SYMPOSIUM

ON

HISTORY OF SCIENCES IN SOUTH ASIA

CONTENTS

PREFATORY NOTE

One of the objects of the National Institute is 'To promote and maintain a liaison between science and letters'. The Symposium on the *History of Sciences in South Asia* shows the earnestness of the Institute to maintain such a liaison. In fact, the development of science, apart from that of humanities, is not happy for human welfare in the long run. As this was the first attempt to bring together historians, oriental scholars and scientists, some sharp differences of opinion, especially about the dates of the 'Source Material', were evident but such differences were resolved by agreeing to certain dates as an *interim* measure and to ensure uniformity of treatment. In this connection, reference may be made to Appendix IX, in which are reproduced from *Nature* a critical review of the papers of the Symposium by Dr. Joseph Needham and, a note, elucidating certain points in it by the undersigned and a postscript by Dr. Needham. It was decided by the National Institute that, as the full papers required considerable revision, a summary of the papers presented at the Symposium and discussions arising therefrom only should be published. It is hoped that the material presented in the present account will serve a useful purpose, for, as Dr. Needham has pointed out 'the study of the history of science in India remains enthralling'.

Mathura Road,
New Delhi 1,
27th November, 1951.

S. L. HORA,
President,
National Institute of Sciences of India.

A brief account of the Symposium on the History of Sciences in South Asia, held in Delhi, 5–7 November, 1950.

The idea of holding a Symposium on the 'History of Sciences in South Asia' was first mooted by Dr. D. S. Kothari, one of the Secretaries of the National Institute of Sciences of India. He at the outset thought it desirable to discuss the matter with Prof. A. Wolsky, Principal Scientific Officer of the U.N.E.S.C.O. Science Co-operation Office for South Asia, in Delhi, in view of the work that his office was doing for the progress of science in India and elsewhere. Prof. Wolsky welcomed the porposal and offered wholehearted co-operation, and assured Dr. Kothari that if the National Institute undertook to initiate the proposal to hold the Symposium, it could count on the active support of the U.N.E.S.C.O. Science Co-operation Office for facilities and financial assistance.

Dr. Kothari and Dr. Wolsky then discussed about the arrangements to be made for holding the Symposium and decided on the following preliminary details :—

(1) The National Institute of Sciences should form an *ad hoc* Sponsoring Committee which in its turn would appoint a Convener (or an executive secretary) for making plans in consultation and in collaboration with the U.N.E.S.C.O. Science Co-operation Office. The Sponsoring Committee should preferably consist of individuals rather than of representatives of different learned bodies.

(2) The Symposium should be a study group of not more than 20 to 25 scholars who should survey the existing contributions to the history of science from South Asia and also attempt to correlate the advances made in different branches and the social implications of the scientific developments.

(3) There should be some background material or working papers for the guidance of the scholars at the Symposium, which might be obtained from the Secretariat of the International Union for the History of Sciences and possibly some more help and materials from a person who might be approached to come and attend the Symposium as an expert consultant. Dr. Wolsky mentioned that he had already approached Prof. Joseph Needham for the purpose and that he would also write to Prof. Bernal if they could give some directions as to the agenda and working of the Symposium.

(4) Each delegate should be required to submit a report on the progress on the history of sciences in his particular branch in his own country. These reports should contain not only the achievements but also a list of published materials and the possible sources of other materials which might be tapped for further intensive study. An attempt should also be made to get some special papers which might show the influence of the achievements of scientists in the East on the development of sciences in the West and *vice versa*.

The general plan of work was then decided to be as follows :—

(1) The Symposium should be preceded by a short opening session where two lectures on the general aspects on the history of sciences should be given and interested people should be invited to attend the session. After the inaugural meeting, the Symposium group consisting of about 20 scholars should sit consecutively for at least three days and discuss papers on the History of Sciences and also deliberate on ways and means of intensifying the study of the History of Sciences in

South Asia. In this task the participants of the Symposium, grouped into three classes, as historians, scientists and research scholars on the history of sciences, should sit in separate groups, and again jointly, for formulating practical recommendations.

(2) At the close of the Symposium there should be another short general session, while even in the course of the session of the Symposium there should be two or three popular lectures in the evening.

(3) Delegates should be invited from Ceylon, Burma, Thailand and Indonesia and it was likely that reports from those countries would cover all the branches in a single report. There might be one or two scientists in China who might as well be induced to come and take part in the proceedings so as to make the discussions as comprehensive as possible.

(4) It was felt that better success of the Symposium would be achieved if active national committees or societies were formed in various countries and steps taken for a planned preparation of a history of the development of sciences in the countries of South Asia. This would stimulate scholars, interested in the history of sciences, to prepare for the forthcoming International Union for History of Sciences to be held in Amsterdam in August, 1950, so that more attention could be drawn to contributions from this part of the world.

Prof. Kothari and Dr. Wolsky then made some preliminary selection of scholars to be approached for contributing to the Symposium and it was thought advisable to wait till the Council of the National Institute of Sciences would approve of the suggestions. Afterwards details of the arrangements would be worked out after consultation with the U.N.E.S.C.O. Science Co-operation Office which, as Dr. Wolsky suggested, would act as secretariat for the Symposium. Dr. Kothari proposed to hold an exhibition of some of the materials having bearing on the History of Sciences. He also suggested that the University of Delhi might be approached for giving facilities for holding the Symposium in their premises.

The proposal of holding the symposium and the decisions arrived at by Dr. Kothari and Dr. A. Wolsky were placed before the Council of the National Institute of Sciences of India, at their meeting on 3rd March, 1950. The Council approved the proposal, and as suggested by Dr. Wolsky, a Sponsoring Committee was appointed, with power to co-opt additional members, to organize the holding of the Symposium under the auspices of the Institute, in collaboration with the U.N.E.S.C.O. Science Co-operation office for South Asia.

The Sponsoring Committee, appointed by the Institute, held two sittings, one in March and the other in September, 1950. At their first meeting, a preliminary discussion took place of the theoretical assumptions on which the idea of a Symposium on the History of Sciences in South Asia was based, and a programme of work was tentatively fixed for the meeting, which was:—

2000 B.C. (*circa*)—From Mohenjo Daro Civilization (i.e. Indus Valley Civilization) to A.D. 1857, i.e., beginning of the British Rule, to be detailed under the following heads:—

(1) (*a*) Chronology of the achievements; and
(*b*) Defining the periods of achievements.

(2) Life Stories of the pioneers.

(3) Contacts with outside on countries' own initiative or by the adventurous trips of foreigners.

(4) General history of those periods with stress on social conditions.

(5) Impact of the discoveries of the scientists on military strategy of the kings and on the general living conditions, like town planning, public health, agriculture, transport and industries.

(6) (*a*) Library sources of manuscripts; and
(*b*) Important centres of ancient scientific research as possible locations to trace manuscripts.[1]
(7) Promotion of study of History of Sciences.
(*a*) An organized body of scholars with a programme of work to meet frequently and contribute papers; and
(*b*) Funds for engaging research scholars and endowing fellowships.

The Committee also made a suggestion that the following categories of scholars should be invited to participate in the Symposium:—

(1) Scientists who have studied the progress of ancient scientific thought and methods;
(2) Historians who have made studies of special periods of history relating to the scientific achievements; and
(3) Scholars (linguists and historians) in Ancient History who have made special studies of ancient records, inscriptions, manuscripts, etc.

The Sponsoring Committee also suggested that a press note announcing the holding of the Symposium be issued in April, which should be followed by a circular to learned bodies in India, Ceylon, Malaya, Burma, Indonesia and Pakistan, seeking their co-operation by contribution of papers from historians and scientists who are connected with them and by the supply of list and locations of source-materials. Personal requests were also to be made to individuals known to be in a position to contribute to the Symposium.

In accordance with the decision, a press-note detailing the objects of the Symposium was published in important papers in India and invitations were sent to important cultural and scientific societies in India. The response was encouraging, both from India and abroad, including Indonesia, Burma, Ceylon and Thailand. As the adhering body to the International Union of the History of Sciences, the Government of India, Department of Scientific Research, have accorded their approval to the Symposium being held under the auspices of the National Institute of Sciences in collaboration with the U.N.E.S.C.O.

At the second meeting of the Sponsoring Committee, arrangements for holding the Symposium were further discussed, which related to its administration, such as, fixing of final dates for the Symposium, accommodation of representatives, travelling fare of delegates, scientific institutions to be invited, and the estimated total expenditure for holding the Symposium. At this meeting, a local Reception Committee was constituted, and the subscription of its members was fixed at Rs.5 per person.

It may be mentioned that it was the original intention of the Sponsoring Committee to hold the Symposium in the latter part of June, 1950, when it was expected to have the presence of Dr. Joseph Needham, who was engaged in the writing of a History of Sciences in China, would come to India for the purpose as an expert consultant. The expectation did not materialize as Dr. Needhám's pre-occupations did not allow him to come to India. The final arrangements for holding the Symposium were complete only by the end of the year, and it was held, in Delhi, from November 5 to 7, 1950 (*vide* Programme of meetings. Appendix I). The meetings were held in the rooms of the University of Delhi, and the authorities of the University, the Vice-Chancellor and the Dean of the Faculty of Science, offered hospitality to the participants. Scientists and historians from various parts of India participated in the discussions and several scientific societies were also represented by delegates. Indonesia and Thailand were represented by Dr. Prijohutomo and Mr. P. Rochanapurananda respectively,

[1] Apart from manuscripts, there are epigraphical and archaeological sources all over in South Asia.

who came to India especially to participate in the Symposium. Besides the contributors, there were 30 observers representing 12 learned bodies. A list of participants is given in Appendix II. Messages of good wishes were received from a number of historians of science from other countries. It was the first time in India that scholars devoted to humanities and sciences met together to trace the History of Sciences. The contributors agreed that History of Sciences was eventually the history of civilization and human mental evolution and that a collaboration between the historians and scientists would lead to fruitful results.

The U.N.E.S.C.O. office, under the able guidance of Dr. Wolsky, had circulated to the intending participants mimeographed copies of the papers that had been received from oriental scholars and scientists for reading at the Symposium. When scientists and scholars arrived for the opening session, it was evident to all of them that considerable controversy was likely to arise in connection with the fixing of dates of the important ancient texts, especially of manuscripts of pre-Christian era. In order to tide over this difficulty, the participants of the Symposium considered it desirable to appoint a Chronology Committee from among them. A Chronology Committee was then appointed and they met and discussed the chronology of ancient texts at length, and decided on a chronological table basing mainly on Winternitz's *History of Indian Literature* (*vide* Appendix III). They also recommended the dates that were decided upon should be taken as a working hypothesis for the discussion of papers of the Symposium. This was accepted by all.

The participants of the Symposium then elected Sectional Chairmen and Rapporteurs for respective sections for conducting various Sectional meetings (*vide* Appendix IV).

The Symposium was opened under the Chairmanship of Dr. S. L. Hora, President-Elect of the National Institute of Sciences of India, for 1951, and Director, Zoological Survey of India, who gave a short address congratulating the organizers and detailing the objects of the Symposium (*vide* Opening Remarks Appendix V).

Papers contributed to the Symposium (Appendix VI) revealed the rich heritage of the people living east of Arabia and also discussed the decline of learning among those people. No momentous technical revolution took place in the countries of the East, though their knowledge travelled to Europe (mostly *via* Arabia) and helped the people of the West to progress with technical improvements and inventions on a very revolutionary scale. The papers were followed by discussions regarding the references that had been quoted, the dates assigned to them and the interpretations given of the texts. The general approach was also considered a topic for discussion a number of times.

The papers, presented at the Symposium, were classified under five headings, for convenience of discussion, as in the International Congress for the History of Sciences. As the number of participants was small, Sectional meetings were held one after the other and everyone took part in each Sectional session. This led to good interchange of ideas about developments in different branches. A summary of the papers and some of the more important points raised in the discussions are given in Appendix VII.

In the afternoon of the second day, there was an open session, where general discourses took place on History of the Biological Sciences, History of the Physical Sciences and Historical Aspects of the Development of Sciences. There were also two popular lectures.

After the discussion of the papers, there was a general discussion on the teaching of History of Sciences. Suggestions were made for extension lectures at the Universities, dealing with scientific developments from historical point of view. Endowment of chairs and funds for research on the subject were considered to be of urgent importance.

In the concluding session, resolutions were adopted to the effect that (*a*) a National Group affiliated to the International Union for History of Sciences be founded in each of the participating countries of South Asia; (*b*) a Board under the National Institute of Sciences of India be constituted for the study of History of Sciences. A Committee was appointed to bring into existence the National Group of India which was also entrusted with the task of going into the suggestions received at the Symposium regarding the formation of the National Group, organization of teaching and research and other general topics (*vide* Appendix VIII).

FINANCE

The total expenses of holding the Symposium amounted to Rs.10,036, covering several items of expenditure, including the travelling allowances of delegates. The major portion of them was borne by the U.N.E.S.C.O. and a very small portion by the National Institute of Sciences of India. The expenses for 'At Home' were met jointly by the Reception Committee, U.N.E.S.C.O. and the University of Delhi.

