middle of 1948 have been fully considered.

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P. R.

Modern Plastics—by Harry Barron. Published by Chapman & Hall. 2nd Edition, revised & enlarged. Pp. 778 ; price 50 Shillings.

This century has provided the background for an enormous expansion of the plastics industry. Technical and scientific knowledge regarding plastics is, however, still confined to a few scientists and competent technicians.

The spread of technical education is imperative for the healthy growth of any major industry. This book has been written with a view to removing the lack of knowledge on Plastics as the author rightly thinks that "Lack of knowledge and lack of efforts results in the facile and disastrous industrial policy of purchasing foreign licenses for processes and goods. This is the easy way out but it subsidises foreign developments and effectively stiffles one's own".

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The book, divided into 5 parts (each subdivided into several chapters) dealing respectively with (I) Raw materials for plastics and Theory of plastics formation, (II) Thermosetting resins and their plastics, (III) Cellulose Plastics, (IV) Vinyl Plastics, (V) Glyptal, Casein, Silicone and Polyamide plastics, (VI) Analytical aspects and Physical Testing of plastics, provides a considerable amount of technical information which though seemingly "somewhat sketchy to the erudite" is adequately comprehensive and of much practical value.

The presentation of the subject is well balanced.

B. K. M.

Chyma : Annual Studies in the History of Chemistry, volume II. Editor in Chief: Tenney L. Davis. Published by the University of Pennsylvania Press, Philadelphia, 1949.

Chymia is rendering a great service to the History of chemical science of the world in publishing authoritative articles of well reputed authors on the subject ; some of them are professors of the History of Science and curator of research institutes. It appears like the first volume of this study to be less representative so far as chemistry in ancient India is concerned. Even in the article on "The experimental origin of chemical, atomic and molecular theory before Boyle," Professor Hooykoas has not unfortunately mentioned anything about the theory of atom in Indian philosophical science, though it is very likely that the Greeks imbibed the idea of atoms from the Indians.

R. C.

Quarterly Reviews—Vol. II, No. 1, 1948. Pp. 91. Price 8/- Sh. The Chemical Society, London.

These reviews are being published by the Chemical Society. The present issue which forms No. 1 of Vol. II deals with the recent development of our knowledge on the following subjects :—

1, Disproportionation in Organic Compounds.
2. The Chemistry of Silicon Polymers.
3. Physiologically active unsaturated Lactones.
4. Far Ultra-violet Spectra, Ionisation Potentials and their Significance in Chemistry.

As these reviews have been made by competent workers in the respective field, they will undoubtedly be found very useful by all advanced students and workers in chemistry. And as such they should find a place in all scientific libraries.

P. R.

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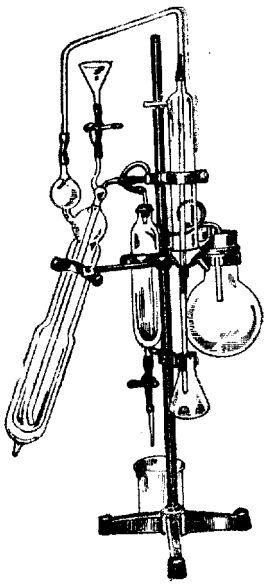

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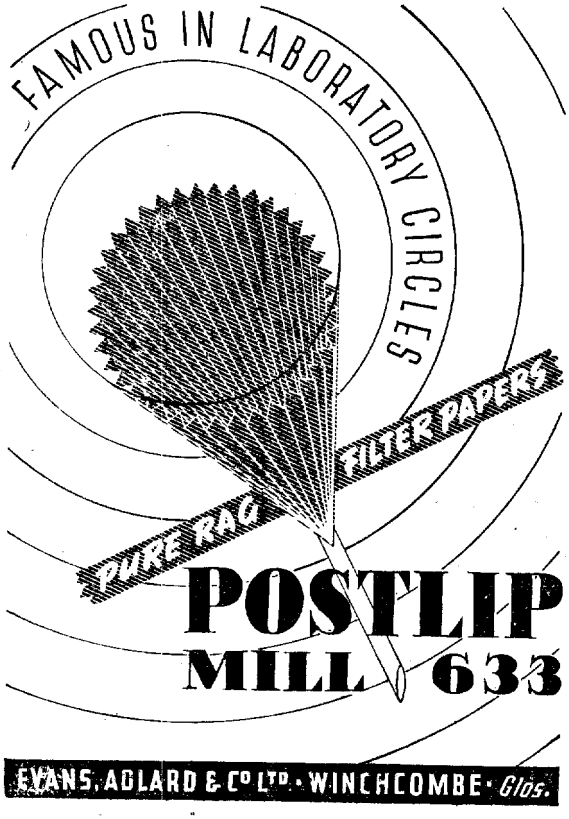

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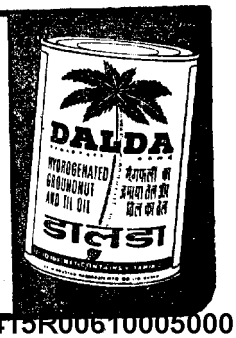

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ILLEGIB

VIJNAN-KARMEE

VOL. II June, 1950 No. 6

MORE ABOUT THE PLANNING COMMISSION

Elsewhere in this issue we have published a letter from a member of our Association and also a resolution adopted by the ASWI Unit of the Central Laboratories of Scientific and Industrial Research, Hyderabad. Both are highly critical of the editorial entitled "The Planning Commission" which appeared in the April issue of the *Vijnan-Karmee* and which they consider to be in conflict with the resolution passed at the Poona Session of the Association. In that session the following resolution was adopted: "The Association of Scientific Workers of India views with grave concern the rapidly deteriorating economic condition of the country which vitally affects the scientific workers along with other sections of the population, leading to mass scale unemployment and hindering the healthy growth of the community. This Association is of the opinion that the solution of the problem lies in the industrialisation of the country on the basis of a socialist economy". This resolution was reproduced in the April issue of the *Vijnan-Karmee*, to which the editorial of that issue also directed attention. The Association stands by this resolution. Hence the misgiving that this Journal is trying to go behind this resolution should be dismissed.

Doubtless, planning can achieve its fullest objective only in a socialist framework. It is a socialist economy free from the inhibitory contradictions inherent in capitalism, which can raise production to undreamt-of heights. In a society in which production is motivated by private profit, the cycles of boom and slump are bound to occur. If production goes up, prices tend to fall and profits tend to decrease. Prices are then sought to be raised artificially by curtailing production. Thus, while the world is still in need of goods of all kinds, factories may close down depriving the people of those goods and at the same time throwing large masses of workers into unemployment. In many cases even essential commodities which have been produced are destroyed in order to keep up prices. Even at present it is reported that in America thousands of tons of potatoes are being coloured with a dye so that they may be rendered unacceptable for human consumption. These are being fed to animals. Similarly wheat is being fed to cattle, whereas a large part of the world including India goes hungry. It will be remembered that America recently refused to reduce the price of wheat for India even by a small amount. It is not necessary to blame only America for it. Wherever the capitalist system works, its inexorable laws operate and in plethoric plenty people perish. During the economic depression of the thirties, as everybody knows, coffee used to be burnt in Brazil and oranges thrown into the sea by Spain. Under socialism, on the other hand, the means of production is owned by the community and production is also meant for the entire community and, therefore, the artificial hindrances which private enterprises put up to the expansion of production do not exist. Production can, therefore, be

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increased freely to meet the requirements of the community. Planning in such circumstances, as in the Soviet Union, can achieve astonishing results in a relatively short time.

There are of course critics of socialism. They point out that with the abolition of private enterprise initiative would tend to disappear and people would not work to the best of their capacity. This postulates that the love of profit alone can stimulate a person to action. It is true that in the early stages, as had happened in the Soviet Union, such a psychology inherited from the old society tends to persist but by education and example it is possible, at least to a great extent, to make the people socially minded, so that they would work to the best of their capacity knowing that in a socialist community one is for all and all for one.

While, therefore, it seems to us that there is no fundamental solution of our problem if we by-pass socialism, we have still to take cognisance of the contemporary situation and see what can be achieved even within the limitations from which we suffer. The Planning Commission which has been set up by the Government of India surely cannot achieve results which it could have done in a socialist economy. We shall be wrong if we expect the Planning Commission to give results like those which flowed from the Planning Commission of the Soviet Union. But to turn our back on the Commission in a spirit of non-co-operation would hardly help matters. Even in the capitalist system of America, President Roosevelt introduced limited planning as in the experiment with the Tennessee Valley Authority. Here within a particular area and inspite of the opposition of many vested interests, the life of a population has been greatly transformed and the whole condition of the people has been changed from listlessness and poverty to comparative happiness and prosperity. Who would ignore the planned achievement of the TVA and ridicule it simply because it was established in a capitalist society?

It appears that the Planning Commission has been established in order to function as an overall authority for preparing integrated plans of development and having them executed by the different Government departments under a system of priorities. It will also probably coordinate these plans with those of private industry. Apart from the question of socialism and capitalism, it is well-known that in India even for projects which are sponsored by the Centre and by the States there is a great deal of competition for money, material and foreign exchange. There are the river valley projects, three of which are in the process of active execution—the Damodar Valley, the Hirakund and the Bhakra. Besides these there are a large number of river valley projects which are at different stages of investigation and planning. There is an urgent need for the additional production of at least 1-2 million tons of iron and steel annually. There is the necessity for the large-scale production of fertilisers, of synthetic petrol, of essential drugs like penicillin, sulpha drugs and paludrin. These projects are Government-sponsored. Even for these priorities have to be determined. Essential materials, both indigenous and imported, have to be canalised in the right direction. Which organisation exists in India to (a) see the needs of all branches of national economy in perspective (b) prepare plans for these branches, (c) integrate these plans (d) establish priorities and (e) canalise money and materials for the production of commodities in the order of their importance and also according to a time schedule? The Planning Commission is apparently meant to take charge of this work. In the absence of such a Commission, there would be a lot of confusion and wastage of materials and effort.

It is true that the composition of the Planning Commission leaves much to be desired. We would have liked to see on it representatives of scientific workers and of peasants and workers who constitute the vast bulk of our population and whose needs must determine the whole

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course of planning and execution of projects. We would have liked further to see that Government accepted socialism as the basis for this planning. But that has not happened. Should we jettison this Planning Commission? Or should we, while holding that the Planning Commission could have best functioned in a socialist framework and while knowing that it must suffer from limitations under present conditions, try to give it assistance so that it may achieve even the limited objectives it holds? It is now reported that the Planning Commission has decided to set up an Advisory Board. The Planning Commission could thus at least associate themselves with representatives of various interests mentioned above through this Advisory Board if they wished to do so. When the Commission prepares its plans or establishes priorities for execution we have a right to offer our suggestions and criticisms. It would be far better to try to keep the Planning Commission on the right path than merely take a negative attitude to it in the present circumstances of the country.

SCIENTIFIC TALENTS FROM ABROAD

Considered in a background of post war financial difficulties, of the limited resources of our country and of the pressing and exacting problems associated with the rehabilitation of the displaced persons, it is no small achievement on the part of the Government of India to have established on a firm footing the National Chemical Laboratory, the National Physical Laboratory, and the Fuel Research Institute within a period of six months and venture on the completion of a fourth one. Elsewhere in this issue appears a brief life sketch of Sir Edward Mellanby, the sixtysix year old British scientist who has been appointed the Director of the National Drug Research Institute of India. The news item in the daily papers reporting this appointment, just as we were going to the press, stated that Sir Edward was likely to take up his duties at Lucknow by October next. So we can fondly expect that the fourth institute in the chain of our proposed national laboratories would start functioning with its full complement of staff within a short while.

Without the dynamic leadership of our popular Prime Minister Pandit Jawahar Lal Nehru and the untiring efforts of his able lieutenant in the Department of Scientific Research Shri Shanti Swarup Bhatnagar, it is doubtful whether we could have achieved in the domain of science the little that we have done so far. It would be a very happy augury indeed if there is greater scientific outlook amongst our civil servants for solution of many of the problems that beset the country. We must say that before the Nehru Government came into power the outlook of the main body of civil servants was woefully lacking in proper scientific bias, and scientists, whether in Government service or in the universities, were regarded as "penny in the slot machine" for answering certain questions that cropped up in the administration. Not that such an archaic bent of mind of the administrators has radically changed but there is today a greater appreciation of science and what science can do.

Our Association is fully alive to the need for recruitment of scientific talents from abroad in the proper development of science and technology in our country. This subject was given the fullest consideration by our Association at its annual general meeting held at Poona in January last. Resolution No. 6* unanimously adopted at the annual general meeting, enunciated in no uncertain terms the views of our Association. One of our suggestions was that

*See pages 5 and 6 of Vijnan-Karmee, February 1950.

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the foreign experts who may be appointed from time to time, according to the needs of the country, should be of such age and experience as may permit of associating themselves with the active pursuit of science along with their local colleagues, thus not only inspiring the young Indian scientists but also raising the existing standard of technique and laboratory practice. Consequently, we had expressed ourselves against the principle of appointment of superannuated persons even of established reputation from abroad, and particularly of those who had been cut away from the active pursuit of science for a considerable period. We have the greatest respect for Sir Edward Mellanby as a top ranking nutrition scientist and for his abilities in managing the affairs of the Medical Research Council as its Secretary for a period of more than 15 years. True it is that he held for some years the appointment of Professor of Pharmacology at Sheffield but he has spent almost tho whole of his life on nutrition research. Now that the appointment has been made we welcome Sir Edward in our midst and we hope that he will do his best to stimulate drug research in this country.

In our Resolution on the recruitment of foreign scientists we had expressed ourselves strongly in favour of appointment of Indians as directors of our national laboratories. Certainly, we did not want that anybody who is not suitable should be appointed simply because he was an Indian as such a practice would be against the spirit of science which we profess and also against the interest of the country in general. We had greatly appreciated the appointment of Professor K. S. Krishnan* as the Director of our National Physical Laboratory. In view of the fact that Shri Ram Nath Chopra had truly and well laid the foundation of drug research in the country many years ago, and as more than one of his able assistants had earned, we presume deservedly, recognition of their work both in this country and abroad, we were looking forward to the appointment of an Indian at the helm of our national drug research. But that was not to be. The appointment of a nutrition scientist even of the eminence of Sir Edward indicates, and we regretfully note the fact, that in the opinion of the Government we do not possess, amongst the scientists in India employed on the research on drugs, a suitable person who could be given the responsibilities of the Director. Whether one possesses adequate qualifications to hold a certain appointment is purely a matter of opinion and consequently we would not like to raise any controversy based on opinions alone. However, we hope that within a short time scientists in our country would attain that experience, ability and eminence which is needed to guide the destinies of our national laboratories, and recruitment of foreign scientists except as temporary advisers, would not be necessary. We would, however, advocate invitations extended to eminent men of science from abroad for lecture tours in the different centres of teaching and research in the country.

* See page 1 "Vijnan Karmee" March, 1950.

CRISIS IN THE TEXTILE INDUSTRY

We have published in this issue an article on the present crisis in the Textile Industry. It is not justifiable in the present shortage periods to close down the mills and stop the production of cloth because the parties interested do not get as much profit out of the working as they feel they should get. It has been suggested that the Government should constitute an advisory body consisting of representatives of technicians and labour whose joint efforts are sure to keep a mill in production.

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DEVELOPMENT OF INDIAN INDUSTRY

THE CRISIS IN THE COTTON TEXTILE INDUSTRY

(By— A Scientific Worker)

The crisis in the Cotton Textile Industry not only creates a crisis in the homes of those directly connected with it but has wider implications on the national well-being itself. The fall in production inherent with the crisis offers scarcity of the basic requirement of the population with resulting soaring prices and black-marketing, and ultimately inflation to the ruin of the nation.

It is not an uncommon experience that whenever a man, engaged in a textile industry, comes across a common man in confidence he is confronted with a volley of questions such as :

(a) Why this closure of Mills ?
(b) Why there is accumulation of stocks ?
(c) How long the shortage of cloth will continue ?
(d) Will we ever get cheap cloth as before the War ?

In order that one may be able to answer these questions scientifically and unbiased, one has to have comprehensive knowledge of the Indian Textile Industry in particular and world textile position in general. Unfortunately all the scientific workers, though intimately connected with the industry, are not aware of the various factors—both real and unreal-responsible for the occasional crisis as the top management being part and parcel of capital is not interested in taking the rank and file of the technicians into confidence and giving them useful information to understand the position possibly because they themselves form one of the targets of attack in case of the crisis.

Further, it is not unlikely that in not too distant future, the Government of the country, realising the need of consumers, may embark upon a policy of taking the scientific workers into confidence to evolve a way out of this catastrophic situation, On the above considerations it is essential that there should be frequent discussion among Scientific Workers in the know of the situation so that they may be able to arrive at definite conclusions and educate the public and suggest ways and means to the Government to meet the situation.

Such a discussion was held recently amongst our members wherein the points raised by the Industrial Unemployment Committee formed the basis of discussion. The Industrial Unemployment Sub-Committee, appointed by the Bombay Provincial Labour Advisory Board, on 8th June' 49, has attributed the crisis to one or more of the following causes :—

(1) Cotton shortage.
(2) Accumulation of cloth and yarn stocks.
(3) Financial stringency.
(4) Transport bottle-neck.
(5) Non-availability of stores and spare parts.
(6) Reduced margin of profits due to increase in wage bill.
(7) Staggering hours.
(8) Lack of co-operation between capital and labour.

1. Shortage of Cotton :

Due to the partition of the country into India and Pakistan, the shortage of cotton has come to stay for some time to come. Against the total production of 3,190,000 bales in 1947-48 from 11 million acres, the internal requirements including extra Factory consumption (270,000 bales) amounted to 4,480,000 bales leaving a deficit of 1,290,000 bales. Out of this total production about 230,000 bales of short staple cotton were surplus to internal requirements. These are exported. If allowance is made for this, the real deficit comes of the order of

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1,520,000 bales which has to be met by imports. The Government of India was aware of the substantial gap of 7 to 9 lakh bales for the year 1948-49 but failed to remove it by imports on a commensurated scale. This is a genuine source of trouble which can be over-come with foresight.

The second cause of the shortage of cotton is artificial. Due to the failure of the Government to control the price of Kapas, its price has gone up considerably resulting in hoarding of cotton and leading it to black market. Distribution of raw cotton to textile mills and a greater security and supervision of all sales and purchases and the fixation of ceiling price for cotton and controllod price of Kapas will mitigate this evil considerably.

However, as far as the supply of cotton is concerned, the tension has to a great deal eased. The Government of India has made arrangements to import 8 lakh bales and if need be more, and cotton from abroad has already come and the shortage is fast disappearing. Besides, the Government has undertaken measures to increase cotton production by increasing acreage under cotton, providing irrigation facilities, supplying suitable fertilizers etc. It is claimed that the increase in production due to these measures will be to the order of 8 lakh bales in 1950-51.

2. Accumulation of Stocks :

Some time back the accumulation of stocks in mills was said to be the maior headache leading to the closure of mills. This is something un-understandable when we look at the figures of total production and per capita cloth available to the population.

Total Mill Production in 1949	=3,929,680,000 yds.
Production of hand-looms in 1948-49	=1,300,000,000 yds.
Cloth imported in 1948-49	= 47,430,000 yds.
	=5,277,110,000 yds.
Exported to Pakistan in 1948-49 (200,000 bales of approx. 1500 yds)	= 300,000,000 yds.
Exported to countries other than Pakistan in 1948-49	= 340,863,000 yds.
Total Export in 1948-49	= 640,863,000 yds.
Net available to consumers (337,038,000 people)	=4,636,247,000 yds.

Per capita cloth available comes to 13.8 yds. annually.

The per capita cloth available for consumption in 1938-39 was 17.94 yds. which has fallen to 13.8 yds. in the year 1948-49. This figure will be reduced to 13.8 yds. per head per annum, if we consider 100 million yards of cloth purchased for defence services and other government requirements, and it would be further reduced to 12 yds., if we take into account the quantity of cloth smuggled into Tibet, China and other areas adjacent to Bengal and Punjab and other illicit exports from small ports. Considering still further, the differential need of the Urban population which form 13% of India's total population whose need comes to an average of 25 yds./head/annum the cloth available for the Rural population comes to approximately 10 yds. per head per annum. The is quite insufficient especially when one compares it with the world's average per capita consumption which was 42 yds. in 1928-29. But still we hear of the accumulation of stocks. How is this ? Is it not due to the fact that cloth prices are so high that it is not within the purchasing power of the masses? Because of the high price of the textiles, not only the home consumption has declined, but the export trade has also suffered a decline. In the year 1948-49 Pakistan did not take even 60% of the cloth and yarn allotted to

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it. Of the 350 million yards of cloth earmarked for export during 1948 to countries other than Pakistan, only 167 million yards could be exported. Luckily due to devaluation of the currency this position has improved considerably and once again Indian textiles have demands out-side India.

In this connection the Textile Commission's contention for the accumulation of stocks is significant and is as follows:—

(1) Manipulation with the cloth packing.
(2) Production of cloth having no demand in the market in order to take maximum advantage of the price structure.
(3) High pricing of cloth coupled with falling purchasing power of the masses.

Mr. Barat, the Textile Commissioner, has told in one of his statements that the accumulation of stocks at that time of the year was a seasonal phenomenon and would ease out when the harvesting was over.

Thus it will be readily seen that the cry of accumulation was meant to get the controls removed and the capitalists succeeded partially in lifting of controls on distribution. But did it solve the problem as the capitalists claimed? The answer is an emphatic *No.*

In the first week of November, 1949 there were 2,02,000 bales with the mills in the Bombay Province as against 2,42,000 bales in the first week of September. In course of two months only 40,000 bales had been disposed of. This fact alone suffices to prove that controls were not responsible for the accumulation of stocks.

Finally, the Government of India, realising the need to counter-act the deterioration of the export trade in first half of 1949 and the urgent need of stimulating export to earn much needed foreign exchange, set up an Export Promotion Committee under the Chairmanship of Mr. A. D. Gorwalla. On the basis of this Committee's recommendations, the Government has liberalised their export policy with the result that most of the so-called accumulation has disappeared since then. The devaluation of the Indian currency on 19th September, 1949, in terms of dollar by 30½%, as pointed out earlier, has a further stimulating effect. It is no news that huge quantities of grey Bed Linens are finding profitable dollar market.

But this over-activity on the export side has its dark side too. It is learnt reliably that at the very first instance the entire quota of one quarter was completed in one month and most of the mills are now concentrating on exports sorts. Since there is lack of commensurate increase in the over-all production, this substantial increase in the export trade will create a void and there is risk of serious shortage of textiles for internal consumption.

3. Financial Stringency :

The third reason of inadequate finance is mostly coming from uneconomic and small units with insufficient resources. But from the very fact that these concerns did very well during war and the period following it, one must not accept it on its face value. Instances are not lacking to show that such conditions have been created due to mismanagement, internal dissensions and family feuds of the Managing Agents. The case of Sholapur Spg. and Wvg. Mills is an example. It is now an accepted fact that this is not an uneconomic unit and that the source of trouble were the Managing Agents and the Board of Directors.

It is, therefore, thought necessary that the Government should appoint an Experts' Committee to study how many of such mills are small and uneconomic and suggest ways and means to work these mills.

4 Transport Bottle-Neck :

Those who have followed the recent discussion on the Railway Budget must have found with relief that this headache has gone once for all.

5. Non-availability of Stores and Spare Parts:

To any technician who has had any experience of the industry during the last war

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days, this argument will not be acceptable. We are able to get our spare parts and stores with ease from abroad and our local work-shops too are in a better position to supply most of our demands. When the industry could work to the fullest capacity in those trying days of war giving target production, closure of mills on this ground is flimsy.

6. Reduced Margin of Profits due to Increase in Wage Bill :

At the very outset one has to consider that the wage bill is not the major factor in the cost of Indian Textiles. Moreover a proper scrutiny will show that though there is an increase in wage bill its percentage increase is very much below that of the percentage increase in the prices of cloth. Besides it is not true that there are reduced profits. Following facts speak for themselves.

The block capital of the entire cotton textile industry is slightly more than 100 crores and the industry reaped the gross profit of 372 crores between 1940 and 1946. Indeed a substantial portion of it went as taxes but the net profit itself was 79.42 crores and the Managing Agents commission amounted to 40 crores. It will be seen that 119.42 crores or much more than the block capital was realised in 7 years only. Thus even if there is reduced profit, there is hardly any reason to close the mills in the interest of the nation. But according to Mr. M. P. Gandhi, the truth is different. "The year 1948 was a year of bumper profits to the textile mills. According to one source the total profits made by the Bombay Textile Industry alone in 1948 amounted to 20 crores as against Rs. 7 crores in 1947." The figure for the year 1949 is not available but looking at the industrial balance sheets the position continues to be encouraging.

7. Staggering hours :

Dispute between the Management and the Labour is quite natural for working staggering hours. Because whereas the capitalist gains by way of higher production, the workers resent it since it occupies practically the whole of their day towards their duties.

8. Lack of co-operation between Capital and Labour :

Without considering the pros and cons of the recent Government legislations, one thing is certain that they have been instrumental in reducing dislocation of work due to labour disputes. The man-hours lost during the last year were considerably small, 50 per cent of the loss was due to lock-outs.

On the above analysis and further discussions, the following conclusions were arrived at which if implemented will go a long way in averting the present crisis as well as putting the industry on surer and scientific footing.

Abolition of the Managing Agency System.

Any student of economics will admit that the Managing Agency system has out-lived its existence. Whatever may be its merit a few decades earlier, it is an accepted fact that it is not in tune with the time. A substantial portion of the company's earning goes as Agent's commission with no corresponding gain. Whilst the net profits for the year 1940 to 1946 were 79.42 crores, the Managing Agents' commission paid during the period was 40 crores and thus it will be seen that an amount equal to 50 per cent of the net profit went as such.

Compulsory Grouping.

As the growth and development of the Indian Textile Industry was not on a planned basis, a number of small and uneconomic units at odd places came into being. In order to improve the working of such units, the compulsory grouping of such mills into manageable and economic corporations is highly desirable. The superiority of such managements has been amply demonstrated in various countries. In Czechoslovakia, the Government has centralised over 300 independent units of textile industry into about 30 national corporations to run on commercial lines with very fruitful results. In China a huge corporations with 50 units was set up in the year 1945. It is said that within

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two years, it amply demonstrated its superiority in both efficiency and reduced cost of production over the privately owned mills.

Standardization of Production.

Advantages of standardization of production have come to be recognised in all quarters. A beginning was made during the war in this direction by the introduction of the utility clothes. This scheme, however, did not succeed due to the half-heartedness of the measure, sabotage from the industrialists and finally mismanagement in the distribution from the officials.

In order that the scheme of the standardization of production may be a success, the following points have to be taken into consideration.

1. The needs of the broader sections of the population of various regions as regards their tastes and requirements have to be scientifically studied, both from the point of quantity and quality.

2. Grouping of the mills on the basis of their capacity to produce the various standardised qualities in order to get maximum efficiency. Attempts should be made that the mills cater to the needs of the regions in which they are situated as far as possible.

3. While drawing specifications for standardised sorts, it has to be borne in mind that the clothes are of balanced structure so as to offer better durability.

Control on Raw Materials.

Unless the raw material is made available to the mills at reasonable price, it is too much to control the prices of yarn and cloth. The Government is certainly to be blamed for taking only half-hearted measures such as controlling the price of cotton and leaving kapas uncontrolled.

Controls to be effective should start right from raw materials to the finished goods. Not only cotton but all other important raw materials and accessories etc. should be controlled if the costs of production are to be kept within reasonable limits.

Items like dye-stuffs, chemicals, spare parts etc. which are imported from outside should be purchased in bulk by the Government and distributed according to the requirements of the industrial concerns. Such a practice in U. K. in the purchase of cotton has proved successful. This will further ensure the import of only essential articles and thus save the much needed foreign currency.

Scientific Utilisation of Labour.

Work-load assessment on a scientific basis, through Time Study, as a means for proper utilisation of men and machinery is now well recognised. The system of allocating jobs to operatives up till now has no scientific basis at all, which has led to inequitable distribution of work-load whereby some are called upon to do a larger share of work than normal whilst others have hardly sufficient work to do. In order, therefore, to take maximum advantage of labour productivity, work-loads must be scientifically distributed, keeping in view actual effort, skill, training etc.

Under the stress of present conditions, it is becoming increasingly important to cut down manufacturing costs to a minimum while increasing the wages of the operatives. This can only be done through a system of Rationalisation by getting the maximum output per operative and per unit of machinery installed.

The Re-deployment scheme of the British Textile Industry has been a major success in spite of the initial difficulties.

Setting up of an Advisory Body.

The Government should constitute an advisory body consisting of representatives of technicians and labour which will advise the Government on matters concerning the Textile Industry and suggest executive actions in the cases of mills mis-managed.

In order that such an advisory body may function satisfactorily and the technicians in general be in a position to offer impartial advice, security of their services should be safeguarded.

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SIR EDWARD MELLANBY

Famous Nutrition Scientist Appointed Director of India's National Drug Institute.*

Sir Edward Mellanby, one of the eminent nutrition scientists of the United Kingdom and until recently the Secretary of the Medical Research Council, was born in 1884 and was educated in Cambridge. He was a student of St. Thomas's Hospital, London where he obtained his M.A. and M.D. and began his teaching career as demonstrator in Physiology. From 1913-20 he was lecturer and later Professor of Physiology at the King's College for Women in the University of London. He then went to Sheffield as Professor of Pharmacology until 1933 when he received his appointment as Secretary of the Medical Research Council of the United Kingdom. Two years later he was elected Fullerian Professor of Physiology in the Royal Institution.

His early pieces of research work concerned the physiological effects of alcohol. About this time the late Professor Hopkins was carrying on his research which led to the determination of vitamins. By dietary experiments on puppies Mellanby found that rickets was caused by the absence from their diet of a fat soluble substance which controlled the deposition of calcium in the bones. This work led to the identification of Vitamin D as separate from Vitamin A. He is also responsible for proving the rachitic properties of cereal diet, and he identified the substance as "Phytic Acid". He was elected a Fellow of the Royal Society as long ago as 1925. His investigations in the field of nutrition have included a study of the effects of the lack of iodine. In one of his latest researches he has demonstrated that bread made from the flour bleached chemically by nitrogen trichloride, popularly known as agene process, can cause in dogs canine hysteria. He has long been recognized as an authority on Nutrition in the United Kingdom and was a member of the successive committees appointed to advise the Ministry of Health. He was associated with the League of Nations also and acted as Chairman of two international conferences for the Standardisation of Vitamins and International Technical Commission on Nutrition. He is a member of the Scientific Advisory Committee to the Cabinet of his country. He was the recipient of quite a series of honours. He was Oliver Sharpey lecturer of the Royal College of Physicians in 1902; obtained the Stewart Prize for Medical Research from the British Medical Association in 1924; Bissett-Hawkins Medal of the Royal College of Physicians 1929; Cameron Prize of the Edinburgh University in 1932 and Royal Medal of the Royal Society the same year. He was appointed the Croonian Lecturer of the Royal College of Physicians in 1933 and a Linacre Lecturer in Cambridge the same year. He with his wife May Mellanby, who is also a famous nutrition scientist, was awarded the Charles Mickle Fellowship of the Toronto University in 1935, Moxon Medal, Royal College of Physicians 1936, appointed Harveian Orator Royal College of Physicians 1938, Rede Lecturer Cambridge University in 1939, Croonian Lecturer of the Royal Society 1943 and was finally awarded Buchanan Medal of the Royal Society 1947. He has been elected honorary member of various learned societies in quite a number of foreign countries. He retired from the Secretaryship of the Medical Research Council in October 1949. His has been a life full of achievements and glory. Though basically a medical graduate, he made his mark in Physiology and Biochemistry and was awarded Doctorate from most of the reputed Universities in the United Kingdom.

*Adapted from a report of the British Information Services.

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Letters to the Editors

Your editorial on "The Planning Commission" in the April issue of *Vijnan-Karmee* has prompted me to make the following remarks.

There seems to be a general tendency to believe that some sort of planning is a magic cure-all for all the ills that our country is heir to. Readers of *Vijnan-Karmee* could not have failed to notice that this widespread misconception is implicit in the whole tone of the editorial. But it must be remembered that there is planning *and* planning. From a study of the plans in fourteen countries, Prof. S. E. Harris has crystallised the salient features of the different plans in the following subtitles of chapters in his book: "Economic Planning" (A. Knopf, 1949).

U.S.A: Approach to planning.
India: An Exercise in Economic Arithmetic.
Germany: Imposed Plans.
Greece: A Plan from Abroad.
Japan: Diagnosis without Therapy.
Norway: Diagnosis, Prognosis and Programme.
Netherlands: Planning under Duress.
France: Planning to Modernize.
Poland, Czechoslovakia and Hungary: Approaches to a fully Planned Economy.
USSR: A Planned Economy.
Argentine: Planning towards Autarchy.

All these are Plans ! It is clear that any plan can be judged from two points of view. Firstly, whom does it benefit ? Secondly, how far will it be put into practice?

Every plan is designed to benefit those who do the planning and the groups or classes to which they owe allegiance. Our Planning Commission does not consist of any representatives of the workers and the peasants. On the other hand, it is composed of the big financiers, the capitalists, their stooges and their lawyers. The Commission has been appointed by the present Government of India which is completely in the grip of the capitalist and feudalist vested interests and whose reactionary anti-labour policy is notorious throughout the democratic world. Any plans produced by such a Commission can only profit the vested interests and cannot do any good to the people. The "presence of our Foundation-President" is naively supposed to "vouchsafe a scientific approach to the problem." It is well to remember that his presence in the Government of India has not in any way resulted in a scientific approach to problems facing our country. On the contrary, every problem has been tackled from the point of view of enriching and consolidating the reactionary vested interests. Even if a scientific approach is guaranteed by some miracle, what is there to be happy about in the *scientific* exploitation of the common worker ?

Considering now the second point, it is obvious that the "Master Over-All Plan" will be just one more file to be pigeon-holed unless it is implemented in all its entirety. Otherwise it is as good as leaving the country in the hands of the few who greed for private profit, as is being done now. The method of implementation of the plan has been left delightfully vague in the terms of reference of the Commission. This is quite deliberate and the reason is simple. If by chance, one or two clauses which are likely to do some good to the ordinary people were to be included and if the implementation of these were not likely to bring in quick profits, the vague terms of reference provide a loophole by which such clauses may not be put into operation. It is clear that those parts of the plan which do not benefit the the planners and their representatives but which have been forced in by popular pressure of a troubled conscience will never be implemented. In your editorial you made the usual stuff about the "main difficulty" being that of

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"finding out money". Do you remember what Dr. S. Trone, the planning expert, has been trying to knock into our heads all these months? "The important thing in plan," he said, "is not the money. It is the people". To quote one example, have you heard about the Ferghana Canal, 157 miles long, which was built in the record time of 17 days because the people knew they were working for themselves? To quote another, what could the Chinese National Planning Commission do under Chiang-Kai-Shek with all those billions of notorious American dollars?

Instead of pointing out all these implications, you smugly mention "the general expression of satisf ction at the appointment of the Planning Commission"! Do you realise that millions in our country have not even heard of the Commission, leave alone express satisfaction at it? Q oting our Poona resolutions in the body of your editorial, you have omitted the words "on the basis of a socialist economy" after the words "the industrialisation of our country" Line 25, col. 1), but instead you call for "increasing production", like one of the stooge bosses from the INTUC. You mention the "minor issue" of the "absence of a scientist" as being a disappointment to many scientific workers" and even consider it as "deliberate"! You finally end with a silly and inane joke about technical and non-technical personnel and "the fundamental rule in mathematics"!

I have been forced to deal with this editorial at length because it exhibits the same incoherence, the same irrationality and the same bankruptcy of thought that have characterized the previous editorials in *Vijnan-Karmee*. I wish that all members of the Association will come forward to protest against these so-called editorials which say nothing, mean less and lead nowhere.

N. N. Narayan Rao,
Member, ASWI, Bangalore Branch.

The Editors have received the following resolution from the Secretary of the Central Laboratories, Scientific and Industrial Research, Hyderabad Unit of ASWI.

"This meeting of the CSIR Unit of ASWI takes a serious view of the editorial appearing in the April issue of Vijnan-Karmee on the Planning Commission and feels that it goes against the spirit and aim of the Policy Resolution No. 1, passed at the Third Annual General Meeting of the ASWI at Poona as also at the Allahabad session of the Association."

"These resolutions clearly lay down that till the Government adopts the policy of nationalisation of basic industries and builds the economy of the country on the socialistic-basis, the deteriorating economic conditions of the country "affecting the scientific workers along with the other sections of the population" cannot be remedied."

"In view of the present policy of the Government that they do not envisage any nationalisation for the next 15 years or more, only the appointment of the Planning Commission without accepting the fundamentals of a planned Socialist economy cannot *solve* the present economic crisis. Therefore, we strongly feel that the organ of the ASWI cannot advocate such on apnointment without a clarification of the objectives as enunciated in the resolution of the ASWI and much less can it afford to offer full cooperation to the Commission on behalf of ASWI. With the limitations of the Commission above pointed, the inclusion or non-inclusion of a scientist is meaningless. And hence, the editorial not only is at variance with the fundamental policies of the Association but also creates illusions and false hopes among scientific workers."

"We therefore feel that the Vijnan-Karmee should clearly demand for a fundamental change in the policy of the Government in favour of socialist economy as a prelude to the appointment of a Planning Commission and mobilise

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the opinion of the scientific workers all over the country to bring about such a change."

Dismissal of Prof. Joliot Curie...An attack on the charter of Scientific Workers.

The dismissal of Prof. Frederic Joliot-Curie from his post of High Commissioner for Atomic Energy is reminiscent of Hitler's attack on Prof. Einstein and the banishment of the world famous scientist from Germany. Attack on Science has always been a symptom of desperation on the part of reaction.

Reuter's message announcing the news to the world reports that "The Premier, M. Bidault, dismissed the brilliant 50 year old nuclear scientist because the Professor's public statements and unreserved acceptance of resolutions passed at the French Communist Party Congress three weeks ago made it impoossible for him to retain his job." The obvious referenee is to the activities of Prof. Joliot in championing the cause of peace and demanding a ban on the Atom Bomb. The activities of the Professor as the President of the World Committee of Partisans of Peace seeking to mobilise the conscience of the world for a ban on the Atom Bomb directly follow his understanding of the social responsibilities of the Scientist recognised by the Charter for the Scientific Workers adopted by the World Federation in its very first Assembly. The Charter has the following to say regarding the responsibilities of the Scientist.

"1.3. To the world.

1.31 To maintain the international character of science.

1.32 To study the underlying causes of war.

1.33 To aid agencies seeking to prevent war and to build stable bases for peace.

1.34 To work against diversion of scientific effort to war preparations; in particular to the use of Science in providing methods of mass destruction"

(Vijnan Karmee p. 3 Vol. 1 No. 1)

The directives of the Charter are absolutely clear and unambiguous. The basic tenet underlying the Association of Scientific Workers all over the world is the fact that a scientist can not just confine himself to his laboratories but has to take active interest in the social values created by the advance of science; and stand on guard against perversion of science to the detriment of society. Prof. Joliot Curie offers, in his own person, a concrete example of how this can be done.

The professor's record has been consistently patriotic. "When War broke out in 1939, he was working in atomic research based on heavy water. When the Germans over-ran France, he was able to ship to England the whole of his supply of heavy water - a vital contribution to the allied lead in the race for the Atomic Bomb. He himself remained in France as a resistance worker." Subsequently the efforts of Prof. Joliot in seeking to save the world from the horrors and devastation of a third world war and for bringing that Government which first uses the atomic bomb before the bar of world opinion as a war criminal are a source of inspiration to every scientist eager to fulfil the obligations laid on him by the Charter. Only those whose aims are not in consonance with the interests of world peace and are not for the utilisation of scientific development for peaceful purposes can take fear at the activities of Prof. Joliot. It is significant to note that no sooner the Prof. was dismissed than a feeling of relief was expressed in some quarters.

"The dismissal of M. Joliot Curie was hailed in Congressional Circles in Washington as likely to lead to a greater inclination in Congress to cooperate with France on Atomic Energy matter.

Sources close to Senator Brien Mcmohan (Democrat, Connecticut), Chairman of the Joint Committee on Atomic Energy, said the change would be welcomed by the members of the Committee and that there would be a greater inclination to cooperate."

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The indefatigable efforts of Prof. Joliot in the struggle for peace and against war are a matter of pride and encouragement to all scientists and hold out to them concrete ways and means of not just becoming helpless spectators of the tragedy of the utilisation of the fruits of their research for destructive purposes but of taking active steps in preventing the tragedy.

The attack on Prof. Joliot is an attack on science and a fetter on every scientist that bars him from effective fulfilment of his social role as a crusader for peace and prosperity. It will be wrong to console ourselves that the issue is just a political one and that Prof. Joliot was removed from his high office because he was a member of the Communist Party. It is worthwhile to remember that he was a member even when he was appointed to the post. No change has occurred in the interregnum in this regard. The only change has been that the struggle for peace has taken a concrete and decisive turn and the scientist himself has become acutely conscious of his own responsibilities in this struggle.

Prof. Joliot is the President of the World Federation of Scientific Workers and it is only fair that the Association of Scientific Workers of India which is affiliated to the world body should raise its united voice against this attack on the right of a scientist to enter the struggle for peace and prosperity. Loyalty to the basic principles of the Charter for Scientific Workers demands such a protest when a scientist is taken to task for fulfiling the obligations arising out of the Charter. The attack on Prof. Joliot is thus an attack on the Charter for Scientific Workers and an ominous harbinger of disastrous consequences to the cause of science itself in future. It behoves every scientific worker to defend the Charter and the principles embodied therein like the apple of his eye.

A Scientific Worker

Aptitude for Scientific Work.

In spite of the Approved For Release 2001/09/06 as CIA-RDP83-00415R006100050001-7 well as private, scientific workers with high academic qualifications and experience are taken in thereby utilising the scientific talent of the country for the national prosperity. But there are certain facts regarding the conditions of their work which must be studied and changed to improve the conditions.

We are told that there is a dearth of scientific workers in the country and that is why the various national projects could not be effectively put into operation and this might require some time if the present system is not radically changed. In our country we have got a considerable number of scientific workers engaged in purely non-scientific jobs. Can these scientific talents be not better utilised by some re-orientation of their appointments? The Association of Scientific Workers of India in co-operation with the various other national bodies can surely make an attempt to collect data regarding the number of scientific workers (both trained and untrained) available in India and urge upon the Government to take immediate steps to arrange for proper employment. We bring this most important point before the scientfic workers of India so that the opinion of scientific workers could be mobilised. Coming back to the scientific department where scientific workers are employed for technical work, it is often experienced that the departments do not give due consideration to the experience of scientific workers in the particular branch of science in which they are specialised resulting in the mal-employment malutilisation of scientific knowledge. Surely neither the country nor the scientific worker gains by such a wasteful practice which chould be stopped forthwith, the earlier the better. We suggest at this stage that the reorientation of scientific allocation of work is absolutely necessary to get the best of a scientific worker.

We are glad to know that at least in one Government Scientific Department, the head of the department has felt the necessity of the and has been preparing 'Aptitude Cards' for all Gazetted

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Officers of the department so that the officers may indicate their choice of subject in order of preference and the department can re-allocate duties suitable to them in accordance with their qualifications, experience and aptitude. We are glad at this move and offer our congratulations to the head of the department. At present the system is meant for Gazetted Officers only but we have no doubt that it will soon be extended to the lower class of Government servants as well, because these scientific workers are actually the primary workers who carry out the day to day routine work as well as non-routine developmental work.

We hope that this example will soon be followed by all the scientific departments in the country. The scientific workers of India indeed need such encouragement today and we urge upon the Government to do their best to derive the maximum benefit out of scientific workers giving them fullest scope for better work irrespective of the position they hold in the department.

A. C. D.

✚

Need for Proper Encouragement of Scientific Workers.

There were days when scientific research was confined to the priveledged few. The situation now is different. The methods of research have undergone a radical change. We have research departments where hundreds, nay thousands, of scientists are working along definite coordinated lines. The workers are divided into different categories determined by their qualifications, experiences etc.

Scientific advancement is at its peak in those countries which, besides having adequate resources, give fullest encouragement to those having the necessary aptitude for research. In some countries, notably in the U.S.A., the process of selecting promising scientists begins at the High School age. There the School boys and girls are given all facilities to develop their respective talents. Encouraged by all kinds of facilities placed at their disposal some students have displayed remarkable creative ability. In last year's scientific talent competition one boy suggested a new experiment in atomic physics by the applicaiion of a well known law of Relativity; another girl was able to trace the habits of a large number of birds by suitably enclosing them in fields. Inventors are given every help to getting their works published readily in numerous technical Journals.

Unfortunately, the state of affairs in our country is quite different. Many a would-be-scientist finds almost no response from established scientists to their ideas. In matters of publication of original work too there are numerous hurdles to be crossed by a scientific worker. There are instances where communications intended for publication have been withheld for as long as four years by departmental authorities and subsequently lost. Then again there are complaints against non-acknowledgment of help rendered by a scientific worker in research projects. Surely, such indifferent treatment coupled with apallingly low scales of pay are bound to demoralise our scientific workers.

It is high time that scientists at the helm of affairs in our country did something to remove the numerous difficulties facing a promising generation of scientific workers. There is no dearth of scientific talent if only we know how to tap it.

D. S.

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NEWS AND VIEWS

Nehru-Bhatnagar effect.

Sir C. V. Raman - the Indian Physicist Nobel Laureate - who was present at the inauguration of the Fuel Research Institute by the President Dr. Rajendra Prasad humourously described the openings of such institutes as the result of a new effect - "Nehru-Bhatnagar Effect." Sir C. V. Raman said that there was a time when the Government Treasury was sealed and locked against any demand for scientific work in this country but on account of the new light in the field of science the atmosphere had changed and Government financial help was gradually becoming available for setting up new laboratories.

✚

Technical and Scientific Terminology.

The Central Advisory Board of Education, Government of India at its recent meeting held in April decided that the national language Hindi should be developed as laid down in the Constitution. International technical and scientific terminology would be adopted, the words borrowed being properly assimilated and their pronounciation being adopted to the phonetic system of Hindi.

The Board also accepted the recommendation of the University Education Commission as regards the training of scientists. The Commission have emphasised the desirability of training a large number of scientists in view of the acute shortage of scientific man-power. They also recommended the institution of a large number of scholarships and free places for really good students at the M.Sc. and Ph.D. stage for this purpose.

✚

Sardar Patel on "Planning."

Sardar Patel, the Deputy Prime Minister addressed the Chief Ministers of States and Presidents of State Congress Committees on planning and on the necessity of having one 'Plan' for the whole country. Sardar Patel said that it was necessary to industrialise the country quickly and efficiently in certain directions. We would be doomed otherwise. In the modern world the army must also be given all the modern requirements.

✚

Members of the Parliament on study tour.

Some Members of the Parliament have undertaken a tour of some of the industrial areas in the country at the request of the Federation of Indian Chambers of Commerce and Industry. After seeing for themselves the awakening in the industrial field and the progress made, they have admitted that so far they were in the dark and did not know anything of the industrial activity. It is a good example which might be profitably followed by other Members of Parliament. Such personal knowledge gained in the different spheres of activities of the nation would help in giving a correct turn to the different problems before the country.

✚

Age limit for Scientists and Technical Personnel.

It could be seen from the answers given to some questions in the Parliament that in view of the dearth of technical personnel in the country the Government were considering the possibility of extending the age limit for Government Scientific Personnel. Only a temporary advantage would result from such an arrangement unless steps were taken at the same time to increase the number of scientists working with the experienced scientists and take proper care about the service conditions of the junior scientists.

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Mr. C. P. Ramaswamy Iyer on Planning.

Speaking on the "economic and industrial out look of India" at the spring lecture series at Poona started by the Late Lokamanya Tilak,

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Mr. C. P. Ramaswamy Iyer said that the problem of reconstruction in India could not be considered without reference to what was taking place in other parts of the world. He welcomed the appointment of a Planning Commission but pointed that planning should be such as to enthuse the entire people of the country.

Dismissal of Prof. Joliot-Curie.

News has appeared in the Press that Prof. Joliot-Curie - High Commissioner for Atomic Energy in France for the last three years - has been relieved of his important post by the French Government. Prof. Joliot-Curie has been intimately connected with the movement of Scientific Workers, being the President of the World Federation of Scientific Workers. The Scientific Workers all over the World would be interested to know from the World Federation the exact circumstances which have led to the dismisal of the Professor.

We can do it.

An atomic clock which will be a standard device for the measurement of time is among a series of interesting inventions perfected in a laboratory of the Council of Scientific and Industrial Research, India. The clock will remain unaffected by any known factors, including variations in temperature, altitude or humidity.

ACTIVITIES OF THE BRANCHES

Poona Branch.

Association of Scientific Workers ordinance establishment, Kirkee.

The Executive Committee of the Association for the year 1950-51 has been constituted as follows :—

Mr. V. G. Mehandaley	...	President
Mr. S. Umakant	...	Vice-President
Mr. M. S. Subramaniam	...	Secretary
Mr. L. G. Rairikar	...	Treasurer
Mr. B. P. Sinha	...	Member
Mr. B. M. Chakraborty	...	"
Mr. F. M. S. A. Shaikh	...	"
Mr. E. K. Nambiar	...	"

Hon. Auditors.

Mr. N. C. Puri and Mr. P. R. Kamath.

Naihati Branch.

A General Meeting of the Naihati Branch of the Association of Scientific Workers of India was held on Thursday the 20th April 1950 at 6.30 P.M. Sri Probodh Kumar Adhikari conducted the meeting.

The Branch Secretary placed a report giving summary of the activities of the Branch. He mentioned in the report the following activities.

The Branch has made a survey of the conditions of Scientific Workers of the locality and submitted a report to the Headquarters regarding the same.

The Branch organised an extraordinary general meeting which was addressed by Dr. B. C. Guha, Vice-President of the Association. The meeting was attended by some members of Calcutta Branch as well.

The Branch organised four scientific talks during the period.

The Branch has organised a library for providing members with current scientific journals.

The Branch has organised a Technical Class for imparting technical knowledge to the interested persons.

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The Branch had to condole the death of Shri M. M. Boral, an active member of the Branch.

The following members were duly elected as office bearers for the current session.

President	...	Shri S. C. Chatterjee
Vice-Presidents	...	Shri P. K. Adhikari
		Dr. U. N. Guha Thakurta
Secretary	...	Shri N. K. Gupta
Joint Secretary	...	Shri S. S. Das Gupta
Treasurer	...	Shri D. C. Tapadar
Members	...	Shri B. B. Das Gupta
	...	„ S K. Sen Gupta
	...	„ G. C. Sen
	...	„ R. M. Chakravarty
	...	„ D. B. Dasgupta.
	...	„ J. M. Sen
	...	„ A. K. Banerjee.
		Auditors

Sri K. C. Banerjee and Sri S. K. Sinha.

Bomday Branch :

The Annual General Meeting of the Bombay Branch of the ASWI was held on 20th March, 1950. The following office-bearers have been elected for the current year :—

President :

Dr. V. R. Khanolkar, Tata Memorial Hospital, Parel, Bombay.

Vice-President :

1. Dr. N. R. Tawde, Royal Institute of Science, Bombay.
2. Dr. Y. N. Kotwal, Dadar Sewage Purification Department.

Hon. Secretary :

Mr. Y. S. Nimbkar, Haffkine Institute, Parel Bombay.

Jt. Hony. Secretary :

Miss K. Ramaswamy, Tata Memorial Hospital.

Hon Treasurer :

D.K. Rao, Meteorological Department, Bombay.

Executive Committee.

1. Mr. D. R. Sukhantkar, Raptakos, Brett & Co. Ltd., Worli, Bombay.
2. Mr. R. B. Adhikari, Bombay.
3. Mr. P. N Sarangdhar, 163, Mathar Bhuwan, Dadar, Hindu Colony.
4. Mr. N. K. Verma, Tata Memorial Hospital, Parel, Bombay.
5. Mr. J. N. Banerjee, 6, West View, Dadar, Bombay.
6. Mr. Ramkrishnan, Meteorological Department, Bombay.
7. Dr. D. B. Desai, S. G. S. Medical College, Bombay.
8. Mr. V. E. Kulkarni, Haffkine Institute, Parel, Bombay.

Bangalore Branch.

The following report was read at the Third General Body meeting of the Bangalore Branch of A.S.W.I. held on 9th March 1950:-

The activities of our Branch Association commenced early in November 1949 with a review of Prof. P.M.S. Blackett's book 'Military and Political Consequences of Atomic Energy' by Mr. T.L. Kasturi, Lecturer, Central College. In a dispassionate analysis, the speaker clearly pointed out the logic in Prof. Blackett's view that the Atomic Bomb cannot be decisive weapon in a future war and also that there is no fear of an immediate atomic war. This expose of the atom diplomats emphasised the necessity for the fight to establish permanent peace in the whole World.

A popular lecture by Prof. N. R. Dhar was arranged at the National College on 'Our National Diet'. There the learned professor stressed the importance of a balanced diet suitable to our Nation.

The visit to Bangalore of Prof. J. D. Bernal, the Vice-President of the World Federation of Scientific Workers was a great fillip to our Organisation. A lecture and a short discussion was arranged for the occasion. Prof. Bernal spoke on 'National and International Organisation of Science and Scientific Workers". During the discussion members to run the Association essentially on a trade union

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basis and to co-operate whole heartedly with the members of the other trade unions.

When Prof. Englehardt came down to Bangalore a few days latter, all the members were very keen to hear about the Biological Controversy in U.S.S.R., and accordingly a discussion was arranged by the Association. Prof. Englehardt deseribed Academician Lysenko, the President of the Lenin Academy of Agricultural Sciences as a genius who revolutionised the methods of Agricuture in U.S.S.R. He spoke glowingly of the extraordinary healthy growth of the plants and abundant supply of grain during the harvest after Lysenko's principles were put into practice on millions of acres of Soviet Land. Prof. Englehardt denied the persecution of the orthodox genetists and said that there people are now actually directing work on classical lines in certain Institutes in U.S.S.R. and that if any one were to go to Moscow, he could meet them in the corridors of the Academy of Sciences.

Dr. B. C. Guha, Vice-President of our Association addressed the members when he visited Bangalore in the month of February 1950. He stressed the importance of building a strong organisation of Scientific Workers in India and particularly in Bangalore. In his opinion, the organisation can function as a suggestive body to the Government in its initial stages as it may not be possible to fight for the betterment of Scientific Workers on a Trade Union basis. Many members of the Association afterwards expressed their view that his replies to the questions were inconclusive and unsatisfactory.

Recently Dr. S. Trone gave a series of lectures on 'Planning in India' for nearly eight hours on four days. Other Associations of the Institute readily co-operated in arranging this series of lectures. Our thanks are due to the Government of Mysore who were very hospitable to Dr. and Mrs. Trone during their stay in Bengalore. Dr. Trone repeatedly pointed out the absolute necessity of a thorough overall plan, and emphasised that during the execution of a National Plan, people and the Government must move together. He illustrated his talk with numerous examples from Russia, Japan, China and Germany. Various questions were asked and Dr. Trone was kind enough to reply them very cheerfully.

A memorandum with regard to pay scales and service conditions of Scientific Workers which was adopted by the General Body at the 3rd Annual Meeting of A.S.W.I was sent to all the important Factories and Firms in the Mysore State requesting them to give favourable consideration and implement the various grades of pay and amenities to the Scientific Workers as asked for in the memorandum.

At the request of our Association, the Scientific Film Society was kind enough to exhibit the following few films to the members of our Association:—

(1) "Taking sides with nature"
(2) "Circuit Breakers",
(3) 'Flight" and
(4) "Library of Congress".

We offer our grateful thanks for their hearty Co-operation in popularising science.

If the question were to be of merely the popularisation of science or some scientists, it could have been solved from one of the many platforms that exist today. But none can deny our movement is premarily the Trade Unionism of Scientific Workers aimed at the same objectives towards which all the genuine Trade Unions work. Having this point in view, arrangements are to be made for the scientific study of Trade Unionism.

Whatever may be the other considerations one thing is evident that we must make the scientific workers face the basic issues and gather the maximum support among the mass of Scientific Workers. On that basis questions such as retrenchment, scales of pay, dearness allowance, civil-liberties, food situation, atomic and hydrogen bombs, peace movement, imperialistic intervention and creation of gases for war

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purposes are some of the important issues which we should propagate in an everwidening circle.

A. R. Vasudeva Murthy.

Kanpur Unit.

Under the auspices of the Kanpur Unit of the Association a talk on 'Resonance and Parachor' was given by Prof. V. K. Bhagwat of the Science College, Ujjain, on March 2, 1950. The speaker elucidated the relationship between the two physical properties and explained on the basis of his new hypothesis the phenomenon of Resonance. As interesting discussion ensued after the lecture.

Delhi Branch.

1. Some of the active workers of the Delhi Branch met in an informal meeting to discuss the activities of the A.S.W.I. and have formulated a scheme for consideration of the Branch Executive committee. The members felt that more close contact between the Units should be maintained and discussions on some scientific and technical subjects be arranged and summaries of the discussion published in the Vijnan-Karmee.

2. The D.C.M. Textiles Unit arranged a discussion on "The CRISIS IN TEXTILE INDUSTRY" in which members from other units also took part. The problem was discussed in detail and an article on the subject is being prepared for publication in the Vijnan-Karmee.

3. The I. Met. D. Unit has initiated a 'study class' and drawn up a programme on the discussion of various scientific subjects in which all the members of the Department are co-operating. Mr. B. R. Pisharothy, Meteorologist spoke on 15-4-50 on "UPPER AIR ANALYSIS" and the members took active interest in the discussion. The Unit is grateful to the Departmental authorities for the co-operation in this regard.

A deputation of the Delhi Branch of the Association of Scientific workers of India met the Honourable Minister for Food and Agriculture in connection with the Memorandum on the Central College of Agriculture prepared by the Delhi Branch. The Honourable Minister gave a sympathetic hearing to the deputation and said that there were no two opinions about the necessity of such a college. The question was of finance and he would consider all the suggestions given in the Memorandum. It is now reported that the Ministry of Agriculture are considering the feasibility of the suggestion of amalagmating the Central College of Agricultural with the Indian Agricultural Research Institute.

A. C. De.

Abdullapur Branch.

It is a good news that a new Branch of the Association has been started at Abdullapur. There are four mills, namely Shree Gopal Paper Mills Ltd, Saraswati Sugar Mills, Bharat Starch and Chemicals Ltd., and S G. Vegetable Products where a large number of Scientific Workers are employed. A Scientific Society was formed at Abdullapur in 1946. This Society has now merged with the Association of Scientific Workers of India. The Branch was inaugurated on the 27th May 1950. The first elections took place on the same day and the names of the elected members of the Branch Executive Committee are :—

President	... Dr. J. C. Aggarwal, Chief Chemist, S. G. Paper Mills Ltd., Abdullapur.
Vice-Presidents	... Shri P. K. Nanda, Asstt. Manager (Tech). S. G. Paper Mills Ltd. Abdullapur.
	... Shri Suresh Chandra, Chief Chemist, Saraswati Sugar Mills, Abdullapur.
Secretary	... Shri Amrit Lal, Research Chemist, S. G. Paper Mills Ltd., Abdullapur.
Joint Secretary	... Shri V. P. Chadda, Asstt. Chemist, S. G. Paper Mills Ltd., Abdullapur.
	Shri G. G. Khanna, General Asstt. (Back

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End), S. G. Paper Mills Ltd., Abdullapur.

Members ... Shri Sansar Chand, Chemist, Sugar Mills, Abdullapur.

... Shri Suraj Balraj Sikka, Asstt: Engineer Sugar Mills, Abdullapur.

... Shri K. L. Sehgal, Mech. Engineer, S. G. Paper Mills Ltd., Abdullapur.

... Shri V. S. Mrig, Apprentice Chemist, S. G. Paper Mills Ltd., Abdullapur.

... Shri V. K. Parrikh, Chief Chemist, Bharat Starch & Chemicals Ltd.

... Shri K. K. Malhotra, Apprentice, Bharat Starch & Chemicals Ltd.

... Bawa Harbans Singh, Science Master, Mukand Lal National High School, Abdullapur.

A full account of the proceedings will be given in the next issue of the Vijnan-Karmee.

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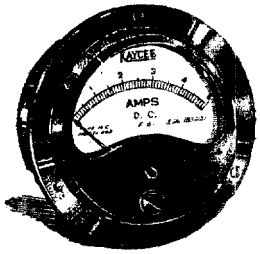

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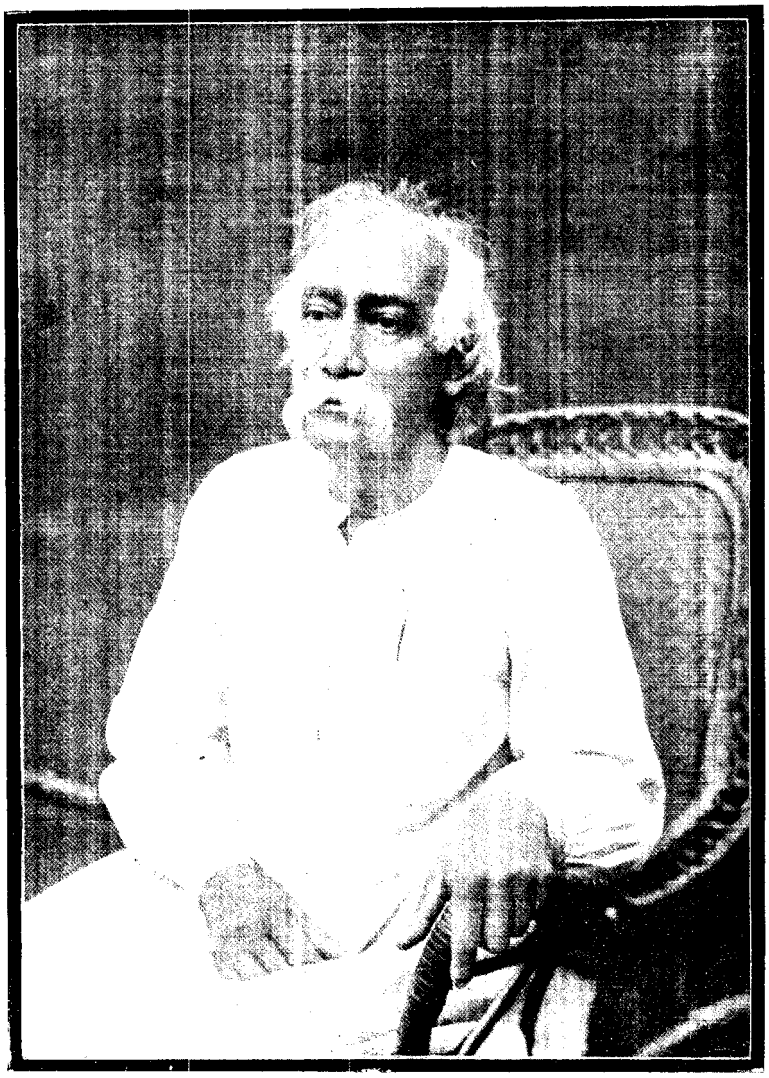

Dr. Mahendra Lal Sircar, M.D., D.L.

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THE INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

PART I

HISTORY

Science in the Seventies of the Last Century

In the progressive countries of the West, science has now entered into all avenues of human activity and has improved the life of man beyond all recognition. In India and other less fortunate countries, however, science has not yet effectively taken up its humanitarian mission and has scarcely been utilized for the establishment of a better social order and standard of life. But the teaching and pursuit of science has been developed on a scale wide enough to convince every body in this sub-continent, irrespective of his political creed or profession, that economic prosperity and national well-being depend entirely on intensive and large-scale application of science to all departments of human activity.

In India, this conviction is, however, of recent origin. Even three-quarters of a century ago, study of science was practically unknown in this country and the ultimate aim of education was to produce better and more efficient clerks for helping British rulers and trading companies. The universities and the educational institutions had hardly organized teaching in sciences and most of the colleges were not in a position, either for lack of interest or resources or for both, to offer any facilities for study in scientific subjects. The only institution which offered any such opportunity for a scientific career was the Calcutta Medical College founded in 1835, and similar colleges at Bombay and Madras, and for a long time the licenciates and the graduates from the Medical Colleges were the only scientific men to be produced in this country. "In none of the existing educational institutions with the exception to some extent only of the medical schools", wrote Dr. Mahendra Lal Sircar about 1870, "is any provision to be found for the thorough and practical teaching of science". How truly the same could be said of the whole of India!

As to research in science, it simply did not exist. The Asiatic Society of Bengal, founded by Sir William Jones in 1784 had now been in existence for over one hundred years and had carried on a series of useful researches in India's past history, literature, language, culture, archaeology, ethnology, geology and some other field sciences. But the Society by its tradition and resources, was more suited for historical and cultural researches than for

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research in natural sciences. Whatever investigations in geology and field sciences the Society was credited for were carried out, almost without exception, by the European members in the service of the Government or by the various Surveys established in different lines on the suggestion of the Asiatic Society of Bengal.

It was at this time that Dr. Mahendra Lal Sircar, a private and leading medical practitioner of Calcutta, was dreaming of a day when the scientists of India should not only collaborate, on the same footing, with the scientists of European countries in furthering the bounds of knowledge, but should apply scientific knowledge for the betterment of human life. His conviction grew as he dreamt, and he set upon himself the arduous task of preaching the gospel of science to his countrymen.

The Movement for the Science Association

The idea of founding a research institution with libraries and laboratories, where young Indians could be offered facilities for research was first advocated by Dr. Sircar in an article "On the desirability of a National Institution for the Cultivation of Sciences by the Natives of India", published in August 1869, in the *Calcutta Journal of Medicine*. In this memorable article, Dr. Sircar tried to rouse his countrymen to a sense of national dignity and self-reliance in matters of positive thinking and cultivation of sciences in which ancient India had once led the world, and put forward the proposal for a Science Association with the following objective:—

> ".....We want an Institution which will combine the character, the scope and objects of the Royal Institution of London and of the British Association for the Advancement of Science. We want an Institution which shall be for the instruction of the masses, where lectures on scientific subjects will be systematically delivered and not only illustrative experiments performed by the lecturers, but the audience should be invited and taught to perform them themselves. And we wish that the Institution be entirely under native management and control.....".

The Royal Institution of Great Britain, whose example inspired Dr. Sircar to set up a similar scientific institution for India, was founded on March 7, 1799, by Benzamin Thomson, Count Rumford. As expressed in the words of its founder, the Institution had for its first object the "bettering the condition and increasing the comforts of the poor...." by "forming by subscription, in the metropolis of the British Empire, a Public Institution for diffusing the knowledge and facilitating the general introduction of useful mechanical inventions and improvements and for teaching by courses of philosophical lectures and experiments the application of science to the common purposes of life". It was subsequently developed into a research

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institution, though its primary objective of popularizing science through organization of lectures and demonstrations always forms a prominent feature of its activities. With Thomas Young, the exponent of the wave theory of light, as its first professor and the young Cornish chemist, Humphrey Davy, as a lecturer, the Institution embarked on its brilliant career of scientific discoveries and achievements. Here worked and lectured Faraday, Tyndall, Dewar, and William Bragg. If the Institution had a few parallels as a home of original research, it had certainly none in its effort to popularize science among the British people. It is said that the whole of London used to flock to the famous lecture theatre of Albemarle Street to hear Davy, Faraday and Tyndall, each, in his own time, unrivalled demonstrator, lecturer and expositor in science.

Dr. Sircar's article in the *Calcutta Journal of Medicine* and the proposal for a science institution roused considerable interest among the enlightened section of the public, and he published the following prospectus for the Institution in the *Hindoo Patriot* of January 3, 1870:

> "1. The cultivation of Sciences by the Natives of India being deemed particularly desirable, it is proposed to establish in Calcutta an Institution for the purpose, to be called the Indian Association for the Cultivation of Science. This is to be the parent Institution—branches will be established in different parts of India according as time, necessity, and other circumstances will suggest.
>
> "2. The object of the Association will be, as its name indicates, to invite, encourage and enable the Natives of India to cultivate science in all its departments. A correlative object will be to rescue from oblivion whatever is connected with India, ancient or modern. Thus the Association will aim at editing and publishing the ancient records, so replete with interest and wisdom.
>
> "3. The chief requisites to the formation of the Association being a local habitation, scientific works and instruments, and men able and willing to work, it is proposed to purchase a piece of land in Calcutta and to build a suitable house thereon; to purchase scientific instruments and standard works on the various branches of science; and to invite to join the Association men who are either already prosecuting their studies in especial departments, or who are just out from our educational institutions—ambitious, but unable from want of means, to prosecute scientific studies.
>
> "For such and all these purposes money is the one thing needful. All well-wishers of Progress and of India are therefore solicited to contribute their quota in furtherance of the project which has been so feebly and imperfectly set forth".

Dr. Sircar devoted his whole energy in enlisting public support in favour of his proposal for the establishment of the research association and to the collection of funds for this purpose. The great cause

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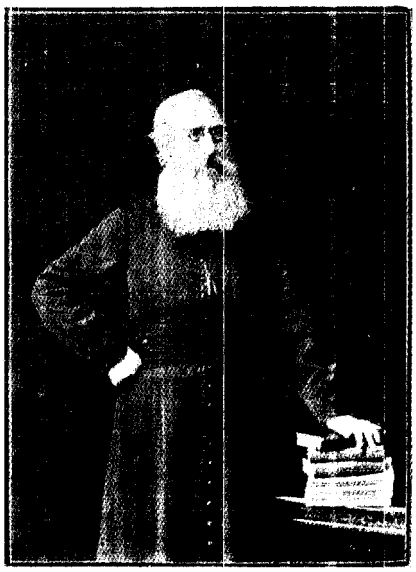
soon received strong support and encouragement from the leading educationists of Calcutta, including among others, Rev. Father E. Lafont, Rector of St. Xavier's College, Pandit Iswar Chandra Vidyasagar, Raja Rajendralal Mitra, Rai Kristodas Pal Bahadur, Acharya Keshab Chandra Sen, Maharaja Sir Joteendra Mohan Tagore Bahadur, Moulvi Abdul Latif Khan Bahadur, Babu Joy Kissen Mookerjee and his son Raja Peary Mohan Mookerjee, Hon'ble Sir Ramesh Chandra Mitra, Justice Gooroo Das Banerjee, Rai Kanailal Dey Bahadur and many others far too numerous to mention. Babu Joy Kissen Mookerjee was the first to have come forward with a donation of Rs. 1,000 which was soon followed by those from others.



Rev. Fr. E. Lafont, S. J.

Among the early subscribers to the general fund mention should be made of H. H. Maharaja of Patiala (Rs. 5,000), Maharani Swarnamayee (Rs. 8,000), Rai Annadaprosad Roy Bahadur of Kashimbazar (Rs. 4,500), Raja Kali Kissen Tagore (Rs. 2,500; he also contributed to the building fund, his total donation amounting to Rs. 32,750), Maharaja Joteendra Mohan Tagore Bahadur (Rs. 2,500), Raja Kamal Krishna Deb Bahadur (Rs. 2,000, in addition to Rs. 1,000 which he contributed for the Lecture Hall), Maharani Shyam Mohini (Rs. 2,000), Hon'ble Sir Ramesh Chandra Mitra, Kumar Purna Chandra Singh Bahadur and Kumar Kanti Chandra Singh Bahadur (Rs. 2,000 each). Besides rendering financial assistance, many of them took active interest in the Association and continued to do so as long as they lived. Raja Peary Mohan Mookerjee very actively associated himself with Dr. Sircar in the various phases of development of the Association and in pulling it through



Raja Peary Mohan Mookerjee

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all its financial and other stresses. Later he served as its first non-official President when the Lieutenant Governor of Bengal declined in 1912 to serve as its President, which was the earlier convention. Before this he served the Association as a Vice-President for a quarter of a century since its very foundation. He continued to conduct very efficiently the affairs of the Association as its President till death removed him from this world in 1923. Another very enthusiastic associate of Dr. Sircar was Sir Gooroodas Banerjee. He also was the Vice-President of the Association since its foundation until the last day of his life and took very lively interest in all its activities.



Sir Gooroodas Banerjee

With the co-operation of such leading educationists and public-minded Rajas and Maharajas of India, Dr. Sircar was able to raise about Rs. 80,000 by the end of 1875 for his projected Association. The Government of the Province also became convinced of the importance of such a research institution and thought fit to lend their support and encouragement to the cause. In his Minutes dated January 21, 1876, published in the *Calcutta Gazette* of February 23, Sir Richard Temple, then Lieutenant-Governor of Bengal, placed on record the deep appreciation by his Government of this effort to establish an Association for the Cultivation of Science and provided for the following aid:

> "I propose, therefore, to take up an eligible building, with its premises, situated at the junction of College Street and Bowbazar, and to make it over unfinished to the Association for occupation free of all charge for a term of years, which would be settled separately in consultation with the Committee for the purposes as set forth on condition that at least Rs. 70,000 be actually obtained by donations of which at least Rs. 50,000 must be invested by the Committee in Government Securities and that a monthly subscription of at least Rs. 100 per mensem be promised for two years ....".

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Bahadur of Paikpara (Rs. 5,000), Raja Kali Kissen Tagore (Rs. 5,000), Maharaja of Bettiah (Rs. 3,617 and odd), H. H. the Maharaja of Kashmere (Rs. 3,000), Babu Akshoy Kumar Dutt (Rs. 3,050) and Kumar Sarat Chandra Singh Bahadur (Rs. 2,000).

New donations also poured in, and the Gaikwar of Baroda and several others contributed to the fund. Special mention, however, should be made of the munificent donation of Rs. 50,000 from H.H. the late Maharaja of Vizianagram for laboratory buildings. The donation from the Maharaja of Vizianagram has an interesting history. Dr. Mahendra Lal Sircar cured the Maharaja of some painful disease and instead of accepting a large fee running into nearly five figures, asked him to give a suitable endowment to his favourite Association, whereupon the donation followed. The hall of the Association is named *Vizianagram Hall* in grateful acknowledgment of this gift.



H.H. Maharaja of Vizianagram

Thus, public munificence, Government patronage and above all, the unsparing efforts of Dr. Mahendra Lal Sircar combined to bring into existence seventy-two years ago the oldest scientific research institution in India. Firmly seated in its new buildings, the Association now rightly looked forward to a future of great scientific activity. But even at this stage the Founder had the foresight to realize that his efforts to see the Association function as a full-fledged research institution were doomed to failure until he had succeeded in creating endowed professorships and paid posts for research workers. He strongly believed that sustained work in research could not be expected from anybody, however enthusiastic he might be, if he was not freed from worries and his basic wants. From the very beginning of the Science Association movement, he had seized every opportunity to bring home to his countrymen the urgent need for the creation of paid posts for research workers. But

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in spite of his repeated appeals, the funds of the Association continued to remain insufficient for any such purposes.

Now that the building problem was solved and the good work of the Association in respect of teaching and popularization of science was widely recognized, Dr. Sircar turned his whole attention to collecting funds for endowed chairs and paid research posts, and succeeded, after hard pursuasions, in establishing three endowment funds, each for instituting a professorship.* Among the principal donors to these funds may be mentioned the names of Sir Gooroodas Banerjee, Babu Ganesh Chunder Chunder, H.H. Maharaja Shivajee Rao Holkar, and Maharaja Benoy Krishna Deb Bahadur. A notable contribution was that of the Maharaja of Coochbehar who came forward with a donation of Rs. 100/- a month, starting from April 1899, and the subscriptions were continued till the death of the Maharaja in April 1923. The donation was utilized at the beginning for paying the remunerations of the Coochbehar Lecturers in Chemistry; later, the donations were funded as the Coochbehar Professorship Fund. But the positions of these funds, even at the time of the Founder's death in 1904, were so deplorable that, taken together, they did not permit the creation of a single professorship. Dr. Sircar deeply regretted the inability of his countrymen to endow, within his life time, a single professorship in his favourite Association for which he lived, worked and died. At the Annual Meeting of the Association held on September 4, 1902, he observed:



H.H. Maharaja of Cooch Behar

* Ripon Professorship Fund (started in 1884), Hare Professorship Fund (1896) and Victoria Professorship Fund (1901). The total income for these Professorships is only Rs. 840/-per annum.

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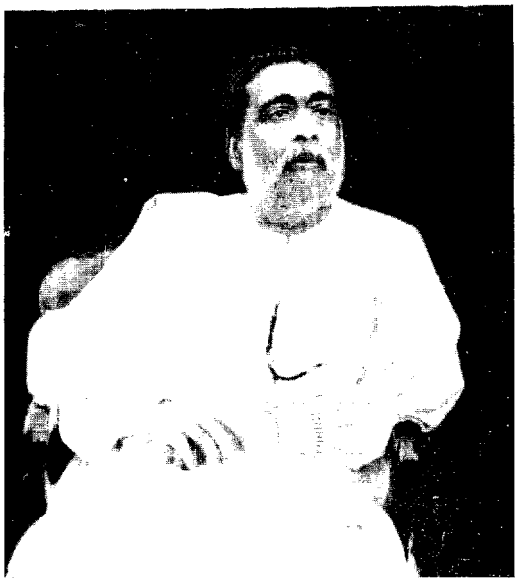
"I can only give expression to one feeling that has taken over powering possession of me, and that is a feeling of regret at having wasted a life. I have failed in fulfilling a task which I had imposed upon myself, and for which I had solicited your co operation . . .

"The co-operation that you have accorded me has not enabled me to endow a single professorship, though three have been started in succession . . .

". . . If I had rigorously applied myself to the practice of my profession, I am sure I could have left as a legacy an amount of money equal to that I have succeeded in collecting over 30 years ..... But the Institution thus founded after my death would not have been of a national character and would have been a belated Institution."

But the posterity knows that the life of the great Founder who was much ahead of his time could not have been better spent. He laid the foundation of science and of spirit of scientific research in India. A young generation was already rising before him, as he lay dying, to bear, and keep burning more resplendently, the torch of science he had kindled in the country he loved. Not long after his death (on the 23rd February 1904) his favourite Association was destined to become a foremost research institution, humming with life and research activity and attracting the attention and respect of the whole scientific world.



Dr. Amrita Lal Sircar

After his death, his son Dr. Amrita Lal Sircar succeeded him as the Honorary Secretary and carried on the work of the Association with great ability upto 1919. Great credit goes to him for allowing all the facilities of the laboratory of the Association, keeping it open at all hours, to Sir (then Mr.) C. V. Raman and thus making it possible for him to carry on original investigations in the midst of his duties in a Government post.

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The necessity for creation of an endowed professorship,—which the Founder had strived hard to meet—was more and more keenly felt as the research activities of the Association grew. It was in 1934 that one such professorship, named after the Founder as the 'Mahendra Lal Sircar Professorship', could be established with the accumulated funds of the Association, the collections of the Mahendra Lal Sircar Memorial Fund, and a munificent donation of Rs. 1,00,000 from Rai Bahadur Vehary Lal Mitra. A cherished dream of the Founder was thus realized.



Rai Bahadur Vehary Lal Mitra

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PART II

TEACHING, RESEARCH AND SCIENTIFIC PUBLICATIONS

Early Teaching Activities

During the early days, the activities of the Association were mainly confined to the dissemination of scientific knowledge through popular lectures arranged with the co operation of well-known local scientists. A programme of research could not be initiated right from the beginning, owing partly to the inadequacy of funds for necessary equipments and partly to the scarcity of trained and able people for research work. It was, therefore, thought more advisable — and rightly too—to take up the task of educating the people in the latest developments of science and making them familiar with the methods of experimentations.

