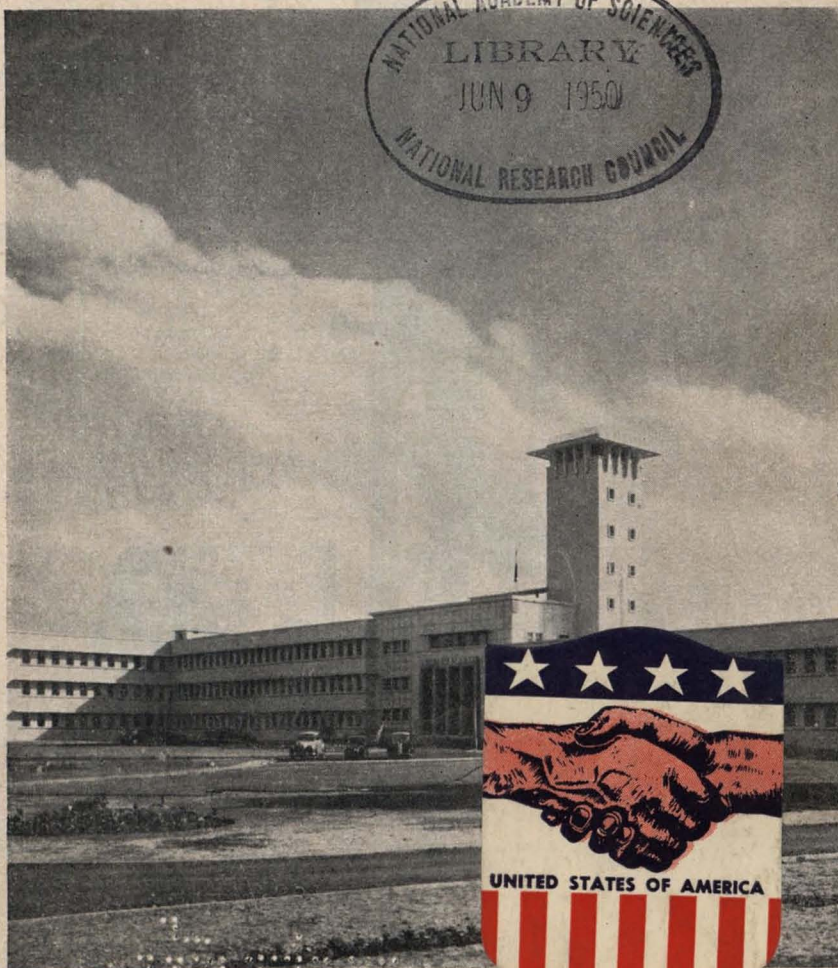


# Journal of Scientific & Industrial Research



V. 9, No. 4, APRIL 1950



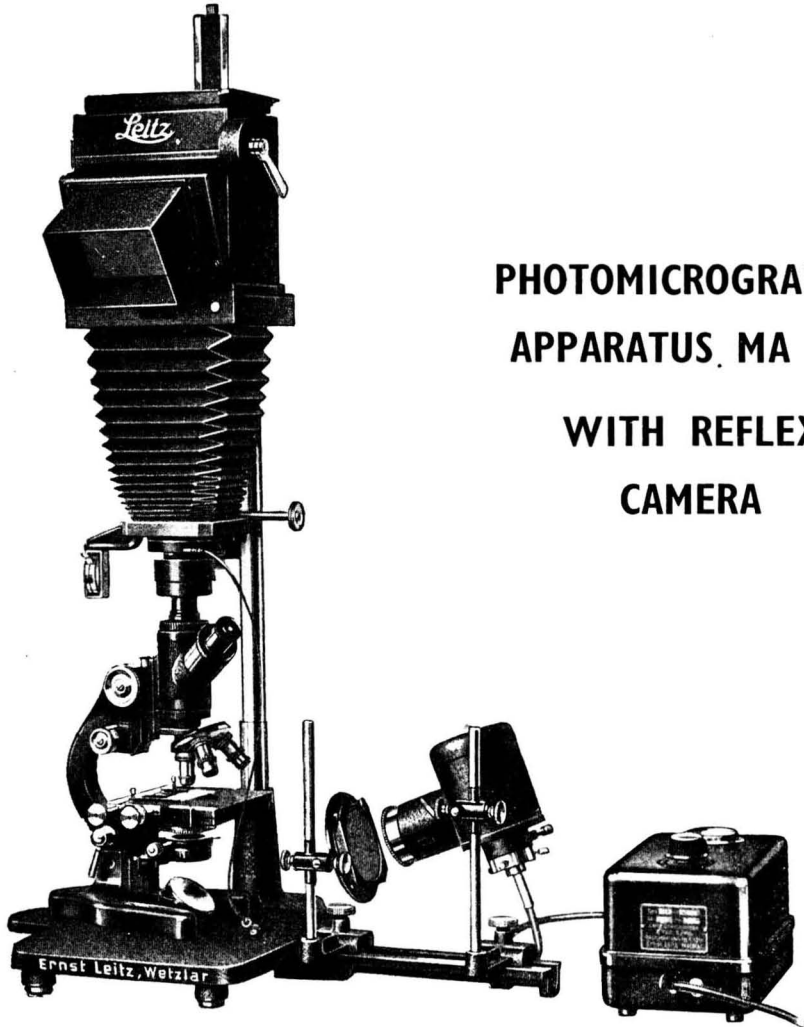
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- Science & State Aid
- Seismology in India
- Mandi Salt Deposits
- Antioxidants
- Alkaloids of Indian Stephanias
- Estimation of Coconut Oil in adulterated Samples
- Preservation of Shark Liver Oil

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## COVER PICTURE

Picture on the cover shows the National Physical Laboratory, India, which was declared open by Sardar Vallabhbhai Patel, Deputy Prime Minister of India, on January 21, 1950. This Laboratory is the second of the eleven National Laboratories sponsored by the Council of Scientific & Industrial Research declared open.

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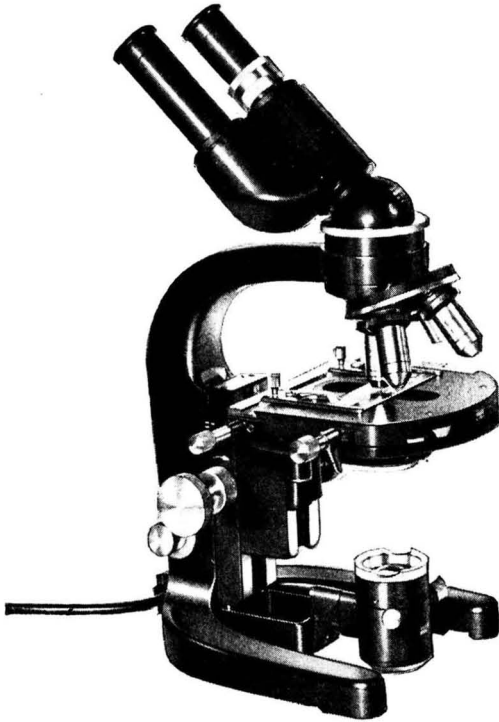
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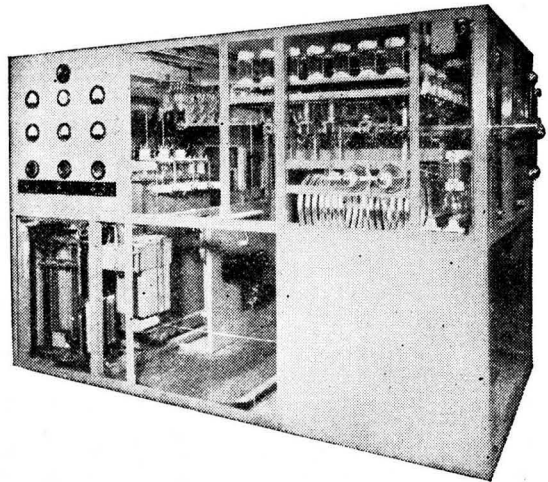
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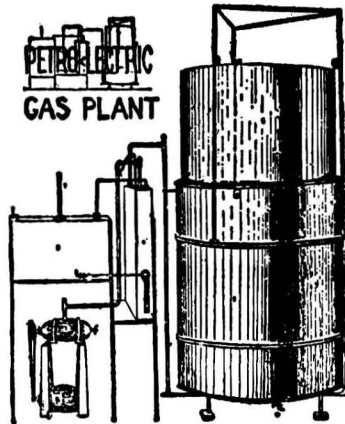
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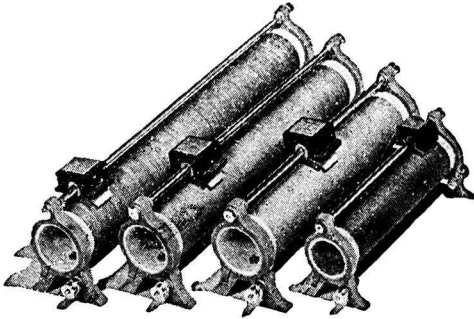
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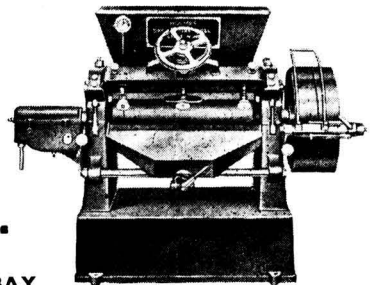
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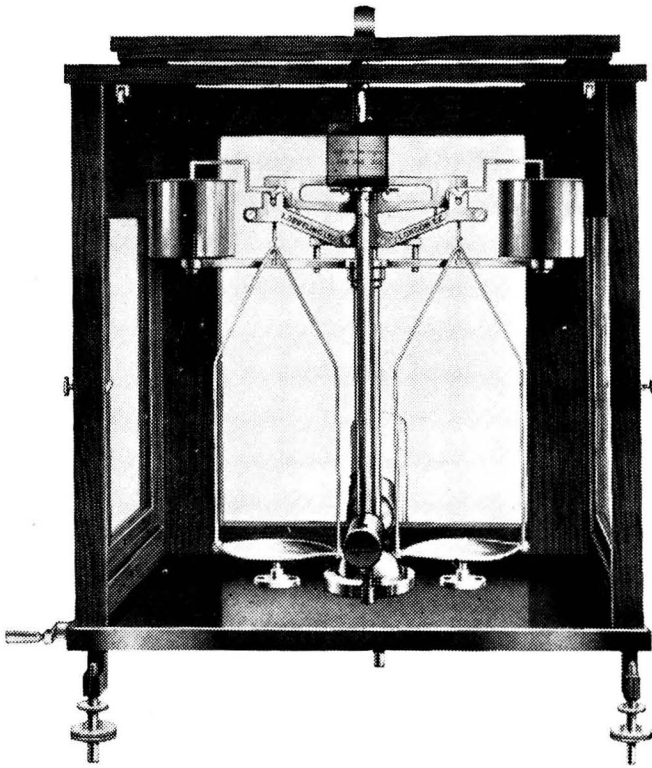
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These observations on science and research made by H.E. Sri C. Rajagopalachari at the opening ceremony of the National Physical Laboratory are of more than ordinary interest in the context of the much-discussed questions of State aid, planning and direction of research. They emphasize the pre-eminent position of fundamental research in any programme of scientific development, and the need for aid to such research without restrictive conditions. This robust faith shows an enlightened recognition of the enduring values of science in relation to human progress, which all those entrusted with the responsibility of planning, financing and administering of research projects would do well to ponder over.

There has been an almost universal recognition of the urgency for raising the tempo of scientific research in every country. This has been a noteworthy feature of the post-war period, and is perhaps traceable to the demonstrable contributions which science made to the war effort. The ordinary citizen was thus awakened to the

practical possibilities and social consequences of science. This public recognition, which is a positive gain to science, is the direct outcome of the close partnership between government, science and industry, brought about under the stress of an emergency, when the gap between research and utilization was bridged, and all scientific effort was directed unerringly to a well-defined end. Well may it be asked why science which produced such remarkable results during the war should not be equally effective in solving the many problems in peace time?

The first link in the chain of events—research, development, production, and use—is research, whose value was first established in the 17th century. The scientific method of observation, theory and experiment replaced the scholastic method of argument in man's endeavour to understand natural phenomena. Since then the march of science has been triumphant, and it has served to “extend the empire of man and to ameliorate the condition of man”. Science has become the source of knowledge “indispensable to the progress of civilization, without which the thoughts of man run in circles and all progress ceases”. To provide the requirements of a growing population, there is undoubted need for rendering the techniques of developing natural resources continuously more effective through investigation and research. It is this realization that has led governments in various countries to extend aid to research on a scale that would not have been deemed possible a few years ago. Thus, in the United Kingdom the annual research expenditure (about 100 million pounds) is a little over one per cent of the national income; in the United States of America, it is a little less than one per cent and amounts

to about 2,000 million dollars. Compared to these appropriations, research expenditure in India is small and is estimated to be one-fiftieth of one per cent of the national income. It is encouraging, however, that there is a growing appreciation of the importance of research in India, and recent developments have shown that Government aid is becoming generous and substantial.

The increasing support which governments have begun to extend to scientific research raises a few questions. Does State aid necessarily mean emphasis on utilitarian research? If so, what are its repercussions on the progress of fundamental research? State patronage is welcome — nay, necessary — if research is to expand in volume and intensity. Science, like the fine arts, has sought and flourished under patronage. Government, however, cannot remain unconcerned to the practical outcome of such aided research. Government quite properly invests its money in areas which bring a return to the tax-payer. Writes Dr. Alan T. Waterman of the Office of Naval Research, Washington D.C., in this connection: "Uncle Sam is properly a realist. He may believe in charitable donation for some of the people all the time, for all the people some of the time, but not for all the people all the time. In general, he expects to pay only for services rendered. Thus the federal government does not provide financial support unless a need can be established, and when such support is provided, it must be expected to show some return to the taxpayer".\* The utilitarian aspect thus receives emphasis under any scheme of Government-sponsored research, and such research is concerned with development based on existing knowledge rather than with the creation of new knowledge and is likely to prove attractive to most men. The emphasis on application is attended by the danger to which Dr. Vannevar Bush draws attention in his *Science — the Endless Frontier*, viz. that applied research tends to drive out fundamental research. This danger must be guarded against, the State support should be so directed that the sources of knowledge are maintained at the highest level of functional efficiency.

H.E. Sri C. Rajagopalachari says in this connection: "If we limit the efforts and

the operations of scientific men within utilitarian plans and schemes, we may make small and useful routine achievements, but the biggest discoveries never come that way. They come, so to say, by accident and indirectly, and then the discovery produces an enormous gift for human progress and happiness." This enlightened assessment of the relative values of development research and fundamental research affords a weighty support to the view that fundamental research is entitled to State aid in its own right regardless of the practical outcome.

Recent surveys of government allocations in the U.K. and U.S.A. have brought home the fact that grants to fundamental research represent but a small proportion of the total and fall far short of the requirements. The problem of restoring the balance between research and development programmes has received careful scrutiny, and there is emphatic support to the view that fundamental research should be encouraged and fostered on a generous scale. For instance, in the U.S.A. the expenditure on fundamental research is to be quadrupled and federal support to universities and non-profit research institutions is to be progressively increased to at least 250 million dollars by 1957. The view that support on a liberal scale to the traditional centres of research, viz. the universities, would bring handsome returns is now fully accepted, and such support should form a part of an overall plan for raising the standard of higher education. This would alleviate the shortage of trained manpower — a shortage which prevails in most countries, and has restricted many a programme of development. Scientific development in the ultimate analysis depends on the quality and calibre of research workers, and the strengthening of universities with the view of not only augmenting facilities for free and unrestricted inquiry but also of ensuring the training of youth for a research career is an urgent necessity.

Progress of science does not depend merely on the accumulation of new facts; it depends on the continuous development of new and fruitful concepts, and it is through proper education and training that creative talents can be encouraged and qualities essential for exploration and discovery developed. Under the care of an enlightened National Government, science in India is

\* *Science*, 1949, 110, 703.



beginning to receive the recognition and encouragement which had been denied to it so far. The observations of India's leaders provide an assurance that State aid to science would be liberal and that the needs of scientific inquiry would be met. What is needed is leadership for the development of universities which would be as effective as that we have for scientific research and

which has secured improved facilities and a network of eleven National Laboratories. We hope that the attention given to scientific development would be supplemented by an equally energetic attention to universities, which set the standard for the quality and tempo of research, and serve not only as centres of fundamental research but also as institutions for research scholars.

## National Planning Commission

THE TERMS OF REFERENCE TO THE NATIONAL Planning Commission appointed by the Government of India include: (1) the assessment of the material, capital and human resources of the country, including technical personnel, and the investigation of possibilities of augmenting such of these resources as are found to be deficient in relation to the nation's requirements; (2) the formulation of a plan for the most effective and balanced utilization of the country's resources; (3) the determination of priorities, defining the stages in which the plan should be carried out, and proposing the allocation of resources for the due completion of each stage; (4) the indication of factors which are tending to retard economic development, and determining the conditions which, in view of the current social and political situation, should be established for the successful execution of the plan; (5) the determination of the nature of the machinery which will be necessary for securing the successful implementation of each stage of the plan in all its aspects; (6) the appraisal from time to time of the progress achieved in the execution of each stage of the plan and recommending the adjustments of policy and measures that such appraisal may show

to be necessary; and (7) the recommendation of such interim or ancillary measures as appear to it to be appropriate either for facilitating the discharge of the duties assigned to it; or on a consideration of the prevailing economic conditions, current politics, measures and development programmes; or on an examination of such specific problems as may be referred to it for advice by Central or State Governments.

The Commission, which will make recommendations to the Cabinet, will act in close understanding and consultation with the Ministries of the Central Government and the Governments of the States. Responsibility for taking and implementing decisions will rest with the Central and the State Governments.

The work of the Planning Commission will affect decisively the future welfare of the people in every sphere of national life. Its success will depend on the extent to which it enlists the association and co-operation of the people at all levels. The Government of India, therefore, earnestly hope that in carrying out its work, the Commission will receive the maximum support and goodwill from all interests and, in particular, from industry and labour.