ACKNOWLEDGMENTS

At the conclusion of the Symposium, thanks were recorded to the authorities of the University of Delhi for giving facilities for holding the Symposium at the University Buildings, and for giving accommodation to the delegates. Thanks were also recorded for the organizers of the Symposium as well as to the U.N.E.S.C.O. Science Co-operation Office for South Asia, Delhi, for their co-operation and financial assistance and to all those who contributed to the success of the Symposium.

APPENDIX I

PROGRAMME OF MEETINGS

SUNDAY, NOVEMBER 5, 1950.

10 a.m.	*Business Meeting.* Election of Sectional Chairmen. Election of Sectional Rapporteurs. Adoption of the Agenda of the Symposium.
10-30 a.m. to 12-30 p.m. ..	Section I. History of Mathematics, Astronomy, Physics, Geography and Geology. *Discussion of papers*
2-30 to 4-30 p.m. ..	Section II. History of Chemistry, Mineralogy, Pharmacy and Biology. *Discussion of papers.*

MONDAY, NOVEMBER 6, 1950.

9-30 a.m. to 12-30 p.m. ..	Section III. History of Applied Sciences, Technology and Engineering. Section IV. History of Medicine. *Discussion of papers.*
2-30 to 4-30 p.m. ..	Open Session: (*a*) Address of welcome by Chairman of Reception Committee. (*b*) Messages. (*c*) Address by the President-Elect of the National Institute of Sciences of India. (*d*) Discourses on— History of Biological Sciences (Dr. S. L. Hora). History of Physical Sciences (Prof. N. R. Dhar). Historical aspects of Development of Science (Prof. R. C. Majumdar).
4-30 p.m.	At Home.
6 p.m.	Popular lecture: Traditional knowledge and scientific understanding (Dr. S. L. Hora).

TUESDAY, NOVEMBER 7, 1950.

9-30 a.m. to 12-30 p.m. ..	Section V. General problems (historical approach) methods and philosophy of science. *Discussion of papers.*
2-30 to 4-30 p.m. ..	Discussions on— (1) Teaching of the History of Sciences. (2) Organization for study of the History of Sciences. Adoption of Report to the National Institute of Sciences of India.
5-30 p.m. ..	Popular lecture (Prof. N. R. Dhar).

APPENDIX II

LIST OF PARTICIPANTS

Altekar, A. S., M.A., Ph.D. *Professor of Ancient History and Head of the Department of Culture, Patna University, Patna.*

Bagchi, P. C., M.A., D.Lit., F.A.S. *Director, Vidya-Bhavana, Vishva-Bharati, Santiniketan, W. Bengal.*

Chakravarti, N. P., M.A., Ph.D. *Director-General of Archaeology, India (on leave); 16 Tughlak Road, New Delhi.*

Chatterji, S. K., M.B., D.T.M., Ph.D. *Chemical Examiner to the Government of West Bengal, Chemical Department, Medical College, Calcutta.*

Chhabra, B.Ch., Ph.D. *Government Epigraphist for India, Ootacamund, S. India.*

Dhar, N. R., D.Sc., F.N.I. *Professor of Chemistry, Allahabad University, Allahabad.*

Dixit, K. R. *Professor of Physics, The Institute of Science, Bombay.*

Dutta, P. C., Lt.-Col., O.B.E., F.R.C.S.(E). *Director, Medical Services, Punjab (India), Simla.*

Hora, S. L., D.Sc., F.R.S.E., C.M.Z.S., F.Z.S.I., M.I.Biol., F.A.S., F.N.I. *Director, Zoological Survey of India, Jabakusum House, 34 Chittaranjan Avenue, Calcutta.*

Hossain, M., M.A. *Department of History, Muslim University, Aligarh.*

Kothari, D. S., M.Sc., Ph.D., F.N.I. *Scientific Adviser to the Government of India, Ministry of Defence, New Delhi.*

Majumdar, G. P., Ph.D., F.N.I. *Head of the Department of Biology, Dacca University, Ramna, Dacca.*

Majumdar, R. C., M.A., Ph.D., F.A.S. *Ex.-Principal, College of Indology, Banaras Hindu University. 4 Bepin Pal Road, Kalighat, Calcutta—26.*

Majumdar, R. C., Dr.Phil.Nat., F.N.I. *Professor of Physics, Delhi University, Delhi.*

Prijohutomo, P. *School for Police, Sukabumi, Java.*

Raghavan, N. G. S., Major, M.B.B.S., *Director, Malaria Institute of India, 22-Alipore Road, Delhi 2.*

Ranganathan, S. R., M.A., Ph.D. *Professor of Library Science, University of Delhi, Delhi 1.*

Rahman, A. *Central Laboratories for Scientific and Industrial Research. P.O. Lallaguda, Hyderabad, Deccan.*

Ray, P., M.A., F.N.I. *Palit Professor of Chemistry, Calcutta University, 92 Upper Circular Road, Calcutta 9.*

Rochanapurananda, P. *Department of Science, Ministry of Industry, Maharaj Road, Bangkok, Thailand.*

Saran, P., M.A., Ph.D. *Department of History, Delhi University, Delhi 1.*

Satyanarayanamurti, G. V., M.B., B.S. *Additional Professor of Medicine and Paediatrics, Andhra Medical College, Visakhapatnam, S. India.*

Seshadri, T. R., M.A., Ph.D., F.N.I. *Professor of Chemistry, Delhi University, Delhi 1.*

Shukla, K. S., M.Sc. *Department of Mathematics and Statistics, Lucknow University, Lucknow.*

Singh, Dr. Amarjit, *Department of Physics, Delhi University, Delhi.*

Singh, A. N., D.Sc. *Head of the Department of Mathematics and Statistics, Lucknow University, Lucknow.*

Ukil, A. C., M.B., M.S.P.E., F.S.M.F., F.A.S., F.N.I., *Ex-Principal, Calcutta Medical College; 67 Dhurrumtollah Street, Calcutta.*

Varma, S. R. *Director of Horticulture, P.E.P.S.U., Patiala.*

Wadia, D. N., M.A., D.Sc., F.G.S., F.A.S., F.N.I. *Geological Adviser to the Atomic Energy Commission, Ministry of Natural Resources and Scientific Research, Government of India, Room No. 191-A, North Block, New Delhi.*

Wolsky, Dr. A. *U.N.E.S.C.O. Science Co-operation Office for South Asia, University Buildings, Delhi 1.*

Yin, H. C. *U.N.E.S.C.O. Science Co-operation Office for South Asia, University Buildings, Delhi 1.*

APPENDIX III

CHRONOLOGY COMMITTEE

The appointment of a Chronology Committee at the outset was necessitated by the fact that though authenticity of the claims of ancient Indian achievements in scientific field went mostly unchallenged, scientists and historians present at the opening session of the symposium in respect of chronology of texts and scientific developments held divergent views.

The Committee consisted of :

Dr. R. C. Majumdar	(Chairman)
Dr. A. S. Altekar	(Member)
Dr. P. C. Bagchi	,,
Dr. S. L. Hora	,,
Dr. D. S. Kothari	,,
Dr. A. N. Singh	,,

This Committee met on 5th November, 1950, and after discussing the matter at length, recommended that the following chronological table should be taken as a working hypothesis:—

Age of the Ṛgveda ..	2000 B.C.–1500 B.C.
Age of Saṁhitās and Brāhmaṇas	1500 B.C.– 800 B.C.
Age of the old Upaniṣads ..	900 B.C.– 500 B.C.
Caraka ..	100 A.D.
Caraka Saṁhitā (Kernel of) ..	100 A.D. but being enlarged in later times.
Suśruta Saṁhitā	200 A.D.–500 A.D.
Vedāṅga Jyotiṣa (Present text)	500 B.C.
Śulbasūtras	500 B.C. and later.
Dharmasūtra	600 B.C.–200 B.C.
Mahābhārata, Manusmṛti, Rāmāyaṇa	200 B.C.–200 A.D.

Adopted by the General Meeting of the Symposium on 7-11-1950.

S. L. HORA,
Chairman of the Meetings.

APPENDIX IV

LIST OF SECTIONAL CHAIRMEN AND RAPPORTEURS

The following Sectional Chairmen and Rapporteurs for conducting various sectional meetings were appointed on 5th November, 1950, by the participants of the Symposium before the opening session:

Section I.

Mathematics, Astronomy, Physics, Geography and Geology.
Chairman: Dr. A. N. Singh. *Rapporteur:* Dr. K. S. Shukla.

Section II.

Chemistry, Mineralogy, Pharmacy and Biology.
Chairman: Dr. S. L. Hora. *Rapporteur:* Dr. G. P. Mujumdar.

Section III.

Applied Science, Technology and Engineering.
Chairman: P. Rochanapurananda. *Rapporteur:* Mr. A. Rahman.

Section IV.

Medicine.

Chairman: Dr. A. C. Ukil. *Rapporteur:* Dr. G. V. S. Murty.

Section V.

General Problems, Methods and Philosophy of Science.
Chairman: Dr. R. C. Majumdar. *Rapporteur:* Dr. A. S. Altekar.

APPENDIX V

OPENING REMARKS BY DR. S. L. HORA, CHAIRMAN OF THE SYMPOSIUM, ON 5-11-1950

It is very often said that 'History repeats itself'. Events have shown that such is sometimes the case. It follows, therefore, that for forecasting the future of a nation, a sound study of its past history is often a very useful guide. Science cannot be an exception to this general truism. One can build solidly the future development of science of any country only on the foundations of its traditional knowledge and achievements. It may sound like a paradox, but it is true all the same, that more you wish to look into the future, the greater must be your effort to dig into the past. The scientific achievements of any country, when thoroughly sifted and evaluated according to modern standards, can be an index to its past glory, cultural heritage and human values. Scientific thought is only one aspect of human life and its development or suppression depends, during any one period, on other circumstances affecting human life, particularly peace or war. The study of the History of Sciences can, therefore, serve two main purposes. Firstly, the trends of development or evolution of our past achievements can guide us to the possibilities for the future and we can thus plan accordingly. Secondly, it helps to complete our history as a whole by elucidating actions and reactions of scientific achievements on other phases of our lives, such as religion, philosophy, culture, material prosperity, industrial or agrarian developments, etc. The organizers of the present Symposium have, therefore, done a great service to India by holding it in the historic city of Delhi and thereby bringing to limelight the achievements of South Asia, which has long been regarded as the cradle of Human Civilization.

'Science is nothing but the finding of unity,' says Swami Vivekananda. That also is the goal of all the United Nations Organizations. Let us then seek unity among warring nations in the study of science—its past history and likely future achievements. If the history of sciences has to subserve this noble purpose, its study must be free from personal or racial prejudices because you cannot have a clear vision of anything through jaundiced eyes. Any nation can be rightly proud of its past achievements, but it should not be oblivious of the achievements of other nations. Friendships can be cemented only on mutual understanding and not on biased judgements. Science is international and let a scientific approach to all our problems be our guiding principle. The study of the History of Sciences, by providing a background of past events, will help us to fix true scientific principles for our everyday life.

APPENDIX VI

LIST OF PAPERS PRESENTED AT THE SYMPOSIUM ON THE HISTORY OF SCIENCES IN SOUTH ASIA

Section I

Mathematics, Astronomy, Physics, Geography and Geology.

Mr. K. S. Shukla. Chronology of Hindu achievements in astronomy.
Dr. K. R. Dixit. The history of Indian astronomy.
Dr. D. N. Wadia. Geological knowledge in ancient and mediaeval India.
Dr. A. N. Singh. Chronology of Hindu achievements in Mathematics.

Section II.

Chemistry, Mineralogy, Pharmacy and Biology.

Dr. S. L. Hora. Zoological knowledge with special reference to fish and fisheries in India before 225 B.C.
Prof. P. Ray. The History of Chemistry in India.
Dr. G. P. Majumdar. The History of sciences in India from pre-Vedic times to eighteenth century A.D.
Prof. N. R. Dhar. India's contribution to the chemical knowledge.

Section III.

Applied Science, Technology and Engineering.

Mr. P. Rochanpurnananda. The History of technical achievements in Thailand.

Section IV.

Medicine.

Dr. G. V. Satyanarayanamurty. A historical and chronological survey of the practice of hygiene and medicine in India from antiquity.
Dr. A. C. Ukil. The History of Indian medicine from ancient times to the eighteenth century.
Dr. S. K. Chatterji. Legal medicine; its study and practice in India (from historical point of view).

Section V.

General Problems, Methods and Philosophy of Sciences.

Mr. A. Rahman. Social factors in the history of sciences in India.
Dr. P. C. Bagchi. Indian sciences in the Far East.
Dr. A. S. Altekar. A periodwise and critical survey of India's achievements in the scientific field.
Dr. R. C. Majumdar. Scientific achievements of the ancient Hindus; chronological and sociological background.
Dr. Prijohutomo. Indonesian cultural history until the seventeench century.
Mr. A. Rahman. The History of sciences and some problems of teaching.
Dr. A. Singh. A history of sciences course for undergraduates.