Dr. Sircar himself first started delivering regularly illustrated popular lectures on physics, and soon Father Lafont joined him in this selfless task. Later Dr. Taraprasanna Roy began to deliver similar lectures on chemistry. These lectures attracted a fairly large audience which gradually grew in size and numbered 300 in 1886, including some ladies. It was then possible to secure the co-operation of a few more well-known scientists and the number of honorary lecturers was thus increased. With their help it was possible to arrange for popular lectures on topics not only in physics and chemistry, but also in geology, applied mathematics, biology and botany. Among these honorary lecturers who spared their valuable time for this noble cause were included Sir Jagadish Chandra Bose,



Sir Jagadish Chandra Bose

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Sir Asutosh Mookerjee and Sir Nilratan Sircar. Names of others deserving special mention are Mr. Chuni Lal Bose, Chemical Examiner, Government of Bengal, Dr. Rajani Kanta Sen and Mr. Ram Chandra Datta in chemistry, Mr. Mahendra Nath Ray and Mr. Syamadas Mukherjee in applied mathematics, Mr. Pramath Nath Bose, discoverer of the Gorumahisani iron deposits and indirect promoter of the great Tata Iron and Steel Works, in geology, Mr. B. L. Choudhury in biology, Dr. Amrita Lal Sircar in physics and Mr. Girish Chandra Bose in botany. A few years later the Association arranged for regular classes in botany, physics and chemistry for the I. Sc. students.



Sir Asutosh Mookerjee

The ultimate aim of developing the Association into a research institution was, however, never lost sight of. So, when by 1904, the Calcutta University introduced separate science degrees and the various colleges undertook conducting practical classes in science, the Association gradually discontinued its programme of regular science teaching and devoted more and more to research. Periodical public lectures on popular scientific subjects, however, still continued to be delivered by eminent scientists, and this feature has persisted even to this day. Great scientists from different parts of the world have been occasionally invited to deliver courses of lectures on the latest developments in the subjects of their special interest. These lectures are generally published and made available to a much wider range of students of science.

Beginnings of Research Activities

We have already referred to the difficulties in undertaking research programme during the early stage of the Association. Failure to secure the services of whole-time research workers for want of paid posts and the limited resources of the laboratory long prevented the Association from developing into a research institution, and during the first thirty years of its existence the Association had indeed very little record of original scientific investigations carried out in its laboratories. With the turn of the century, the spirit of research began to be gradually visible among those con-

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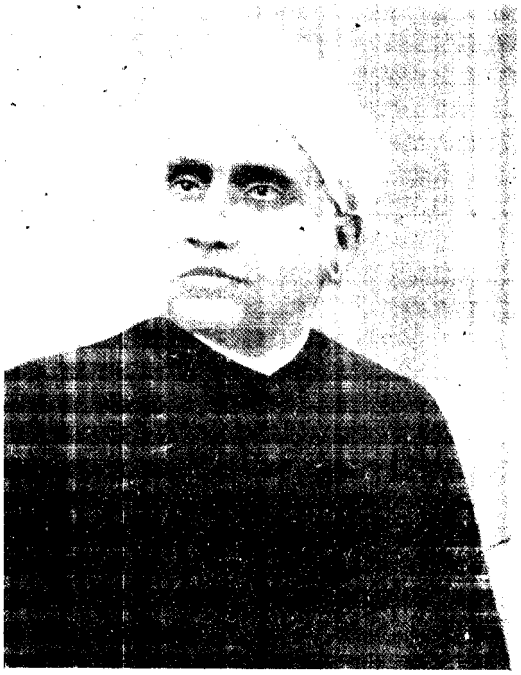
nected with the Association. In 1902, Dr. Sarasilal Sircar, then Assistant Chemical Examiner to the Government of Bengal, carried out some interesting investigations on crystalline copper ferrocyanide. In 1906, the Association undertook another important programme; it started recording meteorological observations twice daily and published them in the daily newspapers. This practice was continued for a long time. Another early scientific activity was the routine chemical analysis of foodstuffs and other articles, under the guidance of late Dr. Chunilal Bose. Some chemical problems were also investigated by Dr. Rasik Lal Dutta and two research scholars of the Association, Mr. Manindra Nath Banerjee and Mr. Jagadindra Nath Lahiri.

Prof. Raman and his pupils

In 1907, the course of events in the Association took a momentous turn. Mr. (now Sir) C. V. Raman, then an officer in the Finance Department of the Government of India, was attracted by the activities of the Association and started some experimental investigations in acoustics in its laboratories. Under the inspiration of Raman, the Association entered into a new period of continued and intensive research activities and developed into an active and leading research institution in the East, in fulfilment of the long cherished dream of its departed Founder.

Chandrasekhar Venkata Raman (born 1887) had been a student of physics of the University of Madras, where he had a uniformly brilliant academic career. While still a student he gave promise of originality in thinking and investigation, and is known to have carried out some researches in acoustics. The Government of his Province, however, did not consider him suitable for any post higher than one in the Subordinate Educational Service, and he was actually offered one in the said department. Raman refused



Prof. C. V. Raman

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this and like many other brilliant students, successfully competed for the Indian Finance Examination. He was stationed in Calcutta, but soon developed a great dislike for the dull routine work of his department. He planned to carry on in his spare time the researches he had begun in his early life and decided to join the Association.

In 1907, Raman was elected a member of the Association (next year a life member) and was permitted to carry on his investigations as a regular part-time honorary research worker. Although he could devote very little time to his investigations after attending to his duties in the office, and the facilities available in the laboratory of the Association were far from satisfactory, he was able, in course of a few years, to publish a fairly large number of original papers on acoustical problems in foreign scientific journals. These papers attracted the attention of the physicists of Europe and America, and students and young research workers began to flock to the Association to work under him.

The acoustical problems investigated by Raman during the early years (1912-1920) of his research at the Association include maintenance of vibration by variable spring, maintenance of combinational vibrations, motion in a periodic field of force, motion of bowed strings, vibration on bowed stringed instruments of violin family, partial tones in bowed strings, 'Wolfnote' in violin and other stringed instruments, alteration of tone by violin-'mute', 'wolfnote' in pizzicate playing, whispering gallery, Indian stringed instruments, mechanically played violin and forced vibrations of strings. Investigations dealing with discontinuous wave motion and the nature of aerial wave generated by impact were also undertaken. Among his early collaborators in acoustical problems may be mentioned the names of Mr. A. Dey, Dr. B. N. Banerjee, Dr. S. K. Banerji who rose to be Director General of Observatories, Dr. R. N. Ghosh, the late Dr. P. Das, and Mr. M. N. Mitra.

Joint Research Activity of the Association and the newly established University College of Science

The research activities of the Association received further impetus in 1917, when Mr. C. V. Raman, on the invitation of Sir Asutosh Mookerjee joined the Calcutta University as Palit Professor of Physics. The Palit Professorship was created through the munificence of Sir Tarak Nath Palit, a leading barrister of Calcutta, who gave his life's saving amounting to nearly 3 million rupees to the cause of science. But the College of Science at 92 Upper Circular Road had no laboratory yet, and the authorities of the Calcutta University were far-sighted enough not only to permit

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Prof. Raman to continue his researches at the Association, but also to allow him to borrow apparatus bought with the grants of the Universiy and set them up at the laboratories of the Association.

Prof. Raman was thus provided with the combined facilities and resources of the Palit Laboratory and of the Laboratories of the Association. Even some of the Palit research scholars carried out their investigations at the Association in order that Prof. Raman could supervise more conveniently the work carried out by them as well as that of the research scholars of the Association. By this time, owing to the munificence of Kumar Sri Panchanan Mookerjee of Uttarpara, grandson of Raja Peary Mohan Mookerjee, two research scholars could be appointed by the Association to assist Prof. Raman in his investigations. Thus the number of whole-time research workers increased and the Association developed into a great centre of research in Physics.

In 1921, Prof. Raman undertook a research tour in Europe and America, and in recognition of his services in founding a research school in physics, he was elected to the Fellowship of the Royal Society of London in 1924. At this stage, the Government of India also realized the importance of the work done at the Association and sanctioned an annual grant of Rs. 10,000 as contribution towards the research expenses in 1926, which was increased to Rs. 20,000 in 1927 partly through the influence of Sir R. N. Mookerjee, who was then the President of the Association.

With such increased resources and facilities of research, Prof. Raman now extended his sphere of investigations into the field of optics, X-rays and magnetism. Thus problems relating to (1) Interference and Diffraction of light, (2) Rayleigh-scattering, (3) Birefringence due to electric and magnetic fields, viscous flow and stress, (4) Magnetic susceptibilities of gases, liquids and solids, and (5) X-ray diffraction in liquids and solids were all investigated about this time. His investigations on light-scattering led in 1928 to the discovery of a new phenomenon known after him as the **Raman Effect.** A brief account of these investigation for which the fame of the Association spread far and wide appears in what follows.

Interference and diffraction of light

In optics, Prof. Raman and his collaborators including Drs. N. M. Basu (now Professor of Mathematics, Dacca University), P. N. Ghosh, B. N. Banerjee, N. K. Sethi, K. S. Rao and B. B. Ray undertook a series of investigations on interference and diffraction of light. Some of the important problems under this head include the

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diffraction of light by cylinders of large radius, diffraction figures due to an elliptic aperture, diffraction by straight metallic edges, colours of striations in mica plates, lamellar diffraction in mica, Powell's and Talbot's bands, Quetelet's rings, scattering of light by liquid droplets, the problems of coronas, glories and iridescent clouds and similar other interference phenomena.

Rayleigh scattering

Sir C. V. Raman's first work on light-scattering was a note in *Nature* on the Doppler effect in the molecular scattering of light. Subsequently he published several such notes dealing respectively with smoky quartz, colour of the sea, molecular scattering of light in crystals, molecular scattering in liquids, opalescence phenomena in liquid mixtures, thermal opalescence in crystals and the ice glaciers, the scattering of light by anisotropic molecules, by liquid and solid surfaces and structures of molecules in relation to their optical anisotropy and other topics. He also published a few papers dealing with scattering of light in the refractive medium of the eye, light scattering in water and its bearing on the colour of the sea, and light-scattering in amorphous solids and binary liquid mixtures.

Under his guidance Dr. B. B. Ray investigated the scattering of light by sulphur suspensions. A theory of light-scattering taking into account the anisotropy of the polarizing field of neighbouring molecules, was developed by Prof. Raman and Dr. K. S. Krishnan. They also made important contributions to the understanding of various optical and electrical properties of liquids. Dr. L. A. Ramdas working under Sir C. V. Raman investigated very extensively the scattering of light by liquid and solid surfaces and by gaseous mixtures at high pressures. Prof. Raman and Mr. K. S. Rao studied the problem of extinction of light in liquids and determination of the Avogadro constant. These two authors also studied the polarization of light scattered by gases and vapours.

Special mention should be made of the work of Dr. K. R. Ramanathan who investigated light-scattering in liquid mixtures, polarization of light scattered by some organic vapours and the structure of molecules in relation to their anisotropy. He investigated the electro-magnetic theory of scattering of light in fluids and discussed the problem of fluctuation of dielectric constant in liquids in the theories of scattering of light. Dr. I. Ramakrishna Rao investigated into the optical anisotropy of molecules from the experimental studies of the polarization of scattered light.

There were also other important workers in this branch of physics. The investigations of Dr. N. K. Sur on the light-scattering

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by smoky quartz, of Dr. A. S. Ganesan in oblique scattering of light in gases and liquids and the polarization of light scattered by organic vapours, of Dr. S. Venkateswaran on the molecular scattering of light in aqueous solutions and polarization of light-scattering in liquids, and of Dr. C. M. Sogani on the optical properties of chromatic emulsions, contributed significantly to our knowledge about the scattering of light and allied phenomena.

This list is far from complete, but is sufficient to indicate the thoroughness with which Prof. Raman and his Calcutta School organized research in the various aspects of scattering of light and related problems. As a matter of fact, the Association had at that time very few rivals even outside India, in the matter of research in optical scattering and was acknowledged to be one of the best centres of research in this subject in the whole world.

Messrs. Rama Chandra Rao, M. N. Mitra, A. N. Banerjee, Kameswar Rao and D. Banerjee also carried out useful work and published papers on light scattering.

Birefringence due to Electric and Magnetic fields, Viscous flow and Stress

In collaboration with Dr. K. S. Krishnan, Sir C. V. Raman discussed the theory of electric double refraction (Kerr effect) in liquids with special reference to the relative contributions of electric polarity and optical anisotropy to this effect and also the theory of mechanical birefringence in liquids. They started experimental investigation on magnetic double refraction with the help of a large electromagnet constructed in the workshop of the Association and studied the phenomenon in benzene and its derivatives and calculated the magnetic anisotropy of benzene molecule from its structure. Sir C. V. Raman and Dr. I. R. Rao and later Dr. Chinchalkar observed magnetic birefringence in aliphatic hydrocarbons, water, alcohols and a number of other compounds.

Dr. K. Banerjee studied the double refraction produced by stress in isotropic solids in relation to their internal atomic arrangements.

Magnetic susceptibilities of gases, liquids and solids.

Dr. V. I. Vaidyanathan developed a sensitive apparatus for the measurement of magnetic susceptibilities of gases with which he investigated the diamagnetic susceptibilities of a few gases and vapours.

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Dr. S. Bhagavantam studied the magnetic susceptibility of naphthalene and anthracene crystals and pointed out definitely that the structure of these crystals, determined previously by Sir William Bragg from results of X-ray analysis, could not explain the results of magnetic investigations obtained by him. Mr. Paramasivan discovered a remarkable anisotropy in magnetic susceptibilities of graphite and Dr. Ramachandra Rao found that the susceptibilities depended on the particle size.

In collaboration with Dr. K. R. Ramanathan he put forward a theory of diffraction of X-rays in liquids and amorphous solids. The experimental investigations to verify the theory were first carried out by Dr. C. M. Sogani. Dr. Krishnamurti found a correlation between the diffraction due to some powdered crystalline organic compounds and by those of the same substances in the liquid state.

The theory of Raman and Ramanathan was extended by Dr. K. Banerjee by taking into consideration the intermolecular forces; thus the correlation between the liquid and solid patterns observed by Dr. Krishnamurti could be explained. The phase diagram of the liquid alloy of sodium and potassium was also studied by Dr. Banerjee by means of X-ray diffraction.

Important investigations on the structure of solids by X-rays have also been carried out in this laboratory. Of particular interest are the structures of naphthalene and anthracene determined by Dr. Banerjee. These structures were different from those found previously by Sir William Bragg who later accepted the structures determined by Dr. Banerjee as correct ones and thus removed the difficulties of explaining the results obtained by Dr. Bhagavantam in his investigations on magnetic susceptibilities of these crystals. Mr. J. Dhar also completely analysed the structures of diphenyl and dibenzyl. Dr. C. Mahadevan did pioneering work in applying X-rays to the study of coal.

Discovery of Raman Effect and Subsequent Work

Prof. Raman's work in the scattering of light culminated in the discovery in 1928 of what is now universally known as the *Raman Effect* for which he was awarded the Nobel Prize in Physics for 1930. An account of the discovery of the Raman Effect was first published by Sir C. V. Raman in the *Indian Journal of Physics* in 1928. It was pointed out how the "weak fluorescence", which had been observed previously by the workers of the Association to persist even after careful distillation of the liquids, turned out to be

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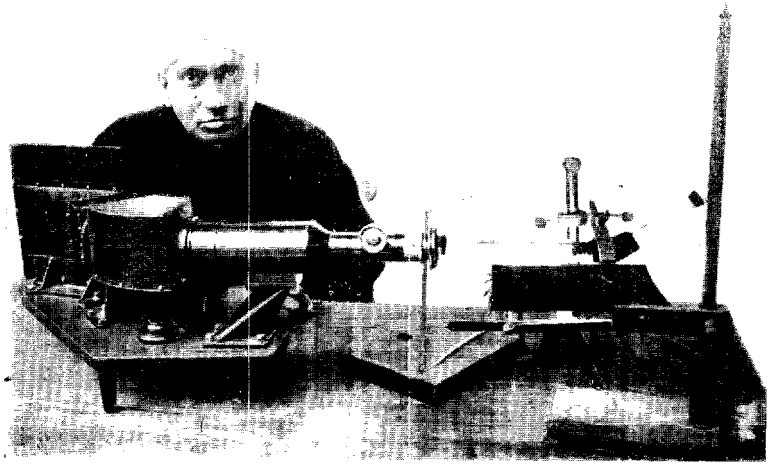
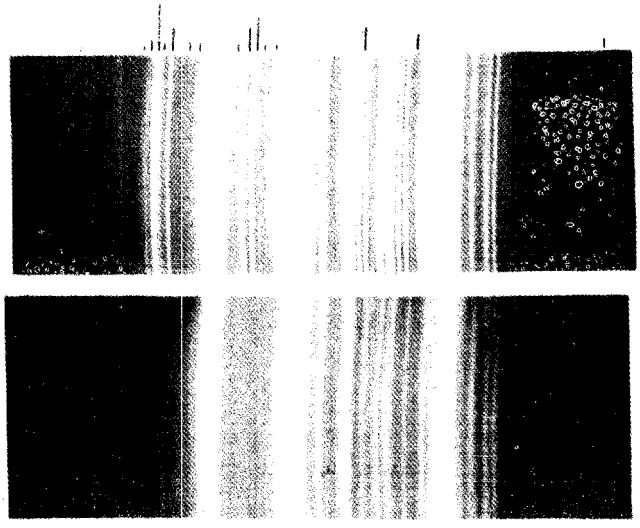
a scattered radiation with changed wave-length. The universality of the phenomenon was tested with complementary filters, but the



Prof. C. V. Raman with his Apparatus

spectral analysis of the light scattered by benzene was also made with the help of a very small Hilger quartz spectrograph. The first spectogram obtained by Sir C. V. Raman is reproduced below:



Discovery of Raman Effect
(From *Indian Journal of Physics*)

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In the paper mentioned above, Sir C. V. Raman announced only the observed degradation of frequency in light scattering. The enhancement of the frequency in light scattering was later observed by him in collaboration with Dr. K. S. Krishnan. These authors also pointed out in another communication the relation of frequency shifts observed in the Raman Effect with the frequencies of the extreme infra red absorption bands, and they studied in detail the Raman spectra of a few substances like benzene, toluene and water. The Raman spectra of calcite and quartz and the influence of temperature on the Raman effect, were also studied by Dr. Krishnan.

The notable workers in Raman Effect at the Association include Dr. L. A. Ramdas, Dr. S. Bhagavantam, Dr. P. Krishnamurti, Dr. S. Venkateswaran, Dr. A. S. Ganesan and Dr. S. C. Sirkar. Dr. L. A. Ramdas observed some Raman lines in the case of ether vapour. Dr. Bhagavantam studied the Raman spectra of a number of elements and simple molecules in the liquid and solid states and the polarization of the Raman lines due to some of the liquids. He next turned his attention to gases and studied the Raman spectra of hydrogen, oxygen, nitrogen, carbon dioxide, hydrogen sulphide, etc., at high pressures and the polarization and intensities of the Raman lines in some of these cases.

Dr. P. Krishnamurti studied the Raman Effect in crystal powders. He also studied the hydrolytic dissociation and formation of hydrates by Raman Effect.

Dr. S. Venkateswaran, Mr. A. Karl and Dr. A. S. Ganesan studied the Raman spectra of a large number of organic liquids.

The measurement of the relative intensities of Stokes and anti-Stokes lines in the Raman spectrum and also the influence of ultra-violet absorption frequency on these relative intensities received special attention by Dr. S. C. Sirkar. He also investigated experimentally the dispersion of polarization of the Raman lines and the influence of electric field on the polarization of the Raman lines. Mr. J. Dhar studied the relative intensities of Rayleigh and Raman lines in light-scattering.

K. S. Krishnan as the First M.L.S. Professor (1934-42)

In 1933, Sir C. V. Raman accepted the Directorship of the Indian Institute of Science, Bangalore, but he kept contact with the Association as its President till 1934.

The *Mahendra Lal Sircar Professorship* was founded in 1934 and Prof. K. S. Krishnan was appointed as the first M.L.S Professor. As a scholar at the Association he had collaborated with Prof. C. V. Raman in the discovery of the Raman Effect. In 1928 he accepted

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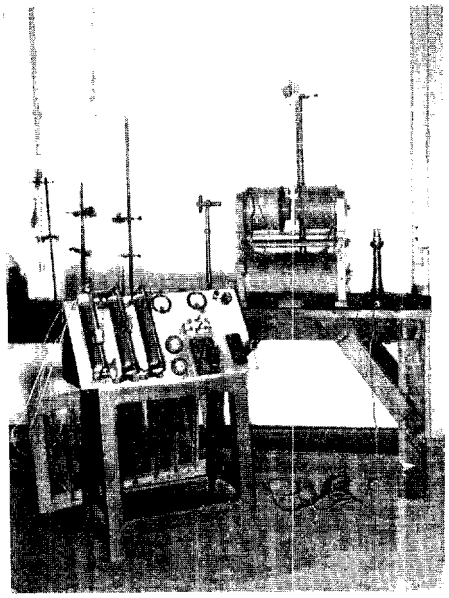
the post of Reader in Physics at the Dacca University and developed there a method for studying magne-crystalline action. After joining the Association as M.L.S. Professor, he continued this work in collaboration with his students. His own method of determination of the magnetic susceptibilities along different directions in the crystals, originally developed at Dacca, was improved at the Association, in collaboration with Dr. S. Banerjee and Dr. A. Bose. Jointly with these two authors and also with Mr. A. Mookherji he measured the magnetic susceptibilities and magnetic anisotropy of a large number of organic and inorganic crystals. These investigations guided many workers in their X ray analysis of structures of some of these crystals, and soon attracted widespread attention.



Prof. K. S. Krishnan



Prof. Krishnan's Apparatus for study of magne-crystalline action

Their magnetic studies of paramagnetic crystals threw considerable light on the nature of the crystalline fields. Dr. A. Bose, Mr. A. Mookerji and Dr. B. C. Guha undertook extensive studies on salts of the iron group of elements and rare earths beginning from room temperature to that of liquid oxygen with the help of an ingenious cryostat devised by Dr. A. Bose.

Prof. Krishnan in collaboration with Mr. N. Ganguly carried out an invetigation into the remarkable magnetic properties of graphite. They found that graphite possesses an extremely high anisotropy which

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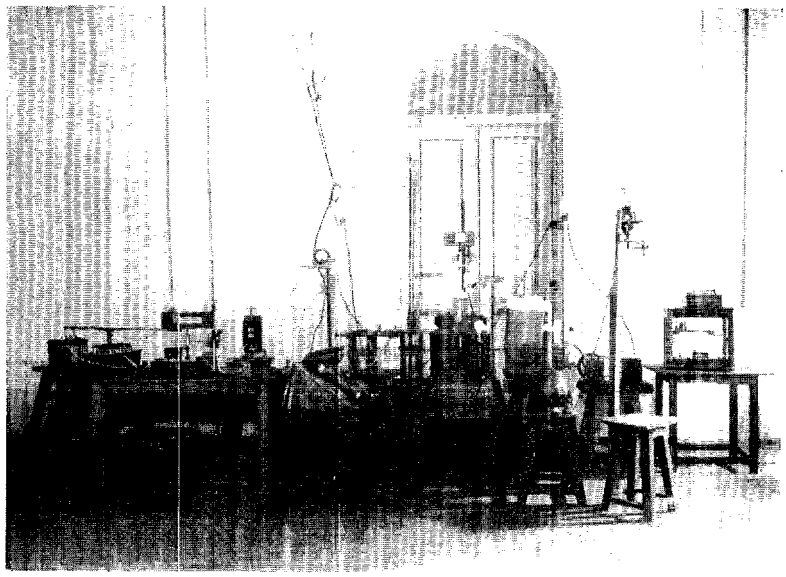
is temperature-sensitive. The results yielded very clear conceptions regarding the electronic structures of semi-conductors. The investi-



Cryostat for Magnetic Studies at Low Temperatures

gations were extended to bismuth and antimony crystals by Mr. W. J. John, working in this laboratory.

The absorption and fluorescence spectra of aromatic molecules of special structural interest in different physical states were extensively studied by Messrs. P. K. Seshan, D. C. Chakravarty and S. C. Ganguly under the guidance of Prof. Krishnan.

Dr. S. W. Chinchalkar measured the magnetic double refraction of many organic compounds in the state of solution in suitable solvents. The work was followed up by Messrs. Satya Prakash and L. D. Mahajan.

Investigations for the determination of the structure of some organic and inorganic crystals by X-ray methods were made by Messrs J. Dhar and A. C. Guha, Dr. H. K. Pal and Mr. S. L. Chorghade.

The principal refractive indices of various organic crystals were determined by Messrs Sundararajan and Chorghade.

Raman effect of organic, inorganic and organo-metallic compounds were studied in detail by Mr. N. Gopal Pai.

In recognition of his work on magnetic anisotropy and crystalline structure, Prof. Krishnan was elected a Fellow of the Royal Society in 1940.

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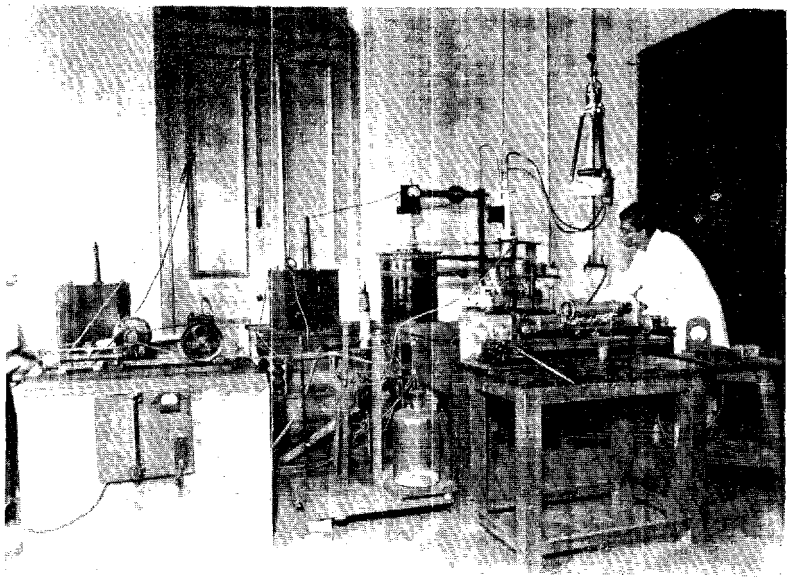
Prof. K. S. Krishnan left the services of the Association in 1942 on receiving a call to the Professorship of Physics at the Allahabad University. Even after he left the Association, Prof. Krishnan continued to be associated with it as a member of its Committee of Management (now known as its Council).

Research Work Under Prof. K. Banerjee as M. L. S. Professor during the period 1943-48

Before joining the Association as M. L. S. Professor, Dr. Banerjee had been carrying on X-ray analysis of crystal structure.



Apparatus for X-ray Analysis of Crystal Structure

The X-ray equipment of the Association has been considerably improved by him during this period, so that it has developed into a modern X-ray laboratory. During this period, owing to war-conditions most of the equipments required by him could not be purchased, and they had to be constructed in the workshop of the Association under his directions.

Very interesting results have been found from the investigations of Messrs. R. K. Sen and M. N. Datta, carried out under his guidance on the extra reflections from phloroglucine dihydrate and benzil crystals. The explanation of these phenomena offered by Dr. Banerjee resolves some of the difficulties in crystal dynamics. Investigations on the extra reflections from a number of other crystals have also been carried out by these workers. Messrs. B. K. Banerjee and B. S. Basak have obtained interesting results in their studies on glass and organic fibres with the help of X-rays.

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Mr. S. C. Ganguly has investigated the fluorescence of a few aromatic compounds both in the solid state and in solutions. He has investigated the influence of the frequency of the exciting radiation as well as of the temperature on the fluorescence spectrum. He has also investigated the absorption spectra of these substances.

Mr. A. Dutta has studied the magnetic properties, electrical conductivity and Hall effect of semi-conductors in different crystallographic directions at various temperatures ranging from —180° C to 200° C and has obtained results which have been very useful in understanding the nature of semi-conductors.

Research work under Dr. S. C. Sirkar, Reader in Physics during 1943

Dr. S. C. Sirkar was appointed a Reader in Physics in 1943 and carried out with Mr. B. M. Bishui investigations on the Raman spectra of a few alkyl sulphides in the solid state and of ethylene dibromide and dichloroethylene in different states. With Mr. S. B. Sanyal he studied the temperature dependence of intensities of Raman lines in the case of a few substituted benzene compounds. He further carried out in collaboration with Messrs. N. N. Saha and B. M. Rudra an X-ray analysis of jute fibre. He left the Association by the end of 1943 and joined the War Department and has recently been appointed Professor of Optics in this Association.

Scientific Publications

The Association published Annual Reports from its very foundation. The early reports are records of activities of the Association and of lectures delivered by Dr. Mahendra Lal Sircar as Secretary and by other members of the Committee of Management. These records are full of interest and information as to the state of scientific education and research then obtaining in India and will constitute an invaluable source for a history of scientific education and developments in India, if and when it comes to be written.

From 1906 the Association undertook to publish, as appendices to the Annual Reports, the records of meteorological observations and reports of the chemical analysis of the articles of general importance. In this way much useful scientific data received publicity at that time and have been preserved for future reference.

As research activities developed in the Association, the authorities keenly felt the need of a local scientific journal for prompt publication of the results of this work. At that time in India there was no medium for publication of original scientific papers of a general nature. The bulletins or reports of the Government scientific departments generally published survey types of work and were

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very specialized in scope. So the scientific workers had to send their results to foreign journals for publication, which meant unnecessary delay apart from other inconveniences.

These considerations led the Association in 1909 to start publication of a series of special research bulletins containing results of investigations carried out at the Association. The first five bulletins were only reprints of publications in such important journals as *Philosophical Magazine*, *Physical Review* and *Nature*. From 1912, however, original papers and contributions, not published elsewhere, appeared in these bulletins. Before long these bulletins received widespread appreciation for the high standard of their communications, and their publication became a regular feature of the Association.

In 1914, a separate section designated as *Transactions of the Science Convention* was introduced in the Annual Reports. In this section were published proceedings of the scientific meetings at which original papers were read and discussed. At first, these meetings were few and the numbers of papers limited, so that a small separate section at the end of the Annual Reports proved quite sufficient for recording such activities. But with the increase in the volume of research work, the scientific meetings of the Association were organized more frequently, and larger number of papers came to be read and presented for discussion. The little space devoted to the "Transactions of the Science Convention" in the Annual Report now failed to cope with such increasingly large number of papers accumulating throughout the year, and necessity arose for a separate journal to be published at more frequent intervals. The **Proceedings of the Indian Association for the Cultivation of Science** thus came into publication. It is of interest to note that the first issue of the **Proceedings** appeared with a paper by Sir P. C. Ray, read at one of the scientific meetings of the Association, held on February 6, 1915.

Initially, most of the papers published in the **Proceedings** were local contributions, but its high standard soon appealed to scientific workers all over India, and it became the only scientific medium in the country for publication of research papers in all branches of sciences. As the research activities of the Association, under Prof. C. V. Raman, became more and more concentrated on physics, contributions on other sciences received for publication fell off rapidly, and the **Proceedings** turned out to all intents and purposes to be a journal of physical researches. In 1926, it was, therefore, decided to change the title of the journal to **Indian Journal of Physics and Proceedings of the Indian Association for the Cultivation of Science.**

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The Indian Journal of Physics has so long been published bi-monthly; it has been converted into a monthly journal this year. It is recognised throughout the scientific world for its high standard and quality. Its present popularity is largely due to the unsparing efforts of the authorities of the Association and of thousands of scientific workers who have preferred this journal to foreign scientific periodicals as a medium of publication of their investigations. In this connection mention should be made of the very active co-operation and assistance of the Calcutta University which offered to publish the journal free of cost. Recently, the Journal received a grant from the Rockefeller Foundation, through the National Institute of Sciences of India. Despite such voluntary co-operation and help, the financial position of the journal has never been very happy, and more funds are needed for its further improvement.

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PART III

DEVELOPMENT PLANS

The remarkable and striking achievements of science in recent years have completely revolutionized the traditional technique of scientific research. Until recently the development of science centred round individual workers each cloistered in his own laboratory and pursuing his favourite line of work. But scientific knowledge has grown to such an extent and the different methods of tackling a problem are so inter-related that though solitary workers can still be expected to make notable contributions to the cause of science, there are certain types of scientific investigations which require well-directed team work.

The Committee of Management of the IACS during the war-years of 1943-1946 realized the supreme need of re-organizing the activities of the Association so that it might play an increasingly important part in the domain of fundamental researches in Molecular Physics, a branch of science in which it has made a name and has a tradition to cherish. The Committee very rightly felt that it must not be satisfied with any plan of mere re-building and extension of the laboratory or of improvement of its equipment, but that the planning must recognise the new trends and tendencies of scientific research. The plan ultimately formulated by the Committee early in 1946 envisaged the creation of an active Research School where the problem of Molecular Structures would be investigated by the concerted team work of a band of physicists and chemists. The entire resources of the Association for fundamental researches in X-rays, Optics, Raman Effect and Magnetism would be fully utilized and the works in these fields would be supplemented, co-ordinated and blended with the works of a Theoretical Physicist, a Physical Chemist and a specialist in Optics, and with the researches of an Organic and an Inorganic Chemist in the field of Structural Chemistry. In fact, the plan is for a more intensive and unified study of problems which the Association has set as its goal almost from its inception, and this is sought to be done by starting the five new Departments referred to above.

Our statesmen and scientists have begun to realize that if India is to take her rightful place in the Assembly of Nations it is highly necessary for her to undertake an intensive programme of simul-

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taneous and co-ordinated development of both fundamental and applied research. It is now recognised that such researches alone can ensure the security of a country in war and its prosperity in peace. It is hoped that India will inaugurate a new era where fundamental and industrial researches will be harnessed for the service of her people.

The Committee of Management of the IACS has kept it in view that the future programme of work of the Association must necessarily be planned in consonance with the general plan of research enterprise in India, and the scope and functions of its line of researches should be such that the results achieved would find application in the study of subjects of technical importance. For the present the Committee has chosen to concentrate on investigations in the physics and chemistry of High Polymers.

This subject has attained enormous scientific and industrial importance during the last 25 years. Next to Atomic Energy this is to-day receiving the greatest attention of chemists and physicists of Europe and America, but unfortunately it has not yet attracted sufficient attention in our country. High polymers include such diverse substances like Rayon and Nylon; synthetic rubber and gutta percha; nitro-cellulose lacquers, varnishes and adhesives; and Plastics. Synthetic products like Nylon bid fair to eclipse all old established fibre industries; synthetic rubber has already become a major war and peace-time material; and plastics have found such wide applications that it is truly said that from the age of steel we are fast passing into an age of plastics. Industrial India of the future will have to develop these industries on her own.

The IACS with its equipments and resources, and its proposed personnel and experience, will be one of the Institutes best fitted to undertake pure and applied researches in this subject. The studies of its Departments of Chemistry would be helpful in understanding the chemistry of polycondensation and polymerisation in all its aspects and in utilizing this knowledge for industrial application in our country; while the researches of the different Departments of Physics would supply data regarding the optical, electrical and thermal properties of the products, and help to throw light on the internal structure and valence forces responsible for polymer formation.

ADMINISTRATION, STAFF, BUILDING AND EQUIPMENT

Administration

The general administration of the Association, according to the new Rules which have been approved by the Government of India, is

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vested in the Life Members, Ordinary Members, and Members of other categories, whose general direction and advice is sought through a General Meeting of the Association which is usually summoned once a year, but may be summoned at any time for specified, extra-ordinary reasons.

Under the new regulations, the scope of membership has been widened, enabling provincial governments, city corporations, and industrial firms to be associated actively with the development and administration of the Association.* It is hoped that these new avenues will be exploited by the parties concerned.

The actual administration is vested in a Council of 22-28 members, of whom 12 are elected by the general body of members, 4 are nominated by the Government of India (Ministry of Education) including two nominees of the National Institute of Sciences of India, and up to 5 members are elected by Donors and Subscribers. 10 members of the Council must retire every year. The Office-bearers of the Association are the President and 2 Vice-Presidents.

Between the meetings of the Council, the administration will be carried on—in special cases, in consultation with the President—by the Director who will generally be a whole-time, salaried officer of the Association.

The financial affairs of the Association are looked after by the Finance Committee of the Council, and by a body of 5 Trustees, elected for life by the Association.

Personnel of the Staff.

The Research Departments proposed are:

(1) X-Rays & Magnetism (2) Optics (3) Theoretical Physics (4) Physical Chemistry (5) Organic Chemistry (6) Inorganic Chemistry—each under a Professor or Reader.

To assist the Professor or Reader in each department there would initially be:

one Research Officer, one Laboratory Technician, one Senior Research Scholar and two Junior Research Scholars;

but the personnel will have to be increased in near future. In addition to these, necessary technical staff would be provided for the

*Any association or corporate body will, on payment of a sum of not less than Rs. 2,500/-, enjoy the rights of Life Membership. And further, each association or corporate body or person making a donation of Rs. 2 lakhs, or subscribing a sum of not less than Rs. 10,000 annually, shall have the further right of electing one nominee to the Council of the Association; provided that—in the event of the number of members so eligible exceeding five, a Donors' Constituency shall be formed with all such donors to elect *five* nominees to the Council.

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laboratories, workshop, glass-blowing, gas production, and auxiliary services of the laboratory, details of which have been worked out by the Council.

In order to ensure co-ordination of work of the different departments, the Professors will be required to meet at least once every month, under the chairmanship of the Director.

To meet the growing needs of the newly-created Departments, the library will also have to be expanded with a larger range of periodicals and standard books of reference.

The administrative work will increase to a considerable extent, and a Registrar has been appointed to look after routine administrative work under the supervision of the Director. Under the new Constitution, he is the *ex-officio* Secretary of the Association, its Council and all its committees.

Site

The Association being at present housed in a crowded locality in Calcutta, schemes of expansion are difficult to carry out. It is therefore contemplated to sell out the present land and building and to shift to a quieter part where land sufficient for the full development of the Association is available for a modest price. The Council has been able to acquire, through the good offices of the Bengal Government, a plot of land covering nearly 29 bighas at Jadavpur. The land adjoins the buildings of the College of Engineering and Technology, Bengal, and that of the Central Glass and Ceramic Research Institute (under C.S.I.R.). The Association will thus have neighbours most intimately interested in researches of an applied type.

The lay-out map of our new home attached to this brochure shows the tentative plans for all the buildings. The completion of the project will take a long time, but for the present the Council is taking up the construction of the main laboratory building which is to be a partly three-storied and partly two-storied structure with a total built-up area of 80,000 sq. ft. It is being so planned that there will be ample scope for future extensions without impairing the architectural harmony of the structure. The building will incorporate recent ideas of laboratory construction and laboratory services, and will provide accommodation for all the laboratories, library and meeting halls, and for an athenæum.

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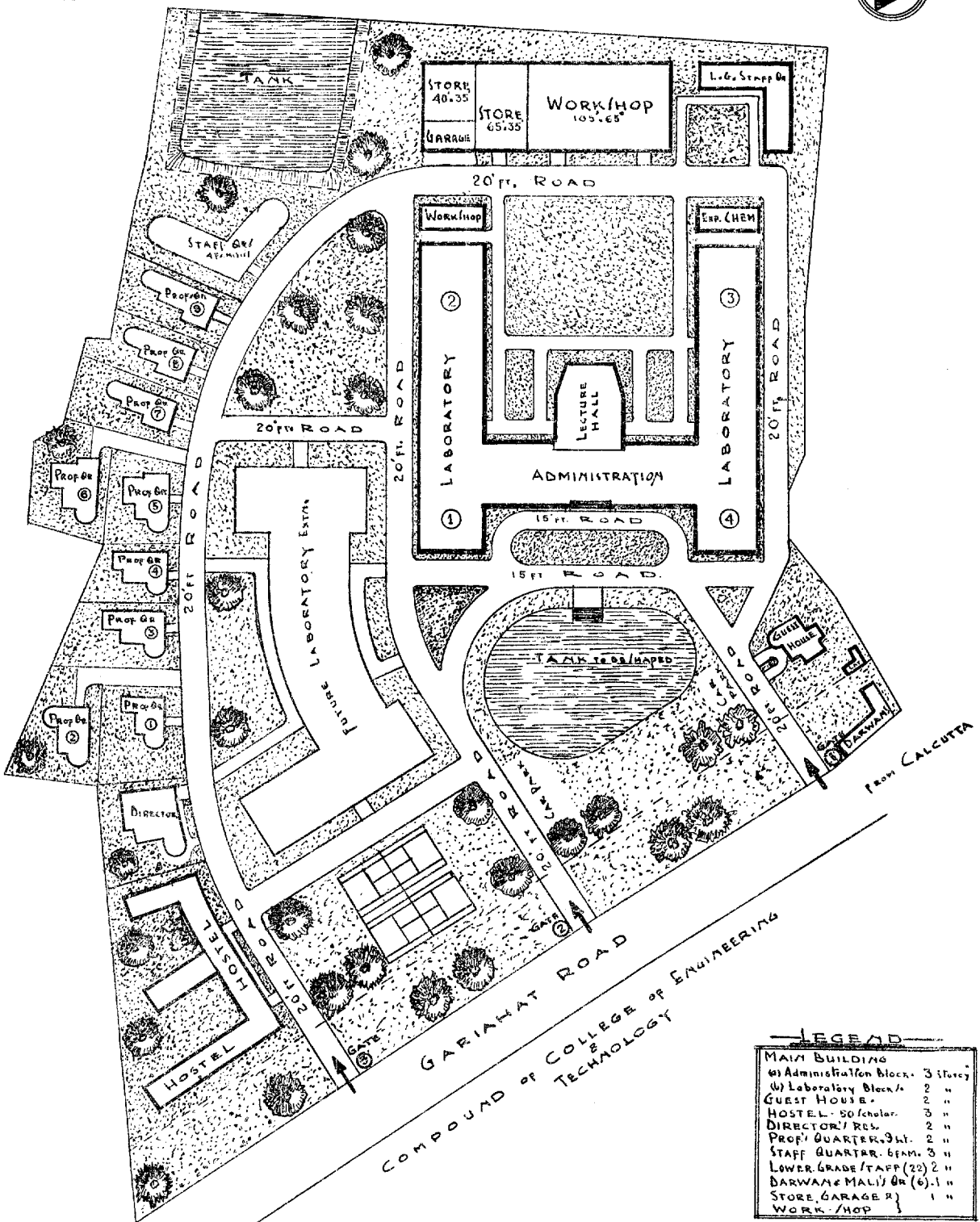
PROPOSED RESEARCH LABORATORY AT JADAVPUR

FOR INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE.

SCALE — 0 50 100 150 200 FEET.



LEGEAD

MAIN BUILDING	
(a) Administration Block.	3 Storey
(b) Laboratory Block/s	2 "
GUEST HOUSE.	2 "
HOSTEL. 50 scholar.	3 "
DIRECTOR'S RES.	2 "
PROF'S QUARTER. 3 bl.	2 "
STAFF QUARTER. 6 fam.	3 "
LOWER GRADE STAFF (22)	2 "
DARWAN & MALI'S QR (6).	1 "
STORE, GARAGE & WORK./SHOP	1 "

DRAWN BY. B.M.C. | DRAWING NO 31-45-1 | LAY OUT PLAN | CHAUDHURI & GUHA

DATE - 2.2.48

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ENGINEER-ARCHITECTS

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FINANCIAL IMPLICATIONS OF THE SCHEME

The financial implications of the present scheme may be summarised as follows:—

Estimate of Capital Costs:

Cost of land acquisition	..	Rs. 5,00,000
Cost of construction of the laboratories and workshop	..	,, 17,00,000
Electric connections, gas and water lines, laboratory fittings, provision for water supply and gas production	..	,, 5,00,000
New apparatus for the laboratories	..	,, 2,50,000
Additional workshop equipments	..	,, 75,000
	Total	Rs. 30,25,000

Thus, in giving full effect to the immediate scheme a capital expenditure of about thirty lacs of rupees will be involved.

The Government of India has sanctioned an interest-free loan of Rs. 5,00,000 and has provided further capital grants of Rs. 3,10,000 in 1947-48 and Rs. 1,22,000 in 1948-49. The Association has thus available a total sum of Rs. 9,32,000 only and it would require a further sum of about twenty-one lacs of rupees for the construction of all the laboratories and for their full equipments. The Council has therefore thought it necessary to issue a public appeal for funds, a copy of which is given in the appendix.

The laboratories would be located outside the city and the Council therefore contemplates that residential quarters for the staff and a hostel for the scholars should be provided.

Estimate of Recurring Expenses:

The Council has fixed the salaries of the staff and remuneration for the scholars in the light of those adopted for the National Laboratories of India and recommedation of the Central Pay Commission. It is estimated that to give full effect to the initial scheme a sum of Rs. 3 lacs would be required in the first year, thereafter rising progressively to about Rs. 4.3 lacs. This includes all salaries and scholarships, provident fund contributions, grants for the laboratories, workshop and library, contingencies, maintenance charges, and dearness allowances. With the strengthening of the research personnel and the opening of new departments the cost will naturally go up higher.

The Government of India has sanctioned a sum of Rs. 2,66,700 for 1948-49 and subsequent years; and the Council has a normal income of

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about Rs. 17,000 only per annum from endowments etc., which can be utilised for the establishment. Thus the amount available to the Association falls far below its requirements, and the Council appeals to the Government and the generous public for funds to meet the deficit in the capital expenditure, and for adequate endowments or annual grants on a permanent basis.

Research departments in the Universities and Research Institutes like the IACS are national assets, and as such, they have a legitimate claim on the national income. In fact, research expenditure has already assumed a significant proportion of the national expenditure in western countries. It is encouraging to note that the Government of India has recognised the utility of such expenditures in starting and maintaining several National Research Institutes and subsidizing Research Associations. It is high time that our industrialists should also utilize these Research Associations to their advantage. The Indian industrialists will now have to face a ruthlessly competitive world and it would be a mistaken policy to depend for their success upon tariff protection, abundance of raw materials, cheapness of labour and other similar factors. They must move forward and find out ways and means for increasing application of the results of pure research in a constant endeavour to improve their products. Not every commercial concern can, however, maintain adequately equipped and properly staffed research laboratories; and Research Associations could be of immense benefit to them.

The Council of the IACS has planned that the Association would also undertake both short-time and long-range research problems on the Industrial Fellowship basis. Such Fellowships can be created by individual industrial concerns or by associations of manufacturers. The Mellon Institute of Industrial Research in the U.S.A. provides a parallel of a private organization of research workers where this system of Industrial Fellowship has worked very satisfactorily. The following excerpt from an annual report of the Institute will convey an idea as to how the system works:—

> "The Institute provides laboratory, library, and consultative facilities, the use of its permanent research equipment, direction to the progress of the work, and an atmosphere which is conducive to productive investigation. Each Industrial Fellowship is a case of trust, and knowledge concerning its progress and subject matter is withheld from the public, if the donor so desires..... Further, the knowledge gained by one Industrial Fellow along one investigational line becomes available to another research man, provided that such co-operation violates no trust.
>
> Reports are placed in the archives of the Institute to be released for publication at such a time as will not injure the interests of the donor. No

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scientific or technical papers are prepared for publication without the consent and approval of the donor concerned....."

"The donor, on his part, provides a foundation sum which is adequate to cover the annual cost of maintenance of the Industrial Fellowship, which includes operating charges, the purchase of all necessary special apparatus or other equipment, and the salary of the research man or men selected to work on the particular problem....."

In 1911-12 the number of such Fellowships in this single Institute was 11, the number of Fellows 24, and research expenditure £39,700; whereas, in 1946-47 the corresponding figures were 80, 295, and £6,67,817,—which reflects the growth, popularity and serviceability of the system. The Council of the IACS hopes that our industrialists will also adopt this system with benefit to themselves and to the cause of a healthy growth of science in our country. Calcutta being the biggest industrial centre in India, the institution of Industrial Fellowships is expected to meet with large response.

RESUME

The history of the Indian Association for the Cultivation of Science is the story of a group of persons whose visions were far in advance of their times and who dedicated their lives for the scientific advancement of their country. At a time when there was no arrangement for scientific instruction anywhere in India, they founded the Association to spread scientific knowledge among the people and to train up scientists who later disseminated far and wide the knowledge acquired by them. The Association demonstrated that high class scientific discoveries of international importance are possible in India as well. Under great difficulties of every description the Association inspired, nourished and fostered this spirit of research and thus led the way to the establishment of other research institutions and research centres under the Science Faculties of the Universities. By publishing a scientific journal of a high standard it encouraged further research activities. It has produced two Fellows of the Royal Society and the only Nobel Laureate in scientific subjects in the East and thereby raised the status of India in the world of Science.

The Association is at present faced with a difficulty that was not so formidable in the past. Within the last two decades research techniques have changed enormously. High traditions and collection of a batch of industrious, selfless and talented workers can no longer be of much avail in a laboratory with weak finances and consequently poor equipments. The Association with its long and glorious record of solid achievements is a national asset. It is, therefore, up to the nation to find the finances for strengthening the research personnel and improving its equipments so that the country may reap the fullest benefit from its activities.

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APPENDIX I

Presidents and Honorary Secretaries of the Association

For the first 35 years of its existence the Association used to have the Lieutenant-Governor of Bengal as its President. But since 1912, it has been the practice to elect non-official presidents.

The invaluable services rendered to the Association by its Founder-Secretary Dr. Mahendra Lal Sircar (1876-1904), by Raja Peary Mohan Mookerjee as Vice-President (1876-1911) and then as President (1912-25), by Dr. Amrita Lal Sircar as Secretary (1904-1919), by Sir C. V. Raman as Secretary (1919-33) and then as President (1934), and by Sir K. S. Krishnan as Secretary (1934), have already been mentioned in detail in the body of this report. The efforts of some of the presidents and secretaries who took particularly great interest in advancing the cause of the Association within recent years, deserve special mention here.

PRESIDENTS: Sir R. N. Mookerjee, the great industrialist of Calcutta, helped Sir C. V. Raman in securing a grant of Rs. 20,000 per annum from the Government of India in 1927-28, and thus to maintain the large and increasing number of scholars which gathered round him. Sir U. N. Brahmachari (1942-46), great as a medical practitioner and greater still as an investigator whose discovery of Urea Stibamine saved millions of lives in India, took very great interest in the affairs of the Association in spite of failing health, and scarcely missed any single meeting. He was responsible for enlisting a large number of life members and ordinary members, and he had other larger plans in the making when he was snatched away by the cruel hand of Death. We hope that his sons would give practical shape to his wishes which are well-known to them.

Professor Meghnad Saha, the present President, has been connected with the Association since 1926, when he became a life-member. So long as he was at Allahabad he could not take much active interest in the affairs of the Association. Since his return to Calcutta in 1938, he has been actively associated with the administration of the Association as a member of the Committee of Management, as Vice-President, and since 1945, during the long-illness of Sir U. N. Brahmachari, as acting President, and afterwards as President. After the reorganisation of the Association, he has been unanimously re-elected as its President.

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The new plans for reorganisation and active measures to give effect to the schemes were evolved during the regime of Prof. Saha as President, and Prof. P. Ray as Secretary. We have to thank above all, for the successful negotiation with the Government of India, Dr. D. M. Sen, Deputy Secretary of the Ministry of Education, Sir S. S. Bhatnagar, Director, Council of Scientific and Industrial Research, Sir J. C. Ghosh, Prof. J. N. Mukherjee and others.

SECRETARIES: The Association has been fortunate to have very eminent scientific men as Secretaries, whose services have been recorded in the body of the report. Profs. S. K. Mitra and J. N. Mukherjee were Secretaries from 1934-1935, and 1935-1944, and with their usual energy and devotion piloted the Association skilfully through a period of great unrest and difficulties.

The Association has thus been able to receive devoted honorary services of many public-spirited citizens and scientists of the country as Presidents, Secretaries, and members of the Committee of management (now Council) during the first seventy-two years of its existence; and if, as it hopes, the future citizens and scientists of India continue to come forward with the same spirit of service, its future is assured.

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Past Presidents.

1876—The Hon'ble Sir Richard Temple.
1877—Sir Ashley Eden.
1882—Sir Rivers Thompson.
1887—Sir Steuart Bayley.
1890—Sir Charles Elliot.
1895—Sir Alexander Mackenzie.
1898—Sir John Woodburn.
1903—Sir Andrew Henderson Leith Fraser.
1909—Sir Edward Norman Baker.
1912—Raja Peary Mohan Mookerjee.
1925—Sir B. C. Mahtab, The Mahárájádhiraja Bahadur of Burdwan.
1927—Sir R. N. Mookerjee.
1934—(Jan.-June)—Sir C. V. Raman.
1934—Sir Nil Ratan Sircar.
1942—Sir U. N. Brahmachari.
1946—Prof. M. N. Saha (re-elected, Dec. 1947, under the new Constitution).

Past Honorary Secretaries.

1876—Dr. Mahendra Lal Sircar.
1904—Dr. Amrita Lal Sircar.
1919—Sir C. V. Raman.
1934—Sir K. S. Krishnan.
1934—Prof. S. K. Mitra.
1935—Dr. J. N. Mukherjee.
1944—Prof. M. N. Saha.
1944—Prof. P. Ray.
(The office has been discontinued under the new Constitution).

Director.

1947—Prof. P. Ray (Honorary).

Trustees

Hon'ble Mr. Justice C. C. Biswas.
Mr. Nirmal Chunder Chunder.
Dr. Bimala Churn Law.
Mr. Ramaprasad Mookerjee.

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APPENDIX II

Who is who among the past Research Workers of the Association

Banerjee, A. N.	....	Professor of Physics, Surendra Nath College, Calcutta, and Assistant Editor, Indian Journal of Physics.
Banerjee, B. N.	....	Formerly Meteorologist, Government of India. Retired from service a few years ago.
Banerjee, D.	....	Lecturer in Physics, Calcutta University.
Banerjee, K.	....	Reader in Physics, Dacca University, (1933-43); joined this Association as Mahendra Lal Sircar Professor of Physics in March, 1943. F.N.I.; President, Physics Section of Indian Science Congress, 1947.
Banerjee, S.	....	Formerly Senior Research Assistant, Inspectorate of Stores at Cawnpore. Has just come from America after specialising in Geophysics.
Banerji, S. K.	....	Director-General of Observatories; F.N.I. President, Physics Section of Science Congress, 1923; past President, Indian Physical Society.
Basu, N. M.	....	Professor and Head of the Department of Mathematics, University of Dacca.
Bhagavantam, S.	....	Principal, Science College, Andhra University, President, Physics Section of Indian Science Congress, 1946.
Bhattacharyya, D. K.		Professor, Patna University. Since retired.
Bose, A.	....	Professor, Jagannath College, Dacca; now Research Officer, Indian Association for the Cultivation of Science in the Department of X-rays and Magnetism.
Chakravarty, D. C.	....	Lately, Registrar, Bose Research Institute, Calcutta.
Chinchalkar, S. W.	....	Professor of Physics at King Edward College, Amraoti (Berar).
Choreghade, S. L.	....	Assistant Meteorologist.
Das, P.	....	Was part-time Lecturer in Applied Mathematics, Calcutta University. Since deceased.
Deb, S. C.	....	Assistant Director of Industries, Government of West Bengal.
Dey, A.	....	Was Prof. Raman's Laboratory Assistant, but did some research work.
Dhar, J.	....	Head of the Department of Physics, Indian School of Mines, Dhanbad.
Ganesan, A. S.	....	Professor of Physics, Science College, Nagpur.
Ganguly, N.	....	Professor of Physics at St. Edmund's College, Shillong.
Ganguly, S. C.	....	Professor of Physics at Bangabasi College, Calcutta.
Ghosh, P. N.	....	Was Sir Rash Behari Ghosh Professor and Head of the Applied Physics Department, Calcutta University; F.N.I.; President of Physics Section, Indian Science Congress, 1941. Died on the 23rd December, 1946.
Ghosh, R. N.	....	Reader in Physics at the Allahabad University. F.N.I.
Guha, A. C.	....	Professor of Physics at K. N. College, Berhampore, Bengal.
Guha, B. C.	....	Lecturer, Presidency College, Calcutta.
Krishnamurti, P.	....	Joined the Indian Institute of Science, Bangalore, as Personal Assistant to the Director. Now Officer, Gas Mantle Co., Bangalore.

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Krishnan, K. S.	....	Reader in Physics, Dacca University (1928-33); M.L.S. Professor at the Association (1934-42); Professor of Physics, Allahabad University (1942-47); now Director, National Physical Laboratory. F.N.I.; F.R.S. President, Physics Section (1941) and elected General President (1949), Indian Science Congress.
Mahadevan, C.	....	Joined the Geological Department, Hyderabad and is now a Professor of Geology and Head of the Department, Andhra University. Elected President, Geology Section, Indian Science Congress, 1949; F.N.I.
Mahajan, L. D.	....	Professor of Physics at the Maharaja's College, Patiala.
Mitra, M. N.	....	Joined the Bengal Education Service; since retired from service.
Mookherji, A.	....	Professor of Physics, Birla College, Pilani.
Mukherjee, B. N.	....	P.A. to Director, Lac Research Institute, Nankum. Ranchi.
Pai, N. Gopal	....	Now in the Institute of Hygiene and Health, Calcutta.
Pal, H. K.	....	Prof. of Physics, A. M. College, Mymensingh.
Parthasarathy, S.	....	Assistant Director, B.S.I.R.
Rai Chaudhuri, D. P.		Senior Professor of Physics, Scottish Church College, Calcutta.
Raman, C. V.	....	Worked in the Association, 1907 to 1933: was its Secretary (1919-33) and President (1934). Palit Professor of Physics, Calcutta University (1916-33); Director (1933-35) and then Professor of Physics, Indian Institute of Science. Fellow of the Royal Society; Nobel Laureate; President, Phyiscs Section (1924), and General President (1929), Indian Science Congress.
Ramanathan, K. R.	....	Superintending Meteorologist, Meteorological Office, Poona. F.N.I.; President, Physics Section, Indian Science Congress, 1939.
Ramdas, L. A.	....	Agricultural Meteorologist at Poona. F.N.I.; President, Physics Section, Indian Science Congress, 1948.
Rameswaram, C.	....	Meteorologist, Government of India.
Rao, I. R.	....	Formerly Reader in Physics, Andhra University, now Director of Research, Andhra Scientific Apparatus Co.
Rao, K. R.	....	Professor of Physics at the Andhra University, Waltair.
Rao, S. Ramachandra		Formerly Professor of Physics, Annamalai University; now Professor of Physics, Mysore University, Central College, Bangalore.
Ray, B. B.	....	Was the Khaira Professor of Physics, Calcutta University; President, Physics Section of Science Congress, 1942. Died on the 29th July, 1944.
Seshan, P. K.	....	Assistant Foreman, H. E. Factory at Kirkee.
Sethi, N. K.	....	Professor of Physics at the Agra University.
Sirkar, S. C.	....	Reader in Physics at this Association in 1943; Radiologist, Inspectorate of Ammunition, Kirkee, Poona; then Lecturer in Physics, Calcutta University; now Professor of Optics at the Association. F.N.I.
Sogani, C.	....	Lecturer in Physics, Benares Hindu University.
Sur, N. K.	....	Regional Director, Meteorological Department; now retired.
Vaidyanathan, V. I.	....	Physicist, River Research Institute, Madras.
Venkateswaran, S.	....	Trade Marks Registrar, Bombay.

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APPEAL

In releasing the present Report on the working of the Indian Association for the Cultivation of Science the Council wishes to appeal to the public for generous contributions to its funds, so that the Association may be enabled to fulfil its objective of serving the cause of humanity and of the country through science.

The contributions may take the shape of:

(a) permanent endowments for a particular objective, viz. institution of Professorships, Readerships or Fellowships (e.g. the Mahendra Lal Sircar Professorship founded by the late Rai Bahadur Vehary Lal Mitra), or construction of laboratories;

(b) temporary contributions for Fellowships particularly Industrial Fellowships, or other objectives;

(c) Life Memberships on the part of firms or individuals.

The Association has to raise an amount of about 20 lacs of rupees to fulfil its present objective. This will enable the Council to give effect to its present schemes of development for which the Government of India has made a generous donation of Rs. 9.32 lacs for land acquisition and construction, and a recurring grant of Rs. 2.667 lacs for current expenditure.

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CALCULATION OF THE PIEZO-ELECTRIC CONSTANTS OF α-QUARTZ ON BORN'S THEORY

By BISHAMBHAR DAYAL SAXENA and KRISHNA GOPAL SRIVASTAVA

(Received for publication, July 31, 1948)

ABSTRACT. The relationship between the piezo-electric, dielectric and elastic constants has been obtained on Born's method and it has been shown that by using a generalised system of force-constants, results are obtained which are much nearer the observed values than those obtained on Born's assumption of the validity of Cauchy's relationship. Using only four force-costants, calculations have been made of 17 other constants in approximate agreement with observed values namely 2 piezo-electric constants, 7 elastic constants and 8 Raman and infra-red frequencies. The calculated values of the piezo-electric constants are $\epsilon_{11}=7.56\times10^4$ and $\epsilon_{41}=3.18\times10^4$, (obs. 5.1×10^4 and 1.23×10^4).

INTRODUCTION

The electric moment developed in the crystal due to strain is related to the components of the strain by a general relation of the form $p_i=\epsilon_{kli}u_{kl}$ where p_i are the components of a vector 'p' and u_{kl} are the components of the strain. In α-quartz, which belongs to the point group D_3 there are only two piezo-electric constants given by the equations :—

$$p_x=\epsilon_{11}(u_{xx}-u_{yy})+\epsilon_{41}u_{yz}.$$
$$p_y=-\epsilon_{11}u_{xy}-\epsilon_{41}u_{xz}.$$
$$p_z=0 \qquad \ldots \quad (1.1)$$

p_x, p_y, p_z, are the components of the electric moment along the axes x, y, z, of the crystal—x being the electric axis, z the optical axis and y the mechanical axis at right angles to both, and ϵ_{11} and ϵ_{41} are the longitudinal and transverse piezo-electric constants. The best values of ϵ_{11} and ϵ_{41} according to Cady (1945) are 5.1×10^4 and 1.23×10^4. In our calculation of the peizo-electric constants we first find the relationship between the piezo-electic, dielectric and elastic constants by following the work of Born and Meyer (1924) on ZnS. We have then obtained the piezo-electric constants by using a generalised force system of valence forces, intra-valence forces and deformation forces.

According to the work of Born, which refers to ionic crystals of the cubic type, Cauchy's relations will hold for piezo-electric crystals (*i.e.*, crystals not possessing a centre of symmetry) provided the piezo-electric forces were not taken into account. This implies, as shown later, that central forces alone are responsible for the elastic equilibrium, which is not true since Cauchy's relations do not hold even for some cubic metals like gold, silver and

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tungsten. We have shown that by adopting a more generalised force system for which Cauchy's relations do not hold, results are obtained which are in much better agreement with the observed ones than those obtained by following Born's assumption. There is only a rough agreement and it is likely that the values of force constants chosen and the co-ordinates of atoms in the unit cell are responsible for the discrepancy.

RELATION BETWEEN ELASTIC AND PIEZO-ELECTRIC CONSTANTS

We make use of Born's theory for finding the relation between elastic, dielectric and piezo-electric constants. According to this theory a general homogeneous distortion of the crystal lattice can be represented at the point $\mathbf{r}_k^l$ where k is the basis index and l the cell index by the distortion vector $\mathbf{u}_k^l$ whose Cartesian components are given by :—

$$\mathbf{u}_{kx}^l = \mathbf{u}_{kx} + \Sigma u_{xy} y_k^l.$$

where $\mathbf{u}_{kx}$ corresponds to the inner distortion and $\Sigma u_{xy} y_k^l$ corresponds to the homogeneous distortion of the lattice from the continuous standpoint. The change in the energy density of the homogeneously distorted lattice from its original undistorted configuration can be represented by second order terms in the distortion components—the terms of the first order being absent and those of the higher order can be neglected. If 'U' be the displacement energy, the force on each individual atom Ω_{kx} is given by

$$\Omega_{kx} = -\frac{dU}{d\mathbf{u}_{kx}} \qquad \ldots \quad (2.1)$$

and the stress components are given by

$$K_{xy} = -\frac{dU}{du_{xy}} \qquad \ldots \quad (2.2)$$

As there is no resultant force on the basis in a homogeneous strain $\Sigma_k \Omega_{kx} = 0$. Further, in order to secure equilibrium we must have not only the result of all basis forces vanishing, *i. e.*, $\Sigma \Omega_{kx} = 0$ but for every basis atom,

$$\Omega_{kx} = 0 \qquad \ldots \quad (2.3)$$

Born assumed that for the elastic energy corresponding to a homogeneous distortion, Cauchy's relations are valid. This assumption of Born is not correct because it means that all crystals which are non-piezo-electric must satisfy Cauchy's relatons, which is not the case in many crystals. Therefore in writing the expression for the elastic energy of α-quatz we are not justified in using Cauchy's relationship. Quartz, like zinc sulphide, contains only two basis atoms, silicon and oxygen. For the unit cell of α-quartz in which the horizontal electric axis is taken as the axis of 'x,' we write the displacement energy per unit volume as :—

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$$U=\tfrac{1}{2}A(\mathbf{u}_{1x}-\mathbf{u}_{2x})^2+\tfrac{1}{2}A(\mathbf{u}_{1y}-\mathbf{u}_{2y})^2+\tfrac{1}{2}B(\mathbf{u}_{1z}-\mathbf{u}_{2z})^2+C(\mathbf{u}_{1y}-\mathbf{u}_{2y})\ (\mathbf{u}_{1z}-\mathbf{u}_{2z})$$
$$+(\mathbf{u}_{1x}-\mathbf{u}_{2x})\ (Du_{xx}+D_1u_{yy}+Eu_{zz}+Fu_{yz})+(\mathbf{u}_{1y}-\mathbf{u}_{2y})\ (Gu_{xy}+Hu_{xz})$$
$$+(\mathbf{u}_{1z}-\mathbf{u}_{2z})\ (Iu_{xy}-Ju_{xz})+\tfrac{1}{2}R_{11}(u_{xx}^2+u_{yy}^2)+\tfrac{1}{2}R_{33}u_{zz}^2+R_{12}u_{xx}u_{yy}$$
$$+R_{13}u_{zz}(u_{xx}+u_{yy})+\tfrac{1}{2}R_{44}(u_{yz}^2+u_{xz}^2)+R_{14}(u_{xx}u_{yz}-u_{yy}u_{yz}+u_{xz}u_{xy})$$
$$+\tfrac{1}{2}R_{66}u_{xy}^2.$$

$\mathbf{u}_1$, $\mathbf{u}_2$ are the displacement vectors for the two types of atoms and the terms in (R) give the strain energy from the continuum standpoint. A, B, C, D, E, F, G, H, I, J, are the constants whose values are to be determined. All the other terms are absent on account of two-fold symmetry about the 'x' axis.

With the help of the relations (2. 1) and (2. 3) together with the relation GC=AI and HC=AJ, we obtain

$$\mathbf{u}_{1x}-\mathbf{u}_{2x}=-[Du_{xx}+D_1u_{yy}+Eu_{zz}+Fu_{yz}]A$$
$$\mathbf{u}_{1y}-\mathbf{u}_{2y}=-G/A\ u_{xy}-H/A\ u_{xz}$$
$$\mathbf{u}_{1z}-\mathbf{u}_{2z}=0 \qquad \ldots \quad (2.4)$$

The piezo-electric moment along the 'x' axis is given by

$$p_x=\frac{1}{\Delta}(\Sigma e_k\mathbf{u}_{kx}+\Sigma_y u_{\ y}p_y^0)$$

where Δ is the volume of the unit cell and p_y^0 the moment along the y axis in the undeformed condition. The second term vanishes when the cell has no moment in the underformed condition. This is true for α-quartz. In each unit cell there are six oxygen atoms and six silicon atoms which are shared between the two-cells. Each silicon atom carries a charge of +4 units and each oxygen atom a charge of −2 units. As the silicons are shared between the two cells, we may assume that in each cell silicon atoms carry a charge of 2 units and oxygen atoms 2 units. Writing $2e=e_k$ and using (2. 4) we have

$$p_x=\frac{e_k}{\Delta}\left(\mathbf{u}_{1z}-\mathbf{u}_{2x}\right)=-\frac{e_k}{\Delta}\left(\frac{D}{A}u_{xx}+\frac{D_1}{A}u_{yy}+\frac{E}{A}u_{xx}+\frac{F}{A}u_{yz}\right)$$
$$p_y=\frac{e_k}{\Delta}\left(\mathbf{u}_{1y}-\mathbf{u}_{2y}\right)=-\frac{e_k}{\Delta}\left(\frac{H}{A}u_{xz}+\frac{G}{A}u_{xy}\right)$$
$$p_z=\frac{e_k}{\Delta}\left(\mathbf{u}_{1z}-\mathbf{u}_{2z}\right)=0 \qquad \ldots \quad (2.5)$$

Comparing the above equations with equation (1. 1) we find

$$D=-D_1, \quad E=0, \quad H=-F, \quad G=-D$$

and therefore

$$e_{11}=-\frac{e_k}{\Delta}\frac{D}{A}, \ e_{41}=-\frac{e_k}{\Delta}\frac{F}{A} \qquad \ldots \quad (2.6)$$

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With the help of the equations (2.2) and (2.4) we get the stress components k_{xx} etc. as

$$K_{xx}=\left(\frac{D^2}{A}-R_{11}\right)u_{xx}-\left(\frac{D^2}{A}+R_{12}\right)u_{yy}-R_{13}u_{zz}+\left(\frac{FD}{A}-R_{14}\right)u_{yz}$$

$$K_{xz}=\left(\frac{FD}{A}-R_{14}\right)u_{xy}+\left(\frac{F^2}{A}-R_{44}\right)u_{xz}$$

If the strain energy is expressed in terms of the elastic constants c_{11}, c_{22}, etc. we get

$$K_{xx}=-c_{11}u_{xx}-c_{12}u_{yy}-c_{13}u_{zz}-c_{14}u_{yz}$$

$$K_{xz}=-c_{14}u_{xy}-c_{44}u_{xz}$$

Comparing the co-efficients in the above equations we get

$$-c_{11}=\frac{D^2}{A}-R_{11}\ ;\ -c_{12}=-\frac{D^2}{A}-R_{12}\ ;\ c_{13}=R_{13}\ ;\ -c_{14}=\frac{FD}{A}-R_{14}\ ;$$

$$-c_{44}=\frac{F^2}{A}-R_{44}\ ;\ c_{33}=R_{33}\ ;\ -c_{66}=\frac{D^2}{A}-R_{66} \qquad \ldots\ (2.7)$$

RELATION BETWEEN DIELECTRIC AND PIEZO-ELECTRIC CONSTANTS

When the crystal is placed in an electric field, an electric moment is produced due to the displacement of the charges parallel to the direction of the field. This moment will be superposed on the moment produced due to the mutual displacement of the atoms if the crystal be distorted. If Ω_k be the force on a single atom 'k' per unit volume then under an electric field 'E', we have

$$\Omega_k=-\frac{e_k}{\Delta}E$$

$$\text{or } \Omega_{1x}=-\frac{e_k}{\Delta}E_x,\ \Omega_{2x}=\frac{e_k}{\Delta}E_x \qquad \ldots\ (3.1)$$

On application of the field we may assume that although there is a change of polarisation, the crystal is not deformed. The stress components K_{xx}, K_{xy} etc are therefore all zero. Therefore with the help of equations $K_{xx}=K_{yy}=0$ and $K_{yz}=0$ together with the relations (2.1), (2.2), (3.1) we get, if we put $\frac{c_{44}c_{66}-c_{14}^2}{R_{44}R_{66}-R_{14}^2}=\gamma$,

$$u_{1x}-u_{2x}=\frac{e_k}{\Delta}=\frac{1}{Ay}E_x$$

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Similarly with the help of equations $K_{xz}=0$ of $K_{xy}=0$ together with the relations (2.1), (2.2) and (3 1) we get if 'C'=0,

$$u_{1y}-u_{2y}=\frac{e_k}{\Delta}\frac{1}{A\gamma}E_y$$

$$u_{1z}-u_{2z}=\frac{ek}{\Delta}\frac{1}{B}E_z$$

Therefore by the use of equations (2.5) we get

$$p_x=\frac{e_k^2}{\Delta^2}\frac{1}{A\gamma}E_x=\frac{\eta_\perp-1}{4\pi}E_x$$

$$p_y=\frac{e_k^2}{\Delta^2}\frac{1}{A\gamma}Ey=\frac{\eta_\perp-1}{4\pi}E_y$$

$$p_z=\frac{e_k^2}{\Delta^2}\frac{1}{B}E_x=\frac{\eta_\parallel-1}{4\pi}E_z \qquad \ldots \quad (3.2)$$

$\eta_\perp$ and $\eta_\parallel$ are dielectric constants for the free crystal perpendicular and parallel to the optic axis. This will take into account the secondary changes in the polarisation produced by the piezo-electric effect although this secondary effect is very small in quartz. $\eta_\perp$ for α-quartz is 4.5 (Cady *loc. cit.*). As atoms are not point charges, the electronic shell of the atoms will be distorted when the field is applied. Born therefore puts the polarisation $p\frac{\eta_\perp-\eta_0}{4\pi}$ where $\eta_0=n^2$ 'n' being the refractive index. With this modification the equations (3.2) together with (2.6) give

$$\epsilon_{11}^2=\frac{\eta_\perp-\eta_0}{4\pi}\frac{D^2}{A}\gamma$$

$$\epsilon_{41}^2=\frac{\eta_\perp-\eta_0}{4\pi}\frac{E^2}{A}\gamma \qquad \ldots \quad (3.3)$$

CALCULATION OF PIEZO-ELECTRIC CONSTANTS

The calculation has been done in two ways :—

1. On Born's asumption :—

If we adopt Cauchy's relations to hold in the expression of the elastic energy we must have $R_{44}=R_{13}$ and $R_{12}=R_{66}$. This enables us to calculate $\frac{D^2}{A}$ and $\frac{F^2}{A}$ from (2.7) and ϵ_{11} and ϵ_{41} from (3.3). We then get

$$\epsilon_{11}^2=\frac{\eta_\perp-\eta_0}{4\pi}\ \tfrac{1}{2}\ (c_{12}-c_{66})\ \gamma$$

$$\epsilon_{41}^2=\frac{\eta_\perp-\eta_0}{4\pi}\ (c_{13}-c_{44})\ \gamma$$

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Since $\eta_0 = 2.4$, we get $\gamma = -1.272$ and $\epsilon_{11} = 18.5 \times 10^4$ and $\epsilon_{41} = 30.7 \times 10^4$ by using the values of the elastic constants given by Voigt. The expressions for ϵ_{11} and ϵ_{41} given above show that it Cauchy's relations hold *i.e.*, $c_{13} = c_{44}$ and $c_{12} = c_{66}$, both ϵ_{11} and ϵ_{41} would be zero and the crystal would be non-piezo-electric.

2. Using a more generalised force-system :—

If we assume only central forces between the atoms, then as shown below, Cauchy's relations are found to be valid for quartz. The failure of Cauchy's relationship therefore shows that the above assumption regarding the forces between the atoms is not correct and this will be all the more true for quartz which is a valence crystal as is shown by its hardness and the high frequencies of vibrations. We therefore use a more generalised force system. In an earlier paper Saxena (1944) has found the force-constants in quartz from the various Raman frequencies, and with the help of these the elastic constants were calculated from the continuum standpoint. In making these calculations, the structure of the crystal as determined from the X-ray data of Gibbs (1926) was used. If 'K' is the valence force constant of the Si-O bond, 'K_1' and 'K_2' the deformation force constants of the Si-O-Si and O-Si-O angles, and 'K_3' of O-O repulsion, we get

$$R_{12} = \frac{1}{111.2}\left[1.729 \times 10^{-16}K - .2403K_1 - 1.638K_2 + 7.5 \times 10^{-16}K_3\right] \times 10^{24}$$

$$R_{66} = \frac{1}{111.2}\left[1.729 \times 10^{-16}K + .241K_1 + 3.314K_2 + 7.5 \times 10^{-16}K_3\right] \times 10^{24}$$

$$R_{44} = \frac{1}{111.2}\left[2.87 \times 10^{-16}K + .617K_1 + 2.091K_2 + 9.35 \times 10^{-16}K_3\right] \times 10^{24}$$

$$R_{13} = \frac{1}{111.2}\left[2.87 \times 10^{-16}K \quad - 3.344K_2 + 9.35 \times 10^{-16}K_3\right] \times 10^{24} \quad \ldots \quad (4.2)$$

(The terms C_{11}, C_{12} etc. in the above paper are R_{11}, R_{12} etc. in the terminology of this paper).

We see immediately that if we adopt central forces only *i. e.*, if both K_1 and K_2 are zero in expressions (4.2), we have $R_{12} = R_{66}$ and $R_{13} = R_{44}$ which are Cauchy's relations for quartz class 'D_3'. The expressions (4.2) give

$$R_{66} - R_{13} = \frac{1}{111.2}\left[.481K_1 + 4.952K_2\right] \times 10^{-24}$$

and

$$R_{44} - R_{13} = \frac{1}{111.2}\left[.627K_1 + 5.438K_2\right] \times 10^{24} \quad \ldots \quad (4.3)$$

Thus the relations (4.3) together with (2.2) and (3.3) enable us to calculate the piezo-electric constants ϵ_{11} and ϵ_{41} with the help of only two deformation force-constants K_1 and K_2.

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CALCULATIONS

With the help of the Raman frequencies and the infra-red frequencies the author has determined $K_1 = 1.056 \times 10^{-11}$ and $K_2 = 1.315 \times 10^{-11}$ dynes. From (2.7) we then get

$$\frac{D^2}{A} = 2.05 \times 10^{11}, \quad \frac{F^2}{A} = 2.62 \times 10^{11}, \quad \frac{FD}{A} = 2.31 \times 10^{11}$$

This gives $\gamma = .57$ and we get $e_{11} = 13.2 \times 10^4$ and $e_{41} = 15.0 \times 10^4$

If, however, we take $K_1 = 1.0 \times 10^{-11}$, $K_2 = .8 \times 10^{-11}$, together with $K = 5.0 \times 10^5$ and $K_3 = -.6 \times 10^5$ dynes, we get a better agreement with the observed and calculated values of the piezo-electric constants while maintaining an approximate agreement between the observed and calculated values of the elastic constant and the Raman and the infra-red frequencies of α-quartz:

(1) Piezo-electric constants: Using (4.3) we get

$$\frac{D^2}{A} = .3725 \times 10^{11}; \quad \frac{F^2}{A} = .066 \times 10^{11} \text{ and } \gamma = .9198$$

which give on using $(3.3)/e_{11} = 7.56 \times 10^4$ and $e_{41} = 3.18 \times 10^4$, the observed values being 5.1×10^4 and 1.23×10^4 respectively.

(2) Elastic constants: Using the formulæ given by the author for calculating the elastic constants of α-quartz in his earlier paper (Saxena, 1944). we get

	c_{11}	c_{12}	c_{33}	c_{13}	c_{44}	c_{14}	c_{66}
calc.	15.0	2.3	13.7	5.4	9.9	2.0	6.3×10^{11}.
obs	8.7	73	10.5	1.4	5.8	1.7	4.0×10^{11}.