## THE NATIONAL PHYSICAL OPENING CEREMONY,

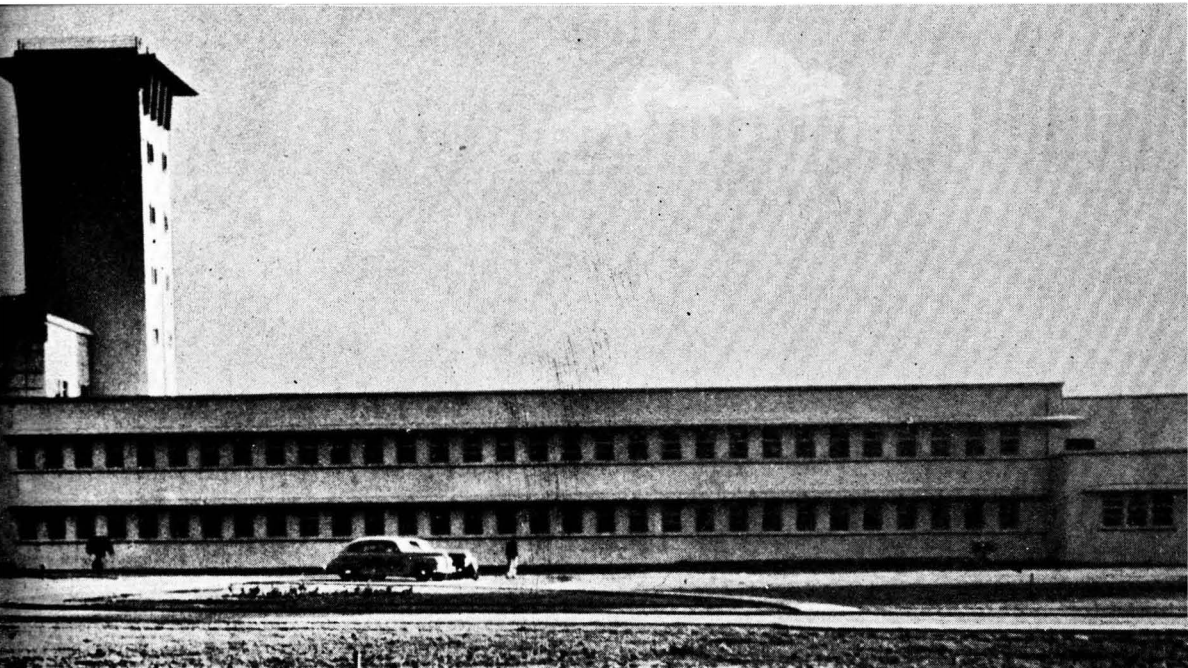
**T**HE National Physical Laboratory is the second in the chain of eleven National Laboratories to be declared open. At an impressive ceremony which took place in Delhi on January 21, 1950, Sardar Vallabhbhai Patel, Deputy Prime Minister of India, declared the Laboratory open before a distinguished gathering of scientists, industrialists and public men. His Excellency Sri Chakravarti Rajagopalachari, Governor General of India, presided over the function.

Three years ago Delhi witnessed a similar gathering of the scientific fraternity and the public when Pandit Jawahar Lal Nehru laid the foundation stone of the magnificent structure that is now the National Physical Laboratory. The construction work was taken up a year later and progressed rapidly. The front block of the building, with its imposing tower, was ready for occupation in the latter part of 1949.

The National Physical Laboratory owes its inception to the vision, energy and resourcefulness of Dr. Shanti Swarup Bhatnagar. It

was in 1941 that Dr. Bhatnagar put forward specific recommendations for the establishment of the Laboratory. These recommendations were accepted by the Government, and in 1945 funds were made available for the work. A Planning Committee was appointed, and after a searching inquiry into the needs of physical research in the country, and a study of the designs and equipment of physical laboratories in the United Kingdom and the United States of America, the committee formulated plans. In finalizing the plans, in speeding up the building work and in equipping the laboratory, the Council — nay, the country — was fortunate in having the guidance and direction of Dr. Shanti Swarup Bhatnagar. In the words of the Governor General of India: “the cause of advancement of science in India has found in Dr. Bhatnagar a great organizer”.

The growth of the science of physics in India during the present century has been rapid and impressive. The first noteworthy contribution to modern physics by an Indian scientist which received world attention was



## LABORATORY, INDIA

JANUARY 21, 1950

on the generation of ultra-short electric waves, and this was by Sir J. C. Bose in 1895. Since then, Indian physicists have made many significant contributions to the advancement of physics, notably in optics, acoustics, magnetism, cosmic rays and astrophysics. The establishment of the University College of Science at Calcutta in 1915 gave an impetus to organized research, and many important discoveries emanated from the Calcutta University and from the Indian Association for the Cultivation of Science. The development of research facilities in universities, Government scientific departments and research institutions accelerated the growth of research. The last decade witnessed the establishment of the Raman Research Institute at Bangalore, and the Tata Institute of Fundamental Research at Bombay. The names of Prof. C. V. Raman, F.R.S., Prof. M. N. Saha, F.R.S., Prof. K. S. Krishnan, F.R.S., and Prof. H. J. Bhaba, F.R.S., are known wherever the science of physics is taught and studied. These scientists have inspired many young men and women and



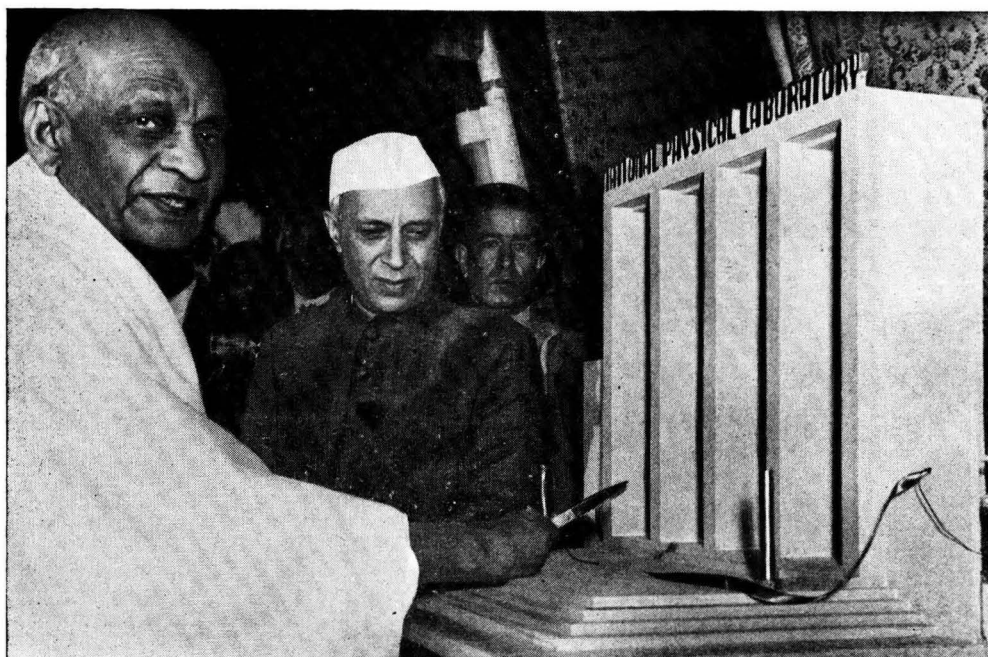
DR. K. S. KRISHNAN, DIRECTOR, NATIONAL PHYSICAL LABORATORY.

have established important schools of research all over the country.

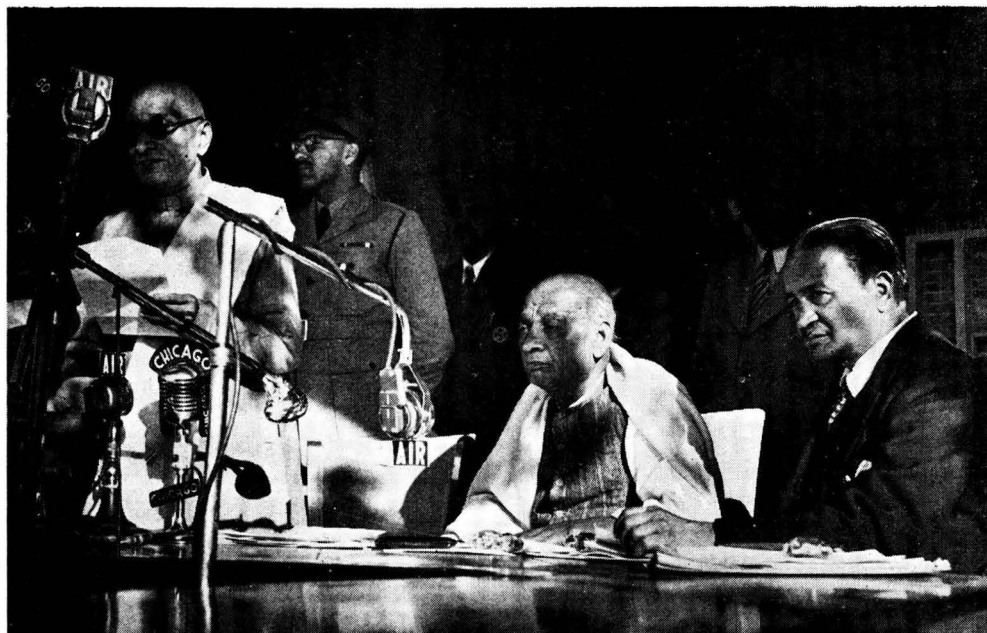
These developments, impressive and important as they undoubtedly are, have emphasized the need for even greater facilities and specialized large-scale laboratories. To quote the words of Dr. S. S. Bhatnagar: "One aspect of fundamental research work which can hardly be neglected in India is that which requires specialized, large-scale laboratories. During recent years, and particularly during the last World War, organization of scientific work has undergone vast changes. Not only does some of the present type of work require large-scale specialized organizations well outside the scope of university work, but also expenditure of large sums of money which could only be justified if diversified, co-ordinated and regulated application and professional continuity of work are guaranteed. This is not usually possible in the universities where teaching and research necessarily go hand in hand, and are essentially preparatory. Research work there is bound to be scrappy, discontinuous and unco-ordinated. Those who long for the old

days with lone worker in a damp basement room with his wax and string and glass-blowing torch, can have them. I believe that the essential spirit of the old days — freedom of enquiry and time for thought — can be obtained even in the pressure of great new physical and organizational techniques. It is a fact that fundamental research has now become a huge organized industry in itself."

The National Physical Laboratory has been carefully designed and expertly planned to meet the exacting needs of research. The main features of the building are the provision of air-conditioning, flexibility, which allows a change in the sizes of rooms in steps of six feet units, and a long basement which serves as a store as well as a tunnel for services such as gas, steam, water, electricity and compressed air. These services lie vertically in every room in the Laboratory without winding themselves round the walls and corridors, thus saving lakhs of rupees and providing means of introducing any new service lines, which may be necessary, without having to dig into the walls and floors of the rooms.



SARDAR VALLABHBHAI PATEL OPENING THE LABORATORY.



HIS EXCELLENCY SRI C. RAJAGOPALACHARI DELIVERING HIS SPEECH.

The main functions of the Laboratory relate to the maintenance of standards in all branches of physical science where precision of measurement is required. This refers not only to the fundamental standards of mass, length and time, but also to derived standards like those required for electrical and electronic instruments, temperature, luminosity, properties of metals and their behaviour, purity of chemicals for spectroscopic and other specialized applications. In fact, the whole range of scientific work which calls for instrumentation falls within the scope of the Laboratory. It will also be concerned with problems of physical research, which relate fundamentally to the utilization and processing of raw materials for industry, standardization of processes, and scientific controls for improvement in the quality of industrial products. Another important function of the Laboratory will be to give advice on the framing of specifications and of devising suitable tests, whereby the quality of manufactured products could be easily tested in the Laboratory. This work of the Laboratory will eventually raise the standard of industrial efficiency by helping in systematizing industry to a common measure of funda-

mental standards, specifications, control of quality, performance and practice.

The work of the Laboratory will be carried out through the following nine divisions: Weights and Measures, Applied Mechanics and Materials, Heat and Power, Optics, Electricity, Electronics and Sound, Industrial Physics, Hydraulic Research and Analytical Chemistry. Its work is directed by the distinguished Indian physicist Dr. K. S. Krishnan whose "fame as a physicist transcends the limits of this country". He is one of the big men of science who are India's pride. He is a scholar of eminence, and his genius "rests on the solid foundation of innate culture and a balance without which co-operative effort in research is an impossibility". Dr. K. S. Krishnan is assisted by a team of eminent scientists, each distinguished in a special branch of physics.

Declaring the Laboratory open, Sardar Vallabhbhai Patel said: "The magnificent building set in such picturesque surroundings indicates that while it is no answer to the spiritualist's doubts or the humanist's despair, it is essentially a response to the man's call for precision and perfection. It will combine the emotional zeal of the fundamentalist

with the practical approach of the utilitarian. It will furnish that scientific aid to industry without which the present-day industrial efficiency would soon find itself lost in the desert sands of dead habit." He asked the distinguished scientists present "whether science in its quest for Nature's secrets" is going to advance human race towards its goal of eternal happiness or whether it will open a veritable Pandora's box of evil forces for the destruction of mankind. "It is my earnest and sincere prayer that this Laboratory and the distinguished band of research workers who will operate in it will provide a positive answer to this problem as an inspiration to their fellow-scientists in other parts of the world."

His Excellency Sri Chakravarti Rajagopalachari referred in his address to research expenditure and pointed out that "money spent on fundamental research is not money wasted on empty prestige, but is a good and necessary investment which progressive nations will do well not to grudge". He continued: "It would be unwise to limit scientific research. If we limit the efforts

and operations of scientific men strictly within utilitarian plans and schemes, we may make small and useful routine achievements, but the biggest discoveries never come that way." He hoped that search for truth, which is the ultimate goal of all scientific research, should go on, and India should contribute her share of work in science and take her share of fame in return. "There is no medium for international prestige as effective as scientific research. Our laboratories are our best embassies."

The foreign scientists who were present at the opening ceremony offered their best wishes for the success of the Laboratory. Founded under such good auspices and with abundant goodwill to back it, the National Physical Laboratory starts on its career of exploration of science with its endless frontiers. Men of goodwill all over the world will join His Excellency Sri C. Rajagopalachari in the wish that love of truth for its own sake, and the spirit of investigation with all its vigour would inspire those who will work in this Laboratory.

## Characteristics of the Ionosphere over Calcutta (January 1950)

S. S. BARAL, R. K. MITRA, D. C. CHOUDHURY,  
(MRS.) T. K. BHAR & A. P. MITRA

*Wireless Laboratory, University College of Science, Calcutta*

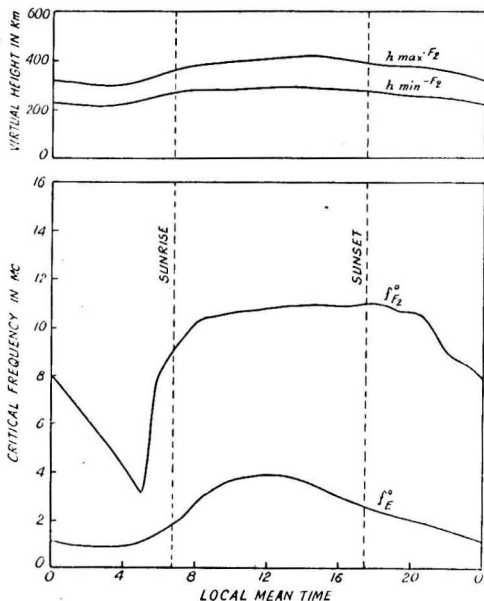
**T**HE following are the ionospheric data observed at Calcutta for the month of January 1950.

Fig. 1 represents the mean hourly values of the penetration frequency of the E region and the penetration frequencies and virtual heights of region  $F_2$  in graphical form. The figures are obtained from average values of the data taken for each hour of the day for 5 days a week. Fig. 2 gives the prediction of the maximum usable frequencies which can be used for different distances of

transmission by reflection at the F region over Calcutta for the month of April 1950. Table I gives the different occasions during routine observation when sporadic E ionization was observed and the values of the corresponding penetration frequencies and heights.

Sporadic E ionization was found to occur less frequently in this month. Absorption of normal E echoes at mid-day was also less. The behaviour of region  $F_2$  was found to be normal in this month.

BARAL *et al.*: CHARACTERISTICS OF THE IONOSPHERE OVER CALCUTTA



(5 HR. 54 MIN. AHEAD OF G.M.T.)  
FIG. 1 — JANUARY 1950.

TABLE I

MONTH & YEAR	DATE	HOUR	$f^{\circ} E_s$ Mc.	$h_{E_s}$ Km.
January 1950	2	22.00	7.55	105
		23.00	7.00	105
	4	08.00	4.15	105
		09.00	4.30	105
	6	18.00	2.85	90
		21.00	3.00	90
	7	08.00	3.10	90
	9	17.00	3.00	105
		21.00	2.75	90
	10	03.00	2.90	90
		04.00	3.15	105
		15.00	4.75	120
		16.00	6.50	120
		17.00	4.00	105
18.00		4.20	105	
	22.00	3.00	90	

TABLE I — contd.

MONTH & YEAR	DATE	HOUR	$f^{\circ} E_s$ Mc.	$h_{E_s}$ Km.
January 1950	16	17.00	3.30	105
		18.00	3.35	105
	17	18.00	3.20	90
	19	16.00	3.20	105
		17.00	3.20	90
		20.00	3.00	90
	20	19.00	3.00	90
		20.00	2.50	90
		21.00	2.55	90
	26	16.00	4.25	105
	27	19.00	3.00	90
		22.00	4.00	90
	30	17.00	3.35	105

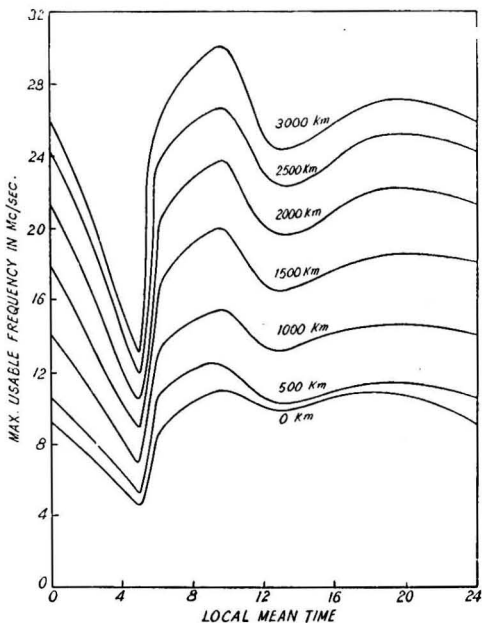


FIG. 2 — PREDICTED M.U.F. VIA  $F_2$  LAYER DURING THE MONTH OF APRIL 1950.

# Studies in Seismology in the India Meteorological Department

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K. S. AGARWALA

*India Meteorological Department, New Delhi*

THE study of seismology in India has been receiving attention mainly from three Government departments, viz. the Geological Survey of India, the Survey of India Department and the India Meteorological Department. The Geological Survey has published a large number of monographs giving detailed study and survey of earthquakes in India and neighbouring areas. On the other hand, the cognate studies of the Survey of India on gravity anomalies have suggested some useful ideas on earthquake problems. Seismology is also included among the scientific functions of the India Meteorological Department which has carried out a good deal of work in this direction during the past forty years. An endeavour is made here to give a brief review of the work so far done in the India Meteorological Department.