Other papers received

Dr. R. V. Seshaiya. Ancient Indian ideas of human development.
Mr. N. N. Chatterjee. Ancient India's contributions to geology and mineralogy.
Mr. A. K. Yegnanarayana Aiyer. Dairying in ancient India.
Dr. Mrs. Bani Chatterji. Musical science and scientific relations between East and West from the historical point of view.
Dr. P. M. Mehta. The medical man and his ideals in the golden age of Āyurveda.
Lt.-Col. B. L. Raina. The study of medical history in India.
Mr. J. K. Dholakia. Progress of sciences in South Asia before the eighteenth century.
Dr .K. K. Datta. Impact of industrial revolution on India's economy.

APPENDIX VII

SUMMARIES OF PAPERS AND GISTS OF DISCUSSIONS

(*Prepared by Dr. Amarjit Singh* [1])

SECTION I. MATHEMATICS, ASTRONOMY, PHYSICS, GEOGRAPHY AND GEOLOGY

Chairman .. Dr. A. N. Singh.
Rapporteur .. Mr. K. S. Shukla.

MR. K. S. SHUKLA. *Chronology of Hindu achievements in Astronomy.*

Mr. Shukla stated that Astronomy was originally developed in India for determining the times for Vedic rituals, and that subsequently it outgrew its original purpose and was cultivated for its own sake. He proceeded to give the following periodwise survey of these developments.

Vedic Astronomy (*c.* 2500 B.C. to *c.* 1000 B.C.): Views expressed in the Aitareya-Brāhmaṇa on the rising and setting of the sun indicate that the Vedic Hindus were aware of the sphericity of the earth. The sun's yearly motion was well known and was believed to be the cause of the seasons. In the Ṛg Veda the sun's annual course has been described as a 'twelve spoked wheel', the reference being probably to the 12 signs of the zodiac. The moon was studied with reference to 27 *nakṣatras,* forming so many constellations in the path of the sun and the moon. The time was reckoned on the basis of a solar year containing 12 lunar months and an intercalary month, every third year.

The Vedāṅga period (*c.* 1000 B.C. to *c.* 500 B.C.): The Vedāṇga Jyotiṣa is the earliest work which deals exclusively with Astronomy. It was meant to be a handbook for the priest engaged in the performance of Vedic rituals. It gives a glimpse of the primitive Astronomy of the Hindus and shows that at that remote period the Hindus considered Astronomy as a separate subject of study. This work contains a study of the months, years, *muhūrtas*, risings of *nakṣatras*, *yogas*, full moon and new moon, days, seasons, equinoxes and *ayanas*, which fall in a cycle of five solar years.

The unknown period (500 B.C. to A.D. 500): References to the last half of this period show that considerable work was done. However, works of this period are not available, probably having been discarded because they did not use the place value system of writing numbers. The new system was universally adopted about the end of the fifth century A.D. Some of the important astronomical works were, however, recast in the new style. Examples are, the *Sūrya-siddhānta*, the *Romaka-siddhānta*, the *Puliśa-siddhānta*, the *Pitāmaha-siddhānta*, *Vasiṣṭha-siddhānta* and the *Pañcha-siddhānta* of Varāhamihira which summarizes all the previous five.

A.D. 500–1200: This was a period of great activity and progress. Numerous Astronomical works were written of which the following are important examples.

The *Āryabhaṭīya* (A.D. 522) of Āryabhaṭa I. It is a small work setting forth principles of Mathematics and Astronomy. It uses a new system of notation for expressing numbers in verse and a new scientific division of time. It introduces certain alterations in the revolution numbers of the planets. It states that the earth rotates round its axis. It explains planetary motion on the basis of an epicyclic theory, different from that of the Greeks. It gives a correct interpretation of the eclipses and methods for calculating the times of their occurrence.

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[1] The Council of the National Institute of Sciences of India are grateful to Dr. Amarjit Singh for preparing summaries of papers and gists of discussions. (*Editor.*)

The *Brahma-sphuta-siddhānta* (A.D. 628) of Brahmagupta. In this treatise on Astronomy the teachings of the five *siddhāntas* and of Āryabhaṭa I have been criticized and several astronomical elements and rules have been modified.

The *Laghu-mānasa* (A.D. 932) of Mañjula. This manual of Astronomy is marked for its brevity and conciseness of expression. It is the first work to make use of the differential of a function. It states the lunar correction called evection in its modern form.

The *Siddhānta-śekhara* of Śripati (A.D. 1039). This work gives rules relating to (i) the correction for the equation of time due to the obliquity of the ecliptic and (ii) the correction to the east-to-west line determined from the shadow of the gnomon.

The *Siddhānta-śiromani* of Bhāskara II (b. 1114). This is the last and the best work of this period. The subject matter and the literary qualities of composition of this work have rendered it to be an outstanding work on Hindu Astronomy. This work is regarded as a standard text book on Hindu Astronomy even today.

A.D. 1200–1700: After the time of Bhāskara II, not much progress in Astronomy was made in Northern India. The Astronomers generally engaged themselves either in introducing refinements in the existing theoretical methods and almanac-making or in writing commentaries on works written in the previous period. Little advance seems to have been made in practical Astronomy.

The Astronomers of the South, notably Kerala, made certain notable contributions to Mathematics. They devised better methods of calculation, used processes akin to differentiation and integration, obtained expansions of trigonometric functions in infinite series, and made refinements in Astronomical methods.

Discussion. Dr. R. C. Majumdar objected to the dates ascribed to the Vedic period and to the Vedāṅga Jyotiṣa. Dr. A. S. Altekar pointed out an error in the interpretation of a Vedic passage. Mr. K. S. Shukla agreed to modify the paper in the light of the discussions. (The dates in the above summary are from the modified paper sent in by Mr. Shukla.)

Dr. K. R. Dixit. *The history of Indian astronomy.*

Dr. Dixit discussed the development of Astronomy in India, in the framework of the following three periods.

Vedic period (6000 B.C. to 1600 B.C.).[1] In the time-reckoning used in this period, the months were lunar, the year solar and an extra month was added every third year. No definite distinctions were made between *nakṣatras* and planets. *Śatapatha-Brāhmaṇa* mentions that the *krittikās* (pleiades) always rise due East. From the known rate of precession of the equinoxes, this can be used to fix the date of that text as 3000 B.C.

Vedāṅga Jyotiṣa (1600 B.C. to 600 B.C.). This period is characterized by three tracts: (1) the Ṛgveda Jyotiṣa, (2) the Yajurveda Jyotiṣa, and (3) the Atharvaveda Jyotiṣa. These tracts give empirical rules which relate to the determination of the duration of the day at the time of the winter and summer solstices and the interval between these two. This second set of rules enabled Mr. Dixit to arrive at the conclusion that these Vedāṅga Jyotiṣa texts must have been composed at about 1400 B.C. and at some place situated between the latitudes 34° 46′ N. and 34° 55′ N. According to this calendar, a period of five solar years is taken as a *yuga*. During this period the sun and the moon complete 5 and 67 revolutions respectively. The Atharvaveda Jyotiṣa which must have been composed much later contains besides the rules already mentioned some Astrological information. Some non-astronomical books which belong to this period contain references to items of astronomical importance such as the retrograde motions of the planets and their conjunction with each other and the sun and the moon.

[1] The dates accepted by the Symposium are given in Appendix III.

During the *Siddhānta* period (600 B.C. to A.D. 1800) a large number of books were written on Astronomy. All these books give methods of calculation for obtaining mean positions of the sun, the moon and the planets; and the time of the solstices, equinoxes and eclipses. The ancient five *siddhāntas* belong to this period: They are (1) the *Pitāmaha*, (2) the *Vaśiṣṭha*, (3) the *Puliśa*, (4) the *Sūrya*, and (5) the *Romaka*. The first three *siddhāntas* are allied to the Vedāṅga Jyotiṣa system, while the *Romaka-siddhānta* has a close resemblance to the work of the great astronomer Hipparcus, who lived about 150 B.C. The *Sūrya* system is based on the *Kalpa* hypothesis. The *Kalpa* or *Yuga* is a period of time—probably the least time—which is an integral multiple of the periods of revolution of the five planets, the sun and the moon. The *siddhāntas* give methods for calculating the mean positions of the sun, the moon and the planets. Their true positions were calculated from their mean positions by two additional corrections.

The next important book is the *Ārya-siddhānta* of Āryabhaṭa (born in A.D. 477). In addition to genuine topics pertaining to Astronomy, this book deals with topics like, ratio and proportion, areas of triangles and circles, and volumes of solids and spheres. This book makes use of trigonometrical sines and gives the ratio of the circumference of a circle to its diameter as 3·1416. Āryabhaṭa was followed by Varāhamihira (b. A.D. 505) and Brahmagupta (b. A.D. 598), both of whom have written their own *siddhāntas*, Varāhamihira mentions some periodic comets and also describes their path, duration of their visibility and the time of their reappearance. According to Mr. Dixit, it was Brahmagupta who invented the *Turīya-Yantra* (quadrant) for taking observations. The precession of the equinoxes appears to be first mentioned by Viṣṇuchandra (A.D. 580). The rate of precession was given by Mañjula (ninth century A.D.) to be about 58 seconds, compared with the present value of about 52 seconds. A few works of no great importance were written after Brahmagupta till we come to Bhāskarācārya (born in A.D. 1114). He has written two books on Astronomy. Bhāskarācārya has adopted the data of Brahmagupta in respect of mean positions of the sun and the planets. He says in the *Golādhyāya* section of the *siddhānta-śiromani* that the earth attracts by its power any solid body in the sky. May be he had an inkling of the force of gravitation of the earth. Brahmagupta and Bhāskarācārya gave the diameter of the earth as 7,905 miles, the earth-moon distance they then calculated is fairly accurate, but the calculated distances of the planets and the sun are wrong. The next astronomer of repute was Gaṇeśa Daivādhya (born in A.D. 1498). He gives methods for calculating the mean positions of the sun, the moon and the planets in terms of their positions on the 19th March, 1520. The positions of the celestial bodies as described by him on that day are remarkably accurate. His quick methods of calculation are used even to this day. Unfortunately there was no astronomer of distinction after Gaṇeśa and it was during this period that considerable progress was made in Europe in astronomy.

The progress of astronomy in Europe was due to navigation, whereas in India it was due to the religious edicts prescribing that the performance of sacrifices and other religious functions is permissable only at certain auspicious times. Such an attitude probably served as a damper for progress beyond the ability to predict these times.

Discussion. Vedic chronology was the main topic discussed. Dr. R. C. Majumdar objected to the dates given to the Vedic period. Dr. A. S. Altekar did not agree with the astronomical method used in fixing dates. He said that an astronomical fact in a particular work could be based on an observation made a thousand years before the work was written. So the date derived on the basis of that astronomical fact may not necessarily be the date of composition of that work. Dr. A. N. Singh was not in favour of totally rejecting all astronomical evidence regarding the date of a book. In his reply, Dr. Dixit made a distinction between exact and vague descriptions of astronomical events. He suggested that in the case of an event like the rising of pleiades due East, the time of a text recording it would not be far removed from the time of actual occurrence of the event.

DR. D. N. WADIA. *Geological knowledge in ancient and mediaeval Asia.*

Dr. Wadia referred to Charles Lyell who had quoted passages from ancient Hindu and Arabic writings to show that they possessed some knowledge of the imperceptibly slow changes which the earth passes through over a long period of time. Mohd. Qazwani (*c.* A.D. 1250) was quoted for an allegory based on the same knowledge.

Dr. Wadia then proceeded to discuss the knowledge of minerals in ancient India. The excavations at Harappa and Mohenjo-Daro (civilisation dated 3500–500 B.C.) give evidence of mining ores from comparatively great depths, the art of smelting metals from ores, the use of copper, silver, and gold and to a lesser extent of lead, zinc and tin and knowledge about metallic alloys.

Ancient Hindu books such as the *Rasaratnasamuccaya* give the metallurgy of calamine and the production of metal from zinc ore. They also describe the localities where metal ores are to be found. Vāgbhaṭa mentions ores of mercury and their application in ancient chemistry and medicine. Sulphur obtained from sulphide ores or probably from 'Barren' island was used for making gun-powder. The *Rāmāyaṇa* and the *Mahābhārata* frequently mention gems and show a knowledge of their properties. Dr. Munn has described mining for gold by the ancient Indians in the Hyderabad area up to depths of 700 ft.

In the Discussion that followed, questions were asked regarding the various minerals and their sources.

DR. A. N. SINGH. *Chronology of Hindu achievements in Mathematics.*

Among the earliest Hindu works on Mathematics are the three recensions of the Vedāṅga Jyotiṣa (1000 B.C.). Then there are the *Śulba-sūtras*, which were written in the period 800 B.C. to 400 B.C. These works give methods of construction of sacrificial altars and an account of the more important geometrical propositions involved in their construction.

The period 400 B.C. to A.D. 500 represents a gap in Sanskrit mathematical and astronomical literature. The names of the mathematicians belonging to that period as well as quotations from their works are available, but the works themselves are now lost, probaby because of a change in style introduced by Āryabhaṭa I. His *Āryabhāṭiya* is divided into three sections: (*a*) *Gaṇita* (Mathematics), (*b*) *Kālakriya* (calculations with time) and (*c*) *Gola* (spherics).