It has to be pointed out that the values of R_{11}, R_{12} etc., calculated from (4.2) and from (2.7), using the given values of D^2/A and F^2/A, do not tally. This is due to our insufficient knowledge of force-constants in quartz. For if we take $K = 2.526 \times 10^5$ dynes and $K_3 = -.3238 \times 10^5$ dynes instead of the above values, we find that the two values of R_{11}, R_{12}, R_{13}, R_{44} and $R_{66}(R_{11} - R_{12}/9)$ agree exactly but those of R_{33} and R_{14} do not, and in addition the agreement between the observed and calculated values of Raman frequencies becomes much worse. Even if we disragard the Raman and infra-red frequencies and consider only the elastic constants, we see that four force-constants are not enough for calculating the six elastic constants as the disagreement in the two values of R_{33} and R_{14} is evidently due to this cause. Therefore when we are calculating 17 quantities with only four force-constants, the disagreement between the two calculated values of R_{11}, R_{12} etc., may be expected and it does not in any way vitiate the method of calculating the piezo-electric constants adopted in the paper.

(3) Raman and infra-red frequencies: Using the determinants given by the author in the earlier work (Saxena, 1944, 45) we get

	Raman frequencies				Infra-red frequencies			
calc.	156	256	473	1109	1147	772	479	101
obs.	207	356	466	1984	1111, 1190	800	488	385 ?

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As we have calculated 17 different constants (2 piezo-electric, 7 elastic and 8 Raman and infra-red frequencies) with the help of only four force-constants, only a rough agreement between the observed and calculated values can be expected. Moreover, neither the structure of quartz nor the force constants are correctly known, for according to the structure of Gibb's (1926) and Wei (1935) the Si-O distances in quartz have only one value while according to Machatschky (1937) there are two values which differ widely and according to Brill, Hermann and Peters (1942) the two values differ only very slightly. However, it is evident that the values of the piezo-electric constants calculated by using a generalised system of force-constants are much closer to the observed values than those obtained on Born's assumption of the validity of Cauchy's relationship.

There are no calculations of the piezo-electric constants of quartz. Gibbs calculated only the piezo-electric modulus δ_{11} of α-quartz by finding the relative shifts of the centres of gravity of oxygen and silicon atoms for the pressure of one dyne and got a value which is nearly five times too high. We have obtained much better agreement and the discrepancy is most likely due to the uncertainty in the structure of quartz and the values of the force-constants K_1 and K_2.

LONGITUDINAL COEFFICIENT FOR β-QUARTZ

The expression for the displacement energy 'U' immediately enables us to show that e_{11} for β-quartz must be o. For α-quartz the values of the constants in the expression for 'U' are such that E, C, I, and J are all zero while $D=-D_1$. and $H=-F$, $G=-D$. In β-quartz, which possesses a six-fold symmetry, both x and y directions are axes of two-fold symmetry. The energy 'U' should therefore remain unaltered if $(x, y, z,)$ is changed into $(-x, y, -z)$ so that u_{1x}, u_{2x}, u_{xy}, u_{yz} appear with negative signs. This will be possible only when D, G and R_{14} are zero in the expression for 'U'. Hence e_{11} must be zero from (2.6).

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PARAMAGNETISM OF SINGLE CRYSTALS OF THE SALTS OF THE IRON GROUP OF ELEMENTS AT LOW TEMPERATURES, PART III, SIX CO-ORDINATED IONIC SALTS OF Cu^{++} AND Fe^{++} IONS

By AKSHAYANANDA BOSE

(*Received for publication, Aug. 28, 1948*)

ABSTRACT. In the present part of the paper the *reciprocally related* D-state ions Cu^{++} and Fe^{++} are discussed. The Stark-pattern of such states, under a predominantly cubic crystalline field with a feeble rhombic component, consists of a doublet and a triplet. For 6-co-ordinated Cu^{++} salts the doublet lies lowest, whereas the pattern ie inverted for similar iron salts. But experimentally, the result of this inversion from Cu^{++} to Fe^{++} is not obvious, since, both show large anisotropies and deviations of the effective moments from the *spin only* value. An explanation is attempted to be given of the observed behaviour of Cu^{++} and Fe^{++} salts namely, that in the former the orbital contribution is confined to a single direction in the crystal and in the latter these act *against* the spin in some of the directions and *for* the spin in others. For the Cu^{++} salts from known X-ray data for the crystals a correlation is given between the *ionic* and the *crystalline* moments. The variation with temperature of the angle between the different ionic groups is calculated and an explanation for the change in the orientation of the magnetic axes of the crystal is given on this basis. From these studies, it is plausible to ascribe not only the cubic but also the small rhombic part of the field to the charged particles in the immediate neighbourhood of the paramagnetic ion. Further, it is reasonable to conclude that the disposition of charged atoms about the paramagnetic ion and hence the crystalline field symmetry for a particular ion, is largely decided by the degeneracy of the ion itself. The temperature variation of the moments of the Fe^{++} ion have an apparent similarity to the Co^{++} ions but unlike cobalt all the principal moments tend to *spin only* value at high temperatures showing the relative unimportance of high frequency contributions in Fe^{++}.

INTRODUCTION

In the two earlier parts of the present paper (Bose, 1948), it has been made sufficiently clear how the crystalline electric field theory of Van Vleck (1932), Penney and Schlapp (1932), Görter (1932) and others, has successfully explained the behaviour of the F-state ions Ni^{++} and Co^{++}. It was shown that under a predominant cubic field with a small rhombic field superimposed upon it the ground state of an F-state ion is split up into a singlet and two adjacent triplets. For the Ni^{++} ion the lowest lying level in this Stark-pattern is the singlet when the cubic field potential is positive, whereas, for the same type of field the triplet lies lowest for Co^{++} ion. On the other hand, the situation is exactly reversed with a negative value of the potential. Such an

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TABLE I

For Principal Anisotropies of Crystals

$CuSO_4(NH_4)_2SO_4, 6H_2O$ Monoclinic; $\beta = 106°6'$ $a:b:c = 0.7433:1:0.4838$				$CuSO_4K_2SO_4, 6H_2O$ Monoclinic; $\beta = 104°30'$ $a:b:c = 0.7490:1:0.5088$				$CuSo_4, 5H_2O$ Triclinic; $\alpha:\beta:\gamma = 82°6'$. $107°26'$. : $102°40'$. $a:b:c = 0.5721:1:0.5554$		$FeSO_4(NH_4)_2SO_4, 6H_2O$ Monoclinic; $\beta = 106°48'$. $a:b:c = 0.7466:1:0.4950$				$FeSO_4K_2SO_4, 6H_2O$ Monoclinic; $\beta = 104°32'$. $a:b:c = 0.7377:1:0.5020$			
(1) 'b' axis vertical. (2) 'a' axis vertical, 'b' axis along field				(1) 'b' axis vertical. (2) 'a' axis vertical, 'b' axis along field.				Anisotropy values are taken from measurements by Krishnan and Mukherji (1936-38)		(1) 'b' axis vertical. (2) (20$\bar{1}$) plane vertical and 'b' axis horizontal and along the field*				(1) 'b' axis vertical. (2) 'a' axis vertical, 'b' axis along the field			
Temp. °K.	Angle** between 'a' axis & χ_2 axis $= \theta$	$\chi_1 - \chi_2$ $\times 10^6$	$\chi_1 - \chi_3$ $\times 10^6$	Temp. °K	Angle** between 'a' axis & χ_2 axis $= \theta$	$\chi_1 - \chi_2$ $\times 10^6$	$\chi_1 - \chi_3$ $\times 10^6$	Temp. °K	$\chi_1 (= \chi_3) - \chi_2$ $\times 10^6$	Temp. °K	Angle** between 'a' axis & χ_2 axis $= \theta$	$\chi_1 - \chi_2$ $\times 10^6$	$\chi_1 - \chi_3$ $\times 10^6$	Temp. °K	Angle** between 'a' axis & χ_2 axis $= \theta$	$\chi_1 - \chi_2$ $\times 10^6$	$\chi_1 - \chi_3$ $\times 10^6$
303.1	−61	300.0	63.5	303.1	−88.0	367.0	74.5	303.1	275.0	303.1	− 37	2582	224	303.1	−43.8	1841	− 345.2
280	−64.7	337.7	117.1	280	−89.4	393.8	81.2	280	290.0	280	− 37	3091	263	280	−43 8	2125	− 426.0
260	−67-0	374.4	161.7	260	−90.3	422.5	88.8	260	306.5	260	− 37	3637	313	260	−43.8	2428	− 515 0
240	−68.3	412.1	200.3	240	−91.2	455.0	97.0	240	327.0	240	− 36.5	4315	372	240	−43.8	2788	− 628.0
220	−69.1	455.4	238.7	220	−92.0	494.9	108.8	220	352.1	220	− 36	5177	443	220	−43 8	3218	− 774.0
200	−69.8	504.4	239.6	200	−92.6	544.3	125.6	200	383 9	200	− 36	6267	535	200	−44 8	3747	− 938.0
180	−70 3	560.3	322.8	180	−93.1	602.7	142.6	180	423.8	180	− 36	7698	658	180	−44 8	4422	−1164
160	−70.8	629.0	373.6	160	−93.5	671.9	160.8	160	471.8	160	− 36	9649	822	160	−44.8	5311	−1489
140	−71.1	712.0	431 6	140	−93.8	759.8	181.4	140	535.4	140	− 35	12330	1039	140	−44.8	6572	−2015
120	−71.1	824.1	502.0	120	−94.0	878.4	206.7	120	615.5	120	− 35	16540	1365	120	−45 8	8612	−2566
100	−71.1	1013	629.9	100	−94.0	1052	248.1	100	717.8	100	− 35	22840	1900	100	−45.8	11510	−3162
92.9	−71.1	1109	698.0	90	−94.0	1155	276.4	90	782.0	90	− 35	26920	2270	90	−45 8	13550	−3467
—	—	—	—	83.9	−94.0	1226	298.2	88.7	789.5	84.8	− 35	29090	2465	86.3	−45.8	14440	−3558

* Angle (001) : (20$\bar{1}$) = 64°5′ ** Angle measured in degrees.

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inversion of Stark-pattern should generally occur, as was mentioned in the earlier papers, for the "reciprocally related" ions *i. e.*, for those ions in which the incomplete $3d$ shell contains n or $5+n$, and $5-n$ or $10+n$ electrons respectively. The remarkable differences in the magnetic behaviours of such ions are beautifully demonstrated by the six-coordinated salts of Ni^{++} and Co^{++} and also the four-coordinated blue cobalt salts. Thus we should expect similar widely divergent properties in the Cu^{++} and Fe^{++} salts also, in which the numbers of electrons in the $3d$ shells are nine and six, respectively.

With the same experimental techniques as before we studied the monoclinic ammonium and the potassium Tutton salts of Cu^{++} and Fe^{++} and also the triclinic salt $CuSO_4, 5H_2O$. The principal magnetic anisotropies $\chi_1-\chi_2$ and $\chi_1-\chi_3$ are given in Table I and the squares of the principal magnetic moments and the mean moments in terms of the Bohr magneton in Table II. Figures 1 – 5 indicate graphically the variations of these quantities with absolute temperature.

TABLE II

For the Gm. Molecular Principal Susceptibilities and the Squares of the Effective Magnetic Moments. (*Corrected for Diamagnetism*)

Crystal	Crystal suspension & the direction along which the susceptibility is measured, *i.e.*, the direction setting along field.	Temp. °K	$\chi_1 \times 10^6$	$\chi_2 \times 10^6$	$\chi_3 \times 10^6$	p^2_1	p^2_2	p^2_3	p^2
$CuSO_4, 5H_2O$	'c' axis vertical, (100) plane at 27°.2, and (1$\bar{1}$0) at 53°.3 to the field. χ measured = χ_1 approx.	295.2	1650	1370	$\chi_1=\chi_3$	3.923	3.258	$p^2_1=p^2_3$	3.701
		230.0	2116	1768		3.920	3.277		3.706
		168.8	2871	2422		3.904	3.294		3.701
		88.7	5337	4549		3.814	3.251		3.626
$CuSO_4(NH_4)_2$ $SO_4, 6H_2O$.	(001) plane vertical, 'b' axis horizontal and along field	295.9	1709	1397	1628	4.072	3.330	3.881	3.761
		225.0	2289	1850	2063	4.149	3.354	3.740	3.748
		173.6	2910	2328	2571	4.069	3.256	3.595	3.640
		124.9	4124	3333	3642	4.150	3.354	3 664	3 723
		92.9	5554	4445	4856	4.157	3.327	3.634	3.706
$CuSO_4K_2SO_4$ $6H_2O$	'b' axis vertical, χ_1 axis along the field	295.9	1696	1321	1619	4.042	3.149	3.859	3.683
		176.9	2800	2188	2655	3.990	3.117	3.783	3.630
		83.9	5824	4597	5525	3.935	3.107	3.734	3.592
$FeSO_4(NH_4)_2$ $SO_4, 6H_2O$	(20$\bar{1}$) plane vertical, 'b' axis horizontal & along field	296.8	12893	10189	12662	30.83	24.36	30.28	28.49
		182.5	22162	14670	21522	32 58	21.57	31.63	28.59
		84.8	50227	21137	47762	34.32	14.44	32.62	27.13
$FeSO_4K_2$ $SO_4, 6H_2O$	'a' axis vertical, 'b' axis along field	296.8	12463	10553	12825	29.80	25.23	30.67	28.57
		185.6	19577	15370	20665	29.27	22.98	30.90	27.72
		86.3	41277	26837	44835	28.69	18.65	31.18	26.17

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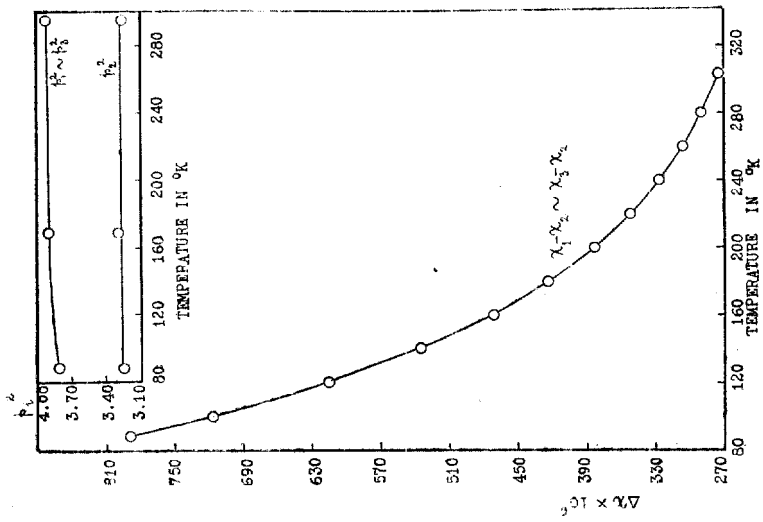

FIG. 1

Temperature Variation of Principal Anisotropies and Effective Moments of $CuSO_4, 5H_2O$.

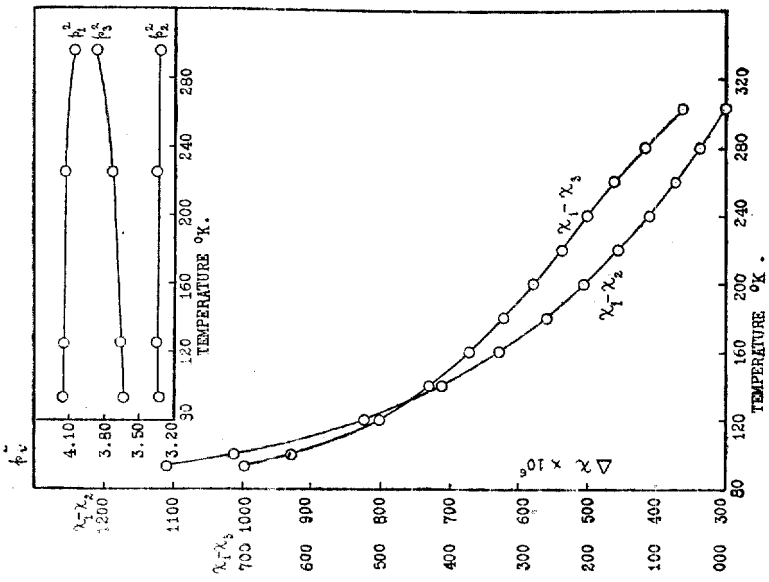

FIG. 2

Temperature Variation of Principal Anisotropies and Effective Moments of $CuSO_4(NH_4)_2SO_4, 6H_2O$

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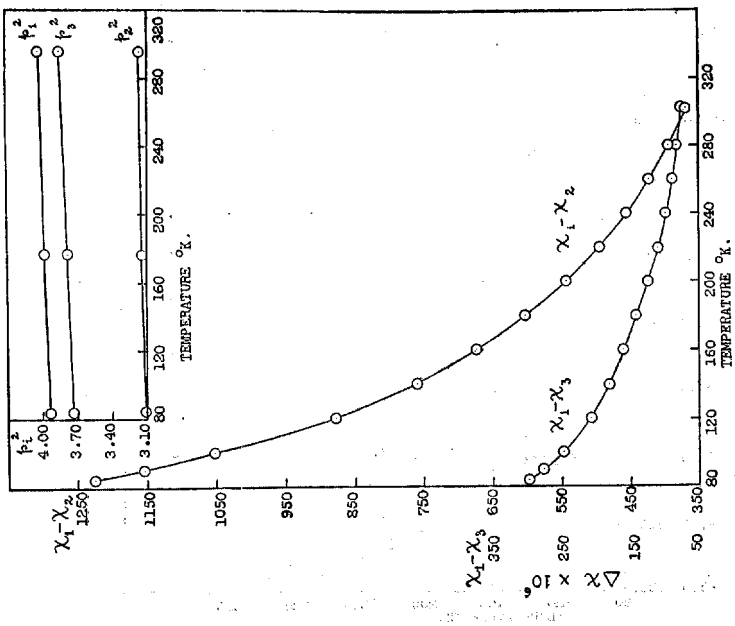

FIG. 3

Temperature Variation of Principal Anisotropies and Effective Momen of $CuSO_4.K_2SO_4, 6H_2O$

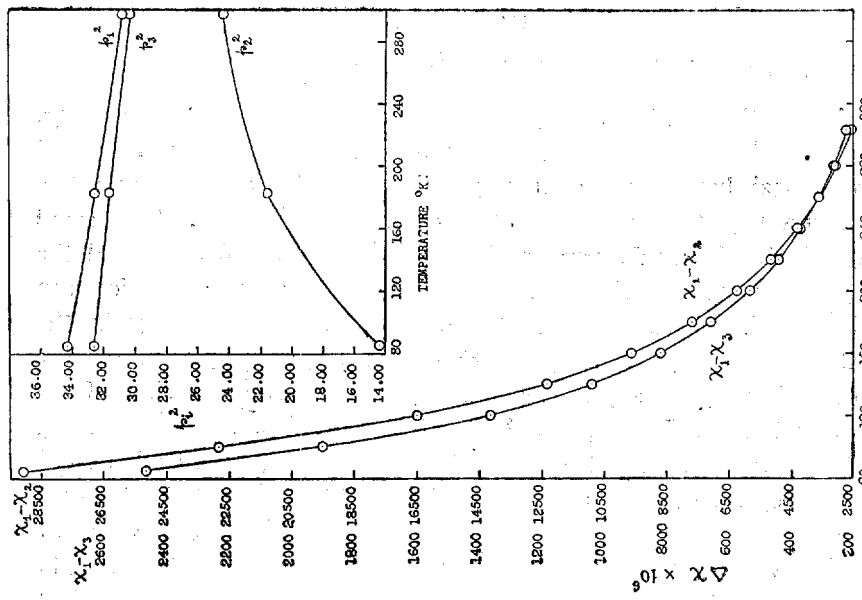

FIG. 4

Temperature Variation of Principal Anisotropies and Effective Moments of $FeSO_4(NH_4)_2SO_4, 6H_2O$.

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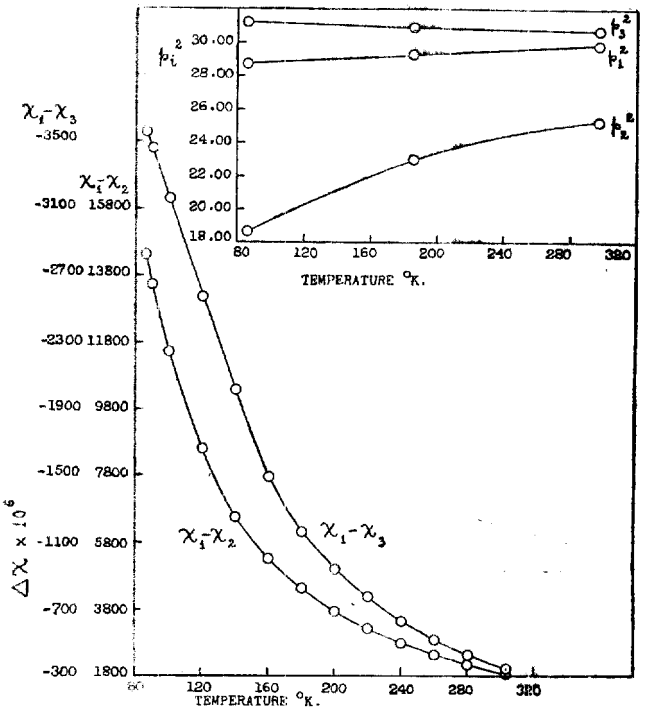

FIG. 5

Temperature Variation of Principal Anisotropies and Effective Moments of $FeSO_4.K_2SO_4.6H_2O$.

DISCUSSIONS

1. *Inversion of Stark-pattern from Cu^{++} to Fe^{++} Salts*

It is known that both Cu^{++} and Fe^{++} ions are in the D-state, namely, $3d^9\ ^2D_{5/2}$ and $3d^6\ ^5D_4$ respectively. It has been shown by Bethe (1929) and Van Vleck (1932) that in a predominantly cubic field a D-state splits up into a doublet and a triplet separated to the order of 10^4 cm^{-1}. The small superimposed rhombic field separates the components of the doublet and the triplet by an amount much smaller than the above cubic separation but comparable to kT. Hence, whether the doublet is the lowest lying in the Stark-pattern or the triplet, the population of the upper components of the lowest level will be quite appreciable. Thus, the magnetic behaviour of the D-state ions will not be as simple as that of the F-state ions with singlet lying lowest. Now, the Cu^{++} ion has nine electrons in the $3d$ shell while Fe^{++} has six. Hence, their Stark-patterns in a *given* cubic field will be inverted with respect to each other (Fig. 6) and the difference in the magnetic behaviour of the two ions will depend on whether the doublet or the triplet is the lowest in one or the other. Actually, for a cubic field with positive value of the coefficient D in the expression $V=Ax^2+By^2-(A+B)z^2+D(x^4+y^4+z^4)$, the disposition of the patterns will be as given below.

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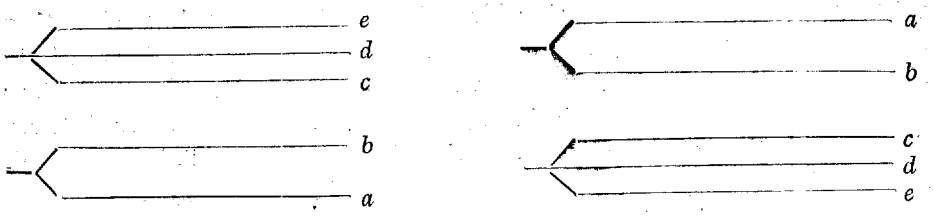
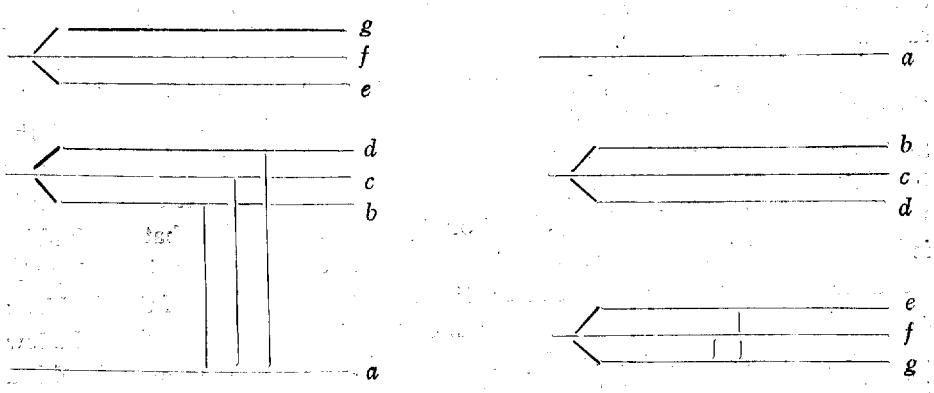


Stark-pattern for Cu^{++} in a cubic field with +ve D.

Stark-pattern for Fe^{++} in the same field.

FIG. 6

In the case of Co^{++} and Ni^{++} salts we found (Bose, 1948) that such an inversion in the Stark-pattern is responsible for the striking contrast in the magnetic behaviours of the two salts and arises in the following manner (Van Vleck, *loc. cit.*) as can be readily seen from their respective Stark-patterns. (Fig. 7).



Stark-pattern for Ni^{++} in a cubic field with +ve D.

Stark-pattern for Co^{++} in the same field.

FIG. 7

In the case of Ni^{++} in which the ground level is a singlet, the contributions from the orbital moments to the susceptibility will depend inversely on the frequencies ν, corresponding to the energy separations $a \rightarrow b$, $a \rightarrow c$ and $a \rightarrow d$, for the different directions of the incident magnetic field in the crystal. In the first place, these frequencies will be large, since they correspond to separations produced by the predominant cubic part of the field. Secondly, they will differ from one another by small amounts, since $\Delta\nu/\nu$ will be of the same order as the ratio of the separations produced by the rhombic part of the field to that produced by the cubic part. The results will be that for Ni^{++} salts (1) the contribution from orbital moments to the total effective moment cannot be large ; (2) these contributions will be practically the same along the different crystal directions, thus producing very little anisotropy. On the other hand, when as in Co^{++} the pattern is inverted making triplet level the lowest, the orbital contributions along different directions will be mainly given by the frequencies corresponding to the energy separations $g \rightarrow f$ and

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$g \rightarrow e$ respectively, due to the rhombic field, which are much smaller than those due to the cubic field. Further, the separations $g \rightarrow f$ and $f \rightarrow e$ will be of comparable magnitudes. Hence we conclude (1) that the contributions from the orbital moments will be large ; (2) that the differences between these contributions along different directions in the crystal, will be comparable to their absolute magnitudes, leading to a very high anisotropy of the order of 25 to 30 % for Co^{++} in comparison with 3 to 4 % only for Ni^{++} salts, all at room temperatures, as is quite well known (Bose, 1948).

On the other hand, Tables I and II show that there is no such marked contrast between the cupric salts and the ferrous salts, in spite of the inversion of the Stark-patterns for the two. In both of them the orbital contributions are found to be large, as is shown by a comparison of the *observed* p^2 values of Cu^{++} and Fe^{++} ions, with the *spin only* values for the two ions, namely 3 and 24 respectively. Both the salts show large anisotropies of the same magnitude, $\Delta p^2/p^2 = 19$ to 24 % for the different salts at room temperatures.

One would, therefore, be tempted to attribute the negative results of the inversion to the fact that, whether the Stark-pattern is erect or inverted the ground level is a multiplet and hence would correspond to large contributions to orbital moments and to a large anisotropy. But such a simple explanation is vitiated by the interesting fact pointed out by Bethe, (*loc. cit.*) that the doublet is 'non-magnetic' *i. e.*, there can be no orbital contributions involving the frequencies corresponding to the separation of the components of the doublet ; so that the large orbital contributions in Cu^{++} salts cannot arise from the low frequency terms, as it presumably does in Fe^{++} where the ground level is a triplet. So one has to invoke, to explain the orbital contribution in Cu^{++}, the terms depending on the separation between the doublet and the triplet ; and in order to explain the large anisotropy we have further to postulate that it is only the lower of the two levels of the doublet that will be occupied, even at the highest temperature in our measurements ; in other words, to postulate a separation between the two levels of the doublet, much greater than kT even at these temperatures. The latter postulate is plausible, since, the separation produced by the rhombic part of the field, though smaller than that produced by the cubic part, can still be much greater than kT.

Thus, we should expect the orbital contribution in Cu^{++} to be much smaller than in Fe^{++}. But since, the contribution from the spin moments in Cu^{++} is also much smaller than in Fe^{++}, namely in the ratio of 3 : 24, the ratio of the orbital contribution to the spin contribution is of the same order in both the salts as actually observed. In the ferrous salts, the high anisotropy is due to the orbital contribution being different along different crystal directions—actually adding to the spin contribution along two of the directions, and acting against it along the third. The p^2 value along this direction will, hence, be less than even the *spin only* value of 24. On the other hand, in

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cupric salts the high anisotropy is due to the orbital moment being confined to a single direction.

2. *Magnetic Properties of Cupric Salts*

Among the cupric salts studied by us copper sulphate penta-hydrate is the most interesting. The crystal is triclinic and from the X-ray analysis of this crystal made by Beevers and Lipson (1934), we know that it contains two molecules of $CuSO_4, 5H_2O$ in the unit cell. Further, each Cu^{++} ion is surrounded by six oxygen atoms, four of which belong to four water molecules and form a square with the Cu^{++} ion in the centre and each at a distance of 2.0 Å, and the other two oxygen atoms belong to SO_4^{--} ions located centrally above and below the square, each at a distance of 2.4 Å from the Cu^{++} ion. This octahedral arrangement of the oxygen atoms is thus not quite regular but has a tetragonal symmetry, which may be regarded as obtained from a regular arrangement by pulling out the diagonal joining the last two oxygen atoms. Presumably thus, the crystalline field in the neighbourhood of the Cu^{++} ion should also be predominantly cubic in symmetry, with a tetragonal component superposed upon it, the principal axes of the two fields being the same.

As have been shown by Krishnan and Mukherji (1936, 1938), the tetragonal axis of the field, associated individually with the two Cu^{++} ions in the unit cell of the crystal, are nearly perpendicular to each other. Further, denoting the direction of the tetragonal axis of the ion by z and the principal susceptibilities of either ion along this axis and in the plane perpendicular to it by $K_\parallel$ and $K_\perp$ respectively, and distinguishing the axes of the two ions in the unit cell by subscripts 1 and 2 respectively, they conclude that (1) $K_\parallel > K_\perp$, (2) the direction in $CuSO_4, 5H_2O$ crystal perpendicular to the z_1z_2 plane, should be one of the principal magnetic axes of the crystal, (3) the exterior and the interior bisectors of the angle between z_1 ane z_2 directions should be the other two principal axes, (4) since z_1 and z_2 are nearly at right angles, the susceptibilities along the latter two axes must be nearly equal and of the magnitude $(K_\parallel + K_\perp)/2$, and that along the first axis at right angles to z_1z_2 plane equal to $K_\perp$. Denoting the two nearly equal susceptibilities by χ_1 and χ_3 respectively and the third by χ_2

$$\left.\begin{array}{ll} \text{we have} & \chi_1(\sim\chi_3)=(K_\parallel+K_\perp)/2 \\ & \chi_2=K_\perp, \\ \text{and since} & K_\parallel > K_\perp, \\ & \chi_1(\sim\chi_3)>\chi_2. \end{array}\right\} \quad \ldots \quad (2)$$

All these various results have been verified by Krishnan and Mukherji. Further, using the data for susceptibility at low temperatures of powdered crystal by de Haas and Görter and from their own measurement of the anisotropy down to liquid air temperature, they conclude that though the squares of principal magnetic moments $p_1^2 (\sim p_3^2)$ and p_2^2 are very different, they are both nearly independent of temperature. In other

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words, all the susceptibilities follow the Curie law but with different Curie constants *i.e.* a law of the type

$$\chi_i = \frac{C_i}{T}, \quad i = 2, 3(\sim 1) \qquad \ldots \quad (3)$$

$$C_2 = 0.399 \text{ and } C_1(\sim 3) = 0.486 ;$$

unlike the usual type of variation

$$\chi_i = \frac{C}{T - \theta_i}, \quad i = 1, 2, 3, \qquad \ldots \quad (4)$$

where C is the same but θ's different in different directions.

We have directly measured the absolute susceptibilities at different temperatures down to 80°K along one of the directions in the crystal, namely, the one that sets parallel to the field when the crystal is suspended with 'c' axis vertical, and using the anisotropy data of Krishnan and Mukherji, calculated the values of $p_1^2 (\sim p^2_3)$ and p^2_2 for the crystal at these temperatures. The data are given in table II and are in agreement with those of Krishnan and Mukherji. The p^2 values also agree with various other authors and are given in Table III, together with p^2 values by the same authors for the two Tutton salts of copper to be discussed later.

TABLE III

p^2 For Various Copper Salts By Different Observers.

Author	$CuSO_4, 5H_2O$		$CuSO_4,(NH_4)_2SO_4,6H_2O$		$CuSO_4,K_2SO_4,6H_2O$	
	Temp.°K	p^2	Temp.°K	p^2	Temp.°K	p^2
da Haas and Görter (Leid. Comm., 210d	290.0	3.705	—	—	—	—
	169.4	3.663	—	—	—	—
	77.47	3.626	—	—	—	—
	14.29	3.505	—	—	—	—
Janes (1935)	—	—	295.7	3.741	296.8	3.729
	—	—	229.8	3.708	205.6	3.696
	—	—	83.3	3.660	82.1	3.657
Reekie (1939)	292.2	3.654	292.7	3.720	287.5	3.684
	80.4	3.632	79.9	3.690	78.6	3.633
	14.78	3.528	14.00	3 648	14.13	3.630
	1.58	2.634	1.60	3.642	1.60	3.579
Present Author	295.2	3.701	295.9	3.761	295.9	3.683
	168.8	3.701	225.0	3.748	176.9	3.630
	88.7	3.626	92.9	3.706	83.9	3.592

We may draw attention here to the interesting result that for the crystal of $CuSO_4, 5H_2O$, p_2^2 conforms roughly to the *spin only* value of 3, whereas the other susceptibility is considerably in excess of it, which shows, in view of the relations (2) between the principal susceptibilities of the *crystal* and the *ion* stated earlier in this section, that the contribution of the orbital moment

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is practically confined to one direction, namely, to the tetragonal axis of the crystalline field in the neighbourhood of the ion. Denoting the effective moments of the *ion* by $P_\parallel$ $P_\perp$, as against the effective moments $p_1(\sim p_3)$ and p_2 of the *crystal*, we have

$$p_1^2(\sim p_3^2) = (P_\parallel^2 + P_\perp^2)/2 \quad \text{and} \quad p_2^2 = P_\perp^2 \qquad \ldots \quad (5)$$

from which we obtain :—

TABLE IV

$CuSO_4, 5H_2O$

T°K	295.2	88.7
$P_\parallel^2$	4.588	4.377
$P_\perp^2$	3.258	3.251

—from which one can see, that the contribution from the orbital moment is considerable and is confined to the direction of the tetragonal axis of the crystalline electric field. The temperature variation of the moment if any, should be also more prominent in this direction as it actually is.

The above results are interesting, since, from the 'non-magnetic' nature of the ground level which is the doublet level, we were already led to the conclusion that the orbital contribution is confined to one direction in the crystal. That when the crystalline field has tetragonal symmetry this direction should be along the tetragonal axis, is indeed to be expected, and can also be explained from direct considerations of the symmetry of the field ; since the orbital moments will be quenched almost completely along directions perpendicular to the tetragonal axis, and if any part of it is conserved it must be along this axial direction only.

In view of the fact that the magnetic anisotropies in the two cupric Tutton salts are nearly the same as in copper sulphate, it is tempting to try whether a similar cubic field with a feeble tetragonal component will also fit the observed data for these two salts. The Tutton salts as already mentioned are monoclinic and contain two Cu^{++} ions in the unit cell. Assuming the field to be tetragonal, the χ_1-axis of the crystal should be evidently the projection of the tetragonal axis of the ion on the (010) plane of the crystal. Denoting the inclination of this tetragonal axis of the ion to the (010) plane by ϕ, we get the following simple relations between the principal magnetic moments of the *crystal* and those of the *ions* :—

$$\begin{aligned} p_1^2 &= P_\parallel^2 \cos^2\phi + P_\perp^2 \sin^2\phi \\ p_2^2 &= P_\perp^2 \\ p_3^2 &= P_\parallel^2 \sin^2\phi + P_\perp^2 \cos^2\phi \end{aligned} \qquad \ldots \quad (6)$$

If the above assumptions, regarding the tetragonal symmetry of the crystal field associated with each Cu^{++} ion, be correct then we should expect $p_2^2 = P^2_\perp$, to have practically the *spin only* value of 3. This is actually so as will be seen from below.

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TABLE V

Crystal : $CuSO_4$, A_2SO_4, $6H_2O$

	Temp. °K	$P^2_\perp = p_2^2$	$P_\parallel^2 = p_1^2 + p_3^2 - p_2^2$
$A = NH_4$	295.9	3.330	4.623
	92.9	3.327	4.464
$A = K$	295.9	3.149	4.752
	83.9	3.107	4.562

Knowing $P_\perp^2$ we can indeed go further and calculated $P_\parallel^2$ from the observed values of p_1^2 and p_3^2 using the relation (6), since then $P_\parallel^2 + P_\perp^2 = p_1^2 + p_3^2$. The values of $P_\parallel^2$ so obtained are given in the table above.

These values agree well with the values deduced from the crystal $CuSO_4$, $5H_2O$ and show (1) that the fields in the Tutton salts do have tetragonal symmetry, in spite of the fact, that in the Tutton salts, the Cu^{++} ion is surrounded by six identical oxygens all belonging respectively, to six water molecules, unlike in copper sulphate in which two oxygen atoms are different from the rest and belong to two SO_4^{--} groups ; (2) that even the magnitudes of the cubic and the tetragonal parts of the field are the same in the Tutton salts as in copper sulphate. The above conclusions lend strong support to the view expressed by us in our earlier papers (Bose, 1947, 1948), and which has generally been adopted in our discussions, that in addition to the cubic part, the feeble noncubic part of the field also may be due to the immediately neighbouring atoms, and as long as these neighbours are the same and arranged in the same configuration in different crystals, the crystal fields in them also will be the same. These results, have important significance in view of the interesting theorem of Jahn and Teller (1937, 1938), that the asymmetry and the magnitude of the crystalline field are determined ultimately by the degeneracy of the ground state of the paramagnetic ion.

The six oxygens surrounding the Cu^{++} ion will be strongly bound to the ion and the group as a whole will form a more or less rigid system having tetragonal symmetry. But the binding between two such groups present in the unit cell will be much feebler and hence the two tetragonal axes may slightly change their relative orientations with change of temperature ; consistent of course with the requirement of the monoclinic symmetry of the crystal of these Tutton salts. namely, that one of the groups should be the mirror image of the other. In other words, though the crystal fields and therefore, $P_\parallel$ and $P_\perp$ will be practically independent of the temperature, the angle ϕ, which the tetragonal axis makes with the (010) plane, as also its projection on the (010) plane, may change slightly with the temperature. The projection of the tetragonal axis is evidently the χ_1 axis of the crystal, and thus we can readily see how without any change in the crystalline field, either in its magnitude or in its asymmetry, there can be appreciable change in the

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direction of the χ_1 and χ_2 axes of the crystal. The angle ϕ may be calculated from the relation,

$$\frac{p_1^2 - p_3^2}{P_\parallel^2 - P_\perp^2} = \cos 2\phi \qquad \ldots (7)$$

and its temperature variation for the two Tutton salts may be seen from the Table VI. We specially emphasise this point, since an explanation of the change of axis in terms of the change in crystalline field, as has been attempted by Jordahl (1934), is not only complicated but requires a large rotation of the rhombic field axes with reference to the axes of the cubic field.

TABLE VI

For the angle ϕ

Crystal : $CuSO_4$, A_2SO_4, $6H_2O$

	Temperature °K	Angle ϕ in degrees
$A=NH_4$	295.9	40.8
	92.9	31.3
$A=K$	295.9	41.8
	83.9	41.0

Before concluding this section we should refer to some important results obtained by Reekie (1939, vide Table III) on the mean susceptibilities of these three cupric salts at liquid hydrogen and helium temperatures. For all the three salts the effective magnetic moment, corresponding to the mean susceptibility, is practically independent of temperature down to about 14°K (as we have also found for each of the three principal moments separately and over a shorter range of temperature). But below this temperature there is a striking contrast in the behaviour of the copper sulphate on one side and the two cupric Tutton salts on the other. Whereas, in copper sulphate the value of p, comes down rapidly at liquid helium temperatures and the trend of the p^2 against T curve suggests that it may reach very low values in the neighbourhood of absolute zero; in the Tutton salts the fall in p, is very slight and its rate is of the same order as at higher temperatures. Presumably, associated with this is the observation of Ashmead (1939) that the specific heat versus temperature curve of copper sulphate shows a large hump in the region of 4°K, which is completely absent in the corresponding curves of the two cupric Tutton salts. These results do not appear to be explicable on the crystalline field theory, and indeed, at present, on any theory.

3. *Ferrous Salts Versus Cobalt Salts*

As we mentioned in an earlier section, the triplet level in the Stark-pattern of the D-levels of Fe^{++} being lowermost, there should be a large contribution from the orbital moments, and the contributions should be different

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along different directions, actually adding to the spin contribution along p_1 and p_3 directions and acting against the spin along p_2 direction. Hence the large anisotropy in the crystals. We further see from the experimental data given in Table II that p_1 and p_3 have nearly the same values which vary little with temperature and they are not much different in the two salts. In cobalt salts (Bose, 1948) all the three p's tend to become temperature-independent at high temperatures, the values being very different from the *spin only* value of $p^2=15$. The experimental values for Fe^{++} show that p_1 certainly, and probably also p_1 and p_3 will reach temperature-independent values at high temperatures, and it is not unlikely that those temperature-independent values may all be the same, namely, the *spin only* value corresponding to $p^2=24$. If this is so it would mean that high frequency contributions in Fe^{++} are much less than in Co^{++}.

ACKNOWLEDGMENT

The author takes this opportunity of thanking Prof. K. S. Krishnan, D.Sc., F.R.S., for his kind interest and help in the series of investigations on the iron group of salts, of which the present paper is the last, which were completed before 1941 but could not be published so long due to unavoidable circumstances.

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A NEW HORIZONTAL ELECTRON MICROSCOPE

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Plates XVIA and XVIB

ABSTRACT. A new horizontal electron microscope with several special features has been constructed. The technical details of its construction, power supplies and operation are given in this paper. The microscope can be operated at a maximum electron energy of 80,000 electron volts and is designed for an electron optical magnification of twenty thousand diameters.

INTRODUCTION—HISTORICAL

An electron microscope with several distinctive features has been produced in the University College of Science, Calcutta. It is the aim of this paper to describe these features in detail. However, from the point of view of interest to the reader, a short historical account of the development of the electron microscope up to its present stage will be given, before the technical features of the new microscope are described.

The science of electron optics is of recent origin Its basis is the fundamental theoretical work on electron lenses by Busch who first showed in 1926, that axially symmetric electric and magnetic fields possess lens characteristics with respect to electron radiation. The practical development of magnetic lenses was carried out by Knoll and Ruska (1931, 1932) in the Technische Hochschule, Berlin. The first electron microscope employing magnetic lenses with pole pieces—the prototype of all modern instruments—was constructed by Ruska in 1934. A cold cathode gas discharge tube was used as the source of electrons, there was no provision for air-lock arrangement for introduction and removal of specimens and the final image formed on a fluorescent screen was photographed through a window by means of an external camera. Marton introduced several improvements in the design of an electron microscope developed by him in the University of Brussels, in 1935. He used a heated filament, air-lock specimen chamber and arrangement for direct recording of electron micrographs on photographic plates introduced into the vacuum. He was also the first to photograph biological specimens with an electron microscope.

Two years later in 1937, the first electron microscope in Britain was constructed by the Metropolitan Vickers Company for Martin, Whelpton and Parnum 137. At about the same time Burton in Canada organised a programme

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of research in electron microscopy in the University of Toronto. Two of his graduate students, Prebus and Hillier (1939) built the first electron microscope in America. By 1939 resolving powers better than 100 A° were obtained by Canadian and European workers. (Burton, Hillier and Prebus 1939).

At this stage when the great potentialities of the new microscope was well proved by these successful research instruments, developed primarily in the university laboratories, industry took up further development. The first commercial electron microscope was built at about this time by Siemen's company in Berlin (Borris and Ruska 1939, 1940). The lens coils and the filament of the microscope used current from storage batteries and the coils were water cooled. The high voltage unit consisting of the conventional transformer rectifier system was in a seperate assembly on account of its great bulk and for better shielding of the microscope from sixty cycle electro-magnetic radiation.

Von Ardenne in 1940 published a description of his universal electron microscope developed in the Kaiser Wilhelm Institute, Berlin. It was designed for bright field, dark field and sterio operation. The notable features of this instrument were the arrangement for tilting of the specimen for sterioscopic photography and perfect alignment and also the possibility of direct electronic magnification up to 50,000 diameters.

In 1939 Marton came to U. S. A. and joined the R. C. A. laboratories. There he developed the first R. C. A. electron microscope called R. C. A. type A (Marton 1940, Marton, Banca and Bender 1940). A year later R. C. A. announced the development of the first commercial electron microscope in U. S. A, called R. C. A. type B. (Zworykin, Hillier, and Vance 1941 *a*, Hillier and Vance 1941). The chief improvements on its predecessors were (a) combination in a single unit of both the microscope and its power supplies and (b) the use of high frequencies for generation of high voltage and heating of the filament. For stabilisation of the high voltage, feed-back principle was used.

In 1941 various attempts were made to increase the electron energies so as to make possible the examination of thicker specimens with the help of an electron microscope. Müller and Ruska (1941) adopted a Siemens microscope for operation at 220 ekv. Von Ardenne (1941) modified his electron microscope described earlier for operation at 200 ekv. Zworykin, Hillier and Vance (1941*b*) also reported the construction of a 300 ekv. microscope.

In these cases the microscope body was similar to those already described. Only the electron gun was built in two or three stages and the voltage distributed between them by means of a voltage divider across the high voltage supply for stable operation.

In 1942 Prebus built an electron microscope in the Ohio State University, Columbus, following the design already developed at Toronto. Microscopes

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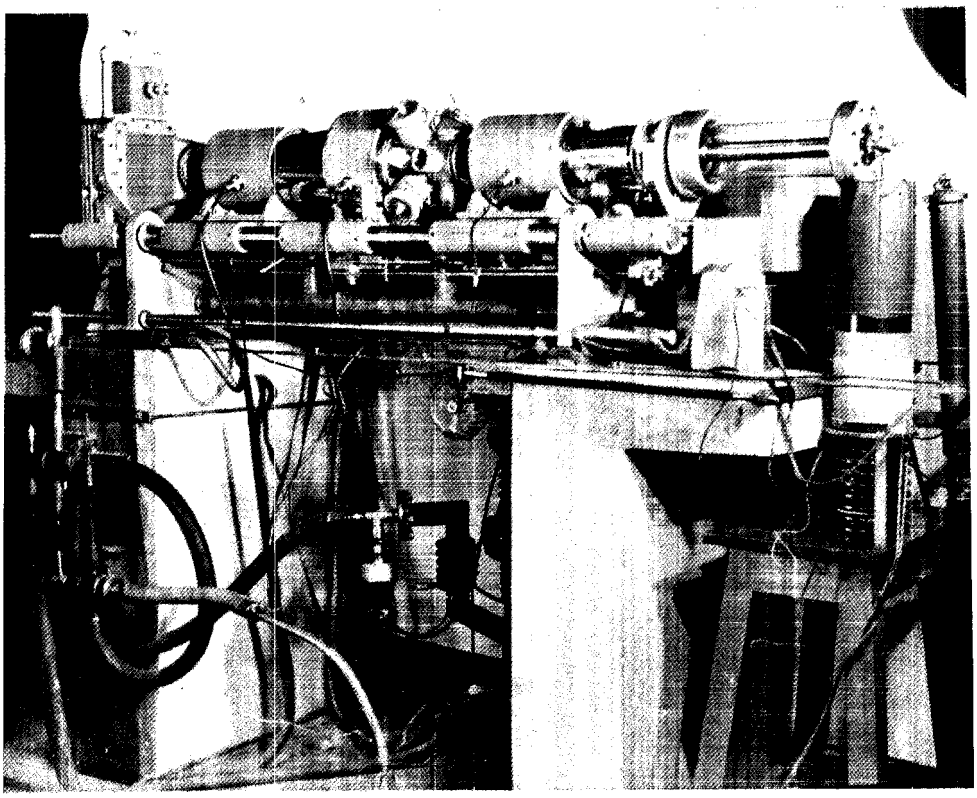

Fig. 1

Photograph of the Calcutta University Electron Microscope.

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based on this design were also installed at the Eastman Kodak Co. and in Columbia Carbon Co., in U.S.A. In the subsequent year R.C.A. announced the development of a small compact electron microscope called R.C.A. console model (Zworykin and Hillier 1943). In this unit the condenser lens was eliminated and the objective and the projector lenses contained in the same magnetic circuit. This extreme simplicity of design had been obtained at the cost of a fixed magnification of only 5000 diameters and an operating voltage of only 30 ekv. The resolution was reported to be better than 100 A°.

In 1945 Marton, now at the Univerity of Stanford, produced an electron microscope employing five lenses and designed for three stage magnification which could be varied from 400—40,000 diameters. This microscope had an intermediate lens in between the usual objective and the projector lenses and was designed for operation at 100 ekv.

During war the research and development of electron microscopes was mostly restricted to U.S.A. However, some work was carried on with great difficulty in Holland, France and Great Britain. Poole developed in 1944 an electron microscope in the Institute of Electron Optics at Delft, Holland whose details have just been published (Poole 1947). This instrument operates at 150 ekv and is a four lens unit. With a distance of only 60 cms between the object and the final image the magnification produced can be varied continuously between 1000 and 80,000 diameters. This instrument has also an arrangement for using 35 mm. film. In 1947 the Metropolitan Vickers Co. in England anounced the production of the first commercial electron microscope in England EM3 Model of Metro Vick. (Haine 1947).

The instruments described so far are electromagnetic instruments using electromagnetic type of lenses. The development of electrostatic lenses and of electron microscopes using such lenses has proceeded almost side by side with that of the electromagnetic instruments. Shortly after Busch's original discovery, Davisson and Calbick (1932) in U. S. A. and Brüche and Johannson (1932*a*) in the A. E. G. laboratories in Berlin successfully developed electrostatic lenses. Brüche and Hagen (1939) and Mahl (1939) designed the first electrostatic microscope of high magnification in the A. E. G. laboratories in Berlin. Boersch (1942) built at the University of Vienna a versatile type of electrostatic electron microscope. This instrument could be easily adapted for taking the usual transmission pictures, electron shadow micrographs as well as diffraction patterns. In 1943 Bachman and Ramo, of the G. E. C. laboratory in U. S. A. developed a three stage electrostatic instrument. With a very simplified design they obtained a resolution 10 times that of the light microscope and an electronic magnification varying from 500-1000 diameters. In France, the Compagnie Generale de Telegraphie sans Fil (C.S.F.) has also produced an electrostatic instrument. Although the electrostatic instruments are simpler to construct, from the point of ultimate performance they have not yet appeared on the market as any serious rival of the electromagnetic instruments.

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DESCRIPTION OF THE NEW MICROSCOPE

An illustration of the new electron microscope is given in Plate XVIA, Fig. 1. Fig. 2 shows a section of the complete electron optical system. There are several

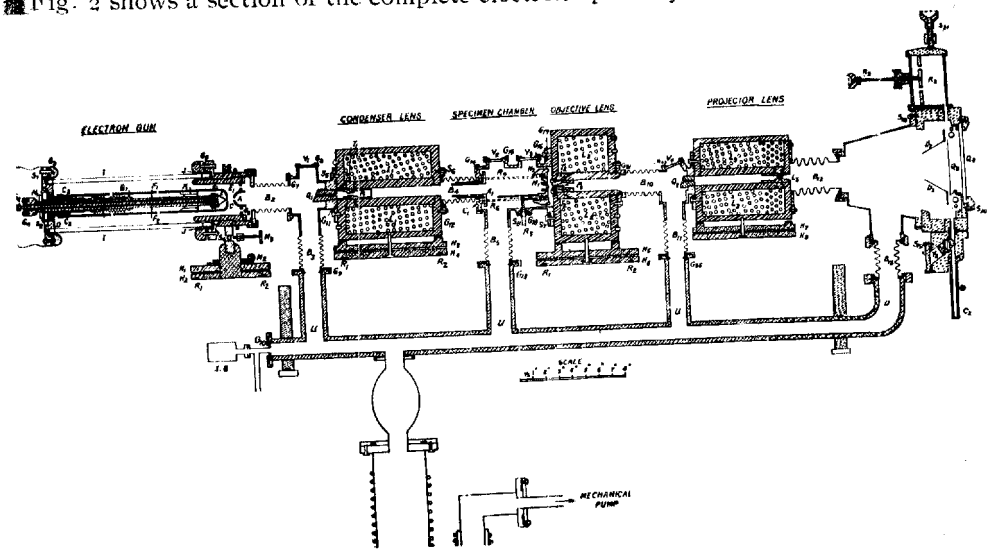

FIG. 2
Sectional Diagram of the New Microscope

features which distinguish this unit from all the instruments described earlier. This instrument is a completely horizontal unit with different elements mounted on two stainless steel rods held in position by brass sleevings which can slide over the steel rods. It is thus possible to dismantle any part of the microscope without disturbing the rest. The distance between any two elements can be varied, it is also possible to interpose an extra element between two of the existing ones if desired. The instrument is thus essentially a research unit, very flexible in design and highly suited for investigations on electron-optical problems. Due to horizontal positioning each microscope element is approachable from all sides and the image formed on the final fluorescent screen can be demonstrated to a number of people simultaneously. The instrument consists of the usual three lenses, the condenser, the objective and projector lenses and is designed for a maximum electronic magnification of twenty thousand diameters.

The electron gun, the condenser, the objective and the projector lenses are supported on separate carriages consisting of pairs of horizontal brass plates H_1 H_2, H_3 H_4, H_5 H_6, and H_7 H_8. Any of the pairs of brass plates can slide together in a horizontal plane perpendicular to the axis of the microscope on a pair of stainless steel guide rods R_1 R_2, fixed to the frame of the instrument. The upper plates H_1, H_3, $H_5$and H_7 supporting the microscope elements can also be raised or lowered with respect to the lower plates by a set of screws. These two motions at right angles to the optic axis can be given to any element of the microscope. By means of transmission gear arrangement the operator,

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sitting at the control table near the final fluorescent screen, can move any of the lenses or the gun for proper alignment. Each of the three lenses has four levelling screws by means of which the lens may be slightly inclined to the axis so as to allow for any asymmetry of the pole pieces. In addition to lateral motions, the gun can be slightly tilted about horizontal and vertical axes passing through the tip of the filament F, by means of the screws M_3 and M_2 respectively.

The different elements are connected with one another and with the vacuum manifold U by sylphon bellows so that relative movement is possible maintaining the vacuum. The length of the microscope column from the filament tip to the objective is 59 cm. and the length from the objective to the fluorescent screen Q_4 is 79 cms. For evacuating the microscope column an oil diffussion pump and a Cenco Hypervac 20 are used. The mechanical pump is housed in a specially designed underground chamber a little distance away from the microscope in order to reduce noise and vibration. A thermocouple gauge measures the fore-vacuum while the high vacuum within the microscope is indicated by an ionization gauge.

A. Illuminating System

The illuminating system consisting of the electron gun, the primary viewing screen Q_1 and the condenser lens L_1 is shown in the figure 3. The electron gun is a three electrode system consisting of the filament F, cathode shield C and the anode A. The filament consists of a .005 inch diameter tungsten wire bent into hair pin shape. The filament current leads F_1, F_2 consist of a steel cylinder surrounding a steel rod; the two are kept insulated from each other by means of a pyrex tube. The filament is heated by means of a high-frequency (150 kc/s) current and may be maintained at a maximum negative potential of 80 ekv. with respect to the anode which is earthed together with the main body of the microscope. The cathode shield is a cylinder of stainless steel with an 1/8 inch diameter aperture, located just in front of the filament tip. The filament is kept fixed axially within the cathode shield by means of an alsimag cylinder K. For changing the filament, a part of the cathode shield may be unscrewed at C_1. The cathode shield is insulated from the filament and may be suitably biased when it serves as a control grid. The distance between the filament tip and the centre of the shield can be varied by means of the adjusting screw M_1 at the high potential end.

The anode A is a copper hemisphere, drilled axially with an 1/8 inch hole to allow the beam to pass through. The distance between the anode and grid aperture is about 1 inch but may be adjusted by screwing at C_2. The anode is surrounded by a steel shield E_1 which cuts off X-radiation from the anode due to bombardment of high energy electrons. The high voltage insulator I consists of one ft. long pyrexcylinder metallised at the end

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to which are soldered steel flanges J on either end. The complete filament assembly is held in position by the centering aluminium disc D. The whole

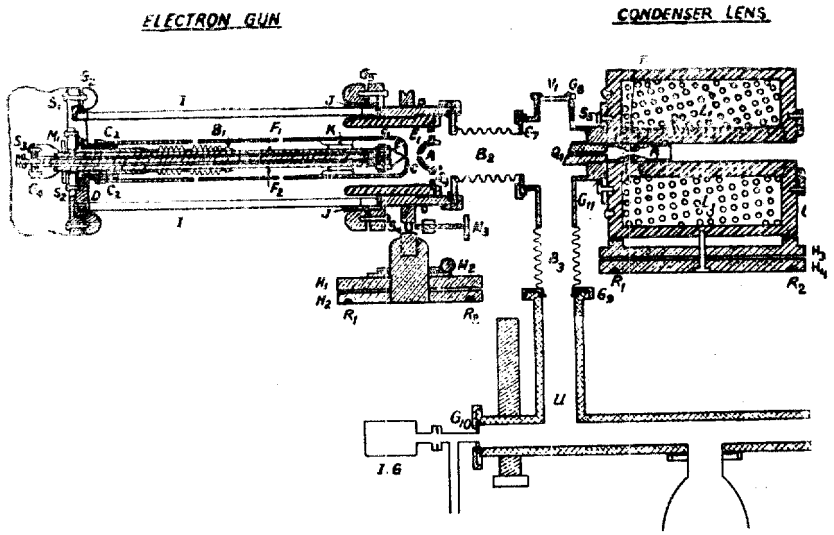

FIG. 3

Illuminating System of the New Microscope.

A anode, B_1-B_3 sylphon bellows, C cathode shield, F filament, G_1-G_{11} vacuum gaskets, H_1-H_4 brass carriages for movement of the electron gun and condenser lens, I metallised pyrex insulator, J steel flanges soldered to the insulator, K alsimag cylinder, L_1 condenser lens coil, M_1-M_3 adjusting screws for controlling the position of the electron gun, P_1 condenser pole piece, Q_1 primary viewing fluorscent screen, R_1, R_2 rods permitting horizontal motion of the gun and condenser lens, S_1-S_5 gasket tightening screws, T_1 brass spacer in condenser lens, U vacuum manifold, V_1 viewing port.

gun assembly is demountable and is made vacuum tight by means of the rubber gaskets G_1-G_6 and gasket tightening screws S_1-S_4. For a change of filament, the filament unit together with the cathode shield can be taken out by unscrewing S_1.

The electron beam after leaving the gun assembly falls on the primary fluorescent screen Q_1 which is a copper rod with an axially drilled hole. This allows the central portion of the beam to pass through and enter the condenser lens L_1. V_1 is a small port for viewing the crosssection of the illuminating beam at this position.

The condenser lens L_1 is also shown in Fig. 3. It consists of a coil housed in an iron cylinder of length $7\frac{1}{4}$ inches, external diameter $6\frac{1}{2}$ inches and internal diameter $5/8$ inch. The magnetic circuit is completed through the iron except for a small gap bridged by non-magnetic brass piece T_1, through which the field extends into the vacuum. The field is further concentrated by the insertion of accurately machined pole pieces P_1 of special design, drilled with a central hole for the passage

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of electrons. The coil of the condenser lens is outside the vacuum system; only the inner hole of 5/8 inch diameter is connected to the vacuum system.

B. Specimen Chamber

A vertical section of the specimen chamber through the optic axis is shown in Fig. 4. The object stage N is held in position by means of four

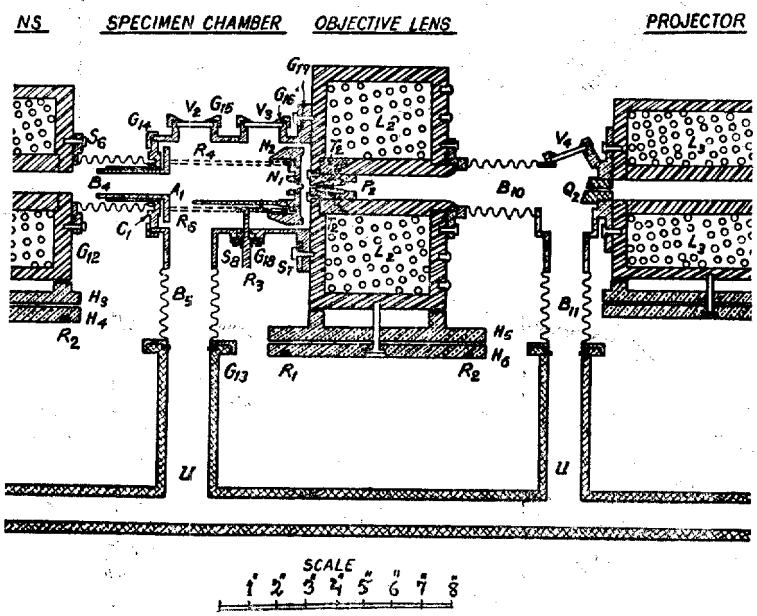

FIG. 4

Objective and Specimen Chamber of the New Microscope.

A_1 brass end piece, B_5, B_5, B_{10}, B_{11} sylphon connections, C_1 brass cylinder. $G_{17}-G_1$ vacuum gaskets, H_5, H_6 brass carriage for movement of objective lens, L_2 objective lens coil, N_1, N_2 object stage with the movable part N_1 within the fixed part N_2, P_2 object lens pole piece, Q_2 intermediate viewing screen, R_1, R_2 rods permitting horizontal motion of objective lens, R_3 sterio-motion rod, R_4-R_6 horizontal supporting rods for specimen stage, S_6-S_8 tightening screws, T_2 brass spacer in objective lens, U vacuum manifold, V_2, V_3, V_4 viewing ports.

horizontal rods $R_4 - R_7$, attached to the end piece A_1 which fits tightly into the brass cylinder C_1. For stereophotography the part N_1 of the object stage can be rotated through a small angle within the fixed part N_2. The tilting of the stage for stereography is accomplished by means of the rod R_3 which projects from the lower side of the chamber, through a Wilson seal. Two viewing ports V_2 and V_3 on the upper side of the chamber allow a view of the specimen stage through all operations.

A vertical section of the object chamber perpendicular to optic axis is shown in figure 5. Four hydraulic sylphon bellow $B_6 - B_9$ are

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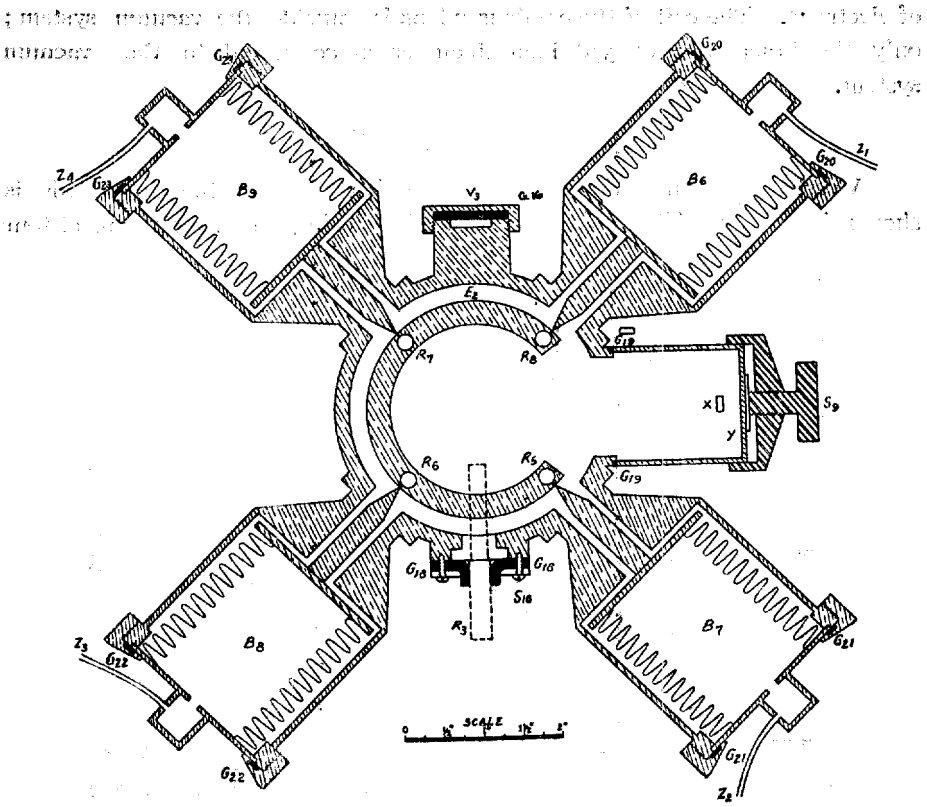

FIG. 5

Mechanism for Movement of Specimen Stage.

B_6-B_9 hydraulically operated sylphon bellows, E_2 brass ring holding the horizontal rods R_4-R_8 together, $G_{18}-G_{23}$ vacuum gaskets, R_3 sterio motion rod, R_4-R_7 horizontal brass supporting rods, S_9 tightening screw for air-lock chamber, V_3 viewing port, X forked handle for removing specimen from stage to air-lock chamber and *vice versa*, Y air-lock chamber, Z_1-Z_4 hydraulic connections from the sylphons to the control panel.

fitted at 90° to each other for moving the object stage in two perpendicular directions at right angles to the optic axis. In normal position the tips of the bellows rest in four accurately drilled holes in a brass ring E_2 fixed to the carrier rods R_4—R_8. The four bellows, slightly compressed, press against each other and help to keep the stage accurately centered and also at a fixed distance relative to the object lens pole piece P_2 (Fig. 4). By compressing and expanding the hydraulic sylphons it is possible to move the stage in a plane perpendicular to the microscope axis and thus explore different parts of the specimen. The fluid from the sylphons $B_6 - B_9$ passes through small copper tubes $Z_1 - Z_4$ to a corresponding unit on the control desk. It is thus possible to move the stage while looking at the image on the final fluorescent screen Q_4. The unit on the control desk is provided

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with both coarse and fine control adjustments, so that the specimen can be placed accurately in any desired position. The arrangement has no backlash and gives a very smooth motion of the specimen across the field of view.

The specimen change operation is performed with the help of the airlock arrangement shown in Fig. 6 which is a vertical section of the unit. When removing the specimen from the vacuum, a phosphor bronze fork XX holds the bucket W and a 90° rotation of the fork handle from outside releases the bucket from the specimen stage and brings it into the air-lock chamber Y_1. In this position the bucket is pressed from behind by the brass rod R_8 carrying the gasket G_{27}. Half a turn of the nut C_1, presses the gasket G_{27} against the back of the bucket and seals it off from the microscope vacuum. While the bucket is held in this position, air is introduced into the airlock

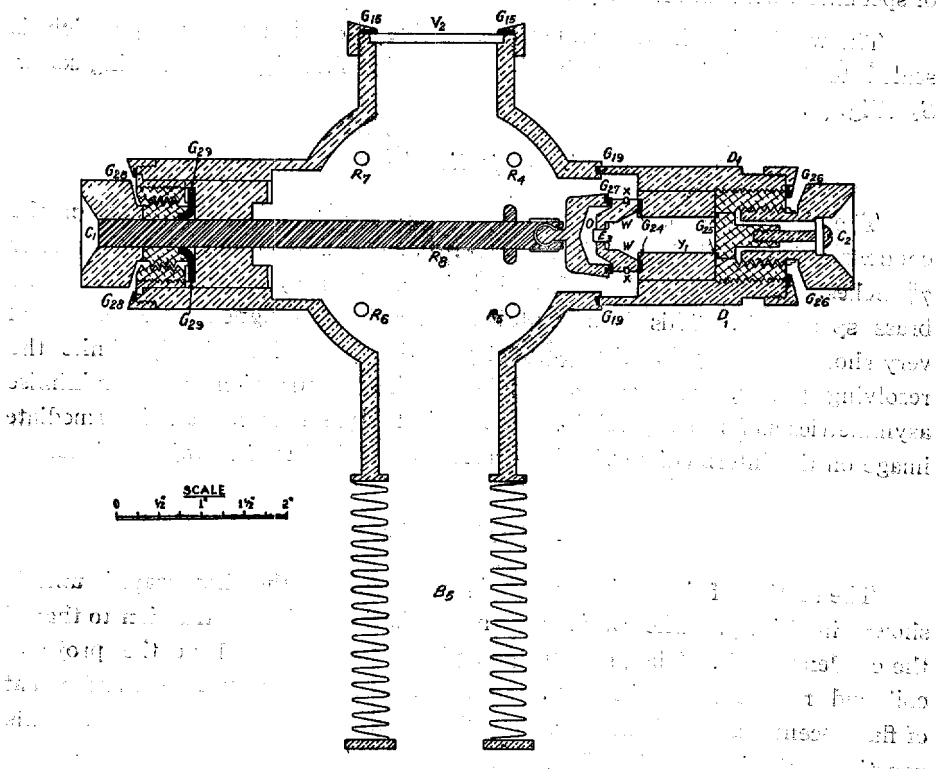

FIG. 6

Vertical Section of the Airlock Chamber at Right Angles to the Optic Axis.

B_5 sylphon connection to the manifold, C_1, C_2 split nuts for closing and opening the airlock chamber, D_1 brass box containing airlock arrangement, E_3 specimen holder, G_{15}, G_{19}, G_{24}, G_{29} vacuum gaskets, O object, R_4-R_7 four brass rods which support the stage and allow it to be moved by the hydraulic stage shifter, R_8 rod for sealing off (by means of gasket G_{27}) the specimen from the microscope vacuum, operating through the Wilson seal G_{29}, V_2 viewing window, W section of the bucket which carries the specimen from the stage to airlock chamber Y_1 or vice versa, Y_1 airlock chamber.

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chamber Y_1 by releasing the nut C_2. The specimen holder E_3 is now removed through the opening made by removal of C_2.

The procedure is reversed for introduction of new specimens into the vacuum system. When a new specimen has been replaced with the bucket in the position shown in Fig. 6, the nut C_2 is locked in first thereby isolating the airlock chamber Y_1 from the external atmosphere by means of gasket G_{25}. The rod R_8 is now pushed back and by means of the fork XX the bucket is replaced in the specimen stage N_1. Once the bucket is held by the specimen stage, it is freed from the fork and can then be moved about by means of hydraulic arrangement described previously. Only the air trapped in the small chamber Y_1 is introduced into the microscope each time a specimen is replaced. This arrangement permits quick replacement of specimens without seriously disturbing internal vacuum.

The whole airlock arrangement is contained in a brass box D_1 which is sealed to the specimen chamber by means of gasket G_{19} and clamping screw S_9 (Fig. 5).

C. Objective Lens

The objective lens L_2 is shown in Fig. 4. This coil is bigger than the condenser lens coil L_1, with an inner diameter 2 inches and outer diameter $7\frac{3}{4}$ inches. The whole coil is shrouded in an iron cylinder except for the brass spacer T_2. This lens contains a specially designed pole piece P_2 of very short focal length. As asymmetry of the pole piece finally limits the resolving power, great care was taken during construction so as to minimise asymmetries as far as possible. The objective lens forms an intermediate image on the intermediate viewing screen Q_2 attached to the projector lens.

D. Projector Lens

The section of the projector lens L_3 together with the photographic unit is shown in Fig. 7. The projector lens coil is similar in construction to that of the condenser coil. The projector pole piece P_3 is inserted at the projector coil end remote from the gun. A copper rod with an axial hole and a coat of fluorescent material is fixed to the other end of the projector lens. This constitutes the intermediate fluorescent screen Q_2.

E. Photographic Unit

Fig. 7 shows a vertical section of the photographic unit through the optic axis. The final image may be obtained either on the flourescent screen Q_4 or intercepted by the photographic plate Q_3. The plate magazine K_2 holds about twenty photographic plates and is demountable for loading in the dark room. The plates are moved forward by a pressure pad, the pressure being maintained by the vacuum. In order to release one plate into

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the photochamber the knob R_9 on the back of the photochamber is pulled. One plate then drops on to the carrier bar R_{10}, which can be moved from

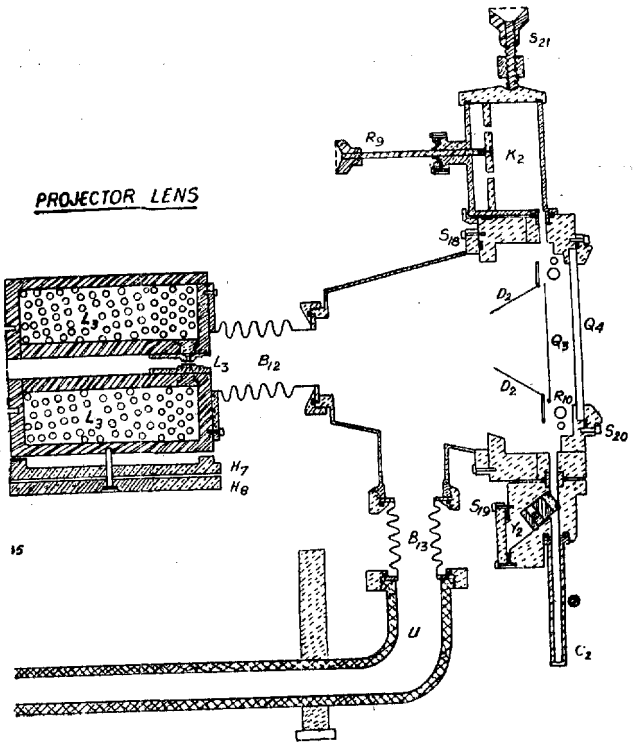

FIG. 7

Vertical Section of the Projector Lens and Photographic Chamber through Optic Axis. A_2 terminal aluminium plate, B_{12}, B_{13} sylphon connections to the rest of the microscope, C_2 plate receiver, D_2 adjustable photographic shutter, E_4 pressure pad holding the plates in readiness for dropping one at a time, $G_{37}-G_{50}$ vacuum gaskets, K_2 photographic plate magazine holding about twelve $3\frac{1}{4}'' \times 4''$ plates, L_3 projector lens coil, R_7 knob for releasing one plate at a time, P_3 projector lens pole piece, Q_2 intermediate flourescent screen, Q_3 photographic plate in position and carried by the carrier bar R_{10}, Q_4 final flourescent screen 6" diameter, S_{16}, $S_{18}-S_{21}$ gasket tightening screws, U vacuum manifold connection, Y_2 valve interlock into the airlock chamber.

outside and the plate held in any position in the exposure field. Four exposures can be made on a single photographic plate. After the exposure is made the shutter D_2 is closed and the carrier bar lowered until the plate drops into the plate receiver box C_2. The air-lock valve Y_2 is now closed, air introduced into the receiver box and the plates removed for development. By means of a knob it is possible to swing the whole plate carrier and shutter mechanism out of the path of the electron beam so that the total area of the fluorescent screen (5 inches in diameter) can be utilised for visual observation of the micrograph.

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The whole photographic unit is mounted on stainless steel guide rods by means of brass sleevings (Fig. 1, Plate XVIA). The unit is connected to the vacuum manifold and the projector lens by means of sylphon bellows B_{12} and B_{13}.

ELECTRONIC CONTROL CIRCUITS

A. High Voltage Supply for Electron Gun

Figure 8, Plate XVIB is an illustration of the r.f. high voltage unit. The schematic diagram of the high voltage circuit is shown in Fig. 9.

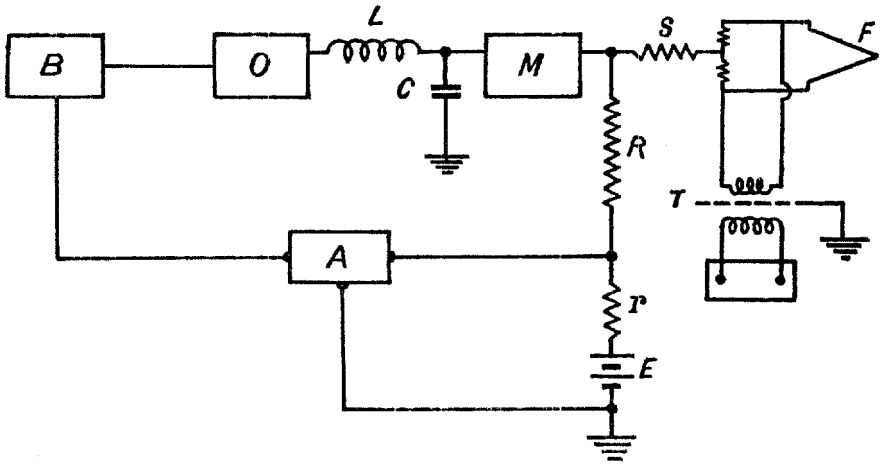

FIG. 9

Schematic diagram of high voltage generator and regulator.

The circuit arrangement follows basically that developed by Hillier and Vance (1941). A high frequency oscillator O supplies 500 volts at 50 kc/sec. to the series resonant circuit consisting of L and C of resonance frequency 50 kc/sec. The resonant circuit, by virtue of its inherent characteristic, steps up the input voltage Q times across the terminals of the condenser C, Q being the efficiency factor of the series resonant circuit. Q in our case being about 40, the voltage across C is 20 kv at 50 kc/s. This voltage is subsequently quadrupled and rectified by the unit M in the manner first described by Greinacher (1921) and later used by Cockroft and Walton (1932). The unit M incorporates a resistance-capacity network which serves to filter out the ripple content from the output voltage. The output, thus multiplied, rectified and smoothed, is 80 kV negative relative to the ground and is connected to the filament F of the microscope through a current limiting resistance S.