The first seismograph in India was installed by Dr. Moos at Bombay in 1898. Later, more instruments of the eye-reading type were installed by the India Meteorological Department at Simla, Calcutta, Kodaikanal and Agra and by the Survey of India at Dehra Dun. In 1905 Omori-Ewing instruments were also set up at Simla, Colaba (Bombay) and Calcutta. Sensitive photographic recording Instruments of the Milne-Shaw type were installed in India during 1922-25. The department at present maintains four seismological observatories at Colaba (Bombay), Calcutta, Delhi and Kodaikanal, besides an experimental station at Poona. These observatories are equipped with Milne-Shaw seismographs supplemented by Omori-Ewing instruments. Since 1948 sensitive high-magnification Wood-Anderson seismographs have also been set up at Bombay and Delhi and a few more instruments of this type are expected to be installed soon. There are seismological observatories at Dehra Dun and Hyderabad also, which are maintained by the Survey of

India and the Nizamiah Observatory respectively. It may be pointed out that India lags much behind some advanced countries in the establishment of a network of seismological observatories and that the installations in use at its existing observatories are also inadequate. In the U.S.A. there are many whole-time seismologists and over 40 seismological observatories which are generally equipped with the following four types of instruments: (i) accelerographs or strong-motion seismographs for recording ground movements of destructive magnitude; (ii) high-sensitivity seismographs for recording weak local shocks; (iii) "intermediate type" instruments for location of earthquakes up to 1,000 miles distant and (iv) "long range" seismographs for registering distant earthquakes. In Japan (which lies in the seismic zone) over a hundred seismological stations are maintained with a large number of whole-time seismologists working in them. In India, however, not even a dozen seismological observatories are functioning yet and there are only two whole-time seismological officers.

The seismological data collected at the Colaba observatory were being published in the annual Bombay Observatory volumes along with magnetic and meteorological data. All seismological data, however, began to be published in the department's annual publication *India Weather Review* from 1908. In 1938 the department started a *Quarterly Seismological Bulletin* for the publication, in a convenient form, of all the available seismic data obtained from departmental observatories as well as from Hyderabad, Dehra Dun and Colombo. Information regarding shocks felt and reported by voluntary observers in India is also included in these quarterly bulletins.

The first departmental paper<sup>1</sup> on the "Simla Seismograms obtained between June 1905 and November 1908" was published



in 1909. The chief centre of seismological studies in the India Meteorological Department has been the Colaba Observatory, Bombay. At this Observatory comprehensive studies<sup>2,3</sup> of microseisms associated with disturbed weather in the Indian seas have been made with the help of Milne-Shaw instruments. These studies have led the way in recent years to the development of a method of locating the position of storms at sea. Investigations have also been carried out on artificial vibrations of ground<sup>4</sup>. Microseisms and their application to the forecasting of certain weather situations in India have also been studied<sup>5,6</sup> in more recent years. A few sets of Strengnether microseismic equipment have very recently been obtained from America to get bearings of storms and cyclones in the Indian seas from an analysis of the microseisms and are being set up for use. The theory<sup>7</sup> of seismometers has been discussed in two recent papers. The distribution of earthquakes in India and neighbourhood has also been studied<sup>8</sup>.

Important earthquakes which have occurred in India and her neighbourhood have formed the subject of detailed study in the India Meteorological Department. The seismograms of the great Bihar earthquake of 15th January 1934 have been studied and the detailed results published<sup>9</sup> in a memoir of the Geological Survey. Another severe earthquake occurring in India in recent years was the Baluchistan (Quetta) earthquake of 31st May 1935. Seismological studies of this earthquake have also been made<sup>10,11</sup>. The seismological features of the Satpura Range earthquake<sup>12</sup> of 14th March 1948 and of the Hindukush earthquake<sup>13</sup> of 21st November 1939 have also been studied. The special features of the Mekran earthquake of the 28th November 1945, which occurred in the neighbourhood of India, have also been examined and discussed<sup>14</sup>. Attention has also been paid to the study of some noteworthy earthquakes which occurred outside India, e.g. the very large Pacific earthquake of 10th November 1938, the catastrophic Chilean earthquake of 25th January 1939, the Anatolian earthquake of 27th December 1939, the Rumanian earthquake of 10th November 1940 and the Mexican earthquake of 15th April 1941.

During the past few years the department has given considerable attention to the

improvement of existing seismological instruments as well as to the design and construction of new seismic instruments suitable for use at Indian observatories. During the great Bihar earthquake of the 15th January 1934, the couplings between the mirror and the boom in the Milne-Shaw instrument were dislodged; to prevent such a happening in future, a suitable mechanical device was developed at Agra. At Poona, the electric motor for the recording unit of the Milne-Shaw seismograph was remodelled into a quick run drive in order to obtain a more open time-scale. At Colaba valuable experimental work has been done on the design of hydraulic seismographs<sup>15</sup>. An experimental seismological station has been set up at Poona recently for the purpose of developing new instrumental methods and techniques. A horizontal strong motion seismograph of the Jaggat pattern embodying some improvements was constructed and tried. Very recently a satisfactory apparatus of the Wood-Anderson type has been evolved and several instruments on this model have been constructed at the departmental workshop at Poona<sup>16</sup>. The Poona workshop has also recently made eclipse clocks for use at different seismograph stations to give contacts of definite duration every minute and hour. In order to study short period vibrations in earthquake zones in India, a quick run recorder has been designed and constructed recently. For driving these recorders in places where electricity may not be available, a weight-driven governor-controlled clock has also been constructed<sup>17</sup>. The ultimate aim is to obviate the necessity of importing costly seismic instruments as far as possible.

The expansion of the seismological organization in India was held up during the recent war, but since the termination of the war the matter has again been engaging the attention of the department. The Special Seismological Branch which was formed in 1939 with the appointment of a Special Officer for Seismological Research was strengthened by the posting of an Assistant Seismologist from 1st March 1947. During the last 3 years a considerable amount of planning work for the expansion of the seismological organization in India has been done. Plans are in hand for setting up a first-class seismological observatory at Shillong (which falls in the region of intense seismic activity,

and where the headquarters of the Seismological Organization is to be set up) and also for the installation of seismographs at a few other new stations in the country. In connection with the multi-purpose and water-power projects of the Central Water-power, Irrigation and Navigation Commission, plans have been prepared for setting up a high-class seismological station with a number of accelerograph stations around the proposed site of the Kosi river dam. The object is to investigate the movements to which the foundations will be subjected in the event of earthquakes of given intensity in that area. It is also planned to establish a seismological observatory in the Damodar catchment in view of the importance of the study of seismicity of that catchment in connection with the Damodar Valley Project.

In view of the many large multi-purpose schemes of construction which have been undertaken in the earthquake zone of India and risk of damage to them by earthquakes, the need for the early implementation of the plans referred to above as well as of those recommended<sup>18</sup> in 1948 by the Planning Committee for Geophysics appointed by the Government of India is manifest. It may, however, be emphasized that not only the *scientific* but also the *economic* aspects have to be kept in the forefront in the future

programme of development of the seismological organization in India.

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## Abbreviations for Titles of Periodicals

THE DRAFT STANDARD WHICH HAS BEEN prepared to assist scientific workers to conform to rational conventions in the method of reference to scientific literature, covers the abbreviations for titles of the principal periodicals published in European languages, and is based on the Draft Recommendations of the International Standards Organization

on the subject. In order to meet Indian requirements, the rules have been modified and the list of abbreviations including common generic and geographical terms has been extended. Comments on the draft are invited by the Director, Indian Standards Institution, 19 University Road, Delhi 2.

# Rock Salt Deposits of Mandi\*

B. S. L A M B A

*Indian Bureau of Mines, New Delhi*

**W**ITH the partition of the country, Mandi salt deposits constitute the only source of rock salt in India.

This factor combined with the fact that there is a deficit of about half a million tons of salt in the country makes a strong case for the immediate development of the salt industry in Mandi.

Mandi is one of the important Punjab Hill States comprising an area of about 1,200 sq. miles. The nearest railway station is Nagrota which is connected to Mandi by a 75-mile road. Mandi town (elevation 2,200') is situated on the left bank of Beas river which runs northwards for a couple of miles along the zone of the main boundary fault. No outcrops of salt are visible, but the salt-bearing formation outcrops extensively along the western flank of the mountain Gokhar-ki-Dhar along the main boundary fault from Joginder Nagar to Mandi. Detailed exploratory work of this area has not been undertaken.

*Geology* — The great Himalayan boundary fault runs north-west to south-east along the foot of the mountain Gokhar-ki-Dhar. The rocks comprise the Autochthonous Fold Belt — “tightly compressed, vertically disposed strata or of recumbent folds intervening between the crystalline schists of the nappe zone and the foreland of Murrees”. The contact between the Palaeozoic on the east and the Tertiary beds on the west of the fault is well exposed. The Tertiary beds on the west comprise of Kasaulies at the top and Siwaliks below, including upper Siwalik boulder bed. On the east of the fault lies the salt-bearing formation termed “Lochan” with the Krol dolomite below. The succession of beds is as follows: (1) Slate; (2) Trap; (3) Lochan; (4) Dolomite Fault and (5) Siwaliks.

*Slates* — These are widely distributed, and cover most of the area including the mountain Gokhar-ki-Dhar, and are the continuation of

Simla Slates and Chail series. They are more highly metamorphosed than the Krol series reaching the “epi” metamorphic stage and are composed of silky slates and phyllites. The colour is dark grey to green with frequent red stains due to ferruginous matter. The general strike is north to south.

*Trap* — This is equivalent of Punjal Trap of Kashmir. It is bluish green in colour in contrast to the pink of Lochan. It is very much broken up and forms the bulk of the scree on the hillsides. The rocks (sp. gr., 2.77 to 2.93) appear mottled owing to the alteration of the mineral to delessite. A portion, soluble in hydrochloric acid, contains oxides of iron and pyrites. Under the microscope is seen a network of feldspar and augite crystals set in viridite which in part appears to represent original glossy base. Portions of augite crystals have been altered into brownish-green granular matter. Scattered through the mass is white mineral matter, probably leucoxene, a product of alteration of ilmenite.

*Lochan* — This is the salt-bearing formation with a characteristic pink colour representing the leached out portion of salt rock. The term Lochan is probably derived from Lokhan Lun and Khan meaning salt mine. White powdery spots resembling volcanic ash and angular fragments of dolomite are frequently met with. The formation is loose being arenaceous clay and crumbles down when wet. This is the chief obstacle for the mining of salt. At some places it is about 250' thick. The salt occurs at the bottom of the formation and has been proved to be over 100' thick, the average being 70'.

*Dolomite* — The formation is bluish grey to white in colour, hard and compact, sometimes massive and mostly bedded. Usually it underlies the Lochan and shows faulted contact with the Siwaliks. This is the Krol limestone of Himalayan series, probably Permian in age. Pinkish quartzite bands

\* Published by the kind permission of the Director, Indian Bureau of Mines.

are also frequently met with. The Krol series is homotaxial with Shali series. The upper portion is composed of cherty massive quartzite and the lower of massive dolomite with layers of chert banded at the base.

*Siwaliks* — The outcrops of sandstone are well exposed all along the boundary fault, usually in contact with Krol dolomite. The top portion is the brownish Kasauli sandstone with middle Siwaliks below. The lower Siwaliks are not seen.

*Age & Origin* — The salt occurs sandwiched between the trap rock and Krol dolomite and at some places it is in direct contact with the Tertiaries. The salt is always found to the east of the fault line as part of the Palaeozoic rocks. The salt and Lochan formation exhibits some special characteristics. No bedding planes are visible in Lochan which is one massive structure like the soft marl of the Punjab Salt Range. The salt does not show any strike or dip, though occasional striations parallel to the prevailing dip of the associated rocks are seen. This points to compression and subsequent metamorphism. Earthy matter and angular fragments of calcareous matter are found in the salt which, however, is not associated with gypsum and other salts characteristic of drying oceanic waters. White spots resembling volcanic ash are visible in Lochan formation and salt is associated with the Trap. All these factors render probable the conjecture that the salt deposition is due to igneous activity. The upper carboniferous age is characterized by intense volcanic activity as a result of which we have the Punjab Trap in Kashmir and the Trap rock in Mandi. Salt was probably contemporaneous with the Trap and a result of volcanic activity. A possible argument against this hypothesis is that due to its fluidity during subsequent folding and overthrusts, it should have been completely squeezed out. This very argument may explain the absence of salt elsewhere and the occurrence of suppressed and pinched out lenticular salt masses here. The anticlinal structure of the major salt sources lends support to this view. The salt occurs below the crest of anticlines at Guma and Darang, the former being asymmetrical.

*Reserves of Salt* — There are vast reserves of rock salt in Mandi which has been worked for the last four centuries. All the salt that

could be easily worked by open working has been extracted. The quarries in the Darang Khad get flooded during rains. At Guma it has been worked to the bed of Luni naal. There is little further room for quarries at both these sources though Maigal is still amenable to quarrying. The reserves are still large and a conservative estimate is about 70 million tons. If an igneous extrusive origin of the deposits be accepted, the reserves may be several times this estimate.

*Quality of Salt* — The quality of salt mined in Mandi is poor. The average sodium chloride content is 75 per cent in Guma salt and 65 per cent in Darang salt. Analytical results of a few samples of salt and brine are given in Table I.

TABLE I

	GUMA		DARANG	MAIGAL (Brine salt)
	1st sample	2nd sample		
Sodium chloride	75.62	77.09	62.61	99.01
Sodium nitrate	0.42	...	...	...
Calcium chloride	0.21	...	...	...
Calcium sulphate	1.86	0.75	0.49	0.96
Magnesium chloride	5.00	...	Traces	...
Calcium carbonate	5.25	22.14	36.72	...
Ferric oxide	0.10			
Insoluble in HCl	10.55			
Insoluble in HF	2.30			
Moisture	0.28	...	...	...

*Salt Sources* — Salt has been worked in the past mainly at Guma, Darang and Maigal. The average annual production from these sources has been one lakh maunds.

*Guma* — The mine is situated about 7 miles south of Joginder Nagar and 28 miles north of Mandi, left of Luni naal. The bed of the gorge and the hill on the left side of the gorge called Hirma Devi are said to be honey-combed with old workings. All the salt that could be made available from the bed of the gorge by open working has been extracted. Considerable danger attends the mining of salt in this area as the scree is liable to collapse. When the author inspected Guma, the mine comprised one tunnel, 5' in height, which ran through 145' of debris, with sides and roof supported by wooden props, some of which were giving way. At this distance salt was reached and it was being worked in three chambers, two of which had met old workings through which water was flowing into the mine. Chamber No. 1 was extended to the west and as a barren hard band appeared in front of the working, a pit about 40' deep was made

wherefrom salt was being excavated. The following year the old mine gave way and the salt chambers collapsed after the rains. The salt was worked to a limited extent after clearing the debris. A drift was started at a distance of about 200' west of the old entrance to catch the salt in the old mine. But as it was not taken in the correct alignment, it met with water from the fault-zone and had to be abandoned. If arrangements for draining the water are made, there is no need to abandon further work in the drift. Work is being continued by driving a drift at a lower level than that of the present bed of the gorge. Adequate provision will have to be made to safeguard the mine from flooding during rains. The salt, though massive, shows occasional striations striking south-east to north-west and at places showing a dip of  $70^\circ$  in a direction  $E.20^\circ N.$  No reliance can, however, be placed on strike and dip. The salt occurs under an anticline which is faulted, the fault running along the bed of the gorge from east to west. The northern side on the right side of the gorge is the down-throw side and salt has gone much deeper below the surface level.

Probably a huge deposit of salt exists under the Hirma Devi Hill and is continuous for a couple of miles to the south-east. There is a probability of its continuity for about 15 miles up to Maigal. The best position for a new mine is on the roadside near the junction with the Krol dolomite. The salt should be proved by putting a number of bore holes in the hill.

The best mode of working salt at Guma seems to be by driving bore holes to the bottom of the salt bed and recovering saturated brine for the manufacture of salt. In view of the fact that the salt is impure and huge deposits exist, the method of extraction by solution is well suited to the conditions obtaining in Guma. The drilling machinery required will be light, as bore holes not exceeding 500' will have to be driven. Ample fresh water supply for this purpose is available locally.

*Darang* — The salt mine is about 11 miles north of Mandi on the left side of Joginder Nagar-Mandi road. The high cliffs of pink Lochan beds outcrop over a fairly long distance and are visible from the main road. All the salt from the bed of the gorge has been removed by open working and quarrying is no more possible. A mine existed at

the northern end of the hill but as the management started pumping in fresh water to get saturated brine for manufacture of salt by solar evaporation, the whole mine collapsed in 1943.

The Bhatog tunnel was started in 1943, deep in the bed of a nullah on the recommendation of the State Mining Engineer and the approval of Mr. E. B. Lewis, Chief Mining Engineer, Khewra. 200' were dug out in 3 years. On inspection in 1946, the author found that the surface cover was only a couple of feet thick and there was danger of the hillside debris coming down. The eastern end of the tunnel that had opened up due to the absence of surface cover was destroyed by a landslide in 1947. A new tunnel was started at Burari at the author's recommendation 40' below the level of the main road to catch the main salt below the cliff and any deposit that may have been left below the west limb of the anticline. The progress has been slow and in a year's time only 30' were reached. A good tunnel was also driven at Nagrota but the yield was very small and it was abandoned due to water trouble underground.

Darang salt is inferior to that of Guma, and the locality is unsuitable for placing bore holes. Judicious mining is the only way to obtain salt in this area and a suitable site can be found below the west side of the main road. Although a fair amount of barren ground will have to be traversed, it will pay in the long run. A contour map of the area has been prepared (FIG. 1).

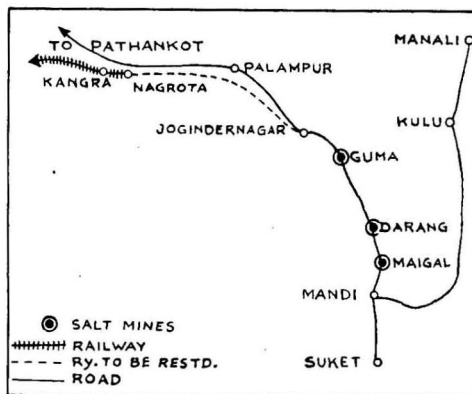


FIG. 1 — A MAP OF MANDI SHOWING THE DISPOSITION OF THE SALT MINES.

*Maigal*—This locality is about 5 miles north of Mandi. In the northern branch of the nullah, the salt formation runs below the bed of the gorge and there is scope for further quarrying. Care has to be taken to preserve this site for systematic mining.

Brine springs exist in the other branch of the nullah. They are situated about 2 furlongs left of Joginder Nagar-Mandi road. The specific gravity of brine is 11°Bé. Measurements of rate of flow of brine and its density taken for a period of six months show that the brine does not get diluted during the rainy season even with a considerable increase in flow, the average being 3,000 gal. per hr. which should be capable of yielding about 1,000 md. of salt per day. This valuable brine, which has been found to contain 99 per cent sodium chloride, could very profitably be used for the manufacture of salt by solar and/or thermal evaporation.