In the 6th century we find Varāhamihira writing his well-known work *Pañca-siddhānta* which contains summaries of the *Puliśa-siddhānta*, the *Romaka-siddhānta*, the *Vaśiṣtha-siddhānta*, the *Sūrya-siddhānta* and the *Pitāmaha-siddhānta*, mentioned probably in ascending order of antiquity. Many of the *siddhāntas* were re-written in the new style, i.e. using the place value of new system of numeration, in the sixth century.

In the seventh century may be mentioned Brahmagupta, Bhāskara I and Lalla. The last two were followers of Āryabhaṭa. Brahmagupta has adversely criticized Āryabhaṭa in his *siddhānta*.

Śridharācārya made important discoveries in algebra. He was followed by Mahāvīrācārya who wrote a comprehensive work entitled the *Gaṇitasārasaṁgraha* (A.D. 850). Commentaries and manuals were written by Sumiti Ācārya, Padmanābha, Haridaṭa, Govinda and Śaṅkaranārāyaṇa. Among the prominent writers in the tenth century may be mentioned Mañjula (A.D. 932) and Āryabhaṭa II (A.D. 950). The most prominent writer of the eleventh century was Śrīpati who wrote the *Siddhānta-śekhara* and *Gaṇita-tilaka*. A large number of *karaṇa* works were also written in this century.

In the twelfth century flourished Bhāskara II (A.D. 1150), one of the outstanding mathematical personalities of India. He wrote the *Siddhānta-śiromani*, a comprehensive treatise on mathematics and astronomy. This work was in three parts. The first part deals with Astronomy, the second, known as *Līlāvati*, deals with Arithmetic and Mensuration and the third part, called the *Bījagaṇita* deals with Algebra. The presentation and literary style of this work are superior to those of any other on the subject.

Nothing of importance written in the thirteenth century is available. Amongst the prominent writers of the fourteenth century may be mentioned Nārāyana, Mahendra Sūri and Makaranda.

The sixteenth century marks another period of mathematical activity in India. Amongst the important writers may be mentioned Nīlakaṇtha, Jñānarāja, and Gaṇeśa. In the seventeenth century Munīśvara wrote works on Astronomy which sought to affect improvement on the system taught by Bhāskara II.

The eighteenth century marks the end of important astronomical and mathematical activity in India. Interest in mathematics and astronomy was created by the erection of a number of observatories by Raja Jai Singh, and the establishment of a School of Medicine and Astronomy at Jaipur. The most celebrated writer of this School was Jagannātha.

Dr. Singh then proceeded to give the following discussion of the salient features of this historical account: (*a*) Decimal place value notation was invented by Hindus. Use of a symbol for zero is found in Piṅgala's *Chandah-sūtra* (200 B.C.). All works after A.D. 500 contained this system. The invention may have occurred about 500 B.C. (*b*) The works written after A.D. 500 contain not only the place value system of notation but also methods of performing addition, subtraction, multiplication, division, root extraction and deal with problems of fractions, proportions and interest. Thus Arithmetic had been developed before A.D. 500. (*c*) The main characteristics of Hindu Algebra examplified by Āryabhaṭa I, Bhāskara I and Brahmagupta are: (i) use of letters of the alphabet for unknowns, (ii) multiplication and division of positive and negative quantities, (iii) use of powers and exponents, and (iv) use of equations. Āryabhaṭa knew the solution of simple and quadratic equations. He also knew solutions of indeterminate equations of first degree. Brahmagupta extended this to the second degree. (*d*) The interest of Hindus in geometry has always been practical. Rules for determination of areas and volumes are found in their works. Greek Geometry was transmitted to them, but they developed it along independent lines. (*e*) Their great interest in Astronomy was responsible for their special study of trigonometry, of series, and of methods of the calculus. They worked with half chords instead of the chords of the Greeks. They defined sine and cosine functions and prepared the first tables of these. They found out the addition formula and used other trigonometrical identities in their calculations. All this is contained in the work of Āryabhaṭa I. In A.D. 932 Mañjula used the following interpolation formula:

$$\text{Sin}\,(\theta+\delta\theta) - \text{Sin}\,\theta = \delta\theta\,\text{Cos}\,\theta.$$

Bhāskara defined the velocity as a differential 'coefficient' and found that the differential coefficient vanished at a maximum or a minimum. The mathematicians of South India continued progress up to the sixteenth century. For example, Nīlakaṇtha used the following formula:

$$\text{Sin}\,(\theta+\delta\theta) = \text{Sin}\,\theta+\delta\theta\,\text{Cos}\,\theta - \frac{(\delta\theta)^2}{2}\,\text{Sin}\,\theta.$$

They also succeeded in getting infinite series for sin θ, cos θ and $\tan^{-1}\theta$.

SECTION II. CHEMISTRY, MINERALOGY, PHARMACY AND BIOLOGY

Chairman .. Dr. S. L. Hora.
Rapporteur .. Dr. G. P. Majumdar.

DR. S. L. HORA. *Zoological knowledge with special reference to fish and fisheries in India before 225 B.C.*

Dr. Hora expressed difference from the opinion held in some quarters that the Hindus and the Chinese contributed very little to progress in Biology. He proceeded to give the following instances of activity in this field among the Indians, at very early times. The classification of animals was on the basis of those having a back-bone and those without it. Other methods of sub-classification were according to the number of feet; differences in habitats, or the number of senses possessed by different types of animals.

Suśrutasaṁhitā (A.D. 200 to 500; Suśruta himself lived in 600 B.C.) contains a remarkably modern conception of the correlation between form and locomotion of fishes. If all the Sanskrit synonyms of fish are taken together, one gets a very good definition of fish as a class of animals. In Kauṭilya's *Arthaśāstra* (*c.* 300 B.C.), hints of a very advanced fishery administration are given and metaphors showing knowledge of the habits of fishes are included. Aśoka's Pillar Edict V (246 B.C.) contains five names of fishes which are very significant in regard to their respective characteristic features. On this pillar edict, fish are declared to be inviolable on certain days in the three *chāturmāsīs*. If the 'three *chāturmāsīs*' could be interpreted as the 'third chāturmāsī', then the edict would appear to be meant for the protection of fishes during the breeding season.

The author, in conclusion, directed attention to the great wealth of historical knowledge that exists in ancient Sanskrit literature.

Discussion. Dr. Altekar objected to the interpretation that Aśoka's pillar edict was intended to protect fish during the breeding season. He pointed out that the edict prohibited the slaughter of other animals also during the three days of the three Chāturmāsīs. Dr. R. C. Majumdar advocated caution in claiming scientific knowledge for our ancestors on the basis of insufficient evidence of systematic thought. Dr. Satyanarayanamurti suggested that as the contributions in question were made about twenty centuries ago, they should be assessed against the background of the then existing thought and culture. Dr. Hora gave a suitable reply to these comments.

PROF. P. RAY. *The History of Chemistry in India.*

Prof. Ray traced the origin of chemical knowledge in India to the days of the Mohenjo Daro (Indus Valley) Civilisation (4000–3000 B.C.). An account was given of the various practical arts like the extraction and working of metals, making of glazed polychrome and painted potteries, faience, terra-cotta objects, and the construction of houses with kiln-fired and baked bricks, as revealed in the excavations at Mohenjo Daro and Harappa. Uses of metals like gold, silver, copper, lead and tin, as well as alloys of gold and silver (electrum) copper and tin (bronze), and of copper and arsenic, were referred to. Mention was made of the findings of a large number of ores and minerals used for ornamental purposes. Some like galena, cerussite and cinnabar were believed to have been used as cosmetics and medicine. White lead, gypsum and lime, found in the excavation, were supposed to have been used for plastering work and for the making of floors and drains.

The picture of cosmogenesis, as found in the *Sāṁkhya*, *Yoga* and the *Vedānta* systems of philosophy, and particularly the atomic and molecular theory of Kanāda (*c.* 500 B.C.) was referred to briefly.

The development of chemistry in ancient and mediaeval India, following the Vedic age, was divided on the basis of P. C. Ray's *History of Hindu Chemistry*, into four periods: viz., Āyurvedic period (from the pre-Buddhistic era to about A.D. 800), Transition period (A.D. 800–1100), Tantric period (A.D. 800–1300) and Iatrochemical period (A.D. 1300–1500).

Dealing with the Āyurvedic period reference was made to the two important treatises; *Caraka* and *Suśruta saṁhitās*, which constitute a rational and methodical presentation of the Hindu system of medicine and surgery respectively, and contain almost all the chemical informations of the time. Metals like gold, silver, copper, iron, lead, tin and mercury and alloys like brass and bronze were known in this period. Reference was also made to the *Arthaśāstra* of Kauṭilya (*c.* fourth century B.C.), which described working of metals, making of alloys and coins, as well as varieties of precious stones and gems. An account was also given of the archaeological specimens of copper and iron of historical significance, in the shapes of statues, pillars, caskets, beams, weapons and implements found at different places, testifying to the skill and ability of the workers of metals in Ancient India. Particular mention was made of the iron pillar at Delhi (*c.* fourth century A.D.), iron beams in the temple of Bhubaneswar (*c.* A.D. 540) and that of the Sun-god at Konarak (*c.* A.D. 900–1000) as well as of the solid copper bolt in the Rampura Aśoka pillar (*c.* third century B.C.).

Discussing the progress of chemistry in the transitional period, reference was made to the preparation of metallic compounds like sulphides of copper, mercury and silver.

The Tantric period was described as the alchemical age of Indian chemistry, as it was devoted to the study of the chemistry of mercury (*rasa*) which constituted the main ingredient of the so-called *vital elixir of life*. Much attention was also paid during this period to the preparation of recipes for transmuting base metals into gold. The most renowned Indian alchemist, Nāgārjuna, flourished during this period (*c.* A.D. 700). He was the author of the alchemical treatise, *Rasaratnākara*, as well as of a treatise on metallurgy. Description of various apparatuses for sublimation, distillation, extraction, etc., are found in the alchemical treatises of this period. Red sulphide of mercury (*makaradhvaja*) and the black sulphde (*kajjali*), valued as important medicines, are described in these treatises. It was stated that in the Iatrochemical period, the vast mass of chemical information of the previous periods found their application in medicine. The *Rasaratnasamuccaya* is a very notable treatise of this age.

Attention was drawn to the preparation of caustic alkalies and alkaline carbonates, as described by Suśruta.

Reference was also made to the exchange of scientific ideas between India and Arabia following the Mohammedan invasion, as well as between India and China during the Buddhistic period.

The paper concluded with a discussion of the influence of science on the Indian society, both past and present.

Discussion. Dr. Altekar suggested that in the references cited, full details be given regarding the location of particular statements. He expressed the view that the *Nyāya* and *Vaiseṣika* systems of philosophy, in their views on atoms were not drawing on observation and experimentation. Dr. Satyanarayanamurti advocated patient research on the cultural relations between the Indus Valley civilisation and the Indo-Aryans of the Vedas. He was also against imputing present-day advanced theories to the ancient Indians when the statements are only intuitive speculations. However, he agreed with Prof. Ray that the *Nyāya* and the *Vaiseṣika* systems, laid down the methodology of science as being based on experimentation. Dr. Ranganathan suggested that in papers on special subjects, attention should be concentrated on topics closely related to that subject.

In reply to Dr. Altekar, Prof. Ray pointed out that references to the sources of information contained in his paper are given in the bibliography added; the detailed references to every statement made was not possible for consideration of space. In reply to Dr. Satyanarayanmurti, Prof. Ray stated that the theories advanced by the ancient Indians were certainly speculative and were not based on experimental observations. But he only tried to show that the ancient Indians were capable of such conceptions. To Dr. Ranganathan's suggestion, Prof. Ray replied that the theory of cosmogenesis and the atomic theory are certainly an essential part of Chemisty, for Chemistry deals with the sum total of knowledge about matter and its transformations.

PROF. G. P. MAJUMDAR. *The History of sciences in India from pre-Vedic times to eighteenth century A.D.*

It dealt with the sciences of Botany, Medicine, Agriculture and Arbori-Horticulture. Prof. Majumdar discussed the development of Botany as follows:—

The Indus Valley people used to live in villages, cities and towns, wore clothes, cultivated crops, including wheat, barley, millet, dates, vegetables, melon and other fruits and cotton; worshipped trees, glazed their pottery with the juice of a plant and painted them with a large number of plant designs. Thus beginnings in Botany had been made.

Agriculture became a holy and dignified occupation in Vedic India. In Vedic literature we find a large number of terms used in the description of plants and plant parts (both external features and internal structure), a definite attempt at classification of plants, and evidence that manuring and rotation of crops were practised for the improvement of the fertility of soil and the nourishment of plants. There is indication in the hymns of the Ṛgveda that the Vedic Indians had some knowledge of the rôle of light in the manufacture of food in green plants.

During the centuries that followed, the study of Botany made great progress in connection with the studies of the allied sciences, particularly the science of Medicine. In the Caraka Saṁhitā (Sūtra 1, 51-52) it is expressly stated that a man well acquainted with the names and external features of plants, and able to use them properly according to their properties, is to be called an expert physician. The *Vṛkṣāyurveda*, a treatise on Botany by Parasara (*c.* 250–100 B.C.) gives an account of the life of a plant in its various aspects, including the genesis of the science. Its outstanding contribution is an attempt made by the author at explaining the 'origin of the first organic body (*ādibījam*)'.