The stability of this high voltage is an important consideration for best resolution of the electron microscope. In order that want of sharpness in the final image, due to fluctuations in the high voltage supply alone, will not exceed 10 Å. the maximum permissible variation in the high voltage supply

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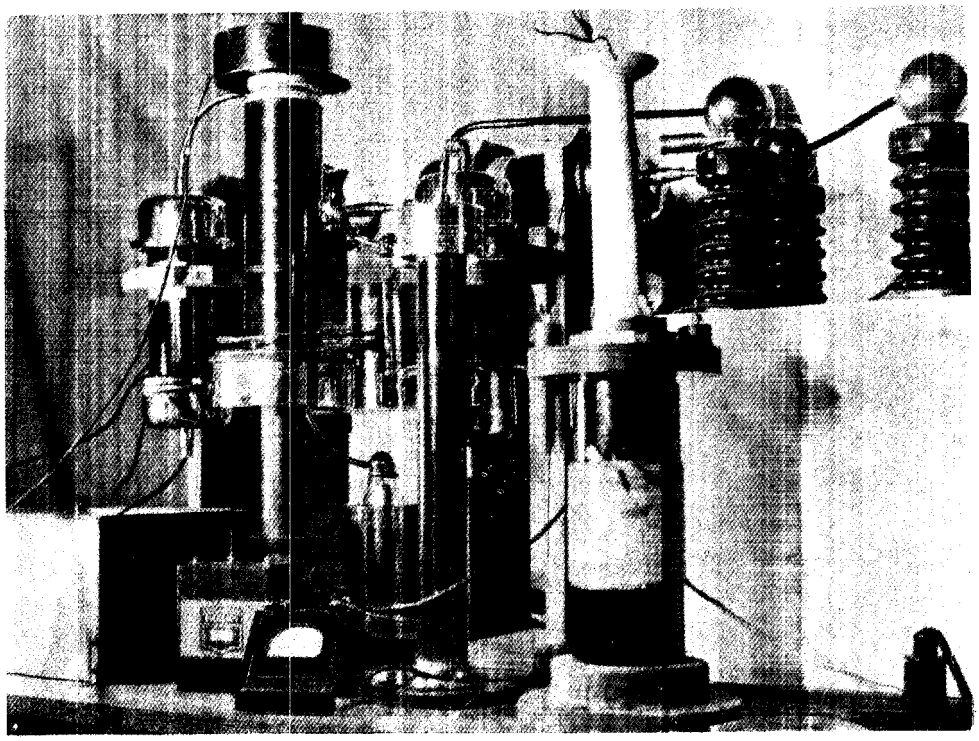

Fig. 8

Photograph of High Frequency Voltage Unit.

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is 1 part in 10, 000. This degree of stabilisation is achieved by making use of the principle of inverse feed back. By means of the voltage divider $R+r$ across the high tension generated at M, a part of the output voltage is balanced by the dry battery E and the difference is applied to the direct current amplifier A. Any out of balance voltage due to instability is amplified by A and then supplied to the electronic regulator B which in turn controls the high tension anode input to the oscillator O. This feed-back amplifier arrangement is such that the variation in the oscillator output is in antiphase to those of the rectifier quadrupler unit and is capable of neutralising the original variation in high tension.

The d. c. amplifier A consists of 2 stages, the output variation of which is in the same phase as that of input. This affects the electronic regulator B which acts as a series load to the oscillator tube in O. The electronic regulator B is similar to that used for regulating currents to various lenses (described below).

In addition to the above electronic voltage regulating system the whole a. c. supply is pre-stabilised by a constant voltage transformer of saturable reactor type.

B. Microscope Filment Supply

The filament of an electron microscope usually requires 2·3 amperes at about 2 volts depending on the nature of the filament used. The filament supply has to be maintained at a very high negative voltage with respect to ground and also has to be accurately controllable for varying the intensity of the beam through the microscope. In the present unit, the microscope filament is heated by r. f. current of about 150 kc/s. This reduces the problem of electrostatic shielding and also simplifies that of high voltage insulation. The filament current is supplied by the secondary of a r. f. transformer T through the primary of which passes the r. f. current from an oscillator. The anode voltage of the oscillator is supplied through a variable resistance by means of which the output of the oscillator can be easily regulated thereby controlling the microscope filament current.

The anode circuit of the oscillator is completed through a relay system, operated by the current from the ionisation gauge measuring the vacuum. Whenever the vacuum inside the microscope column falls below the limit, at which it is safe to operate the instrument, the ionisation gauge current becomes excessive and this automatically disconnects the anode voltage. The oscillation ceases at once and the filament of the microscope is thus saved from being burnt off.

C. Current Regulators for Electromagnetic Lenses

In a magnetic electron microscope it is essential to keep the currents through the various lens coils strictly constant. The stabilisation tolerences

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of the different current supplies for a resultant image unsharpness of 10 Å. can be computed theoretically (Zworykin, et al 1946) ; the values so obtained for an optimum aperture are as shown below :

Supply	Tolerance $\Delta I/I$
Condenser lens	1.0×10^{-3}
Objective lens	5.5×10^{-5}
Projector lens	1.3×10^{-4}

The three lenses have three separate electronic regulators of the general type shown in figure 10.

A number of 6*L*6 beam tetrodes connected in parallel serve as the main power tubes driving the magnetising current through the lens coil L in series with a variable resistance R (eventually a number of resistors providing the coarse, medium and fine controls). The voltage drop produced by the load current on passing through the resistor R is compared to that of a dry battery and the difference is applied to the grid of a 6*SJ*7 tube. The anode voltage of this tube controls the grid excitation of the 6*L*6 tubes. The circuit is thus essentially a degenerative voltage regulator described by Hunt and Hickman (1939). It maintains a constant voltage across the control resistor R and with constant load, it acts as a good current regulator at very low frequencies. The regulator action is further helped by the screen connection of the 6*SJ*7 as shown in the Fig. 10. Variation in the current is obtained by variation of R.

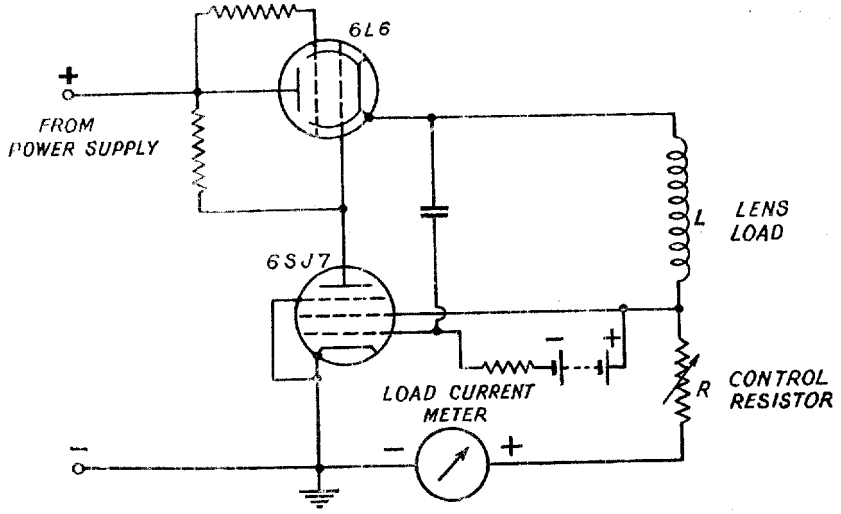

FIG. 10
Circuit diagram of the lens-current regulators.

The simple electronic circuit alone is incapable of giving the required degree of stability. The primary a. c. supply is further pre-stabilised by a conventional constant voltage transformer of saturable reactor type.

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With this circuit, it has been possible to secure the required order of stability. Slow drifts arising from changes in resistance due to heating or changes in thermionic emission, etc., have been observed, which have been minimised to some extent by using stabilised a. c. voltage to heat the filament of the tubes.

D. Vacuum Gauge and Relay Circuits

The electronic circuit also includes a thermocouple and an ionisation gauge for measurement of microscope vacuum. The thermocouple gauge is fitted before the diffusion pump and measures the rough vacuum produced by the mechanical pump. The ionisation gauge is placed after the diffusion pump very close to the microscope filament. It indicates the final vacuum produced at this point.

A relay is fitted in the ionisation gauge circuit which automatically shuts off the high voltage and the heating current of the microscope filament as soon as the pressure inside the microscope becomes more than 3×10^{-4}mm of mercury. Thus the vacuum gauge and the relay system protects the microscope from damage due to accidental failure of the high vacuum as a result of a suddenly developed leak. A second relay is incorporated in the high voltage circuit, which shuts off the high voltage, if for any reason, the current drawn from the high voltage becomes excessive. This relay therefore protects the components of high voltage circuit in case of an accidental failure of electric insulation.

CONCLUSION

In this preliminary report the constructional details of the new electron microscope have been given.

It will be seen from the introduction, that in every country the electron microscopes were first developed in the university laboratories. It was only after a great deal of experience had been gained, during researches carried out in these laboratories, that it was possible to produce an electron microscope commercially, first in Germany nearly ten years ago and then in U. S. A., and only last year in countries like England, Holland and France. This paper contains an account of the attempt to construct for the first time in a university laboratory in this country an instrument of this type.

ACKNOWLEDGMENTS

In this project we have been helped by one of the pioneers in this field, *viz.*, Prof. L. Marton. We are all indebted to him for his

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advice and guidance in designing the instrument and help in the procurement of parts from U. S. A. Mr. Bert F. Bubb of Stanford University has been of great assistance in the mechanical construction as well as in designing. Apart from the mechanical parts, the complete electronic power system consisting of the high frequency oscillators, both for the microscope filament heating as well as for the rectified 80,000 volt d.c. source for the electron gun, the highly stabilised current supplies for the three electromagnetic lenses, the vacuum gauge and the safety relay systems were built up in our laboratory. Some of the local radio manufacturers particularly Messrs. Indian Radio Institute and India Radio Manufacturing Co. of Calcutta, have helped us by making high Q radio frequency coils and transformers according to our requirements.

The authors are thankful to Mr. B. M. Banerji of this laboratory for some useful suggestions on circuit problems. They are also very much indebted to Prof. M. N. Saha for his constant encouragement and enthusiastic help in this project.

It is a great pleasure to acknowledge with thanks the gift of Rupees 17,500 made by Dr. B. C. Law for the purchase of components for this microscope.

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ASSOCIATION OF SCIENTIFIC WORKERS OF INDIA

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MEMORANDUM
ON
THE CENTRAL COLLEGE OF AGRICULTURE, GOVERNMENT OF INDIA, NEW DELHI

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ASSOCIATION OF SCIENTIFIC WORKERS OF INDIA
MEMORANDUM
ON
THE CENTRAL COLLEGE OF AGRICULTURE, GOVERNMENT OF INDIA, NEW DELHI

The Central College of Agriculture was started on a permanent basis in 1947 on the personal initiative of Dr. Rajendra Prasad, the then Minister for Food and Agriculture. Thc fact that high priority was accorded to the establisment of an All India Central Agricultural College at a time when the Government was preoccupied with partition work and problems arising out of it, is but one indication of Government's recognition of the importance of Agricultural Education in the country.

Now when the recruitment of staff and procurement of equipment are just complete and when the first batch of students is about to appear for their degree examination, the decision of the Govenment not to admit students in the next academic year comes as a big surprise. The principal reason adduced in favour of this decision appears to be the need for economy. This decision and the 'Grow More Food' drive, however, ill go together. Indeed, the establishment of first rate Agricultural Colleges is the *sine quanon* of development of agriculture on modern scientific lines and the decision to close down the College, if true, cannot but be regarded as a retrograde step, and certainly false economy.

GENESIS OF THE COLLEGE

It was in 1944 that Sir Pheroze Khareghat, then Secretary to the Ministry of Agriculture, in his memorandum to the Indian Council of Agricultural Research (I. C. A. R.) pointed out the necessity of atleast ten more agricultural colleges to serve the needs of the country for the proper development of its agriculture. The I. C. A. R. formulated a scheme for opening one such college at Delhi. The scheme was accepted by the Government of India after close scrutiny and a college christened as Central College of Agriculture was opened on a permanent basis in 1947 at a temporary site located at Anand Parbat to cater for the needs of Centrally Administered Areas and provinces and states having no Agricultural Colleges of their own (vide Appendix A). Funds (Rs. 80 lakhs) were made available for securing a permanent site and construction of new buildings. Various sites were inspected but unfortunately, no final decision was taken and major portion of the grant was surrendered at the end of the financial year 1947-48. The college is still continuing at its original temporary site.

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The recruitment of staff and procurement of equipment are, however, almost complete. Over Rs. 12 lakhs have already been spent. The college has now all the four classes and the first batch of students is to appear for the degree examination (B.Sc. Hons Agr.) in April, 1950.

CASE FOR THE COLLEGE

The reasons which necessitated the starting of the College in 1947 are now more pronounced, for neither have any new colleges imparting education upto the B.Sc. Hons. Agr. been started nor have the boundaries of the States of the Indian Union been so adjusted as to enable the existing agricultural colleges to cater for the needs of the entire country. A Central College continues to be as essential as before.

It may be stated that there are 14 agricultural colleges in the states of Madras, Bombay, Uttar Pradesh, Bihar, Madhya Pradesh Punjab (I), Mysore and Delhi covering an area of 537, 985 square miles, thus leaving a huge area without agricultural colleges still. There are thus no agricultural colleges in West Bengal, Assam, Orissa including the States, Ajmer-Merwara, Coorg with states, Vindhya Pradesh, Madhya Bharat, Rajasthan, Matsya Union, P. E. P. S. U., Saurashtra, Himachal Pradesh, Jammu & Kashmir States and United States of Travancore and Cochin.

Comparison with other countries is quite interesting. In England and Wales with an area of 58,343 square miles, there are 7 agricultural colleges each governed by a separate foundation and seven Universities with departments of Agriculture each providing courses in Agriculture leading to a Degree (Luxmoore Committee report 1943, pages 20-21). In the U. S. A. with an area of 3,022, 387 square miles, there are 48 land-grant colleges of agriculture - each attached to a State University. Thus, while in England and Wales one agriculture college serves an area of 4,167 square miles and in U. S. A. 62,966 square miles, in India the area served is 107,300 square miles.

The various committees set up for the improvement of agriculture have given different estimates of agriculture graduates required for the next few years as, for example, the Khareghat Memorandum places the estimate at 7000 for the Indian Union, excluding the States, the Agricultural Education Committee of the Central Advisory Board of Education estimates the number at 18,000, for the next 10 years. The annual out turn of graduates from all the colleges was estimated to be only 400 in the year 1942-43 and may now at best be about 500. Thus, there is a wide gap to be filled up.

Inspite of the fact that more than 75% of the population of the country is engaged in agriculture, India has still to import food worth several millions of rupees. This is a sad commentary, but the reasons

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are not far to seek. Undoubtedly, the chief cause is that our methods still continue to be antidiluvian. To remedy this defect, it is essential that as large a number of trained personnel as possible should be made available, and for this purpose the number of agricultural colleges must be multiplied and not that even existing colleges should be abolished.

RECOMMENDATIONS OF THE UNIVERSITY EDUCATION COMMISSION

The University Education Commission set up by the Union Government in 1948 has also bestowed some thought to the problem, and their recommendations are contained in Chapters 4 and 7 of their report. A few of these are :

1. That agricultural education be recognised as a major national issue.

2. That, since in a democratic country sound agricultural policy must rest on the understanding and participation of those engaged in agriculture, the study of agriculture in primary, secondary and higher education be given high priority in national economic planning.

3. That present Agricultural Colleges be strengthened in equipment and in teaching staff, and that each one, in addition to a programme of well proportioned general and agricultural education, endeavour to find some phase of agricultural practice or some related interest such as agricultural credit or agricultural co-operatives in which it shall undertake to achieve mastery.

4. *That new agricultural colleges*, where possible, be associated with new Rural Universities, so that agricultural education may be supported and enriched by contact with other fields, and by common use of personnel and equipment; and that each such new agricultural college should also explore some phase of agriculture often related to the locality, in which it will strive to become an outstanding authority.

Dr. Rajendra Prasad, the President of the Indian Republic, in his speech on the 28th February 1950 at the Silver Jubilee Session of the Inter University Board at Banaras, has appealed to the States and the Centre for the implemention of the recommendations of the University Commission (Vide Appendix B).

ARTICLE 48 OF THE CONSTITUTION OF INDIA

The importance of agricultural development has been specially emphasized in the Constitution of India. Article 48 provides :

Organisation of Agriculture and Animal Husbandary.

"The State shall endeavour to develop agriculture and animal husbandry, on modern and scientific lines and shall, in

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particular take steps for preserving and improving the breed, and prohibiting the slaughter of cows and calves and other draught cattle."

The need of agricultural colleges is thus patent.

THE PROPOSAL TO ABOLISH THE COLLEGE

Though no authoritative announcement seems to have been made re: the reasons for such a retrograde proposal, the following considerations may possibly have weighed with the Government in coming to the decision to retain the college without new admissions (Vide Appendices C & D)

1. Till the College has its own building, a large amount (Rs. 91,000) is paid each year towards the rent of the buildings.

2. That various States of the Indian Republic are contemplating to start colleges of their own and there is not much demand for seats at the College from the States.

3. That the construction of new buildings for the College and Hostels and acquiring the new site will require a huge sum, and even if the college is shifted to I. A. R. I. a sum of over Rs. 20 lakhs will be required for additional buildings.

These reasons are examined below:—

1. The rent paid by the Government for the College Estate is about Rs. 91,000 annually. This covers the buildings, three Hostels, Swimming Pool and over 100 barracks out of which the College itself is utilising about 35 barracks. This estimate covers the accommodation occupied by the Indian Institute of Fruit Technology (which is now shifting to Mysore) and Plant Protection Staff of the Agricultural Ministry. The rent collected from the occupants of the above accommodation totals to Rs. 55,000/- per annum; and as stated by the Hon'ble Shri Jairamdas Daulatram in the Indian Constituent Assembly (Legislature) on 21st December 1949, the annual rent for the colege is only Rs. 36,000 (vide appendix C). One of the hostels is occuplied by the Post and Telegraph staff, the 65 barracks are in the possession of displaced persons, and the Swimming Pool is lying unused eversince the college started for want of supply of water. Further, no separate room rent is charged from the college students nor are they charged for electricity. If appropriate rent is charged from the displaced persons occupying the barracks or from the Ministry of Relief and Rehabilitation who is responsible for their occupation, a room rent is charged from the boarders as is done in colleges all over and the Swimming Pool is surrendered to the Ramjas Trust, the expenditure to Government

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on account of heavy rent can be reduced to less than half i. e. Rs. 15,000/- per annum.

2. The new colleges (three) which have been started in the States are only up to the Intermediate Standard. In view of the difficulty in obtalning the equipment and the qualified staff, it is well nigh impossible to develop them as first rate colleges in the near future. The neighbouring colleges are too crowded and can not be expected to cope with the increasing demand in the conntry. If the Centre is finding it difficult to spend a paltry sum of a few lakhs to develop and maintain one agricultural college, how can the Union States be expected to start first rate Agricultural Colleges when there is acute financial stringency practically all over. Orissa, West Bengal and Travancore-Cochin are already reported to have given up the schemes for starting Agricultural Colleges, due to the financial difficulties. In spite of the short period for which the College has been in existence, it has attracted students from all over the country and indeed a large number have to be disappointed on acconnt of a limited number of sixty seats being available. The selected candidates come from Delhi, Ajmer-merwara, Andamans, Coorg, Himachal Pradesh, Bengal, Orissa, Jorhat, Travancore, Nepal and Indonesia. Displaced students from Pakistan have also been admitted.

3. As explained earlier the funds once made available for a permanent site and construction of buildings, had to be surrendered. It does not mean that due to the indecision that prevailed then, the future generations should suffer. However, due to the financial crisis if it is not possible to find the necessary sum in one financial year, it could easily be spread over two or three years. In the meantime, the college can continue on the present site with reduced expenditure as proposed in (1) above. The expenditure can be further curtailed if for practicals, the students are taken to the Indian Agricultural Research Institute. The small distance should not stand in the way of this essential facility. This is usually the practice in foreign countries where the farms are situated 8 to 10 miles away from the college and students attend to field work by going in trucks. The trucks could perhaps be obtained from the Central Ground Water Organisation of the Ministry of Agriculture, which is now closed down (one such truck has already been obtained).

SUGGESTIONS REGARDING THE ECONOMICAL RUNNING OF THE COLLEGE

The Economy Committee has already suggested that this College which is designed to admit 100 students per year should either be transferred to the Delhi University or be placed under the Director, Indian Agricultural Research Institute. If the latter proposal is given effect to, the students and the staff will have the benefit of the best Agricultural Library in the East and the well-equipped Research Laboratories and thus keep abreast of day to day discoveries and

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researches. The Standing Advisory Committee of the Legislature for the Ministry of Agriculture at its meeting in May 1949 suggested that the College be integrated with I. A. R. I. and this would result in economy in non-recurring expenditure We wholly endorse the above views and further urge that to provide the necessary educational and academic atmosphere, the College shouid be immediately affiliated to the Delhi University and its relevant statutes and ordinances (appendices E and F) implemented, which so far has not been done, though the College has been functioning for three years under provisional recognition. It must be particularly mentioned that statute 31(2)(a) provides that recognition can be given to a college if it is established on a permanent basis.

If it be argued that the College cannot be housed in the present accommodation of I. A. R. I. it is suggested that the present allotment accommodation to the staff there be readjusted. Only laboratorles for practical classes may be constructed for the time being and this should not cost much.

It might be pointed out here that most of the equipment and apparatus for the college work has alreardy been purchased, and whatever more is required already exists in the I. A. R. I. and Central Tractor Organisation. The Metreological Observatory at I. A. R. I. can also be utilised for the special training in the Agricultural Metereology according to the syllabus recommended by U.N.E.S.C.O. Such facilities cannot be provided to any other College located elsewhere in the country. By adjusting the present designation and duties of the staff according to the Delhi University ordinances, the necessity of extra staff can also be eliminated.

THE ADVANTAGES OF THIS COLLEGE

This is the only college which imparts education on an all India basis and the graduates naturally develop an all India outlook which is essential if the agriculture industry is to make effective headway.

The college being near the University and the I. A. R. I. would have a higher standard of education than any other college can afford to give and indeed is already training students for the B.Sc. Agr. (Hons). The students here come in contact with research workers of repute and are in touch with latest developments in the Agricultural Science. The staff will also have facilities for research and can thus inspire the students with a spirit of enquiry and reason. As already mentioned, candidates from *Nepal* are receiving their training in this college and even candidates from *Indonesia* seek admission. The college with all the facilities it has, is, therefore, ideally suited for developing as a centre of Agriculture for atleast the entire South East Asia region, and rendering the exchange of students possible.

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In conclusion, from what has been stated above, it will be clear that there is full justification for continuance of the college and that its need has not only not disappeared but has actually become greater. The Hon'ble Finance Minister struck a very hopeful note in his latest budget speech (appendix G) and now that a surplus is anticipated it is not too much to hope that this nation-building institution will survive the axe. Our Prime Minister has given assurances on more than one occasions that existing permanent institutions and other useful schemes already taken up will not be closed down or abandoned on account of financial difficulties. We, therefore, most earnestly appeal that the College be permanently retained and developed as a first-rate institution, and the provisions of the Constitution implemented.

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APPENDIX A

Extract from page No. 470 of Indian Farming of Sept., 1947 Vol. VIII No. 9.

Q. I have heard that an Agricultural College has been started in Delhi. Will you please furnish me with information regarding the standard of admission and the subjects taught in the institution? Does the College intend to impart practical training in agriculture?

A. The aim of the Central College of Agriculture, Delhi is two-fold : to give a systematic course of scientific agriculture to young men, with a view to prepare them for promoting modern agriculture in the country-side on economic lines, and to train students for undertaking research in agricultural problem. The need for qualified staff required for the execution of agricultural schemes has long been felt, as each requires approximately 200 agricultural graduates a year, and the Central Government requires, for the execution of its own plans, about 500 trained men immediately, and more in the near future. Similarly Indian States are in dire need of trained personnel. .....

It is also intended to organize a one year course with Hindustani as the medium of instruction. This course will be entirely of a practical nature comprising inter alia the study of crops and improved methods of cultivation, farm management, modern dairying, horticulture and simple treatment of pests and diseases of cattle and crops.

The College is open to students deputed by the Governments of Centrally Administered Areas and other provinces which have not got Agricultural Colleges, to students deputed by Indian States, by the Government of British Colonies or other countries outside India and to private students who are residents of Centrally Administered Areas.

APPENDIX B

Extract from the speech of Dr. Rajendra Prasad, President of the Republic of India on the occasion of Silver Jubilee Session of the Inter University Board at Banaras on the 28th of Feb. 1950, as reported in the 'Statesman' dated 1-3-1950.

"We have recently had a Commission appointed by the Government of India to go into the whole question of university education. It had among its members distinguished educationists not only from India but also from England and America, and was presided over by Dr. Radhakrishnan. The Commission has submitted a very valuable report containing not only a review of the achievements of our university education, but also making suggestions and recommendations which are of a far-reaching character.

"We have had many republics in this country, but they were tiny compared to the Republic which we have just established. The responsibility of the people

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has correspondingly grown in size and intensity and it is for our educational institutions to fit the citizens for the great task that awaits them.....

'I understand that it is going to be expanded on a larger scale consistently with efficiency which depends on the number of suitable and competent teachers. I believe expansion there is limited only by the time that is taken in training and preparing the various grades of teachers for the purpose. The scheme of rural universities, as has been pointed out by the authors of the report, is only an extension of that scheme with such modifications as appealed to them.

"I feel that in recommending the expansion of education in that direction, the Commission has done the greatest service to the country in its present set-up. It is now for specialists and experts and for the State Governments and the Central Government to work out the practical details and implement its recommendations.

APPENDIX C

Extract from the report of the Ministry of Agriculture, 1949-50

THE CENTRAL COLLEGE OF AGRICULTURE DELHI:—

With the new admissions made in August and the formation of the final year class, the College had started functioning with all the four classes and the total number of students is 176. The College showed good results at the examinations of the University of Delhi, the passes from the second year class being as high as 92 per cent. Physical training is compulsory and the students are taken on study tours to all parts of India. The College, however, continues to be located on the leased Estate, and to overcome the difficulty for want of properly equipped laboratories, practicals had to be arranged at the Indian Agricultural Research Institute and by borrowing apparatus from the C.P.W.D. Far from there being an expanasion in the coming year, considerations of finance have considerably affected the growth of the Institution. It has been decided to retain the Institution without new admissions for another three years, till all the students now on the rolls complete their course. If, however, the financial situation improves, it is intended to review the position.

APPENDIX D

Extract from the proceedings of Constituent Assembly of India (Legislative) Part I Vol. IV-No. 18 Wednesday, 21st Dec. 1949. pages 602-604.

(AGRICULTURAL TRAINING INSTITUTIONS).

*795. *Shri Satis Chandra Samanta* : (a) Will the Honourable Minister of Agriculture be pleased to state how many new agricultural training institutions have been started in the years 1948-49 and 1949-50, by the Government of India ?

(b) Are there any private agricultural training institutions and farms in India ?

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(c) If so, is any of them recognised by Government ?

The Honourable Shri Jairamdas Doulatram : (a) None. (b) and (c). There are eleven agricultural training institutions in the provinces and States. Nine are recognised by Government. A statement containing details is laid on the Table of the House (See Appendix XX, annexure No. 1.).

Shri Satis Chandra Samanta : May I know whether any short course training arrangements have been made for those officers in service who have not sufficient experience in agriculture ?

The Honourable Shri Jairamdas Doulatram : We have got post-graduate training arrangements at Delhi in the Pusa Institute.

Shri Satis Chandra Samanta : Have Government any arrangements for imparting training to officers in the Department who have had no training in agriculture ?

The Honourable Shri Jairamdas Doulatram : Officers who were not at all trained in agriculture need not be in the Department.

Shri Upendranath Barman : Is it a fact that the Government of India is proposing to close the Central College of Agriculture ?

The Honourable Shri Jairamdas Doulatram : No.

Shri Upendranath Barman : Is it a fact that new admissions have been stopped ?

The Honourable Shri Jairamdas Doulatram : They may be stopped from the next year but the College will continue for *three years atleast* unless the situation changes.

Shri Deshbandhu Gupta : May I know whether it is a fact that the decision referred to by the Honourable Minister regarding the Central College has been taken on account of the expenditure, which is incurred on the residence of the students and the figures supplied were not correct ?

The Honourable Sri Jairamdas Doulatram : That was only one of the considerarions but it is difficult to expand the college in the present set-up on account of financial stringency.

Shri P. T. Chacko : May I know whether the Central College is being housed in a rented building and if so, what is the rent ?

The Honourable Shri Jairamdas Doulatram : It is in a rented building and the rent is Rs. 3,000/- a month.

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Dr. P. S. Deshmukh : May I know if the Honourable Minister has any scheme for assisting and giving grants-in-aid to private Agricultural training institutions ?

The Honourable Shri Jairamdas Doulatram : I think a number of institutions are receiving grants from the Provincial Governments and naturally it will be the function of the Provincial Governments to give financial aid to local Agricultural institutions.

Shri A. Karunakara Menon : Have any existing institutions already been stopped or hampered by the economy drive of the Government in the year 1949-50 ?

The Honourable Shri Jairamdas Doulatram : Not, so far as the Central Government is concerned. So far as the Provincial Government is concerned, I will have to secure information.

Shri Deshbandhu Gupta : Is it a fact that there are certain facilities available to the Central College of Agriculture in Delhi which are not available in other provinces and if the institution is closed, there will be great hardship ?

Mr. Speaker : Order, order, Next question.

APPENDIX E

University of Delhi, Act No. VIII of 1922
and statutes (1949 Edition)
Statute, No. 31 (page 49).

(2) A College applying for recognition shall satisfy the University on the following points :—

(a) that it guarantees a satisfactory standard of educational efficiency for the purpose for which recognition is sought, and *that it is established on a permanent basis:*

(b) that its financial resources are such as to make due provision for its continued maintenance ;

(c) that it is under proper management and is suitably oragnised;

(d) that its buildings are suitable and sufficient ;

(e) that the furniture and library and laboratory equipment are adequate;

(f) that the provision for the residence, discipline and supervision of students is satisfactory ;

(g) that due provision is made for the health and recreation of students ;

(h) that qualifications and number of its teaching staff are adequate, and the conditions of their service such as may be approved by the University ;

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(i) such other matters as are necessary for the maintenance of the tone and standards of University education.

(3) A College applying for recognition shall give full information in the application on the following matters:-

(a) constitution and personnel of its Governing Body;

(b) standards and subjects in respect of which recognition is sought;

(c) accommodation, library and laboratory equipment and strength of the College;

(d) number, qualifications, work, emoluments and conditions of service of teachers;

(e) provision for hostels, playgrounds and the residence of the Principal and other members of the staff;

(f) fees proposed to be levied;

(g) *the financial provision made for the continued maintenance of the College*;

(h) such other matters as may be prescribed by the Ordinances Statute No. 30 (page 47).

3. Each College recognised by the University shall be managed by a regularly constituted Governing Body which shall include the Principal and at least two other members of the teaching staff of the College elected by the teaching staff including the Principal and not less than two members appointed by the University. The rules relating to the constitution and powers of the Governing Body and the appointment, powers and duties of the Chairman and other officers of the Governing Body shall be such as may be prescribed by the Ordinances.

(9). *Every College shall comply with the relevant Statutes, Ordinances and Regulations of the University.*

APPENDIX F

Ordinances of Delhi University, 1949

Ordinance No. XII (College appointed teachers) page 24.

1. No wholetime teacher shall be engaged by any College as a member of its staff at a salary less than Rs. 200/-/- p.m. (*In C.C.A., the minimum start is Rs./- 160- p.m.*)

2. No whole-time teacher shall be engaged by any College as a member of its staff except on an Agreement of service in the form annexed hereto, or an agreement substantially to like effect, and every teacher shall sign the Agreement before he enters upon his duties.

3. (1) No whole-time teacher may be engaged for less than twelve months, save in the case of a temporary appointment made to fill a

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sudden and unexpected vacancy, but such temporary appointments shall not be made for a period exceeding six months, and shall be reported forthwith to the University.

(2) A temporary appointment may be made in the case of a temporary vacancy caused by the absence of a teacher on leave, but shall not extend beyond the date of the termination of the leave of absence of that teacher, and shall be reported forthwith to the University.

Government Maintained Colleges

Ordinance XIX (page 36)

1. A Government Maintained College (in this ordinance called a Government College), shall, subject to any general rules of the Government of India, be a self-contained and autonomous institution and, subject as aforesaid, have control over its own affairs and its own finances.

2. (1) No Government College shall have more than 600 students on its rolls, but so long as the preparatory classes for University degree courses continue to exist with the approval of the Government of India, the number in those classes shall not be included in the College rolls for the purpose of this Ordinance.

(2) The Governing Body shall meet at least once every academic term and, subject to the general rules of the Government of India, have general supervision and control of the affairs of the College and shall maintain its own records of its proccedings.

(3) The Governing Body shall appoint a secretary, not being a member of the Governing Body, who shall summon meetings, record proceedings and perform such other clerical functions as the Governing Body may direct.

3. (1) The member of the Governing Body of a Government College elected by the teachers or appointed by University shall not hold offlce for more than three years at a time, but shall be eligible for re-appointment or re-election.

(2) Every Government College shall, subject to the general supervision of the Governing Body, have a duly constituted College Council, consisting of not less than seven members of the teaching staff elected by the teaching staff, to advise the Principal on the administration of the College.

4. (1) The method of appointment of teachers in a Government College and their conditions of service shall be such as may be approved from time to time by the Government of India after consultation with the University.

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(2) The payment of salaries to teachers in a Government College shall be in accordance with *scales approved by the University*.

(3) The Governing Body, before advertising a post on the teaching staff, shall give notice to the University of their intention to do so and shall take into consideration any representations the University may make thereon within fourteen days.

5. The number of recognised teachers in a Government College shall be such that the proportion of students on the rolls of the College to the teachers in the College shall not exceed twenty to one in the case of Pass students and twelve to one in the case of Honours and postgraduate students, unless a higher proportion is approved by the University.

6. The Executive Council may from time to time cause an inspection to be made of a Government College for the purpose of satisfying themselves that the conditions of this Ordinance or any conditions on which recognition has been given are being complied with.

APPENDIX G

Extract from the Budget Speech of Dr. J. Matthai, Minister for Finance, on the 28th February, 1950 as reported in the 'Statesman' dated 1-3-1950.

"It has been a year of great difficulties and great anxiety. It has been a period of almost unprecedented trouble. There were times during the year 1949 when some of us most immediately concerned with the economic activities of the Government had a sense of almost overwhelming crisis, but on a close examination of facts as they stand today, I feel that I am in a position to tell the House that the stage of crisis at any rate is now definitely passed", said Dr. Matthai, India's Finance Minister, when he presented the Budget in Parliament on Tuesday."

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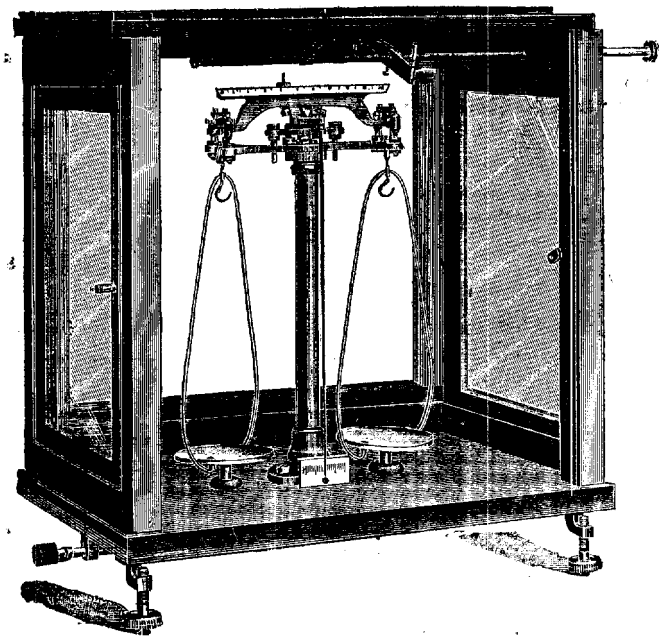

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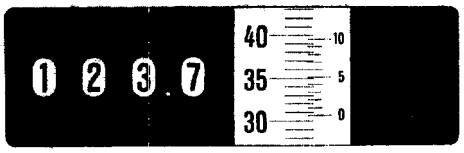

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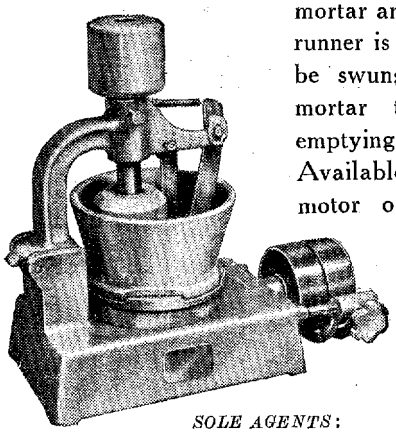

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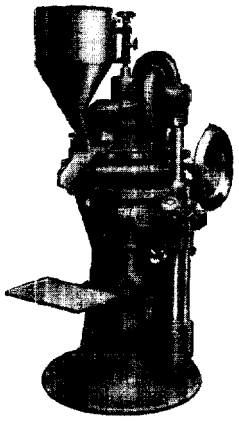

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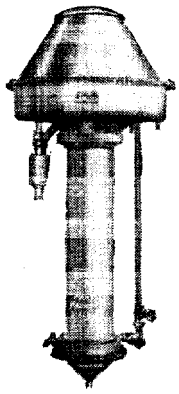

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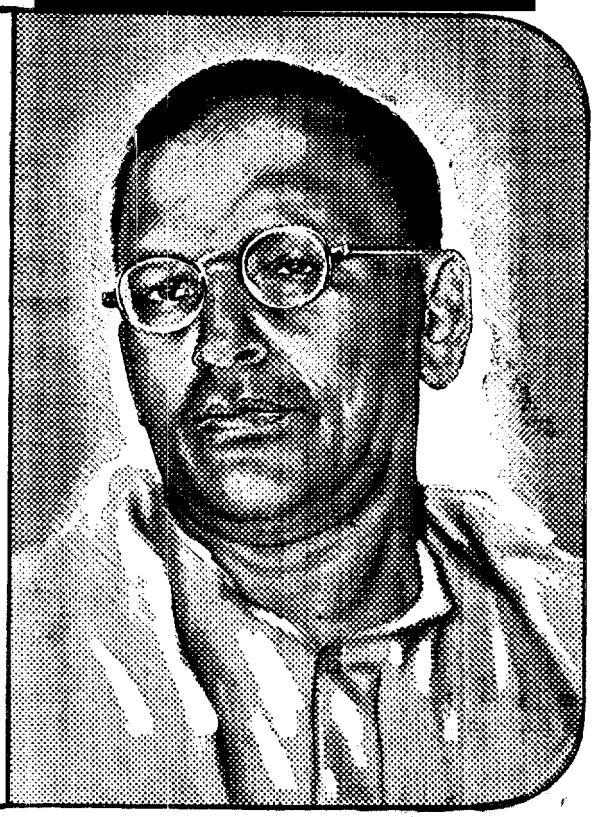

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AGRICULTURAL EDUCATION AND RESEARCH IN INDIA

III

IN a previous article[1] we gave an account of the progress which had been made during the first half of the century towards the introduction of agricultural research, education and development in this country; at the same time the movements for rural cooperation, rural reconstruction, and basic education were also described.

We shall now try to assess the achievements of these movements and to indicate the directions along which future development should proceed.

Research and Development—Some notable progress had been made through the efforts of the Institutes for Agricultural and Animal Husbandry Research, in some of the provincial Agricultural Experiment Stations, and also in some under Central Commodity Committees.

The opinion has however been expressed that "while under grants-in-aid received from the I.C.A.R. a good deal of research work has been carried out, the improvements effected have not been taken up by the cultivators" *i.e.*, there has been a lack of coordination between research, development and extension work. The implication has been that the latter two are the responsibilities of the provincial agricultural departments, and they have not pulled their weight in the team work. In our view, which shall be discussed later, a better machinery has to be devised for this purpose which involves certain redistribution of subjects now placed in the Union, State, and Concurrent lists in the Indian Constitution.

Taken all in all, the progress achieved so far has not been commensurate with the vastness of the problems involved and with the variety of subjects relating to agriculture on which government action is necessary. We have probably in Institutes under the Ministry of Agriculture and in the Commodity Research Stations and Technical Laboratories small sections dealing with the breeding of disease resistant food, cash, and other crops, for Agricultural and Soil Engineering, Agricultural Chemistry, for Dairy Industry and Animal Husbandry, for Entomology and Plant Quarantine, but most of them are in their early stages of development. There should be a large number of regional laboratories for plant science and animal husbandry, and for their processing and industrial utilization, soil investigation laboratories, bureaus for the classification and study of microorganisms and pests, so far as they affect agricultural and animal husbandry industries. The Centre should also take an active part in starting and financing of provincial agricultural experiment stations and in providing machinery for the coordination of the work of the central and provincial agencies. Agricultural education in the higher stages, the training of teachers for agricultural high schools in the provinces, as well as extension work, should also be the responsibility of the Centre.

Financing of Agricultural Research—We have collected in the following table some data obtained from different sources on the relative areas under cultivation of the different food, and cash crops; and the amount spent for research, processing and marketing of these commodities.

We find that a disproportionate amount of money is spent on research on cash crops which form only about 14% of the area under cultivation, while research on food grains and pulses and other crops which form about 81% of the area under cultivation are comparatively neglected. This was probably a result of the British rule when the foreign traders and industrialists were primarily interested in the raising and technological processing of cash crops. This arbitrary division of food and cash crops should be done away with, and all commodity research stations should be placed on the same footing as in the U.S.A.

Problem of Agricultural Education—From the beginning the education was top heavy. There was a need for the starting of agricultural colleges for the training,

[1] *Science and Culture, 15,* 407, 1950

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at least of recruits to Government agricultural services, but the openings were relatively limited, and the colleges

TABLE

Authority	*Source of Income*	*Amount of grant*	*Percentage of cultivated areas*
I.C.A.R.	Cess on certain agricultural commodities	Rs. 11.00 lakhs	
I.C.A.R.	Ministry of Agriculture I.C.A.R.	Rs. 11.70 "	80.9%
		Rs. 2.63 " (food grain & pulses)	
Commodity Research Institutes for Rice, Potato etc.	Ministry of Agriculture	not known	
Under Central Commodity Committees	Whole or part of cess levied	Cotton (Rs.18 lakhs) Lac (Rs. 10 ") Jute (Rs. 7 ") Sugarcane (Rs.11 ")	8.3% approximately
		Oilseeds	6%
		Tobacco and Coconut	not known

Cotton, Lac, Jute and Sugarcane Central Committees have their Technological Research Laboratories at Matunga, Nanakum, Calcutta and Kanpur respectively.

The data are approximate and taken from I.C.A.R. Hand book (1948), I.A.R.I. Report (1944-45) and Famine Commission Report (1944).

did not attract sufficient number of the sons of land owning classes. On the other hand there is not a large class of yeoman farmers whose sons could have benefitted by education in agricultural colleges and particularly in agricultural high schools. The latter have been utilized for the training of agricultural overseers; it is doubtful whether the training given was sufficiently thorough in theory and in farm practical work. The majority of the sons of cultivators, burdened with uneconomical holdings, did not receive any primary education, much less education of a suitable kind. Rural education must be reorganized from the bottom upwards, from basic primary and agricultural high schools to colleges situated in the midst of agricultural areas.

The possibility of introduction of such education depends on some measure of rural prosperity, which will act as an incentive to the people for further cooperative efforts to improve their economic and social status. The Gandhian ideal of self sufficient village communities supported by the present type of agricultural industry and handicrafts, will not be able to meet the requirements of an overpopulated rural community facing competition of industrialized towns. The Congress movement of the 1930's attracted a large number of idealist worker. But since Congress has come to power from 1947, the movement appears to have lost much of its idealism and driving force.

Rural Indebtedness and its Removal—The high agricultural prices prevailing since the commencement of the last war and which is still continuing, have to a certain extent removed one of the permanent handicaps to the development of healthy rural communities *viz.*, rural indebtedness, based upon low prices of agricultural commodities. The pre-war exploitation of the rural population by the industrial and commercial communities has for the present been reversed, resulting in a general rise in the cost of living. This black mailing of the town by the country will not be an unmixed evil, if it leads, at least in some of the more flourishing of the rural areas, to the abolition of indebtedness amongst the cultivators, and to instal in the latter a desire to introduce better amenities of life in the villages. The State can help this movement by providing amongst other facilities, cheap electric power to the rural communities. This will benefit not only agricultural production but also help in the introduction of power driven rural industries. The Famine Commission (1944) reported that between 1942 and 1945, there was a substantial reduction of rural indebtedness in all the provinces, especially amongst cultivators with large holdings and to a considerable degree amongst those with medium holdings. On the other hand it appears probable that the small holders as a class have not benefitted materially.

The beginnings of rural prosperity thus initiated, cannot be maintained unless some scheme for regulation of prices of agricultural commodities be adopted, which will ensure a fair minimum price for the cultivators and a fair maximum price for the consumers, and undue fluctuations of prices be prevented. For reasons stated in their Report, the Famine Commission recommended that the simplest remedy would be to maintain the prices of the two principal cereals, rice and wheat within predetermined limits, even if it should be found that the prices of the other commodities cannot be regulated.

Rural Rehabilitation—Future development of rural areas will depend on two sets of factors *viz.*, (*i*) the facilities which the Government can provide and, (*ii*) how the people can organize themselves so as to obtain the maximum benefit for themselves out of the facilities so offered:

(*i*) The Government can promulgate laws regarding the size of holdings and their assessment, minimum prices for agricultural commodities, can supply rural areas with cheap electricity, irrigation facilities, suitable education and health services, provide the rural communities with improved disease resistant seeds, manure and fertilizers, make provision for large scale supply of credit and of technical assistance and supervision.

(*ii*) Government assistance can only be effective when the community is organized for cooperative efforts in all spheres of their lives. If they can develop an enlightened cooperative spirit, in which their rational self interest will be safeguarded, and know how to demand and utilize Government assistance, then only will prosperous self governing rural communities develop.

After discussing the respective merits of 'Collective farming, Joint farming and Cooperative farming',

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the Famine Commission came to the conclusion that the future development of agriculture in the case of small and medium farmers depend in considerable measure on the organization of these classes into multi-purpose village cooperative societies. They make recommendations as to how these societies should be federated into unions, and what procedure should be adopted for their effective working. Large landholders are to be encouraged to organize themselves into agricultural associations, and the farm workers also be encouraged to organize themselves.

In the concluding chapter of their Report they remark:

> that "the food problems with which we have been primarily concerned, merges into broad problems of agricultural and economic developments, and these in turn are linked up with fundamental social questions. Poverty and hunger have been too often accepted as part of the nature of things and much of the countryside may almost be described as a rural slum, where hopelessness engendered by slum conditions prevail. Such an attitude of mind, on the part either of rulers or of ruled, is incompatible with progress. Without vision and faith in the future little can be achieved".

This brings us to the consideration of proposals which the University Commission has made for providing an educational programme suited to bring into being the new state of rural society. As an illustration of how such things have been done in other countries, they describe in detail the part played by the 'land grant' colleges of the U.S.A., with their associated Agricultural Experiment Stations and Extension Services all run on a cooperative basis between the Agricultural Department of the Federal and State Governments. The Commission's recommendations on agricultural education and rural universities are very much influenced by the U.S.A. examples.

We do not believe that the Indian problem can be solved by an unintelligent imitation of U.S.A. practices. The U.S.A. is a comparatively thinly populated country which has made it possible to have large farms ; the shortage of labour has encouraged mechanization of farm work. During recent years horse drawn agricultural machines have been replaced by power driven tractors and other appliances. Such large scale farming has led to certain undesirable agricultural practices under which the soil has in many regions deteriorated badly. Efforts are now being made to stop this soil deterioration. While the yield *per capita* of agricultural worker is very high, the yield per acre is moderate compared to what is obtained in many of the western European countries. In this country, primarily of small holdings and superfluity of manual compared to available mechanical power, the problem requires a different approach. Nevertheless due to the similarity in political structure in the two countries *viz.*, Federal union of States enjoying a great deal of autonomy, the machinery evolved in the U.S.A. for coordinating the activities of the Federal and State Departments of Agriculture are worth studying and adoption, with necessary modifications, in our country.

We shall devote the rest of the review in discussing

A. American agricultural administration and education programme;

B. Reform in Indian agricultural education and administration; and

C. Rural, Secondary and University Education in India.

A. *American Agricultural Administration*—It is interesting to note that during 1862, when under the Morril Act grants of federal lands were made to the different States and Territories of the U.S.A., for the endowment, support and maintenance of at least one college in each State, which were enjoined "to teach amongst other things such branches of learning as are related to agriculture and to mechanical arts, in order to promote liberal and practical education of the industrial classes in the several pursuits and professions of life", the Congress in the same year established the Department of Agriculture, with the directive that "the general designs and duties of the Department shall be to acquire and to diffuse among the people of the United States useful information on subjects connected in the agriculture in the most general and comprehensive sense of the word". Further the Commissioner for Agriculture was directed to acquire information "which can be obtained by means of books and correspondence; and by practical and scientific experiments, by the collection of statistics and by other appropriate means within his power".

Thus these two agencies started in the same year, have revolutionized the development of agriculture in the U.S.A.

The U.S.A. Department of Agriculture: consists of (*a*) eight large operating or program units, which are named

(*i*) Offices including Extension, Forest, and Soil Conservation offices,

(*ii*) Administrations : including Farm credit, Farmers Union, Production and Marketing, Rural Electrification, and Agricultural Research; and

(*b*) in addition there are eight Staff and Service Offices at departmental level. These are :

Budget and Finance,
Foreign Agricultural Relation,
Information,
Library,
Personnel,
Plant and Operation,
Solicitor,
The Bureau of Agricultural Economics.

Of these the functions of the Extension Service and of the Agricultural Administration are of most interest to us for our present discussion.

The latter consists of six large Bureaus *viz.*,

(1) *Agricultural and Industrial Chemistry*, which deals with chemical, physical and engineering research into the properties of farm commodities and the method

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of utilizing such commodities. The bulk of the researches in this Bureau are conducted in four Regional Research Laboratories, whose efforts are directed to discovering ways of utilizing specific agricultural commodities for food, feed and non-food industrial purposes, especially of farm commodities in which there are regular or seasonal surplus.

(2) *Animal Husbandry and Production*—deals with applied and fundamental research relating to the breeding, feeding and management of farm stock, except dairy cattle, poultry and fur bearing animals, and the technology of animal products. There are four regional laboratories.

(3) *Bureau of Dairy Industry.*

(4) *Entomology and Plant Quarantine.*

(5) *Human Nutrition and Home Economics*—deals with (*a*) Basic human needs for food, clothing, housing and other goods and services and (*b*) Relative utility and economy of goods available for basic human needs.

(6) *Plant Industry, Soil and Agricultural Engineering*—devoted to (*a*) Improvement of crop plant production, by reducing the hazards of crop production and improvement of yield and quality of crops. There are three regional laboratories for basic research.

(*b*) Soil Science deals with classification and improvement of soil, management of soil in humid and dry-land regions, and under irrigation. Study of basic soil-plant relationship and research on the preparation, technology, and use of fertilizers etc. There are two regional research laboratories devoted to basic research.

(*c*) Agricultural Engineering devoted to engineering problem of primary processing of farm products, use of electricity, use of farm buildings and equipments and operation of farm machinery.

Office of Experiment Stations—Its function is to direct as well to coordinate the researches carried out in the Federal Experiment Stations. Its other function is to advise the State Experiment Stations, located in 'land grant' colleges, and to coordinate their work with those of the Federal Laboratories.

It is stated that these Experiment Stations have been tremendously important to the development of scientific farming of the Nation. The new and improved commodities and farming methods developed by these stations are outstanding examples of the great values which accrue to a Nation through scientific research. The importance of the stations can be scarcely over emphasized.

Agricultural Experiment Stations—The stations grew out of the 'land grant' colleges. We have referred to the latter in the introduction to this section, and shall deal with them in detail later.

Between 1862 and 1887 the Federal Government acted to extend agricultural experiment stations to all States and Territories with 'land grant' agricultural colleges; 14 States had independently established such stations. Besides a main station there are branch stations and field laboratories in different parts of the States, to suit differences in soil, climate and diversification of agriculture.

Federal Grants for State Experiment Stations—The Hatch Act of 1887 appropriated $15,000/- annually to each State for the experiment stations. The grant was increased progressively till in 1928, the authorization reached a total of $ 90,000/- per station per year. The States have contributed 2 to 3 dollars for each dollar of Federal grant. During 1947, the grant from Federal funds to the Experiment Stations was approximately $ 6.2 million, out of which about $ 3.1 million was utilized for background research, $ 2.95 million for applied research and only 0.15 million for development work.

The research programmes of the State Experiment Stations include Industrial Utilization, Agricultural Engineering, Animal and Dairy Industries, Entomology and Zoology, Forestry, Home Economics, Plant Science, Soil Science and Watershed Protection and Conservation.

The Hatch Act also laid down specific authorization for scientific research at Federal Stations; the directives were mostly for applied and developmental character. Later the Bankhead-Jones Act of 1935 directed the Secretary for Agriculture 'to conduct research into laws and principles underlying basic problems of agriculture in its broadest aspects' and also "authorized and directed (the Secretary) to encourage the same type of research in Agricultural Research Stations" *i.e.*, basic research was introduced in the latter.

The role of the Federal Department in the administration of grants for financing the State Experiment Research Stations, was also laid down in the Hatch Act of 1887, which directed the Secretary 'to indicate from time to time such lines of enquiry which shall appear to him most important and in general to furnish such advice and assistance as will best promote the purpose of this Act'. In later Acts the Secretary was directed to coordinate "the work of the Department of Agriculture with that of the State Agricultural Colleges and Experiment Stations".

In principle, it appears that there is nothing to differentiate the type of agricultural research undertaken by the Federal and State Departments of Agriculture. The cooperative participation of the Federal Department of Agriculture is limited to problems which are common to two or more States or are of regional nature.

Commodity Committees—In the Federal Department of Agriculture, there are a large number of Committees, of inter-departmental and of inter-bureau character, which have been created to serve in an advisory policy making role to the Secretary of Agriculture. Amongst these we select the twenty inter-bureau Committees, whose combined assignments encompass the entire commodity responsibility of the Department. The Committees were established to bring together in one group, individuals from all research units with interests in one particular commodity. Each Committee is concerned with recording the primary problems related to their commodity areas and recom-

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mending research programmes needed for their solution. Through this method research programmes for cotton, grain, rice etc. are developed which cut across bureau lines and represent an integrated research programme. Some of the commodities are:

Poultry	Cotton	Grain	Citrus fruits	Peanut
Dairy	Flax Wool	Rice	Deciduous fruits	Treenut
Livestock	Tobacco	Potato		Dry Bean
Feed	Sugar	Vegetable	and Transportation	

Here there is no separation, as in India, into cash and other commodities, of which the former are under semi-autonomous All-India Central Committees.

Land grant Colleges—These were started, as stated earlier, under the Morril Act 1862 with Federal land grants. There are now 70 of such Colleges and Universities. Each State has at least one and in 18 States there are two. In about half the States, they are the State Universities, all but two have Agricultural Colleges. From 1887 Federal grants were given to 'land grant' Colleges, to launch Agricultural Experiment Stations, Laboratories and experiment fields, which provided the source materials for the entire land grant system of liberal and practical education. Class room instruction and research stimulated each other. Throughout the country, land grant colleges pushed back the walls of intellectual darkness, each discovery opening new potentialities. The experiment was so successful that by 1914, the farmer's complaint was not that science was too slow or fruitless, but the knowledge of the laboratories was fully 25 years in advance of general farm practices. Hence they demanded that new steps be taken to make the results of science available to the men on the land.

'So the *Federal State Extension* system was launched. Here was an unique 'land grant' experiment. An adult educational system reaching from laboratories, class room and experiment fields to men and women throughout rural America'. "In that half century, the land grant colleges had enlarged and enriched all types of and phases of education, not only at the college level but at the secondary school level as well". The teachers trained in these institutions "in agriculture, industrial arts, home economics, basic sciences, and liberal arts were introducing new courses into high schools, just as extension agents were carrying information to the farms and homes of the land".

"The land grant institution now enrol on their register approximately as many students as the other 1200 Colleges and Universities combined— about a million students".

The *agricultural programme of the land grant college is three fold* :

(1) the Colleges/ or teaching division,

(2) the Experiment Station or Research Institute,

(3) The Agricultural Extension Service.

So far as one can make out, the Experiment Station with branch station and laboratories in different parts of a State is the main, if not, the sole agency by which agricultural research is conducted in a State. As a recent report states "Research supported by State and Federal funds is frequently indistinguishable at the experiment station. Different facets of a single problem may be supported both by Federal grants and State funds. The same scientist may direct men paid by either fund. The results of both are commonly utilized".

The Agricultural Extension Service became another aspect of Federal and State cooperation. The new knowledge about scientific agriculture as developed in the Experiment Stations are incorporated with instructions given in the Colleges. This scientific information which is the basis of all progress in agriculture on the farms, is supplied to the latter by the Extension Service, which is a cooperation programme of the Federal Government and States and local communities. The persons who carry this knowledge and demonstrate it to the farmers are called County Agents. They are trained in the Agricultural Colleges and have a bachelor's degree in agriculture as minimum qualification. They are appointed by and work under colleges. Teaching of agriculture in rural high schools was given a stimulus by Act of Congress passed in 1917. Before this act was passed, less than half the States gave any grant-in-aid to secondary schools for the teaching of agriculture. The new Act appropriated Federal money for the preparation of teacher training, in agriculture as a cooperative venture with teacher training institutions. It carried the stipulation that funds appropriated for the preparation of teachers shall be matched dollar for dollar by the States, or by local community or both. At present 72 Colleges and Universities are training teachers and supervisors of vocational agriculture, of this number 63 are land grant colleges.

B. *Reform in Agricultural Education in India*— The short account given above gives a picture of the key position held in the U.S.A. by the 'land grant' colleges in carrying on agricultural research in Experiment Stations, incorporating the results in teaching of agriculture, in training teachers for agricultural secondary schools, and County agents for Extension Service. It is not surprising that the American members of the Indian University Commission should place before their Indian colleagues, the principle of 'land grant' colleges as model for agricultural education, associated with the proposed rural universities in India.

Some of the Commission's recommendations on agricultural education are:

(*i*) that as far as feasible agricultural education be given a rural setting so that it shall include direct participation in and experience with agricultural life and practices;

(*ii*) that new agricultural colleges, where possible be associated with new rural universities so that agri-

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cultural education may be supported and enriched by contact with other fields, and common use of personnel and equipment;

(*iii*) that a widespread series of experimental farms be developed by the central and provincial Governments as resources and adequately trained men become available; these experiment stations to represent all major types of soil, climate, crops and topography; that as nearly as possible every basic elementary school, every rural secondary and every rural university should have its own small experimental farm, so that the spirit of research and experiment shall prevail all rural life, and that where practicable every experiment station or college where student on work or study programmes may provide labour while becoming acquainted with experimental and research methods.

Regarding existing agricultural colleges, the Commission recommend that they be strengthened in equipment and teaching staff, and that each one, in addition to a programme of well proportioned general and agricultural education, endeavour to find some phase of agricultural practice or some related interest, like agricultural credit or agricultural cooperatives, in which it shall undertake to achieve mastery. Similarly the new agricultural colleges should explore some phase of agriculture or related interest often particularly related to its locality, in which it will strive to become an outstanding authority.

Reform of Indian Agricultural Policy

Agriculture in the New Constitution—Subject matter of laws made by (Union) Parliament and the Legislature of States is defined by Article 249 of the Constitution. There are three lists given in the seventh Schedule of the Indian Constitution, of which list I contains the names of subjects which the Parliament is alone empowered to deal. There is another list (II) with which the States (provincial) Legislature is alone empowered to deal. While there is a third list (III) of concurrent subjects with which the Union (Central) and the State Legislatures can both deal.

Article 48 provides: The State (Union) shall endeavour to organize agriculture and animal husbandry on modern scientific lines and shall in particular, take steps for preserving and improving the breeds, and prohibiting the slaughter of cows, calves, and other milch and draught cattle.

On looking through the three lists in seventh Schedule we discovered to our surprise, that agriculture, which should be the responsibility of both the Union and the States, does not find a place in List III of concurrent subjects. On the other hand in State List II, we find No. 14 : Agriculture, including agricultural education and research, protection against pests, and prevention of plant diseases ; and

No. 15 : Preservation, protection and improvement of stock and prevention of animal diseases ; veterinary training and practice.

In the concurrent subject List III the only reference to agriculture and animal husbandry is in No. 29 : Prevention of the extension from one State to another of infectious or contagious diseases affecting men, animal or plants.

The above noted ommission should be rectified and the sections 14 & 15 of List II should be transferred to List III.

In implementing the changes suggested in the Constitution, the following powers and responsibilities should devlove on the Union Government:

(*i*) For the maintenance of administration, bureaus and services on the lines existing under the U.S.A. Department of Agriculture, the different functions will be developed out of the existing machinery and taken up as resources and adequately trained personnel become available.

(*ii*) In particular the functions listed under the Agricultural Research Administration of the U.S.A. and at present carried out by the All India Institutes for Research in Agriculture, Animal Husbandry and Dairy Industry should be extended by the opening of a number of laboratories and experiment stations suited to the requirements of different regional areas of the country. Such work should be in cooperation with State Experiment Stations and deal with problems affecting two or more States or of regional nature.

(*iii*) Special regional laboratories for soil science and for watershed protection and conservation should be started.

(*iv*) The distinction between cash and other agricultural commodities should be abolished. If it is found necessary to continue, for research and development purposes, the imposition of cess on these commodities, the total cess collected should be credited to a central authority who will be responsible for its utilization. The Minister of Agriculture will be advised by suitable constituted Commodity Committees who will bring together in one group individuals from all research units with interest in one particular commodity. These committees will be responsible for recording the primary problems related to their commodity area and research programmes needed for their solution.

Agricultural research and development can be carried mainly through the agencies of the States Experiment Stations. Plant breeding, basic investigations on rusts, fungi, insects etc. affecting economic plants, storage of their products and similar investigations on animals, and evolving methods for their prevention and control, can best be undertaken by cooperation between Regional States and University laboratories specializing in such work.

(*v*) Similarly the work of technological laboratories at present under Central Committees *viz.*, on Cotton (Bombay), Jute (Calcutta,) Lac (Namkum) and Sugar (Kanpur) should not be confined to investigations on products of one economic plant or insect only. They should be converted into large regional laboratories equipped for investigations of physical, chemical,

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and engineering problems connected with, and for the discovery of new uses for, economic crops, which are the speciality of each of the regions. So far as possible duplication of work in the different regional laboratories should be avoided.

(*vi*) The Union Government should be responsible, jointly with State Government for the proper equipment and maintenance of State Experiment Stations, State Agricultural Colleges, for the training of teachers for agricultural secondary schools and for Extension work. The I.C.A.R. is at present discharging, not very satisfactorily, some of these functions. Further extension of its powers on the lines of the Federal Office of Experiment Stations of the U.S.A. is necessary.

(*vii*) The responsibilty of the Union Government for (*iv*) will in part take the shape of grants to the States, which will be matched by similar grants by the latter and other local agencies. The other part of the Union's responsibility will be to provide machinery for supervision and coordination.

The problems of agricultural administration of this country with its peculiar social and economic structure and its traditional agricultural practices are vast and complicated. We have suggested certain changes of Constitution and administrative reorganization and expansions and a new adjustment of the activities of the Union and State departments of agriculture, with a view to securing expansion, better rationalization and coordination of their respective functions. These proposals require to be supplemented by detailed studies, one of the most important and complicated of which is the machinery for Extension service, which in view of the small holdings and present illiteracy of the cultivators must go much further in directions not considered necessary in the U.S.A. In most of the Central and State agricultural departments, there has been many failures in the work of extension.

It is over 20 years that an Agricultural Commission was appointed to examine on the state of agriculture and rural economy of the country. The Famine Commission of 1944 has done valuable work in this direction. Probably the appointment of a Committee to report on the overhauling of the machinery of agricultural administration (both on Union and State levels) on the lines discussed above may be desirable.

C. *Rural, Secondary and Universlty Education*—In 'B' we quoted some of the important recommendations of the University Commission on Agricultural Education (Chap. VII). They were based upon an adaptation of the structure of 'land grant' colleges to our local conditions. We are told that these 'land grant' colleges provide 3000 occupations including such as are suitable to students from agricultural vocational schools, who desire to specialize in different aspects of agriculture. The Commission recommended that the new agricultural colleges, 'where possible, should be associated with new rural universities, so that agricultural education may be supported and enriched by contact with other fields, and by common use of personnel and equipment'. In Chapter (VIII) on Rural University we did not discover any coherent scheme of rural collegiate education, correlated with agricultural education and extension work. It appears to us that Chapters VII & VIII were written by different members of the Commission, and no attempt was made subsequently to fuse them into a coherent system. This has to some way detracted from the usefulness of the Report.

The whole of rural education is divided by the Commission into :

8 years of basic education ;
3 or 4 years of post basic or secondary education ;
3 years for college, and
2 years for post-graduate university work for master's degree.

The expression 'college' in this connection refers to not only to education leading to an academic degree but to any education beyond the secondary school whatever may be its form.

Adult education through People's College—

The Commission views the possibility that a large proportion of Indian rural boys and girls may not attend formal school beyond the seven or eight years of basic education. The Commission suggest that for such people some form of adult education may be arranged similar to that provided by the People's College of the Scandinavian countries, especially of Denmark.

People's College of Denmark are residence institutions for adult young people, chiefly from rural life. They are not vocational but cultural in their purpose. All of them and of the Agricultural Schools are private institutions, usually owned by principals, but sometimes by an association. A People's College applying for public funds must be first recognized by Government.

While the Government allows a certain proportion of students under eighteen, the People's College are conducted on the assumption that it will be well to have a break in schooling between the 14th and the 18th year or longer. Many Danes hold that during this period between adolescence and maturity young people want to grapple with practical affairs, to become self-sufficient and self-reliant. It is felt that students should first learn the manual labour of their future occupation, and should not attend People's College unless and until they have a strong desire for education. There is no space here to evaluate the results of the People's College movement. Their alumni have taken leading role in the cultural achievements of the country, in initiating social legislations and in helping the economic development of the country. The Commission does not however indicate how the proposed rural universities will help in the starting of any adult education movement in this country on the lines of the People's College.

Basic Education—To see rural higher education in good perspective it is considered necessary to have

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some idea of the elementary and secondary education out of which it should emerge. The Commission consider that the programme of Basic National Education for grades one to five, may be considered as a representative statement of what basic education for rural areas should be. This programme is in practice in several parts of India, and appears in main to be justifying the expectations of those who gave it form. A possible criticism of actual practice is, over emphasis on one process of producing fabric and cloth. 'In some ways it seems desirable that a more distributed interest and attention to varied processes of rural life would be desirable'. There is no attempt to indicate how the agricultural activities can be made to provide such interests.

As post basic secondary school programme has been less carefully worked out and while that of higher education has not been clearly formulated, the Commission proceed to consider them in detail.

Rural Secondary Schools—A successful development of secondary rural education should presume decentralized well balanced progressive industrialization. In fact a considerable part of the vocational training of post basic school should be to prepare boys and girls, no longer needed for agriculture, for other callings. The industrial development of India is being handicapped by the lack of workers who are skilled in hand and eye, to fill positions not requiring full professional training. As rural industries develop, the rural secondary schools should go far to meet that need. Again we miss here any references to special types of agricultural vocational schools necessary to provide:

(*i*) Training to sons of yeomen farmers, to fit them to become better cultivators of land ;

(*ii*) Training for village guides, who will pass on to the cultivators all the information about improved agricultural technique in State and agricultural college experiment stations; and

(*iii*) To provide overseers for such stations.

Amongst the number of types of rural secondary schools which will emerge as the general principle of basic education find expression in practice, the Commission selects one type for detailed consideration. Such a school should, unless there are good reasons to the contrary, be residence school with pupils living in hostels or if feasible, in such houses as would be suitable for good village life. On the other hand it is important that school experience shall not divorce him from his village associations, so that he cannot return to work in the world from which he came.

The secondary school village would as a rule serve a group of villages and should be conveniently situated with reference to them. It will cater for 150 to 200 students, and will require 30 to 60 acres of land, of which 10 acres should be used for school house, hostels, homes for teachers, play grounds, workshops and industrial sites. The rest should be for agriculture, forest and pasture. All this is very desirable, only the cost of starting and running such schools in large numbers appears to be prohibitive. Certain suggestions are given for reducing the cost of construction *e.g.*, by making the pupils and teachers take part in building the school village, with the help of a person trained in village and school planning. Further the life of the school should follow the course of life of a good village, except that about half the working time should be given to study, and about half to practical work. There are some kind of work with which nearly every pupil should become familiar, such as child care, cooking, and keeping of home for girls, and agriculture and the use of household tools for boys and girls. The school should raise most of its food and should teach boys and girls how to make the land yield as much as possible. The practical work should include farming, building, carpentry, housekeeping, weaving, street clearing, and other useful village work. It should also include one or more modern industries, manufacturing goods for sale.

Rather than work and study for a part of each day, it probably will be well to divide the students into two shifts, each shift studying and working on alternate days or more probably alternate weeks or fortnights. For many of the pupils the secondary school period would complete the schooling and their special training. Others would find it desirable to go to more advanced rural schools or colleges.

A syllabus is given of the more formal type of education to be given in these schools, both for the imparting of information and what is more important the development of attitudes of mind and spirit.

Other topics like self support in Basic Education and Division of Labour in Basic Secondary Schools are discussed in the Report, into which we cannot enter for want of space. A very attractive picture of rural secondary school is presented in the Report; it will require to be tried in specially selected rural areas, as pilot scheme, for tests,

(*i*) regarding the cost involved;

(*ii*) on the development of cooperative building and other practical activities amongst the teachers and pupils, and

(*iii*) on the feasibility of combining the formal and practical portion of the training as mapped out with the capacity of the pupils to assimilate the training within 3 or 4 years of post basic education.

Rural Colleges and Universities—As a general type of arrangement it is suggested in the Report that a rural university should include a ring of small resident undergraduate colleges, with specialized and university (post-graduate) facilities in the centre. The number of undergraduate students in each college should be about 300 and the maximum overall enrolment for colleges and university combined about 2500. This arrangement will combine the advantages of small resident undergraduate colleges where there are close relations between teachers and students with the advantage of fully developed university which offer a wide range of specialized and advanced educational opportunity to

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advanced students or to other students with specialized interest.

The aim of each college would be to equip its students with general educational foundation and to encourage the development of individual aptitudes and interests as they appear. A great deal of flexibility and adaptability in the courses to be offered to the students is recommended. While there should be many elements common for all students, the curricula should be made to fit the needs of individuals; and not to make the students to conform to an arbitrary curriculum. Each student should be given the opportunity, without sacrificing the general core of education, to begin specialization at whatever time he is ready for it, even at the risk that he might later change his field of occupational interest. Some students have clearly defined occupational interests at an early age.

The other important recommendation is that in rural colleges as in rural secondary schools, general studies should be united with practical courses, so that those who attend college should become cultured educated men and women, and also persons trained and skilled in some field or prepared for further advanced training. Probably the greater part of rural college students will not have further schooling except for 'refresher courses' and so their college courses should include occupational preparation. Also as with rural secondary students, rural college students may spend about half their time at studies and half at practical work. The working and study period should be longer than in secondary schools, the interval between work and study being perhaps 5 or 10 weeks each. This programme of work and study has been developed in some places in Europe and America, through more than 35 years, and has been successful. In America a steadily increasing number of universities, technical institutes and similar institutions now use it.

"There is a tendency in University circle which look upon alternating work and study and also upon 'practical' courses, especially those calling for manual craftsmenship as suited to inferior minds, while professional courses are for intellectuals. This separation of skill of hand from skill of mind has greatly retarded the mastery of the physical world and has been the major cause of poverty, especially in India. Practical skill should be looked upon as equal in dignity and worth to purely intellectual skill. Like scholarship, it should be recognized with ascending grades of achievement and opportunity, so that the man who develops high ability with hand and eye may have an open road to advancement equal to that of the purely intellectual worker". Examples cited in the Report to support this view are the great contributors to astronomy who have based their work on mechanical skill. Charles F. Kettering the famous General Motors Manager, and Henry Ford in their earlier years worked out ideas with their own hand as mechanics.

Ways and Means—As to ways and means of getting the rural education programme under way, the Commission remarks: "The criticism would be made that while the programme outlined would be a desirable one, India does not have the resources to put it into effect. Most of the provinces are already committed to the principles of basic education. Each of them might well establish a number of resident secondary school villages and they might cooperate in establishing one or more rural universities. Similarly the Central Government might well establish several resident secondary school villages and a rural university. The growth of the new system will depend largely on the supply of suitable teachers. The Central Government or the Provinces might establish one or more training schools for teachers of this programme.

"The Gandhi Memorial Trust might well establish several secondary school villages over India, and one rural university, staffing them with persons trained in existing training centres and with others who are sincerely committed to the principles of basic education. It will be no disadvantage for the programme to have varied independent beginnings. The new type of secondary schools and universities should be vigorously developed as essential element of the educational expansion on which the future of India depends".

We bring our survey of "Agricultural Education and Research in India" to a close with the above extract. The proposals for rejuvenation of rural education and the starting of rural universities are too complex to be described adequately in a few paragraphs or can be assessed at the tail end of our present review. If occasions arise, we hope to return to it again.

D.M.B.

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IS COMMUNAL CONFLICT OR WAR INSTINCTIVE ?

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INSTINCT refers essentially to a conative impulse which man inherits for the satisfaction of his most fundamental needs of life. So instinct is in the individual's psychological make-up. Aggressiveness is regarded by McDougall to be an unit of this make-up. But killing is not the only manifestation of human aggression. Litigation in the defence of one's own interest and political campaign not leading actually to any war also come of the aggressive impulse. Even intellectual endeavour to understand and master the environment is considered sublimated manifestation of the aggressive impulse. So the mere fact that man has aggressive impulses does not necessarily imply that war is inevitable and unavoidable. Thus war is not a co-existent factor of aggression. In fact war may come out of some specific conditions which it is not possible for one to establish from the study of the individual's psychological make-up. The American history shows generally a peaceful state of human affairs—quite different from the state of mind which the people of Europe present. These people, deriving from the same stock behave differently in different countries not because of any changed psychological structure, but because of the different socio-political conditions under which they live. So the basic human factors remain almost constant while the sociological factors are the variables. But Freud finds in this basic human nature the unavoidable element of war. According to him war is the unavoidable manifestation of man's innate destructiveness. He believes that destruction for its own sake is one of the strongest human motive forces. In international wars this self-destructive tendency of the people is indeed deflected to an outward object. So according to Freud the innate destructiveness of man causes war ; and war is unavoidable. Men must hate and destroy something.Only if they have a common external object of hate can they be saved from each other's destructiveness. Leaders understand this instinctively ; and in order to avert revolution they institute war.

This is not the place to discuss Freud's problematic death-instinct theory. But even if it is true that man is innately destructive and that war is the manifestation of destructiveness it does not necessarily follow that man will always have to conduct wars. We observe that Freud has studied the manifestation of this destructiveness under different conditions and found that this destructiveness might be diverted towards external objects.[1] But he has not discussed the necessary relationship of this destructiveness to war. So war as a manifestation of this destructiveness may occur only under certain social conditions—national or international. It is not well known whether an innate destructiveness for its own sake goes beyond the limits of self-preservation. The relationship of aggressiveness to self-preservation is still uncertain. But there is no doubt that a destructiveness for its own sake may exist as a secondary phenomenon in the form of sadism. This sadism is often considered as a secondary erotization of an originally self-preservative aggressiveness. It seems that in morbid development, when a large quantity of inhibited hostile impulses accumulate these may be drained by sadistic behaviour which serves merely as a gratification and not for self-preservation. So even when destructiveness for its own sake causes war or hostile conflicts it is under special conditions of life that such development arises.

So the conditions of war-like conflicts may primarily be mental or environmental. Though the conditions of the two kinds are not exclusively separate but still their relative importance in the determination of conflict or war varies in different cases. When the emphasis is made on the environmental factor it means that the existence of a particular people is threatened by particular environment ; that is to say, when a people endeavours to ensure its existence its endeavours conflict with the strivings of other peoples subjected to the same environmental forces. Thus we find that when an environment is brought about by the strivings of a people in its struggle for existence— rendering it difficult for other peoples to adapt themselves to it, then an attempt is made to alter that environment, but this attempt is resisted by the people who consider that any alteration of the environment will affect its own existence. As a result communal conflict or war follows. This is an economic crisis which it is difficult to prevent through psychology.

But Freud in a letter to Einstein holds that 'conflict of interest among mankind is in the main usually decided by the use of force. This is true of the whole animal kingdom from which mankind should not be exempted'.[2] It means that war is the usual way of setting conflicts between groups. This view tends to refute those who seek the causes of war in a specific emotional disturbances of the masses and refer to it as a mass psychosis. We observe communal conflict often come out of a mass psychosis. In this conflict the aggressors as individuals remain relatively normal, well-adapted persons. They go about their business, take care of their family and so forth. But it is only when they join a group, when they become members of a mass, they lose certain qualities which determine normality and thereby become instrumental in helping to produce a mass delusion, belief in which is shared by all the other group members; their delusion is a mass delusion and may not be effective individually under the test of reality. Individually there

[1] Why war? (Paris International Institute of Intellectual Co-operation, League of Nations, 1933), pp.3-9.

[2] *ibid.*, p.3.

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may remain a few persons who may have friends among the members of the other community whom they hate collectively. But these few people may be influenced by propaganda through newspapers, leaflets etc. and may believe in the wickedness of the members of the other community without argumentation. Thus they become intellectually participant in the mass delusion without active cooperation with the mass. This mass psychosis which operates in the origin of communal troubles is distinct from the individual psychosis and so we find that a delusional disorder of the mass-mind may leave the individual mind still intact.