*Refinery*—A small salt refinery was erected at Mandi on the bank of the Beas river

and completed in 1946. The output was only about 150 md. per day. The refinery was closed down as soon as the salt duty was abolished by the Government of India in 1947. The cost of manufacture was Rs. 4 to 5 per md. and Khewra salt, after removal of duty, was selling at the rate of about Rs. 2/8 per md.

Maigal is best situated for erecting a refinery. The brine from the springs can be brought down by gravity to the site of the refinery. Electricity being cheap in Mandi, the installation of a thermo-compression unit at this spot is recommended. With a unit costing Rs. 15 lacs and capable of producing 60 tons of white granular salt per day, the cost of manufacture will be Rs. 15 to 20 per ton. A bigger plant of double the capacity could be erected at Joginder Nagar with the brine supply from Guma. The combined output of salt from these sources will meet the requirements of the Punjab and the western districts of the United Provinces.

## Antioxidants in Science & Industry

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**D**URING recent years, the subject of antioxidants has attracted a considerable amount of attention. Apart from their value in scientific research, in which they represent a new and a vast field, antioxidants play a very vital part in a number of important industries. Thus, the success of several of the industries relating to the use of rubber, petroleum and other hydrocarbon oils, fixed oils and fats, essential oils, soaps and cosmetics, paints and varnishes, textile oils, food products, vitamins, pharmaceutical preparations, etc., depends on the use of antioxidants. In addition to the rapidly growing scientific literature, there is also a vast amount of patent literature on the subject. Several of the applications have only been generally indicated, while many others, which are known to be practised, have not been published or recorded in sufficient detail. A review of the progress in such a

field presents many difficulties, but an attempt has nevertheless been made in the following pages to indicate generally the scope of the subject and its various practical possibilities.

Oxidation—spontaneous and induced—plays a very big part in a variety of chemical processes. In some cases where oxidation is necessary to complete the process but is not easily achieved, the presence of small amounts of substances, known as pro-oxidants or positive catalysts, accelerates the action of oxygen. In other cases, where oxidation proceeds spontaneously in the presence of atmospheric oxygen, addition of minute amounts of certain materials known as antioxidants or negative catalysts can retard the action of oxygen.

Preservation of materials from oxidative deterioration is a very important problem in a chemical industry. This is particularly

so in the case of rubber, different kinds of fats and oils and food industries. Many products are spoiled during storage through want of fortification with suitable preservatives, with the result that the industry loses its reputation and tends to die out. The present contribution has been prepared with a view to drawing attention to the importance of the application of antioxidants to materials which are prone to oxidative deterioration.

Until about twenty-five years ago, the properties and usefulness of antioxidants were practically unknown to the scientific world. Only, since 1922, when Moureu and Dufraisse<sup>1</sup> discovered that traces of certain phenolic compounds like hydroquinone, pyrogallol, etc., when added to auto-oxidizable substances, can prevent their rapid deterioration—a work which subsequently pointed to the commercial possibilities of antioxidants in protecting materials like rubber from destructive oxidation—a vast number of materials have been described in literature as possessing the property of inhibiting oxidative changes. According to the application of antioxidants to various industries, they may be broadly discussed under the following heads.

#### Rubber & Rubber-like Materials

The influence of antioxidants on the preservation of natural and synthetic rubber deserves to be first mentioned, because, the progress of the application of antioxidants to various industries originated from their use in preventing the deterioration of rubber.

One of the major problems of the rubber industry is the control of "ageing and fatigue" of rubber goods. The ageing of rubber becomes manifest in different ways according to the conditions of service and is principally due to oxidation and polymerization. The polymers, being rigid and brittle, do not possess the elasticity of rubber and are useless for all practical purposes. Metals like copper are well known to exert a marked positive effect on the oxidation of rubber.

Considerable progress in the manufacture of rubber goods was made only after it was realized that antioxidants must be used. The use of these compounds in rubber industry has been extended from crude rubber to the finished rubber goods. Antioxidants for rubber are more commonly known as "anti-agers" and those which have the

specific action of preventing catalytic oxidation due to copper in rubber are sometimes marketed as "copper inhibitors".

The practical aspects of the use of antioxidants must be considered in selecting a suitable antioxidant for rubber. Apart from having effective age-resisting property, an antioxidant for rubber must satisfy several other conditions as well, viz. (1) it must not affect vulcanization of rubber and must not react with the vulcanizing agent used; (2) it must not effloresce the rubber; (3) it must be non-staining and must not produce any undesirable colour in the finished product; and (4) it must not reduce the elasticity which is the fundamental property of rubber and should impart anti-flex-cracking property to it. The solubility of the antioxidant in rubber is important in connection with the tendency to "blooming", the latter being also affected by the state of division of the antioxidant.

Instead of following the customary method of incorporating antioxidants in the material of rubber, in some cases the surface application<sup>2</sup> of antioxygen as a solution to the surface of the vulcanized rubber may be an effective method.

The rapid increase in the number of new antioxidants available year by year makes it difficult to classify them satisfactorily. The development of modern antioxidants is tending towards the use of more and more complex compounds. Many of them have been developed empirically and it is not always clear how they function. In this field, practical application may be stated to have gone ahead of theory.

Recent patents reveal a very marked trend towards complex amines and their numerous complicated derivatives. A few illustrations of the direction of these investigations are (a) secondary aromatic amines and their derivatives<sup>3</sup>, particularly, derivatives of diarylamines, e.g. mono-N-methyl diarylamine<sup>4</sup>, carbamylamino-diarylamine<sup>5</sup>, alkyl-diaryl-amines containing at least 14 C-atoms<sup>6</sup>, polyhydroxy or polyalcoxy-diaryl-amines<sup>7</sup>, diamino-diaryl amines and their hydroxy or alkoxy derivatives<sup>8</sup>, etc., and (b) tertiary amines<sup>9</sup>. Condensation products<sup>10</sup> from amines with ketones have been claimed to possess superior antioxygenic power.

Hundreds of patents have been taken on the use of complex phenolic compounds as

anti-agers. A few of the examples include alkenylamino phenols<sup>11</sup>, alkylideneamino phenols<sup>12</sup>, octylphenols<sup>13</sup>, and ethers thereof. The condensation products of phenols with ketones<sup>14</sup>, or with simple aliphatic aldehydes<sup>15</sup> have also gained much prominence.

Some of the other miscellaneous products which can exert antioxygenic action are amino ethers<sup>16</sup>, alkylhydroxyaryl sulphides<sup>17</sup>, amino derivative of diphenylene oxide<sup>18</sup>, etc.

A marked progress in the field of modern antioxidants is revealed in a number of patents<sup>19</sup> which claim improved resistance to ageing of rubber by including in a mixture, in addition to an antioxidant capable of inhibiting atmospheric oxidation, an organic oxygen absorber to eliminate the oxygen present originally in the compound and an organic base non-volatile at the vulcanization temperature and miscible with rubber to activate the oxygen absorber.

Some of the antioxidants which can prevent the ageing of rubber can also protect other rubber-like materials like natural and synthetic resins from deterioration. As examples may be cited the use of terpene haloalkyl ether-amine condensation products<sup>20</sup> or esters like propyl and secondary amyl p-hydroxyphenyl-amino-acetates<sup>21</sup>, etc., to prevent the deterioration of rubber and resins.

### Hydrocarbon Oils

The mineral oils (commonly known as petroleum oils) and their derivatives, viz. fuel oils, gasoline, etc., are prone to be affected through the gradual oxidation and polymerization of the unsaturated hydrocarbons present in them. Cracked gasoline, in particular, tends to form gummy and resinous matter, both in storage and in service, which is very objectionable. A marked improvement in the gasoline industry was achieved only when the application of antioxidants was started to enhance its resistance to oxidation at elevated temperature and pressure. In this connection, it is interesting to note that, under favourable conditions, some antioxidants may also act as knock suppressors<sup>22</sup> and may impart improved anti-knock properties to fuel oils and gasoline.

All lubricating oils, particularly the automobile and aircraft lubricants, tend to oxidize while in service with the formation of compounds which are generally of a gummy, resinous, asphaltic and acid character. The

oxidation products are subsequently deposited in oiling systems as "sludge". The formation of sludge is accelerated by the constant agitation of thin oil films under elevated temperature and pressure and high-speed conditions with air, moisture and solid impurities, especially rust, worn bits of metals and filings, which act as powerful catalysers promoting rapid and substantial oil deterioration.

Chemical stability of lubricating oils is a subject of prime importance. Improvement in the quality and stability of lubricants has been well achieved by the incorporation of suitable antioxidants in them.

A very large number of substances have been recommended as inhibitors for gasoline and lubricating oils. The chemical constitution of the antioxidants for these oils are so diverse that a rational and scientific classification is not possible.

Some of the antioxidants for rubber are suitable for hydrocarbon oils also, e.g. alkenylamino phenols<sup>11</sup>, alkylideneamino phenols<sup>12</sup>, octyl-phenols<sup>13</sup>, and ethers thereof, amino-ethers<sup>16</sup>, phenol-ketone condensation products<sup>14</sup>, etc., exert inhibiting action for hydrocarbon oils also.

A few of the other typical antioxidants which have been the subject of modern patents are tertiary alkyl-substituted O-dihydroxybenzenes<sup>23</sup>, hydroxyaryl<sup>24</sup> or dialkyl-diphenol<sup>25</sup> sulphides, selenides or tellurides; dialkyl-cyclohexyl<sup>26</sup> or nitroso-alkyl<sup>27</sup> phenols; diamylmercapto-dimethyl ether<sup>28</sup>; N-containing diphenylmethane derivatives<sup>29</sup>; alkali or alkaline earth metal phenoxides formed from high mol. wt. phenols<sup>30</sup>; N-nitro-aryl-tetra-hydroquinoline compounds<sup>31</sup>; polyesters of 12-hydroxystearic or other high mol. wt. acids<sup>32</sup>; heavy metal salts of the dicapryl ester of di-thio-phosphoric acid<sup>33</sup>; phenol sulphide metal salts<sup>34</sup>; etc.

For the prevention of rust formation in bearing materials, the incorporation of single substances or mixtures of compounds of the formula



(where R stands for hydrogen or an alkyl or aryl radical) with the lubricating oil have been recommended<sup>34x</sup>.

For the stability of mineral waxes towards oxidation, the addition of one or more of the



following substances at low percentages has been found to be efficacious<sup>34y</sup> :

Catechol, thymol, eugenol, guaiacol, hydroquinone, phloroglucinol resorcinol, quinone, pyrocatechol, para-aminophenol, unsymmetrical diphenylhydrazine, mono-benzyl para-aminophenol, dibenzyl-para-aminophenol, alpha-naphthylamine, beta-naphthylamine, phenol, cresylic acid, thymol condensation product with oxymethylene camphor, clove oil and pyrogallol.

Patents<sup>35</sup> on the use of mixtures of two or more antioxidants are also becoming increasingly common. The importance of the phenomenon of synergism between two or more unrelated substances is now becoming increasingly realized and a large amount of scientific literature is developing on the subject.

Antioxidants like aromatic nitrogenous hydroxy compounds<sup>36</sup>, reaction products of amines and carbonyl compounds<sup>37</sup>, etc., which prevent deterioration of gasoline and other oils when they are in contact with metals like copper, iron or their compounds, which tend to catalyse oxidation, are generally called "deactivators" of the oxidation catalysts.

One of the important properties that an antioxidant for hydrocarbon oils must possess is that it should be oil soluble and water insoluble. Some simple phenolic compounds like pyrogallol<sup>38</sup>, though they are effective inhibitors for cracked gasoline, fail to satisfy other conditions.

#### Fixed Oils & Fats

The glyceride fats and oils which include (a) all vegetable oils and hydrogenated vegetable fats; (b) all animal fats like tallow, lard, butter fat, etc.; and (c) marine animal oils, viz. fish and liver oils are in general more susceptible to atmospheric oxidation than mineral oils. The unsaturated glycerides present in them easily absorb oxygen and the rancidity develops with the characteristic "off odour" and bad taste.

The rate and extent of rancidity development are, however, greatly influenced by several factors, viz. presence or absence of oxygen, prevailing temperature, exposure to light, the incorporation of certain pro-oxidants like metals and metallic oxides and the presence of free fatty acids. Actual continuous exposure to the air is not always necessary. Oils produced under usual condi-

tions may contain enough oxygen dissolved in them to bring about oxidation.

The fish-oil industry, in particular, is confronted with the problem of rancidity, because fish and liver oils are, in general, highly unsaturated and are, therefore, extremely susceptible to oxidative deterioration.

The chemical antioxidants for fats and oils and fatty foodstuffs can be broadly classified as (1) *acid-type inhibitors*, viz. several organic and inorganic acids<sup>39</sup> like citric, ortho-phosphoric, etc.; (2) *phenolic inhibitors*, viz. hydroquinone<sup>40</sup>;  $\beta$ -naphtho-quinone<sup>41</sup>; di-resorcinyl-quinol<sup>42</sup>; pyrogallol<sup>43</sup> and its derivatives like haematoxylin<sup>44</sup>, gossypetin<sup>45</sup>, etc.; gallic acid and alkyl gallates<sup>46</sup>, complex derivatives<sup>47</sup> of quinol like hydroxy-chromans including tocopherols, hydroxy-chromans, hydroxy-coumarans, hydroxy-coumarones, etc.; pyrocatechol<sup>40a</sup>; guaiacol<sup>48</sup>; resorcinol<sup>43</sup> and a host of others; (3) *dienols*, viz. l-, d- or iso-ascorbic acid<sup>46</sup>; ascorbyl monoesters<sup>49</sup> of fatty acids; and (4) *nitrogenous inhibitors* including aromatic amines<sup>43,50</sup> like phenyl-naphthyl amines; sugar amines<sup>51</sup> and their salts like methyl glucamine and its stearate; and the amino acids<sup>52</sup> like tyrosine, glycine, etc., and their esters.

The keeping quality of fats and oils is greatly influenced by the nature and proportion of the natural antioxidants present in them. Hence, apart from the chemical antioxidants, inhibitors can be isolated and concentrated from natural sources and added to the oils to increase their stability. Among the natural antioxidants, cereal flours<sup>53</sup>, especially oat flour and their extracts, unsaponifiable fractions<sup>39,54</sup> of vegetable oils, crushed oil-seed cakes<sup>55</sup> and their extracts, crude preparations of carotenoid pigments<sup>56</sup>, crude lecithin<sup>39</sup> and cephaline<sup>39</sup>, gum-guaiac<sup>57</sup>, *kamala* dye<sup>58</sup>, etc., have gained prominence. Antioxygenic action of certain non-pathogenic bacteria<sup>59</sup> also has been reported.

In spite of the great variety of antioxidants reported in literature, it is rather difficult to select a suitable antioxidant for edible products. This is so, because, in addition to having superior antioxygenic power, an antioxidant for foodstuffs must satisfy other conditions also. *Pharmacological safety*, non-toxicity, sufficient solubility or dispersibility in the medium to which it is added and inertness from the point of view of affecting the normal taste, colour and odour

of the treated products are the additional characteristics of an ideal antioxidant for food products.

Several workers have shown that a mixture of two antioxidants of different classes is more efficient than either of them individually (*synergetic action*). The synergetic effect is generally achieved by the use of<sup>59</sup> (1) a combination of an antioxidant of phenolic character with an acid-type inhibitor; (2)<sup>60</sup> mixtures including a phosphorus compound like phosphoric acid, a phosphatide or a phospho-protein and a poly-hydroxy benzene or a related compound; (3)<sup>61</sup> mixtures of a sugar with a phenolic antioxidant; (4)<sup>62</sup> a combination of a sugar with a phosphorus compound or (5)<sup>63</sup> ascorbic acid in association with hydroquinones, tocopherols, hydroxychromans, hydroxycoumarans or related compounds. Hence, in order to afford maximum protection, it is always desirable to use a mixture of suitable antioxidants.

#### Fat-soluble Vitamins, Carotene, Vitamin Concentrates & Other Vitamin Preparations

The fat-soluble vitamins, particularly vitamins A and E, are very unstable and easily susceptible to oxidation. Vitamin D is comparatively more stable than vitamin A.

A good deal of work has been done on the stabilization of vitamin A in ghee<sup>45,58</sup> and in liver oils<sup>46a,64,53c</sup>. It has been reported<sup>53c,65</sup> that the development of oxidative rancidity and the destruction of vitamin A in fats and oils proceed simultaneously and antioxidants which prevent rancidity in oils can usually protect the vitamin present in them.

In a tropical country like India, the liver oils and the vitamin concentrates lose their vitamin A potency on storage at a comparatively rapid rate. During recent years, considerable attention has been drawn to the stabilization of vitamin A in shark liver oil. The vitamin in the oils, as now marketed, however, tends to deteriorate on keeping. It must be preserved with the help of suitable antioxidants if the industry is to continue to flourish in the face of intense foreign competition. The use<sup>65a,66</sup> of an alkyl gallate, especially ethyl or iso-butyl gallate, in conjunction with citric or tartaric acid has been reported to have beneficial effect on the stabilization of vitamin A in shark liver oils of low acidity. The use of haema-

toxylin<sup>44</sup> as an antioxidant for carotene, vitamin A, etc., has been patented.

It should be noted, however, that antioxidants which can prevent the oxidative deterioration of vitamin A in ghee or in liver oils fail to exert their antioxidant power against the destructive action of sunlight<sup>67,66a</sup>. Hence, in order to preserve vitamin A, great care should be taken to avoid unnecessary exposure to sunlight.

#### Vitamin C

Vitamin C also is very unstable and spontaneously oxidizes when exposed to atmospheric conditions. The prevention of the rapid destruction of ascorbic acid in fruits on storage is an important problem which has to be systematically investigated. What little work has been done on finding out a non-toxic antioxidant for vitamin C records that *d*-iso-ascorbic acid<sup>68</sup> appears to be a potent antioxidant for retarding the oxidative changes of *l*-ascorbic acid (vitamin C). Thio-urea<sup>69</sup> exercises a powerful stabilizing action against catalytic destruction by copper and hence has been suggested as a commercial antioxidant for vitamin C. The protective action of pyrophosphate<sup>70</sup> against atmospheric oxidation of vitamin C even in presence of copper has been reported. A few other antioxidants which also are effective to some extent are creatinine<sup>69</sup>, glutamic acid<sup>69</sup>, etc. A good deal of further research remains to be carried out in this field.

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(To be continued)

# REVIEWS

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**Scientific Terminologies in Anglo-Indian Languages**, An English-Gujarati Glossary of Scientific Terms in Nagri Script, compiled by P. G. Shah, I.A.A.S. (Retd.) (Gujarat Research Society, Bombay), 1949, pp. lvi + 200, 9½" × 6½". Price Rs. 6.