Regarding the science of Medicine, Prof. Majumdar stated that some of the outstanding achievements in this field were the knowledge of the circulation of blood; knowledge of pathogenic microbes; development of surgical requisites, anaesthetics and magnifying apparatus, and establishment of hospitals.

As regards Agriculture, Prof. Majumdar stated that its development during the fourth century B.C. reached a high state of perfection. Agriculture became an important department of the State. Meteorological observations were conducted in connection with agriculture. Rain gauge was used to measure rainfall in a region. Pre-sowing treatment of seeds for successful germination and yield was recommended and practised. Use of bone-dust and blood of animals as manure, was also recommended.

Proceeding to the science of Arbori-Horticulture, Prof. Majumdar stated that it played an important part in later days in public administration. Public parks and pleasure gardens were provided by the Government for the health and recreation of the public (Kauṭilya's *Arthaśāstra*). An idea of the subject matter of the science may be had from the subject matter of the *Upavana-vinoda*. This includes: selection of soil, classification of plants, sowing of seeds and various methods of plant propagation, the process of planting, watering plants, rules for the protection of plants, construction of a garden house, examination of soils where wells are to be dug, recipes for nourishment of plants, treatment of plants in diseases and health and Botanical marvels, (experimental results).*

Discussion. The authorship, genuineness and date of the manuscript of the *Vṛkṣāyurveda* by Parāśara, were subjects of scrutiny. Dr. P. C. Bagchi, Dr. R. C. Majumdar, Dr. A. S. Altekar and others took part in the discussion. The opinion expressed was that the manuscript of the *Vṛkṣāyurveda* should be copied and sent to Sanskritists and Indologists for their opinion as to its genuineness and date, and that if it is found genuine, it should be published. Dr. Varma informed the meeting that he had also procured a copy from Nepal, of a Sanskrit manuscript dealing with fruits and fruit culture.

DR. N. R. DHAR. *India's contribution to the chemical knowledge.*

At about the time that Greek philosophers like Democritus were speculating regarding the ultimate particles that constitute matter, Hindu philosophers like Kanāda were also speculating along similar lines. As regards techniques, the following may be mentioned: metallurgy of iron was well advanced, as evidenced by the Iron pillar at Delhi (c. A.D. 500). The technique of preparing steel blades in Damascus, had its origin in India. Preparation, storing and use of caustic alkalies was known, as evidenced by their description in the *Suśruta saṁhitā*. The use of metallic compounds, especially those of mercury, was introduced in Hindu medicine by Nāgārjuna (c. seventh century A.D.). Paracelsus probably had been influenced by the East in his use of metallic preparations in medicine. The metallurgy of zinc is described in detail in later books, the *Rasaratnasamuccaya* and the *Rasārṇava* (c. A.D. 1200). The latter also described the colouration of flames when metals and their compounds were introduced in them.

Activity in the field of the Physical Sciences was greatest around A.D. 700 to 800. It had almost died out by the thirteenth century for political, social and economic reasons.

SECTION III. APPLIED SCIENCE, TECHNOLOGY AND ENGINEERING

Chairman .. Mr. P. Rochanapurananda.
Rapporteur .. Mr. A. Rahman.

MR. P. ROCHANAPURANANDA. *The history of technical achievements in Thailand.*

The Thai is a practical race. Its achievements are in the way of producing articles to fit its needs. Facts with scientific value have not been recorded by the historians. However, one can indirectly get a glimpse of the achievements of this race.

If we examine the structure of some Thai words, we may see evidence of an attempt at scientific classification. For example names of many plants and animals are compounded from a family name, to which are added other words describing the characteristic appearance of the particular plant or animal.

The ancient Thai was well versed in Agricultural science, as shown by his conversion into fertile soil of the originally swampy ground of the watersheds of the Chao Phya river and its tributaries. At present the Northern Thai have shown themselves capable of irrigating over the hill-sides far above the level of the streams.

* The full paper has been submitted for publication in the *Archives Internationales d' Historie des Sciences. Belgique.*

In Sukhotai period (A.D. 1257–1350) the art of bronze casting reached its zenith. Another characteristic achievement of that period was the manufacture of Sungkalok pottery. Technical help in the art of making pottery is likely to have been obtained from China around the year 1300, although the Thai had also mastered the art already. The Thai knew also the technique of making fire-arms. After the year A.D. 1511 iron began to replace bronze for cannons, as a result probably of associations with the Portuguese. These iron cannons were very well made and were adorned with designs in silver.

The techniques of making paper, of brewing and making vinegar were also well known. They knew how to calcine limestones and how to use lime mortar in building. Some manuscripts have been found dealing with topics in medicine and alchemy.

Whether European science had dominated the thoughts of those who had written these manuscripts is still a matter of doubt.

Thus the achievements of the Thai are mostly in the field of arts and crafts.

Discussion. Dr. R. C. Majumdar mentioned that the contribution to science of the original inhabitants of Thailand had not been described. Dr. P. C. Bagchi remarked in this context that early history of Thailand had yet to be investigated. Dr. S. R. Ranganathan suggested that a study of the known immediate past may be a helpful guide for the earlier period. Dr. A. N. Singh mentioned that the first copy of an Indian calendar was discovered at Bangkok. Dr. S. L. Hora disagreed with the statement that scientific knowledge originated especially in Europe and the near East. Mr. A. Rahman suggested that Thailand may have possibly been the ground for cultural contact of China, India and the Middle East. The Chairman in his closing remarks mentioned the cultural strength of his country and said that the conquerors always adopted the native culture. He also mentioned that he would try to appeal to the historians and scientists of his country to make further investigations on the History of Sciences in Thailand.

Section IV. Medicine

Chairman .. Dr. A. C. Ukil.
Rapporteur .. Dr. G. V. Satyanarayanamurti.

Dr. G. V. Satyanarayanamurti. *A historical and chronological survey of the practice of hygiene and medicine in India from antiquity.*

Dr. Murti first gave a brief review of the civilisations of the world and their contacts with one another in the field of medicine. These were illustrated by a chart.

Dr. Murti then proceeded to give the following discussion of the progress of medicine in India from prehistoric times. He said that the Vedas give the first indication of the *Tridosha* theory of disease on which the whole of the *Āyurveda* or the ancient Indian medicine, was subsequently based.

When more knowledge accumulated in respect of disease it was added on to the *Vedas* as an appendix or *Upaveda* and constituted the *Āyurveda* which literally means knowledge pertaining to life.

In India originally, that is prior to 700 B.C., the number of humors was restricted to three and the fourth one, blood, was added later in the works of Caraka and Suśruta. The names of Caraka and Suśruta are mentioned as the earliest eminent men in the fields of medicine and surgery. However, the texts of Caraka and Suśruta have been revised, commented upon and enlarged by numerous authors. This has given rise to considerable confusion in respect of the chronology of Caraka and Suśruta. Though their texts reveal a definite knowledge of surgery in general, the art of surgery was not practised with the same vigour as medicine, probably due to the religious feelings against dissection. Ātreya, who was the brightest pupil of Caraka, established a school of thought based on the teachings of Caraka. By 600 B.C. there were schools of medicine at Takṣaśilā and Kāśī (Banaras), which were imparting organized instructions to pupils in the art of medicine and surgery.

The records that were left by Alexander's followers, and those of Greek chroniclers of subsequent date at the court of Emperor Aśoka, give an account of the knowledge of medicine in India, at the time of Alexander's invasion. Alexander was struck by the skill of Hindu physicians and surgeons whose services were available in the battlefield. Following Alexander's invasion there were intellectual and cultural contacts between Greece and India. The ancient Indians sought knowledge without prejudice.

The inscriptions and stone edicts left by Aśoka the Great reveal that there were hospitals for both men and animals in his time. There are books devoted entirely to animal diseases. Aśoka sent Buddhist monks to the length and breadth of the Empire and the courts of the surrounding countries. Thus knowledge from India spread to other countries also.

In the seventh century A.D., two authors, Vāgbhaṭa and Mādhava, made valuable contributions to the *Āyurveda* literature. Vāgbhaṭa's *Aṣṭānga-saṁgraha* is a book on the eight aspects of medical treatment which were long in vogue in Hindu medicine. Mādhava's *Nidāna* is a book on diagnosis.

About the year A.D. 715, Harun and Mansur, two Arab scholars, came in contact with Indian thought. The Arab texts indicate an influence of Hindu medical literature. The Arabs assimilated the Greek and Roman thought as well. Their knowledge was later transferred to Europe.

It appears that from the eleventh to the fourteenth century A.D. there were a number of commentators on Hindu medicine. Towards the end of this period Saraṅgadhara produced a pharmacopaeia. In this, the use of metal compounds in the cure of disease was stated for the first time in the world's medical literature. A treatise on medicine was published by Bhāvaprakāśa in about A.D. 1550. Subsequent to this date, it appears that there have been no outstanding contributions to Indian medical literature.

Dr. Murti then gave a chronological review of Āyurvedic literature with the help of a chart. This review shows that there is a sense of continuity in these texts and the whole practice of medicine was based on the Tridosha theory of health and disease, which remained unaltered through the centuries.

Next, Dr. Murti explained the Tridosha theory. On the basis of this theory an equilibrium of the three fundamental principles, *Vāyu*, *Pitha* and *Kapha*, is necessary for the maintenance of health. A practitioner of Āyurveda comprehends health and disease on the basis of Doṣas (Principles), Dhatus (body constituents) and Malas (waste products). It is held that food, drugs and external application of drugs influence the body by their physical qualities, chemical constitution, and physiological actions. These last are held to be dependent on the natural constitution, or Prabhava, of the individual. The aim is to rectify the disturbed Doṣa and hence the Dhātus and Malas.

Dr. Murti then reviewed the extent of medical and surgical knowledge in the ancient Indian text-books in its important aspects. These were :—

(*a*) Nothing but the highest ideals were enjoined on those practising the art of medicine (C.S. IX, 6). The text of Caraka abounds in reference to personal hygiene.

(*b*) Chapter 9 of Suśruta mentions how a student of surgery should practise incision, excision, scraping, probing, tying, suturing, venesection and cauterisation on vegetables, skins of animals and dead animals.

(c) Because the physician is unable to name the disease he should not desist from treatment. Thus Indians adopted symptomatic treatment quite early. (C.S. XVIII, 51–54).

(d) Chapter XVII of Suśruta describes suppurating and non-suppurating swellings and a competent surgeon is enjoined to differentiate them. The method of extraction of arrows and splinters is given; also the operation of piercing the lobules of ears which is necessary for the wearing of Indian jewellery is described. Chapter XXV describes the fundamental surgical procedures such as incision, excision, scarification, aspiration, extraction of foreign bodies, evacuation by incision and suturing of open wounds.

(e) Fractures were treated with the use of splints while dislocations were reduced with accuracy and skill. Depletion of blood (by leeches and venesection), induction of vomiting, sweating and purgation, and enemata were commonly used as methods of treatment. Couching for cataract, laparotomy, herniotomy and tonsillectomy were practised. Rhinoplasty was practised as late as 1794.

(f) The value of exercise was early recognised but it was recommended that it should not be indulged to excess (C.S. VII, 31).

(g) There is great emphasis on diagnosis, description of diseases, and prognosis, while operative and medical procedures are described vividly.

(h) Though knowledge of anatomy is meagre, there is some theoretical attempt at the physiology of health and pathology of disease.

(k) The ideals of the nursing profession are stated definitely (C.S. IX, 8).

(l) There is also reference to the construction, equipping and staffing of a hospital (C.S. XV, 6).

Discussion. Dr. Hasan, Mr. Rahman and Dr. Ukil desired that reference should have been made to the social factors that contributed to the development of *Āyurveda* and its later decline. The author stated that it was an aspect that must form the subject of a separate paper. Prof. P. C. Bagchi and Prof. Altekar were of opinion that the quotation from the Ṛgveda should not be accepted to convey the Tridosha theory of later *Āyurveda.* Dr. Bagchi said that there was abundant evidence of the existence of Tridosha theory as well as several references to medicinal plants and diseases in the *Śatapatha Brāhmaṇa* which dates back to 800 B.C. The author was prepared to take the stand for the earliest reference to *Āyurveda* on this last statement. Prof. R. C. Majumdar objected to giving precedence to Caraka over Ātreya and to ascribing to him a date earlier than the sixth century B.C. He considered the second century B.C. as more appropriate and deemed that Ātreya of the sixth century B.C. had nothing to do with Caraka. He also suggested caution in accepting Ceylonese records in respect of reference to hospitals. Dr. N. P. Chakravarti advised the inclusion of the Bower manuscript in the list of literature of Indian medicine.

Dr. A. C. Ukil. *The history of Indian medicine from ancient times to the eighteenth century.*

In the *Ṛg-Veda,* the earliest mention of medicinal plants is found. The *Atharvaveda* has sections dealing at length with medicine, surgery and hygiene. Following this period, the *Āyurveda,* or the science of life, was written, which is regarded as a branch of the *Atharvaveda,*

Through several centuries scholars like Dakṣa, Indra, Bhāradwaja, Bhṛgu, Dhanvantari and Ātreya developed the *Āyurveda.* Agniveśa, a pupil of Ātreya, wrote the *Agniveśasaṁhitā.* Other treatises followed which dealt with the diseases of animals also.