To understand this mass psychosis we should try to analyse the basic complex of the individuals actively participating in the communal massacres. So our endeavour will certainly be misdirected if we merely embark on an investigation of the various accusations brought against the members of one community by the others. False accusation is bound to occur in the communal conflicts. The differences in habits and ways and says of life, differences in wealth, culture and status can not adequately explain the original cause of communal bitterness, because these differences exist among the members of the same community. But we find that when these differences are irrationally exaggerated and used as a weapon in the hands of the politicians ; when false charges and irrational indictments are made by the leaders, they are accepted by the mass-mind and communal fury follows. We shall try to know the mental mechanism that allows the false charges and calumny to spread like an infectious disease and produces such a delusion in the mass-mind that an unrestricted discharge of destructive aggression follows. It has been already pointed out that this aggressive destructiveness is due to the delusional disorder of the mass-mind. The individuals come under the spell of this delusion when they join the mass. This psycho-pathological disturbance of the mass-mind is not a mass-neurosis, it is a mass-psychosis, for the very essence of a neurosis is that it afflicts the individual with inhibitions and makes him asocial, an outsider to the group. So the neurotic individuals cannot form a group. A psychosis is specifically precipitated by a break of the ego with reality. A break with reality means that the individual withdraws his instinct cathexes from the objects of his present world and allows his ego to escape from reality by regressing emotionally to a past level of his childhood—the stage of narcissistic self-love. So the psychotic ceases loving the object and loves only himself ; object-libido becomes transformed into narcissistic ego-libido. The over-abundance of narcissistic self-love makes him megalomanic; and he becomes unconscious of his failure to struggle with reality. The relative incapacity of the psychotic to adapt to reality precipitates all his mental disorder by impelling his ego to escape through the avenue of infantile regression. This regression goes so deep that the peculiarities of primordial narcissism in which hatred governs the environmental relationships develop in the ego. This stage of narcissism is both an ontogenetic and phylogenetic phenomenon and it is this pathology of hate which lies at the basis of communal conflicts in man. In this stage of primordial narcissism there is no barrier of repression ; for the pre-morbid ego of the psychotic in its trend to regression cannot afford that expenditure of energy necessary to sustain the defence mechanism of repression. So the super-ego of the psychotic is not strong and effective. In fact the psychotic ego regresses to the infantile stage of development where there is no super-ego—or where its governing power is still represented by the parent. So Freud has shown that the mental energies from which we build the intra-psychic power of our super-ego stem chiefly from the introversion of suppressed aggressive energies; specially those which we were forced to deflect from our parents. The ego allows these introverted aggressions to be made over to the super-ego. While submitting to this inner parent, the ego perceives its aggressions as pangs of conscience or as feelings of guilt. But in the process of the deterioration of the psychotic ego system the super-ego gradually succumbs to it. So the ego loses its orientation toward reality as well as the capacity to differentiate between the external object reality and inner irrational psychic reality. The psychotic then sees the object world in terms of the irrational imagery of his unconscious. But all the images which populate the world of the psychotic are in essence representative of but one figure—that of the parent. The ego breaks down because it cannot solve its conflict of ambivalence, of loving or hating the parent. This latent ambivalence conflict with the parent which precipitates psychosis in the individual by a break of his ego with reality is split up in the individual through participation in the collective ego of the crowd. The parental power of the unconscious of the individual is re-extroverted into the leader whom he loves and into the people of the other community whom he chooses as the object of his hatred. So the mass-leader represents the beloved parent in whom the child needs to believe for the sake of his own security. By becoming a member of the mass and accepting the mass-leader as the external parental representative the individual becomes a child for the period. So the individual inner super-ego disappears; all his inner responsibility is thus off; the barriers of repression are lifted and the instinct force of primitive hate and destruction unlashed. This release of repression allows the unconscious materials to enter the conscious ego ; and the conscious ego becomes subjected to drives and wishes of the inner irrational psychic reality. So the individuals, as the members of the mass, believe in all false accusations especially conveyed by the leader against the members of the other community not inspite of, but because of their irrationality. So LeBon describes the leader as follows : "The nimbus of the leader is sustained only if what he says is unreal, incomprehensible and beyond discussion. The mass can believe in what he says only, when his speech appeals merely to beliefs and not to approval by argumentation". According to LeBon it is not what is real that counts, but only the unreal matters in the mass. So the crowd is incapable of distinguishing subjectivity from objectivity. So the mass suffers from paranoic delusion and 'wanders, along the borderland of the unconscious, because it is governed by instinctual drives of destruction and wild-

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ness, which', as LeBon holds, 'slumbers in everyone of us'. The crowd man thinks and acts completely under the spell of the primary processes in the unconscious instead of responding to the categories of logic, ethics and aesthetics which govern our conscious mind. So the regressive conscious mind of the crowd man thinks and acts irrationally. For the crowd mind this regression is temporary but during this period of their temporary regression the members of the mass who feel individually powerless overcome their actual infantile impotence by submerging their individual egoes into the collective ego of the group and care for no obstacles in the way of their action impulses. The restoration of this infantile mass—regression to normalcy is at present the problem of the day.

But behind this mass-regression and collective discharge of aggressive energies there is the pathological group-formation. The crowd-mindedness of the people is responsible for all communal riots and conflicts. So LeBon expresses the fear that the crowd-mindedness of modern man will bring about the destruction of civilization. It is the immaturity of individual egoes that make the individuals a more easy prey to the crowd-mind. The egoes are immature as a result of their super-ego weakness. An ego is mature if it has developed a strong and effective super-ego as the internalised representative of the external parental power. This super-ego checks the infantile regression of the ego by helping the ego to test reality and to act in accordance with this testing. So the aim of all measures against communalism should primarily be the effective development of this social super-ego in men so that they are equipped for reality testing. But there is no mechanical process for the development of a lasting reliable strong super-ego in men. Extensive researches on the analysis of different afflicted persons should be undertaken in India in order to understand and combat their mental complexes. Even children should not be neglected in this work. The redirection of destructive tendencies into constructive channels, courses in social living and imparting knowledge of the psychological facts of life should be the educational task so that the basic preparation for the mature development of the super-ego may begin early in life. The old system of totem feasts at regular intervals and of dramatic performances which we call in Bengal '*Jatras*' seem to be useful instruments for the introverted making over of the pent-up aggressive energies to the super-ego. In *Jatras* the audience indentifies itself with the tragic hero who commits terrible crimes and succumbs to the consequences of his guilt. In watching the performance of the drama the audience, by way of fantasy-identification with the hero in his crime and in his downfall and guilt-feeling is enabled to re-introvert the aggressive energies and consequently to augment the strength of the super-ego. At present the aim of the theatre is to offer the people what the people like without considering what the people need. The aim of the games should similarly be not merely to test the relative strength of the contesting teams but the emotional enthusiasm of the people should be utilized on a mental plane after the discharge of their aggression so that the minds of the people are carried from the spirit of competition to the spirit of cooperation and they feel united in love with one another by participating in songs, speeches, theatrical performances etc. It has been pointed out that the communal propaganda becomes most effective if it is irrational and appeals to the unconscious of the mass especially in the cheap locals where chronic alcoholics, addicts and psycho-pathic criminals gather. These psychological slums which breed hate and destruction need mental sanitation just as the unhygienic living quarters need to be weeded out of swamps in order to combat malaria or tuberculosis. In communal fury, we have observed that man as an infantile individual feels weak ; so he flees into the mass and feels so overwhelmingly powerful that—whatever he might do—impunity is assured to him. But when the emotionally regressive individuals are not sure of this impunity and the government lends its strong support to the minority making it as powerful as its opponents the immature individuals may then feel less tempted to become crowd-minded. So *Mahatmā-ji's* move for the safety of the minority in Noakhali, Calcutta and Delhi was most psychological and greatly effective . The opposition of violence by non-violence is indeed a phenomenon of the inner-conflict of ambivalence in man but the phenomenon of unrestricted discharge of destructive energies occurs for the lifting of the barriers of the super-ego which *Mahatmaji* as a re-extroverted super-ego desired to restore in the mass-mind. So this was a most psychological intuition for *Mahatmaji* to feel that 'that which can be exercised only among friends is of value only as a spark of non-violence' while 'the greatest enmity requires an equal measure of *ahimsa*[2] to be cultivated in several births' of generations in an atmosphere of purity and discipline.[3] To establish this intuitive vision of the internalised super-ego *Mahatmāji* possessed and to utilize its truth to the benefit of the people a scheme of work on the analysis of afflicted persons was necessary. Distinguished psychologists and psychiatrists should be employed to study the importance of this epoch making theory. *Mahatmāji's* disappearance may cause the disappearance of this vision unstudied but history will reflect on it. Science always entails for its success a huge waste of money and energy.

[3] No Limitation. *Harijan*, December 14, 1947

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FOREST ECOLOGY AND EVAPORATION MEASUREMENTS IN INDIA

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IN a recent paper Ramdas (1949) recommended that a network of evaporation recording stations be set up in India to providing adequate data for use in Agriculture and Hydrology. He says....."and besides the evaporation records, measurements from soil surfaces (with soil evaporimeter sets) as well as seasonal variations of the depth of water table, etc., should be made (p.174)". This suggestion is very welcome to ecologists, soil scientists and all those who are engaged in the study of vegetation in relation to habitat factors.

Evaporation or, more accurately speaking, a ratio of Precipitation/Evaporation is one of the major ecological factors governing the development of both soil and vegetation.

In humid regions especially in higher latitudes where this ratio is high the chief trend of development in the soil is leaching as a result of which woodland soils with advancing age, become impoverished at the surface of soil bases, especially calcium. Depending upon the amount of calcium present in the rock most forest soils under natural conditions tend to develop a podsolic profile and running parallel to the development of the soil there occur corresponding changes in the development and succession of vegetation. For example, immature or new soils in humid countries of Europe (*e.g.*, in the English Lake District) are less base deficient and support the growth of ash, ash-hazel or ash-hazel-elm type of mixed woodland with exacting requirements on soil bases (Puri, 1949b; 1949e). This type is, however, succeeded in time by oak, oak-brich or in the south of England by beech-holly communities which requires lesser amounts of calcium for their growth (Puri, 1949c). On reassorted soils or those derived from rocks poor in calcium, *e.g.*, Bagshot Sands, the final stage is the conversion to healthy conditions where the soils become very acidic on the surface with a bleached A horizon and enriched B layer with iron, or humus pan. In such areas roots of trees cannot penetrate to great depth in the soil unless hard pan is physically broken to enable them to reach the lower layers.

In regions with a low ratio of Precipitation/Evaporation the chief trend in the development of the soil is evaporation, by which mineral salts from lower layers of the soil are continually brought to the surface. Some of the forest soils in tropical climate of Northern India therefore, become enriched with bases in the course of their development. It is on account of high evaporation from the soil that surface layers in most types of our forests, even in hills at high altitude, are base saturated and show a poorly developed profile. The data of Griffith and Gupta, 1947 ; Taylor and others, 1936; Hoon, 1939f, Puri, 1949, etc., agrees with the argument developed here. It may be pointed out that some high figures for exchangeable calcium obtained by Hoon in surface layers of some soils may be partly due to high amount of Ca present in leaf litter of the existing vegetation.

An illustration of this type of development in the soils and vegetation may be found in the Kulu Himalayas where freshly laid immature soils, rock screes, or sandy alluvia are colonised by the chir pine (*Pinus longifolia*), a non-exacting species. This is succeeded by Kail (*Pinus excelsa*) and deodar (*Cedrus deodara*), species with higher requirements for soil bases, which become available to the seedling growth at the surface layers of the soil through evaporation and leaf litter (Puri, 1949f; 1950c). Fire is also considered by forest officers to play a notable role in the occurrence of those species but the action of fire in this case is similar to that of high evaporation.

At higher altitudes in the main valleys, or in side valleys in the Kulu Himalayas there is a higher precipitation, as a result of which the surface soils tend to be leached of minerals. The development of vegetation in this region is similar to that of Europe and proceeds from broadleaved species of *Cornus macrophylla*, *Prunus padus*, *Juglans regia*, *Aesculus indica*, etc., with high lime requirements, to spruce and silver firs, whose demands on soil minerals are low (Puri, *loc. cit*). Similar sequence is seen in the Kashmir valley (Hoon, *loc. cit.*) and it seems that the development of soils and vegetation is related to the ratio of Precipitation and Evaporation.

In lateritic soils under teak in warm tropical climate of S. India the data of Griffith and Gupta (1947) shows that a change in Precipitation/Evaporation ratio by opening the canopy and increasing evaporation from the soil brings about a deterioration of soil for this species and encourages growth of other species.

The importance of Precipitation/Evaporation ratio in the development of vegetation and soils is abundantly recognised in Europe (see Stamp, 1947, p. 92) and this knowledge is applied to scientific forestry and agriculture in most countries. In this country, however, on account of diverse climatic conditions and lack of adequate records of evaporation (and even rainfall at some places), the significance of this factor in the development of forest vegetation and soils has not been properly appreciated.

My preliminary survey of sal forests in the Dehra Dun valley and available data of Griffith and Gupta as indicated elsewhere (Puri, 1950a,d) tend to show that the failure in regeneration of *Shorea robusta* in places which have been over-exploited is perhaps, related to a change in this ratio. Under close canopies of pure sal, where the soil is little exposed to sun there is less evaporation. Surface soils in such situations are acidic and have low amounts of calcium and high amounts of nitrates. Under these conditions (see table III on pp. 22-23 in Griffith and Gupta, *loc. cit*) it is seen that

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the regeneration of *Shorea robusta*, a non-exacting species with only 1.46% of foliar Ca as compared to 2-6% in most of its associates, is present. An injudicious opening of canopy would increase evaporation as a result of which surface soils become saturated in bases and thus allow the growth of only exacting species at the expense of sal (Puri, 1950a,d).

Changes of a similar nature seem to be working in conifer forests of the western Himalayas as well, where one species or the other fails to regenerate after felling operations. The author's studies on these lines in conifer forests of the Kulu and Parbatti valleys are in progress, and the preliminary results which closely agree with those of Taylor *et al*, (1936) already seem to show the causal relationship between precipitation and evaporation and growth and regeneration of various conifer species.

The examples given above seem to show clearly that exact data on evaporation and rainfall over small areas in a forest are essential for successful silviculture of our important timber species. Ramdas's suggestion for collecting evaporation data embraces only agriculture areas but it is highly essential that similar evaporation measurement stations be set up in important forests of India. Provincial Forest Departments maintain records of rainfall at their offices and Rest Houses in the forest and at some places temperature measurements are also taken. It would be of immense interest to have soil evaporimeter sets at such places to begin with and to extend observatories to other areas in the forests later on. The cost of providing such an apparatus as given by Ramdas (about Rs. 500/-/-) is negligible as compared to the value of the data in forest management, growth and regeneration. The Meteorological Department may perhaps, advise the Forest Department in regard to the extension of their service of soil evaporation measurements for mutual benefit; since observations from agricultural stations alone will perhaps, not give satisfactory results for assessing the effect of climate on vegetation.

The ratio of Precipitation/Evaporation could be of wider application in Ecological Soil Survey in relation to agriculture, forestry and land conservation. Being faced at the moment with shortage of food, wood and fuel we should be interested in putting all available land under vegetation and for this purpose it is necessary to study potentialities of land and soil-climate-vegetation complex on a long term basis. The importance of Precipitation and Evaporation measurements on more accurate lines is thus obvious in the natural economy of our country.

The first attempt at understanding the climate of India on the basis of Precipitation/Evaporation was made by Raman and Satkopan (1935), who used the single value factor "the annual rainfall minus the annual evaporation" for records of 80 different stations in the country At about the same time Hosking (1935) calculated climatic values for regur soils of India for comparison with black earths of Australia and his studies culminated in 1937 in the preparation of a map of India showing Meyer Ratio of Precipitation/Saturation deficit. This map shows the minimum value of Meyer ratio of 5 for central part of Sind and the maximum value of 4000 for Cherrapunji which records the maximum rainfall in India.

Hosking's map of Meyer ratio was used by I.C.A.R. in making the first soil map of India in relation to climatic zones. This map, however, is preliminary and does not show any clear correlation between different types of soil and Meyer lines and relation between vegetation and these lines is still less evident.

A good deal of work has been done in Australia to express Precipitation/Evaporation ratio more accurately with a view to correlating it with different types of soil and vegetation and Prescott (1949) has recently brought forth this relation in an excellent paper, which should serve as a type study for work in this country. Prescott states "that the most efficient single-value climatic index is P/E^m where P represents precipitation, E evaporation from a free water surface, and m is a constant varying from 0.67 to 0.80 with a probable mean of 0.73. A value for this index of 1.1 to 1.5 corresponds to the point where rainfall balances transpiration from vegetation and evaporation from the soil" (*loc. cit.*, p.19).

The Government of India has set up a central committee on soil research (1949) one of the aims of which will be to advise planning of soil surveys and the preparation of soil map of India. It is hoped that this committee will remember the interests of Ecologists (Puri, 1948) and Foresters and recommend an ecological approach to the survey of soils. Soils, being dynamic systems, must be examined, surveyed, and classified not only in relation to climatic (Precipitation/Evaporation ratio) but also to vegetational, biotic and historical factors. The advantages of ecological approach in this survey are obvious, since its aim is primarily to use the soil for the maximum production of agricultural or forest crops without impairing in any way its productive capacity for future use.

The ratio of Precipitation/Evaporation is one of the important ecological factors governing the fertility of the soil, hence it may be stressed that to aid (*i*) Successful forestry, (*ii*) Soil survey, and (*iii*) Soil conservation the service of evaporation measurement stations be enlarged so as to embrace forest areas as well.

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INDIAN WEATHER AND LOCUST IMMIGRATION IN INDIA*

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From the climatic point of view, the outstanding feature which distinguishes the Indian region from other parts of the world is the monsoon which represents interactions between the air masses of the two Hemispheres. Its advent in June and retreat in September are known as the transition periods. In some years, the fluctuations associated with the first transition may commence as early as in April and those with the second may not cease until October.

So far as Rajputana is concerned, the immigration of locusts appears to synchronize with the first transition and emigration with the second transition. This of course is a generalization, departures from which in individual years should furnish a valuable basis for the correlation between the habits of the locusts and the deviations of the various meteorological elements from their respective normals. This note is however mainly concerned with average conditions.

The home of the monsoon winds in India is to the south of the Equator. The monsoon current is popularly known to have two branches, *viz.*, the Arabian Sea branch and the Bay of Bengal branch.

As a southwesterly current, the Bay of Bengal branch strikes Tenasserim in April or May. It then proceeds as a southeasterly current through Burma, and the U.P. and reaches the Punjab and Rajputana by June or July. From the point of view of heavy rainfall, this branch in association with a monsoon depression is important for the Rajputana desert. A monsoon depression usually travels from the northwest angle of the Bay of Bengal, off Orissa, towards Rajputana.

The Arabian Sea branch of the monsoon, on the other hand, strikes Malabar as a southwesterly current by June, and gradually extends northwards to Gujerat, and then proceeds towards the eastern Himalayas across Rajputana. In some years, the Arabian Sea branch causes early monsoon rain in Rajputana.

The advance of the monsoon into Baluchistan is of very short duration and erratic in character. It may be said that on the average the monsoon does not last over the Baluchistan hills for more than five days. The monsoon rainfall extends to the Mekran very occasionally, indeed the number of rainy days in this area and further west in Persia is even smaller and therefore negligible.

On the eve of the establishment of the monsoon, there is a low pressure area over Persia and Baluchistan. It is observed that the monsoon can never establish itself over India until the dry bulb temperatures over Arabia, Persia and Baluchistan are high, the maximum often exceeding 110°F. As a matter of fact, this zone of high temperatures may even extend to the Caucasus in some years.

The summer duststorms are often violent over the Persian gulf and the diurnal range of temperatures in Persia and Baluchistan region is also high. Moreover, the trajectories of the surface and upper winds often provide a light following wind to the locusts. As a matter of fact, the favourite paths of the locusts from Persia entering India and other countries are surprisingly similar to the wind fields in this region.

In June, the locusts migrate from Persia, which is a rainless area in summer, and settle down in India over a desert area *viz.*, Rajputana where there are about three to four days of rain in a month yielding about 2″ of rainfall.

From October onwards, on the other hand, anticyclonic vortices often appear over Rajputana and Gujerat. These are known to cause markedly foggy conditions along the Sind Mekran coasts in the mornings. The trajectories of the light upper winds in these vortices

*This work was done while the author was an Assistant Meteorologist at Karachi in 1945–46 under the direction of Dr. S. N. Sen, the then Dy. Director-General of Observations (Forecasting), Indian Meteorological Department.

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are north easterlies over Rajputana and south-westerlies over Gujerat. The trajectories, therefore, frequently provide following winds for short westward flights of locusts over the north Arabian Sea and then across the Mekran coast. The emigration of the locusts from India in October should therefore be from Rajputana which dries up quickly after the rains, to Persia where the rainy season commences.

The single factor which appears to control the migration of locusts is seasonal desiccation, the direction of flight of most of the swarms being determined by light following winds. The migration cycle of locusts is thus closely correlated with the "rainfall cycle" between Rajputana and Iraq. The cycle is explained by Table 1. It sets out the rainfall and rainy days at some of the Persian and Rajputana stations.

maximum rainfall in the winter to another with its maximum rainfall in the summer. These are the centres between which the cycle operates. It is for the entomologists to consider whether about four to five rainy days in a month giving about two inches of rainfall may be said to furnish the 'Optimum' conditions for locust settlement and breeding. It is a well known fact that there is close correlation between insect and humidity, and swarming is governed by reproductives under the influence of physical factors.

The Meteorologist would like to know whether the locusts dislike dust storms, and like fogs? Further, do they try to avoid temperatures below 50°F. and above 110°F. on the average? There are airsacs in locusts which help in bouyancy and respiration during long flights

TABLE I

NORMAL RAINFALL & RAINY DAYS (above 0.10") IN SOME SELECTED STATIONS OF IRAQ & RAJPUTANA BASED ON 4 YEARS' DATA *i.e.*, 1934-1937.

NORMAL RAINFALL.

	Nov.	Dec.	Janu.	Feb.	March	April	May	June	July	August	Sept.	Octo.
IRAQ												
Hinaidi.	1.07	1.47	1.09	1.19	0.13	0.58	0.59	0.01	0.	0.	0.	0.13
Diwaniqa.	0.53	1.26	0.75	1.29	0.21	0.72	1.62	0.	0.	0.	0.	0.13
Mosul.	3.03	1.63	1.87	2.02	0.89	1.75	1.20	0.	0.	0.	0.	0.62
Rutbah.	0.70	1.04	0.56	0.33	0.19	0.57	0.39	0.	0.	0.	0.	0.76
Shaibah.	1.02	1.95	1.05	1.28	0.39	0.65	0.29	0.	0.	0.01	0.	0.
Muscat.	0.13	0.73	2.74	1.02	0.56	0.06	0.02	0.	0.02	0.01	0.	0.
RAJPUTANA STATIONS & KARACHI												
Jodhpur	0.38	0.23	0.10	0.34	0.03	0.17	0.05	2.07	3.58	3.11	2.24	0.09
Bikaner.	0.13	0.22	0.07	0.53	0.36	0.28	0.10	1.38	4.18	4.57	1.11	0.03
Udaipur.	0.23	0.11	0.16	0.17	0.09	0.06	0.03	2.03	6.29	2.85	5.66	0.13
Barmer.	0.07	0.25	0.26	0.15	9.12	0.16	0.01	0.49	4.66	2.31	1.25	0.08
Karachi. (Drigh Road)	0.	0.34	0.30	0.78	0.02	0.52	0.	1.11	4.11	4.11	0.15	0.01

NORMAL RAINY DAYS.

IRAQ.												
Hinaidi.	2.5	3.0	2.0	2.7	0.3	1.3	1.0	0	0.	0.	0.	0.05
Diwaniqa.	1.5	3.3	2.5	2.5	0.7	0.5	0.7	0	0	0	0	0
Mosul.	7.0	3.5	5.3	6.3	1.7	4.5	3.3	0.	0	0	0	1.7
Rutbah.	1.7	1.3	1.0	1.0	0.5	1.7	1.7	0.	0.	0.	0	1.3
Shaibah.	2.7	4.3	2.3	2.7	1.5	1.7	1.0	0.	0.	0.	0	0
Muscat.	0.3	1.7	2.3	1.5	1.3	0.3	0.	0.	0.	0.	0.	0
RAJPUTANA STATIONS & KARACHI												
Jodhpur	0.5	0.3	0.3	0.7	0	0.5	0.3	3.0	6.3	5.0	4.3	0.3
Bikaner	0.3	1.0	0.3	0.5	0.7	0.5	0.3	2.0	5.3	5.5	1.7	0.3
Udaipur	0.5	0.5	0.3	0.5	0.3	0.3	0.3	6.0	9.0	5.0	8.0	0.5
Barmer	0.5	0.7	0.5	0.3	0.5	0.5	0	1.3	5.7	3.3	2.3	0.5
Karachi (Drigh Road)	0	0.5	0.5	1.5	0	0.7	0	1.7	4.3	0.3	0.7	0

It is seen from the Table that on the average Persia is practically rainless in the summer and Rajputana has little rainfall in the winter. The averages of these elements over long periods fully confirm these features.

The winter maximum of rainfall in Iraq (Persia) is associated with the eastward passage of western disturbances. The summer maximum of rainfall in Rajputana, on the other hand, is more or less associated with the westward passage of eastern (monsoon) depressions.

It is clear from the preceding paragraphs that the cycle of locust migrations is from one desert region of

through air. Could there be no relation between densities of air inside the body and the surrounding air, to urge insect to move forward, and while doing so, takes as a matter of fact, the normal wind trajectories, from surface to about 3000 feet? Do they try to select a region with relative humidity the diurnal range of which is between 50 and 90% for breeding purposes? Can they stand a diurnal range of temperature exceeding 30°? Do they find sandy soil preferable to other types? These are a few of the questions the answers to which might stimulate research in the border line of Meteorology and Entomology.

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WILD MANGOES OF INDIA*

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Introduction

THE mangoes (*Mangifera indica* L.) are broadly grouped under two categories—(*i*) the *seedling races* (both wild and cultivated) and (*ii*) the *horticultural varieties*, propagated by budding or grafting (Popenoe, 1932). The *seedling races*, cultivated or wild, are not so well-known in India, as the mangoes of this country are obtained mostly from grafted varieties, which grow successfully over large tracts of Bombay, Madras, Bengal, Bihar and United Provinces. A fair knowledge about these types is available in the surveys of the varieties in Bombay (Burns and Prayag, 1921), Madras (Naik, 1941), Bihar and U.P. (Woodhouse, 1909), and Bengal (Mukherjee, 1948). On the other hand, the knowledge on the wild types consists mainly in the reports of their occurrence in different areas; no detailed information regarding their fruits being available. Wild forms of *M. indica* (mango) which are closely allied to the cultivated grafted types are reported to occur in the tropical and lower mixed forests of Burma and the Andamans (Kurz, 1877), in the evergreen forests of Khasi Hills and the valleys of Assam (Kanjilal, Das and Purakayastha, 1947), in Sikkim (Hooker, 1876), in the sub-himalayan tract, in deep gorges of the Baraitch and Gonda hills in Oudh, in the outer hills of Kumaon and Garhwal, in the higher hills of the Satpura range, and along the Western Ghats in South India (Brandis, 1864).

As information about the wild types is necessary for utilizing them in any programme for breeding of this fruit tree an exploration was undertaken in the Khasi Hills, Chittagong Hill Tracts, Kalahandi (Eastern States Agency in Orissa) and Chota Nagpur to discover the types of wild mangoes occurring in those areas, an enumeration of which is made in the present paper.

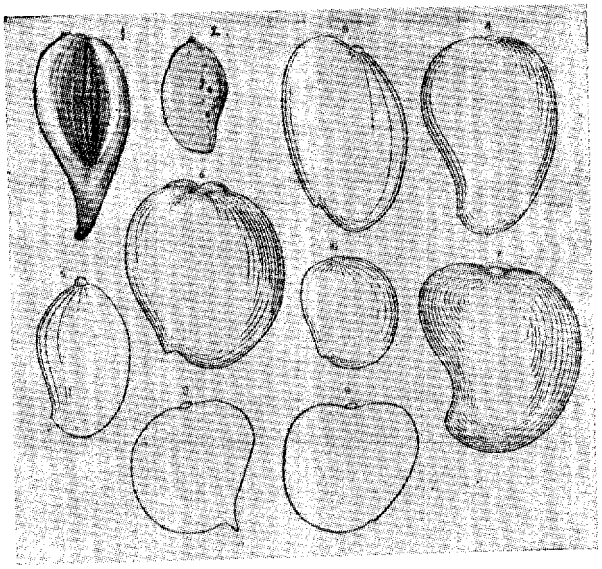
Description of the Wild Types

The genus *Mangifera* L. contains 41 species, distributed from India to the Philippines and New Guinea through Malay Peninsula and the Archipelago. Among these only 3 species occur in India (Mukherjee, 1949a).

Of the Indian species, *M. khasiana* Pierre is of doubtful occurrence as it has not been recently found in Assam, wherefrom the 'type' specimen was collected. The other two species are *M. sylvatica* Roxb. and *M. indica* L. (the common mango), which are very much allied. A description of the wild races of both of these Indian species are given below.

M. sylvatica Roxb., a species occurring only in N.E. India (Assam and Chittagong Hill Tracts) by the side of ravines and small *nullahs* in the hill gorges up to an elevation of 3,000 ft., is a very tall tree attaining a height of about 150 ft. with a straight trunk, 25-30 ft. in circumference at base. The leaves are long and broad like some of the long-leaved mangoes but the petiole is much elongated (3-4 inches). The inflorescence is of the same type as the mango (*M. indica*), with similar pentamerous flowers having only 1 fertile stamen, but completely glabrous.

The fruits are very characteristic (Fig. 1), elliptic in shape with a pointed acuminate apex not found in any other species; greenish yellow when ripe, with a smooth thick epicarp, much thicker towards apex; flesh thin, slimy, almost free from fibres and with a fine aroma.



Figs. 1-10 showing fruits of wild mangoes. (Reduced to ⅛th of the original drawing)

1. *M. sylvatica*; 2-10. *M. indica* (wild races), 2. *Chittagong Hill Tract type*, 3-10. *Kalahandi types* :, 3. *Type I*, 4. *Type II*, 5. *Type III*, 6. *Type IV* 7. *Type V*, 8. *Type VII*, 9. *Type VI*, 10. *Type VIII*.

The fruits of the species, collected from three localities differ in size; the Mikir Hill type (at 1,000 ft.) has the largest fruit (10 cm. × 6 cm.), the Khasi Hill type (at 2,500 ft.) has the smallest fruit (8 cm. × 3.5 cm.) and the Chittagong type (at 1,000 ft.) has fruits of intermediate size. The Khasi Hill type flowers during September-October and produces fruits during December—January, whereas the other two types produce fruits during March-April. This species may improve by breeding and culture, as the flesh of the fruits is almost free from fibres and gives out a fine aroma when ripe. The fruits are reported to be edible and are used for pickles.

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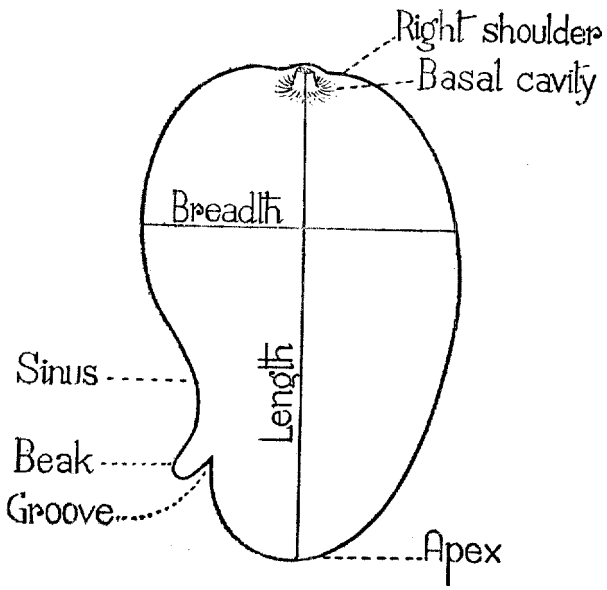
M. indica Linn., has similar tree habit as the former species, and occurs mostly in the evergreen forests at an elevation up to 3,000 ft. in the gorges of the hills or by the sides of ravines and *nullahs*. The leaves are similar to *M. sylvatica*, with long petioles unlike the cultivated types. The inflorescence and the flowers are similar except being pubescent. The fruits are different from those of *M. sylvatica*, and are like the cultivated varieties in shape, but of smaller size. They are described below:

1. *Chittagong Hill Tract type*, collected from the forests, 20 miles from Rangamati, the headquarters of the Tract, where it is very common.

The fruits (Fig. 2) are oblong, small, $5 \times 2.75 \times 2.5$ cm. in size, golden-yellow when ripe; basal cavity absent: shoulders short and equally falling; beak imperceptible; skin thick with short close glands; flesh scanty, adhering to the innumerable fine, soft fibres, juicy and very acidic, with an agreeable flavour; stone almost wholly filling up the fruit.



Diagrammatic drawing of a fruit showing the various parts.

2. *Kalahandi types*, collected from the Thuamul Rampur Forests of the state, about 40 miles from its capital Bhawanipatna. It belongs to the Eastern States Agency of Orissa. Eight different types of fruits have been collected, details of which are given below:

Type I. Fruits are $9 \times 6 \times 5$ cm. in size, elliptic-oblong in shape; basal cavity absent; shoulders smooth, left higher, right sharply falling; beak slight, pointed, 2 cm. below narrowed apex (Fig. 3); flesh thick but traversed with fibres.

Type II. Fruits $9 \times 6 \times 5$ cm. in size, ovate-oblong in shape; basal cavity absent; shoulders almost level; beak very slight, 2 cm. below round apex (Fig. 4); flesh thick but traversed with fibres.

Type III. Fruits $7 \times 4 \times 4$ cm. in size, elliptic-oblong in shape; base protruded; shoulders equally falling; beak slight, almost imperceptible; sinus shallow below the beak (Fig. 5).

Type IV. Fruits quite big and plump, $8 \times 6.5 \times 6$ cm. in size, elliptic in shape; basal cavity slight; shoulders equally falling but prominently ridged; beak prominent, broad, pointed upwards, 2.5 cm. below apex; glands prominent on skin; flesh thick but traversed with fibres (Fig. 6).

Type V. Fruits as big as some good cultivated grafted varieties, $9 \times 7 \times 6$ cm. elliptic-oblong in shape; basal cavity deep; left shoulder broader; beak almost imperceptible; sinus prominent below the beak; flesh thick but traversed by fibres (Fig. 7).

Type VI. Fruits $6.3 \times 6 \times 5.2$ cm. in size, roundish in shape; basal cavity slight; shoulders almost level, left broader; beak slight, almost imperceptible; apex round (Fig. 9).

Type VII. Fruits $5.5 \times 5.2 \times 4.4$ cm. in size, roundish in shape; basal cavity absent; shoulders level, left slightly broader; beak very prominent; protruded side ways from apex (Fig.8).

Type VIII. Fruits $5.3 \times 4.6 \times 3.6$ cm. in size, ovate-oblong in shape; basal cavity absent; shoulders level, equally falling; beak very slight, almost imperceptible, 2 cm. below round apex; flesh thin, fibrous (Fig. 10).

Conclusion

The two species, *M. sylvatica* Roxb. and *M. indica* L. occurring in India, are very much allied in their morphological characters differing mainly in the fruits. The leaves of the 'wild' types of *M. indica* show tendencies towards formation of large leaves with long petioles, as are found in the wild species, *M. sylvatica*; but in the cultivated varieties of mango the petioles are much shorter. This similarity suggests that *M. sylvatica* has played some part in the evolution of *M. indica*, wild types of which are very common in the areas of NE. India where the former species occurs. Moreover the chromosome number for both the species is same, $2n=40$ and $n=20$ (Mukherjee, 1949b). The anatomical studies has not indicated much difference between the three species *M. indica*, *M. caloneura* and *M. sylvatica* (Mukherjee, 1949 c.). An analysis of the pollen grains also shows that they have grains of almost similar size and shape (Mukherjee, 1949d). All these evidences suggest that interspecific crosses between these two species may easily occur, as the flowering season in some of the *M. sylvatica* types merges with that of the mango; and hybridization in nature has therefore played an important part in the evolution of the mangoes.

The different fruit types reported in this paper show that the wild mangoes also possess a variety of shapes as are found in the cultivated varieties. Moreover in the forest areas where suitable conditions for their growth are available, they attain almost the same size (*Types II, IV and V*), as the good cultivated varieties. The cultivated horticultural varieties of

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mango have been classified by Woodhouse (1909), Burns and Prayag (1921) and Popenoe (1911) on the basis of fruit-characters. Mukherjee (1948) has recently classified them into 3 groups—*Round*—, *Ovate-oblong*— and *Long—fruited* on the basis of fruit-shapes and delimited the different varieties by the presence or absence of beak, sinus, basal cavity etc. The types enumerated in this paper show that these different fruit-shapes are also represented in the wild races, along with the different characteristics of beak, basal cavity, ridges on the shoulder etc. It appears therefore that selection by man has played an important role in the production of these cultivated varieties from the various wild types growing in India.

SUMMARY

An exploration into the forests of Assam, Chittagong Hill Tracts (near Burma border), Kalahandi State (Eastern States Agency, Orissa), and Chota Nagpur has led to the discovery of the three types of fruits of *M. sylvatica* and 9 types of *M. indica*. The fruits of the wild mango are of various shapes as are found in the cultivated varieties, and sometimes attain the same size as the latter types. It is indicated that selection by man played an important role in the production of cultivated mangoes.

M. sylvatica and *M. indica* are very much allied in morphological features, with the same flowering time in some types. As they occur in the same area and have the same chromosome number and similar anatomical features and pollen-morphology it appears quite likely that hybridization in nature between the two species has played an important role in the evolution of the mangoes*.

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EDUCATION IN GERMANY WITH SPECIAL REFERENCE TO THE SYSTEM OF CHEMICAL EDUCATION

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WHEN we come to look at the list of Nobel Prize winners in chemistry we are surprised to find that among the 40 recipients of the prize from the year 1901 to 1939; 15 are German and 3 are Swiss. I mention the number of the Swiss winners as the method of instruction in Swiss educational centres is of the same type as in the German scientific institutions. That almost half the Nobel Prizes in chemistry should go to practically one country cannot be attributed to mere chance nor can it be attributed to climatic effect or racial superiority of the people. There must be some fundamental causative factor for the remarkable efficiency of the Germans in the field of chemical science. The secret of success of the German people lies in the very high standard of their method of instruction inaugurated by men of genius like; Liebig Hofmann, Kekulé, Baeyer, Emil Fischer and others, and steadfastly maintained in the foremost chemical institutions of the country.

Now I should like briefly to describe here the educational system in Germany, laying special stress on the instruction in chemistry that obtains in the German scientific institutions.

In Germany education of children begins in the primary schools or 'Volkschule'. In the 4-year course children from the age of 6 to 10 learn reading, writing, simple calculation, domestic science and religion.

Next they join high schools 'Oberschule' or 'Gymnasium'. In Switzerland these schools are known as 'Mittelschule' or middle schools which offer 6-year course for students of the age from 13 to 19 years. The Gymnasium provides 9-year course in which pupils from 10 to 19 years of age learn Latin, French, English, German, sometimes Greek, including literature. Mathematical course consists of arithmetic, algebra, geometry, trigonometry, arithmetical and geometrical progressions, fundamental principles of spherical trigonometry as well as differential and integral calculus. Biology and chemistry are also included in the course. Chemistry is divided into general inorganic chemistry, fundamental conceptions of organic and physical chemistry. Principal topics to inorganic and physical chemistry are : chemistry of water, of lime and mortar, carbon-dioxide and a few other well-known metals and non-metals, stoichiometric fundamental conceptions, io-

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nic reactions, introduction to the modern conceptions on the structure of atoms as well as co-valent and electro-valent combinations. Introduction to organic chemistry includes fermentation catalysis, hydrocarbons, alcohols, organic acids, esters, carbohydrates, di-and polysaccharides and proteins. The practical course consists of simple inorganic analyses, esterification, nitration, saponification, etc. The course of physics includes mechanics, optics, acoustics and electricity. There are theoretical and practical exercises in chemistry and physics. Besides one has to study general and economic geography of all countries, history of German and other European countries, religion and history of the Church, artistic and technical drawings, history of fine arts, music and gymnastics including sports. The student has to appear in the oral and written examinations in these subjects. This school-final examination is a strict one, and is called "Reife-Prüfung", "Maturum' or "Abitur". The written examinations are organized by the Ministry of Education and the oral examinations take place in the presence of the ministerial staff. After passing his 'Abitur' the student is entitled to higher studies either in the University, in the technical Hochschule or in the Akademie. An Akademie generally imparts training in fine Arts and Music.

In the University there are the following faculties:-

(1) Philosophical Faculty and Faculty of Natural Sciences,
(2) Medical Faculty,
(3) Legal Faculty, and
(4) Theological Faculty.

The Philosophical Faculty deals with German, English, Sanskrit and other languages and literature as well as history, philosophy, etc. The Faculty of Natural Sciences, on the other hand, is divided into chemistry, physics, mathematics, geology, zoology, botany, etc.

The Technische Hochschule is composed of two faculties :

(a) Faculty for Applied Sciences. (b) Faculty for Pure Sciences.

The following subjects fall under the former category :

(1) Construction of Machine and Apparatus,
(2) Electrotechnique,
(3) Building Engineering,
(4) Land Survey, etc.,
(5) Agriculture, and
(6) Fermentation and Brewery.

To the Faculty of Pure Sciences belong :

(1) Chemistry, (2) Physics, (3) Botany, (4) Geology, Minerology, and Mathematics.

The scientific subjects (1, 2, 3, 4) taught in the Hochschule are mainly of the applied type. The outlook of the Hochschule is oriented to a practical point of view. The University on the other hand cherishes the advancement of fundamental science.

The president of a Faculty is known as "Dekan" and the president of a Hochschule or a University is called a "Rektor".

The system of education adopted in the University is described in brief below :

University study leads to the degrees of Dr. Phil. II. or Dr. Chem. The principal subject may be any one of the natural sciences. We should here concentrate our attention to the course of studies required for Dr. Phil. in chemistry. The frame work of the study consists of practical work.

(*a*) Analytical Chemistry : Carrying out of a certain number of inorganic qualitative analysis : metals, anions; technical analyses, the alloys. When the student has performed satisfactorily the prescribed number of analyses and experimental work he is allowed to undertake quantitative analytical practical work. Here also he must carry out a fixed number of gravimetric, colorimetric, titrimetric and potentiometric estimations. On successful completion of all these (duration 2 to 4 semesters) the student must appear at the theoretical oral examination in analytical chemistry (individual examination lasting for 30 minutes). If he passes these examinations he is allowed to take up preparations of organic compounds.

(*b*) The student has to prepare here 10 inorganic and 34 organic preparations, and further he has to synthesize 5 dyestuffs and correctly to solve 5 organic analyses. If he performs this course satisfactorily in 3 to 4 semesters he must appear at an examination in organic practical chemistry (Methods : aliphatic; aromatic, and heterocyclic chemistry in fundamentals. Individual examination oral, lasting for 30 minutes). When he has passed this course he must take during the vacation a three week's course in microanalysis. He must learn the handling of microbalance as well as the micro-determination of CH-, N-, $-OCH_3$, active hydrogen, acetyl, C-methyl and so forth. If he has satisfactorily gone through this course he is entitled to take up his doctorate work, which generally takes 4 to 5 semesters' time. This consists of an independent research work under the guidance of corresponding Dozent.

Besides this practical frame work, side examinations in other branches are also required. Along with his attendance in the general and special lectures in chemistry the student must also occupy himself with other branches of natural science. Before doctorate examination the student has to go through 3 examinations in other branches and this must not be before 5 years of his doctor-examination. For a student of chemistry, mathematics and physics are compulsory. Besides he is to take one of the following subjects—mineralogy, geology, physiology, zoology and botany. All examinations are oral—each test lasting for 30 minutes. Mark below 40% are not counted. Marks above 60% are considered as marks of distinction. When a candidate has passed all these examinations (when one of them is not sufficient he can repeat it once more), he is entitled to present his dissertation. If the dissertation is approved by the Faculty he must be

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prepared for the final examination within 6 months. For a student of organic chemistry this examination consists of : physical chemistry, oral 30 minutes; organic chemistry ; written 4 hours and oral 1 to 2 hours. A candidate desirous of doctorate in physical chemistry has naturally to take a short course in organic chemistry.

In the University, before doctorate degree, generally no diploma is given. In some German Universities, however, the student has to pass diploma examination (8 semester course) to qualify himself to take the doctorate course. When the performance of a student has been specially good (all examinations with marks above 60%, and dissertation also very good) it may be mentioned in his diploma (distinction) but no addition is made to his title. After his doctorate degree a student acquires no other distinction or degree.

As the first step to academic career he must be associated with a professor as Dozent. This stage is known as Habilitation Period. He must now publish a series of good work and conduct a long habilitation work and submit an inaugural dissertation. The corresponding Faculty decides the acceptance of this dissertation or 'Habilitationsschirft'. The student is now eligible for academic facilities; and is entitled to give lectures as a recognized 'Privatdozent' at the University. He is not yet a professor but if there is any vacancy he may be nominated or appointed to the post of a professor. In the teaching line in the University or Hochschule the following grades of service exist :

(*a*) Privat-Dozent;
(*b*) Ausserordentlicher Professor,
(*c*) Ordentlicher Professor.

Technische Hochschule offers facility for the diploma of Chemical Engineer in 7 years. Here the annual courses are strictly and properly organized. After two years' study the student must appear at the first preliminary diploma examination in four subjects, conducted orally. After another 2 years he is to sit for the second preliminary diploma examination. This is also conducted orally, but in a number of subjects. The student has then to undertake a short diploma work, which is naturally of much lower standard than the doctorate work. When this is completed, he appears at the final diploma examination consisting of both oral and written papers. The diploma of the Hochschule (as of the Eidgenossischen Technischen Hochschule of Zürich) is a highly prized one. After getting his diploma an ambitious student can devote another 2 years or so for doctorate work there. For this he is to submit a thesis and to sit for the doctorate examinations—oral and written. Dr.ing, Chem. or D.Sc. of the Hochschule and Dr. Phil. II of the University are absolutely equivalent degrees.

In addition to the prescribed courses mentioned above; a 'Doktorand' (candidate for doctor-degree) must read a few papers on some notable chemical problem of the day in a colloquium, where all the 'Doktorande', 'Dozenten' and professors of the allied subjects of the institution assemble together.

The higher students have also got opportunity to attend lectures in the chemical society arranged once every week.

We have already noticed the difference between the function of the University chemical institutes and Technische Hochschule. There is, however, another category of institutions which are mainly concerned with technical training. In Switzerland there are two such institutions—one at Winterthur and the other at Burgdorf. No Middle School attendance or school-leaving certificate is necessary for admission into these institutions. They impart purely technical training in different subjects to youngsters. The course of instruction varies from 2 to 4 years.

Besides the technical training received at such a 'Technikum', a young man may avail himself of the facility to qualify himself as a 'Laborant' (laboratory assistant). To attain this end the candidate must be associated with an eminent chemist (a professor or a research chemist) for a 3-year course. After this apprentice training period he must pass the prescribed tests to become a recognized 'Laborant'.

It is needless to mention that people trained in this way add greatly to the efficiency of the academic or industrial laboratories of the country.

The system of chemical education in the Swiss University institutions and Hochschule is practically the same as in the corresponding German institutions. In both the countries after the 'Doktor Diplom' no further academic recognition exists.

As it is almost impossible at the present time to visit German chemical institutions on account of political restrictions, the Indian students would do well if they visit Swiss chemical institutions. But the students must acquire a working knowledge of German before they start for Switzerland. The minimum expenses for board and lodging at Zurich amount to about 225 to 250 Swiss Franks (Rs. 100-85 S.F.) The student has again to spend additional 50 to 75 Franks for tuition fee and the cost of the chemicals and apparatus he has to use per month.

While describing curriculum I have used the term semester. Their academic year is divided into two semesters— summer and winter semesters. The research is organized on the pattern of a routine manufacture. One can traverse step by step without any loss of time. Standard equipments like high vacuum pumps, hydrogenation and ozonization apparatus, equipments for microanalysis, the ultraviolet spectrograph, spectrophotometer, microhydrogenation apparatus, pressure hydrogenation apparatus, thermostat etc. arye always ready at hand. The expert pharmacologist is also not wanting in this picture. A new chemical compound is prepared today and by to morrow evening all the relevant physical and chemical constants of the compound are ready at the worker's desk. Unless such facilities are forthcoming no progress worth the name can be expected in any branch of practical science today.

The library facilities are equally great and commendable. Any recent journal or book and any old

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reference book including patent literature of every land are within easy reach of every student.

This brief account is written in the hope that the gifted persons at the helm of our educational affairs will come forward to remodel the existing system of chemical education in a way which will facilitate positive progress long overdue in this most important branch of natural science upon which rests the well being and prosperity of our newly awakened nation. We are quite confident that given proper facilities and efficient organization of our institutions for higher chemical studies and research, the present and coming generation of our chemistry students will not fail to give a good account of themselves and will significantly contribute to the advancement of chemical science in the country.*

*In fine I should like to express my deep sense of gratitude to Dr. Robert Schwyzer, privat dozent to Professor Paul Karrer, to Dr. H. Oeppinger of the I.G. Farbenindustrie, Hoechst, and to Dr. C. Schuster of the Badiche Anilin und Sodafabrik, Ludwigshafen, Germany for the help they extended to me in this connection.

TOTAL SYNTHESIS OF ESTRONE AND ITS ISOMERS*

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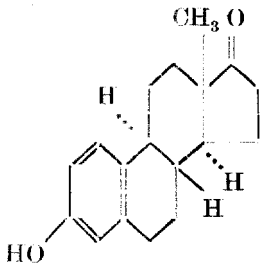
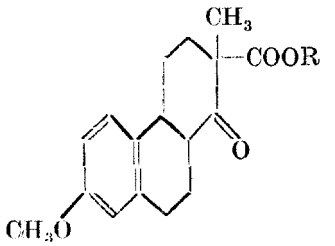
COLLEGE OF ENGINEERING & TECHNOLOGY, JADAVPUR

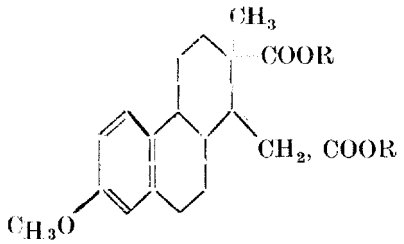
THE first total synthesis of the naturally occurring sex hormone estrone (I) was achieved by Anner and Miescher[1] in 1948. The programme of this synthesis which was finally made successful by the Swiss workers was initiated by Robinson and coworkers[2] as early as 1935 and considerable progress was recorded in 1938, when the conversion of the key compound-keto-ester (II) to the diacid (III) was reported[3].



I



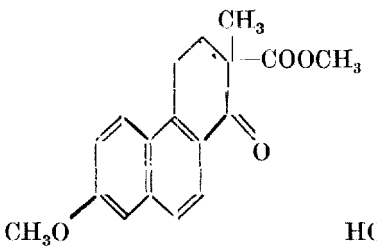
II



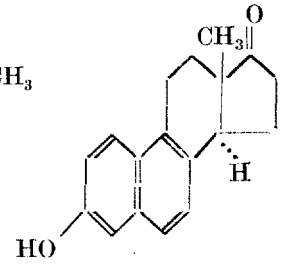
III

R = — H or — C_2H_5

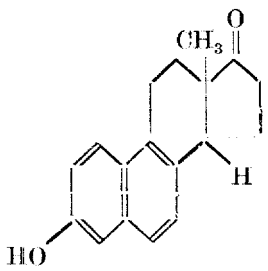
In 1940 Bachmann, Cole and Wilds[4] in America announced the first total synthesis of a naturally occurring sex hormone equilenin.† This classical piece of work can be considered as a triumph of technique in the synthetic organic chemistry. In this synthesis keto-ester (IV) was converted into *d*, l-equilenin (V) and *d*, l-isoequilenin (VI) through a series of steps, all of which were attended with very high percentage of yield. Following the same sequence Bachmann, Kushner



IV



V



VI

and Stevenson[6] in 1942 succeeded in synthesizing a stereoisomer of estrone, "estrone a" from the keto-ester (II), which was prepared by a method somewhat different from that of Robinson *et al.* In their successful synthesis of natural estrone Anner and Miescher have used essentially the same scheme as Bachmann *et al*; but they have exhibited exceptional skill and thoroughness in isolating three out of four possible racemic isomers of II. Conversion of all these isomers into six of eight possible racemic forms of estrone, estrone *a-f*, have now been reported[7]. This includes natural estrone, estrone *b*.

Very recently a completely new synthesis of natural estrone and remaining stereoisomers *g* and *h* has been reported by Johnson, Banerjee, Schneider and Gutsche[8]. Investigation on this synthesis started with the successful conversion of α-decalone (VII) to *trans* 8-methyl-hydrindanone-1 (VIII) by Johnson[9].

*Based on a lecture delivered at the Indian Association for the Cultivation of Science.

† Since then two different syntheses of equilenin have been reported by Johnson and coworkers.[5]

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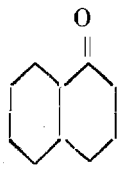
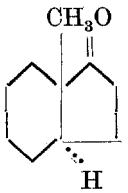
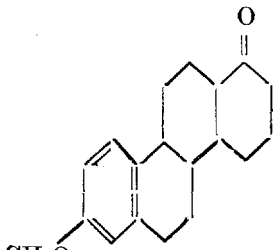
This model experiment was carried out with a view to applying similar reactions to the terracyclic ketone (IX) for its conversion into estrone molecule. Starting



VII

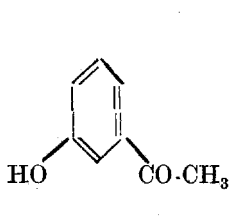


VIII

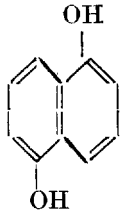


IX

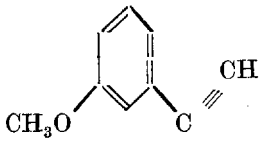
materials for the preparation of IX are m-hydroxyacetophenone (X) and 1, 5-dihydroxynaphthalene (XI), both of which are easily available cheap products. X and XI were respectively converted into *m*-methoxyphenylacetylene (XII) and 1, 5-decalindione (XIII). Latter two compounds were condensed, reduced and dehydrated to give the unsaturated ketone (XIV) in 70% overall yield. Cyclisation of XIV was carried out with hydrogen chloride and aluminium chloride in benzene solution and an oily mixture was isolated, from which were crystallized in about equal amounts two stereoisomers of IX. Both these isomers were converted into corresponding benzal derivatives, which were methylated to yield four different angularly methylated stereoisomers in conformity with the previous observation during the model experiment on α-decalone. All these methylated benzal derivatives were oxidized with ozone to corresponding *d*, 1-homomarrianolic acid methyl ethers. Latter dibasic acids on ring closure and demethylation yielded estrone *b* (natural estrone), estrone *d* (previously isolated by Miescher) and new isomers estrone *g* and *h*.



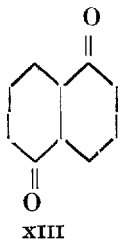
X



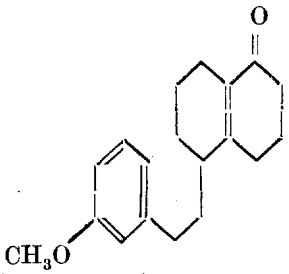
XI



XII



XIII



XIV

Total synthesis of all possible stereoisomers of the estrone molecule may be regarded as unique achievement in the history of organic chemistry and will provide immense impetus in future for the synthesis of more complicated molecules in the steroid field.

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5 Johnson, Peterson and Gutsche, *ibid., 69,* 2942, 1947; Johnson and Stromberg, *ibid., 72,* 505, 1950.
6 Bachmann, Kushner and Stevenson. *ibid., 64,* 974, 1942.
7 Anner and Miescher, *Helv. Chim. Acta., 32,* 1957, 1949.
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9 Johnson, *ibid., 65,* 1317, 1943; *ibid., 66,* 215, 1944.

ATOMENERGIE AND ATOMBOMBE *

EINSTEIN wrote a letter to President Roosevelt on August 2, 1939, outlining some of the potentialities of atomic energy including the atomic bomb. There was an initial grant of 6,000 dollars for beginning the work and it reached the final total of two billion dollars for making the bomb. Since 1940 the United States Government has invested 4.5 billion dollars in this project, a sum which exceeds the total national debt since 1918. This does not include the cost of the projected hydrogen bomb.

On December 2, 1942, the first controlled atomic pile started working at the University of Chicago. On 16th July, 1945, the first atomic explosion took place in the deserts of New Mexico under the supervision of Dr. J. R. Oppenheimer, who as a student of the *Bhagwad Gita* (he read Sanskrit with Aurthur Ryder, whose delightful translation of the *Panchtantra* is available in a cheap edition) was reminded of the *shloka* in the 11th chapter mentioning the splendour of a thousand suns. This test practically demonstrated the

*By Dr. Friedrich Dessauer, Professor of Physics, in the University of Freiburg, Switzerland, (2nd onlarged edition, 342 pages, published by Verlag Otto Walter Ag Olten: in German).

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possibility of a chain reaction for atomic explosion when fissionable material exceeded a certain critical mass.

On August 6, 1945, the first atomic bomb (uranium 235) was dropped on Hiroshima. Two days later a plutonium bomb fell on Nagasaki. This was followed by two atomic explosions in peace time for the Bikini tests.

Plutonium was first produced in U.S.A. from an atomic pile in January, 1944, and a start was made with only half a milligram to study its chemistry. As a result of it the Hanford plant came into operation for the production of plutonium. It also occurs, as has recently been revealed, natrually in traces with uranium, but is not available in sufficient quantities to dispense with its preparation from an atomic pile.

The book appeared in its 2nd edition as a result of the great interest aroused by atomic energy and atomic bomb, and was published simultaneously in a French translation at Neuchatel. It deals with the developments up to the Bikini tests or the 5th atomic explosion, and does not envisage the development of the thermal-nuclear bomb, the so-called superbomb or the hydrogen bomb, which requires an atomic explosion to furnish the high temperature of about 20 million degrees for synthesizing helium from ordinary or heavy hydrogen provided in the elementary stage or from lithium hydride. On the contrary, the author holds that it is "certainly without prospect" (page 89) that it should be possible to form helium from neutrons and protons with the energy levels obtainable on earth. The book needs third edition to be topical and to catch up with the long strides made by science since it appeared last, and also stands in need of a further revision as it has here and there sentences without verbs and some misprints, as on page 7 in the foreward to the 2nd edition 'Muge' is printed in place of 'Muhe', on page 40 'proved' is spelt 'prooved', on page 132 it is wrongly stated that ordinates show isotopes, on page 190 at the bottom in place of 'm_{-2}-m_{-1}' is printed m_{-2}-m_{-2}, on page 196 in discussing the critical mass for starting a chain reaction is printed $\frac{\gamma 3}{\gamma 2}$ in place of $\frac{\gamma^3}{\gamma^2}$, on page 248 in place of uranium (238) is printed uranium (236), on page 269 'v' is omitted from $20V_2^2$, on page 303 'particles' is spelt 'particels', in the Index graphite as moderator is referred to page 186 wrongly in place of page 157, Fermi is spelt Faemi, J. J. Thomson is spelt Tompson but on page 274 as Thompson. Lise Meitner is sometimes spelt Liese Meitner in the book. Hitler is quoted in the text (page 320-321) but the author has consigned him to oblivion by omitting him from the index where Mr. Winston Churchill is mentioned. It is not revealed if it is because Mr. Winston Churchill is a Fellow of the Royal Society.

As stated in the foreword, only elementary mathematics is used in the book and no more knowledge of physics is assumed on the part of the reader than is available to a student of physics early in college. The book consists of 12 chapters and is generally very readable. In the first eight chapters, it gives an easy background for understanding the production of atomic energy. It treats in an interesting manner such subjects as cosmic ray radiation, electro-magnetic waves, inter-connection between matter and energy, protons, neutrons, materialization of energy, elementary particles, Einstein's Law Equivalence, particle reactions and nuclear reactions etc. It has instructive tables, figures and graphs. At the head of chapters it has neat pen drawings of scientists, and there are also some photographs in the book. The place of honour is rightly given to a portrait of Professor Otto Hahn at the beginning of the book, but just behind it is the photograph of an anonymous scientist standing near a 7mev beam of protons from a cyclotron in Rochester, U.S.A. One wonders who he is and has to read 290 pages to discover that the young man remarkable for a luxuriant growth of hair on his head is the author's son. Like the usual run of Swiss publications the get-up and type of the book are good, and make one wonder when Indian printers and publishers would attain this standard of book-making for ordinary publications.

The author touches upon the question about why the Germans lagged behind in manufacture of the atomic bomb (pages 153-154, and 320-321). The allies had in the continent of America a land without a blackout and without bombing. Their laboratories were not destroyed or damaged by aerial bombing, as repeatedly happened at Peenemunde. Their transport was not destroyed or damaged. There was no scarcity of essential raw materials. Besides, the Nazis persecuted their top ranking scientists who were not Aryans. Hitler stated early in his career, when a scientist protested to him against this kind of persecution, that Germany could do without Physicists for a few years. Einstein went to America. Lise Meitner, a collaborator of Dr. Otto Hahn left Germany. Prof. Hans A. Bethe left Tubingen for the U.S.A. where he later worked on the atomic bomb project at Los Alamos. Prof. Fermi left Italy for the United States, and Prof. Niels Bohr left occupied Denmark for the United States and, like so many others, helped in making the atomic bomb. Other scientists who were in Europe were unwilling to put such a terrible weapon in the hands of the Nazis and very few of the eminent German scientists were Nazis. The author wisely leaves this question for those concerned to answer.

The last chapter has the title "Reflections, Fundamental Questions, Questions of Life, and Question for Humanity". The reflections are not deep and in fundamental questions of philosophy the author is naive and says :

"The natural laws that the research worker finds and expresses are more than mental concepts (Gedankendinge). For if they were only these, and if in the laws and equations there were not truly contained a representation of the reality of nature, how could it be that our machines in fact produce what they are meant to produce, that medicines heal, soothe pain, bring sleep, that our fields produce fruit four and five fold, that aeroplanes fly, that electric light brightens our

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nights, and that, it must be mentioned, the new weapons kill and destroy so frightfully? Is the atomic bomb real? If it is not, but is only a mental concept, why are the Japanese towns destroyed? If it is real then this reality is born of intelligent thought and thinking beings, and the power that resides in them is not of men but the discovered power of nature". (Pages 317-318).

It is to be noted that real and reality have been used with different connotations indiscriminately. The author seems to be unconcerned about analysis of perception and of phenomenon, of the methods and limitations of knowledge, and the views on such subjects of Einstein and Planck, Hume and Kant, Eddington and Jeans, not to mention a host of others. They cannot adequately be discussed in a review of this book, but suffice it to say that they make no such claim for science and scientific laws and hypotheses. When more than one hypothesis or equation can cover the same facts it is a tall claim that reality is confined in any one of the conceptual representations. One need not be a *vedantist* to realize that sense perception, imagination and reason, that is science, can never know the universe as it really is. Such fundamental questions are best left for epistemology and metaphysics. It should be apparent to any student of the above quoted paragraph of the author that the destroyed Japanese towns were as much mental concepts (or reality) as the atomic bombs that fell on them, and the same applies to the machines and the goods they produce as to the medicines and the aeroplanes.

On page 325 the author goes religious and says that all scientific advance is the Revelation of Reality by the Creator on communion. This kind of cheap claptrap and frothy mysticism is best left out of a scientific book.

The author does not mention even casually the question of scientific freedom that is agitating so much the research workers and is making them resentful of State control and glice surveillance. It is also hindering scientific advance as science cannot thrive in a stifling atmosphere that denies freedom of association and discussion to the workers.

V. P. Chandra Gautama.

Notes and News

NADI BIJNAN MANDIR

Dr. B. C. Roy, Chief Minister of West Bengal, laid the foundation stone of the central laboratory of the River Research Institute (*Nadi Bijnan Mandir*) at Haringhata on the Ganges, about 32 miles from Calcutta, on May 21 last before a distinguished gathering of scientists, experts, engineers and Ministers of State. Sri Bhupati Mazumder, Minister, Irrigation and Waterways presided.

Laying the foundation of the Institute, Dr. Roy recalled that a few years back, the people of Calcutta were alarmed at the news that the Bidyadhari River, which used to carry the refuse of the city, was silting up. People in Bengal had then little knowledge of rivers and finally, the Calcutta Corporation had to reorganize the sewage system. Subsequently the river dried up. The maritime Port of Calcutta is at present not in a happy position because of the rising silt and sand deposits. The Port Commissioners are thinking of a ship canal from Diamond Harbour to Kidderpore docks.

A number of swamps, the Chief Minister added had been formed in West Bengal affecting the health of the people and to remedy this, resuscitation of Bengal's drying rivers is essential. The laboratory of the River Research Institute was now opened to help revival of these rivers.

Dr. Roy expressed the hope that the various river projects in India as also in other countries of the world would be benefitted by the results of research in this laboratory.

The Institute, which was opened in 1943, has carried out studies with models of different river projects in India and of many contemplated railway bridges. Following its findings, many changes have been made in the designs of various dams and barrages.

Speaking on the occasion Dr. N. K. Bose, Director, River Research Institute, West Bengal said that after the partition of Bengal the Bhagirathi occupied the most important place among the rivers that had fallen in the State. In the olden days the Bhagirathi was one of the main courses of the Ganga. A number of prosperous towns had grown up on its banks, such as Berhampur, Ajimganj, Nawadwip, Katwa, Hooghly. With the diversion of the Ganga from Bhagirathi course, the importance and prosperity of these towns also decayed.

During the British rule, said Dr. Bose, industrial centre grew up round about Calcutta. Ships full of merchandise sailed into the port up the Hooghly and delivered them at the docks. From there these merchandise spread over the whole of north, west and east of India and also beyond its borders into Nepal and Tibet. The importance and prosperity of Calcutta

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and for the matter of that, of the whole of West Bengal now depended principally on the Bhagirathi and its estuary the Hooghly.

The Bhagirathi has been gradually drying out. It is now extremely difficult to keep this estuary in a living condition. It may be possible by artificial means to keep the Hooghly going for a few years but the expenses would be high and its repercussion on the health of the surrounding country would be difficult to foretell. Flowing rivers keep the countryside full of health, wealth and prosperity whereas artificial means may keep the estuary living but cannot maintain the health of the country.

Explaining the problems of the rivers that were facing the State, Dr. Bose said that to study and solve them on the same lines as were done in the West the idea of establishing the River Physics Laboratory in Bengal was first expressed by Dr. Meghnad Saha in Sir P.C. Roy Commemoration Volume in 1932 and Sri S. C. Majumdar in the National Institute of Sciences of India symposium lecture on river problems in Bengal.

The selection of the site at Haringhata was due to the fact that it had the great advantage of an unlimited supply of clear water and cheap electricity. An area of 320 acres had been set apart for the Institute.

VETERINARY RESEARCH AND ANIMAL HUSBANDRY

The tenth All India Veterinary Conference was held at Bombay from April 25-27, 1950. Dr. S. Datta, Director, Indian Veterinary Research Institute, Mukteswar-Izatnagar presided. In his presidential address Dr. Datta made an earnest appeal to all veterinarians to vitalize the activities of the profession and emphasized the essential unity underlying the vast problems confronting Veterinary Husbandry workers. He deprecated the tendency to separate the problem into loose compartments of Animal Husbandry and Veterinary Science, and pointed out that "Experience has repeatedly shown that whenever the problems have been separated into the loose compartments of Animal Husbandry and Veterinary Science, interests have clashed and improvements been retarded. After all, an animal forms one biological entity, and the ideal that its evolution can be brought about by divided administrative units is irrational and unsound".

Referring to the role played by livestock in the economy of the country, and how greater weatlh and well being of the country are linked with animal husbandry improvement, Dr. Datta observed: "By providing transport for agricultural produce, it is estimated that cattle contribute annually approximamately 160 crores of rupees, while by way of cattle labour for agriculture, India gets about 300-400 crores of rupees every year. Our cattle produce about 1,000 million tons of dung per annum, nearly 67% of which is burnt as fuel whereas the rest is available as manure. Assuming a value of even Rs. 10/- per ton, the total worth comes to about 1,000 crores of rupees. India provides 480 million maunds of milk per year, of which half is converted into *ghee*. The price of this amount of milk products may be conservatively estimated at 750 crores of rupees. The amount of meat consumed in India is about 216 lakh maunds. Its value may be put down at 130 crores of rupees. The number of eggs produced is over 300 crores per annum, so that they also bring about 30 crores of rupees. Annually 583 lakhs of hides and skins are produced in our country, whose value is over 40 crores of rupees. The annual production of wool is about six lakh maunds, whose wholesale price is about 3 crores of rupees".

Comparing the income derived from livestock with that from several industrial commodities like coal, which yields only 500-600 crores and steel, which yields only 10 crores, over which much money is spent and a good deal of effort is being expended, Dr. Datta observed that they fall a large way behind the somewhat underdeveloped and neglected Animal Husbandry of the country, so far as national prosperity is concerned.

Referring to the steps that are being taken to control live-stock diseases and to the problems connected with animal nutrition, Dr. Datta remarked that while these short term policies can help to increase the efficiency of our animals to a great extent, maximum benefits can only accrue if scientific systems of breeding are taken recourse to bring about improvement in their genetical constitution, so that it will be feasible to reduce the number and yet to produce greater efficiency. This will reduce the cost of the animals as well as of the commodities produced from them, so that it will be possible to bring milk, eggs and woolen articles within the reach of the common man. Any effort spent in this direction will be the surest means to safeguard the public health.

In our Constitution it has been laid down said Dr. Datta that "the State shall endeavour to organize agriculture and animal husbandry on modern and scientific lines and shall in particular, take steps for preserving and improving the breeds, of...cattle", but unfortunately the total amount spent on Veterinary and Animal Husbandry projects at present is only 0.08 per cent of the total budget grants.

Laying before the country an ambitious programme of all-round development of verterinary husbandry in all its aspects of conservation, improvement and utilization of livestock, so that our country may be free from epizootic diseases, and the animal might be fed properly and we might have better and more efficient breeds, Dr. Datta spoke of the dearth of properly trained and equipped personnel for this gigantic task. India has about only 10 veterinary surgeons per million head of livestock compared to 35 and 248 respectively in the United Kingdom and Switzerland.

Dr. Datta also referred to the need for reorganizing Veterinary education in the country and urged for the creation of an Indian Veterinary Council which should be a statutory body set up by Act of Parliament. This Council could enforce a certain high standard in all the Veterinary Colleges. It could interest the Central Government to create an All-India Service of Veterinarians

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from which the States could draw in times of emergency. It could also act as the coordinating factor between the various State veterinary departments. Finally, it could put down all quackery in the veterinary profession.

TERRAMYCIN

Streptomyces rimosus, an actinomycete isolated from soil was found to produce an active agent effective against a variety of Gram-positive and Gram-negative pathogens. A team of scientists of Chas Pfizer & Co. Inc. U.S.A. spent several months to obtain a pure crystallin substance from the metabolic filtrate of this microorganism and it is now coming to the world market as a medicine for whooping cough, syphilis, gonorrhoea, and amoebiasis. It is hopeful that the drug shows a very low degree of toxicity in experimental animals. The well known antibiotics streptomycin, aureomycin, chloromycetin and neomycin are all products of different species of *Streptomyces* and this is a new addition to this group of antibiotic agents. (*Science*, *85*, 111, January 1950).

CANCER STUDY ISOTOPES FREE OF CHARGE

The U.S. Atomic Energy Commission has announced that it will make available without charge to qualified cancer research workers in the U. S. all radioisotopes now being sold. Under the program of the AEC, three radioisotopes—those of iodine, phosphorus, and sodium— were available free of production costs for use in cancer research.

The new policy will make available on a free basis the radioisotopes of more than 50 additional elements. Notable among these are cobalt 60, which promises to become an effective substitute for radium, and the radio isotopes of gold and carbon.

The new program has been made possible through the improvement of isotope production techniques at the Oak Ridge National Laboratory, Oak Ridge, Tenn., and at the Argonne National Laboratory, Chicago, III. A sum of $450,000 has been set aside to defray the cost of the new program during its first year of operation. The free isotopes will be allocated for the following purposes: (1) cancer investigations involving animal subjects, (2) research programs studying basic cellular metabolism of cancerous cells, and (3) experimental programs designed to evaluate the therapeutic use of radioactive materials. The only charge to be made will be a nominal $10 for handling. In those cases where the isotopes are synthesized into a chemical compound, the user will be required to pay for the cost of synthesizing the compound but not for the radioisotopes. The same controls over distribution program now in effect will be continued. (*Chemical and Engineering News*, March 7, 1949).

PALAEOBOTANY IN INDIA

The Seventh report of the progress of Palaeobotany in India edited by Dr. R. V. Sitholey of the Birbal Sahni Institute of Palaeobotany shows promising achievements of our Palaeobotanists both in Pure and Applied Research. This is the first issue of the *Bulletin* since the death of its greater Founder—Editor, late Prof. B. Sahni. It is encouraging that the publication of the *Bulletin* is being continued for the benefit of the workers here and abroad.

About eighty-one Abstracts and Reports of papers cover a wide range of plaeobotanical investigations with collections from Pre-Cambrian and Cambrian to Pleistocene. There are a few additional notes and news mostly relating to the activities and organization of the newly created Institute of Palaeobotany.

The growing interest in microfossils among the workers in this country is a noteworthy feature. About one-third of the papers are devoted to this subject. This shows a strong bias to Applied Research specially with reference to the problems of dating, correlation of coal seams and geological rock successions for prospecting work. It is certainly a promising indication towards the development of other aspects of Applied Micropalaeobotany in India, namely exploration of coal seams in unproved area, determination of the nature of coal from its contained microflora as a part of physical and chemical survey of Indian coal, use of microflora in petroleum, approaching ecological problems with news ideas, and the manifold prospects of Palynology as outlined in one of the abstracts of the *Bulletin* by the Late Professor Birbal Sahni.

The notable contributions to Micropalaeobotany include examination of control rock samples from the Cambrian strata of the Salt Range with reference to further observations on the Age of the Saline Series problem, of dating Barmer sandstone, correlation of coal seams at Bokaro coal field and Tertiary succession in Assam, and some articles by Professor Sahni, on the possibilities of Microfossils in Applied Research with reference to India.

Unfortunately the *Convenor* and the *Editor* of the *Bulletin* have overlooked a number of important papers on the correlation of coal seams, and problems relating to dating with special reference to the examination of control samples by workers in Calcutta. This type of ommission may obviously hamper the purpose of the *Bulletin* for which it is meant.

The Abstracts of papers on impressions and petrifactions include important observations on the morphology of 2 species of British Carboniferous ferns, the new group of Jurassic gymnoperms—Pentoxyleae (already published), further examination of the Pleistocene flora of the Karewa formations in Kashmir, and records of a number of petrified trunks, fruits and impressions from different beds and localities. A short report on a petrified forest in Central India appears to be very interesting. Such places should be maintained under protection as Field Museums.

Apart from recording new facts as to the morphology and evolutionary tendencies of our past floras, the Palaeobotanists in India are gradually exploring the great economic possibilities in our microfossils following the workers in England, Holland, Germany, Sweden,

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U.S.S.R. and U.S.A. Progress of such work here has been nicely presented in the *Bulletin*.

Palæobotany has a great future in India, and this *Bulletin* under review assumes the responsibility for playing an important and unprejudiced role in co-ordinating Palaeobotanical researches carried out at different places of this country. (*Jour. Ind. Bot. Soc. 29*, 1-46, 1950). *J.S.*

SYNTHETIC RUBBER FROM TURPENTINE

A new type of high-quality synthetic rubber, made with a chemical derived from turpentine, has been developed at the Bureau of Agricultural and Industrial Chemistry. Under present conditions rubber from turpentine is somewhat more costly than GR-S rubber, stretches better, and generates less heat under stress. The resulting synthetic rubber has a tensile strength of about 3800 psi., will stretch to seven times its length, and in standard tests develops to 18° F. less heat under stress than similarly produced and compounded GR-S rubber.

Main ingredient of the new elastomer is isoprene, a compound that forms the basic molecular unit of natural rubber. It is obtained from turpentine by a special molecule-splitting process developed by Bureau scientists. Isoprene produced from petroleum is already used in some types of synthetic rubber now on the market. The Bureau's method of producing it from turpentine should be a valuable national asset in the event of emergency shortages of petroleum. (*Journal of the Franklin Institute, March*, 1950).

VERY THIN CRYSTAL OSCILLATOR PLATES

The increasing interest in high frequencies for radio communication is accompanied by a demand for very thin quartz crystal oscillator plates having fundamental frequencies up to 100 megacycles or higher. In crystals whose frequency is in the higher range, the thickness of the quartz plate determines the frequency ; the higher the frequency the thinner the crystal must be. A crystal with a fundamental frequency of 100 Mc is about 0.001 in. thick, and its surfaces must be parallel within a few millionths of an inch.

The usual crystal grinding methods and machinery have proven inadequate for producing plates of the required thickness. The National Bureau of Standards has therefore developed improved equipment, capable of producing 0.001 in. thick quartz crystals with a high degree of parallelism and flatness. The apparatus can also be used to produce equally thin wafers from a variety of other materials, for example, extremely thin dielectric plates for miniature radio condensers. (*Journal of the Franklin Institute*, March 1950)

MICROFILM READER AND THE MICROFILM PROCESS

A simple, inexpensive, and practical reader is available in the common box-type substage lamp used with a low power microscope. A piece of glass the size of the top, fastened at the ends with adhesive tape and raised so as just to permit the film to slide through, will hold the film steadily in focus. A magnification of about 10 × affords a visual impression slightly smaller than the printed original, and with wide-field oculars will accommodate a page at a time. With the substage viewer, perfect processing of the film is not important, because underexposed or overdeveloped films are still legible. The viewer may be used for perforated or non-perforated film as well as for 16-mm strips, which is not the case with some commercial readers.

Library equipment for microfilming is elaborate and expensive. For personal use 35-mm camera has proved satisfactory when provided with a supplementary lens to shorten the focus and with a focussing attachment for centering the field.

It is estimated that more than 25 billion records have been microfilmed during the twenty years that this process has been used.

A useful directory of microfilm services in the United States and Canada is available from the Special Libraries Association, 31 East 10th Street, New York City, which lists institutions, commercial firms, costs, stipulations and conditions concerning this important process. (*Science*, March 31, 1950).

NEW ACETYLATING AGENT

Isopropenyl acetate is a new chemical of great potential value in a number of syntheses. Characteristic examples are acetylation in which the mild and easily controlled conditions associated with this reaction recommend the reagent's use with many compounds otherwise difficult to acetylate ; reaction with alcohols and amines to form new esters or amides ; reaction with acids to produce anhydrides of unsaturated and aromatic acids and polymerisation to form either low molecular weight, viscous liquids or when co-polymerised with other monomeric compounds, solid polymers.

The acetate is prepared commercially by the reaction of ketone with acetone in the presence of an acid catalyst. This reaction is reversible and the original components may be readily obtained under the influence of heat and a suitable catalyst.

Isopropenyl acetate is a water-white liquid, specific gravity 0.9202 and boiling point (748 mm.) 96.6°C. Flash point is 14.5°C (58.1°F.). Normally the commercial grade, has an ester content of approximately 98-100 per cent.

The most valuable property of this new Industrial chemical is its ability to act as acetylating agent. Thus, from acetaldehyde and paraldehyde it is possible to prepare vinyl acetate ; from crotonaldehyde, 1-acetoxy-1, 3-butadiene ; from ethacrolein the monomeric substance 1-acetoxyisoprene and from acetophenone, a-acetoxystyrene. These are all polymerisable monomers which may be converted into commercially useful polymers. (*The Chemical Age*, April 15, 1950).

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THE ELECTROCHEMICAL SOCIETY, INDIA SECTION

The Inaugural Meeting of the Indian Section of the The Electrochemical Sociey, Inc. was held on March 23, 1950 at the Indian Institute of Science, Bangalore, in the presence of a distinguished gathering of scientists, engineers, industrialists and others.

Dr. B. K. Ram Prasad in his Inaugural Address on "Some Aspects of the Development of Electro-chemical industries in India", indicated that there were great possibilities for the development of these industries keeping in view the availability of raw materials, present output of electric power and future power development plans. The speaker felt glad that the Government of India had decided to establish an Electro-Chemical Research Institute at Karaikudi and expressed the hope that the Planning Commission recently set up by the Government would consider in detail the development of Electro-chemical Industries in India.

The following were elected officers of the India Section :

Chairman : Dr. B. K. Ram Prasad, Special Officer, Electric Grid Offices, Govt. of Bombay, Bombay; *Secretary-Treasurer* : Dr. T. L. Rama Char, Lecturer in Electro-chemistry, Indian Institute of Science, Bangalore.

The Electrochemical Society is an international organization founded in 1902 to promote the advancement of Electro-chemistry, Electro-metallurgy, Electrothermics, Electronics and allied subjects. The membership is well represented by scientists and engineers actively engaged in the various branches of Electrochemistry.