A PROBLEM OF OUTSTANDING IMPORTANCE today for the progress of science and general culture in India is the place of 6 or 7 principal Indian languages in these pursuits, in future, *vis-à-vis* English that has been adopted by India for the last eight or nine decades. The question is whether the tempo of progress, attained during this period, of at least 20-30 millions of our people in science and culture will be maintained, or re-enforced, or retarded by a change-over from English, which has so far served as the medium of communication between the provinces of India and with the world at large, to the chief languages of the provinces. English has been *par-excellence* the language of science, commerce, law and of matters pertaining to politics and economics above parochial or provincial level, and as such has satisfactorily performed these various functions in the national life of India. It has thus been instrumental in raising the status of India. The chief drawback of English, however, is that it is likely to remain, always, the language of the intelligentsia, barely 10 per cent of the population of the country. For this and several other considerations, a section of the people are demanding — and demanding somewhat impatiently — the replacement of English by the more developed of the provincial languages (Hindi, Bengali, Tamil, Gujarati, Marathi, Kanarese and one or two others) in all departments of public life on the ground that a rich language like Sanskrit is fully capable of supplying vocabularies as rich, comprehensive, precise and flexible. That Sanskrit, and many provincial languages which are daughters of Sanskrit, are capable of this, no one doubts; the doubt most frequently expressed is whether a completely new mintage of glossaries and vocabularies in scientific and educational

subjects will serve the needs of the country better in the present stage of its development. Is it possible that this experiment in individualism after India's plunge in internationalism of the last few decades since World War I will accelerate the progress of the present and future generations in science, education, invention, international commerce, industry?

The general consensus of opinion, from experience gathered so far, seems to be that while workable and systematic vocabularies should be made for most branches of science and trade in order to enable our primary and secondary schools to begin imparting knowledge through the vernacular medium, no universally accepted system or plan for the framing of the new terminologies in the diverse languages of the country yet exists. It is a fact that several elaborate, well-directed and praiseworthy attempts for producing comprehensive English-Indian dictionaries and glossaries in science, law, education, etc., in at least 5 languages, sponsored by learned societies, universities or by individual scholars, have failed to satisfy educated professional opinion or to create a popular demand for further attempts along similar lines.

Serious attention of our educationists and legislators has yet to be focussed on this question of choice of language for instruction of our youth, especially in science, technology and higher research; for, on the right approach to this problem will depend largely the march of the nation along the road to enlightenment.

In this state of indecision of popular opinion, the appearance of a modest work on an English-Gujarati glossary of scientific terms is very welcome. Unpretentious in size and in its immediate objective, it expounds sound principles for building of more comprehensive scientific dictionaries in Anglo-Indian languages. In its preface, the author Mr. P. G. Shah, C.I.E., a devoted scholar who has rendered splendid service during the last 25 years in the cause of scientific and cultural development in Gujarat, reviews the history of previous efforts in Urdu, Marathi, Gujarati, Hindi and of official

efforts in this direction. In a sober objective essay he discusses the disadvantages and undesirability of adopting a uniform, brand new scientific terminology for all Indian languages, the international aspects of the question, the profound reflections of Mahatma Gandhi on this theme and the suggestions made on various occasions by Pandit Jawahar Lal Nehru. He then suggests 14 working rules which should guide the framing of satisfactory systems of scientific terminologies in the principal provincial languages for the use of secondary schools which are sooner or later to begin teaching through the mother-tongue; for the self-instructing adults and persons of the working classes anxious to acquire knowledge of modern science; and for the popular writers on scientific subjects in the newspapers, periodicals and science primers in different Indian languages.

The scientific glossary proper covers exactly 200 pages of the book, including the most common terms used in the physical and biological sciences, medicine, astronomy, mathematics, geology, economics and philosophy. Equivalents of these standard terms in Gujarati are given in the Nagri script. In the reviewer's opinion, the chief feature of the present work lies in the admirable sense of judgement displayed in selecting apt, expressive and suggestive Gujarati equivalents for the standard scientific terms, thus encouraging the reader and learner in his desire to acquire more and more scientific vocabulary in his own language and the avoidance of hard, far-fetched and unfamiliar Sanskritized words and phrases. The use of Nagri script is thoughtful; with a very little change in the grammatical terminations of Gujarati words, the glossary can be adopted for a far larger circle of Hindi users. In this sense the present compilation may be considered as a preliminary to a much larger lexicon of Anglo-Hindi scientific terms encompassing a wider field of more advanced sciences, technology, engineering, etc. The author advocates the adoption of what may be called "international" terms and constants without change, but is rightly against replacing of old Hindi or Sanskrit words of established usage in astronomy, mathematics, medicine, astrology, etc. In general his view is that premature finality and rigidity aimed at by some new systems of nomenclature will do harm, but that they should grow round a nucleus of existing vernacular terms

that are current, well understood and have the sanction of long usage. The author has had the benefit of consultation and collaboration with a number of Indian scientists. On the whole, the scope and distribution of standard terms, constants, symbols and units of the different sciences show balance and judgement, save in one science which has a disproportionate plethora of common words and phrases. A few striking omissions of terms, especially the nomenclature employed for the borderline sciences, are noticeable. These minor defects are easily remediable in a new edition which, there is no doubt, will soon be called for.

The printing, format and general get-up of the book is attractive and gives credit to the Gujarat Research Society, Bombay, who are the publishers.

D. N. WADIA

### **Colloid Science II. Reversible Systems,**

Edited by H. R. Kruyt (Elsevier Publishing Co. Inc., New York), 1949, pp. xix + 753. Price 77s. 6d.

THIS MONOGRAPH IS THE RESULT OF A CO-operative effort of a number of specialists and deals with the reversible colloidal systems which have acquired importance consequent on the development of synthetic macromolecules. The thermodynamical aspect has been treated by J. J. Hermans, with special reference to vapour pressure, osmotic pressure, swelling pressure and heat of mixing. The same author has also written the chapter dealing with physical properties in solution such as optical anisotropy, dipole moments, sedimentation velocity, time of relaxation, viscosity, flow birefringence as well as the properties in the solid state such as elasticity, swelling and double refraction on stretching. A complete chapter on the important subject of determination of molecular weights has been written out by J. J. Hermans and P. H. Hermans. J. Th. G. Overbeek and H. G. Bungenberg de Jong have written the chapter on macromolecular electrolytes. One full chapter on reversal of charge and three chapters on the different aspects of coacervation have been written by Bungenberg de Jong. P. H. Hermans's chapter on gels deals with sol-gel transformation, structure of gels and sorption by gels. There is one chapter by Houwink dealing with solid

macromolecular systems. The last chapter by H. L. Booij deals with association colloids as represented by soaps and dyestuffs.

The book is, on the whole, well written. By way of exceptions a few minor errors may be pointed out: (1) sub-section letterings on page 42 do not correspond with what is given in contents. Similar errors are to be seen on pages 36 and 38. The name of the author of the last chapter is differently spelt on page viii (Booy). In equation (1) on page 50, it is desirable to specify the conditions under which the different partial differential equations hold. While treating hysteresis in sorption, a reference to the early concept of McBain, which has been established by recent experimental work, would have been useful.

The book forms a good guide to the domain of macromolecules and provides an excellent stimulus for research in the field.

K. S. GURURAJA DOSS

**Making Conference Programs Work**, by M. F. Stigers (McGraw-Hill Book Co. Inc.), 1949, pp. 256. Price \$ 3.50.

THIS BOOK IS ONE OF A SERIES OF PUBLICATIONS on industrial organization and management published by McGraw-Hill Book Co. Conferences play a very important part in the American way of life, especially in their large industrial concerns and educational institutions. The author, who is an Associate Professor of Trade and Industrial Education in Purdue University, is well fitted for the task of writing a textbook on the technique of conferences, since he has himself taken a leading part in several such conferences. The observations in the book are born of real and valuable experience gained through several years.

In large industrial concerns consisting of several departments, it is frequently necessary to hold meetings between representatives of the various sections to exchange ideas on common problems, to evolve methods of improving production, both in quality and quantity, to discuss questions of personnel, etc. In big educational institutions also it has been found useful to have such meetings between the various members of the staff to discuss questions about training students. The method of settling questions and evolving procedures by conferences need not be confined to these two fields and can

really be extended to several other fields of group activity.

Mr. Stigers discusses in detail the types of conferences, the physical arrangements necessary for such conferences, the preliminary steps necessary before the beginning of a conference, the way in which the programme of the conference must be drawn up, and the technique and etiquette of a conference. He has concentrated his attention on two important aspects of conferences: (1) the rôle to be played by the conference leader and (2) the method of getting the best results out of such conferences. He has also given in the latter part of the book actual examples of conference programmes in industry and selected conference reports.

It may, at the first blush, appear as if such a book will be of no use to us in India. But nothing would be farther from truth. India is very often the venue of international meetings of the various bodies attached to the U.N.O. Indians have to take part in many conferences abroad. A clear knowledge of the conference technique would be extremely useful to these representatives. Moreover, in many of our big institutions like the Council of Scientific & Industrial Research, the various Departments of the Government, the Tariff Board, etc., a lot of work is carried out in conferences though the word "conference" itself does not figure in the reports. People are invited from distant parts of the country; public money and valuable time are spent on such meetings. At the end of many of these meetings, the members come out with a feeling of futility about the usefulness of such conferences. Very often there is no specific programme before the meeting and the members come entirely unprepared and without forethought. The result is that various loose observations are made and the meeting ends without achieving any result. Mr. Stigers has rightly stressed the necessity of drawing up a proper programme beforehand and specifying the particular problems to be discussed so that the members can think over these problems and come to the meeting with their considered views. Sometimes the leader of the conference "misbehaves", loses his temper with his colleagues, interferes too often in the normal smooth working of the meeting or tries to impose his own views on others. Sometimes after the meeting is over, a biased report about the decisions arrived at in the meeting is

circulated by the leader as an authentic account of the conference. A careful study of Mr. Stigers's book will show how to avoid such pitfalls and how to utilize conferences in the best manner possible.

**Terrestrial Radio Waves**, by H. Bremmer (Elsevier Publishing Co. Inc., New York, Amsterdam, London, Brussels), 1949, pp. x + 344. Price \$ 6.75.

THE MAIN OBJECT OF THE BOOK HAS BEEN the analysis of the mathematical-physical methods for computation of fields due to a radio transmitter. After giving a general introduction, the author divides the subject-matter of the book into two distinct parts. The first — chapters II to VI — deals with a homogeneous atmosphere and estimation of ground-wave field, the conditions for finite heights of transmitter and receiver being, of course, fully discussed. The second part — chapters VII to XI — is devoted to the theory for an inhomogeneous atmosphere including the ionosphere and the troposphere.

The author begins chapter II with the expression for the ground wave in the form of a series of zonal harmonics. Chapter III deals with Watson's transformation and its further modification for numerical solution, specially for radio problems. The total radio field due to primary and directly reflected components is expressed as a series which is dealt with by two distinct methods — the method of residue series having the characteristics of diffraction theories and the saddle point or geometric-optical method. The residue series is elaborated in chapter III and its applications are further discussed in chapter IV. Firstly, the field is computed when both the transmitter and the receiver are on the earth and the limitations of the formula for short distances are pointed out. The relationship between the values from the residue and those from Sommerfeld's solution for the flat earth is certainly interesting. For computation of fields when transmitter and receiver are above the earth's surface, height-gain factors are introduced which make numerical computations lengthy. These are discussed in great detail. Chapter V deals with geometric-optical approximation with the aid of the saddle-point method. It is pointed out that this method is applicable precisely in the region where the series of

residues fails owing to its slow convergence. The field by this method differs from the familiar expressions by the presence of a "divergence coefficient" and also by the Fresnel reflection coefficient being replaced by spherical reflection coefficient. The author has, of course, pointed out that for all practical purposes the Fresnel coefficient may be used without appreciable errors.

Although the discussions are characterized by mathematical rigour, the engineering applications of the complicated formulae have not been overlooked. A survey of the formulae required for numerical calculations, as also many typical results, are presented in the form of graphs in chapter VI. Propagation conditions over ground and sea have been dealt with separately but the important problem of transmission over a composite path of both land and sea has not been studied seriously.

Part II of the book is devoted to an inhomogeneous but spherically symmetrical atmosphere, comprising both the ionosphere and the troposphere. In chapter VII the general nature of the variations of the index of refraction is discussed and the geometric-optical behaviour of wave propagation as also a theory based on wave equations are given. The different components of the total field in presence of ionosphere are discussed in detail in chapter VIII, firstly neglecting absorption and then extending the method for non-negligible absorption. The discussions on the field in the neighbourhood of the skip distance and also at the antipode are very interesting.

Chapter IX deals with the residue method for the sky wave and the relationship between it and the geometric-optical methods as also their respective fields of application. Probable models of ionospheric layers and also for the troposphere for microwaves are discussed in chapter X. Propagation of long and short waves and corresponding numerical computations are then discussed in detail. The theory of super-refraction is also treated at some length on both the methods. The trajectories of cosmic radio waves arriving at the earth are considered at the end of the chapter.

The concluding chapter XI is devoted to the effect of the earth's magnetic field. Conditions for a homogeneous space, applicable for long waves, are first considered, followed by estimates of reflection coefficient

and electric field for typical cases. The conditions for slowly varying anisotropic non-absorbing ionosphere, applicable to short waves, are then taken up. The ray theory has been adopted except in cases where it ceases to hold good. There is no reference to the recent wave treatments of the problem by Saha and his school.

Throughout the book the treatment of the different topics has been made with mathematical rigidity, but at the same time the approximate solutions for conditions usually met with in practice have been pointed out. Being fundamentally a mathematical treatment, it will perhaps not appeal very much to the average radio engineer who will undoubtedly find it difficult to follow. The many numerical computations will, however, be of great interest. A serious student of radio wave propagation will find the book extremely useful.

H. RAKSHIT

**Technique of Radio Design**, by E. E. Zepler (Chapman & Hall Ltd., London), 1949, pp. 394. Price 25s.

THE SECOND EDITION OF THE "TECHNIQUE of Radio Design" is in every way as useful to the radio designer of any developmental or research laboratory as the first edition. There are many excellent text-books dealing with the general principles of circuit design but scarcely any of a practical nature. The author, based on his years of experience as head of the Receiver Development Department of Telefunken Works, has presented a book which deals with practical problems facing a radio designer confronted with building a workable apparatus.

The treatment is accurate and is supplemented by the inclusion of numerous examples which give practical values to the constants so that the dimensions of the problem can be readily assessed, specially by inexperienced design engineers.

The chapters are well arranged following the signal from aerial to loudspeaker and deal with the appropriate portions of the receiver.

In the second edition chapter 3 has been considerably enlarged — specially the section dealing with "Negative Feed Back". Chapter 6 on "Receiver Noise" has 10 additional pages to include the large amount of data accumulated during the last few years.

Chapter 9 on "Undesired Feed Back" is much more exhaustive. On page 309, the portion dealing with "Incorrect Earth Connections" is a useful addition. Pages 318 and 319, paras B and C, under "Spurious Beats" are very good. On page 375 the para on "Noise Factor" is additional.

This book is a "must" to every radio designer. It suggests methods and presents data of practical design which can otherwise only be acquired slowly by experience.

T. V. RAMAMURTI

**Selective Toxicity and Antibiotics**, *Symposia of the Society for Experimental Biology* (Macmillan & Co. Ltd., London), 1949, pp. vii + 372. Price 35s.

THE VOLUME UNDER REVIEW IS A RECORD of the "Symposium on Selective Toxicity and Antibiotics" held in Edinburgh in July 1948.

The term "selective toxicity" is a very terse one which indicates the general way in which the drugs, disinfectants, antiseptics, insecticides, etc., produce the particular effect they are noted for. When such an agent is introduced into a system, it attacks some centres (causes toxicity locally) in preference to others. The precise mechanism, the "why" and "how" of this effect, is now sought to be elucidated so that on the basis of this knowledge we can consciously design and produce the agents we require to control diseases, pests, etc. This subject is an extensive one and requires to be studied from various angles employing different sciences and disciplines. Records of such attempts made in U.K. are found in this volume in the form of twenty-two essays dealing with various topics. Each essay is not a mere compendium but a critical evaluation of the work done by the author or the knowledge in the subject. Some well-known names are missing in this volume, but fortunately their views have been recorded elsewhere. It would be impossible to deal with them and record the reviewer's opinion about them in the space available. To give an idea of the coverage of the symposium, we can just enumerate the headings in the order given in the book: organic chemists' approach to chemotherapy, the differential activity of certain anti-malarial agents against protozoa and bacteria, the study of enzymes in relation to selective toxicity in



animal tissues, the design of bacterial inhibitors modelled on essential metabolites, antibiotics derived from *B. polymyxa*, the resin of hops as antibiotics, systematic insecticidal properties induced in plants by treatment with fluorine and phosphorus compounds, surface activity and permeability as factors in drug action, the permeability of insect cuticle, selectivity of drug action in protozoal blood infections, aspects of the selective toxicity of sulphonamides and their antimetabolic inhibition, the effect of long-chain fatty acids on the growth of *H. pertussis* and other organisms, the effect of unsaturated fatty acids on gram-positive bacteria, the action of penicillin on the assimilation and utilization of amino acids by gram-positive bacteria, adaptation of bacteria to resist drug action, the significance of hydrogen ion concentration in the study of toxicity, the effect of phenyl-carbamates on the growth of higher plants, the comparative toxicity of phytocidal substances, therapeutic interference, some effects of diet on toxicity — the influence of diet on the induction and inhibition of tumours, external metabolites and ecological adaptation, and the production of antibiotics by micro-organisms in relation to biological equilibria in soil. The reviewer has enjoyed reading every line of all these at a breathless pace.

Useful technical books can, from the pragmatic point of view, be divided into two classes. The first class comprise those which are authentic catalogues of facts in a subject that has taken some shape. These are reference books; they serve as aids to memory and come in handy to get at the previous knowledge in a subject in the shortest time possible. The second class of books is not at all valued for the above. Their important function is to generate ideas for further work, to serve as an intellectual ferment or to act as a midwife to bring out ideas in the womb. The volume under review belongs to this class and is sure to fulfil its function. The secretaries are to be congratulated for having brought out this volume and broadcast this symposium held in Edinburgh to a much wider audience.

There are two complaints to make. The symposium was held in July 1948 but the volume reached the reviewer's hand only in January 1950. Secondly, though the printing and get-up of the book are very good, the cost of the book is almost prohibitive for the

researchers to possess. The usefulness of a good book, like that of a drug, is assured only when it reaches the sites where its action is desired. This applies to all technical books now being published. We should now seriously think about ways and means of bringing such books within the reach of all the researchers. In the present case, the I.C.I. could have contributed a little more and thus brought down the cost of the book considerably.

K. GANAPATHI

**A Theoretical Investigation into Some Properties of Ionic Crystals**, by Per-Olov Lowdin (Uppsala University Thesis, published by Almqvist & Wiksells, Uppsala).