After a period of decadence, there came Jīvaka, physician to King Bimbisāra, a contemporary of the Buddha. He specialized in children's diseases and wrote an elaborate treatise called *Kāśyapa Saṁhitā.*

The *Arthaśāstra* of Kauṭilya, a minister of Chandragupta I, gives a good description of the development of the science of medicine, botany and forestry. It mentions rules for the practice of medicine, measures for the control of epidemics, and regulations on hygiene and free hospitals.

The edicts of Aśoka reveal a vast amount of organization for the relief of human and animal suffering. It comprised cultivation of medicinal plants, provision of hospitals and organization of a sanitary department.

Suśrūta, a pupil of Dhanvantari, wrote a treatise on surgery, the *Suśrutasaṁhitā.* It suffered from many interpolations, until Nāgārjuna, the great chemist, redacted the whole book. Nāgārjuna was responsible for the introduction of metallic preparations, principally those of mercury, sulphur and iron.

Caraka, the court physician of Kaniṣka (first century A.D.) redacted and re-edited two-thirds of the *Agniveśasaṁhita,* while the remaining one-third was later on redacted by Dṛiḍhabala (fourth century A.D.). This redacted treatise is known as the *Carakasaṁhitā.* In it 2,000 vegetable remedies have been described, besides a few mineral and animal drugs.

About the fifth or sixth century A.D., Vāgbhaṭa collected materials from the then available Āyurvedic literature and compiled two texts called the *Ashṭāṅgasaṁgraha* and the *Ashṭāṅgahṛdaya Saṁhitā.* Captain Bower discovered in 1870 some manuscripts dealing with medicine, written by a Buddhist (presumably derived from the Hindu works of this period).

Near the end of the eighth century A.D., the essentials of Hindu medicine were translated into Arabic. By holding Medical Congresses of Hindu, Greek, Egyptian and Arab medical scholars, the system of Arab medicine was developed.

In the period A.D. 600–A.D. 1200, progress was not spectacular; however, many books were compiled. Among the better-known authors of this period were, Mādhava Kara (seventh century A.D.), Sorhala (eighth century), Vrinda (ninth century), Chakrapāṅi (1060), Vāṅgasena (eleventh and twelfth centuries), Gayedāsa (eleventh century) and Nityanātha (twelfth century).

Then followed a period in which the chemists devoted considerable attention to the production of medicines. The *Rasaratnākara,* the *Rasaratnasamuccaya*- and the *Rasaratnamāla* are some of the books dealing with the advances thus made.

With the advent of Muslim conquerors, the Arabic system of treatment became the state system of relief and the Āyurvedic system was pushed to the background.

By the time the foundations of the Indian Empire were laid by the British in 1757, the indigenous systems of medicine had further degenerated; the first Medical school on the Western system was established in India in 1822.

The paper has a bibliography which includes 37 authors.

Discussion. Dr. P. C. Bagchi considered that there was no period of decadence and that Chandragupta I belonged to the second century A.D. Prof. R. C. Majumdar was of the opinion that there was a certain amount of confirmation in respect of the various periods referred to by Dr. Ukil. Prof. Altekar desired that Dr. Ukil should have given references to the original texts in the Vedas. Col. P. C. Datta wanted to know if there was any indication of the type of medicine used by the people of the Indus Valley civilization.

Dr. S. K. Chatterji. *Legal medicine, its study and practice in India (from a historical point of view).*

'Legal Medicine' is a branch of medicine which deals with the application of medical knowledge to the purpose of the law and 'Toxicology' forms a branch of the study of Legal Medicine.

The subject of Toxicology, has been dealt with in the *Atharvaveda* under the heading *Agada Tantram* and in the *Suśrutasaṁhitā* under the heading *Kalpasthānam*, and though codes of law regulating the medical profession are to be found in the Vedas and the Codes of Manu, the first systematic study of the subject of Legal Medicine was actually started in the Western countries.

Section V. General Problems, Methods and Philosophy of Science

Chairman .. Dr. R. C. Majumdar.
Rapporteur .. Dr. A. S. Altekar.

Mr. A. Rahman. *Social factors in the history of sciences in India.*

The main thesis of the paper was that techniques of an epoch determine the philosophic ideas and intellectual atmosphere. The paper explained the point by taking Indian examples. It divided Indian history into three main periods as follows :—

(1) Archaeological, i.e. Mohenjo-Daro period : No written records of this period are available. However, from the archaeological data, one gets a picture of India, which resembles that of other civilizations of those times. In fact the first technical revolution had taken place in history round about 4000 B.C., and by roughly 3000 B.C., it was completed. It involved the use and control of fire, control of flooding and irrigation and technique of agriculture, domestication of animals, smelting and use of metals, invention of the plough and the wheel, potter's wheel, wheeled carts and probably the spinning wheel. The basic factor underlying these discoveries was the division of labour in society. A vital question arises, as to why the existing techniques did not develop further. Possible causes are the following : (*a*) division between technicians and scribes, (*b*) political suppression of inventions. There is need for research to find out the real causes.

(2) The period 600 B.C. to A.D. 600. This period is characterized by religious reform movements, such as Buddhism and Jainism. We do not have much documentary data on the technical developments. However, monuments such as the Iron pillar at Delhi, speak for the skill and understanding reached in technical processes. There is considerable development of fields of learning, such as astronomy, mathematics, and medicine. In this period, there also existed, materialistic systems of philosophy, such as the Nāstika, Nyāya and Vaiseṣika systems. A noteworthy feature of the Vaiseṣika system was the development of an atomic theory by Kanāda. Barring, some differences in detail, the development in this period also is very similar to that in Greece and other countries. Again the question arises as to what were the socio-economic and political factors that came in the way of further development.

(3) The third period of an outburst of cultural activity starts round about Akbar's time and continues up to the time of the British occupation of the country. But this was the activity of a feudal society as distinct

from a mercantile society. Artisans and peasants had no incentive for increased production as they felt economically secure under the feudal lords. There were probably prejudices against new professions. Cheap labour obviated the need for machinery. All these factors hindered technical progress.

In the eighteenth century interest in Astronomy was revived under the patronage of Raja Jai Singh. The question arises as to whether India, if left to itself, would have developed towards industrialization, or whether the presence of the British was necessary for a technical revolution. A proper appreciation and investigation of such factors will help us to understand Indian history, and it will be a contribution to the history of sciences.

Discussion. Dr. S. L. Hora, Dr. P. Saran and Dr. A. N. Singh put varying degrees of emphasis on the influence of environment and of individuals on the growth of sciences. Dr. N. P. Chakravarti suggested a more careful study of the prehistoric man ; and Dr. R. C. Majumdar suggested the same for the Vedic period. Dr. Altekar stated that the use of the scriptures for reconstructing the history of sciences, was justifiable where no other data are available. Dr. Bagchi drew a distinction between Greek and Indian genius, saying that the latter was more metaphysical than practical, and that the Indians were satisfied whenever an invention was just sufficient to meet the need of the hour. Mr. Rahman stated in his reply that we should reconstruct the atmosphere of each age to understand its scientific achievements ; and that to discover the cause of progress or stagnation is the most important desideratum for historians of science.

DR. P. C. BAGCHI. *Indian sciences in the Far East.*

Dr. Bagchi tried to prove that the Greeks and the Indians were the only two people which continued to develop scientific knowledge, sometimes in collaboration, after the fall of the ancient civilisations of Egypt and Babylonia. They were also responsible, according to Dr. Bagchi, for the dissemination of scientific knowledge among different peoples. The Greeks transmitted it to the Christian world and later to the Arabs while India transmitted it to Eastern Asiatic countries, Central Asia, China, Tibet, Mongolia, Korea, Japan and the countries of the South-East Asia—Indo-China and Indonesia.

Elements of Indian scientific knowledge first infiltrated to China as early as the third century B.C., most probably through the Scythian intermediaries of Central Asia. In this period the Chinese received Indian geographical knowledge—the conception of a central mountain from which rise four rivers, the theory that the earth consisted of seven continents surrounded by seas and situated around the central mountain, etc. Some elements of astronomical knowledge were also transmitted in this period, such as the knowledge of the 28 lunar mansions, the knowledge of the distinction of planets from the stars, etc. The first calendar was prepared in 104 B.C. but as the knowledge of the precession of the equinoxes was still lacking, the solsticial points were taken as fixed.

Direct contact between India and China was established in the first century B.C. and that led to further development of astronomical knowledge. During the next few centuries greater precision was arrived at in the matter of calculations. In the sixth century, a number of Sanskrit astronomical treatises were translated into Chinese and in the seventh century Indian astronomers were appointed on the official Astronomical Boards.

Knowledge of mathematics also went to China along with astronomy. Mathematical treatises composed in China during the first few centuries of the Christian era seem to have been based on Indian mathematics. The texts are called *Ching Sutra* in the Indian fashion. The unknown quantity in Algebra is called *t'ien-yuan* 'monad' which seems to be a translation of Sanskrit Vīja (of Vījagaṇita). The solution of the indeterminate problems is called pulverisation which is a translation of Sanskrit *kuṭṭikara*. In the sixth century, a number of Sanskrit Mathematical texts were translated into Chinese. China transmitted these elements of scientific knowledge of astronomy and mathematics to Korea and Japan.

Indian medical texts were in use in the kingdoms of Eastern Turkestan during the first few centuries of the Christian era. Some of them were even translated into local languages. The Chinese also borrowed numerous elements of the Indian medical system. Although translations of Sanskrit original texts in Chinese are few, the Chinese medical texts contain a large number of names of Indian drugs and besides the Indian ' theory of wind '.

Indian medical texts were translated into Tibetan after the seventh century and subsequently they were carried to Mongolia where they were translated into Mongolian.

In the Hindu kingdoms of South-East Asia, Indian mathematics, astronomy and medicine were studied in Sanskrit original. What influence they have left in those countries after the disappearance of direct Hindu influence still remains to be discovered.

In the discussion period, Dr. A. N. Singh suggested that translations of the Chinese works showing the influence of India, would enable us to get a clearer picture about the Indian sources. In his view the interpolation of a few Greek words into Hindu Astronomy does not prove the existence of a dominating influence.

DR. A. S. ALTEKAR. *A periodwise and critical survey of India's achievements in the scientific field.*

The data available for reconstructing the history of sciences in ancient India, are rather scanty.

The History of Sciences in India may be divided roughly into four periods, viz. the early Vedic period (*c.* 2000 B.C. to 1000 B.C.), the later Vedic period (*c.* 1000 B.C. to 500 B.C.) the Nanda-Gupta period (500 B.C. to A.D. 500), and the Early Mediaeval Period (A.D. 500 to A.D. 1200).

In the early Vedic period, the Indian Aryans were emerging from the pastoral to the agricultural stage. People had an open and enquiring mind and manual labour and arts and crafts were not held as plebian. Practical needs of the society determined the direction and progress of science. The year was taken to be of 12 months or 360 days. An inter-calary month was added to equalise the solar with the lunar year. Some planets were distinguished from stars. The phenomenon of eclipses was noted but its cause was not known. Diseases were attributed to malignant spirits. Charms as well as herbs were used to cure these.

In the later Vedic period, respect for tradition was cleverly harmonized with regard for progress. Astronomy, medicine and practical geometry were developed. The processes of obtaining metal from ores of the gold, silver, copper and iron were well known. Foreign contacts were few.

The Nanda-Gupta period was a creative and fruitful period. There was intellectual contact between the Greek and Indian scholars. However, the borrowing was by no means blind or one-sided. There was remarkable progress in Astronomy, Mathematics and Medicine. The diurnal motion of the earth and the true causes of eclipses were known and the decimal notation was invented. The medicinal system was still mainly herbal but dissection was practised for first hand knowledge of anatomy. There was progress in metallurgy and practical arts. China and South-West Asia came under the influence of India.

Early Mediaeval Period—In the fields of mathematics and Astronomy Varāhamihira, Brahmagupta, Lalla and Bhaskara were the principal authors of this period. Some of their works were mere manuals; but others record considerable progress in mathematics and astronomy. Brahmagupta discovered the solution of the second degree indeterminate equations. Many previous observations and calculations were corrected. After the rise of Islam, there was contact with the Arab scholars. In the realm of medicine mineral preparations, especially of mercury, were introduced. Huge temples were erected in this age, in Orissa, Bundelkhand and South India, showing considerable knowledge and progress in civil engineering.

Several new developments of this period were detrimental to the progress of science, for example, (i) veneration for old traditions tended to stifle new discoveries, (ii) arts and crafts were regarded as plebian, (iii) the scholars became narrow and bigoted, (iv) royal support no longer remained available for Sanskrit learning after the disappearance of Hindu rule.

The rational outlook on life is now reasserting itself. Progress in science and industry is the first and foremost concern of our modern universities and governments. We may, therefore, look forward to an era of fruitful scientific and industrial progress in the country.

DR. R. C. MAJUMDAR. *Scientific achievements of the ancient Hindus; chronological and sociological background.*

Dr. Majumdar began by emphasizing the need for an understanding of the real connotation of the phrase 'Scientific Achievements'. He stated that we cannot speak of scientific achievement unless we have a clear evidence of systematic thought and careful observation of the phenomena of nature. He gave examples of what he considers as sound and unsound judgments in this connection.