REWARDS FOR DISCOVERY OF URANIUM AND BERYL ORES

Rewards upto Rs. 10,000/- may be given for the discovery in India of deposits of Uranium ore by the Government of India. In the case of Uranium, the new deposits would have to be not less than 100 miles, and in the case of Beryl 50 miles, from any other deposits of these ores the existence of which is already known to the Indian Atomic Energy Commission.

The maximum value of this award is to be given for the discovery of deposits capable of producing 100 tons of Uranium Oxide in ore assaying not less than 0.4% U 308. A similar discovery capable of producing 100 tons of Beryl assaying not less than 12% BeO, or other Beryllium mineral in proportionate amount, may earn an award of up to Rs. 2,000.

Should new deposits of both ores, though not sufficient to be of economic importance in themselves, justify prospecting in the neighbourhood for further deposits, Government may grant funds for this purpose. Grants-in-aid for mine development are available to applicants who produce and deliver not less than 20 tons of Uranium ore and 50 tons of Beryl ore from a concession of mining lease not previously worked for these ores.

In order to help prospectors, the Atomic Energy Commission will make without charge tests of samples submitted, and where necessary, further chemical and field tests for determination of ores.

Applications for rewards should be addressed to the Secretary, Atomic Energy Commission, Central Secretariat, North Block, New Delhi.

TWO HUNDRED RESEARCH SCHOLARSHIPS INSTITUTED

In pursuance of the recommendations of the Scientific Manpower Committee, the Ministry of Education, Government of India, have instituted 50 Senior and 150 junior research training scholarships in universities and other educational and research institutions.

The objective of the scheme is to enable deserving and talented students to engage in scientific and industrial research and to acquire, as a result of such training knowledge and experience for holding research positions.

The scheme provides for two grades of scholarships tenable for a period of three years – senior scholarships of Rs. 200 per month and junior scholarships of Rs. 100 per month.

The Senior scholarships are available for advanced research in basic science and for post graduate research in engineering and technological subjects. The scholarships are to be awarded to research workers who have taken at least a Master's degree in science or a good degree for advanced diploma in engineering or technology.

The junior scholarships are available for research of comparatively lower standards at post-graduate level, and are to be awarded generally to those who have taken at least a good Honours' degree in science or a degree in technology.

In the terms and conditions governing the award of the scholarships, it is laid down that the heads of the institutions concerned shall make the award strictly on the basis of merit, subject to the approval of the Government of India. The grants on account of the scholarships will be given to the institutions concerned in quarterly instalments in advance, and the heads of the institutions will disburse the amount to the scholars at the end of every month. It is also laid down that the heads of the institutions will submit quarterly reports on the satisfactory progress of the work of the scholars to the Government of India. The continuance of the scholarships will depend upon the scholars making satisfactory progress with their work.

DEVELOPMENT PLANS FOR PUNJAB (1)

The Punjab (1) Government is getting plans ready to absorb the Bhakra-Nangal electricity output of 310,000 kw.

At present the State's entire industry can absorb little more than 55,000 kw. An additional output of 72,000 kw. to be generated next year by Nangal power

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is to be diverted to Delhi, Bikaner and U.P. At the moment, Mandi supplies 30,000 kw. and local thermal sets 25,000 kw. Next year, thermal sets are to stop functioning, and Mandi's power will be diverted gradually to Punjab (P). Ferozepore will receive its electricity from Mandi *via* Lahore.

If the State had planned earlier, it could have absorbed Nangal's energy in addition to that of Mandi. The use of Mandi power for home industries would have been far more profitable.

The Government has set up a planning committee of secretaries and departmental heads to study the report of the State's industrial commission. The committee will furnish the National Planning Commission with facts and figures regarding the State's agricultural and industrial potentialities.

The Government wants a trained mineralogist to survey the State's resources. Later a cabinet committee for the development of industry will be set up to consider a proposal to utilize 180;000 kw. from Bhakra. This will include the planning and creation of number of major and auxiliary industries within the State.

The committee will devote its attention to the planned development of cottage industries using power machinery. It will also draw up plans for the expansion of textile, handloom and sericulture industries. The State's supply of oilseeds would be used for manufacturing edible oils.

There is also scope for industries depending on raw products of agriculture. The sugarcane produce of the State could be utilized if the number of mills was increased. This alone would consume over 20,000 kw.

Means have yet to be devised to make trading conditions attractive to industrialists. Refugee industry is to be developed at the 12 industrial townships and also at the site of the capital; the combined efforts will consume about 55,000 kw.

DR. H. K. NANDI

Dr. H. K. Nandi, whose appointment as Director of Agriculture, Government of West Bengal was announced earlier (see *Science and Culture*, *15*, 396, 1950) is a distinguished alumnus of the Calcutta University.

Dr. Nandi graduated with Honours in Botany from the Presidency College, Calcutta in 1929 and later took his master's degree in Botany from the University College of Science, Calcutta in 1931. In his early years he worked under Prof. S. P. Agharkar, the then Ghosh Professor of Botany of the Calcutta University on the systematics and biology of the *Podostemaceae*. In 1933, Dr. Nandi proceeded abroad and joined the King's College, London where he worked under Dr. R. Ruggles Gates F.R.S, and obtained his Ph.D. degree on his thesis on the origin of the cultivated rice.

On his return to India, he was appointed Cytogeneticist, at the Bose Research Institute, Calcutta in 1936 and where he continued investigations on the interspecific hybridization of rice.

In 1938 Dr. Nandi was appointed Economic Botanist to the Govt. of Assam and since 1945 he has been serving as Deputy Director of Agriculture, Govt. of Orissa. He has thus acquired considerable experience on the crops of two contiguous provinces of West Bengal and it is hoped that agriculture in West Bengal will have a new orientation under his able leadership. Dr. Nandi has got 30 publications in different agricultural subjects to his credit some of which were published in the best scientific journals of the world.

ANNOUNCEMENTS

Prof. M. S. Thacker, Head of the Power Engineering Laboratory, Indian Institute of Science, has been appointed Director, Indian Institute of Science, Bangalore.

Under the United States National Student Association's Foreign Student Summer Project at the "Massachusetts Institute of Technology" the following have been awarded the studentship for 1950 tenable from June 6 to September 16, 1950. Sri G. Janaki Ram and Dr. S. Laha, Indian Institute of Science, Bangalore; Dr. A. N. Lahiri, Fuel Research Institute Digwadih; Dr. M. S. Sinha, Bose Research Institute, Calcutta; and Sri K. S. Venkatraman, College of Engineering, Trivandrum.

The M. I. T. has waived tuition costs for the students while expenses in U.S.A. such as room, board, books and incidental expenses will be borne by the Foreign Student Summer Project Committee. Air passage to U.S.A. and back for these candidates will be provided through the Fullbright Foundation.

Sri S. L. Tandon, Lecturer in Botany, Delhi University, has been appointed research assistant in botany at the State College of Washington, Pullman, Washington.

The 12th Annual Meeting of the British Association for the Advancement of Science will be held at Birmingham from August 30 to September 5, 1950. Sir Harold Hartley, President will deliver his address on Man's Use of Energy.

The 12th International Congress of Pure and Applied Chemistry will be held in New york City from September 10 to 13, 1951. On this occasion the American Chemical Society will celebrate its 75th anniversary from September 4-7, 1951, the International Union of Pure and Applied Chemistry will hold its 17th conference on September 8-9 and will close its conference in Washington where it will celebrate the fiftieth anniversary of the founding of the National Bureau of Standards.

President James B. Conant of Harvard University is Honorary President of the Congress. Further details may be had from Harry L Fisher, Division of Chemistry, National Research Council, 2101 Constitution Avenue, Washington 25, DC.

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The Second General Assembly and International Congress of the International Union of Crystallography will be held in Stockholm from June 27 to July 3, 1951. Further information may be had from Mr. R. C. Evans, General Secretary of the Union, Crystallography Laboratory, Cavendish Laboratory, Cambridge, England.

Dr. Ernest Zipkes, formerly head of the Department of Road Research, Federal Institute of Technology, Zurich (Switzerland) has been appointed Director of the Central Road Research Institute, Delhi.

The following research fellowships have been awarded by the National Institute of Sciences of India for 1950–52 :

NIS Senior Research Fellowships :

Mr. S. P. Basu, to work on "Some Physico-Chemical factors affecting fresh water fish cultural practices in India" at the All-India Institute of Hygiene & Public Health, Calcutta (For a year only).

Dr. Sukh Dev, for "Studies in Sesquiterpenes" at the Indian Institute of Science, Bangalore.

Dr. P. B. Mathur, to work on "Preventive Measures to eliminate the loss of vitamin C during storage in potato tubers" at the College of Agriculture, Banaras Hindu University, Banaras.

Mr. V. R. Thiruvenkatachar, to work on "Compressible Fluid Flow" at the Central College, Bangalore.

Imperial Chemical Industries (India) Research Fellowships :

Mr. C. Balakrishnan, for "Study of Internal Conversion Co-efficients of Radio-isotopes" at the National Physical Laboratory, New Delhi.

Dr. I. M. Chak, to work on "Preparation of Haemostatics from oil-seeds" at the Indian Institute of Science, Bangalore.

Mr. A. G. K. Menon, for "Ichthyological Studies with Special reference to Zoogeography" at the Zoological Survey of India, Calcutta.

Dr. G. C. Mitra, for "Morphogenetic studies : The origin and development of the leaves and their parts at the shoot apices of Angiosperms" at the Calcutta University.

NIS Junior Research Fellowships :

Mr. V. Chandrasekharan, to work on "The scattering of light in crystals and determination of elastic constant" at the Intian Institute of Science, Bangalore.

Mr. A. K. Chaudhuri, to work on "Electron Optics of the Electron gun used in Electron Microscopy" at the Calcutta University.

Dr. G. S. Deshmukh, to work on "Analytical aspect of Cerium and Thorium Chemistry" at Banaras Hindu University, Banaras.

Dr. B D. Mundkur, to work on "Heredity and Variation in Ascomycetes, particularly antibiotic yielding Fungi" at the Bombay University.

Mr. N. Satapati, to work on "Petrology, Petrochemistry and Potrotectonics of Eastern Ghats", at the Andhra University.

Dr. G. Venkatachalam, to work on "Animal Breeding including Animal Genetics & Applied Statistics" at the Livestock Research Station, Hosur.

Dr. (Mrs.) Vidyavati, to work on "Problems in the Anatomy of *Labeo rohita*" at the University of Delhi".

ERRATA

In May 1950 issue, p. 410, column 1, line 35, *read* Barber *for* Barbour; p. 411, column 1, line 45, *read* plot *for* plate; p. 446, column 2, line 36, *read* macroscopically *for* microscopically ; p. 451, column 1, line 18, *read* pressure *for* presence.

LETTERS TO THE EDITOR

[The Editors are not responsible for the views expressed in the letters.]

CALCIUM GLUCONATE FROM CANE SUGAR

In the manufacture of calcium gluconate, a very important salt used in calcium therapy, pure crystalline dextrose is almost always employed as the starting material. Only a passing mention is made by Losin[1] of the production of calcium gluconate by the fermentation of cane sugar. The authors, using a modification of the electrolytic process originally developed by Isbell[2] and studied by Fink[3] successfully produced a few tons of calcium gluconate from cane sugar. The quality of the product was comparable to that from pure dextrose and the cost of production was no higher. This is of particular importance as practically no pure dextrose is at present produced in India at competitive rates.

A 70% solution of cane sugar in warm water was hydrolysed by boiling with 2 gms. of conc. sulphuric acid per litre of solution for 10 to 15 minutes. The sulphuric acid was removed by precipitation as barium sulphate and the electrolytic oxidation of the hydrolysate was carried out under the following conditions :

Concentrations of glucose in the electrolysate 18%—20%, KBr 1%, NaCl 1% and calcium carbonate in suspension 5%. Cathodes and anodes of Acheson graphite were used and the approximate current density was 0.6—1.0 amp per sq. dm. The current efficiency under these conditions was about 90% and calcium gluconate cyrstallized out of the electrolysate when nearly all the glucose was oxidized. The fructose (as when cane sugar is used) somewhat contaminates the final product. This is in fact one of the major difficulties in using cane sugar as starting material. The bulky nature of calcium gluconate renders its purification from fructose all the more difficult. However on recrystallization and repeated washing yields of

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about 20%—25% on the weight of cane sugar could be obtained. The material so prepared conformed to the B.P. standard.

It was possible to use the mother liquor from the crystallizations for electrolysis by adding more cane sugar hydrolysate, bromide-chloride mixture and calcium carbonate. But the repeated use of the mother liquors entails large accumulation of fructose and both the yield and quality of the calcium gluconate suffer ultimately. At this stage the syrup containing about 12% calcium gluconate and 40%-50% fructose may be used directly for oral consumption or the calcium gluconate recovered from the syrup as the basic salt. The commercial success of the process will depend largely upon the use to which this mother liquor is put to. However in our large scale production the mother liquor syrup was discharged.

20 porcelain cells of 5 gallons capacity were used and a daily semi-commercial scale manufacture of 30 lbs. of calcium gluconate was kept up for several months.

S. BALSUNDARAM
R. K. HIRANI
V. SUBRAHMANYAN

Department of Biochemistry,
Indian Institute of Science,
Bangalore 3, 1-11-1949

[1] Losin, Carlos L. *Sugar news, 20*, 467-470, 517-21, 1939.
[2] Isbell, H. S. *et al. Industrial Eng. Chem 24*, 375, 1932.
[3] Fink C. G. and D. B. Summers. *Trans. Electrochem. Soc., 74*, 24, 1938.

ON THE BIONOMICS OF THE CARP, *THYNNICHTHYS SANDKHOL* (SYKES)

Thynnichthys sandkhol is one of the indigenous South Indian carps about the bionomics and environmental conditions of which much detailed information is not available. It is an interesting example of discontinuous distribution, and is regarded as an evidence of Malayan affinities in the freshwater fauna of peninsular India [1,2]. The genus *Thynnichthys* Bleeker is mostly confined to the Far East, *T. tynnoides* (Blkr.) and *T. polylepis* Blkr. occurring in Borneo and Sumatra[3], Malaya states[4] and in Siam[5,6]. *T. sandkhol* Sykes, occurs in Malaya[7] and in South India where it appears in the Godavari and Krishna[8] and in theTungabhadra[9]. The elucidation of the natural breeding and nursery areas and of the food and feeding habits of this species is made in this note for the first time. This is of considerable importance, for the fish, though less common than *Catla catla* (Cuv. & Val.) and *Labeo fimbriatus* (Bloch), can now be added to species that are propagated in the provincial waters of Madras.

This medium sized carp may be easily recognized by its silvery sheen, minute scales and spindle-shaped body. It attains maturity when about 12 inches in size, and spawns during the S. W. monsoon (June-September) in the three major rivers, when they are highly turbid with water temperature ranging from 28.4—29.6°C. The waters are also alkaline and well saturated with oxygen (Table I).

TABLE I

Hydrological conditions	Godavari	Krishna	Tungabhadra
Date	13-9-'49	15-7-'49	20-9-'49
Turbidity in cms.	3.0	3.5	7.5
Temperature °C	29.6	28.4	28.6
*p*H	8.0	8.2	8.0
Dissolved O_2 (mg/l)	4.2	5.2	5.879
Free CO_2 (pp. 100,000)	nil	nil	0.253
Carbonates (pp. 100,000)	0.308	0.775	nil
Bicarbonates (pp. 100,000)	4.0	9.77	6.710
Chlorides as Cl. (pp.100,000)	0.8	2.0	0.4
Silicates as SiO_2 (pp.100,000)	1.24	1.12	1.040
Phosphates as P (pp.100,000)	0.046	0.051	nil
Nitrates as N(pp.100,000)	nil	nil	nil

The hatchlings enter tanks, ponds and swamps connected with these rivers, and grow to a size of 18 to 24 inches and weight of 2 to 3 lbs. by the summer months of March, April and May, when they are netted and marketed by the local people. As these waters get dry during summer, it is evident that the rate of growth of this fish is highly satisfactory. The following (Table II) are the hydrological conditions of three waters in which the species grows and attains marketable size within 8 to 10 months. These conditions do not seem to differ much from those of spawning given in the previous table.

TABLE II

Hydrological conditions	Jallakalva (E. Godavari)	Kankipadu tank (Krishna dt.)	Edurur swamp (Kurnool dt.)
Date	13-9-'49	16-7-'49	23-9-46
Turbidity in cms.	3.2	2.6	5.5
Temperature in °C	29.6	31.0	33.2
Free CO_2 (pp. 100,000)	nil	0.52	0.138
Carbonate (pp. 100,000)	0.308	nil	nil
Bicarbonate (pp. 100,000)	15.350	12.92	8.845
*p*H	8.0	7.8	7.9
Dissolved O_2 (cc/l)	4.100	4.680	5.400
Chlorides (pp. 100,000)	3.2	8.0	0.9
Phosphates (pp. 100,000)	nil	0.03	nil
Silicates (pp. 100,000)	1.20	0.8	1.04
Nitrates (pp.100,000)	nil	nil	nil

Over one hundred specimens of the fish were collected from these areas, for the determnation of the natural food. Both the young ones and adults are predominantly plankton feeders. Sandgrains and mud also occurred in some of the guts examined. The following is the composition, in average percentage volume, of the diet of the fish.

Myxophyceae : *Anabaena*, *Gleotrichia*, *Merismopedia*, *Microcystis*, *Oscillatoria* and *Spirulina*-25% ;

Chlorophyceae : *Ankistrodesmus*, *Chroococcus*, *Closterium*, *Coelastrum*, *Cosmarium*, *Crucigenia*, *Eudorina*, *Gonatozygon*, *Mougeotia*, *Oedogonium*, *Oocystis*,

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Pediastrum, *Pleurococcus*, *Scenedesmus*, *Sphaerocystis*, *Spirogyra* and *Tribonema*-40%;

Diatomaceae: *Achnanthes*, *Amphora*, *Anomoeneis*, *Cocconeis*, *Cyclotella*, *Cymbella*, *Eunotia*, *Fragilaria*, *Gomphonema*, *Gyrosigma*, *Melosira*, *Navicula*, *Nitzschia*, *Pinnularia*, *Rhopalodia*, *Surirella*, *Synedra* and *Tabellaria*—15%;

Protozoa: *Chlamydomonas*, *Euglena*, *Trachelomonas*, *Glenodenium*, *Phacus and Stylonichia*—5%;

Rotifera: *Conochilus*, *Diurella*, *Pedalion*, *Rotifer* and *Notholca*—5%; and Crustacea: *Alonella*, *Bosmina*, *Ceriodaphina*, *Diaphanosoma*, *Simosa*, *Stenocypris*, *Diantomus*, *Eucyclons* and *Microcyclons*—*10*%.

We are thankful to the Director of Fisheries, Madras, for according permission for the publication of this note.

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THEORY OF THE CORONA DISC COLOURS

The coronas are rainbow coloured concentric rings seen around a bright source of light, when viewed through a thin cloud or a fog. With monochromatic light, the corona consists of alternate bright and dark rings. The first order dark ring, experimentally observable, has angular aperture varying between 3° to 20° in the direction of observation. The central disc of the corona is illuminated with maximum intensity of light when monochromatic light is used. With white light, the central corona becomes intensely coloured, the colour depending on the size of the drops. The colour changes abruptly with the change in the size of the drops and can best be observed by allowing an artificial cloud formed in a flask to evaporate slowly.

The corona formation is explained by the diffraction theory due to Verdet[1]. This theory explains the maximum intensity of the central corona disc with monochromatic light, but fails to give a satisfactory account of the preponderance of one colour over the others, when white light is used. According to the diffraction theory the central disc colour should be white. Aitken[2], Barus[3] and others have studied the colouration of the corona discs, but no satisfactory explanation of this has been obtained.

In 1908, Mie[4] had proposed a general theory of light scattering, which was used by the author[5] and co-workers to study the scattering of light by large sized water drops. This required the evaluation of a number of scattering functions depending on Bessel functions of high order. These theoretical results explained the experimental observations of the scattering of light. These results are also found to be useful in explaining a number of optical phenomenon in the atmosphere. Meeke[6] used the Mie's theory to explain the formation of the rainbow and the supernumery bows. The numerical results of Mie's scattering theory are capable of explaining not only the colours of the corona discs, but also of coronas, Broken Bows and transmission of light. In this note an explanation of the colours of the corona discs is given on the basis of Mie's theory.

The angular apertures of the corona discs does not exceed by about 20° in the line of observation. It is therefore necessary to find the maxima of intensity for the angles of scattering lying between π and π -20°. The intensity of light depends mainly on $\alpha = 2\pi\rho/\lambda$, the ratio of the circumference of the drops of radius ρ to the wave length of light λ. The results of the intensity of scattered light[5] within these angular apertures for different values of α indicate that the intensity fluctuates with change in α and is a maximum for values of α =6, 8 or 15. Thus for a given wave length of light, there are three distinct sizes of the drops for which the intensity of light becomes a maximum. The following table shows relatively the experimental observations of Barus[3] and the results from Mie's theory.

Colour of the corona discs	Radius of drops in μ for different α					
	α=6		α=8		α=15	
	Mie	Barus	Mie	Barus	Mie	Barus
Red (7000 A.U.)	0.621	..	0.828	0.80	1.55	1.60
Green (5000 A. U.)	0.470	..	0.637	0.65	1.19	1.15
Violet (4000 A.U.)	0.380	..	0.509	0.55	0.955	0.95

The above table indicates that there is a fairly good agreement between theory and experiment. A fuller account of the applications of Mie's theory to other optical problems will be published elsewhere. Further experimental work in this direction is in progress.

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ENERGY OF HOMOPOLAR BONDS

The object of this note is to present a simple method of calculating the purely covalent bond energy of homopolar diatomic molecules. This energy is given by $\frac{e^2}{2r\sqrt{n(n+2)}}$ (1) where e is the electronic charge; r the internuclear distance and $\sqrt{n(n+2)}$ is the *spin* factor of the shared electrons. The value of n is 1 for halogens and 2 for hydrogen and akali metals. The purely covalent energy is therefore 1/3.46 of the Coulombic energy for halogens and 1/5.66 in the case of hydrogen and alkali metals. The results are given in the following tables.

TABLE I

Bond (A-A)	dist.	ionic nature	bond energy	obs. cov bond energy	cal. cov. bond energy	spin factor
	γ°A	$i=\frac{h}{e.r}$	P	$\left(P-i\frac{e^2}{r}\right)$	$\frac{e^2}{2r\sqrt{n(n+2)}}$	$\sqrt{n(n+2)}$
H-H	0.74Sc	0.05	103.4	81.4	79.3	2.82
F-F	1.44Sc	0.014	70.0Sp	66.8	66.6	1.73
Cl-Cl	1.98P	0.024	56.9Sp	52.9	48.4	1.73
Br-Br	2.28P	0.032	45.2Sp	41.6	42.0	1.73
I-I	2.66P	0.043	35.6H	30.0	33.0	1.73

TABLE IB

Bond (A-A)	distance	obs. bond energy	cal. bond energy	spin factor $n(n+2)$
	γ°A	P	$\frac{\gamma^2}{2r\sqrt{n(n+2)}}$	$\sqrt{n(n+2)}$
Li-Li	2.67Ri	26.3	22.0	2.83
Na-Na	3.07Ri	18.4	19.1	2.83
K-K	3.91Ri	12.6	15.0	2.83
Cs-Cs	4.50Ri	10.1	13.0	2.83

H—Herzberg—Molecular Spectra and Molecular Structure.
Sc—Schomaker and Stevenson— *Jour. Amer. Chem. Soc.*, *63*, 47, 1941.
P—Pauling., The Nature of the Chemical Bond.
Ri—Rice., Electronic Structure and Chemical Binding.
Sp—Sponer., Molekul Spektren.

According to Pauling[1] the bond in the hydrogen molecule is due to the resonance of two electrons between the two nuclei which contributes 80% to the total bond energy. The remaining energy should come from the partial ionic binding. An assumption of 5% total ionic character *i.e.*, 2.5% for each of the resonance structure $\overset{+}{H}\ \overset{-}{H}$ and $\overset{-}{H}\ \overset{+}{H}$ would be in agreement with the observed result. On this basis the ionic binding energy $i\frac{e^2}{r}$ is 22 K. Cals. The balance of the observed bond energy and the ionic binding energy, 81.4 K Cal. compares favourably with the value 79.3 K Cal. calculated from the equation (1) and also is in full agreement with the calculation of James and Coolidge[2], which are based upon a thoroughly satisfactory theoretical treatment. It is not therefore necessary to ascribe "15% of the bond energy of hydrogen to complex interaction and deformation terms" (Pauling[1]). Although the small ionic character of hydrogen has been indicated by a moment 0.015 measured by Watson,[3] this value is not enough to account for the observed value of 5% from bond energy data. The covalent bond energy calculated from equation (1) by taking the internuclear distance of hydrogen as 0.6° observed in all covalent bonds, is however in full agreement with the observed.

In the case of halogens small electric moments of the order of 0.1 to 0.4 have been reported which would indicate definite partial ionic character, due to resonating structures $\overset{-}{Cl}\text{-}\overset{+}{Cl}$, $\overset{+}{Cl}\text{-}\overset{-}{Cl}$, $\overset{+}{Cl}\text{-}\overset{-}{Cl}$. These values are given in Table I, column (3). The purely covalent bond energies, after correcting for the ionic binding, given in Table I, column (5) compare favourably with those calculated from the formula (1) and are within the uncertainties of the bond energy values.

In the case of alkali metals the agreement between calculated and observed values is fair. The bond energies are not known with any degree of accuracy.

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EFFECT OF REFINING AND DEODORIZATION OF COCONUT OIL ON CALCIUM UTILIZATION

It has been shown by balance experiments on human subjects[1] that the detrimental effect of coconut oil on calcium metabolism is aggravated when the oil is subjected to the processes of refining and deodorization. Since a large amount of coconut oil in the refined and deodorized conditions is consumed for dietry purpose, further investigation dealing with the problem of nutritional importance of refined and deodorized coconut oil using rats instead of human subjects as the experimental animals was carried out.

Four adult rats were selected and they were first given the diet D-I containing refined and deodorized coconut oil (cocogem of Tata oil Mills Ltd.) at 10 p.c. level of intake. After a preliminary period of four days on this diet the urine and faeces of the animals were collected for a further period of four consecutive days on the same diet. They were then given the diet D-II in which the refined and deodorized coconut oil of D-I has been substituted by the crude coconut oil as sold in the market. The urine and faeces of the animals on this diet were also collected for a further period of four days after a preliminary period of equal days.

Both the diets supplied high grade animal protein and utilizable calcium in the form of defatted milk powder. The diets were further enriched with calcium

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and other minerals by the inclusion of Osborne and Mendel Salt Mixture at 5 p.c. level so as to counteract the detrimental effect of ordinary crude coconut oil on calcium utilization as observed by Basu and Nath[2] and De, Karkun and Roy[3] in their experiment with low calcium rice diet. The composition of the diets are shown in table I. The calcium contents of the daily diet consumed and of the urine and faeces were estimated according to the standard permanganate method as adopted in our previous communication[1].

TABLE I

SHOWING THE COMPOSITION OF THE TWO DIETS BASED ON CRUDE COCONUT OIL AND REFINED & DEODORIZED COCONUT OIL. THE FIGURES ARE EXPRESSED IN GM.

Name of the food stuff	Experimental diet	
	D-I	D-II
Rice	70	70
Pulse	5	5
Defatted milk powder	10	10
Salt mixture (Osborne & Mendel)	5	5
Crude coconut oil	—	10
Refined and deodorized coconut oil ('COCOGEM' of Tata oil Mills)	10	

The results of the balance experiments presented in Tabe II show that with almost an equal intake of calcium when the dietary fat of D-I is changed from the refined and deodorized variety to the ordinary crude variety as in diet D-II the daily calcium retention is improved from +55.0 mg. to +73.2 mg. The above low retention of calcium due to refined and deodorized variety of coconut oil is mostly due to higher excretion of this element in faeces and thus indicating that under the influence of the above variety of coconut oil the absorption of calcium through the intestine does not take place properly. The present results substantiate our previous observations to show that coconut oil produces highly detrimental effect on calcium utilization when the oil is subjected to the processes of refining and deodorization.

TABLE II

SHOWING THE INTAKE, EXCRETIONS AND RETENTION OF CALCIUM IN RATS WHEN THEY ARE KEPT ON CRUDE AND REFINED COCONUT OIL DIET. THE FIGURES ARE EXPRESSED AS DAILY AVERAGE VALUES PER RAT IN MG.

Diet	Dietary intake	Urinary output	Faecal output	Totsl output	Balance
Refined and deodorized coconut oil diet D-I	146.4	4.8	86.6	91.4	+55.0
Crude coconut oil diet D-II	143.3	6.1	64.0	70.1	+73.2

In consideration of the results of the present and previous experiments the authors are of opinion that the manufacture of refined and deodorised coconut oil for edible purpose should not be encouraged.

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DEVELOPMENT OF THE FEMALE GAMETOPHYTE OF *ORYZA COARCTATA* ROXB

The archesporium being hypodermal in origin is differentiated and distinguished in the second layer of the nucellar tissue as a polygonal cell of comparatively larger dimensions with thicker and denser cytoplasm and relatively large nucleus. It is strictly confined to a single cell, as was observed by Kuwada[2] in *O. sativa*. No parietal cell is observed to be cut off and the archesporium acts and functions directly as a megaspore mother cell after proper nourishment and development.

The m. m. cell then undergoes a period of rest before meiosis starts. In the resting stage the nucleus contains one conspicuous nucleolus embedded in the chromatin network. The general cytoplasm is minutely vacuolated throughout at first but bigger vacuoles appear later in the general plasma along with the growth of the cell. Its apex is broader and the lower end is tapering. After the reduction division a cellplate is formed near about the central region, thus dividing it and thereby forming two dyads. The second divisions follow simultaneously in both the cells (upper as well as lower) resulting in a linear tetrad of four megaspores. Kuwada[2], Terada[4], and Juliano and Aldama[1] observed similar type of development in *O. sativa*.

Some time after, the upper three megaspores show various types of contraction leading to the ultimate degeneration and the chalazal one alone functions. These three upper cells after complete degeneration and disintegration are observed as dark-staining shapeless masses covering and capping the functional and developing megaspore. This disintegrated cap lasts till the 4-nucleate stage of the sac.

The development of the female gametophyte is of the usual monosporic eight-nucleate (Normal) type.



Fig. 1. The haploid chromosome number of *O. coarctata* Roxb. × 2000

The haploid chromosome number is counted as 24 (Fig. 1) from the p.m. cells as was previously reported by Parthasarathy[3].

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Fuller details will be published elsewhere.

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NEW REAGENTS FOR THE CHARACTERIZATION AND PURIFICATION OF S-GUAIAZULENE

During our work on some sesquiterpenes derived from S-guaiazulene, it was thought of interest to develop a few new reagents, which should form sparingly soluble, stable, complexes with azulenes, and should possess high crystallizing power. It should also be possible to readily and easily regenerate the azulene in a pure form from such a compound. With this end in view a large number of polynitro compounds were tested for their capacity to form double complexes with S-guaiazulene. Picramide has been found to be superior to all the formerly known four reagents[1,2], which are being used for the identification of azulenes. Picryl chloride can also be used for the purpose and is, in fact, superior to styphnic acid and possibly to picric acid in this respect.

Picramide readily forms a double compound with S-guaiazulene in alcohol-acetic acid solution. The compound crystallizes in black needles with a coppery red luster and is obtained in a very good yield in a more or less pure form from the crude azulene directly. The m.p. of 163.5° is quite sharp. For the regeneration of pure S-guaiazulene from the picramide complex, three techniques have been developed. The compound is refluxed with cyclohexane containing a small percentage of dry benzene, when the azulene is regenerated and the picramide precipitates out. On cooling the picramide is filtered off and the filtrate after dilution with petroleum ether is passed through a column of alumina to remove the last traces of picramide. For larger quantities the addition compound is mixed with an equal amount of an inert material, like alumina, and placed in the thimble of a soxhlet apparatus and extracted with cyclohexane, till the extract is no longer coloured blue. The third method makes use of the decomposition of picramide with alkali.

Picryl chloride also gives a complex, crystallizing in black crystals with a coppery hue, m.p. 97-98°, from alcohol. The azulene can be liberated from this compound by treatment with alkali.

All these methods have been described for S-guaiazulene, but it is hoped that these reagents may also prove to be equally useful for other azulenes.

Full details will be published elsewhere.

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NEED FOR INVESTIGATION ON SYNTHETIC MOTOR AND AVIATION FUEL FOR INDIA

Financial value of loss being sustained by owners of motor cars and transport vehicles year after year since the commencement of restricted supply of petrol, can hardly be over estimated.

Two projects[1] relating to the possibility of producing synthetic petrol, from Indian coal, one costing Rs.23 crores and the other Rs.40 crores are under consideration of the Government of India.

In course of a symposium held in Allahabad in 1949, Dutta Roy[2] correctly adduced statistical support for the establishment of Research Institute on the subject. Stuart[3] discussed the need for synthetic liquid fuel to replace natural petroleum, which is limited, and the two chief alternative processes now in use in U. S.A. are economically unsound. The Minister of Fuel and Power, U. K.[4] stated that the Fuel Research Station of the Department of Scientific and Industrial Research are carrying out researches for several years, but results so far obtained do not yet justify plans for operation on commercial scale in that country. We have, however, now before us the "Report on the Petroleum and synthetic Oil Industry of Germany"—by a Mission from the Ministry of Fuel and Power, Published by His Majesty's Stationary Office, London. This publication offers very little hope for economically successful production of petrol from Indian coal. Instead of depending too much on mere reproduction of what Germany was economically unsuccessful inspite of persistent efforts for years, it seems quite worth while for India to take up the problem on independent lines, based on abundant cheap raw materials which are either available or may be developed with planned long term policy.

Berthelot[4] eighty one years ago combined carbon and hydrogen in his research laboratory at high temperature and produced acetylene. The subject is therefore an absolutely old one, and has been extensively investigated in different scientifically advanced countries for over 80 years so far with no commercial success. Let the fuel technologists imitate one of the plants for defence purpose exclusively. Such step however should

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not console private motor car and transport vehicle owners and industrialists of the country.

Just now molasses has again become surplus in India and undoubtedly will continue to be so. Fuel technologists do not usually get training in high level researches in organic synthesis, therefore, co-ordinated efforts headed by synthetic organic chemists seem to be reasonable to research for production of motor and aviation fuel. Amongst possibilities, (1) ethyl alcohol from molasses and *mohua*, and (2) products of wood distillation from forest wood need careful consideration. Long term policies have to be thought out and worked up step by step. By organized and planned developments molasses may be developed easily as a bye-product from sugar factories, and *mohua* may be grown in course of grossly neglected forest regeneration. Cost price of ethyl alcohol was about four annas per gallon before, and it can be easily brought down to that level by normal efforts. Having based on the production of ethyl alcohol at normal cost, experiments have to be varied, for example, ethylene produced from it may be polymerized and thereafter different processes of cracking have to be adopted to get ultimately some molecules as effective as iso-octane.

Wasteful methods of wood distillation was done in Mysore. If however, the entire process is done correctly, then ingredients necessary for production of synthetic petrol are all plentifully obtainable from wood distillation, quite similarly as those from coal. By making use of wood tar and a suitable catalyst, it is reasonable to expect usual hydrogention of carbon atom from wood or charcoal. Ford Motor Company of America get about 20 percent by weight of inflammable gas at no additional cost. This gas is quite rich in methane, and its production is expected to increase by suitable variation of technique of wood distillation. Our whole country is full of unlimited forest area though grossly neglected. Bye products of wood distillation may be converted with advantage into motor and aviation fuel.

Research laboratories in organic chemistry may now think on similar lines as above and formulate probable avenues of commercial success, leaving aloof fuel technologists to reproduce hyrogenation of coal for defence purposes, irrespective of cost of production and normal trade competition. It is quite serious that owners of private cars and transport vehicles and industrialists need not expect any relief from Indian coal under the planned arrangement for production of oil from coal, from economic aspects.

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SEARCH FOR NEW ANTIBIOTIC PRODUCING FUNGI FOR CONTROLLING PATHOGENIC ORGANISMS

The recent discovery of a large number of antibiotic substances from the metabolic products of micro-organisms tends to support the view that it is quite possible to search for newer types of antibiotic-producing organisms from their natural habitat. Extensive work on this line has been carried out in U.S.A. and Great Britain and an enormous array of literature have accumulated during the last decade. These have been reviewed by Duemling *et al*[1], Waksman[2], Benedict and Langlykke[3], and Bailey and Cavallito[4]. Already there are more than hundred different compounds isolated from micro-organisms, and there is sufficient evidence to believe that a great many others can be obtained, if the organisms are studied in greater detail. There are various methods of approach to this problem and the method suggested by Waksman[2] has been followed in the present investigation.

Cultures of fungi were isolated from various sources, *viz*, soil, compost and vegetable waste by plating with Waksman's acid-agar medium. The isolates were grown in subculture and were subjected to rapid screening tests as suggested by Raper *et al*[5] and a primary selection of the positive antibiotic-producing strains was made. Of 540 isolated fungi, 139 were found to be capable of producing inhibitory substances. These are mostly species of *Penicillium* or *Aspergillus* and a few strains of *Fungi Imperfecti*. The activity of 20 better antibiotic-producing strains are reported in the present communication.

TABLE I

Cultures	Diameter of inhibition zones (mm.) of test organisms			
	Staph. aureus	*E. coli*	*V. cholerae*	*Eb. typhosa*
P_4	28	20	0	0
136	30	30	30	30
F_1 (10)	16	17	0	16
F_2 (20)	20	20	0	17
F_3 (43)	12	16	0	17
IF_4 (54)	23	18	12.5	14
FX_3 (63)	16	14	0	17
F_6 (64)	18	13	15	17
FX_1 (64)	25	13	13	13
F_1 (66)	21	0	0	0
FX_1(68)	15	15	0	21.5
F_2(69)	24	0	0	0
F_2 (70)	26	10	0	0
F_1 (71)	24	0	0	0
F_3 (71)	30	9.5	0	0
FY_2 (71)	30	10	0	0
F_5 (82)	25	0	0	0
FX_3 (82)	28	0	0	0
F_3 (83)	23	0	0	0
F_5 (83)	19	11.5	9	9
Phenol(5%)	26	22	20	22
Mercuric Chloride (1:500)	30	22	25	24

The cultures were grown in modified Czapek-Dox solution with 0.2% malt extract for 10 days at 24°C.

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The culture fluids were assayed according to the agar-cup method using 4 test organisms—*Staph. aureus*, *E. coli*, *V. cholerae* and *Eb. typhosa* and the results are given in Table 1.

The selected test organisms were all human pathogens, of which only *Staph, aureus* is Gram-positive and the remaining three are Gram-negative. It will be seen from the table that the antibiotic-producing organisms used in the above experiment, show a wide specificity in their antagonistic activities. It is remarkable that *Vibrio cholerae* is the least sensitive amongst all the test organisms as in this case the inhibition zone was observed only in 5 instances. *Eb. typhosa* and *E. coli* were inhited in 10 and 14 cases respectively while *Staph. aureus* was inhibited in every case.

One strain of *Penicillium* (No. 136) was found to be effective equally against Gram-positive and Gram-negative test organisms, and the zones of inhibition produced here were highest amongst all the active cultures employed in this experiment. Arrangements are now in progress to test the toxic effect of the purified preparation of the active substances in experimental animals and a detailed investigation on the method of improvement of production of the antibiotic agents will be reported in future.

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S. SEN
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Section of Microbiology,
Bose Institute,
Calcutta, 19-5-1950.

[1] Duemling, W. W. *et. al. Ann. New York Acad. Sci, 48*, 31-228, 1946.
[2] Waksman, S. A., Microbial Antagonism and Antibiotic Substances, 1947.
[3] Benedict, R. G. and Langlykke A. F., *Ann. Rev. Microbiol., 1*, 193-236, 1947
[4] Bailey, J. H. and Cavallito, C. J. *Ibid, 2*, 143-182, 1948.
[5] Raper *et al. Jour. Bact., 48*, 644-45, 1944.

SUNSPOT ACTIVITY AND COSMIC RAY DISTURBANCES

It was reported in *Nature*[1] that "a big group of sunspot brought into view by the sun's rotation on the 14th February will cross out of sight on Feb. 27. In Northern latitude 11°, the centre of the complex group crossed the meridian on February 20.2 U.T..... This group will probably have not been exceeded in size since 1947 (the peak year of the present 11 years sunspot cycle) when the outstanding group had an area nearly double the present. Judging from the size alone the present group is likely to be associated with geomagnetic and ionospheric disturbances".

The results of cosmic ray intensity measurements during the period February 17, to March 2, 1950, carried out in the premises of Bose Institute, Calcutta by one of us (*I.L.C.*) is a continuation of the investigations reported earlier by Chakraborty and Chatterjee on cosmic ray intensity measurements by means of a pressure ionization chamber. The apparatus used is the same as described in the latter communication[2] and the results are given in Curve I.; one of us (*P.K.S.C.*) while engaged in an investigation on the nature of secondary radiation produced by cosmic rays in different thickness of lead, noticed on 28.2.50 an increase by almost one hundred per cent in the frequency of coincidences in a counter telescope placed under 10 cms. of lead. The curve representing the variation in frequency of coincidences with time on 28.2.50 is given in Curve II. The counts were taken for one hour intervals.

In table I appended herewith we have collected together all data available for the present on (*i*) the number of sunspots visible on different dates at Kodaikanal and the position on the sun's disc of the large group of sunspots as reported in *Nature*[1]; (*ii*) solar flare observed at different places; (*iii*) radio fade out observed by A.I.R. in Delhi; (*iv*) magnetic storm as recorded at Kodaikanal and (*v*) variation in cosmic ray intensity as recorded at the Bose Institute, Calcutta. It may be mentioned that the pressure ionization chamber was installed in an air conditioned room on the roof of the main building of the Bose Institute and the coincidence counter arrangement was housed in a hut in the garden at a distance of over 100 yds. from the former.

Table I

	13	14	16	16	17	18	19	20	21	22	23	25	26	27	28
NUMBER OF SUNSPOTS	74	116	139	123	131	135	–	136 CROSSED CENTRAL MERIDIAN	152	160	-	-	-	GONE OUT OF SIGHT	-
SOLAR FLARE					FLARE (2)					FLARE					
RADIO FADE OUT															
MAGNETIC STORM					CALM			STORM		STORM	CONTINUED			CALM	CALM
COSMIC RAY INTENSITY								INCREASE		INCREASE	BELOW NORMAL		NORMAL		

The principal points of interest elucidated from Table I are discussed below :

(*i*) The relative number of sunspots which were observed at Kodaikanal increased from 74 on 13th Feb. to 116 on 14th, the date on which the large group of sunspots mentioned in *Nature* appeared on the surface of the sun's disc; on the 15th the number increased to 139 which coincided with a complete radio fade out observed at Delhi between 11.55 to 12.55 hrs. I.S.T. On the 15th a slight disturbed magnetic storm was also observed at Kodaikanal. (*ii*) On the 17th a solar flare of intensity 2 was observed at Kodiakanal between 02.10 to 02.44 hrs. I.S.T. In curve I, there is an indication of diminution in cosmic ray intensity with a minimum of about 1.82% at 16 hrs. I.S.T. There was however, no magnetic storm ; the Kodaikanal report states calm from 16th to 18th Feb. and on the 19th it was slightly disturbed. (*iii*) According to *Nature* the centre of the complex group of spots crossed the meridian on Feb. 20.2, U.T. In our record there is a sudden

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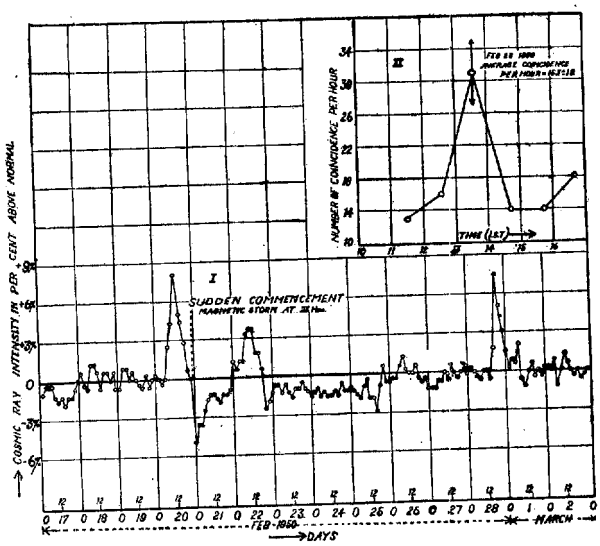
increase of intensity from 6 to 20 hrs. with a maximum of 7.9% at 12 hours. A magnetic storm of the sudden commencement type began at 23.40 hrs. I.S.T. The storm was followed by a sudden decrease in cosmic ray intensity with a minimum of 4.82% at 0.0 hours on 21st Feb. At Delhi a partial severe type of radio fade out was observed on 21st between 15.40 to 16.20 hrs. I.S.T. On the 22nd there was another rise in intensity of about 3.7% at 11hrs. I.S.T., following which there was a drop in intensity below the mean value which continued till the 25th, during which period the magnetic storm, as reported from Kodaikanal, persisted. On the 26th it was slightly disturbed and on 27th and 28th it was calm. No solar flare up was observed during 20th -22nd Feb. at Kodaikanal, probably due to bad weather. There was, however, a newspaper report of observation of such an occurrence on 22nd Feb. from Japan. The group of phenomenon found usually associated with an intense solar flare up was thus observed during the period 20th-25th Feb. The cosmic ray intensity attained

Curves I and II



the normal value from early 26th Feb. (*iv*) On the 28th Feb., the ionization chamber record showed an increase in cosmic ray intensity with a maximum of about 7.3% at about 16 hrs. I.S.T. and the counter telescope arrangement recorded an increase about 100% at 13.30 hrs. approximately (Curve II). The higher percentage increase in counter telescope arrangement seems to indicate that the increase was mainly due to particles of higher energy which also arrived earlier. The increase recorded on Feb. 28 was of a simple nature, neither accompanied by radio fade out nor followed by any decrease in intensity indicating, thereby, the absence of any ionospheric and magnetic disturbances. As this increase could not be correlated with an increase in the number and activity of sunspots or magnetic storm and radio fade out, the question arises whether it could be attributed to solar flare up. According to the report in *Nature* the group of large sunspots went out of sight on the 27th February. Several observations have also been recorded by Ehmert[3] (1941-43) in which increase in cosmic ray intensities could not be correlated with any sunspot activities or radio fade outs.

Our thanks are due to Dr. A. K. Das, Director, Solar Physics observatory, Kodaikanal and to the Research Engineer, All India Radio, Delhi for supplying us with information used in preparing the present note. One of us (*P.K.,S.C.*) is indebted to the National Institute of Sciences of India for the award of an I.C.I. Research Fellowship. We are also indebted to Dr. D. M. Bose, Director, Bose Institute for many helpful discussions.

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12-5-1950.

1 'A Big Sunspot'—*Nature*, *165*, 301, February 25, 1950.
2 Chakraborty, I. L. & Chatterjee, S. D., *Ind. Jour. Physics*, *23*, 525, 1949.
3 Ehmert, A. *Zeit F. Naturforschung*, *3a*, 264, 1948.

SYSTEMATIC SAMPLING, III.

The population to be sampled is a p-dimensional 'rectangular' field consisting of $\prod_{i=1}^{p} n_i$ strata, each of $\prod_{i=1}^{p} k_i$ cells. Let $(x_1, x_2, \ldots x_p)$ be the co-ordinate of a cell in the field. Along x_i-direction, there are n_i sets, each containing k_i 'rectangles' of (p-1) dimensions. Then systematic sampling may be defined as follows:-from a stratum ν cells are taken at random and every k_i^{th} cell along x_i direction from every chosen cell is taken, comprising a systematic sample of size $\nu \prod_{i=1}^{p} n_i$ (*c.f.* Das[2]). Under stratified sampling ν cells are taken at random from each stratum and under random sampling $\nu \prod_{i=1}^{p} n_i$ cells are taken at random out of all the cells in the population.

This population is considered to be a sample from an infinite population in which the expectation and variance of the yield of each cell is constant and the correlation between the yield of two cells is a function of the gap between them (*c.f.* Cochran[1])

Let σ_r^2, σ_{st}^2 and σ_{sy}^2 be the variances of the sample-mean under random, stratified and systematic sampling as in Das (1949), $\rho(u_1, u_2, \ldots u_p)$ be the correlation between two points of gap $(u_1, u_2, \ldots u_p)$ and $\rho(u_1, \pm u_2, \ldots \pm u_p)$ is such that for $p=3$

$$\rho(u_1, \pm u_2, \pm u_3) = \rho(u_1, u_2, u_3) + \rho(u_1, -u_2, u_3) + \rho(u_1, -u_2, u_3) + \rho(u_1, -u_2, -u_3).$$

Let Δ_i and δ_i are the usual difference notations with respect to u_i, and $\Delta_i \rho(u_1, \pm u_2, \ldots \pm u_p)$ and $\delta_i^2 \rho(u_1, u_2, \ldots u_p)$ be denoted by Δ_i and δ_i^2 respectively.

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Then σ_r^2, σ_{st}^2 and σ_{sy}^2 have been calculated and the following theorems proved giving sufficient conditions for all infinite populations :

Theorem 1. If (*i*) $\Delta_i \leqslant 0$, and (*ii*) $\delta_j^2 \geqslant 0$ for $j = 1,2, \ldots p$, and $j \neq i$, then stratified sampling with strips $x_i = \text{const.}$ is more efficient than random sampling.

Theorem 2. If (*i*) $\Delta_1 \leqslant 0$, (*ii*) $\Delta_2 \leqslant 0$ and (*iii*) $\delta_i^2 \geqslant 0$ for $i = 1, 2, \ldots p$; then stratified sampling with strips $x_1 = \text{const.}$ and $x_2 = \text{const.}$ is more efficient than random sampling.

We can state more general theorems equivalent to theorem 2 for stratification by stripes.

Theorem 3. If (*i*) $\Delta_i \leqslant 0$ and (*ii*) $\delta_i^2 \geqslant 0$, both for $i = 1, 2, \ldots p$; then stratified sampling in general is more efficient than random sampling.

Theorem 4. If $\delta_i^2 \geqslant 0$ for $i = 1, 2, \ldots p$, systematic sampling defined here is more efficient than stratified sampling.

[N.B. This theorem is true even if the strata have got different expected means and variances.]

Theorem 5. Under conditions of theorem 3, stated above, systematic, stratified and random sampling methods are in decreasing order of efficiency ; *i.e.* $\sigma_{sy}^2 \leqslant \sigma_{st}^2 \leqslant \sigma_r^2$.

A. C. Das

Department of Statistics,
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24-2-1950.

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[2] Das, A. C. Two dimensional systematic sampling, SCIENCE AND CULTURE, *15*, 157-158, 1949.

BOOK REVIEWS

The Characteristics of Electrical Discharges in Magnetic Field—By A. Guthrie and R. K. Wakerling. Published by McGraw Hill Book Co., Inc. N. Y. Price $3.50.

"The characteristics of electrical discharges in magnetic fields" by Guthrie and Wakerling published by McGraw Hill Book Company in their Manhattan Project Technical section series supplies a book in a field where there were previously none. In the rapidly growing fields of mass spectroscopy and ion accelerators the conditions under which the sources of ions operate have not received that attention it deserved until the growth of the American Manhattan project. The present volume describes the work on characteristics of ion sources produced by discharges in magnetic fields by the group at Radiation larboratory, at the University of California, in connection with the magnetic separation of Uranium isotopes and related fields. The book is comprehensive and lacking only in certain technical and engineering details which have perhaps been omitted for obvious reasons. The practical experience embodied in the book will make it an obligatory reading and reference book for all those who wish to work on mass spectroscope and ion accelerators. There is a last and useful chapter on the Phillips Ionization gauge for measuring high vacua which works on the principle of ionization by collision in magnetic fields. This chapter though not quite related to the rest of the book is an useful addition and is the most complete description of the Philips type gauge that the reviewer has seen.

In printing and the diagrams the conformity with previous volumes of the series has been maintained and the price has been kept low.

B. D. N.

Vaccum Equipment and Techniques—By A. Guthrie and R. K. Wakerling. Published by McGraw Hill Book Co. Inc. N. Y. Price $2.50.

The publication of the volume on vacuum equipment and techniques in the Manhattan Technical series is welcome addition to the inadequate literature on this subject. The first chapter on basic designs of vacuum systems is not usually met with in most books on vacuum technique. It is well written and will be useful to all who want to design vacuum systems for any purpose. The description of the conventional pumps in the second chapter is useful although incomplete and is not meant to be used as a guide to marketed mechanical and diffusion pumps. Vacuum gauges have been fairly completely described. Vacuum materials and equipment are also quite comprehensively treated as far as metal systems are concerned. Glass systems, however, have not been dealt with and the omission I suppose has been purposely made, although the matter of insulated leads into vacuum systems, glass seals, and certain types of metal and glass systems are of importance in certain types of vacuum work. The chapter on detection is again something of great usefulness to all workers in the field. It is regretted that the palladium tube hydrogen ion gauge for detection of leaks which is of general interest and usefulness in this field has been overlooked.

As a handbook to all those who work with evacuated systems this book will be indispensable. As a manual that one can turn over at any page and use as reference it will be useful in any laboratory bookshelf. The printing is good and the diagrams are clear and in comformity with the other books of the series.

B. D. N.

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Bengal Famine (1943)—By Tarak Chandra Das, University of Calcutta, 1949. pp.154, Price Rs. 6/-.

The report under review is a survey of the socio-economic condition of the destitutes who were driven from the villages to the city of Calcutta for food. The survey was carried out by the teachers and students of the department of Anthropology of the University of Calcutta. The report consists of two parts, in the first of which the destitutes have been described in detail and the second part consists of a test survey of the famine condition in a few Bengal villages.

The destitutes were studied mostly in the free kitchens under the jurisdiction of District IV of Calcutta Corporation. They numbered 2537 persons of which 1200 were males and 1337 females. The majority (81.24%)of the above number hailed from the distiriict of 24-Parganas, because of its close proximity and the railway system by which it is connected with the city. Thanks to the railway authorities who carried these destitutes free of cost to the city and back. This free railway transport was a fillip to the influx of the destitutes and its largest number from the district of 24-Parganas.

Mr. Das has very rightly gone into the details of the methodology of the survey and claims that the data collected by the present survey are not comparable with one of the earlier surveys on this famine. It is high time therefore that all such surveys are based on an approved scientific method so that their results are comparable and show a composite picture. Chap. III of the report shows the age, sex and community distribution of the destitutes. Mr. Das has laboured very much to explain the high preponderance of males over females in the lower age groups (0-10) and that of female over males in the higher age groups. He is of opinion:

"Aparently, it is not due to biological causes but appears to be the result of socio-economic factors produced by the famine". To the reviewer, however it appears that the biological factor is the chief cause. The male sex-ratio is always high in the younger ages and as it is accompanied by higher male mortality than the females it is almost balanced during the reproductive periods. In India we have high female mortality towards the fall of their reproductive period and the same has been found in the present destitute samples (p.46). The sex distribution found among the destitutes is entirely in conformity with our present biological knowledge and they are stronger than the socio-economic reasons put forth by Mr. Das. The present report also shows a high male mortality (p.93) and one is reminded of Prof. Crew's apt remark—"the true recipe for longevity is to be born a girl".

The destitutes have been grouped into four communities—"Caste Hindus", "Scheduled Castes", "Muslims" and "Christians". A further subdivision of the first two groups into the different castes would have been better for purposes of indentification and understanding. The reviewer is a native of a village (28 miles from Ballygunge) in 24-Parganas, which sent out a number of such destitutes and the majority of them belong to the Bagdis. This caste was probably the hardest hit in this district and quite a large number of these Bagdis used to come to the town daily in the morning and go back to their villages in the evening. Mr. Das has mentioned (P. 72) that 55.47% of the units did not possess any homestead land. This is rather peculiar in a village and it is doubtful that the destitutes told the truth. There are few public shelters in a village and the communal ways of livlihood among the scheduled castes of 24-Parganas are rare. The destitutes have not always told the truth as the reviewer personally knows the Bagdis of his village and quite a few of them roamed about the free kitchens of Ballygunge. They have posed to be destitutes in a large number of cases and came to the city owing to the high price of food-stuffs, etc. in the village.

Mr. Das has discussed at length the causes of the famine in Chap. XI. The most important point of Mr. Das, contributory causes is the moral degeneration of the people. It is doubtful how far the destitute sample were real destitutes. Further, the report has not mentioned anything of the efforts in the villages to help the poor. The reviewer is aware of two such benefactors in his own village — one giving dry doles and another giving *kichuri* and quite a few of the Bagdis took advantage of these and of the town as well.

The report concludes with some useful suggestions in the form of long term and immediate measures in order to combat famine. It appears that the primary necessity for the benefit of agriculture lies in the resuscitation of the old irrigation channels. This will not involve the State into an enormous expenditure. As an agriculturist the reviewer feels this to be the prime importance than the other suggestions of Mr. Das which will involve a lot of social change.

S. S. S.

Artificial Radioactivity—By P. B. Moon, F.R.S. Published by Cambridge Monographs on Physics. Cambridge University Press 1949. Pp. 102. Price 12s. 6d.

This Monograph on Artificial Radioactivity is a timely publication embodying our present state of knowledge on this branch of Nuclear Physics. In recent years the advancement of Nuclear Physics has been so enormous and rapid that such monographs are particularly welcome by those engaged in the study of Nuclear Physics, as more comprehensive treatment of individual subjects is obtainable than available in in standard text books.

This monograph gives an outline of the main phenomena and techniques of radioactivity as observed in the study of artificially radioactive nuclei. A great variety of artificial radioactive nuclei has been produced in recent years and more data are pouring in. At present more than 500 artificially radioactive nuclei are known. The inclusion of such a large amount of nuclear data has not been attempted in a small volume like this.

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Rather it is intended to provide a basic conception of the main radioactive processes *viz.*, electron and positron activity, K-capture and gamma emission, and the experimental data of some typical nuclei are elaborately discussed to illustrate the processes involved.

The first chapter develops an introductory conception of the formation and different modes of decay of nuclei produced by artificial transmutation. In chapter II the main experimental methods for detection in energy measurements of electrons, positrons and gamma-rays are briefly discussed. The third chapter is devoted to electron and positron emissions from nuclei. A comprehensive discussion of the beta-decay theory including the K-capture process has been given and typical experimental results of a few nuclei are discussed to bring out the corelation with the theory. The last chapter deals with the process of gamma-emission from nuclei. After a concise introduction to the theoretical aspect of gamma-emission process, follows a comprehensive discussion of some interesting gamma-emitting nuclei including those exhibiting isomeric transition.

As the author has limited the discussion to light and medium-heavy nuclei, the process of alpha-emission from artificially radioactive nuclei such as the transuranic elements has not been included. The book includes the references of recent literature on the subject from which earlier references may be obtained. This monograph will be much helpful to those interested in the study of this branch of physics.

S. B.

Proceedings of the National Conference on Industrial Hydraulics Vol. II, 1948. Conference Secretary, Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Illinois, U.S.A. Paper cover, 6″×9″, pp. xxi+154, 1949. Price $3.00.

The Proceedings of the 1947 conference were reviewed in this journal some time back, (*Science and Culture*, Jan. 1950, p. 228). This second volume contains papers presented during Oct. 20-21, 1948, and maintains the same high standard evidenced in the first volume and anticipated in the present one.

As compared with ten papers in Vol. I, this volume contains 13 papers which can be classified into five broad groups comprising of servomechanisms, hydraulic equipment standards, pumps and turbines, hydraulic components and recent applications. The subject of servomechanisms is dealt with in two papers, one dealing with the general history and industrial applications and the other with the prediction, design and test of hydraulic mechanisms by mathematical, mechanical and electronic tools. As in other fields of engineering, standardization of hydraulic equipment is now recognised as aiming towards the advancement of the art of hydraulics, and promoting safety of personnel, uninterrupted production and a long life for machine or other equipment. These aspects are covered in two general papers presenting a clear explanation of the first hydraulic standards for industrial equipment. Pumps and turbines which form the veritable nerve centres of industrial hydraulics are covered in three papers. They deal with the subject of hydraulic surges in pump discharge lines, prediction of liquid jet pump performance and the most recent developments in large hydraulic turbines. This last subject is dealt with in a very illuminating manner wherein the advances in materials for turbine construction are surveyed. These newer developments are characterized by the use of welded plate steel structures, and increased applications of strainless steel and new types of bearings and seal rings.

Three papers cover the field of hydraulic components. The paper on flanged joints, their development and testing will interest many technologists as their applications stretch over a very wide field. The two other papers survey hydraulic packings and seals and gasket design and selection. The applications of hydraulics are dealt with in two papers, one on polyphase torque converter and the other on hydraulic circuits for farm tractors.

A very unusual paper for a subject like this comes from the pen of R. E. Gilmor, Vice-Chairman of the U.S. National Security Resources Board. Entitled "Our Economic Missions in Europe", the paper surveys very lucidly the purposes, benefits, difficulties and the modulus operandi of the Marshall-aid Plan. It is no doubt a very good paper presented in an authoritative, intelligent and clear way and would form ideal for presentation in a journal on economics and management. Its relation however in this volume especially among the technical papers is a little stray and although the reviewer throughly enjoyed reading and appreciating its contents the reason for its inclusion here has left him wondering.

S. K. G.

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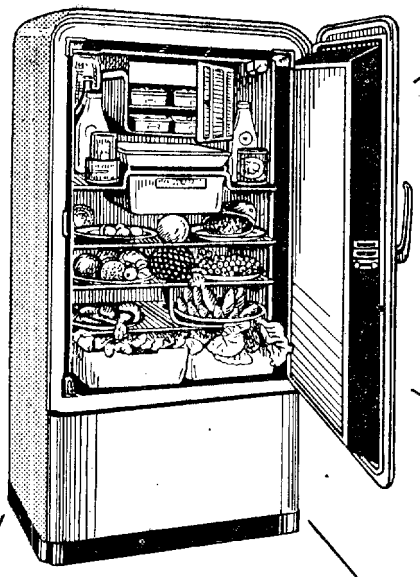

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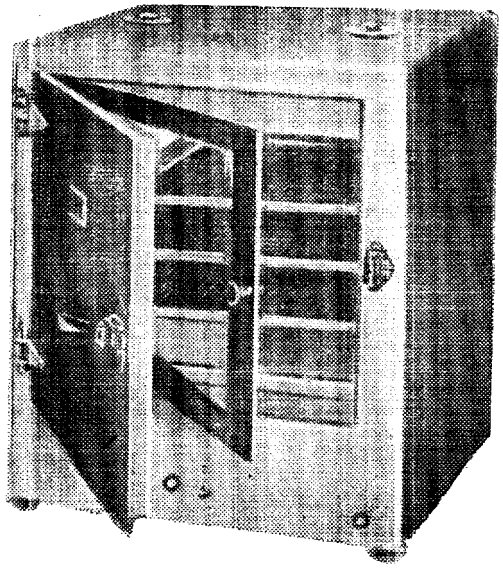

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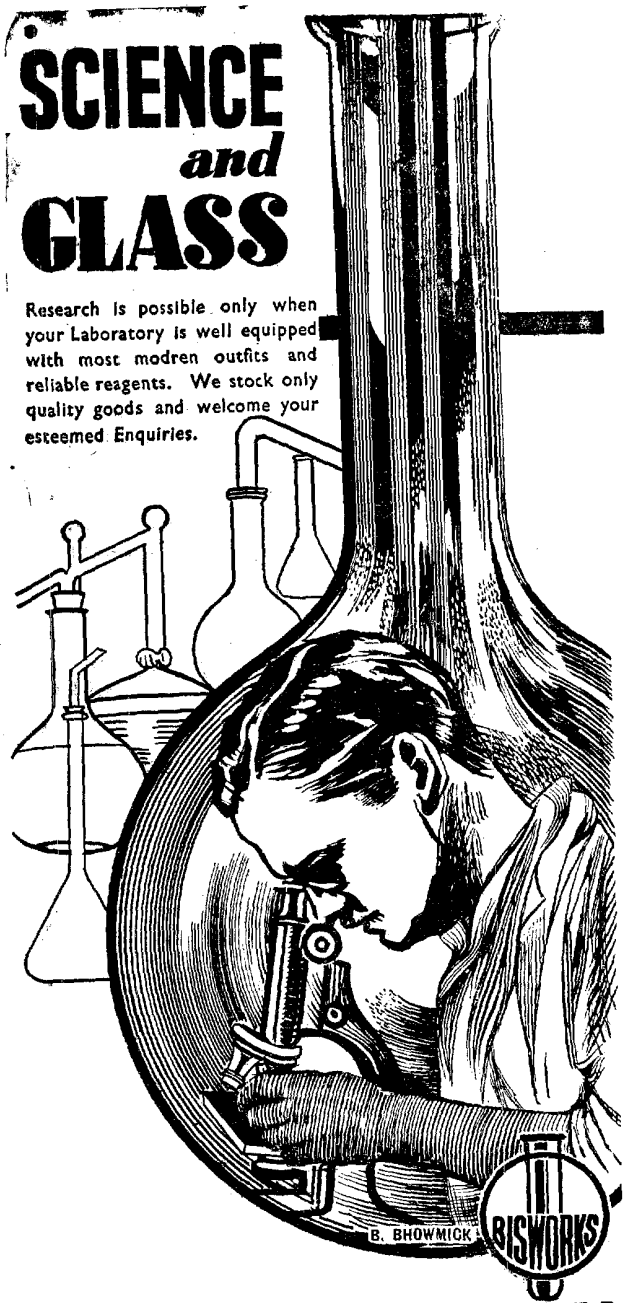

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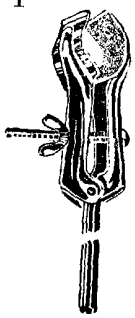

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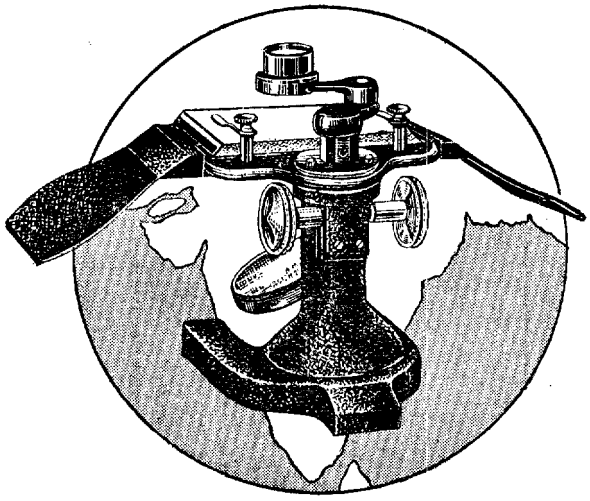

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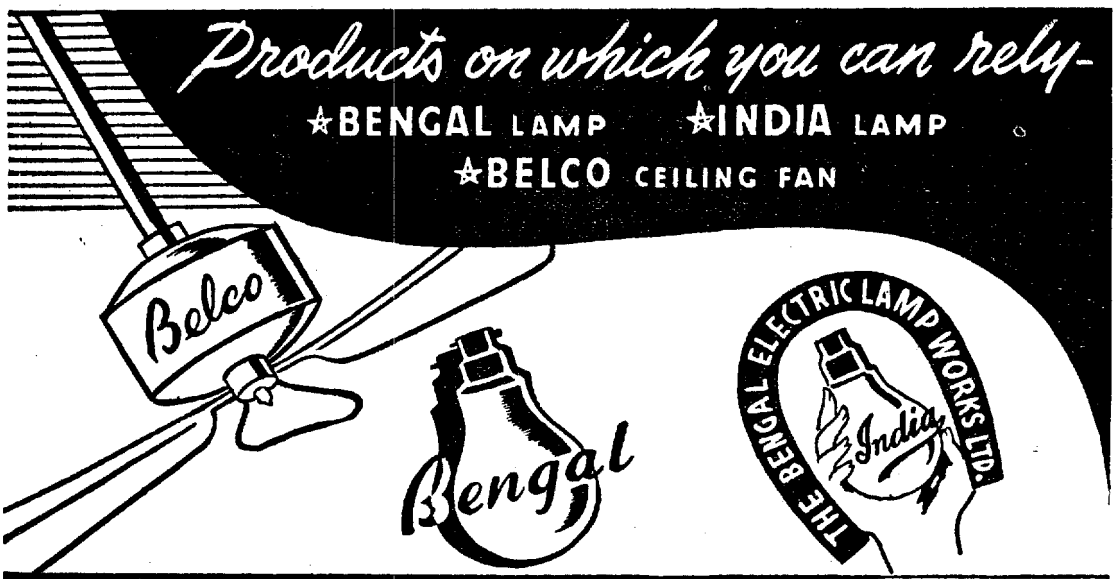

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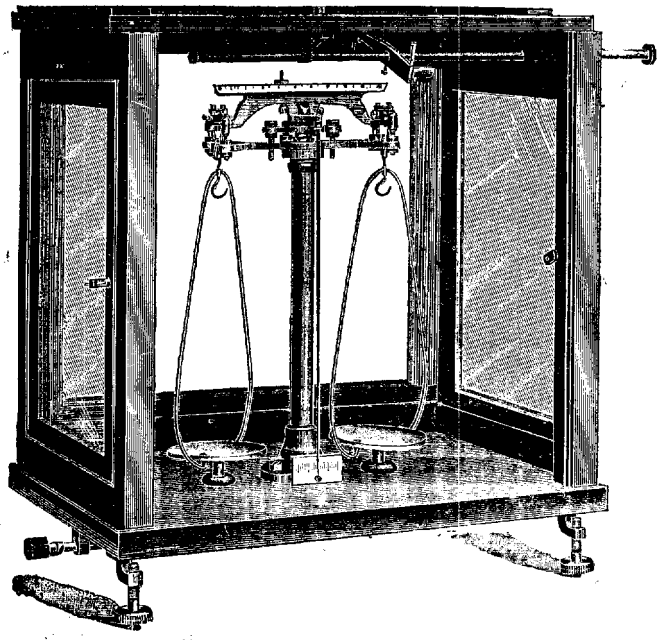

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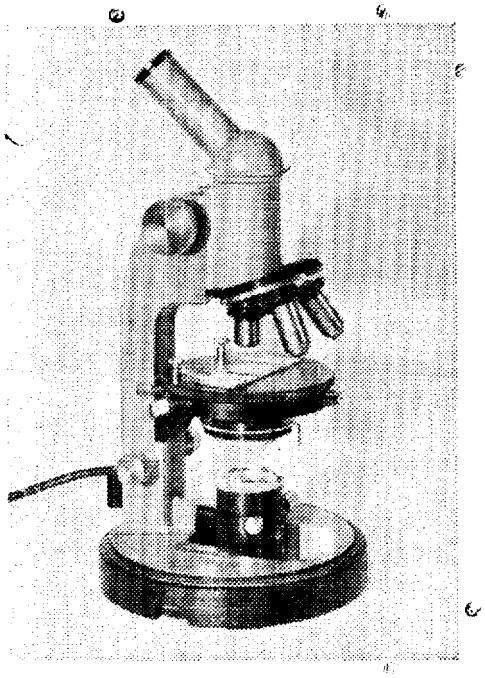

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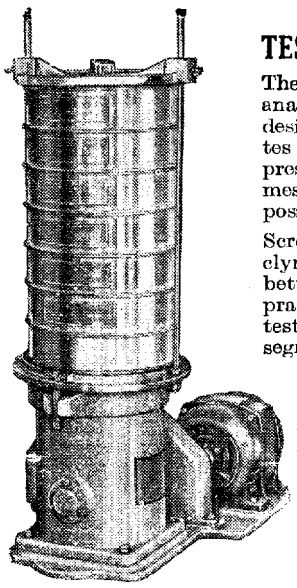

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"*I take tea everyday* at least twice and find it quite invigorating. I am not aware that it has produced any harmful effect on my health. On the contrary, the morning cup makes me cheerful and renders me fit for starting the day's work."

[redacted]

25X1C

☆ *Dr. Meghnad Saha, D.Sc., F.R.S., Palit Professor and Head of the Department of Physics, Calcutta University, is one of the most eminent scientists of India and is famous internationally for his work on Nuclear Physics, especially on the Theory of Stellarspectra which brought him the Fellowship of the Royal Society. He represented India at the 220th Anniversary of the foundation of the Russian Academy of Sciences in 1945.*



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SCIENCE AND CULTURE

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NEED OF A COMPREHENSIVE PLANNING FOR DEVELOPMENT OF AGRICULTURE IN INDIA

IT may have appeared to our readers that we have, of late, devoted a considerable space to the publication of topics dealing with agricultural and food situation in the country. We did it consciously and purposely, because we feel that the Government and the people should think and act more creatively on the grave situation the country is faced with. Production of enough food for the people and sufficient agricultural commodities for Indian industries is the most important single problem before the country to-day. And the degree of its solution and the speed with which we can achieve it will determine the future course—economic and political—of our country for many years to come.

We are already beginning to see the repercussions of the deficit food and cash crop production on the over all economy of the whole country. Importation of cereals alone is currently draining off the country 130 crores of rupees every year; and in aggregate it has already depleted the country of several hundred crores of rupees during the past few years. Paucity of the supply of raw materials is gradually leading two of India's most important and biggest industries, *viz.*, jute and cotton, to a path of major crisis. This may have been of recent origin especially due to devaluation and non-devaluation, and Pakistan's policy, but the country has got to ensure measures to produce enough of these raw materials to meet the requirements of industry or else to buy supplies from outside; but India at present has no surplus foreign exchanges to do so.

The loss of such stupendous sums of money due to food importation is beginning to jeopardize all our post-War nation-building schemes. Multipurpose river-valley schemes, which our leaders displayed so much and on which common people placed so much trust, are being affected due to cuts in financial appropriations. Apart from supplying cheap electricity for ndustrial uses, these multipurpose river-valleys were meant to provide irrigation to millions of acres and to aid in the prevention of soil erosion and control of floods—so harmful to men and crops. Expenditure on food importation is, therefore, retarding execution of the food production schemes of the country. The deficit economy of the country is also beginning to have repercussions on large scale reclamation projects. It now appears that against an original estimate of 4,000 heavy tractors required to perform the projected reclamation of cultivable fallow land, India can now pay for 375 tractors only. Originally India planned to import 500,000 tons of chemical fertilizer, but lack of foreign exchange is putting an impediment to such a large-scale importation.

The above are only a few of the many similar instances that can be cited to show how India's deficit production of agricultural commodities is jeopardizing most of our nation-building schemes. But these deficit food productions are not of yesterday's origin. The frequent food scarcities have demonstrated it very painfully, and it has now assumed a chronic aspect. Years have passed by, reins of Government of the country has passed from alien hands to people's representatives, but unfortunately almost the same situation exists to-day as it existed a few years ago. Apart from Government claims that the country will be turned self-sufficient (in food production) by December 31, 1951 (*now the target date is changed to March 31, 1952*), the common man does not find any signs that the situation is gradually improving in that direction nor it can be comprehended how the 4-million-ton deficit in food production be met.

To become self-sufficient in production of food commodities should not be considered an impossible task. To increase the current food production by 10 to 15 per cent, by which amount the country is running short, is not an impossible task. Agricultural knowledgd and technological methods of production has improvee

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so much during the past few decades that stepping up present yield by 10 to 15 per cent is not at all difficult and can be done within reasonable time provided there be proper planning and conscientious execution of the same. Since 1940, the United States of America has increased her agricultural production by 33 per cent, the United Kingdom could during the same period step up her food production by 30 per cent. So, why not we in India ? Scientific agricultural know-how is no close preserve of any one nation ; *What has been possible elsewhere can surely be achieved here also*, provided there is the WILL, and unflinching resolution to carry out the WILL.

Apart from having spent a few hundred crores of rupees in foreign exchanges to buy imported foodgrains since War II, the Centre and the Provinces have expended so far about 50 crores of rupees on Grow-More-Food campaign and a like amount in subsidizing sale of rationed food commodities at the statutory fixed prices. Even then the food supply position in the country continues to be the same and no substantial increase in production seems to have been achieved.

It, therefore, becomes apparent that there is something basically wrong in the agricultural set-up in the country. The existing defects in the system need be remedied, the agricultural departments at the Centre and at Provincial level are required to be revitalized and thoroughly reorganized before the desired target of agricultural production can be reached. The existing set up has already proved its uselessness.

We, therefore, especially arranged for the publication of a series of articles[1] embodying the results of a comprehensive study of the different aspects of agriculture of U.S.A., admittedly the most agriculturally advanced country in the world to-day. Those articles dealt with all the major aspects of agriculture, *viz.*, (*i*) organization, (*ii*) agricultural finance and credit, (*iii*) industrialization of cash crop production, (*iv*) agricultural research and(*v*) how laboratory findings are placed in the hands of the farmers who can put them into practical uses. A perusal of those accounts of that dynamic Department of Agriculture will in itself stimulate fresh thinking and will provide with many a lesson as to how we in India can revitalize our own agriculture. While publishing those articles we, on our part, reviewed the present position of those specific aspects of Indian agriculture and provided in the accompanied editorials[2] expert advice as to how our existing agricultural departments can be reorganized, how several of the science departments of Indian universities can be harnessed for the purpose of agricultural teaching and research on the model of the land-grant agricultural colleges and agricultural experiment stations in the United States. We have shown how agricultural credit system can be reconstructed and what organization is needed for the purpose. We suggested ways as to how to help industrialization of a few major commercial crops. Lastly we have shown how research can help us to better our agricultural output and the ways in which laboratory knowledge can be placed in the hands of farmers for application in farming practices. We believe our endeavour will not fail to draw the attention of the authorities and the people of the land.

We feel convinced that one-sided measures will not materially improve the situation. The different problems are so much interlinked that they require simultaneous attacks from several aspects, at times apparently unconventional actions. We need research to gather new knowledge on several phases of agriculture, to harvest bigger yield and better quality. It needs adequate financial appropriations to finance research of both short and long term projects ; but more especially do we need to provide the farmers with loans to pay for improved seed, manure and approved farm implements. We need to do away with, or appreciably cut short, the official red tape to ensure that loan amounts, seed and fertilizer reach the cultivator in time and not after the season is over. Above all, we need adequate personnel to carry modern agricultural knowledge to the farmers for their uses. Knowledge confined within the laboratory walls is useless ; it becomes productive only when placed at the hands of the actual tiller of the land to grow two blades of grass where he grew only one before.

Whatever organization we may have on other aspects of agriculture, we find a complete absence of any set-up in the country comparable to the very serviceful Extension Service of the U.S. Department of Agriculture, or the National Agricultural Advisory Service of the United Kingdom established as late as 1946. However meagre the country's research set-up be, it has to credit several breeds of high yielding crop plants and dairy stock. Several strains of Pusa wheat, a few strains of Coimbatore sugarcane, etc., are known to yield twice or thrice the amount compared with the farmers' own varieties. But we still see that the farmers even adjoining the Government farms yet sow their own unimproved strains and harvest one half or even less quantity than the Government farms although there is no physical reason for this disparity. Country's economy can hardly afford to spend money to raise high yielding strains or stock on one hand and not to utilize them for the common good of the country and the people. Proper organization should, therefore, be created to ensure that these high yielders are grown widely over the country. Two things are necessary to achieve this (*i*) the setting up of large seed multiplication farms so that there be enough supplies available to the farmers and (*ii*) the organization of an agricultural extension service on the model of the one in U.S.A. or U.K. to popularize improved breeds of crops and livestock and to aid in other ways farmers who only can collectively help to produce more food in the country.