THIS IS A VALUABLE INVESTIGATION OF THE properties of ionic crystals of the NaCl type based on quantum mechanics. The thesis is divided into two parts. The first deals with the cohesive energy of a system of ions having complete electron shells, ignoring thermal agitation. An expression for the energy is found in terms of one-electron wave functions. The electrostatic energy is regarded as made of two parts, i.e. the Madelung one and the coulomb correction due to the overlapping of the ions. A formula for the exchange energy for a pair of ions is found. The S-energy, depending on the non-orthogonality of the free ion wave functions, is also found out. The sum of these three energies gives the cohesive energy. In the second part of the thesis, applications of the formulae have been made for crystals of the NaCl type. The wave functions of the negative ions  $F^-$  and  $Cl^-$  and the positive ions  $Li^+$ ,  $Na^+$ ,  $K^+$  are found. Numerical calculations of the cohesive energy, the inter-ionic distance, and the elastic constants of the ionic crystals have been made. The agreement between the theoretical and experimental results is good in the case of NaCl, KCl and NaF, while discrepancies exist in the case of LiCl and LiF. But one must say that the theoretical results obtained form an achievement because they do not assume any experimental values except the values of the fundamental constants. The thesis will be a very valuable guide to those who would wish to pursue the matter further and it is indeed a praiseworthy investigation.

N. S. NAGENDRA NATH

# The Indian Science Congress Association

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THE ANNUAL REPORT OF THE EXECUTIVE COMMITTEE OF THE INDIAN SCIENCE CONGRESS ASSOCIATION FOR THE YEAR 1949 records satisfactory progress in all its activities. Several members and office-bearers of the Association were invited by the Government of India to work in a number of expert committees to advise the Government on various developmental schemes and projects. Two important delegations, one to the U.N. Conference on Natural Resources held at New York and another to Australia, were sent by the Government of India and in both these delegations members of the Indian Science Congress Association played a prominent rôle. The Association received recognition from many foreign scientific bodies, notably the British Association for the Advancement of Science and the Institute of Physics and Physical Chemistry, Israel. Members of the Association were also represented on the Indian National Commission for Co-operation with the UNESCO and the Defence Science Conference organized during the year. A Sub-committee of the Association was appointed to report on the development of the Andaman and Nicobar Islands. The Sub-committee on UNESCO has undertaken to prepare and submit reports on the following subjects: Means of extending collaboration between the Association for the Advancement of Science, the science club movement, popularization of science through cheap books and book clubs and the interaction between science and society. A special symposium on "Application of Science in India for Social Welfare" was held at the Allahabad University under the auspices of the Sub-committee for Science and Its Social Problems".

On the suggestions of Prof. A. D. Ross, Chairman of the Australian National Research Council, the Executive Committee approved the idea of holding the Pan-Indian Ocean Science Congress on the lines of the Pan-Pacific Ocean Science Congress. The session, which is to be devoted to discussion of scientific and technological problems peculiar to this zone and to furthering the cause of international science, is to be held immediately after the 1951 session of the Indian Science Congress at Calcutta.

To facilitate the editing of scientific papers and preparation of abstracts, a set of instructions on editorial guidance for papers has been prepared with the co-operation of Mr. J. Coates, President of the Section of Geology, 1949-50, of the Association.

In order to strengthen its membership, the Executive Committee has issued a pamphlet which seeks to popularize the aims and objects of the Association.

The question of building a permanent headquarters for the accommodation of all scientific bodies with their head offices in Calcutta, on the lines of the Burlington House in London, is being studied and details are being worked out.

The budget estimates of the Association for the year show considerable increase in expenditure which has been balanced as a result of a grant of Rs. 15,000 from the Government of India. The

Committee have strongly urged the desirability of increasing its membership subscription from Rs. 12 to Rs. 15.

## RIVER RESEARCH IN WEST BENGAL

INVESTIGATIONS ON MODELS, ANALYSIS OF SOIL FOR the construction of dams and barrages proposed under the Mor (Mourakshi) Project and the Ganga Barrage Scheme formed the main part of the research work carried out at the River Research Institute, West Bengal, during the year 1948. Besides these, investigations were also undertaken for the Damodar Valley Corporation and the Assam Railway.

A new site, 1000' downstream of the site proposed originally, has been recommended for the barrage over the Kopai river as a result of model investigations. Hydrological observations of the river Mor have been carried out at a number of points. Samples of soil from an area under the Messenjore Dam site have been analysed for their suitability in dam construction. Results show that whereas shell material is ample in the vicinity, enough core material is not available. The soil in this area covered by the Mor Project has been found to be porous and likely to produce water logging at low places under perennial irrigation unless proper drainage is provided.

The investigations conducted under the Ganga Barrage Scheme aims at the construction of a barrage across the river Ganga to supply silt-free water into the Bhagirathi-Hooghly to maintain a navigable channel all the year round from Calcutta to the Ganga and to combine a road and railway bridge with this barrage. Gauge and discharge observations and analysis of silt samples collected from the river Ganga at Faracca, estimation of the minimum discharge necessary to maintain the Bhagirathi in a navigable condition indicate that discharge of 12,000 to 13,000 cusecs will maintain a 160' wide and 9' deep channel if a few stretches are resectioned.

Other investigations have been concerned with spill operations necessary to maintain the Tolly's Nullah (channel) in proper condition, methods of reducing scour in the Peechaboni Khal (channel) upstream of the tidal slice, analysis of the sewage water from the sedimentation tank at Bantalla to determine the efficiency of sedimentation, analysis of gauge discharge and silt samples from various sites on the rivers Darakeswar and Selye for construction of dams in the upper reaches of the rivers, hydrological observations of Kalighai river system to prevent floods into Kalighai river valley and run off and soil erosion experiments at Arabari.

The work undertaken for the Damodar Valley Corporation related to hydrological observations of the river Damodar and its tributaries and analyses of soil and water from Damodar river.

## HYDRAULIC & IRRIGATION ENGINEERING RESEARCH IN HYDERABAD

PROBLEMS CONNECTED WITH THE DESIGN AND construction of spillways, weirs, channels and causeways were successfully tackled and interesting results were obtained in analytical studies and insulation tests conducted on various engineering materials at the Engineering Research Laboratories, Hyderabad, during the year.

In the Hydraulics, Irrigation and Hydraulic Machinery Section, investigations were continued on the problem of designing a profile for a spillway for Manair Irrigation Project. A suitable design duly tested on a scale model with regard to coefficients and pressures was recommended to the Executive Engineer. Methods have been devised to reduce the inflow of sand into Polkampalli river and ensure the requisite flow of water into it from Kapeta river. The rivers meet and separate after 7 chains to meet again a few miles downstream. On the right branch after separation, an anicut (weir) and sluice have been constructed to supply water to the canal feeding several tanks. Earlier devices to direct the water into Polkampalli river by constructing first an earthen bank and later a weir across the left branch had failed.

Experiments have been conducted on two models of a tail-race channel proposed to be led parallel to the Nizamsagar canal. This canal has a full supply discharge of 3,400 cusecs and has 3 drops within the first 34 chains from the head sluice, the total drop amounting to 32'. A scheme for utilizing this drop for production of power has been sanctioned.

An investigation was made into the failure of the high-level causeway across Pedda river in Medak district. It is suggested that modifications that tend to increase the coefficient of discharge of the structure as a whole and so reduce the afflux and depth and flow over the crest during floods may be adopted. It is emphasized that in designing causeways across jungle streams bringing in a lot of brushwood during floods, the calculation for stability, high flood levels and afflux should be based on the supposition that all the vents are likely to be blocked during heavy floods. The fact that the high flood level recorded in this particular case is above the designed high flood level does not show that the flood is greater than that for which the causeway was designed. Due to the partial blocking of the vents, the depth of flow over the causeway crest is increased, thus increasing the high flood level above the designed level even at lower flood intensities. On this basis a number of recommendations have been made for reconstructing this and other high-level causeways of the type.

In the Soil Mechanics Laboratory, about 70 soil samples were analysed and tested for roads, canal linings, rammed earth buildings, manufacture of bricks and *sukhi*-mortar including 8 samples of

aggregate for Nizamsagar Hydro-electric Scheme. Traffic census have been conducted on different types of wearing courses and their behaviours observed under the same intensity of traffic.

Laboratory tests were made to determine whether cement-stabilized soil in the form of bricks, slabs or blocks could be used for lining canals to reduce seepage losses and economize in earth work by providing for greater velocities. Test results of 3 soil samples which were found satisfactory are given.

The possibilities of replacing lead with steel and concrete of relative density 2.4 in a room meant for installing a Maximar 250 deep X-ray therapy unit have been examined. The use of aggregates of higher specific gravity and higher unit weight, and selection of the grading of aggregates for maximum unit weight is considered to give a concrete of density 2.4. Specifications of materials with their proportions for the required cement-concrete mix are given.

Studies of cheap insulants for roofing materials to improve their thermal characteristics were made and a model house with country tiled roof registered lower maximum temperature and higher minimum temperature than in shade. The model has, with corrugated iron and asbestos cement sheet roofs, recorded maximum temperature higher than that of shade. In summer, maximum temperature recorded by country tile roof was lowest, corrugated iron roof coming next with asbestos cement roof recording the highest temperature. A study of variation in maximum temperatures at various depths below the roof level has been made. The average daily maximum temperature at any particular position has been found to decrease with the increase in its depth from the centre of the roof. The decrease is greater in summer than in winter.

## INDIAN MATHEMATICAL SOCIETY

THE SIXTEENTH CONFERENCE OF THE INDIAN Mathematical Society was held in Madras from 26th to 28th December 1949. About 30 papers covering topics on modern algebra and abstract spaces, theory of numbers, analysis geometry, astronomy and statistics were presented. There were symposia on "Recent Developments in Harmonic Analysis", "Time Series Analysis", "Fluid Mechanics" and "Teaching of Mathematics". A feature of the Conference was an interesting mathematical exhibition at which models relating to geometrical surfaces and solids, topology, astronomy, statistical charts and photo-print copies of Ramanujan's notebooks were presented. A well got-up souvenir prepared in connection with the Conference contains interesting articles about the origin and development of the Indian Mathematical Society, Ramanujan, and contributions to mathematical thought from South India, besides an illustrated account of the historical and cultural background of Madras.

# NOTES & NEWS

## Lipophilic

### Chemotherapeutics

A NUMBER OF POSSIBLE UPOPHILIC chemotherapeutics of the sulphonamide and sulphone series and 2-sulphanilamido-thiazolones have been synthesized and investigated for their possible activity against tubercle bacilli both *in vitro* and *in vivo* (*Proc. Indian Acad. Sci.*, 1950, **31**, 21).

Among the compounds of the sulphonamide and sulphone series synthesized are the hydnicarpic acid derivatives of N<sup>4</sup>-n-fatty acyl sulphanilamides, N<sup>4</sup>, N<sup>1</sup>-dihydrocarpysulphanilamides, normal fatty acyl derivatives of 4-nitro-4-amino and 4:4-diamino diphenylsulphones, 4: 4-bis-adiphlamido- and 4: 4-sebacylamido-diphenylsulphones and the N<sup>4</sup>-n-caproyl derivatives of 2-sulphanilamido-pyrimidine, 2-sulphanilamido-4-methyl and 2-sulphanilamido-4:6-dimethyl pyrimidines.

In the sulphanilamidothiazolones group, a method for the preparation of the intermediate 2-amino-5-substituted thiazolones starting with the corresponding mono- and dibasic fatty acids has been worked out. New 5-substituted pseudothiohydantoin derivatives from monobasic acids, viz. 5-iso propyl-, 5-n-hexyl-, 5-n-tetradecyl-, and 5-phenyl-2-aminothiazolones. 5: 5' ethylene-bis-2: 2-aminothiazolone and 5: 5-hexamethylene-bis-2: 2-aminothiazolone are among the new members derived from adipic and sebacic acids respectively. A number of sulphonamidothiazolones have also been synthesized.

2-sulphanilamido-5-ethylthiazolone differs in its physical characteristics from those of the sulphethylthiazolone reported by earlier workers and has been found to be markedly active in some acute bacterial infections.

## Synthesis of Citrinin

A SIMPLER SYNTHESIS OF CITRININ which has interesting possibilities for synthesis in the isochromane is described (*Curr. Sci.*, 1950, **19**, 20).

4 methyl-resorcinol-2-carboxylic acid-5 ethyl methyl carbinol is treated at room temperature

(28°-30°C.) with about 10 times its weight of ethyl orthoformate. Crystalline citrinin separates rapidly from the yellow solution. After 30 min., crushed ice is added and the yellow needles of citrinin are filtered, washed and dried. The m.p. (171.5°, dec.) is undepressed by admixture with natural citrinin and the yield is almost quantitative.

## Vitamin B<sub>12</sub> Concentrate

A quick method of obtaining Vitamin B<sub>12</sub> concentrates from commercial sources making use of the relationship between the colour of the concentrate and its potency is described (*Science*, 1950, **110**, 528).

0.5 c.c. of liver injection, USP (Lederle solution extract from leaf liver, 154 per c.c.) was dried and 0.1 c.c. of N HCl added to the residue followed by 0.5 c.c. of a mixture consisting of 0.1 N HCl, n-propanol, and n-butanol in the proportions of 1: 2: 1. The solution when chromatographed on 25 gm. starch in a 10 mm. x 300 mm. column with the 1: 2: 1 mixture as solvent yielded the following fractions having different activity: 4.2 c.c. colourless, 1.8 c.c. slightly coloured, 80 m.u., 1.8 c.c. slightly coloured, 240 m.u. As colour is an index of the potency, it is easy to know what portion of the effluent to collect.

## Aluminium-silicon Alloys

PRODUCTION OF ALUMINIUM-SILICON alloys by thermo-electric methods developed in Germany together with the working of Lurgie-Thermie Factory at Horrum, Rhine, are described in the BIOS final Report No. 253.

In this process impure aluminium silicon alloys containing 40 to 60 per cent silicon produced by electrothermic means are later refined to purer forms of "silumin" (containing 5 to 20 per cent silicon, not more than 2 per cent of other metals and the rest aluminium) by diluting them by pure aluminium so as to give a final alloy containing 11 per cent silicon. The raw materials, alumina, wood charcoal, china clay, quartz and possibly manganese

dioxide, are fed through a mixer with the addition of water to a drum-type briquetting machine which gives flattened, egg-shaped briquettes. The proportion of the ingredients is suitably adjusted according to whether the primary alloy to be produced is 60 per cent or 40 per cent silicon alloy.

The reduction is carried out in single-phase A.C. arc furnaces. The consumption of electrode is 16 per cent on the weight of the alloy produced. The furnace is a stout steel cylinder with "cathode" connections to one side. Power is supplied by separate transformers for each furnace on which the load averages 650 kW. The briquettes are charged into the furnace until it is full and liquid metal is tapped off. The process is continuous with an efficiency of 95 per cent and the power consumption is about 1,520 kWh. per ton. The crude metal tapped, containing 95 per cent aluminium and silicon, is taken to electric refining furnaces of the tilting crucible type where slag is removed under a flux composed of 6 parts of common salt and 1 part of cryolite. The refined alloy is then melted in gas-fired tubular furnaces. Other primary metals are added to yield a wide variety of final alloys (*Production of Aluminium-silicon Alloys*, Literature Report No. 4, by B. S. Srikantiah and B. R. Nijhawan, National Metallurgical Laboratory, Jamshedpur).

## Electrolytic Descaling

A SIMULTANEOUS DESCALING AND tin-plating electrolytic process is described (*Chem. Age*, 1950, **62**, 21).

The operations include degreasing, rinsing, descaling and final wash. Degreasing is accomplished anodically using a highly alkaline cleaner. The scale and oxide are removed cathodically in a bath containing dilute sulphuric acid, a small concentration of tin salt and an addition agent to promote a uniform adherent deposit of tin. The bath is run at a moderate temperature and high current density. The anodes are high-silicon iron except for one or two tin anodes used to maintain the tin content of the bath. The operation frees the work from scale or oxide and covers it with a thin film of tin without effecting any dimensional change. No etching

of the tin occurs and the racks are also protected by the tin film. If desired, the tin coating can be stripped in a bath operated as in the degreasing process.

### Nicotine Extraction

A LIQUID-LIQUID PROCESS FOR extracting nicotine from water by kerosene is under investigation at the *Eastern Regional Research Laboratory*, U.S.A. Distribution coefficients at various temperatures and concentrations and the data on continuous kerosene water extractions have been worked out and a pilot plant based on these results is under construction (*Ind. & Engng. Chem.*, 1950, **42**, 166).

The equipment consists of an overhead reservoir containing a solution of nicotine in tap water, ranging in concentration from 0.10 to 0.15 per cent by weight. The nicotine solution from the reservoir flows through a rotameter via a heating coil into the top of a packed column. Kerosene oil of sp. gr. 0.82 and flash point 70°C. from another overhead reservoir flows through a rotameter via a heating coil and a distributor up through the packed column. The tubing employed is made of polyvinylidene chloride plastic and the heating coils are of copper. The packed column is made of 1.875" inside dia. glass tubing, 48" long. The upper 6" and lower 3" of the column has no packing. The packed section is 39" long with 0.0624 cu. ft. of free space. The kerosene distributor is made from a 0.25" I.P.S. cap with 7 holes of 0.0625" dia.

In most of the runs water was the continuous phase and kerosene the dispersed phase; the interface was held in the upper 6" of the column (above the packing). The column packings investigated were (a) 0.25" ceramic Berl saddles; (b) 0.375" ceramic Raschig rings (0.375" outside dia.  $\times$  0.25" inside dia.  $\times$  0.375" long); (c) 0.5" Berl saddles; and (d) 0.5" Raschig rings (0.5" outside dia.  $\times$  0.3125" inside dia.  $\times$  0.5" long).

Nicotine solutions ranging from 1.01 to 793.9 gm. of nicotine per litre were investigated at temperature ranges 5° to 98°C. 10 to 50 c.c. of the solution measured out in an Erlenmeyer flask and an equal volume of Deobase (a commercial, refined and deodorized kerosene; d.o. 7797 and a boiling range of 160° to 250°C.) added and

the flask maintained at the desired temperature for 24 hr. A sample of the water layer was then analysed and nicotine determined by precipitation with silicotungstic acid. The solubility of Deobase in the water phase is negligible.

At 0.5 to 0.6 per cent nicotine in water, which is the usual concentration in industry, and with equal volumes of solvent and solution, approximately 48 per cent of the nicotine was removed in one extraction stage at 25°C., whereas at 85°C., about 83 per cent was removed. In the solvent extraction of nicotine with kerosene, it is obviously advantageous to operate at high temperature.