Further he dealt with the difficulties of fixing the dates of the earliest works of literature and science; and tentatively fixed limits for the more important ones. A note of caution was sounded in the case of treatises whose versions now available are revisions of the earliest texts.

Dr. Majumdar then discussed the probable lines of scientific progress in different periods of Indian History on the basis of such sociological and political factors as are fairly well-known to us. The earliest period represented by the civilization on the banks of the Sindhu, and reaching back to the third millennium B.C., contains clear traces indicative of scientific knowledge of a fairly advanced type. The early Vedic age was also conducive to the growth of Science. But then followed a reaction in the later Vedic Age in which all the tendencies were opposed to a critical inquiry into the problems and mysteries of physical nature. The sixth century B.C., which saw the birth of heterodox religious sects like Buddhists and Jains, also ushered in a rational age dominated by a new and critical spirit of inquiry which favoured the growth of sciences such as medicine, astronomy, mathematics, mineralogy, chemistry, etc. These reached their high watermark of development during the Gupta age (A.D. 350–600) which saw a galaxy of scientists headed by Āryabhaṭa. Unfortunately the Gupta age also witnessed a revival of Brahmanical religion which, true to its old orthodox views, positively discouraged all arts and sciences and banned all advanced scientific views which were opposed to the old faith, belief, and conventions. Thus the normal growth of scientific ideas was arrested, and a dark age set in when the Hindus lost their political independence in the thirteenth century A.D.

Discussing foreign contacts, Dr. Majumdar stated the following:—

There can be hardly any doubt that Greek astronomy exerted a great influence on the development of that subject in India, but generally speaking the borrowings seem to have been the other way. The Arabs derived from India a great deal of their knowledge of Mathematics, Astronomy and Medicine, and they spread abroad the Indian system of decimal notation which has revolutionized the growth of Mathematics, and thereby also science, in general, throughout the world.

Discussion. The papers of Dr. Altekar and Dr. Majumdar were taken up for discussion jointly. Dr. Hasan and Mr. Rahman, pointed out that the rise of the Arab school took place much earlier than the Abbaside period. Dr. Bagchi stated that the *Bṛhatsaṁhitā* is not a unitary work and the whole of it may not be the work of Varāhamihira. He also suggested the use of the works of Arab scholars who resided in India for the purpose of reconstructing history. Dr. Dhar and Dr. P. Saran were of the opinion that a closer study of the causes of decline of learning in India is needed. Dr. Murti stated that the achievements of the ancient Indians should not be dismissed as practical recipes and unverified speculations. In his view the decline was due to lack of political tranquillity and social security. Dr. Hora asked for information from the authors regarding the Sanskrit literature on Zoology and Agriculture.

Dr. Kothari remarked that the historians had been more critical in their approach, than the scientists. He also stated that progress of science in Europe after the Renaissance had been due to 'an open mind in a closed system'. He explained the 'closed system', as being one in which attention is directed towards particular problems as distinct from philosophical issues.

DR. PRIJOHUTOMO. *Indonesian cultural history until the seventeenth century.*

Before Indonesia was inhabited by the present population, the archipelago was occupied by peoples of Negrite and Wedda origin. About 2,500 years ago, these original people were driven away by the Indonesians, who were coming from Asia. These settlers knew navigation and astronomy, and were skilled in growing rice, cattle breeding and the making of iron objects.

The history of Indonesia begins with the contacts with India at about the beginning of the Christian era. Their greatest influence was on Java. Although there were certainly commercial relations between the two countries, yet the more important factor was the flow of Buddhist missionaries from India, and of pilgrims to India. These contacts produced a fine Buddhist art.

Not only Buddhism, but also Hinduism entered Indonesia. The Hindu influence was greatest in respect of culture and the form of Government. In addition to the information obtained from Indian and Chinese sources there have also been found in Indonesia some copper plates and stone tablets which bear witness to this influence. The Hindu influence on architectural art was strong in Central Java. In Eastern Java, the Hindu art was gradually displaced by the original Javanese art. Buildings in West Java have left no remains, as they were made of fast decaying materials. The Eastern Javanese art declined in the fifteenth century. With the arrival of Islam, the Hindu Javanese art continued to be looked upon by the Javanese as the national art. Because the influence of the Dutch started in the 17th century, a new Islamic art did not develop.

The Javanese literature was also influenced successively by the Hindu, Islamic and European cultures. The Hindu epics entered the Javanese literature also, though in a considerably changed form. In the matter of content, style and meter, etc., the Javanese literature followed the Hindu literature, at first. However, it gradually evolved along independent lines. At last in the history of Java, a Hindu-Javanese culture appeared, the kernel being of a Javanese character.

Java, Sumatra and Bali were influenced by the Hindu culture through direct contacts. Other places in Indonesia were influenced in turn by these. Before Islam entered North Sumatra, it had already been much influenced by the Persian and Indian cultures. But from the nineteenth century onwards, religion developed, in an orthodox direction. as the influence of Arabia was felt directly.

From the sixteenth century onwards, European influence began to be felt through missionaries. Since the seventeenth century Indonesia has been influenced principally by the Dutch.

Discussion. Dr. N. P. Chakravarti remarked that in the Indonesian culture, Indian influence had blended harmoniously with the local culture. As an example of this, he cited the fact that some of the Indian heroes were believed by the Indonesian people to be their own heroes.

Discussion on the Teaching of History of Science

Mr. A. Rahman. *The history of sciences and some problems of teaching.*

The paper began with a discussion of how social environment moulds human activity, including science. It continued as follows:—After the Renaissance there was a separation of the 'Humanities' from 'Science'. The reasons were that (*a*) the influence of science was mainly in the material field, (*b*) whereas the 'Humanities' were based on an appeal to antiquity, 'science' was a return to the contemplation of brute facts observed by experimentation, and (*c*) the newly born universities encouraged scholarship, rather than the new methods of discovery.

Our latest experience shows that this separation is undesirable. Science has begun to play a dominant rôle in the activities of humanity. A powerful new tool, namely 'Scientific Research' has been forged. Out of scientific activity, ethical problems arise inevitably, the atom bomb being an obvious example. This means that there is a need for general education, no less than for specialized education. This dual need poses a big practical problem for educationists. The situation is made more acute by the fact that in the teaching of science also, it has been compartmentalized into various branches.

Teaching of the History of Sciences can bring out the artificiality of the division between science and humanities, and between the various branches of science. It will give an understanding that the growth of science is an evolutionary process, in which many needs, concepts and techniques interact. Again, it will not only bring a new consciousness of the positive factors promoting the growth of science, but also the negative ones retarding it.

Such an understanding is vital for us in India. It will put the old and the new in their proper perspective, and will facilitate the use of the scientific method in solving our problems.

The scientific method has to be applied to education also. The universities have been trying to impart knowledge which the students may be able to *transfer* into use later. They should give them the ability to discover and invent where they meet the ever new problems of life. Owing to historical reasons, teaching in Indian Universities has been particularly narrow, and unrelated to the Indian social background. Teaching of the history of sciences has been neglected, although it has received considerable attention in foreign universities.

The point, however, is not to give a background of science and humanities from mere historical angle but to impress upon the student the historical nature of the process and bring home to him the dominant human tendencies in the various epochs of human history.

The paper was accompanied by a proposed syllabus for teaching of the history of sciences in universities as a combined course for Science and Arts students of Intermediate and Degree classes.

Dr. A. Singh. *A history of sciences course for undergraduates.*

The author presented some practical aspects of a course in the History of Sciences for undergraduates, started at Delhi University, five years ago. The following issues were raised:—

(*a*) Because of the limited background knowledge of the students, the subject matter should be restricted to a comparatively few topics of fundamental importance.

(*b*) It would be advisable to present the subject in two stages. In the first, the growth of sciences as a whole may be presented against the background of the history of mankind; and thus the social relations of science clearly brought out. In the second stage the growth of the various branches of science may be taken up individually, the continuity of ideas being thus emphasized.

(*c*) It is essential that examiners should have a clear idea of the objectives being followed in teaching the subject. This is especially necessary because the subject is so vast and admits of several approaches.

The papers of Mr. Rahman and Dr. Singh were taken up for discussion jointly. At first doubts were expressed regarding the utility of a course on the History of Sciences, under the present conditions. However, towards the end of the discussion, the concensus of opinion was that it would be well to make a beginning in this direction in spite of the existence of handicaps regarding source materials and maturity of students. In order to stimulate the interest of students, extension lectures on sciences should be arranged. The teaching of the History of Sciences may include Sectional Histories but it must also include a general survey in which the various sciences are inter-related, and their interaction with society is brought out.

Other Papers Received

A few papers were received from authors, who could not be present at the Symposium. The following are brief descriptions of the contents of these papers:—

Dr. R. V. Seshaiya.[1] *Ancient Indian ideas of human development.*

This paper draws attention to the *Garbha Upaniṣad* (older than the *Purāṇas*). as a source of information regarding ancient Indian ideas on human development. A translation and discussion of two *mantras* describing the various stages of development of the human embryo, are given.

Mr. N. N. Chatterjee.[2] *Ancient India's contributions to geology and mineralogy.*

In this paper a more or less literal translation is given of the passages in literature, which deal with geological or mineralogical knowledge. The account is divided into the following periods: pre-Aryan period, Vedic period, period of Kauṭilya, period of the epics, period of Purāṇas, period of Caraka and Suśruta, and Kuṣāṇa and Gupta period.

Mr. A. K. Yegnanarayana Aiyer.[3] *Dairying in ancient India.*

The source materials are given as the Saṁhitās of the four Vedas, the later epics and Purāṇas, the Arthaśāstra of Kauṭilya, some Tamil classics and ancient paintings and sculptures. Evidence is given of the veneration in which the cow was held even in Vedic times. The knowledge of the ancient Indians on the following topics is then discussed: dairy cattle, breeds and milk types; the feeding of animals; milk and milk products; and the care of sick cattle.

[1] Head of the Department of Zoology, Annamalai University, Annamalainagar.
[2] Department of Geology Calcutta University, Calcutta.
[3] Retired Director of Agriculture, Mysore.

DR. (MRS.) BANI CHATTERJI.[1] *Musical science and scientific relations between East and West from the historical point of view.*

The paper discusses the origins of music, characteristics of Eastern and Western music, and the contacts between East and West in this field.

DR. P. M. MEHTA.[2] *The medical man and his ideals in the golden age of Āyurveda.*

The paper discusses the aims, dress, behaviour and fees suggested for the medical practitioner, in the Indian medical literature. The ancients' views regarding the Royal Physician, the attendant for a patient, and quacks, are also given.

LT.-COLONEL B. L. RAINA.[3] *The study of medical history in India.*

The paper discusses the approach to the study of medical history, the field to be covered, and the avenues still unexplored. It also gives suggestions for research.

MR. J. K. DHOLAKIA.[4] *Progress of sciences in South Asia before the eighteenth century.*

This paper is a general survey. It includes many quotations from the source materials.

DR. K. K. DATTA.[5] *Impact of the industrial revolution on India's economy.*

The paper discusses how the most important industry of medieval India, namely manufacture of cotton cloth, was gradually stifled by the advent of the Industrial Revolution in Europe. It then describes the changes in India's economy that followed the decline of India's cotton industry. The paper includes an extensive bibliography.

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[1] Tagore Bhawan, Jorasanko, Calcutta.
[2] Dean, Ayurveda Medical College, Jamnagar.
[3] A. M. C., New Delhi.
[4] Mining Engineer, Dhansar (Manbhum).
[5] Professor of History, Patna College, Patna.

APPENDIX VIII

RESOLUTIONS

1. The Symposium recommends that National Groups affiliated to the International Union for History of Sciences be founded in each of the participating countries of South Asia.

2. This conference of Indian historians and scientists resolved that a National Group of History of Sciences be formed in India and a Committee consisting of the following be instituted to take necessary steps to bring the Group into existence:

Prof. R. C. Majumdar, Dr. A. S. Altekar, Dr. S. L. Hora, Dr. D. S. Kothari, Dr. A. N. Singh, Dr. R. C. Majumdar, Dr. Amarjit Singh, Prof. Ram Behari and Prof. M. Habib.

3. The Symposium further resolved to institute a Board under the National Institute of Sciences of India for the study of the History of Sciences.

APPENDIX IX

HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA AND SOUTH-EAST ASIA

Published in *NATURE*, Vol. 168, July 14, 1951. Pages 64ff.

The History of the sciences, pure and applied, in India and other parts of South Asia, still remains the greatest 'unknown continent' in this world of study, so important for the general culture history of mankind. It was, therefore, an excellent idea to gather together in November 1950 a group of Indian and South Asian scholars interested in the history of science, and to publish, even if only in a provisional form,[1] the papers which were read to the symposium. The result shows clearly that there is an enormous amount of material already available for the work of synthesis, in which we must attempt to place the development of science and scientific thought in India in its proper framework of parallel developments, some later, some earlier, in Europe and in other parts of Asia. It is also clear, however, from the papers in this symposium, that the task is perhaps the most difficult of all those which face historians of science today, owing to the extreme uncertainties in the dating of the most important texts, and even of actual objects which have survived.