[1] J. C. Saha. *Sci. & Cul. 14*: 441-446, 488-494 ; *15*: 46-49, 127-134, 1949.

[2] (*Editorials*) *Sci. & Cul. 14*: 439-441, 485-488 ; *15*: 43-46, 125-127, 1949.

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But by past failures and unfulfilled promises, the Department of Agriculture of the Centre as well as of the States has lost faith and trust of the common cultivator. Often he was pursuaded to sow Government supplied seeds only to find to his miseries that they failed to perform upto the promises. Often he received his quota of fertilizer after the season passed by; when he was given agricultural loan, he received it far too late to be of any productive use to him. These and countless other not-too-pleasant past experiences in his dealings with Government agricultural departments have made him suspect even the honest and most sincere intentions of the agricultural departments.

However apathetic he may have grown during the course of the past generations, his goodwill must be earned by persistent efforts—not by empty promises but by sure deeds. This requires a complete change in the outlook of the officials of the agricultural departments and a new spirit down the ranks, a habit of demonstrating with their hands what they want the farmers to adopt and an extensive organization of extension staff to carry to every village knowledge regarding improved agricultural practices. But they can be achieved only after a thorough reorganizat on has been effected in the agricultural structure of the country.

AGRICULTURAL EXTENSION SERVICE IN THE UNITED STATES

J. C. SAHA

THE prosperity that is enjoyed by the farmers in the United States of America has been made possible by the rapid practical application to farming practices of the new knowledge gained in the laboratories and experimental farms of the U. S. Department of Agriculture and of the many agricultural experiment stations of the land-grant (agricultural) colleges and universities of the 48 individual States. One who has spent any length of time in U.S.A. or made a study of the causes behind the agricultural advancement in the North America becomes at once amazed how quickly, effectively and efficiently the results of laboratory findings are placed in the hands of farmers for their use.

Some of the areas and ways in which the U.S. Extension Service has achieved magnificent results during the past few decades include :

"Counselling on farm problems; securing application of the findings of research on the whole range of farm operations from land use, soil treatment, crop and livestock production to better farm management and business methods, better homes and better farm and community living ; working with rural youth ; helping farmers solve problems through group action ; mobilizing rural people to meet emergencies ; developing an understanding of the economic and social factors affecting family living and agriculture in general"[1]. (p.1)

Origin

The Extension Service was established under terms of the Smith-Lever Agricultural Extension Act of May 8, 1914, as an agency under the organizational set-up of the U.S. Department of Agriculture[2]. The Act stipulated personal contact teaching methods among farmers to be financed by Federal grants and conducted co-operatively through the land-grant colleges of the individual States. The Extension Service is entrusted with the responsibilities of making thus available throughout the country the findings of investigations in agriculture and home economics to those who can put the information into practical uses.

Scope of Operation

The Extension Service aims to improve the economic welfare, health, family and community life of the rural population by making the results of agricultural research available to the farmers.

Its sphere of activities includes co-ordination of the agricultural and home economics co-operative extension work of the U.S. Department of Agriculture and the land-grant colleges and experiment stations of the individual States ; it directs the country agricultural agents, home demonstration agents (women) and 4-H Clubs work. It helps to organize county committees to render advisory assistance to war veterans and others wishing to take up agricultural pursuits as means of livelihood.

Although the major items of extension programs are particularly directed towards farm and rural families, its effect is all-pervading, as practical application of new technological development of more efficient methods of production cannot but contribute to the general welfare of the consumers at large and the country as a whole.

Mode of Operation

The modus operandi of the Extension Service in agriculture and home economics are to help farmers and rural families to help themselves by acquainting them with latest utilitarian developments relative to problems facing the farm families or rural communities. It aims to help people to attain, through their own initiative, a higher and more satisfying standard of living. Nothing is done that may appear to be forced from the top. Historically, the extension staff has

[1] Joint Committee Report on Extension Programs, Policies and Goals. U.S. Department of Agriculture and Association of Land-Grant Colleges and Universities, 1948.

[2] J. C. Saha. *Sci. & Cul. 14*, 441-446, 1949.

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recognized the propriety of, and necessity for, the co-operation of the people themselves in determining problem emphasis in extension programs of the individual counties: the methods employed for extension activities depend upon the nature of the problem in question. More important of the extension methods used are:

Individual Counselling. The extension workers visit individual homes or farms, aid the farmers or homes to analyze their problems and counsel them as to the best way of solving specific problems. Although a limited number of families can thus be attended to within any given time, its outstanding merit lies in its effectiveness. Personal counsels are widely sought by farmers; multitudes of farmers and rural homes that possess telephones freely use that facilities to discuss their problems with extension personnel and get the required advices.

Demonstrations on Farmers' Estates. The practical demonstration method is effectively used to teach home and farm practices with effective results. The nature of demonstration varies according to the major problems of a locality. Where soil conservation is the pressing problem of a locality, a badly eroded farm is selected for demonstration work. The extension personnel, aided by local volunteers and if necessary strengthened by a working party of the U.S. or State Soil Conservation Service personnel, help the farmer to put his farm into shape. If pest or disease is the problem in a locality, the extension worker will stage an effective method of spraying or dusting. By such means the Extension Service helps farmers in a locality to get acquainted with the technique of operation and explain to them the benefit resulting from the application of such modern practices.

Meetings and Group Discussions. This method of carrying extension information to farmers or rural communities is being extensively used for the last several years. A great advantage of this method is that a large group of people can be served at a given time. Liberal uses are made of films, photographic slides and other kinds of visual aids.

One of the essential features that distinguishes these meetings is their informality. The farmers are encouraged to raise for discussion any points they might want information on. This permits an exchange of views and pooling of information with the feeling that the extension personnel is not there to bestow on them good sermons only. It is the human touch in understanding the farm communities' daily problems that has endeared these meetings to them and the love with which the extension works are received all over the United States.

Leaflets and Bulletins. Because of high percentage of literacy published teaching devices such as leaflets, letters and bulletins, often nicely illustrated, rank high among the various extension methods used. Depending whether the problem is of local or national importance, the States land-grant colleges or the U.S. Department of Agriculture publish such informative materials and are distributed free to any one on request.

These publications deal with any conceiveable phases of farm and rural community life from practical farming instructions to how to iron a shirt or how to be happy in family life. The following figures will speak of the great popularity of such bulletins. As of June 30, 1948, the number of copies distributed on requests are: Home canning of fruits and vegetables—7.4 million copies; Removal of stains from fabric—3.0 million copies; Farm poultry raising—1.7 million copies; Roses for the home —1.6 million copies, the Farm home garden—1.2 million copies; Home-made jellies, jams and preserves—1.8 million copies; Growing annual flowers—1.1 million copies[3].

One thing that has enabled such wide distribution of the bulletins, criculars, etc., is the provision in the act establishing the States agricultural experiment stations that "Such bulletins or reports and the annual reports of said stations should be transmitted in the mails of the United States free of charge for the postage"[2]

Radio. Possession of radio receiving sets is a common thing with average U.S. farmers. Several of the land-grant colleges maintain their own radio stations, others have specified time allotted to them by commercial radio stations. Hundreds of county extension workers utilize radio facilities to carry extension knowledge to the farm and rural communities.

Operational Units

The activities of the Extension Service are carried on county (the opposite number of a district in administrative status and usually equivalent to a sub-division of an Indian province) basis. Each county has usually one County Agricultural Agent, one Home Demonstration Agent (woman) and one 4-H Club Agent—indicating that each group specializes in one aspect of a mutually complementary programs of extension work. These categories of agents, though paid from the joint Federal, States and Counties funds, are under the administrative charge of the States extension services with headquarters at the land-grant colleges. The extension service at the States level is a department of the land-grant college.

Besides their official extension duties, the county extension personnel are actively encouraged to energetically co-operate with other activities of the farm and rural community life.

County Agricultural Agent. The County Agricultural Agent is the central figure in all agricultural activities in a county. He acts as the representative of the State and the Federal governments in all agricultural matters. He acts as a clearing house of agricultural information, takes active part in organizing meetings and discussion groups, directs the farmer as to the best way of doing a thing or how to proceed

[3] *USDA.* August 30, 1948.

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with in receiving benefits from various State and Federal agricultural upliftment funds. He is usually a graduate in agriculture with extensive training in extension methods.

As of June 30, 1946, there were 4,624 County Agricultural Agents and Assistant County Agricultural Agents on the roll in U.S.A.

County Home Demonstration Agent. Through group meetings, discussion circles, practical demonstrations (such as jelly making, food dressing, sewing, etc.), house to house visits, the Home Demonstration Agent helps housewives to understand how to save time and energy through application of modern devices, how to clothe their families suitably and economically, how to furnish and decorate their houses decently within their own income, how to beautify their home premises. Such activities assist housewives to develop confidence, to enjoy and pride in their contribution to family living.

The County Home Demonstration Agent is a woman and is ordinarily a college graduate majoring in home economics. There were 3,077 County Home Demonstration Agents and Assistant County Home Demonstration Agents in employment on June 30, 1946.

County 4-H Club Agent. The 4-H Club activities are designed to develop the agricultural, homemaking and citizenship abilities of the rural youth. Through 4-H Clubs* over 10 million rural boys and girls (of the age group 10 to 21) have been taught the habit of group actions and helped to acquire information or gain skills valuable to them as future farmers and homemakers.

The programs of work of the members of 4-H Clubs include undertaking responsibility for field crops and livestock production and their marketing, soil improvement or wild life conservation, food preparation and serving, making and caring for clothings, home gardening, etc. Boys and girls, individually or in groups of a few, undertake one or more work projects of their own choice, work on them at leisure at their houses or parents' farms. In the meetings held once a month or so the boys and girls report on the results they have obtained and compare with those obtained by the other groups. The boys and girls discuss their own experiences, arrive at a decision as to the best way of doing a thing. The 4-H Club agents or other non-paid local leaders that are present in the Club meetings act as mere advisers and help the members arrive at right conslusions.

Besides local meetings, the 4-H Clubs meet once a year on State-wise and in all—U.S.A. gathering. Besides reporting and discussion, a part of each meeting—local or national, is devoted to recreational activities.

On July 1, 1947, there were 558 paid workers employed as county 4-H Club workers, known either as County 4-H Club Agents or Assistant Extension Agents.

Specialist Extension Workers. The personnel are training specialists in their own subjects and are expected to keep abreast with latest knowledge in their fields of specialization. They keep the county extension workers advised of the latest developments of new scientific methods and help their application to local problems.

The specialist extension staff consists of Extension Plant Pathlogists, Extension Entomologists, Extension Horticulturists and several specialists in other subjects; they are usually located at the headquarters of the land-grant college of the State and are placed with the divisions of Plant Pathology, Entomology, etc, as the case may be of the land-grant college. Their constant association with the research workers in the land-grant college helps them to keep up with the latest knowledge in their respective fields.

In 1947, there were in U.S.A. 1,827 extension specialists in various agricultural subjects. They work under the directions of the States directors of extension work.

Financing Extension Activities

In 1948, appropriations for extension work in U.S.A. totalled 58.5 million dollars (*i.e.*, about 292 million of devalued Indian rupee) : 47 per cent of the total funds came from Federal appropriations, 29.3 per cent from individual State appropriations, and 2.7 per cent from other local sources.

Extension funds were used in 1946 as follows: 3.4 per cent on administration, 1.4 per cent on publications of bulletins and circulars, 17.8 per cent on specialist work, 47.2 per cent on county agent work, 24.0 per cent on home demonstration agent work, and 6.1 per cent on 4-H Club work.

Federal Appropriations. The methods of determining allotments of Federal funds to the various States for extension work vary with specific provisions made in the several acts of the U.S. Congress. The allotments to the States are made on the basis of (a) specified amounts for each State, (b) rural population, and (c) farm population.

States Appropriations. Most of the States legislatures appropiate funds for extension work biennially for the succeeding two-year period. Requests for extension funds are submitted as separate items in an integrated budget request for all divisions of the land-grant colleges—teaching, research, and extension.

County Appropriations. County appropriations are made by local (county) bodies on annual basis, and are usually ear-marked for specific work projects on the basis of local needs.

*the membership pledge is :
"I pledge my *head* to clearer thinking,
I pledge my *heart* to greater loyalty,
I pledge my *hands* to larger service, and
I pledge my *health* to better living, for my club, my community and my country".

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ORGANIZATION

Agricultural extension work in the United States is under the charge of the Extension Service, an agency under the U.S. Department of Agriculture. Extension Service is headed by a Director, who is responsible to the U.S. Secretary of Agriculture.

Since extension activities deal with work among farm and rural communities, the organization at the Federal headquarters is concerned primarily to aid in the evolution of suitable programs of extension work, evaluation of the results obtained, co-ordination of States and local activities where necessary and to exert an over all supervisory function. At the headquarters at Washington, D.C., the Extension Service has the following divisions :—

Division of Business Administration ;
Division of Extension Information ;
Division of Extension Studies and Training;
Division of Subject Matter ;
Division of Agricultural Economics ;
Division of Field Co-ordination.

Organization at State Level. Administration : Each State has an Extension Director, jointly responsible to the President of the and-grant college of agriculture and the Director of Extension Service of the U.S. Department of Agriculture. The State Extension Director administers all extension funds, is responsible for all extension projects and programs of work within his State.

Supervision. Located at the land-grant college also is a staff of State-wide extension workers including Supervisors and State Extension Leaders who represent the State Director of Extension in dealing with county agricultural agents, county home demonstration agents and 4-H Club agents, and assist in organizing county work.

Subject Matter. Subject-matter Extension Specialists located also at the land-grant college of the State serve as contact officers between the research workers of the agricultural college and the county extension personne incorporating the latest knowledge in their respective subjects into the county extension programs.

Organization at County Level. The county extension personnel are representatives of the land-grant and the U.S. Department of Agriculture and are jointly responsible to these agencies. Stations at headquarters are ordinarily a County Agent, a County Home Domonstration Agent and a county 4-H Club Agent. They work as public officials and are directly in charge of the respective branch of the extension program of the county.

TECHNICAL ASSISTANCE TO UNDER-DEVELOPED COUNTRIES*

A few months ago the problem of underdeveloped countries loomed large at a Conference on the Utilisation of World's Resources at Lake Success. The delegates to that Conference were told that the population of the world had increased by 1,000 million in 4 generations, and the forecasts are that by the end of the century it would be increased by another 1,000 million. It is in this context of a rapidly increasing and not a static population that the problems of better living have to be tackled.

In the more advanced countries, where knowledge of modern science and technology has been applied to resource development, production of the necessities of life has grown much faster than the increase in population ; and men have been assured freedom from hunger from the cradle to the grave and also a reasonable expectation of freedom from want as a reward of normal work, where such knowledge has been little utilized for the enrichment of human life, as in the case of under-developed countries, the standard of living for the common man has remained stationary and even gone down. There men have to live even now in constant fear of untimely death by hunger and disease. For example in India, about 75% of the people live as medieval peasants often in a family of five rarely cultivating more than 3 acres of land. The average per capita income is no more than 36 dollars a year with its inevitable incidence of malnutrition, famine, disease and ignorance.

The seven hundred and fifty delegates and observers from many lands who attended the U.N.O. Conference and surveyed the world's resources in food, water, power, fuel, and other essential raw materials were not daunted by these facts and came to the conclusion that there was every prospect of guaranteeing an abundant life to every man and woman, if these resources were integrated and developed with vision and enterprises, on the basis of maximum production and maximum utilization of existing knowledge. There is, in fact, no real reason to be pessimistic in our outlook of the future.

They were, however, very conscious of the great gap that existed between what could be done and what was being done, and could only hope that by the united efforts of men of good will, public opinion all the world over will be enlightened and this gap would be bridged at an early date. It is not the business of the Unesco to prepare project reports or detailed plans for the development of the resources of the under-developed countries ; that is the business of Governments of those

*Based on a speech by Dr. J. C. Ghosh at the Unesco Conference in Paris on "Technical Assistance to Under-developed countries" held in autumn, 1949.

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countries or of the U.N.O. But it is the special responsibility of the Unesco to spread far and wide the know-how for developing such resources and to focus world's attention on the problem as to how to remove all obstacles that stand in the way of the application of such knowledge. Knowledge often remains imprisoned in secret documents or buried in printed literature ; there are often vested interests which would even prevent its use for economic progress. It is the business of the Unesco to make knowledge visible in action, or as the leader of the British delegation stated the other day, allay thoughts with the doing of things. The Mayor of New York in welcoming us said that the store of scientific and practical knowledge was itself the world's greatest resource. It is a resource that grows with use and enlarged by sharing. It is the special task of Unesco to make possible such sharing of knowledge.

How can this be done ? First and foremost, by providing able teachers of technology to institutions in underdeveloped countries. A vigorous search should be made for such men who would take up these responsible positions as a vocation and not as a career. May be, there are among the rank of technologists, men of ability, who feel that science must have a moral basis in order to prevent the unlimited power which it offers to man from annihilating himself. May be, there are men of science who feel such anguish in their souls because of evil use of science, that they interpret their duties in terms of humanity as a whole—who feel that they may bring peace to this world by fighting the evils of hunger and ignorance wherever they occur, howsoever remote from their own homes. In my recent travels in middle Europe, I have come across many technologists of high ability who have been uprooted from their homes, or who wish to settle down in a new congenial environment, because of unsettled and extremely hard conditions in their own countries. Many of them have sought help from the International Refugee Organization. I am glad that the Secretary of that organization is here with us to-day and I would request him to give us fuller information about the possibility of engaging such refugee technologists in useful work in under-developed countries. If men of real talent and high purpose can be discovered in sufficient numbers and given the fullest facilities to teach the nationals of backward countries how they can also develop their resources, the paradox of rich countries inhabited by poor people can be solved at no distant future.

The facilities that they would require in order to be effective teachers are abundant supplies of cheap books in science and technology and adequate laboratory and pilot plant equipment. It is difficult to make suggestions off hand how this could be quickly done. Publications of cheap editions of standard books on science and technology say, on the model of Tauchnitz Editions which were so popular in Germany—under the auspices of the Unesco for exclusive use in underdeveloped countries will be a great boon to their poor students. It is desirable that a small section of the Unesco Secretariat should prepare detailed plans for quickly achieving this end.

Next in importance, comes the provision of fellowsips which will enable talented young man from backward areas to receive advanced specialized training in foreign institutions which enjoy high reputations as seats of such learning. But it is not enough to acquire such theoretical knowledge from academic institutions. In order to be successful one must learn technology as a science, and also practice it as an art, must acquire the skill for the making of things which are the products of a modern industrial system. Such skill can be acquired in the industry itself ; and to-day the enlightened management of many industries do not hesitate to train their young nationals fresh from a technical college in such skills. But if the student is a foreigner, the doors of such practical training is rarely opened to him. To open such doors will not be an easy task. History shows that interdependence follows industrialization—that a country in the course of its industrial development becomes continously the better customer of another country which is ahead of it. This lesson of history must be brought home to industrial magnates who are not accustomed to look at things from such a long range view point. There is no reason why a determined effort by Unesco should not be crowned with success.

We are thankful that in these International Conferences, the countries that did not matter much before are being given greater attention ; that the UNO and Unesco are seized with the determination to give these countries such technical assistance as would quickly enrich the life of their people. The funds provided in the budget however, are not commensurate with the great task that is being undertaken. I do feel, however, that is the beginning of good work. I agree with the British delegation that more money does not always mean more effective work. A bird may refuse to sing in big case. But if experience shows, as we hope it will, that limited funds have been used for effective work, then I believe, lack of funds will not stand in the way of the wider application of such effective work.

But however generous may be the help that comes from outside, the real progress of a country must come from within. The leader of the Burmese delegation referred to the saying of Lord Buddha—'work out your own salvation'. This is true not only in the spiritual world but also in the material world. After all the worth of a State is the collective worth of the citizens of the country who constitute the State.

Men in high places are not wanting who emphasize the right of primitive communities to live in their own ways. Scholars in the lands of old civilizations, who have inherited the traditional wisdom of their ancestors, are reluctant that the faith of their people in such ancient wisdom should be shaken. They generally do not recognize that science is something more than mere discovery of the facts and forces of nature, and the principles and laws which correlate them. I maintain, that to its votaries science also is a method, a confidence and a faith. It is a method of controlled observations and experiments recorded with absolute

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honesty. It is a confidence that truth can be discovered. It is a faith that truth is worth discovering. It is the essence of the whole process of discovering truth, that new crucial experiments should be continuously performed, and new facts continuously gathered and that men of science should always maintain complete intellectual honesty and re-examine the existing views in the light of new facts. In a world swayed by passions, scientific attitude stands for suspension of judgement, until evidence has been properly weighed. The contribution which this aspect of science can make to the solution of human problem has often been overlooked. It is high time that every effort is made to propagate this cultural mission of science all the world over, specially among people of the older civilization.

Again for under-developed countries, if science and technology were to play their part in promoting human welfare, considerable change in the outlook of life may be necessary. For example, it will not do if people there continue to believe that the world of today is the degenerated product of a golden age of an earlier period. It will not do if they decry pursuit of happiness in this world for the sake of securing happiness in Heaven. It will not do if they harbour mental inertia under the guise of conservation of old ideas. It will not do if they say that children are the gifts of God and are welcome in any number. Rather should man in these lands learn and feel that he can be master of his own environment, that he need not be the victim of fate or of the forces of nature, supposed to be subject only to the will of the Gods. The Director-General of the Unesco in his opening address referred to the famous saying—"I believe in the future because I make it." He and the Unesco will have done their jobs very well to the old countries, if they could inspire their people with faith in the fertility of free will and self-decision. The transformation of helpless masses of men, submissive by long tradition to the vagaries of so called fate into self- reliant communities of people who are conscious that they are masters of their destiny is an achievement worth struggling for. We, who represent under-developed countries in the conference, on our part promise all assistance, and wish Unesco success in this struggle.

THE SOIL AND THE ENGINEER

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THE soil is the oldest and perhaps the most used of engineering materials. It is the upper weathering layer of the solid earth crust. It is never in a state of equilibrium and is changing from one state to another, with consequent changes in its properties, due to physical, chemical and biological processes operating on the mass. The engineer is primarily interested in the physical, mechanical and structural properties of soils. The size and arrangement of different particles and their behaviour under load with variations with moisture content, temperature and air supply are of particular interest to him. It is imperative, therefore, that he should be well acquainted with these properties of soils so that he will be in a position to apply successfully the acquired knowledge to engineering problems.

Important contributions in this field have emanated from the geologist, the soil scientist, the industrial chemist, the highway engineer and the structural engineer. From systematic examinations of soils in the laboratory and fields they have furnished valuable information on the mechanical and physical properties of soils in relation to their suitability for practical purposes. This has resulted in our knowledge being crystallized into definite form, and tests of an engineering nature are now available for comparing the relative merits of different soils.

The important physical and mechanical characteristics which control the behaviour of a soil are : Internal Friction ; Cohesion ; Compressibility ; Elasticity ; and Capillarity. The engineer must be in a position to recognize the effect of the above characteristics on a soil and whether these are primarily due to the structure of the soil, to the constituents or to field conditions, on the basis of information gained from a number of tests. For engineering work, tests are performed on both *disturbed* as also on *undisturbed* samples. When information is required on foundation for dams, bridges, buildings, etc, undisturbed samples should preferably be used ; but for earth dams fills or highway subgrades disturbed samples give satisfactory data.

Selection of Site and Methods of Taking Sample

The selection of the site for taking samples for routine tests is also of importance. For purposes of making a preliminary survey and selection of site, penetration test with a probing rod, such as Mackintosh one man bore-hole outfit, is extremely useful. It can be quickly assembled and exploration to a depth of 50ft. performed in less than an hour. Once the site is located, the most satisfactory method for the examination of the soil strata conditions is by sinking a trial pit. The various strata can be studied in their normal state and the ground water conditions exactly determined. A record of examination must be made at the actual time of excavation of the trial pit, as the conditions of the soil change on exposure to the air or on cantact with water.

Disturbed samples from the chosen site are often obtained by shovelling the soil directly into a sack or

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can. Soil augers are used for greater depths when only a small quantity of the soil is required for exploration or routine work. When large samples are required, pits are sunk.

Many ingenious methods have been devised for collecting *undisturbed samples*. The apparatus most suitable for this purpose consists of a cutting-edge slightly smaller in diameter than the interior of the retaining cylinder about 5″ in diameter and 2′0″ long. The adapter head is provided with a reducer to 1—1/2″ boring rods and a non-return valve for retaining the sample. After sampling, the cutting nose and the head can be removed and end caps fitted in place, which prevents drying out of the sample during transport. The samples may also be sent to the laboratory in watertight containers. The undisturbed samples are kept in a special humid room until actually ready for testing. For taking undisturbed samples of granular material at shallow depths, steel boxes about 12″ on a side are used. With the top removed, the box is inverted over the soil and carefully forced into it while excavating around the edge by any suitable device. When the container is full, the sample is cut from the original material, the box is turned right and the top is replaced.

Soil Tests

In interpreting the results of soil tests, the conditions of the soil in the field, its formations, history, location and natural environment are taken into consideration as all these factors contribute to the performance of a soil as an engineering material. The tests which furnish many of the important soil constants and serve to indicate the presence of constituents having dominant influence upon engineering practices, are detailed in the following table. The types of samples to be used as also the information gained on particular properties are also indicated.

Table 1.

Test	*Type of samples*	*Properties*
1. Moisture Content	Disturbed samples from original location without stones & gravels.	Adsorption capacity; Capillarity; drainage conditions; etc.
2. Specific Gravity	,, ,, ,,	Void-ratio; porosity; moisture content.
3. Apparent Sp. Gravity	Undisturbed samples from the original location.	,, ,, ,,
4. Mechanical Analysis	Disturbed sample; material passing sieve No. 10; stones and gravels removed and weighed.	Grading (relative proportion of sands, silts and clays).
5. Liquid Limit	Disturbed samples ; materials passing through sieve No. 40	Capillary capacity.
6. Plasticity Index	,, ,, ,,	Cohesion.
7. Centrifuge Moisture Equivalent	,, ,, ,,	Combined effect of Compressibility, capillarity and permeability.
8. Shrinkage Limit	Disturbed samples; materials passing through sieve No. 40	Combined effect of cohesion and resistance to consolidation.
9. Field Moisture Equivalent	,, ,, ,,	Combined effect of capillarity and cohesion.
10. Volumetric and Linear Shrinkages	,, ,, ,,	Combined effect of capillarity, cohesion and resistance to consolidation.
11. Electrochemical Analysis	,, ,, ,,	Adsorption and base exchange properties.
12. Chemical Analysis	Disturbed sample; materials passing sieve No. 10.	Absence or otherwise of deleterious materials.
13. Maximum Density*	,, ,, ,,	Consolidation and optimum moisture content.
14. Shear*	Undisturbed samples; on materials without stones and gravels.	Combined effect of internal friction and cohesion.
15. Consolidation*	Undisturbed saturated samples.	Compression of saturated strata.
16. Permeability*	Undisturbed samples for soils in natural state; or compacted soil for fill and embankment materials.	Grading; pore-size distribution; presence of impermeable strata.

*Required in special cases.

Tests help in Soil Classification

Limited space does not allow me to deal with the procedures for various tests. It is, however, of interest to describe as to how the results of soil tests have helped in the classification of soils for engineering purposes. Soils have been classified into eight groups based upon the presence of soil constituents, physical properties and performance. These are :

A—1 : Excellent binder ; contains proper proportion of coarse and fine material; high internal friction; high cohesion ; absence of detrimental shrinkage, expansion, capillarity or elasticity.

A—2 : Improper grading or inferior binding ; may be stable in dry weather and soft in wet weather (plastic type) or highly stable when moist but becomes loose and dusty in dry weather (friable type).

A—3 : Almost pure sand ; high internal friction ; no cohesion ; no detrimental capillarity or elasticity ; flows under wheel loads but furnishes excellent support when loads are distributed.

A—4 ; Predominance of silt ; internal friction variable; practically no cohesion ; no elasticity ; may form stable road when dry but will soften in wet weather.

A—5 : Predominance of silt but with highly elastic properties even when dry ; will not retain compacted density but will rebound on removal of load.

A—6 : Predominance of clay ; low internal friction ; no elasticity; high expansion and shrinkage properties ; can be compacted to permanent density ; often interferes with macadam bond ; deformation

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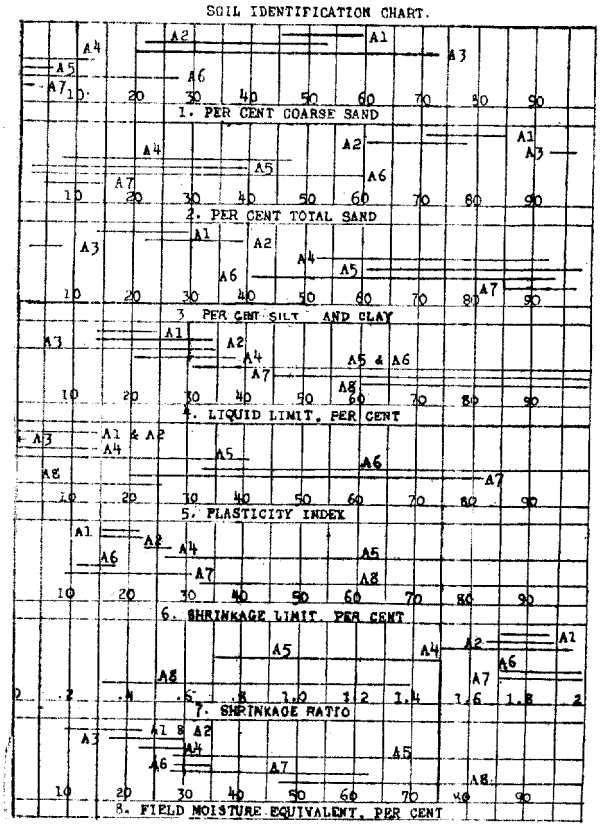
occurs slowly under load and very little rebound on the removal of load.

A—7 : Similar to group A—6 excepting that it is elastic at certain moisture contents ; may have considerable volume change and cause concrete pavements to crack.

A—8 : Contains very large amounts of peat or muck ; no internal friction ; low cohesion ; high capillarity and elasticity ; will settle under load.

In laboratory examinations. the percentage of each soil fraction *i.e.*, grading, is first determined. Then such tests, as liquid limit, plasticity index, shrinkage Limit, shrinkage ratio, field moisture equivalent, etc., are performed. The range of the numerical values of these physical constants for the above eight groups have been shown in the following chart :



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A soils belongs to *A*—1 group if this is indicated in every chart. If both *A*—1 and *A*—2 are indicated although neither is indicated by every chart, the soil should be classed as *A*-2 ; and so on.

Selection of Soils as Engineering Material

The next point of interest is to see as to how the classification of soils into groups has helped in the selection of soils as engineering material and in suggesting soil amendments is specific cases. This point has been discussed under the following three heads :

Soil for Footings, Abutments and Embankments : An examination of the properties of the different groups of soils indicates that the soils belonging to *A*-1 to *A*-4 groups are best suited for foundation work. Next come the less plastic varieties of the *A*-6 and *A*-7 groups. It is important to note that soils of the *A*-5, *A*-8, and the more plastic varieties of the *A*-6 and *A*-7 groups should never be used without special treatment (discussed under treatment of soils for highway and airport construction).

Soil for Fill and Dam Materials : Soils of the *A*-1 to *A*-3 groups and the better varieties of *A*-4 are suitable for use as fil materials either in rolling or hydraulic method of construction. Moderately plastic varieties of *A*-4, *A*-6, and *A*-7 groups can be used for this purpose after stabilization by densification. If possible, soils of the *A*-5 and *A*-8 groups and the more plastic varieties of the *A*-4, *A*-6 and *A*-7 groups should not be used in fill construction. If unavoidable, they must oe adequately densified as per specification laid down by soil tests.

In earth-dam construction, groups *A*-1, *A*-2(plastic), *A*-4 (plastic) and the better varieties of *A*-6 and *A*-7 are quite suitable. Friable *A*-2 and *A*-4 can be used in the core-wall. If possible, soils belonging to the *A*-3, *A*-5, and A-8 group and the more plastic varieties of the *A*-6 and *A*-7 classes should not be used in dam construction. When soils of undesirable qualities are used the densification method of construction should be used or recourse should be taken to compact the soils by rolling or placement by the hydraulic method.

Soil for Highway and Airport Construction : The soils to be used for these purposes need special attention due to the live loads usually exceeding considerably dead loads. Even soils of *A*-1 group need some treatment. The requirements of soils of different groups have been ably summarized by Hogentogler[1]. These are as follows :

A-1 : Drainage when ground water level is high ; treatment with deliquescent chemicals for stabilized soil roads.

A-2 (*friable*) : Moist condition for use as stabilized road material, bituminous surface treatment for use as base course ; thin wearing course in pavement ; *A*-2 (*plastic*) : Drainage to prevent softening of binder from below ; treatment with deliquescent chemicals ; dry condition for use as base for thin wearing courses.

A-3 : Subgrade treatment by admixture of binder or light tars and substantial wearing courses in the absence of binder treatment, thick non-rigid or thin rigid courses.

A-4 : *When drainage possible*, thick macadam or concrete pavement of medium thickness ; subgrade treatment by admixture with coarse constituents ; oiling improves quality. *When drainage not possible*,

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thick concrete pavement, crack control and reinforcement.

A-5 : Same as *A*-4, wet ; conditions worse.

A-6 : *When homogeneous*, thick macadam or rigid pavement for ample load distribution ; surface treatment by oiling and screening; crack control. *Permeable but drainage possible*, macadam or rigid type ; mechanical treatment under traffic increases stability. *Permeable but drainage not possible*. very strong macadam or rigid type with crack control ; reinforcement ; subgrade treatment by admixture of coarse material.

A-7 : Same as *A*-6-homogeneous ; in addition, surface treatment by means of tar-paper for preventing expansion beneath fresh concrete.

A-8 : Ample crack control and reinforcement for pavement.

In conclusion, it may be safely said that any engineering enterprise employing soil should be preceded by an elaborate testing of the soil in question, because the construction is either made with the soil or the structure is built on it. It is, therefore, needless to emphasize that any institution where Civil Engineering is included in the curriculum of studies, should have a well-equipped soil research laboratory.

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PAPER MAKING IN INDIA

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HISTORY

THE ancient Hindus used palm leaves, *Bhurja patra* and Sachipat (barks of Himalyan Silver Birch and Agaru) for writing. The paper was introduced by the Chinese in the early Hindu period or perhaps still earlier. The cultural relation which is as old as the history of the two countries took shape in the interchange of ideas, arts and sciences. The art of paper making was well established in the border provinces of India before it spread to Arabia and Turkistan. At Nowshera near Srinagar (Kashmir), the industry is said to be of at least 1300 year old[1]. Some of the samples of Nepalese paper collected by the Industrial Section of the Indian Museum are still in excellent condition after about 1000 years of their manufacture. There are some samples collected from Manipore and are supposed to have been made several centuries ago. The secret of the art appears to have been kept within the sphere of limited communities. Its growth at any rate must have been very slow and it was only in the Mohammedan period that it developed into an industry. In the middle of the fifteenth century Zainul Abedin brought into Kashmir some experts from Samarkand who introduced an improved technique of softening and beating rags, hemp and cotton-waste into pulp, sizing paper with rice starch and polishing with agate. A sort of standardization of the process was thus set up and the quality of the paper so made has been maintained there ever since. The Kagzis, a class of Mohamedans engaged in the trade spread the industry throughout the country. New raw materials like jute, barks of trees, leaves of date palm were gradually intoduced and the process of manufature was modified accordingly. At the time of the introduction of the modern paper making process, the industry was more or less established in Bengal, the United Provinces, Madras, Trichinopoly and Cochin, Sind and other places. The quality of paper ranged from ordinary 'Tulat' to fairly strong writing papers for account book and strong wrapping papers. The name 'Bally paper' attached to a class of cheap writing paper of brown to reddish brown colour perhaps originated with the mill-made paper of a similar quality produced by the Bally mills, in order to distinguish it from the hand made paper of the 'Kagzis'.

In 1812, William Carey engaged a few native paper makers to make paper in their own way. Gradually the process was modernised and it was in this mill at Serampore, Bengal, that the first steam engine erected in India was installed in 1820 for operating the beating engine. The first Fourdrinier type continuous making machine was also introduced here in 1832. But owing mainly to lack of support, if not definite discouragement on the part of the then Government, the mill was not a success and the machine was eventually trasferred to Bally. The Royal Paper Mills at Bally was started in 1867 and was run on a commercial scale for a number of years and finally absorbed by the Titaghur Paper Mills in 1905 . The Upper India Couper Paper Mills, the third of the series of modern paper mills, was started at Lucknow in 1879 and is now the oldest of the existing mills in this country. In 1913 there were in all seven mills producing 24,000–25,000 tons of paper from Sabai-grass, rags, hemp, jute and imported spruce wood pulp. In this year R.S. Pearson of the Forest Research Institute, Dehra-Dun, published a comprehensive report on the avilability and utilization of bamboo for the manufacture of paper, but the process of boiling with caustic soda suggested by him could be applied to bamboo only if the knots were excluded from the charge. The first paper mill designed to work entirely on bamboo and

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using the entire stem was started at Naihati in 1918. The process, based on cooking the material with a solution of magnesium bi-sulphite, and modified in details, is now one of the most efficient method of pulping bamboo. The Pearson process was also modified by William Raitt by way of cooking in stages and was soon adopted by the Titaghur Paper Mills, followed by various others. There are at present about twenty mills with a total rated capacity of 1,00,000 tons per annum.

Raw Materials

Paper is composed chiefly of plant fibres collected and formed into a sheet from a watery suspension. The quality of the paper is determined by the nature of the fibres. The method of treatment and the finish and its durability depends mainly on the degree of purity of the fibres, *i.e.* the extent of isolation from the non-cellulosic substance. Cellulose may be defined as the structural basis of plants. Chemically, it is a carbohydrate of a very high molecular weight, being composed of a large number of an hydro-dextrose units arranged end to end to form a sort of chain structure. The degree of resistance to chemicals is a function of this chain length, or the degree of polymerisation. The lower forms of cellulose which are soluble in mild acids and alkalis are called hemicellulose. A portion of hemicellulose yield pentose sugars on hydrolysis and is called pentosan. The celluloses and hemicelluloses are held in position by a sort of cementing substance called lignin which is insoluble in water, acids and dilute alkalis but are soluble in strong alkalis and sulphurous acid, sulphites, chlorine and hypochlorites. Besides these there are starches, gum, sugar, resins, fats, waxes, colouring matter and mineral matters in various proportions. The main constituents of some of the more important fibre-yielding materials are as shown in Table I. For fine papers like bank,

Table I

Composition of Fibrous raw Materials

Material	Cellulose %	Lignin %	Pentosans%
Cotton	91.2	—	
Hemp	79.3	5.2	5.5
Sisal	77.0	6.00	13.00
Bamboo	50.0	25.0	15.0
Sabi grass	46.0	5.5	12.0
Barley Straw	48.6	16.4	31.9
Oats	43.8	18.6	22.8
Rice	45.5	10.9	21.5
Wheat	56.7	16.3	28.4
Rye	36.3	11.3	20.4
Flax	82.0	2.7	2.0
Ramie	85.0	1.0	2.0
Jute	64.0	21.0	15.0
Spruce	57.44	28.29	11.3
Pine	54.25	26.35	11.02
Beech	53.46	22.46	24.86
Birch	45.30	19.56	27.07
Poplar	47.11	18.24	23.75

bond, ledger etc., the fibre should be long, strong, light in colour and durable. The length and the structure are characteristics of the parent substance but the colour and the durability depend, as has already been explained, on the purity of the isolated fibres. Generally the substances containing high percentages of cellulose yield fibres of good quality. As the proportions of non-cellulosic matters increase, the method of isolation of celluloses also becomes more and more complex and often the product is degraded due to the fragmentation of the cellulose chains and other chemical changes. For cheap news print and boards, on the other hand, any fibrous raw material is good enough if it can be converted into pulp at a reasonably low cost. Between these two extreme types there are various grades of paper and the choice of the raw materials is determined by the suitability and the cost of conversion to pulp. The raw material if suitable otherwise, should be available in sufficient quantities and at a reasonable price, in other words, it should have little value or should be available in such quantities that the requirements for a paper mill may not interfere with the local demand and prices.

Manufacture of Paper Pulp

Pulping processes can be broadly divided into two classes—mechanical and chemical. The mechanical process consists in grinding the fibrous material with water to a soft workable pulp. The fibres so obtained are weak, impure and subject to rapid deterioration and are suitable only for low grade papers and boards. The mechanical pulp retains about 80% of the raw material and is the cheapest of all commercial pulp. Soft woods of fairly light colour and low resin content are best suited for making news print. If before grinding the logs of wood are softened with steam for a few hours at a pressure of about 45 pounds per sq. inch, a more flexible, strong and durable fibre can be obtained which although dark in colour, is suitable for wrappers and leather boards. The colour can be improved by washing the steamed logs with hot water containing up to 2% of oxalic acid on the weight of the wood. Such and other processes in which the raw materials are reduced to suitable sizes by chipping or crushing and then subjected to a chemical treatment so as to remove a portion of the cementing substances and then ground or otherwise disintegrated to pulp are called semi-chemical processes.

The chemical pulp is obtained by gradual elimination of the non-cellulosic materials and the process usually involves a series of mechanical and chemical treatments. The yield of fibre is low, the process is complicated and costly, but the fibre is stronger and more durable and hence better suited for fine papers than the corresponding mechanical pulp from the same type of raw materials. The impurities of fibrous materials can be removed by boiling with a caustic soda solution of suitable strength and under a moderately high pressure. As the proportion of the impurities increases, the strength of the solution, the percentage of caustic soda, the boiling pressure and the cooking time are all increased proportionately. The caustic soda is largely reclaimed from the spent liquor and re-used in the process. After the digestion is over, the liquor is collec-

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ted together with one or more washes and concentrated to a fairly thick consistency. The concentrated liquor usually contains sufficient organic materials to support its own combustion in a suitably designed furnace whereby soda ash or a crude carbonate of soda is obtained. This is dissolved in water and the green liquor so obtained is then causticised with lime so as to convert the carbonate of soda into hydroxide and thus the white liquor after causticising is a solution of caustic soda, ready for use once more, in the cooking process. Any loss of caustic soda in the process is made up with an equivalent quantity of fresh soda ash added to the green liquor. At high temperatures and pressures a strong solution of caustic soda can dissolve a considerable portion of the isolated fibres, especially the lower forms of cellulose and consequently the quality and the yield of commercial soda pulp is often adversely affected.

By a partial replacement of the caustic soda with an equivalent amount of sodium sulphide, the concentration of the active alkali can be kept sufficiently low, the rest remaining in reserve to make up the loss due to the combination with pectin and lignin as the cooking proceeds. In practice a calculated quantity of sodium sulphate is added to the concentrated spent liquor before burning, the sulphate is thereby reduced to the sulphide and acts as the buffer in the finished white liquor. The loss of chemicals incurred in the boiling and washing of the raw materials may be partially or wholly made up with sodium sulphate and this modified process is called the sulphate process to differentiate it from the straight soda process. The sulphate pulp is generally stronger than the corresponding soda pulp and the yield is also higher.

The general principle of the alkaline cooking process as outlined above can be applied to all plant substances and with proper adjustments of the cooking conditions, vegetable fibres can be isolated in grades of strength and purity suitable for a variety of purposes. Cotton, flax, hemp, jute, deciduous wood, grasses, straws, bamboo, reeds and various type of agricultural wastes are reduced to pulp by this process. The sulphate process is applied to coniferous wood also. Some varieties of specially made sulphate pulps are very strong and durable and are called Kraft pulp.

The action of sulphurous acid on lignin to form lignosulphoric acid is the basis of another very important pulping process called the acid or the sulphite process. In practice the sulphurous acid is used in conjunction with a certain proportion of suitable base so as to neutralise a portion of the lignosulphoric acid formed during the process of delignification, otherwise, under the condition of high temperature, pressure and concentration existing in the digesters the fibre is weakened due to hydrolysis and is often so hard and deeply coloured that it becomes unbleachable and practically useless. Resins are unaffected by the sulphite liquor and always appear in the pulp in a higher concentration than in the raw material. Subject only to these limitations the sulphite process is applicable to any type of wood or other plants but it is mianly used for pulping coniferous wood.

The comparative figures for the requirements of the fibrous and non-fibrous raw materials required for making pulp by the more important commercial processes are given in the Table II.

TABLE II

RAW MATERIALS FOR PAPER PULP

	Mechanical	*Sulphite*	*Soda*	*Sulphate*
Wood	1—1.25 Tons	2.25 Tons	1.5—2.0 Tons	1.5—2.0 Tosns
Bamboo, Grass Straw	—	2.25—3.0 Tons	2.5—3.0 Tons	2.5—3.0 Tons
Lime	—	150—250 lbs.	500—600 lbs.	300—400 lbs.
Sulphur	—	190—300 lbs.	—	—
Soda Ash	—	—	250 lbs.	—
Salt cake	—	—	—	400—500
Steam	—	5000—6000 lbs.	12000—13000 lbs.	9000—12000 lbs.
Water	gall 40,000—50,000	100,000—150,000	100,000—150,000	100,000—120,000
Electricity	70—100 kw	200—300 kw	200—300 kw	200—300 kw

BLEACHING

The raw pulp whether produced by mechanical or chemical process always retains some impurities including lignin, colouring matters which are removed or otherwise altered in a fashion so as to cause the pulp to reflect more true white light by a process of treatment technically called Bleaching. The chemicals in the process are:

(1) Reducing agents like sulphur dioxide, sodium sulphite, calcium-bi-sulphite, zinc hydrosulphite etc., which improve the colour of the mechanical pulp by reducing the colouring matter to a white or colourless material; the action is not permanent, the colour reappears on oxidation or even exposure to light and air.

(2) Chlorine or chloride dioxide, sodium chlorite, calcium hypochlorite and bleaching powder are used for bleaching chemical pulps by way of oxidation and solubilization of the colouring matters which are subsequently removed by washing. The effect is more or less permanent depending on the partcular process and the extent of bleaching.

Various novel processes of bleaching mechanical and semi-mechanical pulps have recently been developed so that fibres of very exeellent colour and durability are now produced by quite unorthodox methods. The principle of chlorination process introduced by Cross & Bevan

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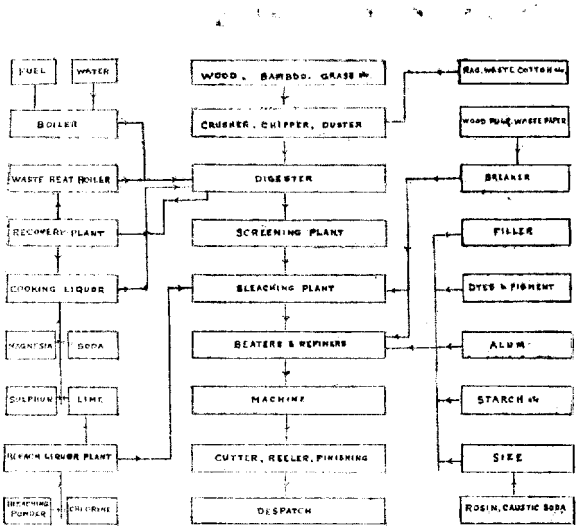
for isolation of cellulose from plant substances is now widely followed in the manufacture of chemical pulps.



A process devised orininally by De-Vain in Holland for pulping straw has been modified by Dr. Umberto Pomilio, an Italian chemical engineer for a continuous operation of pulping grasses, straws, bamboo, bagasse etc. The removal of lignin and other impurities proceeds in stages and the pulp may be obtained in any state of purity from crude pulp for boards to bleached fibres for fine printings. The outstanding advantage of the process is the great saving of steam and the continuity of operation.

Stock Preparation

The first step in the preparation of the stock for making paper is to soften or refine the fibres so as to make an uniformly felted sheet when the diluted stock is filtered through a fine wire cloth. The simplest way to do so is to pound the pulp with a mortar and pestle or on stones with wooden stampers (*e.g.* with a *Dheki*). In modern mills handling a large quantity of materials, the stuff is treated in specially designed beating engines or refiners. The individual fibres are thereby cut macerated and hydrated *i.e.*, allowed to absorb water on the exposed surface of the fine fibrils. By a proper adjustment of conditions the desired characteristics can be developed during the beating process, so that a long fibred stuff can be used for various grades of paper. The process of hydration can be greatly enhanced by using external mucilages like starch and cellulose esters instead of disintegrating the fibres into fibrils. In fact a certain proportion of lower forms of cellulose is essential for the developement of strength and felting quality of the fibres, the highly purified fibre like alpha pulp, and regenerated celluloses like viscose silk are of little use in paper making. Most of the common grades of paper are furnished with a suitable proportion of different kinds of fibre mixed together and refined in the beaters or treated severally and mixed later on in a mixing chest. In writing papers, water-repellant matters like rosin, wax, casein etc. are added in the form of emulsion and precipitated back by means of alum, so that the finished paper may take a neat impression of inks on the surface without getting wet through. Starch, sodium silicate and various other chemicals are also added to impart special qualities like rattle, handle etc. A suitable proportion of mineral fillers like china clay is also added in common grades of writing and printing papers in order to render the texture close, flat and the surface smooth and even. These auxilliary materials as well as the dyes are usually added in the beater and throughly mixed with the pulp.

Paper Making

The stock so prepared goes next to the machine where it is uniformly spread on the machine wire at a suitable dilution, and a sheet of paper is formed after gradual abstraction of water. The machine wire is an endless band of wiremesh spread flat on the supporting table rolls in Fordrinier type of machine or round the circumference of a skeleton cylinder drum in a cylinder machine. Water is drained out through the wire assisted in the process by the capillary action of the supporting rolls as well as the suction applied by means of suitably designed vacuum boxes placed underneath. The process of conversion of the stock to paper on the machine wire and the subsequent pressing, drying, calendering and reeling are all continuous. The paper after leaving the press section is dried over a number of steam-heated cylinders arranged in two tiers and passed through two or three stacks of chilled cast iron rolls whereby the surface of the sheet is calendered smooth. The paper is then removed in the form of reels and finally cut to proper sizes in a cutter machine and finished ready for the market.

The Present Condition and the Future

The chief raw materials used for paper making in India are bamboo and grass. Although 85% of Worlds' paper is made from wood its use in this country is very limited, mainly due to the scarcity of the common pulp woods, the minimum requirement for an economic unit producing soda, sulphate sulphite or mechanical pulp being about 20,000 tons on dry basis. Some of the softer deciduous woods like Simul (*Salmalia Malabarica*), Pituli (*Trewia Nudiflora*), Gewa (*Excaecaria, Agallcha*), Salai (*Boswellia Serrata*) etc are easily reduceable to pulp by the soda as well as the sulphite process. The fibres are short but can still be used as fillers in common grades of paper. Paper Mulberry (*Broussoletia Papyrifera*), Pula (*Kydia Calycina*), Chir (*Pinus Longifolia*) Salai etc. can be pulped mechanically and used for newsprint with about 30% chemical bamboo pulp or 25% chemical spruce [2,3]. The search for a pulp wood among rather unorthodox varieties has resulted in a project for a large news print mill in the C.P.

Most of the Indian mills were designed and constructed by British firms who had specialised in making

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paper from rags and grasses, and consequently the choice and the method of pulping raw materials have also been greatly influenced by foreign interest and practice. But in reality any pulping process can be modified to suit a particular type of raw material and if one material is found suitable otherwise, the particular method of pulping to be followed is a matter of convenience. Sabai grass and bamboo are usually cooked by the modified soda or sulphate process, but in one mill bamboo is pulped very successfully by a modified sulphite process. The cooking conditions in the latter may be controlled so as to widen the range of pulp quality suited for strong wrappers to fine printings. When bleached under standard conditions the sulphite bamboo pulp may be purified to answer the requirements of rayon. The process can be applied to straw and grasses as well. The waste sulphite liquor is an important source of tanning agent, lignin plastics, green bond, power alcohol, and yeast. Moreover at a consistency of 60/70% dry substance, the concentrated sulphite liquor can be easily burnt in a suitably designed furnace and the heat of combustion utilised to raise steam sufficient for the entire process of pulping and concentration, and under properly controlled conditions about 50% of the total sulphur and 70% of the magnesia can be recovered from the products of combustion. A similar course of experiments on wood has resulted in the erection of a large pulp mill in Canada very recently. [4,5] There are several board mills in this country using straw, bagasse and waste paper pulped by very crude processes whereas a modern semi chemical process like the Asplaund would be much more efficient. Extensive researches are necessary in the various branches of the pulp and paper industry.

The forest resources in India are not inconsiderable but the materials required for paper are scattered and the transport facilities are not adequate and consequently the mills are finding great difficulties in procuring suitable raw materials at reasonable prices. The areas rich in bamboo and grass are being exploited without a systematic replacement and thus the source of supplies are gradually receding from the place of manufacture and market. The situation has further deteriorated due to the partition, because an additional quantity, roughly 40,000 tons, of raw materials are now wanted from the forests in the Indian Union. Under these circumstances, the production target fixed by the Paper Panel (2,64,000 tons for 1951-52 and 4,71,000 tons for 1956-57) can hardly be reached by simply erecting more machines. The forest resources have to be more systematically surveyed and the search for new raw materials greatly intensified. Under favourable conditions bamboo grows faster than wood and the average yield per acre from cultivated forest may be as high as 4 tons against .26—.3 tons in case of coniferous woods[6]. Pearson described the occurrence, the nature of growth, and the availability of several types of bamboo in Bengal, Bombay and Madras. On waste land bamboo may be a profitable crop. Some quick growing trees like Sabai, Paper mulberry and Shimul can be cultivated to boost the production of paper pulp. Some of these trees can be raised in bamboo plantations with advantage. The waste wood from timber works and plywood factories can be converted to pulp for lower grades of paper. There are several types of wild grasses and reeds which have not been exploited for paper making. Savana grass and Nal reeds (Arundo Donax) yield fibres not much inferior to that from bamboo.

An elaborate method of treatment and complicated machineries are out of consideration for small scale industries. So the use of bamboo and other fibrous plant is not practicable for making hand made paper, the choice being often limited within cotton and linen rags, waste cotton, hemp, waste papers and imported wood pulp. The bast fibre from paper mulberry may readily augment this list. It is extensively used in Japan and Siam. In Burma it is also made into card board blackened for use as slates for writing purposes in schools. The wood is white and can be pulped by mechanical as well as chemical process. The tree grows in various types of soils and spreads by seeds and root suckers, out-growing other species[7]. If the villages are properly instructed and encouraged this plant can be raised in this country and exploited for paper making.

Three fundamental needs for the healthy growth of the industry are materials, machines and men. Materials we have got, if not enough, more can be grown; machines can be constructed when there is a sufficient demand; but technicians and skilled labour have to be raised from amongst ourselves, and it is a strong policy of the Government that is wanted to correlate or orient the three. Training of the men for the industry should be sufficiently encouraged. The courses of studies in technical institutions should include Paper Technology preferably as a separate subject. An association of the technical men in this and allied industries should be organised and meeting arranged in important localities whereby the technicians may discuss various problems and share one another's experience and knowledge for the betterment of the industry.

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A METHOD FOR COMPARING THE RELATIVE QUALITY OF JUTE YARNS

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Introduction

THE Indian Standards Institution has undertaken the task of specifying the standard methods of estimating the testing and performance of the fibre, yarn and fabric of jute. There are powerful factors which operate as hurdles in the way of devising easy testing standards in the case of jute fibre. These have already been discussed[1]. It is proposed now to examine the factors which affect the basis of comparing the spinning qualities of different varieties.

The technique at present in vogue for a standard method, is a two-pronged one. In the first place, a yarn is spun from a jute under constant conditions of draft, twist and the mass of roving per unit length. This yarn which thus possesses a specified grist, is tested for the breaking load, as well as the coefficient of variation of the mass of pieces having a specified short length by a procedure which is fixed[2]. Hence, along with the coefficient of variation, which is used to indicate the degree of regularity of the yarn, the tensile strength or the quality number (or quality ratio) is employed to represent the bases for comparison of the spinning quality. Between these two measures of quality, the latter (quality number) is considered as of principal importance, for the effect of the former estimation generally *merges into* that of the latter, and also shows, numerically, a much shorter range of variation than the latter. While the quality number expressed as percentage, has been known to vary from about 40 to 120, the irregularity coefficient ranges from about 21% to 38%.

Usually, therefore the yarns from different fibres are compared by their values of the quality number when spun practically to the same grist and twist. In other words, it is considered that the relative test values giving the quality numbers of a set of standard yarns indicate the relative spinning quality of the fibres.

As a standard method for start *i.e.*, until sufficient knowledge has been foregathered, the method described above seems the only way of solving the problem. However, within the last decade or so, much scientific information about the physical characters of jute fibre and yarn, as well as about the procedure of yarn making, have been accumulated. It is now known that when spun from one particular fibre, the quality number at one grist may be relatively higher than that of another similar yarn from a different fibre, while the relative order of superiority may become *inverted* at another grist. This knowledge has necessarily warranted a revision of the standard method for comparing the spinning quality of different yarns. A scrutiny of the fundamental factors which predominate in subscribing to the quality of a yarn is therefore attempted here.

Discussion on Quality of Jute Yarn

It has been noted that the qualities of a jute yarn of specified grist (or fineness) with which a spinner is most often concerned, are, as in the case of any other spun-yarn manufacture, (*i*) the thread strength and (*ii*) the regularity. The regularity of a yarn depends partly on the characteristics of the fibre such as, friction, multiplicity and length of each of the adhering filamentous units which compose the material during the different stages of processing, and also, quite largely, on the distribution of the varying individuals before and during processing.

All spun yarns, whatever the textile fibre used, are more or less irregular, consisting of thick and thin places. The irregularity is very high in the case of jute yarn, and the smallest in the case of the man-made staple fibre. The individuals of staple fibre are more or less uniform in external features so that the effect of distribution is minimum. The variations of thickness are introduced during the drafting operation as a reaction between the fibre characters as distributed in the body of the material under draft, and the drafting treatment and the machinery. There is of course no process yet known, such as can altogether eliminate this effect, particularly in the case of the natural textile fibres. However, this may be reduced in the case of jute in two ways :

(*i*) by ensuring perfect and compiete splitting of the meshy fibre-complex into single filamentous units prior to drafting ; or

(*ii*) by blending suitably-matched fibres.

Both these methods have however got very great practical difficulties lying in the way of consummation. Between the two again, action (*i*) is more difficult to carry out.

Now, if not for any other reason, simply due to the existence of the thick and the thin places, a gradient of strength exists along the length of the yarn. The strength of the single thread we measure is actually the strength of the weakest point of the yarn within the specified test length. Variation of the strength of jute yarn with test length has already been studied[3].

So, it is clear that apart from any direct effect on dyeing, finishing etc., the irregularity of jute yarn also affects the strength of a specified yarn. This effect of irregularity in fact merges in the "quality number" estimate of the yarn. This fact seems to reduce the items of measurement for quality estimation of jute yarn to merely one variable, *viz.*, the strength of a specified yarn. Now, it is a matter of practical

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experience that the quality of a material is usually determined by the amount of work done *on it* to effect disintegration or rupture. So, the quality of a specified jute yarn should be a function of not merely of its strength (for a specified test length) but also of its extension at the point of break under pull. Thus for the study of the quality of a jute yarn under specified conditions of testing, one must consider the grist of the yarn, its breaking strength under tension and the extension at the breaking point. These three factors may be reduced to two by considering the tensile, or intrinsic, strength of the yarn specimen.This tensile strength expressed as the percentage ratio of the breaking load in pounds to the grist in pounds per spyndle (=14,400 yards), has been nominated the quality ratio or quality number of the yarn.

In addition to these two factors which, except for the application of draft, admit of very little personal control, being mainly dependent on the physical properties of the fibre *vis-a-vis* the yarn structure, there is another variable factor which can to some extent modify, through the structural medium, either of these two quality determinants of the yarn. This variable, however, is almost totally under human control. It is the "twist" applied to the spun yarn.

The published methods so far available regarding the assesment of quality of jute yarn, relyon the measurement of the quality number of the yarn spun with a specified draft and twist from a roving of fixed mass per unit length. Such study is only supplemented by measuring irregularity of the yarn as the coefficient of variation of the mass of short pieces of specified length. The factor of extension which, for the whole range of jute yarn formation, varies from 1% to 3% nearly, is disregarded.

On the basis of these considerations, leaving aside the question of irregularity which affects the yarn quality number through its breaking load, and also neglecting the very small effect of extension, it is now proposed to examine the validity of the quality number of a specified yarn as a standard measure for comparing the relative spinning qualities of jute yarns.

Basis of Quality Number of Yarn

There is little doubt now that the quality of a spun (unsized and otherwise unfinished) yarn, is a complex function involving several factors broadly of the two following categories—

(*i*) physical nature of the material;

(*ii*) spinning treatment.

The most relevant physical characters of a textile material, known from experience in the sphere of various other fibres to vitally affect yarn quality number are :—

(*i*) the staple length (l);

(*ii*) the mass per unit length or gravimetric fineness (*m*);

(*iii*) the frictional resistance (ϕ);

and (*iv*) the breaking load (*p*).

In the case of jute, there is one special character which plays no mean part in determining the quality of the yarn spun. It is—

(*v*) the splittability of the meshy complex(μ). Considering these five physical characters to be the principal "material" factors for the production of the resulting yarn quality number in the case of jute, it may be understood that these fibre characters act on the quality number through a quantity, *B*, which is an involved function of l, m, ϕ, p, and μ. In other words,

$$B=f(l, m, \phi, p, \mu)$$

Now, if yarns are spun from different varieties of jute having different physical qualities of fibre, to a specified grist (*G*), using a constant draft (*D*), and a fixed twist (*T*) from roves of the same mass per unit length (*R*), the Quality Number, Q_o, of each yarn will naturally be a function of its *B*. That is to say—

$$Q_o=M(B)=M_1(l, m, \phi, p, \mu)$$

This is the basis of the present quality-number technique of comparing the qualities of yarn from different varieties of jute. The practice in vogue is to spin "standard" yarns under specified spinning conditions from the different jute varieties, find the value of Q_o's for the products, and compare their relative order. However, before proceeding to adjudge the value and the width of applicability of this technique, it is necessary to scrutinise the function, M_1, the fundamental and dominant element in the study of yarn quality.

The Function, M_1:

It is definite that so far as jute is concerned, the staple length (l) remains a mystery until the yarn is spun. Although the jute strands which ultimately go to form a yarn, are, most of them, not small like cotton or any similar fibre, the length nevertheless has an important function in the determination of yarn quality. It was shown[4] how the quality number for the "standard" 10 lb. hessian weft yarn, which bears a curvilinear relation with p/m *i.e.*, the tensile or intrinsic strength of the fibre concerned, happens to assume a rectilinear form of relationship with lp/m. (This is also a clear indication that the strength-reducing "slippage"-factor which operates as a result of yarn structure, for a jute yarn spun under constant spinning conditions, is insignificantly small *i.e.*, practically "zero', just as for long staple cotton fibres[5].)

The importance of '*l*' in the case of the yarn quality of jute, and the fact that '*l*' cannot be known prior to actual spinning of the fibre, make it necessary to find some measureable characters of jute, which should influence the generation of the staple lengths during processing and spinning so strongly, that '*l*' may be replaced in any estimation of yarn quality from fibre characters. No doubt much fundamental work is required to be done before such characters, relevant

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beyond any pale of doubt, can be found. However, as a *Working hypothesis*, in absence of requisite knowledge, one may proceed with characters which seem most probable from *a priori* consideration of facts so far known.

Thus it seems possible that the splittability, or complexity co-efficient, μ, as defined earlier[6], the strength gradient of a filament, $\frac{dp}{d\lambda}$, where λ is the test-length corresponding to a filament strength, p, and the cross-sectional area of the filament, A ($=\pi ab$), the area being assumed to be elliptical[7] with the semi-axes 'a' and 'b' may prove to be such measures. The reasons are :—The complexity determines the probability of transverse break down of the meshwork of a jute into single filaments as well as into filaments of different degrees of multiplicity, in course of yarn making. So, this factor indicates the possibility of longitudinal break down of an element by the drafting force. The strength gradient will show up the minimum drafting force necessary to break-down a filament longitudinally ; and the cross section will indicate the weakest point within a filament, where such minimum force will be likely to break the filament,and so determine the length of the parts. There is of course one definitely known fact in this connection. It is that the maximum possible length of a filament in the yarn cannot exceed the "grip-to-grip' distance (L) between the feed and the delivery rollers. So, always, $l<L$.

Now from the above discussion, the staple length (l) should possibly be a function of μ, A and $\frac{dp}{d\lambda}$; it may therefore be stated that

$$l = \psi \left(\mu, A, \frac{dp}{d\lambda}\right) < L$$

Since each of these three determining factors may vary independently, 'l' will be determined by any one of these particular factors, while the other two remain constant. So, it may be stated that, under such conditions,

$$l \propto \frac{1}{\psi_1(\mu)}, \quad \propto \psi_2(A), \propto \frac{1}{\psi_3\left(\frac{dp}{d\lambda}\right)}$$

Therefore, when all three vary,

$$l = K.\ \psi \left[\frac{\psi_2(A)}{\psi_1(\mu) \cdot \psi_1\left(\frac{dp}{d\lambda}\right)}\right], \text{ where } K = \text{constant.}$$

This may be put as $l=kz$, 'z' representing the function ψ. Evaluation of 'z' is difficult, and requires much ground to be covered before it can be brought under control. However, the values of 'μ' and 'A' can be found. Also, the values of 'p' for different values of 'λ' can be obtained on small representative samples of a jute. Thence, finding the values of Δp for corresponding values of $\Delta\lambda$ the mean value of $\frac{\Delta p}{\Delta\lambda}$ may be used to represent $\frac{dp}{d\lambda}$.

Now, the simplest measure of the function, 'z' which can be conceived, is the linear power of the uninvolved quantities, A and $\frac{\Delta p}{\Delta\lambda}$.

On this consideration, an estimate of ψ may be obtained by calculating—

$$\left[\frac{A}{\mu . \frac{\Delta p}{\Delta\lambda}}\right]$$

This quantity may then be statistically correlated with 'l', measured from different qualities of jute yarn spun under the constant conditions considered above, to test the likely *relevancy* of the combination of the three measurable quantities, μ, A and $\frac{\Delta p}{\Delta\lambda}$, in linear power for estimating 'l'.

However, the qualities of gravimetric fineness, 'm' and the strength, 'p' of jute filament may be reduced to the single factor of tensile strength, p/m. So, the fibre quality function in the estimation of the yarn quality number for the "standard" yarn reduces to one characterised by three factors of more or less an involved nature. That is to say,

$$Q_0 = M_1\ (\phi,\ p/m,\ z)$$

Failure of Q in Comparing Yarns of Different Grists :

Since, for spinning warp or weft yarn of hessian or sacking, having different grists and twists, the drafts need also be varied even when roves of a constant mass per unit length is employed, for jute yarns of different types, to define the quality number (in which 'G' has merged) the *general equation* of quality becomes a function 'q' involving M_1, D and T. In other words,

$$Q=q(M_1, D, T)$$

The complex effect produced in the quality number of different kinds of yarn of different grists, can be seen from the varied nature of the actual G-Q-relationship as depicted in Fig 1. In this figure each value is based on 240 to 300 observations. The fact that the curve for the different jute varieties are not parallel to one another, clearly indicates that for different jute varieties, the judgement of relative quality based on a simple estimate like Q_0 (as found under constant spinning conditions) is faulty and inadequate. The quality number of a particular jute found by using one particular set of D and T can not give a proportionate

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quality number at any other value of D and T. Extending this conclusion it is easy to see that the relative

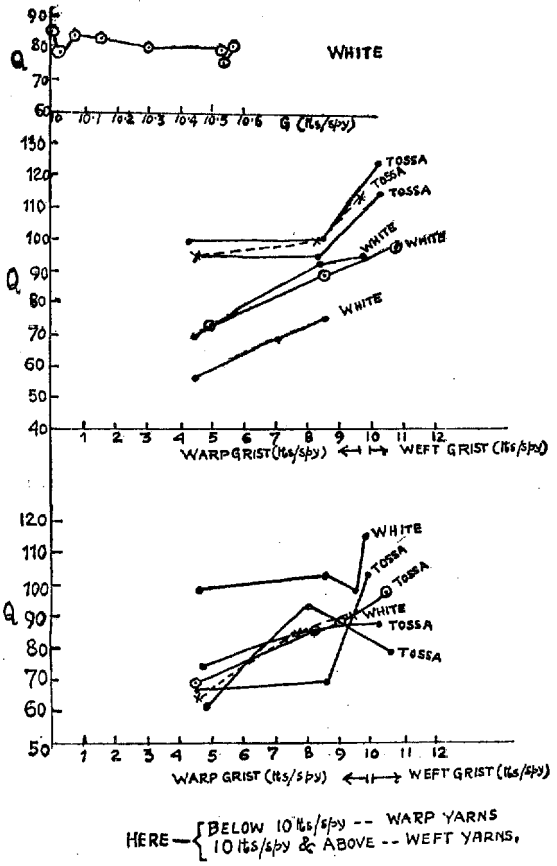

Fig. 1

values of quality number of different jute fibres under one set of spinning conditions cannot be expected to represent the relative values under a different set of those conditions. Any standardisation of procedure of estimating yarn quality must, therefore, be done on some other basis than the simple one of estimating Q_0. But before this is taken up for discussion, it is necessary to see to what extent the specified quality standard should be made to depend upon the breaking extension of the jute yarn also. This factor was ignored in the earlier discussion.

Yarn elongation at break:

In so far as the extension of a yarn at break depends on that of the constituent filament, this character of jute yarn may be relegated to the care of the function 'B' (*ante*) by making it more comprehensive. But besides fibre properties, yarn extension is also governed by the twist *vis a vis* the grist. The graphs in Fig. 2, Fig. 2*a* and Fig. 2*b* give the relative frequency of the breaking extension of yarns possessing different grists and twists, in the case of different varieties of jute. The data are based on 300 observations in all cases but one. In this case the observations numbered 256. From the horizontal positions of the curves and their respective dispersion, one is entitled to think that, most probably, the effect of twist on the breaking

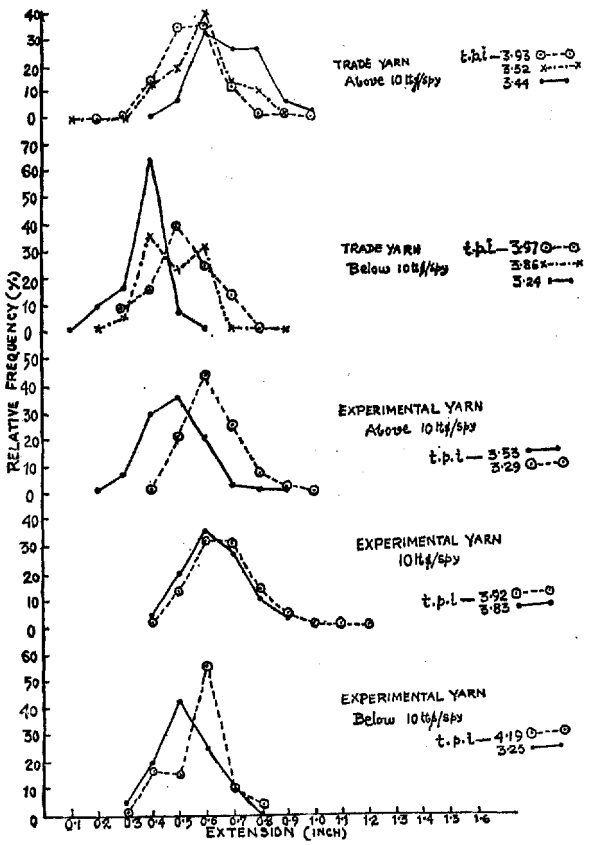

Fig. 2

extension of jute yarn of any moderate grist, is considerably small compared with the effect of fibre quality. The effect of grist is also very slight as the relative horizontal shift, when viewed in Fig.2 vertically, seems to indicate. So it is not expected that any serious fault

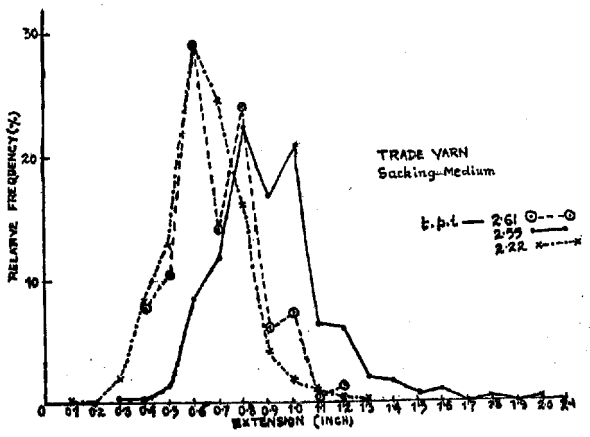

Fig. 2*a*

will be committed if the extension at break which possesses a very small average magnitude also, being

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1% to 3% in the extreme cases, for yarns varying in grist from 7 to 52lbs/spy, and in twist from 4.2 to 1.7 t.p.i. is ignored in finding a generalised standard basis of comparing the spinning quality of jute yarns.

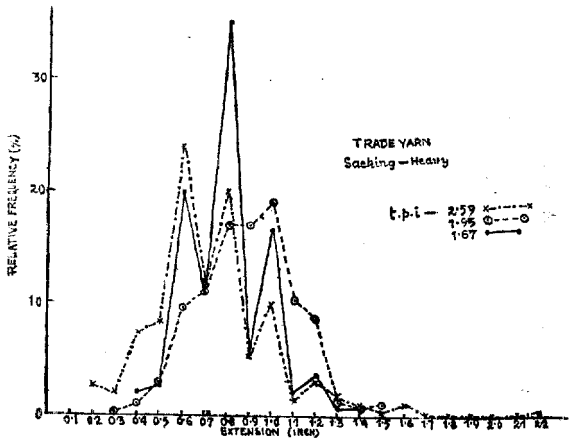

Fig. 2b

The standard quality specification may therefore be wholly based on the functional equation—

$$Q=q\,(M_1,\ D,\ T)$$

Generalised Basis of Efficient Quality Specification:

If the equation $Q=q(M_1, D, T)$ is further generalised by including as variable the gravimetric fineness of rove (R), which has so far been considered constant, the equation which emerges for consideration here, is

$$Q=q_1(M_1, D, T, R)$$

There are, in this equation, four independent variables of which D, T and R can in some respects be controlled in processing and spinning. So, the right-hand expression of the equation can be split up into two parts, one involving only the effect of the fibre characters, which cannot be varied, and the other, the effect of the processing and spinning treatments on the structure *vis a vis* the fibre characters, most of which can be varied at will. Thus the equation can be written as the sum of two terms, one, a simple function of M_1 and the other an involved function of all the four variables. This equation may be written as

$$Q=\alpha\,(M_1)+\beta\,(M_1,\ D,\ T,\ R)$$

Here, β represents the involved function of all the four variables. When D, T and R are constant the effect of M_1 as far as this affects yarn quality, is indicated by this function.

Now, as a matter of *convention*, based on the suitable quality number for the yarn of a particular specification of grist and twist, the value of 'R' may be adopted to be such that for particular specified values of 'D' and 'T', yarns of different grists are produced. In other words, R, D and T can be controlled for particular values of different grists, and the yarns thus produced compared against specified quality number. Under such circumstances, (*i*) for different yarns of a particular grist, D, T and R being constant, Q will become practically a function of M_1, just as Q_0 was shown to be ; and (*ii*) for different grists of yarn from the same material, Q will depend on M_1 as well as on the effect of specified values of R, D and T in so far as M_1 reacts to these factors. Thus by spinning different fibres to a set of grists under the specified conditions and plotting the data for Q against G, a set of curves variously directed, will be obtained. These curves should be expected to intersect the conventional G-Q-curve which is *practically rectilinear*, for warp or weft, at some point or other. The coordinates of the point of intersection (G_1, Q_1) will then represent the immediate data for estimating the standard spinning quality. The estimate of relative quality can be based on the single quantity

$$\frac{G_1 \times Q_1}{100}$$

which may be nominated the Standard Yarn Measure, or briefly, "SYM". The value of "SYM" will be different for the warp and the weft yarns ; for these two different cases two different conventional scales will require to be used. The smaller the value of SYM, the finer will be the yarn capable of being spun to produce the desired quality number. SYM will give the best measure of the standard yarn quality, and different fibres will be easily comparable as their values will, once for all, lie on different points of the same conventional curve *taking into consideration the variability*

TABLE I

CONVENTIONAL SCALES FOR WARP & WEFT

Yarn-type	Grist (lb spy)	T.P.I	Suitable Quality No. Q.
Warp—	3	6.3	90
	5	5.5	85
	7	4.7	80.5
	9	3.9	75.5
	11	3.1	71
Weft—			
Light..	5	4.3	70
	7	4.0	67
	9	3.7	65
	11	3.35	63
	13	3.05	61
	15	2.75	58.5
	17	2.4	56
	19	2.1	54
Heavy..	20	2.1	53
	25	2.1	51
	30	2.0	50
	35	2.0	48
	40	2.0	46
	45	2.0	44
	50	1.9	41.5
	55	1.7	40
	60	1.5	38.5

of Q *with* G. The defect of the present technique of comparing the quality numbers at one and the same

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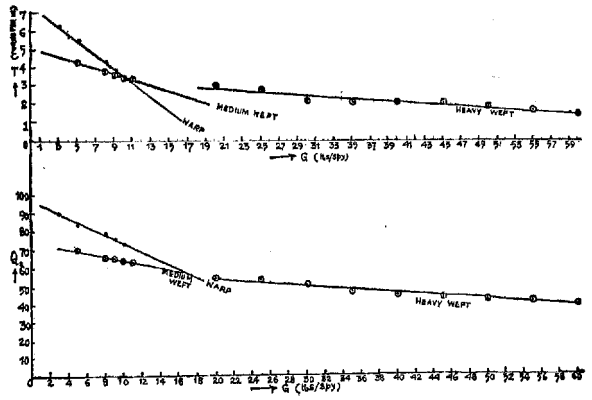
at one and the same grist is that the variation of quality number with grist is not taken into account.

Conventional Scales for Warp and Weft:

In fixing the conventional scales, due regard has been shown to the bases on which the trade judges the suitability of a fibre for a particular quality. The freedom to use any suitable Rove-mass per unit length with appropriate Draft has also been recognised, and so the scales are given as suitable quality number (Q_s) for corresponding grist (G) and turns per inch (T). The different scales for the warp and the weft yarns are given below; in these the values of 'Q' determine the desirable quality number for the specified spinning conditions.



A representation of the conventional graph is given in Fig. 3 which also gives the G—T-graphs.

The results actually obtained for 'SYM' for warp yarns from various species and varieties of jute are stated in Table II. The values of Q_0 *i.e.* the quality number for the present standard 10lbs. hessian weft yarn, are included in the Table for comparison of the order of quality as obtained by the two methods.

TABLE II

ORDER OF QUALITY FOR DIFFERENT FIBRES

Species	Jute Variety	Q	SYM (warp)	Order of superiority
White	I	116	0.66	1
	II	97	5.75	3
	III	94	5.54	2
	IV	74	7.05	4
Tossa	I	114	0.65	1
	II	112	2.28	2
	III	98	8.59	4
	IV	97	5.66	3

The order of superiority by the SYM-method differs to some extent from that by the Q_0-method, as one may expect from the discussion above.