Maximum density of water-nicotine solution occurred at 65 per cent nicotine whereas the density of kerosene-nicotine solutions increased linearly with concentration. The distribution coefficient was constant at any one temperature up to a concentration of 1 per cent nicotine in the original solution. The coefficient decreased with increasing temperature at all concentrations; in concentrations below 1 per cent it decreased from 3.4 at 5°C. to 0.2 at 85°C. At constant temperatures the coefficient increased with concentration, reached a maximum between 50 and 70 per cent nicotine, and decreased again at higher concentrations. By increasing the temperature from 21° to 84°C., extraction of nicotine from water in a packed column increased from 28 to 92 per cent. Extraction increased by about 8 per cent by packing the saddles loosely instead of tightly. The saddle type of packing gave about 5 per cent higher nicotine extraction than the same size of ring packing.

### Cyclone Dust Collectors

CYCLONE SEPARATORS FIND APPLICATION in many industries for the separation and collection of finely ground particles of matter. Professor A. J. ter Linden, in a recent publication, has dealt with the various factors relating to the design of cyclone dust collectors (*Proc. Inst. of Mech. Engrs.*, 1949, **160**, 233). The shape of the cyclone is determined by the following principal dimensions: (1) inlet angle of gases; (2) diameter of cyclone (D); (3) gas exhaust diameter (d); (4) length of exhaust pipe inside cyclone (S); (5) height of cyclone (H); (6) height of cylindrical part of cyclone (h); (7) width

of gas inlet (A); (8) height of gas inlet (B). From experimental work it appears that a gradual entry of the gases into the cylindrical part of the cyclone is essential and the best efficiency is obtained when the inlet angle is 180°. For high efficiency, the following dimensions are recommended:  $S \approx d$  or  $S \approx B$  when  $B > d$ ,  $H \geq 3D$ ;  $D = 2.5d$ ;  $H = 6d$  to  $7d$  and  $A = B$  and the cross-sectional area of the inlet duct ( $A \times B$ ) not much smaller than that of the exhaust.

The influence of gravity on the dust separation in a cyclone is slight and a good cyclone effects a satisfactory separation in any position.

A new type of cyclone with curved axis, horizontal gas exhaust, and vertical downward dust outlet is described. From a consideration of the vertical, radial and tangential components of the velocity and the static pressure inside a cyclone, a simple theory is developed enabling the approximate calculation of the size of the largest particles that may escape a cyclone. The efficiency of a cyclone increases and the particles that escape it become gradually smaller as the diameter of the exhaust becomes smaller. In view of the pressure drop the velocity of the gas in the exhaust may not be raised too high, it is essential to replace a large cyclone by a number of small ones connected in parallel (multi-cyclone construction). The dust concentration has little influence on the efficiency. With an increasing dust concentration, the efficiency will also increase slightly, provided no obstruction occurs in the dust outlet. Efficiencies are given for different sizes of similar shaped cyclones and for various sizes of dust particles. This data enables the selection of a cyclone collector suitable for a particular kind of dust, and the choice of cyclone dimensions for a given efficiency. If a high efficiency for fine dust is required, it is necessary to use very small cyclones. The efficiency of a small cyclone is very high, and it has been shown how this property of a small cyclone may be used to measure easily and accurately the dust content of a flow of gas.

### Fusible Alloys

THE COMPOSITION, PROPERTIES and applications of some of the tin-containing fusible alloys are

discussed in a 24-page booklet recently published by the *Tin Research Institute*, England.

The alloys are based on the eutectics occurring in the alloy systems formed by metals of intrinsically low melting point, e.g. tin, bismuth, lead and cadmium. Alloys of very low melting points formed by the addition of gallium or indium are described. Some of the fusible alloys owe much of their industrial importance to the volume changes during and after solidification of the alloy, on which depends the production of castings having dimensions equal to, or greater than, those of the mould in which the metal is cast. The factors influencing such dimensional changes are discussed in detail.

The low melting temperatures of fusible alloys enable them to be cast in wooden or paper moulds and poured around hardened steel dies without danger of affecting the hardness of the tools. Their use in aircraft factories, foundries and engineering workshops has simplified many assembling operations and production processes and resulted in considerable saving in time, labour and materials. Thin-walled tubes and open sections containing these alloys as filling material can be bent without risks of buckling or cross-sectional distortion and the manufacture of intricate holloware, such as ornamental handles for cutlery, is facilitated. Metal to metal joints can be made by conventional soldering techniques at temperatures as low as 100°C. and vacuum-tight seals can be made between glass and glass or glass and metals.

Some of the novel uses to which the fusible alloys have been put to, include determination of the maximum temperature attained by the valves of internal combustion engines and bearings of motors, which are not easily accessible with the usual thermostatic measuring devices; making casts of features and finger print impressions using the quinary eutectic containing indium which melts at 47°C. and can come, in molten state, into direct contact with the human body without discomfort. Other important applications where fusible alloys find use are in safety devices, foundry patterns, moulds for thermo-plastics, magnetic assemblies, electro-forming processes, dentistry and metallized wood.

The booklet has an adequate bibliography and is illustrated by

photographs showing the use of fusible alloys in aircraft assembly jigs and in press tools. It is obtainable free on application to Tin Research Institute, Fraser Road, Greenford, Middlesex.

### A New Oscilloscope

DEVELOPMENT OF A DEVICE BASED on the Graphecon and the use of a television screen (instead of the conventional oscilloscope) which permits the study of instantaneous phenomena is reported at the *R.C.A. Laboratories*.

The main feature of the device is the Graphecon memory tube which consists of a target on which an electrical charge, such as an oscilloscope or radar trace, can be "written" at any speed desired by an electron gun. The charge, or signal, is scanned or "read" off the reverse side of the target by an iconoscope-type electron beam such as is used in television. The beam may take as long as 60 sec. to completely remove the charge—thus providing the storage period. The signal is then amplified and applied to a kinescope or television viewing screen for inspection or photographing.

### Reed Vibrometers

THERE ARE MANY PROBLEMS associated with the elimination of vibration encountered in engineering practice. The harmful effects of vibrations on machine parts and structures are well known. *Messrs G.E.C. (India) Ltd.* have put on market a simple reed vibrometer, useful in on-site analysis of vibrating structures.

This instrument has a reed in the form of a steel strip whose effective length can be varied by means of a knob on the side of the vibrometer. This is done until the natural frequency of the disturbance, when the reed will vibrate most vigorously, be easily observed. A scale on the vibrometer indicates the fundamental frequency of vibration. This instrument, designed essentially for use on linear systems of vibrations, contains an electromagnetic pick-up in close proximity to the reed which permits a display of the results on a cathode-ray tube.

### Absorption Bands of Uranyl Salts

THE ABSORPTION SPECTRA OF several uranyl salts at liquid air

temperature have been analysed in a manner similar to that adopted for the fluorescence spectra (*Proc. Indian Acad. Sci.*, 1950, **31**, 35).

The relationship between the two spectra is shown by two closely-lying common bands ( $a_0$  and  $b_0$  in absorption) at low temperatures. In fluorescence, the lower frequency band  $b_0$  is always more intense than the  $a_0$  band while in absorption the reverse is usually the case suggesting thereby that transition to the ground levels in the uranyl ion is from a single upper state and that the origin of the  $b_0$  and  $a_0$  bands is due to transitions to this state from the two low-lying electronic states (named  $X$  and  $\Sigma$ ), the latter of these being the ground state. Analysis of the spectra of 6 uranyl salts shows that the two levels (A-B interval) in the ground state, which are separated by a small frequency interval of nearly 150, take part in absorption. The appearance of  $c$ , however, involves a level nearly 220 above the lowest state. In view of the high transition probability for this series, its existence for this series is proved to be justified. The necessity of using much higher levels (as high as 2,000 as done by earlier workers) does not arise.

### Polarographic Determination of Digitoxin

POLAROGRAPHIC METHOD FOR the estimation of digitoxin in concentrations as low as 0.1  $\mu$  gm. in alcoholic solutions and in blood is described (*Science*, 1949, **110**, 526).

Varying amounts of a stock solution of the pure drug prepared in absolute alcohol and then diluted with distilled water were added to 0.5 c.c. of 0.2 N tetraethyl ammonium hydroxide in a Heyrovsky reaction vessel and diluted to 5 c.c. total volume with 50 per cent alcohol solution in order to study the half-wave potential and height of break at different concentrations. Nitrogen was bubbled through the solution for 15 to 20 min. and the polarogram recorded. The process was repeated until a satisfactory curve of height versus concentration had been determined and the average half-wave potential was calculated. The determination in blood was carried out by extraction of digitoxin with petroleum ether, followed by polarographic estimation as above.

In concentrations down to approximately 0.6  $\mu$  gm., the alcoholic solution and the blood extraction curves coincided reasonably well. Below this concentration, the curve of digitoxin extracted from blood drops sharply and approaches zero. This drop may be due to the distribution of digitoxin between the extraction solvent and blood at these low concentrations. The average half-wave potentials were found to be -1.965 in alcoholic solutions and -1.958 when extracted from blood.

### Determination of Magnetic Field Intensities

A NEW TECHNIQUE FOR THE quantitative study of electrostatic and magnetic fields of extremely small dimensions developed at the National Bureau of Standards is described (*J. Franklin Inst.*, 1949, 248, 540). The new method is better adapted to precise determination of field intensity.

The object to be studied is placed between an electron source and a system of electron lenses. The lens system focuses the electron beam to form an image of the object on a fluorescent screen. By placing a wire mesh of known gauge just beyond the back focus of the lens system, a shadow image of the mesh is superimposed on the image of the wire. The portion of the shadow network adjacent to magnetized regions of the recording wire show considerable distortion which has been found to be due to the deflection of the electron beam by the field of the recording wire at each magnetized region. The displacement and change in size of the shadow image, which depend on the strength of the field of the magnetized wire, give an accurate measure of the field intensity.

The technique is well adapted to investigation of the fundamental nature of ferromagnetism and is being applied to the study of spherical aberration in electron lenses.

### New Microsectioning Technique

EXTREMELY THIN SECTIONS OF uniform thickness (fractions of a micron) for study with either the light or electron microscope can be obtained by a simple device developed at the National Bureau of Standards (*J. Franklin Inst.*, 1949, 248, 541).

The specimen embedded in polybutyl methacrylate is fed to the microtome in extremely small increments by means of the thermal expansion of a metal specimen holder cooled by CO<sub>2</sub>. As the holder begins to warm and expand, it moves towards the cutting edge of the microtome. The length of time between cuts and the control of carbon dioxide determine the thickness of the section.

### Plasma Substitute

INVESTIGATIONS LEADING TO THE development of a satisfactory, non-antigenic and inexpensive plasma substitute from sugar beet juices are described (*Uppsala Lakareforenings förhandlingar*, 1949, 54, 107). The product has found extensive use in the treatment of shock prophylaxis.

High molecular dextran, when partially hydrolysed with the aid of acids, yield products with molecular weights of the order of magnitude of 1,00,000. By varying the conditions of hydrolysis, products with molecular weights in a range of 20,000 to 2,00,000, suitable as a plasma substitute, can be obtained. This treatment was carried out on a 8 per cent solution of a high molecular dextran at 90°C. Hydrochloric acid was added until the solution became 0.12 N. After 20 min. the hydrolysis was interrupted by neutralization with NaOH and dextran precipitated with alcohol and dried. At this stage a major portion of dextran molecules have a large molecular size. A more homogeneous preparation was obtained by performing a fractionation procedure which eliminated the largest and the smallest molecules.

Fractionation of dextran isolated from the urine of patients given intravenous infusions of partially hydrolysed dextran revealed that molecules slightly larger than the magnitude of molecular weight 36,000 were excreted. Adsorption experiments with active carbon on some of the fractions indicated that the adsorption increases with decrease in molecular weight except in the series glucose, disaccharide, trisaccharide, etc., where adsorption increases with increasing molecular weight.

The clinical tests have shown that the result of shock treatment with dextran is good and that when required several litres of

dextran solution can be injected without the occurrence of injurious secondary reactions. The dextran concentration in plasma can rise to several per cent, in which case the concentration of protein can be appreciably lower than normal. The concentration of the colloids seems to adjust itself so that the colloidal-osmotic pressure of the blood becomes normal. A part of the blood-protein can consequently be temporarily replaced by dextran without inconvenience. Afterwards, new plasma protein is formed at the same time that dextran disappears from the blood.

Raw dextran is produced by *Swedish Sugar Corp.* by cultivating *Leuconostoc mesenteroides* in sterile sugar solutions. The very high molecular dextran formed in the sugar solution is precipitated with alcohol. It is partially hydrolysed with HCl and purified by several reprecipitations and filtrations through adsorbents after which the material is dried *in vacuo*. Solutions containing 6 per cent partially hydrolysed dextran and 0.9 per cent NaCl are prepared and sterilized at 100°C. Each batch of the product is so controlled as not to contain fractions of dextran with too high a molecular weight. Methods have been worked out for fractionation of the polymolecular dextran into products more homogeneous with respect to molecular weight.

### Jute Substitutes

WITH A VIEW TO FIND SUITABLE jute substitutes, an intensive study of various indigenous fibre plants is being conducted under an elaborate programme of research planned by the Indian Central Jute Committee. Extensive surveys of fibre plants from different parts of the country and abroad are in progress and the following plants so far collected are being studied for isolation and breeding of improved strains, varietal trials, inheritance characteristics, cultural methods and economics of growing the various crops, anatomical and cytological investigations, the incidence of pests and diseases, and technological examination of fibres: *Hibiscus cannabinus* (Mesta), *Boehmeria nivea* Ramie, Agave spp. (sisal).

Varietal trials on 5 improved sunn-hemp varieties and inherit-

ance studies on pigmentation, hairiness and leaf characters of *Hibiscus sabdariffa* (Rosella) are in progress in different parts of the country. A plantation of *Boehmeria nivea* (Ramie) has been set up at Chinsurah farm. Work on this is in progress along the following lines: isolation, selection and multiplication of desirable types, study of degumming and extraction process of the fibre by biological and mechanical means, economics of cultivation and evaluation of technological possibilities. A plantation of *Agave sisalana* is being set up and bulbils are being reared in the nursery for the purpose. Induction of polyploidy in *Sida*, *Urena*, *Hibiscus cannabinus* and *Hibiscus sabdariffa* are being carried out. Trials are in progress with different chemicals for hastening germination in slow germinating seeds. Incidence of a number of fungal and bacterial diseases on different fibre crops are being studied: *P. sabdariffa* and *Ceroospora hibisci* on *H. sabdariffa var altissima*, *Uromyces spp.* on *Crotalaria juncea*, fusarium on *Urea lobara* and *Crotalaria juncea*. Detailed studies on the biology of *Phenacoccus hirsutus* and *Spermothagus tessellatus*, the former a pest of *H. sabdariffa var altissima* and the latter a pest of mesta seeds, are also being conducted. An indigenous predator on *Phenacoccus hirsutus* has been located for biological control of the pest.

**Control of Tomato Hornworm**

THE CONTROL OF TOMATO HORNWORM on tobacco is described (*Sci. Agric.*, 1949, 29, 553). Flue-cured tobacco was used in all the experiments. Nicotine bentonite, synthetic cryolite, barium fluosilicate, calcium arsenate, lead arsenate, chlordane, benzene hexachloride and DDT were employed. The effects of varying strengths of the insecticides indicate that in the case of arsenate of lead, a thoroughly applied early spray was effective. Synthetic cryolite proved effective at a rate of 18 to 20 lb. per acre; because of its higher cost it cannot be widely used. DDT was by far the most effective, even at comparatively low concentrations (0.72 lb. per acre). Moreover, it did not leave much undesirable residue on the foliage as lead arsenate or cryolite.

**Central Pepper Research Station, Madras**

RESEARCH ON VARIOUS ASPECTS of pepper cultivation is to be undertaken in a Central Pepper Research Station to be established in Payannoor in North Malabar, Madras, with a view to rehabilitate the pepper industry in South India. The programme of work includes: collection of all existing varieties of pepper and the study of their agronomic and genetic characters; hybridization of promising varieties with the wild and cultivated types to evolve better types; comparative trials of varieties for vigour, yield, resistance to pests and diseases, etc.; study of relative merits of different cultural practices; study of manurial requirements; study of root system of the pepper plant in relation to soils and the effect of hydrogen ion concentration on the development of the system; study of the relative merits of different varieties; shade regulation in respect of yield; diseases of pepper; insect fauna that attack the root, stem, leaves, flowers and methods for their control; and study of the physiology of spike shedding.

**Disease-resistant Tobacco Hybrid**

NEW HYBRID TOBACCO PLANTS that are resistant to major tobacco plant diseases have been obtained in the United States by cross-breeding wild tobacco plants with domesticated species, the former being used as the pollen source and the latter as the female parent. The progeny has proved to be both stable and fertile (*USIS*).

**Announcements**

*Prof. M. S. Thacker*, Head of the Power Engineering Laboratory, Indian Institute of Science, has been appointed Director, Indian Institute of Science, Bangalore.

*Dr. H. S. Pruthi* and *Dr. S. Pradhan* were elected President and General Secretary respectively of the Entomological Society of India for the year 1950 at the Annual General Meeting of the Society held at Poona.

The following were elected office bearers of the Indian Ecological Society for the year 1950 at the Annual General Meeting of the Society held in Poona: President: *Dr. F. R. Bharucha*; Hony. General Secretary and Hony. Treasurer:

*Dr. B. S. Navalkar*; Hony. Jt. Secretary: *Dr. T. J. Job*.

*Dr. B. P. Pal* and *Dr. R. Misra* have been elected as President and Hony. Secretary respectively of the Indian Botanical Society for the year 1950 at the Annual General Meeting of the Society held during January 1950.

*Dr. B. B. Mundkur* and *Dr. R. Prasada* have been elected President (for 1950) and Secretary-Treasurer (for 1950-52) respectively of the Indian Phytopathological Society.

*Dr. Walter Baukloh*, formerly Professor of Metallurgy and Director of the Institute of Iron-metallurgy, Technical University of Berlin, has joined the Bengal Engineering College, Sibpur, as Professor of Metallurgy.

**Publications Received**

*Industrial Microbiology*, by S. C. PRESCOTT & C. G. DUNN, McGraw-Hill Book Co. Inc., 1949, pp. x + 386, price \$ 8.50.

*Organic Chemistry*, by G. B. BACHMAN, McGraw-Hill Book Co. Inc., 1949, pp. x + 432, price \$ 4.25.

*Elements of Thermodynamics & Heat Transfer*, by EDWARD F. OBER, McGraw-Hill Book Co. Inc., 1949, pp. xiv + 372, price \$ 4.50.

*Frequency Modulated Radar*, by DAVID G. C. LUCK, McGraw-Hill Book Co. Inc., 1949, pp. xviii + 466, price \$ 4.00.

*Theory of Wing Sections*, by IRA H. ABBOTT & ALBERT E. VON DOENHOFF, McGraw-Hill Book Co. Inc., 1949, pp. viii + 693, price \$ 15.00.

*Bengal in Maps*, by S. P. CHATTERJEE, Orient Longmans Ltd., 1949, pp. 105 + 1 flow sheet map, price Rs. 1/8.