Some of the papers, such as the general surveys given by A. S. Altekar and by R. C. Majumdar, are judicious and careful concerning this, and will no doubt be in greatest demand if copies are available separately. Some of the specialised papers (such as that by B. L. Raina) are also reasonably cautious. Unfortunately, this cannot be said of the majority of the papers, which put forward quite unacceptably early datings especially for texts purporting to date from the first two millennia B.C.; particularly bad examples are the two papers on astronomy (by Shukla and Dixit) as well as others on chemistry (by N. R. Dhar), embryology (R. V. Seshaiya) and medicine (G. V. Satyanarayanamurti). The accompanying table shows the divergence of opinion. It is even maintained that the Babylonians owed the sexagesimal division of the circle and the system of twenty-eight lunar mansions to India. In general, we find throughout the papers too marked a chauvinistic tendency, an effort to minimise foreign influences on Indian science and to emphasise all outward transmissions—this is, of course, all too easy so long as Indian history has not been provided with a strict chronology. Typical of the desire to make a case is the praise bestowed upon the potters of the Mohenjo Daro civilisation (P. Ray), where no comparison is made with other pottery products studied by the author, nor is any ceramics expert cited whose opinion might carry weight. Along with these tendencies goes the fault of trying to read too much into ancient texts, as when the Pillar Edicts of Asoka or the text of the 'Arthaśāstra' are appealed to as evidence for advanced fishery legislation (S. L. Hora); here the writer is roundly taken to task by a colleague (R. C. Majumdar). But great uncertainty seems to reign, for the sceptic himself seems to be perhaps too sceptical regarding the military use of arsenical smokes—which were certainly developed quite early by the Chinese. So while most of the writers are too rash, others are too modest, notably the writer on Siam (P. Rochanapurananda), who disclaims any contribution of his own Thai people to science, failing to mention the work of la Loubere[2] in the seventeenth century, which shows that Europeans were at that

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[1] Proceedings of a Symposium on the History of Science and Technology in South Asia, Delhi, Nov. 1950. Organised by U.N.E.S.C.O., and obtainable in mimeographed form from the U.N.E.S.C.O. Field Science Co-operation Office, c/o University of Delhi. About 150 pages, mostly single-spacing, mimeographed foolscap-size typescript.

[2] A New Historical Relation of the Kingdom of Siam.... Tr. A. P. Gent, F.R.S., from the French edition of 1691 (London, 1693).

time much interested in what the Siamese knew. Even if this turned out to be mostly Chinese—as it did—Siam must certainly have had something to show in fields such as textile technology. The same applies to the paper on Indonesian culture (Prijohutomo).

Until the problem of the dating of Indian texts is solved, all those of transmission must remain impossible to deal with. Hence the confidence shown by papers such as that on Indian-Chinese relations (P. C. Bagchi) is entirely misplaced. We cannot admit the derivation of the Chinese lunar mansions from India (probably both systems are ultimately Babylonian). It is absurd to claim Indian influence on a mathematical work such as the 'Sun Tzu Suan Ching' (third century A.D.) on the ground that the word 'Ching' was afterwards used for translating the term 'Sūtra' in Buddhist texts—all canonical books were known as 'Ching' from the time of the Warring States (fourth century B.C.). Nor is there any mention in this paper of the numerous cases which have been noted of the reappearance of Chinese mathematical problems in subsequent Indian texts.

Dating of Indian Text.

	Dating accepte by critical modern scholarship (and in papers by A. S. Altekar and R. C. Majumdar).	Paper by K. R. Dixit and G. V. Satyanarayanamurti.	Paper by K. S. Shukla.	Paper by P. Ray, S. L. Hora and R. V. Seshaiya.
Vedic material ..	c. −14th (−1400/−1000)	−6000/−1500	−4000/−2000	..
Upaniṣads period ..	−10/−6th	−17th/−7th	..	−2500/−2000
Calendrical Texts:				
'Jyotiṣa Vedāṅga' ..	−600/−200/	..	−1400	..
'Sūrya Prajñapati' ..	c. −200		−500	..
Astronomical Text:				
'Sūrya Siddhānta' ..	+4th or 5th	..	0	..
Economical and Technological Text:				
'Arthaśāstra' ..	−1st	..	..	−4th
Medical and Biological texts:				
'Suśruta Saṁhitā' ..	1st (Present text +11th)	−7th	..	−6th
'Caraka Saṁhitā' ..	+1st (Present text +8th)	−7th	..	−6th

Nevertheless, the study of the history of science in India remains enthralling. The following words of Filliozat,[1] in the preface to his recent splendid monograph on the theories of classical Indian medicine, are well worth pondering:—

'Some may doubt the legitimacy of placing Indian and Greek science on the same level, preferring to compare the former rather with that of Islam. The common opinion that Indian science lacked originality presupposes that it was derived from Greek science, and is, therefore, sister to the science of the Arabs....

'This problem has been far too much prejudged. Indian scholars, moved by national pride, are prone to maintain that their sciences in high antiquity surpassed even those of today. In the West, on the other hand, many maintain that the

[1] Filliozat, J. La Doctrine Classique de la Medecine Indienne. *Imp. Nat.* (*C.N.R.S. and Geuthner, Paris, 1949*).

spirit of scientific research could only have been born in Europe, and that what science the Indians had they borrowed. In either case the only proofs presented are a few examples claimed as characteristic and used as the basis for generalisations, hypotheses taking the place of facts which are still undiscovered or which people will not take the trouble to seek. Indeed, opinions rest on racial or national preconceptions rather than on a profound comparative study of the two great scientific traditions the value of which is to be determined. One notes also that those who speak with the greatest certainty in these matters are just those who are familiar with only one of the two traditions, knowing the other only by scattered facts, or studies which they are unable to appreciate. To say nothing, of course, of those 'authorities' who know nothing of either of the two traditions about which they speak.

'The greatest historians of science have not always escaped from the inconvenience of knowing only one side of the matter. Paul Tannery, so famous for his studies on ancient mathematics, is an example. We know that the trigonometric sine is not mentioned by Greek mathematicians and astronomers, that it was used in India from the Gupta period onwards (+third century), that the Surya Siddhanta (+fourth or +fifth century) gives a table of sines, that the Arab astronomers knew them from their Indian contacts and passed them on to Europe in the +twelfth century, when the work of al-Battani was translated into Latin. The only conclusion possible is that the use of sines was an Indian development and not a Greek one. But Tannery, persuaded that the Indians could not have made any mathematical inventions, preferred to assume that the sine was a Greek idea not adopted by Hipparchus, who gave only a table of chords. For Tannery, the fact that the Indians knew of sines was sufficient proof that they must have heard about them from the Greeks.

'If this is the way we are to argue, there was never any science other than Greek science, and the question whether science has any origins other than the Greek "miracle" is solved in advance. Only a profound study of Indian scientific developments in parallel with those which took place elsewhere about the same times, can reveal the degree of originality of that science, and hence enable us to understand the rôle which India played in the history of the growth of man's knowledge of Nature.'

In the present symposium, the writer on Siam ends, somewhat pathetically: 'At present we all seem to believe that science is something which originated especially in Europe and the Near East, and that the Far East had no share in the building of this most important branch of human knowledge. Yet Asian countries such as India and China were important centres of culture both materially and spiritually. Their peoples had learned how to control the natural world around them, and to live a life in which there was room for leisure, only it seems that the knowledge gained by them never joined up with what we know today as modern science. However, Asian people now find no difficulty in learning science and do not lack ability in scientific research.'

In my opinion, future research on the history of science and technology in Asia will, in fact, reveal that the achievements of these peoples contributed far more, in all pre-Renaissance periods, to the development of world science than has yet been realised. The programme of Filliozat is the answer to the perplexity of Rochanapurananda.

JOSEPH NEEDHAM.

NOTE FROM THE PRESIDENT, NATIONAL INSTITUTE OF SCIENCES, WITH REFERENCE TO THE REVIEW OF THE SYMPOSIUM PAPERS BY DR. JOSEPH NEEDHAM, F.R.S.

Published in *Nature*, Vol. 168, December 15, 1951, p. 1047.

Dr. Joseph Needham has very ably reviewed in *Nature* (Vol. 168, July 14, 1951, p. 64) the series of papers that were read at the Symposium on the 'History of Sciences in South Asia' and has drawn some pertinent conclusions therefrom. He has, however, not been able to gauge the spirit in which the Symposium was held, or expatiate on the new lights that were thrown on the subject. He has, on the other hand, omitted to mention certain salient facts about the organization of the Symposium and the review gives by omission the erroneous impression that it was solely the work of the U.N.E.S.C.O. Science Co-operation Office for South Asia. As Chairman of the Symposium, and now President of the National Institute of Sciences of India, it is incumbent upon me to clear the position as regards the part played by the National Institute regarding the Symposium.

The idea of holding a Symposium on the 'History of Sciences in South Asia' was first mooted by Dr. D. S. Kothari, one of the Secretaries of the Institute, which received the support and co-operation of the U.N.E.S.C.O. Science Co-operation Office in Delhi. Accordingly, the Symposium was held under the auspices of the National Institute of India, in collaboration with the U.N.E.S.C.O. Science Co-operation Office, in Delhi, from the 5th to 7th November, 1950. Facilities for holding the meetings and accommodation for the visiting delegates were generously provided by the University of Delhi. A number of scientists, historians and oriental scholars from India and abroad attended the Symposium and took part in its deliberations. From the mimeographed copies of the papers that had been circulated in advance, it was clear at the very outset that considerable controversy was bound to rage about the dating of the most important texts and to overcome this difficulty a Chronology Committee, consisting of historians and scientists, was appointed at the business meeting prior to the Symposium. This Committee felt that it was very difficult to ascertain with accuracy the dates of Indian literary works supposed to belong to the pre-Christian era. But after discussing the matter at length, they recommended that the chronological table given below, might be taken as a working hypothesis in connection with the discussion of papers of the Symposium. The table is based on the standard work *History of Indian Literature* by Winternitz.

CHRONOLOGICAL TABLE.

Age of the Ṛgveda ..	.. 2000 B.C. to 1500 B.C.
Age of Saṁhitās and Brāhmaṇas	.. 1500 B.C. to 800 B.C.
Age of old Upaniṣads ..	.. 900 B.C. to 599 B.C.
Caraka	.. 100 A.D.
Caraka Saṁhitā, Kernel of	.. 100 A.D. but enlarged in later times.
Suśruta Saṁhitā ..	.. 200 A.D. to 500 A.D.
Vedāṅga Jyotiṣa, Present text	.. 500 B.C.
Śulbha Sūtras ..	.. 500 B.C. and later.
Dharmasūtra ..	.. 600 B.C. to 200 B.C.
Mahābhārata, Manusmṛiti, Rāmāyaṇa ..	.. 200 B.C. to 200 A.D.

The authors of papers were then asked to revise their papers according to the dates given in the table for various texts but owing to very divergent views, it was not intended to have all the papers published in full. In reviewing that motley of papers, which were not authorized for publication, and by giving a note that mimeographed copies are available at the U.N.E.S.C.O. Science Co-operation Office in Delhi, Dr. Needham has unknowingly done an injustice to the N.I.S.I. and to the organizers of the Symposium. A summary of the proceedings of the Symposium is under preparation for publication by the N.I.S.I.

The great difficulty with which a scientist is faced for a study of the History of Sciences in India lies in the fact that the available ancient materials and documents are written either in Pali or Sanskrit languages with which he is generally not familiar. He has, therefore, to depend upon oriental scholars for interpretations and commentaries of texts for dating ancient literature. Lack of scientific knowledge among historians and orientalists is somewhat evident which makes it difficult for them to appreciate and evaluate scientific thought of ancient India. In the case of fixing of dates to various texts, there is no unanimity among them. In consideration of this, the participants in the Symposium came to a decision that in future scientists dealing with the History of Sciences should give original texts and the names of the source books for reference by the historians and orientalists.

The scientists in India, as elsewhere, have sound experience of sifting and analysing their data before arriving at any definite conclusions. For instance, my contributions on Fishery Legislation, based on *Arthaśāstra* and the Aśoka Pillar Edict were read by many eminent oriental scholars who have expressed agreement with the interpretations suggested by me, and since their publication, I have received appreciation and agreement from many others. As a matter of fact, whenever any modern conservative view on any matter is challenged, adverse comments are likely to result. It is, therefore, the duty of the scientists to make a correct approach to and appraisal of the scientific knowledge of ancient Indians notwithstanding the prejudices that may exist already about the history of India's cultural heritage and scientific thought. 'The study of the history of science in India', as remarked by Dr. Needham, 'remains enthralling.'

S. L. Hora

I have read Dr. Hora's communication with interest and sympthy. It was a great disappointment to me that I was not able to accept the invitation to participate personally in the Conference, but after the publication of my review in *Nature* I became aware of the work of the Chronology Committee through the report published by Dr. Hora at the conclusion of Dr. Wolsky's review in *Archives Internationales d'Historie des Sciences*, 4, 579 (1951), and I was pleased to find so much concordance of view. My chief object in acceding to the request of the Editors of *Nature* that I should review the conference papers sent to them, which neither the Editors nor I knew were in any sense unauthorized, was to encourage interest in the history of Indian contributions to science.

Joseph Needham