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Notes and News

DAMODAR VALLEY CORPORATION

The Damodar Valley Project came in for sharp criticism during the debate last month on the budget grants for the Ministry of Works, Mines and Power.

The criticisms levelled against the Corporation's work were mainly three-fold. The first referred to the question of the degree of autonomy which should be given to the Corporation, and a number of members led by Mr B. Das and Mr. B. Shiva Rao expressed strong view that the Centre should exert far greater control on its work than it had done heretofore. Secondly, extravagance in expenditure was hinted by some members who feared that the original estimate of the total cost would go up by nearly 30 percent. The third criticism would have it that the Government had given undue importance to foreign engineers and had not made the best possible utilization of the available Indian engineering talent.

In reply to the first criticism, Mr. Gadgil, Minister for Works, Mines and Power, compared the relation between the DVC and the Centre with that existing between National Coal Board and the Ministry of Power and Fuel in the United Kingdom. He explained that the Centre could control policy, exercise indirect control over financial commitments when the Corporation wanted foreign exchange and give directions, if necessary, under the provisions of the Bill. But the criticism as to what extent this control was exercised was left largely unanswered.

The Minister's reply regarding the charge of extravagance was far from reassuring. He simply said that he did not think the overhead expenses were too

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heavy and that if he felt it was the case he would not hesitate to use his powers to reduce such expenses. Regarding the fullest possible use of available of Indian engineering talent, the Minister's statement that only two out of the total twelve technical experts employed by the Corporation were foreigners was generally acclaimed. What was more important was his disclosure of the unwillingness on the part of certain Indian States to release their senior and experienced engineers for the DVC work, and the specific case of the Government of Madras refusing to spare a senior engineer was mentioned. Such difficulties are not new, and these only unmistakably show that after all we do not possess any sizeable reserve of top-ranking engineers to whom work of the magnitude of the Damodar Valley Project could be entrusted. The Minister also revealed that a chief engineer was shortly going to be appointed to the DVC and that efforts were made to secure the services of a qualified engineer from the U.S.A.

WEST BENGAL'S PROGRAMME OF INDUSTRIAL DEVELOPMENT

The West Bengal Assembly have passed Rs. 73,78,000 for expenditure in 1950-51 for industrial development. The main features of this development include extension of electrical power supply, fish culture and small-scale cottage industries. The North Calcutta Electricity Scheme planned to cover an area of about 750 sq. miles and supply power upto Santipur, Nabadwip and Birnagar would cost Rs. 24,00,000. Ranaghat, Santipur and other places would receive electricity from June this year and the scheme is expected to be completed by 1952.

Silk, sugar and salt featured prominently in the government's programme for small-scale and cottage industries for which a sum of Rs. 4,00,000 had been provided. Up to the end of December last year, silk worth Rs. 7,06,000 was produced and about Rs. 5,00,000 received from the sale of silkgoods. The government had undertaken development of this industry on a co-operative basis.

The Chief Minister reported that one of the sugar mills allotted by the Central Govt. to West Bengal would be established at Krishnagore and would start working within a year or so.

A survey had been recently made by experts of a French Salt industry at the invitation of the government in the Contai area, Midnapore, according to which about 5 million mds. of salt a year could be produced in this area.

A sum of Rs. 20,89,000 was voted for expenditure under "fisheries". The State's deficiency in fish was brought out by the Minister for Fisheries, when he said that the total supply of fish from the State itself was only 50,000 tons against the total annual requirement of 4,32,000 tons. The government had paid great attention to fish culture and had produced about 2 million fry in their nurseries which were distributed to private pisciculturists. The government's estimation was that if half of this fry survived, the fish production would increase by 8000 mds. at the end of three years. A Danish expert had been invited to make a survey of the off-shore and coastal fishing in the Bay of Bengal area.

The production of cinchona received a budgetary allocation of Rs. 32,64,000. In moving the demand, the Chief Minister said that the government had about 150,000 lbs of quinine in storage and additional plantations to be developed at Maungpoo would yield about 50,000 lbs. of quinine annually.

FOREST RESEARCH IN INDIA

The Forest Research Institute, Dehra Dun, is now being reorganised with a view to develop the forests and improved uses of forest products of our country. Under the new set-up there are some minor administrative changes and that the Utilization Branch has been replaced by 7 independent Branches (See "*Forest Research in India and Burma*, 1946-47, Part I).

The Silvicultural researches include routine experiments as to the methods of stockings, seed-testing, investigations relating to trees and crops, soil analysis sample plot calculation, resin tapping etc.

The importance or correct identification of timber, their mechanical tests and physical determinations, proper and improved seasoning, best and cheapest methods of preservation, and uses of different timbers for specific purposes are now being gradually realised by consumers and the staff of the various branches of the Forest Research Institute have rendered valuable services to the timber users in this direction.

It is pleasing to note the manufacture of modern furniture of laminated construction with decorative veneers at a comparatively cheap rate, and that there are serious attempts to make use of waste veneers, wood shavings and saw dusts as table tops, flooring blocks, electric switch cover etc. Interesting observations have also been recorded in connection with impregnated wood and plywood research, production of absorbent cotton, high grade papers, preparation of pulp from various sources, peppermint oil from the Indian strain of *Mentha piperata*, camphor from *Ocimum* sp, pectin from tamarind seeds and resins from various other sources.

The mycologists and entomologists are now developing new methods and projects to save our forests and forest products from fungi and insect pests. The plant protectors are now exploring the possibilities of collecting information and data on specific tree diseases and host relationships of the parasites and other wood forests in particular areas for employing these information in prevalent Silvicultural practices.

The results obtained by the staff of the various departments at the institute and the projects at hand are encouraging.

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NATIONAL PHYSICAL LABORATORY

One of the subjects on which the NPL, which was opened at New Delhi on January 21, 1950 (See *Science and Culture 15*, 318, 1950), will undertake work is research on fundamental standards of length, mass and time and their derived standards. Specialised equipment and precision instruments have been secured from abroad. Besides its valuable apparatus for precision work the laboratory will have one of the best equipped libraries in physical science. Nearly 10, 000 books have been obtained and more are on order. A large and well equipped workshop, including glass blowing and optical workshop, photo and drawing offices, a gas house and a cafetaria will be additional features of the laboratory, which will also accommodate the laboratories of the Defence Science Organization. The laboratory has recently acquired an Electron Microscope which will shortly be installed.

The work of the laboratory will be carried out through the following Divisions: Weights and Measures, Applied Mechanics and Materials, Heat and Power, Optics, Electricity, Electronics and Sound, Industrial Physics, Hydraulic Research, and Analytical Chemistry. The laboratory will also have a Research Information Service.

The different section will be in the charge of Dr. S. Parthasarathy, Mr. V. Cadambe, Dr. S. Jnananandla, Dr. K. N. Mathur, Mr. G. D. Joglekar and Dr. W. M. Vaidya, *Assistant Directors*. Dr. K. S. Krishnan, the eminent Indian physicist, is the director of the laboratory.

JUBILEE OF NATIONAL PHYSICAL LABORATORY (England)

The National Physical Laboratory, Teddington (England) recently celebrated the jubilee of its foundation on January 1, 1900 when Dr. R. Glazebrook took up appointment as Director. Originally the laboratory was housed in Kew, but shortly afterwards it was moved to its present site at Teddington. The staff which in 1900 was about 21, has in course of time increased to its present strength of over 1,100. The laboratory was originally founded for the standardization, and verification of instruments, the testing of materials and for the determination of physical constants At the time of the opening of the new building at Teddington in March 1902, the late King George V, then Prince of Wales, had expresed a hope that the laboratory may develop into a national organization for "furtherance of application of science to commerce and industry." This hope has during the last fifty years been more than fulfilled.

"The laboratory" according to *Nature* "unlike most of the Government scientific establishments, is organized on the basis of subjects, rather than the service of particular objects"; its different divisions cover most of the fields of physical science, which has enabled it to be the seed-bed in which different researches have germinated and grown until they were sufficiently vigorous to lead a separate existence elsewhere. Thus the Building Research Station, the Road Research Laboratory have grown out as separate organizations. Similarly research in hydraulics, instituted by the previous Director Sir Charles Darwin, has been transferred to the control of the Hydraulics Research Organization. It is only lack of facilities which is delaying the transfer of the radio work of the laboratory to the formal care of the Radio Research Organization. This applies also to the transfer of much of the work of the Engineering Division and some of the work of the Metrology Division to the Mechanical Engineering Research Laboratory which is being established at East Kilbride.

In addition to its long term research, the Laboratory has fulfilled a very real need in the services which it provides in carrying out special investigations for other Government Departments and industries. The special feature of the N. P. L. is considered by *Nature* to be as follows "In many research establishments the needs are determined by higher authority; but in an establishment working primarily for the general welfare of all industry, and organised by subjects, the needs and problems must, in general, be recognized and formulated by the research workers. The latter is the case in the National Physical Laboratory which, in this sense, therefore, is similar to a university; but it has been able to meet some needs beyond the scope of universities in the past. The staff being members of the Scientific Civil Service, have been able to carry on long-term research on a more stable basis than in many universities, where the nature of the research can change suddenly with changes of staff. Also, the possession of large scale and expensive equipments, most of which was previously beyond the reach of universities, has enabled the Laboratory to work on subjects which universities could not tackle."

NATIONAL CHEMICAL LABORATORY

The various sections of the NCL, Poona, which was opened on January 3, 1950, (See *Science and Culture, 15*, 317, 1950) have already started operating and a good deal of research in Indian oils and fats is being done in the Organic Chemistry section under Dr. J. S. Agarwal and 16 scientists. Work in the Biochemistry section is in progress under the direction of Dr. M. Damodaran and 14 scientists. Dr. J. H. Truttwin of Sweden has taken charge of the Chemical Engineering section with 10 scientists. Dr. J. Gupta, who was on study tour abroad, has recently taken charge of the Inorganic section with 7 scientists, which would deal with research on mineral chemistry. The Survey and Intelligence section is in charge of Dr. K. G. Mathur with 8 scientists, and the Administration section dealing with the Standardization and Production of Pure Chemicals is in charge of Dr. B. D. Laroia and 2 scientists. Work in the Plastics and High Polymers and Physical Chemistry under 16 scientists is to be commenced hortly. Dr. J. W. McBain is the director of

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this laboratory. (See *Science and Culture*, *14*,419, 1949) Scientific research has not been sufficiently utilized for industrial production in India. One of the most important functions of this laboratory will be to bridge this wide gulf. In this, all the divisions will play their part in helping to meet some of the practical difficulties of chemical and agricultural industries and in ensuring effective co-ordination between scientific research and industrial production. The Laboratory will welcome close co-operation with the Universities and other Research organizations in India. It will also serve the Government Departments, including that of Defence, in the many problems referred to it.

WHY STARS TWINKLE

According to the usual explanation, stars twinkle because the upper atmosphere is unstable Local turbulences alter the density and optical properties of the air. As a result, the amount of light passing through it varies continually, and the stars appear to flicker. This commonly accepted physical explanation is now challenged by a new physiological theory reported in British journal *Nature*. H. Hartridge of the Institute of Ophthalmology in London, believes that the twinkling takes place not in the skies, but in our eyes.

Hartridge based his theory on two well-known facts :(1) the eye is always in motion, and (2) its rod-shaped cells, which serve as "Brightness meters", are not all equally sensitive. The eye rests on a point for only about a tenth of a second, and then shifts slightly to some other nearby point. Because of these rapid jerking motions, images continually move back and forth on the retina. Since the rod cells in the retina vary in sensitivity, images seem to vary in intensity as the eye shifts.

To test his theory that twinkling has nothing to do with the upper atmosphere, Hartridge experimentally observed "artificial stars" at ground level. Watching an electric lamp from a distance of several miles on a dark night, he found that to the naked eye it twinkled "very obviously". But the twinkling disappeared when he used an eight-power telescope. On the basis of further experiments in his laboratory, Hartridge believes he has found the explanation for this phenomenon. A telescope, collecting more light than the naked eye, makes the image considerably brighter. Hence small local variations in the sensitivity of the retina's rod cells are not noticed. In support of this conclusion, Hartridge notes that extremely bright stars do not twinkle and that many stars stop twinkling when viewed through a telescope. The biologist did not, however, attempt to explain why stars twinkle more on nights of poor "seeing" than on clear nights.

(*Scientific American*, February, 1950).

BERYLLIUM TOXICITY

The report of the toxicology Research Unit, Porton, Salisbury, on the experimental investigation of toxicological problems is that beryllium in the form of its soluble salts has a high degree of specific toxicity. A satisfactory method for the microdetermination of beryllium in body tissues has been developed. The acute liver necrosis that follows the intravenous injection of small doses of beryllium salts has been shown to depend on a rapid focal concentration of the metal within the liver; it is this liver necrosis that causes death in such cases.

Malignant bone tumours have been produced in rabbits by injecting the chemically insoluble beryllium silicates. (*The Chemical Age*, February 4, 1950).

POLARIZER FOR INFRA RED RAYS

Existence of a plastic film that polarizes infra red heat rays was officially revealed at the annual meeting of the Optical Society of America. Created during World War II for secret signalling and other military duties, the film is expected to find a number of applications in science and industry.

Like the polaroid material used in sunglasses, the infra red polarizer "combs out" the waves passing through it, but the waves are the long invisible heat rays instead of shorter rays of visible light. It is the first polarizer in convenient sheet form for the infra red rays. Previous infra red polarizers have involved cumbersome reflecting plates. It was invented during the war by Polaroid research scientist R. P. Blake.

The new polarizer is effective over the region of the spectrum from 0.75 to 2.8 microns, wavelengths used in infra red photography, communications and the analysis of materials. In this range, two pieces of the material transmit about thrity per cent of the heat rays when their axes or "optical slots" are held parallel, less than one per cent when their axes are crossed at right angles. During the demonstration the intensity of a beam of infra red light is controlled at will, by rotating one of the new polarizers over another, gradually silencing a sound system energized by the beam.

Describing the chemistry of the new polarizer, Blake called it "the talented offspring" of two earlier types of polarizers. One of these, developed by Polaroid's president and director of research, Edwin H. Land for use in sunglasses, is given its polarizing properties by stretching polyvinyl alcohol plastic to bring its molecules into alignment and then treating it with iodine. The other, developed by Land and H. G. Rogers to meet the special high-temperature conditions imposed by the proposed Polaroid headlight system, gets its properties from the treatment of the stretched polyvinyl alcohol film by dehydration. Both are efficient polarizers for visible light, but give no indication of polarizing properties for the longer wavelengths. Nevertheless, Blake created his new polarizer simply by combining the two treatments, first treating the polyvinyl alcohol plastic with iodine and then dehydrating it. (*Journal of the Franklin Institute*, January, 1950).

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ACTION ON THE SUN

Motion pictures taken at the High Altitude Observatory of Harvard and the University of Colorado was shown by Dr. Donald H. Menzel at the meeting of the American Association for the Advancement of Science, in New York on December. A study of some 15,000 feet of motion picture film taken since 1943, chiefly by Dr. Walter O. Roberts, has led to a complete revision of the classification system for solar prominences and has resulted in a new theory of prominences, flares, the corona, and the relation of these phenomena to the earth, said Dr. Menzel.

In such records of prominence activity, downward moving matter appears to be much more prevalent than that rising upward. Dr. Menzel proposes that the source of the downward moving matter is the sun's polar spicules. These comparatively small bright jets, recently discovered by Dr. Roberts, are seen close to the sun's surface in its polar regions; each shoots out a core of luminous gas that fades away while it is still rising. Dr. Menzel suggested that these expanding jets go to form the solar corona. The curves of the corona follow lines of magnetic force. The complex network of magnetic lines of force around the sun are to be regarded as a sort of semi-flexible roof to the sun . If the concentration of coronal material in some region becomes too great, these lines of force will sag. The prominences other than those associated with sunspots are largely due to such caving action.

The motion pictures show many examples of matter (hot gases) streaming through a funnel-shaped region whose shape remained relatively constant even though the matter itself was continually changing. Occasionally the internal pressure of the gases moving inside the funnel is so great that the walls break and matter streams forth in graceful curves, carrying the lines of magnetic force along with it.

Long, filamentary regions of prominences stretching as much as a million miles across the solar disk are possibly caused by a series of funnels with stretched zones between. When the magnetic force lines tend to shorten suddenly they may account for rapidly expanding arch-type prominences.

From Dr. Menzel's theory it may follow that any matter reaching the earth from the sun must come from the polar spicules. The observed correlation of flares on the sun with magnetic storms 24 hours later on the earth would then simply mean that both had a common origin, as Dr. Menzel believes that flares do-not necessarily eject material outward from the sun. (*Sky and Telescope*, February, 1950).

RADIOACTIVE STANDARDS FOR CARBON 14

The National Bureau of Standards has prepared a series of standard ampoules of sodium carbonate solution containing definite, known amounts of carbon 14. These ampoules serve as comparison standards for the calibration of measuring instruments used in actual radioactive tracer work with carbon 14.

The bureau's preparation of the carbon 14 standards have involved a carefully controlled chain of operations. A sample of barium carbonate, in which approximately 4% of the carbon atoms is carbon 14, was procured from the Oak Ridge National Laboratory and its ratio of carbon 12 to carbon 14 determined in a number of laboratories with the aid of the mass spectrometer. A weighed amount of the radioactive barium carbonate was converted to sodium carbonate in a vacuum by allowing the sample to react with perchloric acid and collecting the evolved carbon dioxide in a solution of sodium hydroxide. The standard ampoules were filled with a dilute solution of the enriched sodium carbonate whose disintegration rate was first carefully determined. Carbon dioxide was liberated from the sodium carbonate solution in a vacuum by reaction with sulphuric acid, frozen in a liquid air trap, and then allowed to expand into an ionization chamber. The amount of ionization, which is proportional to the number of disintegrating atoms, was determined with the aid of a vibrating-reed electrometer.

Another phase of the bureau's work on carbon isotope has been a redetermination of its half life which is approximately 6,000 years. (*Chemical and Engineering News*, January, 9, 1950).

PERMANENT NEUTRON STANDARD

The National Bureau of Standards has recently developed a primary neutron standard which makes it possible for all laboratories to measure neutron radiation intensities in terms of a common reference value. The neutron standard consists of a solid beryllium sphere 4 cm. in diameter, enclosing at its geometrical center a capsule of radium. The capsule is made of platinum-iridium closely fitted to a gram of radium bromide compressed to maximum density. Neutrons are produced in the beryllium sphere by the action of gamma rays from the radium. Preliminary measurements indicate that the standard emits 1.1 million neutrons per second. The rate of neutron emission will change slowly as the radium decays, but this change is only about 0.04% a year and can be taken into account with sufficient accuracy.

A duplicate standard has been prepared for loan to other research laboratories requiring standardization of their neutron measurements. The standard is now ready for use and any future revision in the neutron emission rate will result in only a small correction to any data based on the present provisional value. If, as has been suggested, the unit of neutron intensity is defined in terms of the new standard, it will then be possible to express measurements from different laboratories in directly comparable units.

The calibration of the permanent neutron standard was accomplished in the bureau's radioactivity laboratory by placing the beryllium sphere in an extensive

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absorbing medium which captures practically all of the emitted neutrons. Boric acid was used as the absorber, in such a concentration that most of the neutrons were absorbed by boron rather than hydrogen. The source strength (the number of neutrons emitted per second) was measured by a mechanical integration scheme using indium and manganese foils as detectors of slow neutrons. The beryllium sphere and four foils were suspended in the tank of boric acid while a synchronous-motor drive carried the foils radially outward from the source at a predetermined speed, taking either two or four hours to travel 15 cm.

The foil activity was measured at the end of each irradiation period. No detectable activity was observed beyond 20 cm. from the source. The number of neutrons emitted per second from the primary standard was given by the average of the values for the indium and manganese foils. Calibration of the foils was accomplished in a fixed paraffin geometry in which uniform neutron flux was supplied by two quarter-gram radium beryllium sources mounted on opposite sides of a boron trifluoride counter so that the counter would detect the alpha particles emitted from boron under neutron bombardment (*Chemical and Engineering News*, January 16, 1950).

ATOMIC ENERGY FOR DIAMOND

Atomic energy may possibly change the colour and other properties of gems, especially diamonds. It is suggested that hardness of diamonds may also be increased, thus making the lower quality stones more suitable for industrial uses. These possibilities are claimed in a recent patent, open to public inspection.

The method consists of the use of neutrons to produce permanent colour change by altering the "pigmentation" factors in the nuclear structure, thus modifying physical and chemical properties, *i.e.*, transmutations *in situ*. Neutrons must be so selected that they have no adverse effect on the main structure of the gem, such as carbon in the diamond, which might be converted into boron under energies of about 20 MeV.

The nuclear reactions of impurities and colouring matter must be such that there is no risk of return of the initial element, *e.g.*, through the beta radioactive element, as exemplified in the case of Al^{27}. Other necessary conditions are stipulated as to the amount of neutrons per sq. cm/sec. and their appropriate action. It is not unlikely that some impurities act as catalysts in the transformation of graphite to diamond, with considerable shortening of the time factor. It is not, however, necessary to wait a year for colour changes, for colour is due to a combination of factors, including impurities. It is claimed that after a few week's irradiation the initial percentage of impurities will have changed and new pigments been formed. (*The Chemical Age*, February 11, 1950).

ROYAL ASIATIC SOCIETY OF BENGAL

The Annual meeting of the Royal Asiatic Society of Bengal was held on Monday, February 6, 1950, Hon'ble Justice Shri Ramaprasad Mookerjee presiding.

Speaking at the meeting, His Excellency Dr. Katju expressed hope that now that the people of India had formally established a Sovereign Republic, scholars and historians would, by careful research and investigation, probe into the working of the national mind in past centuries and discover the basic principles which had appealed to the Indian people in regulating their own conduct. He remarked "what we urgently need today is a history of the Indian people themselves, not of their kings or rulers".

The Governor unveiled a portrait of *Vedacharya* Satya Brata Samasrami, a Bengali Vedic scholar who was one of the earliest Indian Honorary Fellows of the Society.

The Society's *Peace and Culture Medal for 1949* was awarded to Sri Aurobindo, the philosopher-saint of Pondicherry.

Dr. W. D. West received the *Pramatha Nath Bose Memorial Medal* for his contributions to the study of geology with special reference to Asia, and Dr. K. V. Krishnan the *Barclay Memorial Medal* for his work in medical science with special reference to India. The *Dr. Bimala Charan Law Gold Medal* for ancient Indian history went to Dr. U. N. Ghosal, and the *Sir Jadunath Sarkar Gold Medal* for history to Dr. Hari Ram Gupta.

Justice Shri Mookerjee was re-elected *President* and Dr. Nihar Ranjan Ray, *General Secretary* of the Society for 1950-51. The *Vice-Presidents* elected were Dr. M. N. Saha, Dr. M. Siddiqi, Dr. R. C. Majumdar and Mr. K. P. Khaitan.

The Society founded in 1784 by Sir William Jones, will soon be known as the "Asiatic Society" : the prefix "Royal" which it acquired in 1936 and the words "of Bengal" which crept in nearly 50 years after its foundation will be dropped.

INDIAN DAIRY SCIENCE ASSOCIATION

The Third Annual General Meeting of the Indian Dairy Science Association was held on Wednesday, March 1, 1950, at Bangalore, Dr. K. C. Sen, Director of Dairy Research, presiding.

The Association, which was started in 1947 by leading dairy scientists in the country with the object of furthering the advancement of dairy science, has made noteworthy progress in all directions. The Association has been publishing a journal called *Indian Journal of Dairy Science* which is now running in its third year. A non-technical monthly Journal entitled *Indian Dairyman* is being published under the joint auspices of the Association and the Bangalore Dairy Cattle Society for disseminating knowledge to the layman.

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In the course of his Presidential address, which was read out by the Chairman, Sir Datar Singh pointed out the need for re-orienting our cattle and dairy development policy keeping in view our financial resources, the basic stock available, the conditions of milk production, economic position of the producer and purchasing power of the people. For increasing milk production we have necessarily to depend on our indigenous resources, qualities and habits. In this we have, more and more to depend on the co-operation of the people both in the productive sphere as well as in the marketing side and must organize producers' and consumers' co-operative societies. Considerable advance in this direction has been made in Madras, Bombay, Utter Pradesh and elsewhere. The Indian Council of Agricultural Research had sponsored the Key Village Scheme under which a coordinated programme of cattle development was to be launched and which envisaged measures like providing approved breeding bulls, giving technical and veterinary aid to the producers, supply of cattle feeds at reasonable rates and castration of all scrub bulls. Encouragement was being given to various humanitarian organisation to salvage dry cattle from cities and to establish *Go-sadans* in interior areas where unproductive cattle could be maintained on natural grazing and prevented from further propagation. Sir Datar drew particular attention to the antisocial practice of adulteration of milk and milk products which should be eliminated quickly before the marketing of milk and milk products could be organised successfully.

Sir Datar Singh, was re-elected President of the Association for the year 1950-51.

TELEGU ENCYCLOPAEDIA

The Telegu Bhasha Samiti, a linguistic Society established in October, 1947 for the promotion and advancement of the Telegu language, has undertaken to publish a Telegu Encyclopaedia in twelve volumes. The twelve volumes will be respectively devoted to biology, zoology, botany and geology; modern scientific medicine and Indian systems of medicine; mathematics and astronomy; physics, chemistry and atmospherics; engineering and industry; agriculture, forestry and veterinary science; fine arts, languages, literature and education; religion, philosophy, psychology and ethics, geography, commerce and economics; history and politics; sociology and anthropology; law and order, and defence; and Telegu culture, language, literature, and history. A Sub-Committee has been constituted for each volume with experts for that branch of knowledge. The whole project was worked out by a Planning Committee of eight members, including Sri T. S. Avinasalingam Chettiar, the former Education Minister.

The notable feature of the encyclopaedia is that the volumes have been classified according to broad subjects and not alphabatically, as is the usual practice in such work. Within a particular volume, however, the alphabetical order will be followed. In other word, each volume will be a self contained encyclopaedia for that particular branch of knowledge.

This great enterprise of the Telegu Bhasha Samiti will doubtless be widely applauded. The Samiti is presided over by Sri Bezawada Gopala Reddi and the members of the Council include such able and distinguished men as Sri R. B. Ramakrlshna Raju, Sri Vizayarama Gajapathi Raju, the Chief Justice Sri P. V. Rajamannar and Sri H. Sitarama Reddi. The Samiti is at present housed in the University Buildings, Madras.

ANNOUNCEMENTS

We regret to record the death of Rai Bahadur Dr. N. C. Chatterjee, Forest Entomologist, (retired), Indian Forest Research Institute, Dehra Dun who was recently elected President of the Zoology and Entomology section of the next Indian Science Congress Session to be held at Calcutta in 1951, on February 26 last. A distinguished Entomologist, Dr. Chatterjee was elected a Fellow of the National Institute of Sciences of India in 1942.

Major General Sahib Singh Sokhey, Director of the Haffkine Institute, Bombay, has been appointed Assistant Director General of the World Health Organization. He is shortly leaving India to take up his new post.

Dr. D. Chakravarty, Lecturer in Chemistry, Calcutta University and Honorary Secretary, Indian Chemical Society is appointed Secretary, Council of Post Graduate Teaching in Science, Calcutta University. A distinguished organic chemist Dr. Chakravarty was elected a Fellow of the National Institute of of Sciences of India in 1949. He has been serving the Calcutta University since 1933.

Dr. A. K. Dutta, Lecturer in Physics, Calcutta University and his co-worker Sri B. B. Ghosh of All-India Radio, Calcutta Station have been invited to participate in International Conference of Ultra-Acoustics to be held in Rome from July 14-17, 1950. The conference is being held under the joint auspices of the National Council of Research and the Association of Physics, Italy and the International Union of Physics.

Dr. S. L. Hora, Director, Zoological Survey of India is appointed a Corresponding Member of the Zoological Society of London and an Associate Editor of the journal *Evolution*, an international journal of organic evolution published by the Society for the Study of Evolution.

To help India meet the immediate need for application of extension methods in betterment of agriculture, the United States Government under Public Law 402 has set aside a few thousand dollars to enable some high Indian agricultural officials to proceed to America

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to study U.S. methods of agricultural extension work. A detailed article on U.S. Agricultural Extension Service is published elsewhere in this issue.

We have much pleasure in recording our grateful thanks to the Government of West Bengal for a grant of Rs. 2,000/- only for the year 1949-50 to the Indian Science News Association in aid of our publication. The following other scientific societies are also the recipients of grant from the West Bengal Government: *Bangiya Bijnan Parishad*, Botanical Society of Bengal Calcutta Geographical Society, Zoological Society of Bengal, Calcutta Mathematical Society, Science Club, Calcutta; Indian Chemical Society, Indian Physical Society and the Physiological Society of India.

Dr. H. K. Nandi, Deputy Director of Agriculture, Government of Orissa is appointed Director of Agriculture, West Bengal.

ERRATA

In March 1950 issue, p.358, column 2, line last but one read 'Symptoms in the citrus plants affected with corking and splitting' after "hard fruit" and before 'splitting'.

On p.359, column 2, line 21 *read* "Two" *for* "The"

LETTERS TO THE EDITOR

[*The Editors are not responsible for the views expressed in the letters.*]

THE TAJIK-GALCHA ORIGIN OF PARSIS

I

Desai[1] has drawn certain conclusions, which help to confirm my theory of the location of the original Aryan Home[2], in the region of the *Sir Amu Daria Doab*. Desai has been at pains to prove that "the modern Parsis definitely derive their ancestry from the Tajik and Galcha stocks of ancient Iran, who were more Iranian then Arabian and with negligible differences have remained true to the type", and that "it was definitely Persia which brought about the brachycephaly of South Arabia and they were *the Tajik or Galcha ancestors of modern* Parsis." These statements are no doubt true, as, the author with the aid of the geographical science, after refuting such old theories as Tilak's theory of the Arctic Home of the Vedas, have drawn a similar conclusion that the ancestors of the Parsis, the Peshdadyans or the original ancestors of the Iranians, first lived in the region occupied largely by Tajikistan and Badakshan, now a powerful political division of Russian Central Asia[2]. These very parts have been identified by me with the *upper* Sir Daria and the *upper* Amu Daria, in the neighbourhood of the Pamirs as the first Argar have. After a comparative study of physiography and geography of this region, from modern maps and records, with the description of the original Aryan Home given in the *Vendidad* II and the *Bundahishn* XXV, two of the precious relics of Zoroastrain literature, I have hit upon this land of Tajikistan as the home of the settled Tajik population of ancient Iran, in contrast to the aboriginal and nomadic population of Persia.

No doubt, Tajikistan, after the wave of the Soviet system of Government, has advanced miraculously not only with the aid of the descendents of the versatile Tajik people but also by means of the splendid natural resources particularly of this S.E. corner of Central Asia, *viz.*, the rich loess soil, the silt-laden and health-giving waters of the Sir Daria, which is largely snow-fed and the bracing temperate climate. There are, besides, some precious metallic ores also discovered in this particular region, so that we may expect the rise of this Tajik-Galcha tribe in U.S.S.R. to still greater heights in the near future.

L. Dudley Stamp, also writes in his latest publication about this province as follows:

"Tajikistan (Tajik Socialist Soviet Republic) was formed in 1929 of those portions of Bukhara and Turkistan inhabited mainly by Tajiks, who speak a language allied to Iranian. They are Aryans and numbered 1,333,000 in 1933. The area of the country is 55,545 square miles. The capital is Stalinobad (formerly Dushambe) and the state is remarkable for the development of motor roads. Stalinobad is now not only linked by rail with Termez but also by regular air services. During the Czarist regime, literacy was only 0.5 per cent. It has now risen to 60 per cent. The eastern part of this republic is Badakshan, lying amongst the Pamirs. The Russians have recently carried out intensive searches for minerals, with important results".

Thus, the connection found by Desai between this ancient flourishing Tajik tribe and the modern Parsis is most heartening at a time when the Parsi community of Bombay and other centres on the west coast of India is going down. Desai himself has drawn a very sad picture of the present state of affairs of this community, that made a name in India as well as in Pakistan for their honesty of purpose, capacity for adaptation to the environment and rare philanthropy. The same author has complained of the community's decreasing fertility, late marriages, high infant mortality, beggary and low vitality to withstand the weather or the market fluctuations. Rightly he calls it "A Community at the Cross-Road". This is particularly sad in face of the fact that the descendants of their original inhabitants in Tajikistan have so rapidly risen and are still a virile race. Cannot something be done to bring together these counterparts of the original Aryan stock of human beings? If any fresh blood

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is required and if the Parsis wish to preserve the great and good racial characteristics and the pristine purity of their religion and culture, would it not be well to bring the present day Parsis and the Irani Tajiks into contact with one another ? These are suggestions worthy of consideration by the leaders of this smallest and rarest community in the world. The Parsis are anxious *to continue the noble traditions of a race, which, inspite of their fall in the political sphere, has maintained a high standard of morality, charity, duty and loyalty throughout these* 13 *centuries in India and Pakistan.*

However much we wish for a total unification of the human race in the modern world, there is always this sorting out of good and bad, high and low, pure and impure, forward and backward, etc. going on in nature and as citizens of the world, we must make the situation. Not from any communal pride, racial discrimination or differences of earthly acquisitions but from our willingness and eagerness to share our cultural characteristics and our ancient common heritage, do we Parsis desire to continue to remain in segregation still in this country. If both India and Pakistan can yet be benefited by the self-sacrificing spirit and life of the Parsis, as a separate community, without unduly mingling up with other communities, then it is necessary that the policy of 'live and let live' should be followed in their case.

MANECK B. PITHAWALLA.

Karachi, 7-11-1949.

[1]Desai, S. F. *The Tajik-Galcha Origin of Parsis,* SCI. AND CUL. *15,* 141-145, 1949.
[2]Pithawalla, M. B. Location of the Original Aryan Home and other early Aryan Settlements, *Ind. Geog. Jour. 20,* pp. 37 to 62 ; and pp. 1 to 28.
[3]Dudley Stamp, L. Asia, an Economic and Regional Geography",, Metheun, London, 686-687, 1944.
[4]Desai, S. P. *A community at the Cross-Road,* New Book Co. Bombay 1948.

II

I am glad to note from Pithawala's letter that he derives support to his theory of the Aryan Home from my article "The Tajik-Galcha Origin of Parsis." The Doab formed by the Rivers Syrdarya and Amudarya (Jaxartes and Oxus respectively) is perhaps the most likely home of the ancient Iranians. In a highly interesting work entitled the Duab of Turkestan, W.R. Rickmers (1913) says that whether you turn 'to climatology, geology, zoology, botany, to the human races, to political economy and history,..... you will find all the central and leading facts or types included in the Duab.' According to him the place has not changed much since historic times in spite of something known as Central Asian desiccation. It may therefore be safely assumed that this part may have been the birth place of mankind or more possibly of the ancestors of the present-day Parsis and of the Aryan Hindus somewhere 3000-5000 B.C. The Vendidad describes 16 beautiful places created by God for mankind one after another and some of them like Merv, Balkh, Herat, etc., fall within the area in question or near about. W. Geiger (Civilisation of the Eastern Iranians in Ancient Times, 1885, translated by D. P. Sanjana), on whom Rickmers also relies, writes (vol. *i*, p. 9) ; "The Avesta expressly described the primitive home of the Iranian people, the most holy Aryanavaija, as being situated in the mountainous countries drained by the Sir, the Zerafshan, and the Amu."

Describing the Tajiks, Rickmers says they are 'a mixture but more Aryan in every way'. Describing the Galchas, he says their 'children are sometimes strikingly European in their features.....These are the people called Galchas by many travellers and ethnologists. Undoubtedly they look very Aryan, more like Caucasian mountain tribes, such as the Suanetians, than like the other races of the Duab. That they are the remains of a former Indo-Germanic population of Middle Asia seems not unlikely. Like the Suanetians they have preserved memories of their old religion under the outer cloak of the later creed forced upon them. The sacredness of fire evidently points to Zorcastrain worship'.

Thus looked at from anthropological, historical, geographical and scriptural angle Dr. Pithawala's theory of Aryan Home in the Duab seems plausible.

S. F. DESAI.

Parsi Panchayet Office,
Bombay.
28-1-1950.

IONIC ANTAGONISM IN CATION EXCHANGE REACTIONS—II.

The competitive reaction between cations in exchange processes under equilibrium conditions was presented in Part I. It is, however, important to study this type of interaction under dynamic conditions. For this purpose a clay salt was leached with a mixture of electrolytes until the saturating cation was completely replaced. The amount of the cations adsorbed by the clay from the mixture, when compared with their relative adsorbabilities and/or concentration ratios in the mixture, gives an idea of the influence of one upon the other.

Various combinations of cations at three concentration ratios were used for the measurements. The concentration of the cations was, no doubt, found to have a dominant effect. But the ratios of concentrations in the solution, which have certain fixed values, are in general less than those on the solid phase. This evidently indicates that there is suppression of the exchange of one cation or the heightening of the other, or both. The discrepancies are less marked in the case of the H-bentonite system, as the following results will show.

Plots of the logarithms of m and c (columns 3 & 4) are more or less straight lines. Although individual plots vary appreciably in their slopes the average values of m and c can be put into the form : $m=0.56\ c^{1.05}=c/2$.

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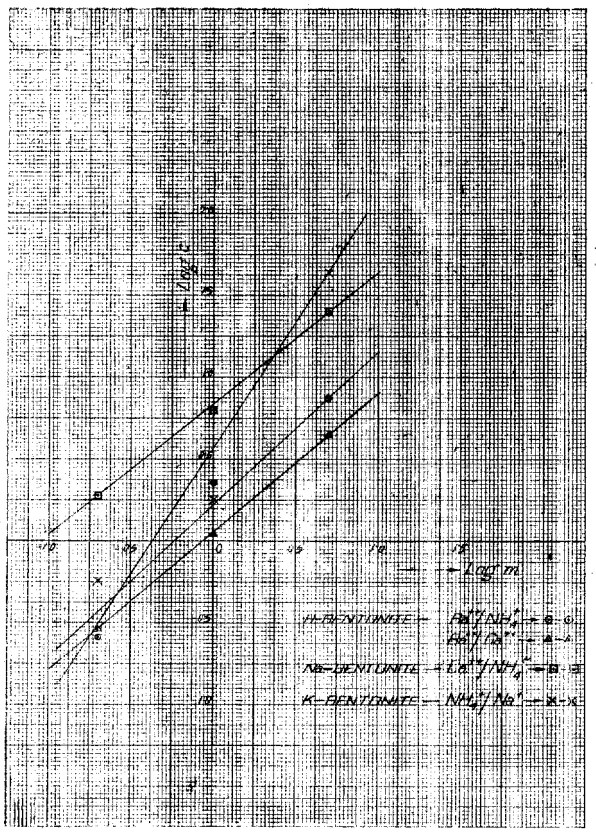
This suggests that the ratio of the cations in the solid phase of the clay is, on an average, double of that in

System : Electrolytes		Ratios in solution (m)	Rations on the clay (c)
H-Bentonite	$BaCl_2 + NH_4Cl$	5.0	7.5
		1.0	2.3
		0.2	0.26
	$BaCl_2 + CaCl_2$	5.0	4.5
		1.0	1.1
		0.2	0.29
Na-bentonite	$CaCl_2 + NH_4Cl$	5.0	25.0
		1.0	6.3
		0.2	1.9
K-bentonite	$NH_4Cl + Nacl$	5.0	43.4
		1.0	1.8
		0.2	0.57



the leaching solution. If the relative entry of the cation is compared with their symmetry values, it is found that the more adsorbable cation, even when its concentration is low, often suppresses the entry of the less absorbable one. This general finding is thus in conformity with that observed in the case of ionic antagonisim under equilibrium conditions (Part I).

My thanks are due to Dr. S. K. Mukherjee for his continued interest in the work.

SHANKARANANDA MOOKERJEE

University College of Science and Technology, Calcutta. 5-12-1949.

COLCHICINE-INDUCED POLYPLOIDY IN *AMARANTUS BLITUM*

The results obtained so far by various workers [1,2,3,4] indicate that although the effect of colchicine on fruit and seed setting has not given promising results, this treatment has generally given increased vegetative growth. For this purpose some of the leafy vegetables were selected for study and preliminary results on *Amaranthus blitum* commonly known as 'Cholai'. and used as a leafy vegetable are reported here.

The most successful treatment for the production of polyploids was found to be 0.10% colchicine applied to the growing point for 13 hours. The first noticeable effect of colchicine treatment was a temporary arrest of growth. The leaves coming out just after the treatment were characteristically thick and appeared abnormal in shape. The subsequent leaves however, were not so thick. 30 day old treated plants had thicker stems, more number of leaves and branches, larger and darker green leaves and were as tall as the untreated plants. The above observation is further supported by higher fresh and dry weights of different parts of the plants after 35 days of growth. It is also worthy of note that water content of the treated plants is higher.

TABLE I

MEASUREMENTS OF CAMERA LUCIDA DRAWINGS

	Size of stomata (cm. × 550)		Size of pollen (cm. × 550)
	Length	Breadth	
Diploid	1.62	1.30	1.10
Colchicine—treated.	2.62	1.71	1.45

The treated plants were further characterised by larger stomata (Table I), lesser number of stomata per unit area, bigger pollen grains (Table I), lateness in flowering and maturity, and bigger seeds with delayed germination. There was, however, variability in the size of the pollen and the seed of the treated plants. 10-20% sterility was also found in the pollen grains of treated plants. The stomata, the pollen grain size and the temporary acetocarmine smears of pollen mother cells were used as criteria for preliminary selection of polyploids.

Larger, darker green and greater number of leaves per plant and prolonged period of vegetative growth in colchicine treated plants suggests a possibility of producing a superior type. The C_2-generation is being raised and detailed results will be published elsewhere.

S. L. TANDON
J. J. CHINOY

Department of Botany,
University of Delhi.
24-12-1949.

[1] Dermen, H. *Bot. Rev. 6*, 599-635, 1940.
[2] Muntzing, A. *Hereditas, 21*, 263-378, 1936.
[3] Nobel, B. R. *Amer. Nat, 75*, 289-365, 1941.
[4] Stebbins. G. L. *Advances in Geneties, 1*: 403-429, 1947.

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OPTICAL SPECIFICITY OF PROTEIN HYDROLYSATES.

A previous note on the 'Optical specificity of protein hydrolysates'[1] prepared by enzymatic digestion shows a linear relationship between the specific optical rotation and the degree of hydrolysis, each protein having its distinct and characteristic path of different slope. A similar study has been undertaken with the acid hydrolysates of those proteins in order to examine as to whether the acid hydrolysates would maintain the same optical specificity under the conditions of the acid hydrolysis. The results so far obtained are being recorded in this note.

It is found that each acid hydrolysate from the different proteins exhibits its characteristic path on a newer scale of assymetry, but all are of the same sl pe unlike the enzymatic hydrolysates. Two proteins of the vegetable source have also been included in the study and their acid hydrolysates are being found to differ from those of the animal proteins in that they form a set of parallel paths of a different slope.

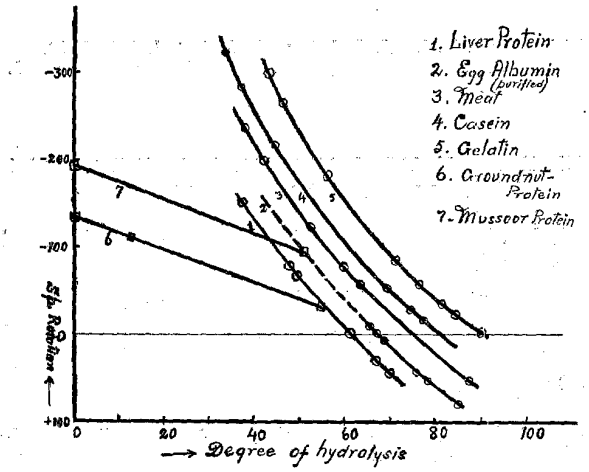

Fig. 1

The curve for each protein tends to indicate its molecular pattern. The specific optical relation of their hydrolysate at the stage of 50% hydrolysis, again provides a specific number for each protein, the number being expressed at the tangent of the angle subtended at the origin by the point on the curve at 50% hydrolysis of the protein. The specific nnmber may in this way be 1.4 for liver, 2.25 for albumin, 3.04 for meat, 3.3 for casein and 4.9 for gelatin. Similarly the vegetable proteins give a different set of specific number *e.g.*, 1.9 for *mussoor* protein, 0.6 for groundnut protein, etc. This protein number would very advantageously facilitate indentification as well as nature of proteins and their hydrolysates, in certain cases. The curve in fig. I also tend to show that the liver protein is most probably of the least complicated nature.

My sincerest thanks are due to Dr. U.P. Basu for his interest in this work.

N. RAY

Bengal Immunity Research Institute,
Calcutta 16, 13-12-1949.

[1] N. Ray, SCIENCE & CULTURE, *14*, 386, 1949.
[2] Hausmann, *Z. Physiol. Chem.*, *27*, 95, 1899.

DOUBLE-STAINING WITH ACETO-CARMINE AND OTHER RAPID TECHNIQUES—IV*

Contrast staining is a well-known and widely practised technique. It facilitates critical study and observation by emphasizing the diffierentiation between the constituent elements of the material under investigation. Further, it imparts added brilliance and beauty to the preparation, especially when complementary colours are used. But as far as we are aware, it has not, so far, been available with aceto-carmine and similar rapid techniques, which, therefore, compare unfavourably in this respect, with the more elaborate permanent preparations.

As already reported, however, we have succeeded, in our present studies, in introducing a contrasting cytoplasmic stain into such techniques, *viz.*, aceto-carmine, aceto- haematoxylin[2], acetic orcein etc. The procedure is simple and may be illustrated with reference to aceto-carmine.

Pollen grains, fresh, preserved or pre-treated [2,3,4] are stained with aceto-carmine (saturated solution in 45% acetic acid in 55%-or weaker — glycerine[5]) as usual. Thereafter, they are irrigated with the glycerine-acetic-acid mixture to remove the extra stain. This is followed by light green in acetic-glycerine (45:55). Only a trace of light green should be dissolved to give a medium green colour. The tinge, however, can be varied according to convenience. The preparation may be slightly warmed.

The grains so treated show the cytoplasm stained pleasant green, against which the nucleus, originally stained red, stands out conspicuously as a more or less magenta coloured structure due to the enveloping green cytoplasmic screen. The vegetative nucleus also shows up, though less deeply stained than the generative. Preparations thus made retain their colour effects for prolonged observations, and possess the brilliance and all the advantages of the double staining by the customary methods. The technique is, therefore, a valuable adjunct to cytological studies by rapid techniques.

Suitable contrast stains have been similarly combined with other rapid nuclear stains, *viz*, aceto-haema-

*These studies have been financed by the Scientific Research Committee of the U. P. Government.

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loxylin with light green, with acetic-orcein and with orange-G. We are trying other combinations also.

N. K. TIWARY
SHANKERJI SHRIVASTAVA

Botany Department,
Banaras Hindu University,
28-12-1949

[1] Tiwary, N. K. & Shrivastava, Shankerji. SCIENCE & CULTURE, *15*, 37-38, 1949.
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A SIMPLE METHOD OF OBTAINING DIFFERENCE EQUATIONS OF PROBABILITY GENERATING FUNCTIONS OF CERTAIN DISTRIBUTIONS

The author[1] has obtained difference equations satisfied by the moment generating function of a number of distributions arising from m points possessing one of k characters arranged at random on a line. It is well known that the probability generating functions can be derived by substituting $e^t = \xi$ in the moment generating function. The methods used for working out the moment generating functions are not of such wide applicability. In fact it is very difficult to obtain the difference equations satisfied by the moment generation functions of any of the distributions arising from points on a lattice. Recently the author has been able to get the probability generating functions by another method which is described below for the distribution of black-white joins for points on a line.

Let p and q be the probabilities of the points assuming the colours black and white respectively. The probability generating function is defined as usual by

$$\phi(m) = P(0) + \xi P(1) + \xi^2 P(2) \quad \ldots \quad \ldots \quad \ldots,$$

where, $P(r)$ is the probability for r black-white joins. Now, let $P_1(m,r)$ and $P_2(m,r)$ represent the probability for r joins when the first point of the arrangement of the m points is black and white respectively. It can be easily seen that P_1 and P_2 for black-white joins satisfy the following difference equations.

$$P_1(m,r) = p\,P_1(m-1, r) + p\,P_2(m-1, r-1)$$

$$P_2(m,r) = q\,P_1(m-1, r-1) + q\,P_2(m-1, r)$$

Similar equations have been given by Wishart and Hirschfeld[2] also. But they have not used them to obtain the probability generating functions.

Substituting the above equations in $\phi_1(m)$ and $\phi_2(m)$, the probability generating functions corresponding to $P_1(m,r)$ and $P_2(m,r)$, they reduce to

$$\phi_1(m) = p\,\phi_1(m-1) + p\,\xi\,\phi_2(m-1)$$

$$\phi_2(m) = q\,\xi\,\phi_1(m-1) + q\,\phi_2(m-1)$$

Eliminating the ϕ's from the above equations we get—

$$\begin{vmatrix} (E-p) & -p\,\xi \\ -q\,\xi & (E-q) \end{vmatrix} \phi(m-1) = 0$$

where E is the operator used in Finite Difference.

The method outlined above has been found to be very powerful in obtaining the difference equations of probability generating functions of a large number of distributions arising from points of different characters distributed in the form of a lattice. The difference equations will enable us to prepare the probability tables for the distributions. Further, since the difference equations give the moment generating functions, they can be used to show that all the cumulants of the distributions are linear functions of the total number of points on the lattice and its sides.

Full details will be published shortly in the *Journal of the Indian Society of Agricultural Statistics.*

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Indian Council of Agricultural Research,
New Delhi, 9-1-1950.

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BOND ENERGY AND IONIC NATURE OF BONDS IN POLYATOMIC MOLECULES

It has been previously shown by us[1] that the total energy of a bond A-B is the sum of both the ionic and covalent contributions *i.e.*, $D(A\text{-}B) = \sqrt{D(A\text{-}A)} \times \sqrt{D(B-B)} \times (1-i) + \Delta\, i$ where D(A—B), D(A—A) and D(B—B) are the energies of the bonds A—B, A—A and B—B respectively, i is the ionic nature of the bond A—B is given by $\frac{Z_A}{Z_A + Z_B} \times n$ where Z^A and Z^B are the nuclear charges of the atoms A and B. $i\,\Delta$ is the energy due to the partial ionic nature of the bond. This relation has been successfully applied in the case of simple diatomic systems like hydrogen and alkali halides. It has been shown that the ionic binding energy $\Delta\, i$ is equal to ixe^2/r.

The object of this note is to point out that similar relationship holds good for the bonds in polyatomic compounds. The energy due to the partial ionic nature of the bond is however $ixe^2/2r$, *i.e.* half the value of the Coulombic energy.

Table I gives the results of such calculations.

The values of ionic natures given in col. (3) as calculated from the relationship [2] $(Z_A/Z_A + Z_B) \times n$ where Z_A and Z_B are the nuclear charges and n a screening constant, are in good agreement with the observed values

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TABLE 1

Bond (A-B)	Energy D(A-B)	Dist.	Ionic cal.	Nature obs.	Ionic Cal.	binding energy Obs.
	p	$\frac{\gamma_o A}{p}$	$\left(\frac{ZA}{ZA+ZB}\right)^n$	$\frac{h}{e\gamma}$	$i\frac{e^2}{2\gamma}$	Δ_1
O-H	110.2	0.96	0.44	0.53	76	75
S-H	87.5	1.34	0.18	0.17	22	21
N-H	83.7	1.00	0.33	0.78	51	55
P-H	63.0	1.46	0.20	0.24	22	21
As-H	47.3	1.56	0.09	0.07	10	11
P-Cl	62.8	2.00	0.47	0.43	39	45
P-Br	49.2	2.23	0.30	0.26	22	29
As-Cl	60.3	2.16	0.66	0.60	56	50
As-Br	48.0	2.23	0.48	0.45	34	34
As-I	33.1	2.54	0.39	0.36	25	29
C-H	87.3	1.07	0.07	0.08	13	15
C-F	107.0	1.41	0.20	0.21[2]	47	58
C-Cl	66.5	1.76	0.19	0.18	18	19
C-Br	54.0	1.91	0.15	0.15	12	10
C-I	45.5	2.10	0.11	0.12	8	4
C-S	54.5	1.81	0.14	0.12	1.3	1.7

p—Pauling., The Nature of the Chemical Bond.

obtained from the data on bond moments calculated from the dipole moment values.

Except in the case of C-F the agreement between the observed and calculated ionic binding energies is quite within the uncertainties of the bond energy values.

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THE FOOD OF *RANA HEXADACTYLA* LESSON, IN RELATION TO FISHERIES.*

Though the Indian bull-frog *Rana tigerina* Daud, is regarded as a predator on fishes[1], there is no record showing whether the South Indian frog *Rana hexadactyla* Lesson is detrimental to pisciculture. The present investigation was undertaken to ascertain the facts in this connection. This frog is common around fish-rearing establishments in South India. Two hundred and fifty specimens of it were collected from various localities, such as departmental fish-farms and nurseries, swamps, canals, rivers, and tanks, and their stomach contents were determined both qualitatively and quantitatively.

The following table shows the results :—

TABLE I

STOMACH CONTENTS (FOOD) OF *Rana hexadactyla*

Name of food organism.	*Frequency of occurrence in the stomachs of the 250 individuals.*	*Largest percentage by volume in a single stomach.*
I. PLANT ORGANISMS :		
Hydrilla	65	80
Ceratophyllum	28	100
Spirogyra	36	100
Potamogeton	15	100
Najas	8	100
Chara	5	30
Oxalis	19	100
Grass blades and stem	32	70
Leaves and flowers of rain tree	51	100
Leaves of margosa tree	16	15
II. INSECTS :—		
Dragon flies and larvae	16	20
Laccortephes	44	100
Lethocerus	30	60
Ranatra	18	20
Plea	26	20
Gerris	13	60
Hydrometra	8	30
Corixa	17	50
Dityscus	17	100
Cybister	22	65
Gryllotalpa	1	60
Black ant (*camponotus*?)	2	20
III. MOLLUSCA :—		
Limnaea	21	20
Bythinia	3	5
Indoplanorbis	13	20
Viviparus	11	10
IV. CRUSTACEA :—		
Gelassimus	3	100
Palaemon	1	20
V. FISHES :—		
Etroplus maculatus	1	100
Gambusia affinis	2	50
Lebistes reticulatus	2	100
VI. MISCELLANEOUS :—		
Stones	2	15
Twigs	4	20
Silk cotton	1	20

The dietary has a wide range and the stomachs examined showed 34 recognizable items. The frog feeds mostly on water insects, water plants, and leaves and flowers of shore trees and rarely on fishes. The latter were discovered in only five stomachs and were of a small size and of no economic importance. The feeding habit thus seems to be mainly related not to fishes, but to the principal plant and animal organisms of the locality. It would be wrong to particularise a "fish diet" for the species.

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While it is improbable that this frog adversely affects the production or yield of the inland fisheries, it may be indirectly of some advantage. It is not unlikely that reptiles, birds, fish, otters and many other forms prey upon it and its tadpole. If it were not present, its enemies would perhaps feed upon fishes of commercial importance and thus harm fisheries. To cite an analogous case[2], the Board of Fish Commissioners in Pennsylvania is stocking lakes and ponds with frog tadpoles along with fishlings so as to provide food for the animals that would otherwise prey upon valuable food and game fish.

We are grateful to Prof. Beni Charan Mahendra, for his criticism and suggestions in the preparation of the present note.

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1-2-1950.

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* Communicated with the kind permission of the Director of Fisheries, Madras. (See also *Proc : 37th Ind. Sc : Cong.* III, 258, 1950)

ABNORMALITIES IN THE FLOWERS OF *VINCA ROSEA* LINN

Vinca rosea Linn. a native of the West Indies is commonly grown in Indian gardens. Its white or purplih pink flowers appear almost all the year round. On July 1946, the author noticed on one plant a branch having some flowers completely turned green instead of normal purplish pink ; other flowers had turned partially green. Besides flowers, vegetative shoots were also affected in various ways.

The green and partially green flowers showed the following abnormalities :

(*a*) Gradual decrease in the size of the flowers; (*b*) elongation of pedicels, some reaching a length of 20 to 25 mm.; (*c*) enlargement of the sepal lobes into long slender linear foliaceous structures ; (*d*) change of salver-shaped corolla into short green petals, each appearing like a stalked leaf ; (*e*) gynaecium absent or modified into leaf-like structure ; (*f*) reduction in the length of the style ; (*g*) the two green bodies at the base of the ovary growing into two short shoots with tiny leaves ; and (*h*) much proliferation. All these are illustrated in figures 2-9. Fig. 1. shows the normal flower of *Vinca rosea* L.

The stamens were quite normal and had not undergone any change. Pollen grains appeared to be normal, but were not so numerous as in normal flowers. Either one or both the axillary flowers at a node showed abnormalities, but the first condition was much more frequent, the latter rather rare.

Similar changes were seen also on other branches and affected vegetative shoots. The most characteristic feature of the vegetative shoots was reduction in the size of the leaves. New leaves became smaller and

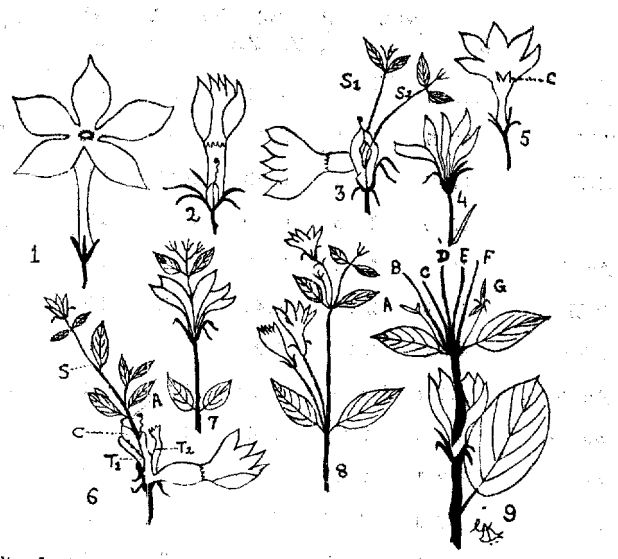

Fig. 1. A normal flower. Fig. 2. An abnormal flower showing enlarged foliaceous sepals, ruptured corolla-tube and curled style. Fig. 3. Another abnormal flower showing enlarged ovaries, reduced style and two shoots in place of two lateral tiny bodies. Fig. 4. An abnormal flower with corolla of free petals. Fig. 5. Phyllody of carpels. Fig. 6. An abnormal flower showing a branch (A) from the apex of the thalamus in place of one of the carpels which is raised and borne laterally and modified into a leaf (C). This axis has grown further and bears leaves and branches and ends in a flower showing phyllody. Two tiny bodies, T_1 and T_2 are developed into elongated structures. Fig. 7. Branch C of Fig. 9, showing opposite leaves and a flower having calyx and corolla and a shoot arising from the apex of the thalamus in place of the carpel. Fig. 8. Branch B of Fig. 9, showing opposite leaves and pairs of axillary flowers in the axil of two of these leaves. Fig 9. Proliferation of the flower showing calyx, corolla and an axis arising from the apex of the thalamus in place of a carpel. This bears opposite leaves and branches A,B,C,D,E,F and G.

smaller with result that in course of time the leaves were very considerably reduced. Both the petiole and the lamina were involved in the reduction of the leaves. The average size of the full grown normal leaf is about 7 to 8 cms. by 2 to 3 cms. The maximum size of fully developed abnormal leaf was found to be only about 3.5 cms. long and 0.7 to 1 cm. broad. Further there was a change of colour in the leaves. Normal leaves are deep green, while the abnormal ones were pale yellow green. The yellowish leaves also fell off early.

Besides these changes a further change observed was the stimulation of growth of axillary buds, including the dormant buds. This also resulted in shortened branches with reduced leaves. Ultimately these got crowded at the axils and the plant took up a characteristic bushy appearance, commonly known as witches' broom. At this stage the appearance of the plant was so much changed that it was difficult to recognise

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its true identity. Further it was noticed that these shortened branches with reduced leaves did not bear flowers and hence no fruits with seeds were set. These shoots became sterile and absolutely useless to the gardener for flowers. Root system of the affected plant consisted of stout shortened tap root with numerous fibrous surface spreading lateral roots arising very close to the base of the tap root.

In order to study further abnormalities several flowers from various healthy plants were examined and three more abnormalities were noticed. They were : (*i*) variation in the number of corolla lobes from 3 to 6 ; (*ii*) transformation of the entire corolla into a bilobed or trilobed structure ; and (*iii*) corolla lobes with much divided margin instead of entire.

The fact that in these abnormal flowers both the sepals and petals had become persistent and the latter also virescent shows that the flowers of *Vinca rosea* described in the present paper were affected by a change of the nature of phyllody. The two fleshy green bodies raised somewhat higher than the carpels and placed alternately with them can be regarded as enations of the receptacle. That they give rise to shoots (Fig. 3) shows that they are capable of further growth. The proliferation of the flowers (Figs. 6, 7 & 9) also proves that the floral axis is capable of further growth.

More or less similar types of abnormalities have been recorded in *Argemone mexicana* Linn.[6], in *Sesamum indicum* Linn[4]. ; in *Crotalaria striata* D. C.[3] and in *Angelonia grandiflora* C. Morr.[13]

Discolouration, phyllody, dwarfing, hypertrophy, atrophy, proliferation, etc. are sometimes symptoms of disease in plants. Diseases in several species of *Vinca* have been recorded by Kerner and Oliver[7] ; Metcalf and Flint[8] and Butler and Bisby[1]. Diseased *Vinca rosea* is recorded by Dastur[5]. Similar symptoms causing disease in economic plants are recorded in brinjal, tomato, chillies and cotton by Chibber[2] ; in brinjal by Thomas & Krishnaswamy[9] ; in *bhindi*, cotton and cardamon by Uppal *et al*.[10,11,12]. Macroscopic and microscopic examination of these metamorphosed shoot of *Vinca rosea* however did not reveal the presence of any causative organism. This disease did not spread by affecting other plants. Self sown plants round about the parents were all healthy and normal. Seeds from the healthy unaffected branches of these diseased plants gave rise to normal healthy plants proving that the disease is not hereditary and not transmitted by seeds. As there was no natural transmission of disease artificial methods of self infection and grafting were tried, but these also were found ineffective.

The author is indebted to Prof. A. C- Joshi for his kind interest and help during the investigation.

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27-2-1950.

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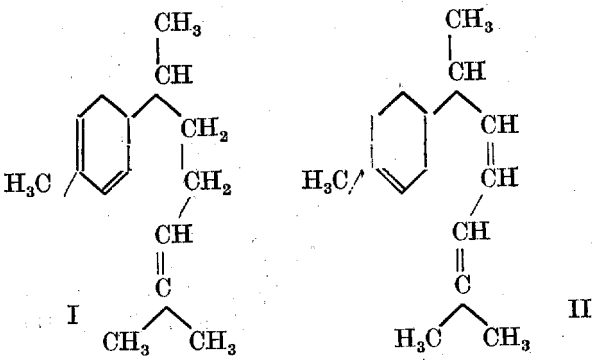
STRUCTURE OF ZINGIBERENE

In a recent communication[1]. Eschenmoser and Schinz have suggested a change in the disposition of one of the double bonds in zingiberene, the conjugated system of double bond being located in the ring—a conclusion based on the results of condensation of zingiberene with acetylene dicarboxylic ester. On the evidences put forward by the above authors the suggested structure I appears to be more satisfactory.



The structure II proposed by Ruzicka and van Veen[2] has been synthesised by me[3], but the attempts to prepare solid derivative such as dihydrochloride of isozingiberene[4] from the synthetic product II, being unsuccessful, the structural identity or otherwise of the synthetic product with natural zingiberene could not be established although both have refractive indices very close to each other, and in spite of the fact that they behave similarly on sulphur dehydrogenation except that the yield of cadalene from the synthetic product was very poor.

Now, in view of the proposed change in the structure, experiments are in progress in this laboratory to synthesise the new structure I as well as to prepare more of II in order to make a comparative study of the infra-red and/or ultra-violet absorption spectra of the

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synthetic products and natural zingiberene, which only can solve this intriguing structural problem.

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BOOK REVIEWS

Physical Aspects of Colour—By Dr. P. J. Bouma, Philips Technical Library, Eindhoven, Holland. (English Edition) Pp. 312, Price 30s.

The book is intended to provide an account of the different principles of colour stimuli and colour sensations. The author has assumed hue, saturation and brightness as three parameters of colour diagram to explain colour sensation. Colour triangle, colour space and colour co-ordinates have been treated in a masterly way with simple geometry and mathematics.

A brief account of colour is followed by definitions of subjective and objective brightness, luminous intensity and other photometric quantities. The colour 'white' is explained by a spectral reflection curve with reference to standard light sources, such as Illuminants A, B, C, and the equal energy source E. According to convention, a colour triangle is formed with three selected spectral colours and is represented by three primaries R, G, B and a white point W. Then in order to express the various chromaticities by numbers, an equilateral triangle XYZ is drawn which encloses completely the curve and the locus of the spectral colours within its boundary. Thus chromaticity is characterized by the ratio of three numbers. Two quantities are required to explain colour mixtures, dominant wavelength and colorimetric purity or the degree of saturation.

The three dimensional representation is needed to specify a colour completely, in which colour space is substituted for colour plane. The three fundamental laws of colour mixture, that is: Grassmann's first, second and third laws, have been developed with vector co-ordinates. The internationally recognized system of colour co-ordinates XYZ, known as the "C.I.E. system" and its application on the transformation from one set of axes to another has been thoroughly discussed. The law of addition for the mixture of colours of two co-ordinates is illustrated with examples and the rule for calculating the monochromatic co-ordinates of a colour from its trichromatic co-ordinates and vice versa is explained.

The chapter on special light sources and colours deals with black-body radiation, colour temperature determination and different system of boundary colours observed when an illuminated edge is viewed through a prism. Two chapters on objective and subjective colorometry give a detailed account of the colour phenomenon with the photoelectric cells and trichromatic colorimeters. A survey of defective colour vision and its hereditary characteristic, is followed by an account of the historical developments and theories of colour science. Different aspects on discriminations and adaptation, and other factors on colour reactions are also discussed. The last chapter deals with the practical applications of colour phenomenon so far discussed in illuminating engineering, and other trade and industry and also with methods of colour reproduction. In the appendix ten tables of data for colour calculations in RGB and XYZ system are given.

The theoretical development of colour problem is based on Schrodinger's work during 1920-1926, but detailed mathematical treatment has not been followed in the book. The author has given stress on the expression of colour by numbers and on the calculation and measurement of colours from simple geometrical considerations.

We are thankful to Dr. P. J. Bouma for this valuable handbook on colour measurement which he wrote in Dutch in April 1945 during his serious illness that ultimately brought an end to his life in January, 1947.

B. M.

Biological Action of Sex Hormones—By Harold Burrows. Second Edition (1949), Cambridge University Press. Price 42 sh. net.

This very useful and instructive work do not require any special introductions to the students of Endocrinology. It gives information and data regarding the different aspects of the working of the sex glands and other endocrine organs which work in co-ordination with these and the regulation of sexual functions.

The Second Edition has been considerably reset with valuable additional information and discussions,

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amplifying most of the problems dealt in the different chapters. These additions are not only from the literature which has been published since the last addition, but many are from older work, which has been introduced to clarify and deal with the subject more intimately. The chapter on Oestrogen, for example, has been so enlarged that it now occupies about double the number of pages than it did in last edition, with added items of study, such as, Oestrogen acquired from the environment.

The work has tried to perform the task of placing before the students of Endocrinology important results and data of a branch of science which so radically affect the structure and functions of the body and which is expanding rapidly.

B. B. S.

Water Supply Engineering, 4th Ed. 1949—By Harold E. Babbitt & James J. Doland, Published by McGraw Hill Book Co. Inc.

The authors of the book are well known professors in the University of Illinois, U.S.A. and this new edition with timely revision and a well arranged index will definitely prove very useful to Degree students in Civil Engineering.

Within a compass of about 600 pages the whole subject of Water Supply Engineering including Hydraulics has been treated in a very thorough and systematic manner with an excellent introduction on the historical side.

There is, however, a little mistake in naming 'Susruta' as 'Ousruta' (Page 4). The chapters on Pumping Machineries and Electrical Equipments are special feature which have greatly added to the value of the book. The chapters on Water Analysis, Sand Filtration, Softening Disinfection and other miscellaneous methods of purification are quite comprehensive and useful not only to the students but also to the practising engineers as a reference book.

B. N. C.

Must We Hide—By R. E. Lapp. Addison Wesley Press Inc., Kendall Square Building, Cambridge 42, Massachussetts, U.S.A. Cloth, $5\frac{5}{8}'' \times 8\frac{3}{8}''$, with dust proof cover, pp x+182, 1949. Price $3.00

Written by an American physicist and one time member of the famed Manhattan Project and now Executive Director of the Committee on Atomic Energy of the Research & Development Board of the National Military Establishment, this book is an appraisal of the power and limitations of the atom bomb. There are three main themes on which the author has based the 14 chapters of his text *viz* : the actual observed effect of the bomb in Japan, its possible mode of attack and destruction in future, and the means of defense. In a clear and lucid manner, a mass of unfamiliar facts are brought to light as regards the nature of casualties and the lack of medical attendance in Hiroshima, and the effect of radiation emitted by the atom bomb as compared with the normal radiation absorbed by us from cosmic rays and medical x-ray examination. In going through the chapter dealing with radiation, the reviewer was reminded of another recent publication, *viz.*, Dr. David Bradley's "No Place To Hide" (Hodder & Stoughton, 1948), in which the author admirably surveys the subject of radioactive contamination—a working knowledge of which he obtained as a member of one of the Bikini monitoring crews. As a surgeon Dr. Bradley describes the Bikini blast, interweaving the theme with a vivid panorama of the series of emotional experiences. Dr. Lapp in his book deals with this test from a purely scientific view point and although it lacks colour as may appear to some, its profoundness and deep significance with future wartime operations will be appreciated by all. In discussing the varied phases of strategic and tactical bombing over Japan and Germany, the author brings to light the fact that more destruction can be caused by a 1000 plane raid than by an atom bomb.

To the uninitiated, a digress on the effects of an atomic bombardment in U.S.A. is very interesting. Basing his comparison on the Bikini test a vivid description is unfurled of what would happen if an atom bomb is dropped in a river or smuggled into the basement of a skyscraper, or released in a main street or on the top of a tall structure. "The problem of atomic defense is a great one but it is not hopelessly great", writes Dr. Lapp in the opening chapter. The best defense really consists in preventing the atom bombs from being brought into the target country by any and all means. According to him this entry can be prevented by intelligence interception through trained observers ; increasing defences by radar and other patrol ; and providing interceptive devices like planes and missiles. In the chapters dealing with planning, decentralization and dispersion, engineers will find much food for thought regarding problems of communication and transport in bomb stricken areas, design of concrete and underground shelters, radiation effects on existing building like skyscrapers and other effects on dams and industrial plants. The layout of three types of cities termed by the author "satellite", "doughnut" and "rodlike" cities with diagrams and a careful analysis is worthy of serious consideration by all engaged in town planning.

In concluding, the author rightly stresses the social implications of atomic warfare, by discussing such topics as the availability of public information on the number of atomic bombs the country is manufacturing, the expenses of maintainiug plants, and the prognosis of another war, which Dr. Lapp believes will not take place till 1960. "Mankind cannot continue to stand in fear of the greatest scientific accomplishment of our time", said Dr. Clark Goodman, Nuclear Physicist of Massachussetts Inst. of Technology. This book goes a long way in dispelling this fear and in producing a rational and correct picture of the potentialities of

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the atom bomb. Nicely bound, clearly printed in bold types and containing over 30 interesting pictures, the book should be read by all who are to call themselves civilised homosapiens.

S. K. G.

Fungi of Bengal—By T. C. Roy, M.Sc., Published by the Botanical Society of Bengal, 35, Ballygunge Circular Road, Calcutta 9. 1949, pp. 44. Price Rs. 3/-.

This book is a comprehensive list of the "Fungi of Bengal". The workers on Mycology and Plant Pathology will warmly welcome the work as it is a very useful addition to the scanty literature on the fungal flora of India. In all 700 species distributed over 248 genera of fungi and bacteria reported from undivided Bengal are recorded.

The subject matter is arranged systematically and the most important feature of the book is the geographical distribution of the fungi on their respective hosts. The author's own experience in researches on Mycology and Plant Pathology has been utilized in the collection work and he has taken great care to compile the host index and the index on the genera of fungi. The bibliography at the end of the book will be of value to the readers for detailed reference. It is expected that mycologists in other provinces will soon bring out lists of fungi occurring in their respective areas.

P. N.

Padarther Swarup (Constitution of Matter)—By Samar Guha. Published by A Mukherjee & Co. Ltd., Calcutta, 1950. Price Rs. 4/-.

The book represents an important effort of popularizing science in Indian language, in this case, in Bengali. During the past few years there has been a marked tendency of writing popular scientific books in this country from a truly scientific point of view and not from the point of view of stunt or cheap entertainment, in which the real scientific facts and principles often inevitably suffer from distortion and misrepresentation. The author has very creditably interpreted to his uninitiated readers for whom the book is doubtless intended the scientific principles and facts which makes for an understanding of the nature and constitution of matter. Starting from simple conception of atoms and molecules, the writer has told the story of electrons and their discovery, the phenomenon of radio-activity, X-rays, the fundamental particles like positron and neutron, transmutation of elements and artificial radioactivity and other allied developments. Heisenberg's Uncertainty Principle has not also been excluded, and a few pages have been devoted to uranium fission. The author ended his discussion with some cosmological problems. The language is simple and lucid. The publisher must be congratulated for the fine printing and get-up. There is still further scope of improving some of the blocks, more particularly, their lay out in the matter itself.

S. N. S.

Garden Weeds and their Control—By Stanley B. Whitehead, D. Sc. Published by J. M. Dent & Sons Ltd., London. Pp 150. Price 7s. 6d net.

This is a small hand book dealing with the various aspects of weed growth and their control. Weed control is a major problem for gardeners as well as agriculturists, and this is the first hurdle to be overcome in any adventure into the realm of plant culture. It has, therefore, received widespread attention in recent years. This small book deals in a short, popular and impressive manner the different aspects of weed control beginning from the old classical method of mechanical eradication to that of the up-to-date and improved methods by chemical substances, some of which are found to act like a plant hormone with specific reaction and in great dilutions. In the text some important and commonly found weeds in gardens and grass-lawns have been described together with their methods of easy and sure eradication. The get up of the book is quite handy and it will usefully serve the purpose for which it has been written. The book can safely be recommended to all lovers of gardening and allied branches.

B. K. K.

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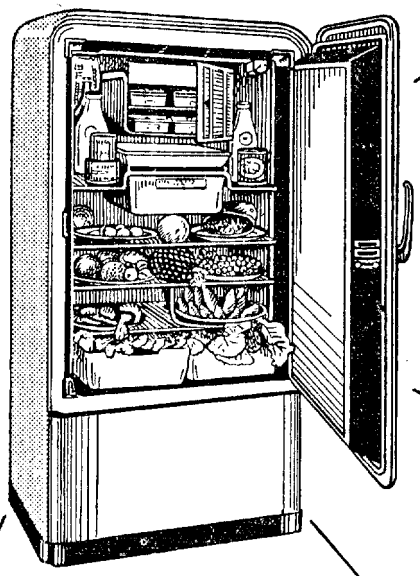

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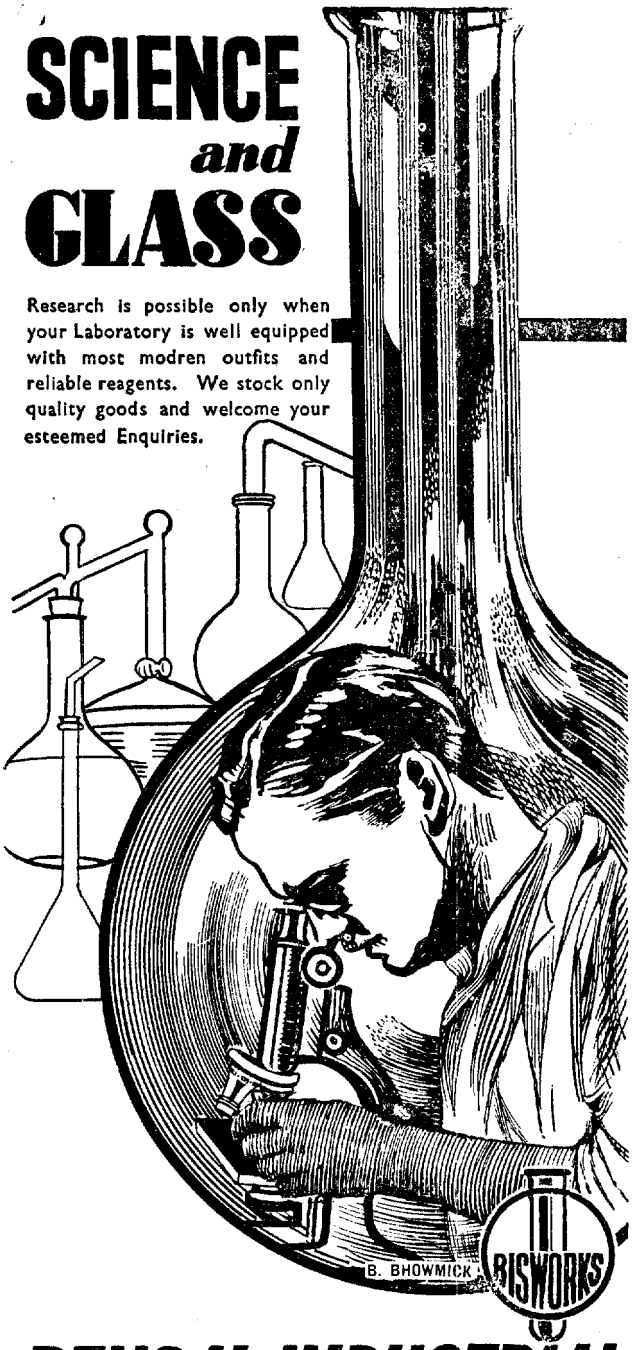

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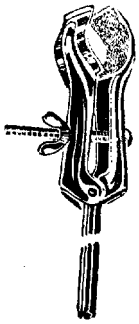

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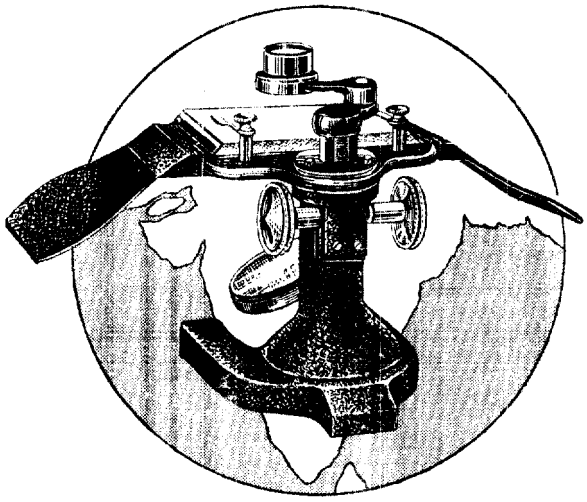

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