*The Indian Handloom Weaving — Industry Annual*, 1949, by M. P. GANDHI, Gandhi & Co., 1949, pp. 67, price Rs. 1/8.

*Metal Market Review — 1949 Annual*, Calcutta, pp. xxxviii + 202, price Rs. 5.

*The Non-parasitic Disorders of Apple Fruit in Australia* (Bulletin No. 238, C.S.I.R., Australia), Council for Sci. & Ind. Research, Australia, 1948, pp. 83 + 24 plates.

*Synthetic Petrol*, by S. L. BHATIA, Indian Science News Series, Govt. College, Ludhiana (Punjab), 1949, pp. 92, price Rs. 2.



# INDIAN PATENTS

The following is a list of a few of the Patent Applications notified as accepted in the *Gazette of India*, Part II, Section 1, for February 1950.

## Organic Chemicals

41785. New naphthylpropionic acids and derivatives: *Reacting naphthyl-(2)-alkyl ketone with a halogen acetic acid ester in the presence of a metal and exchanging the hydroxyl group for hydrogen* — CIBA LTD.
42101. Recovery of organic liquids or solvents: *Mixing steam to the mixture of gases and solvent vapour and fractionating* — A.P.V. Co. LTD.
41511. Vat dyestuffs: *Dyeing with cobalt phthalocyanine or its substitution product as vat dyes* — BAYER & CAUER
40344. New dyestuffs for wool: *Sulphonating 2 = aryl=1': 9' = anthrapyrimidines which contain as substituent in the 6 position* — I.C.I. LTD.
42182. New cinnoline derivatives: *Reacting a pyrimidoaminocinnoline with a quaternating agent* — I.C.I. LTD.

## Food & Kindred Products

40058. Extractor for vegetable oils and process of extraction: *An extracting chamber and a collecting chamber and a filler between said chambers wherein the extracting chamber constitutes a space between said filler and a foraminated wall disposed concentrically to two chambers* — BEUTEN-MULLER

## Fuels & Lubricants

41106. Low temperature carbonization: *Maintaining the temperature of the gases and vapours in the off-tape above the condensation point of the components of the mixture* — STEINSCHLAEGER
41001. Process and installation for the manufacture of gas mixtures by gasifying fine-grained carbonaceous material: *Gasifying carbonaceous material in two reactors; the volume of one is much larger than the other and the principle applied is "cross-flow"*. — DE DIRECTIE VAN DE STAATSMIJNEN IN LIMBURG
40375. Carbonization process: *Injecting a gas-borne stream of coal particles into a fluid carbonization bed* — I.C.I. LTD.

## Leather & Leather Products

40609. Imitation leather: *Mixing aqueous disintegrated fibrous material with finely divided rubber particles and finally fabricating the mixture* — KEMP & UNDERFELTS, LTD.

## Drugs & Pharmaceuticals

40789. Manufacture of oestrone and intermediate products: *1-oxo-2-methyl-1:2:3:4:9:10:11:12-octahydro-phenanthrene-2-carboxylic acid ester is reacted with halogen acetic ester, water is spilt off, the resulting compound is hydrogenated and hydrolysed and finally treated with a cyclizing agent* — CIBA LTD.
41146. Insecticidal compositions: *Containing a*

*carrier and a dithiophosphate ester* — AMERICAN CYANAMID Co.

## Metal & Metal Products

41686. Method of welding aluminium: *Comprising continuously feeding aluminium wire to a point adjacent and spaced from a work piece, maintaining electric arc between wire and work piece, and delivering an inert gas to form an arc atmosphere* — AIR REDUCTION Co. INC.
41798. Fluxes for use in the treatment of light metals: *Comprising at least two chlorides of the group consisting of chlorides of the alkaline earth metals including magnesium, more than 20 per cent of the flux being barium chloride* — MAGNESIUM ELEKTRON LTD.
- 41811, 41824. Condensation of zinc from its vapour in gaseous mixtures: *Carrying out the condensation in two stages, viz. a first stage of surface condensation and a second stage of condensation in a mechanically produced shower of molten zinc. The gases from furnace brought into intimate contact with a spray of molten zinc below the dew-point for zinc, and gases thereafter passed through a vertical stack above the spray* — THE NATIONAL SMELTING Co. LTD.

## Paper & Allied Products

42093. Machine for the intensive opening of fibrous materials: *A striffing beater having on its periphery a series of flexible flaps extending radially therefrom, the beater moving at a higher peripheral speed than the taker-in* — T.M.M. (RESEARCH) LTD. & HUNTER

## Rubber & Rubber Products

42046. Vulcanizing rubber sheet: *Passing the sheet of rubber within a popularity of rollers whose axis lie along the edges of a prism and then vulcanizing the sheet while moving* — DUNLOP RUBBER Co. LTD.
42127. Apparatus for automatically cutting predetermined lengths of tubular or rod-like material: *Having a guide member having a plurality of holes for guiding the material, a cutting member adapted to traverse each of the said guide holes in turn* — DUNLOP RUBBER Co. LTD.

## Stone, Clay & Glass Products

42196. Manufacture of fibres of glass, slag, etc.: *Projecting molten material on a rotating disc and fibres projecting downwards are cut into determined lengths* — ALGEMEENE KUNSTVEZEL MAATSCHAPPIJ, NAAMLOOZE VENOTSCHAP

## Textile & Textile Products

42263. Double twist spindles: *A rotatable vertical spindle having an axial passage, a yarn guide*  
(Continued on page 142)

# Patented Inventions of the Council of Scientific & Industrial Research

## PRODUCTION OF NITROPHENETOLES & NITROANISOLES

B. B. DEY, T. R. GOVINDACHARI & H. V. UDUPA

NITROPHENETOLES AND NITROANISOLES ARE INTERMEDIATES for dyestuffs; *para*-nitrophenetole is also used in the production of phenacetin and other drugs.

### Patent No. 33473

The conversion of nitrochlorobenzenes to nitrophenetoles or to nitroanisoles is effected by heating with ethyl or methyl alcohol respectively in presence of alkali metal hydroxide and is characterized by the use of lead peroxide as a catalyst in the conversion. A minimum of one part by weight of lead peroxide for every four parts of nitrochlorobenzene is used. The proportions of the other ingredients are as follows:

(i) for the preparation of nitrophenetoles, 300 c.c. of 95 per cent ethyl alcohol for every 20 gm. of nitrochlorobenzene;

(ii) for the preparation of nitroanisoles, 200 c.c. of 95 per cent methanol for every 20 gm. of nitrochlorobenzene; and

(iii) 2.15 moles of sodium hydroxide for every mole of nitrochlorobenzene. In the case of nitrophenetoles, the heating is conducted for 15 hr. with gentle reflux using 0.67 N alkali. For nitroanisoles, the heating is for 20 hr. with gentle reflux using 0.67 N alkali or for 15 hr. using 0.89 N alkali.

### Patent No. 34411

Cuprous oxide is used as a catalyst in the process of conversion of nitrochlorobenzenes to the corresponding nitroanisoles or nitrophenetoles. High yields of the pure products have been obtained even when the amount of catalyst added is only 5 per cent by weight of the nitrochlorobenzene used. Thus, when 5 per cent of the catalyst is used, the yield of *para*-nitrophenetole is 90.1 per cent, of *para*-nitroanisole 96.8 per cent and of ortho nitrophenetole a larger proportion of the catalyst, 20 per cent and above, is necessary to secure good yields.

Nitrochlorobenzene (20 gm.) is catalytically reacted with ethyl or methyl alcohol in presence of sodium hydroxide (11 gm.) at boiling temperature with stirring for 15-20 hr.

### Patent No. 34754

Manganese dioxide is employed as a catalyst in the preparation of nitroanisoles and nitrophenetoles from nitrochlorobenzene. The method is effective in suppressing by-products and gives high yields. The manganese dioxide may be recovered completely and used over and over again.

20 gm. *para*-nitrochlorobenzene, 300 c.c. of 95 per cent ethyl alcohol; 11 gm. sodium hydroxide; 20 gm. manganese dioxide; stirring for 15 hr. at boiling temperature yields 19.5 gm. of *para*-nitrophenetole, m.p., 58°C.

## INDIAN PATENTS — Continued from page 141

*fast on the spindle, a yarn package carrier, a yarn guide on the carrier and vanes on the carrier* — REGINA

41387. Process and apparatus for printing textile fabrics: *Applying a film of insoluble glue to one side of a paper sheet, coating said glue film with a layer of fatty substance, colour printing the design on the treated side* — COLOMBO

### Miscellaneous

42120. Electrodes and processes for their manufacture: *Dry substance before addition of the binder is calcined to such an extent that in the baked electrode the dry substance and coke formed by the binder will have approximately same reactivity and electrochemical super-tension and will be moistened approximately to the same extent by the electrolytic bath* — ELEKTROKEMISK

41752. A tube-well boring machine: *Comprising a clamp to support the casing to be rotated and lowered, a rotatable body having vertical guides to engage the clamps and means for rotating the rotatable body* — CHAKRAVARTY

41025. Method of, and apparatus for, continuously digging coal: *Comprising simultaneous chipping and removing coal from region of the chipping operation* — SUNNYHILL COAL Co.

41212. Process and apparatus for carrying out reactions of gases with fine-grained substances: *Particles of fine-grained substance are carried out by gas in upward direction through a vertical column consisting of reaction spaces super-imposed upon each other in such a manner that gas current carrying the particles enters each of these reaction spaces in a direction inclined to vertical* — DE DIRECTIE VAN DE STAATSMIJNEN IN LIMBURG

41947. An improved chemical closet: *A set of pressure levers below closet seats operates means to rotate a rotor in the chamber containing chemical solution, when a person vacates the seats* — CHHAGAN, ISHWARLAL & VASAVADA

42425. Apparatus for treating gases with liquids: *The grids are spaced a short distance apart and the dripping liquid falling from upper grid on the lower grid produces ripple in it* — C.D. PATENTS LTD.

# Journal of Scientific & Industrial Research

V. 9B, No. 4, APRIL 1950

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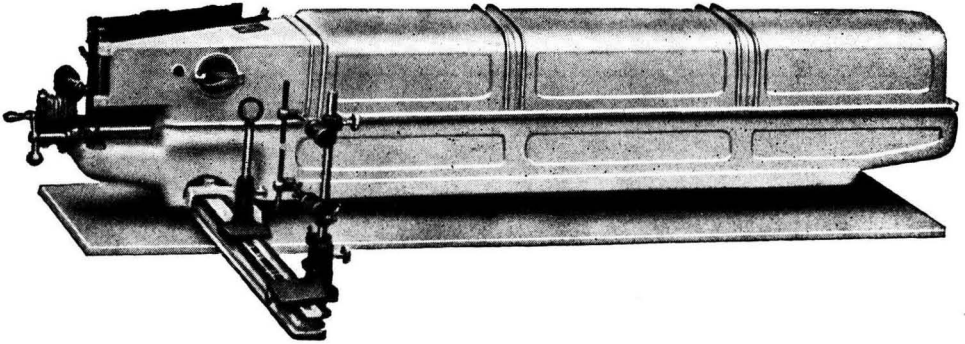
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# The Alkaloids of Indian *Stephanias* : Part I Isolation of Three Crystalline Alkaloids from the Tubers of *Stephania glabra* Miers

GOVIND RAI CHAUDHRY & SALIMUZZAMAN SIDDIQUI

Chemical Laboratories, C.S.I.R., Delhi

Three crystalline alkaloids provisionally named as gindarine,  $C_{21}H_{25}O_4N$ , gindarinine,  $C_{17}H_{19}(OCH_3)_4HNO$ , and gindaricine,  $C_{18}H_{19}O_3N$ , have been isolated from the tubers of *Stephania glabra*. Gindarinine possesses antibiotic activity in contrast to gindarine which is inactive.

**A**MONGST the *Stephania* species (N.O. *Menispermaceae*), *Stephania glabra*, *Stephania herandifolia*, *Stephania elegans* and *Stephania gracilentia* grow plentifully in India. They are all climbing shrubs which grow at altitudes of 3,000' to 8,000' above the sea level in the Himalayas, Khasi Hills in Assam and other hilly tracts throughout the country. There is a great deal of confusion in regard to the identity of the first two species, namely *Stephania glabra* and *Stephania herandifolia*, as the various parts of the two plants are alike except for slight variations in the leaf lamina, according to a private communication from Dr. S. N. Bal of Botanical Survey of India. Osmaston<sup>1</sup> as well as Parker<sup>2</sup> have mentioned that *Stephania glabra* possesses round tubers, but they have not noted this characteristic for either *Stephania elegans* or *Stephania gracilentia*. In view of the promising results obtained with one of the alkaloids, cepharanthine, isolated from *Stephania cepharantha* and *Stephania sasakii*, in the treatment of tuberculosis and leprosy as noted by Buchi<sup>3</sup>, and in view also to the lack of any reference in literature on the chemistry of the Indian *Stephanias*, the present investigation on

*Stephania glabra* was undertaken as a part of a general study of the alkaloids of the *Stephania* species.

*Stephania glabra* Miers (Hindi, *gindaru*) is a large, climbing shrub with greenish-yellow flowers and large tubers, sometimes a single tuber weighing up to 30 kg. Roxburgh<sup>4</sup> states that the acrid root is useful in the treatment of pulmonary tuberculosis, asthma, dysentery, fevers and intestinal complaints. It is also widely used by the hilly tribes for these ailments. As a result of the present investigations, the following alkaloids have been isolated in a crystalline form from the tubers.

1. Gindarine,  $C_{21}H_{25}O_4N$  [ $C_{17}H_{13}N(OCH_3)_4$ ], m.p., 147°C.;  $[\alpha]_D^{25} = -26.1^\circ$  in chloroform; isolated also in the form of its naturally occurring nitrate; yield 1.5 per cent on the weight of the air-dried powdered tuber.

2. Gindarinine nitrate isolated in the form of its naturally occurring nitrate salt conforming to the formula  $C_{17}H_{19}N(OCH_3)_4MNO_3$ . Yield, 1.2 per cent on the weight of the air-dried powdered tuber.

3. Gindaricine,  $C_{18}H_{19}O_3N$ ,  $C_{16}H_{13}ON(OCH_3)_2$ , m.p., 193°C.;  $[\alpha]_D^{25} = +137.0^\circ$  in alcoholic solution. Yield, 0.12 per cent on the weight of air-dried powdered tuber.

A crystallizate consisting of the naturally occurring nitrates of gindarine and gindarinine was obtained directly from the alcoholic extracts of the tubers on concentration under reduced pressure, removal of the fatty matter, and cooling the concentrate after addition of ether and petroleum ether or dilution with

water. The crude crystallizate, on repeated fractional crystallizations from methanol, finally gave gindarine nitrate melting at 222°C. from the less soluble fractions and gindarinine nitrate melting at 248°C. from the tail fractions. During the course of a number of workings, it was noted that whereas the extracts of fresh tubers yielded a crude crystallizate consisting of almost exclusively of gindarine nitrate, the air-dried tubers gave mainly the gindarinine salt. The filtrate from the initial crystallizate of the alkaloidal salts yielded a further quantity of gindarine, either as free base on basification with ammonia, or as its sparingly soluble iodide on treatment of the solution with potassium iodide. The final filtrate from either of these operations gave the bismuth iodide double salt on treatment with bismuth iodide in acidic medium. The double salt gave gindarine on decomposition with ammonia and working up in the manner described in the experimental. Alternatively, gindarine could also be isolated from the final filtrates through treatment with strong caustic alkali and extraction with ethyl acetate in nearly the same yield as obtained through the bismuth iodide double salt.

Gindarine is a mono-acidic base and yields well-defined crystalline salts. The naturally occurring salt of the base has been shown to be the nitrate through comparison with the salt directly prepared from the base. It contains four methoxyl groups, which account for all the oxygen atoms present in the base, and does not contain any  $\text{N-CH}_3$  group or active hydrogen. It could not be acetylated or benzoylated and failed to react with nitrous acid, which would indicate the base to be tertiary in character. With excess of methyl iodide in chloroform solution, the base gave a mono-methiodide. Gindarine could not be reduced either with tin and hydrochloric acid or catalytically with platinum black. The methoxyl value obtained in the case of gindarine is 3 per cent lower (found 31.9; required 35.0 per cent) but agreed well in the cases of both its nitrate and methiodide, the difference in the methoxyl value per group being only 0.25 per cent (found in nitrate: 27.6; required 28.7 per cent; found in methiodide, 23.8; required 24.9 per cent).

Due to the strongly basic character of gindarinine, it could not be liberated from

its salts with ammonia or caustic soda in the usual manner. Treatment of gindarinine nitrate with strong alcoholic alkali gave a crystalline base in the form of colourless needles melting at 141°C. which rapidly coloured on exposure to air or on crystallization from solvents, and could not be sufficiently purified for analysis. This base could, however, be converted back to the original nitrate on treatment with dilute nitric acid. It was further characterized through its various crystalline salts. It contains four methoxyl groups which account for all the oxygen atoms present in it.

Gindarine yields well-defined crystalline salts, and contains two methoxyl groups which account for two out of the three oxygen atoms present in the molecule. Preliminary experiments kindly carried out by Mrs. Osborn at the Sir William Dunn School of Pathology, Oxford, show that gindarinine nitrate possesses definite antibiotic action against staphylococcus. Results of further studies in the constitution of these bases will be dealt with in a subsequent communication.

#### Experimental

*Isolation of Gindarine & Gindarinine from the Fresh Tubers* — 3 kg. of finely minced fresh tubers were repeatedly percolated with alcohol at the room temperature for about 10 days. The combined percolates were concentrated under reduced pressure, and the dark greenish-yellow syrupy concentrate was repeatedly extracted with ether to remove the fatty matter. The ether-insoluble residue was diluted with water and kept in the cold when a large crop of crystals of the naturally occurring salt of gindarine (6.9 gm.) contaminated with darkish resinous matter separated out. On concentration of the combined mother liquors, a second crop of crystals was obtained, but much of the alkaloid remained in the solution and was precipitated out as its crystalline iodide by treatment with potassium iodide after acidification with acetic acid (5.0 gm.). In another working, the base was precipitated out from the mother liquors of the gindarine natural salt with ammonia but the separation of gindarine was more complete through the iodide, as it is less soluble in water than the free base. The crude base liberated from the iodide with ammonia was dissolved in alcohol and treated with ether and petroleum

ether to remove resinous impurities. The clear reddish-yellow filtrate was concentrated and kept in the cold, when crude gindarine crystallized out in the form of greenish hexagonal plates and prismatic rods melting at 142°C. The crude base was repeatedly crystallized from a mixture of alcohol, ether and petroleum ether, and finally from acetone, when pure gindarine was obtained in the form of rectangular hexagonal prismatic plates and prismatic rods which have slightly greenish tinge but give a colourless powder melting at 147°C.

The final filtrate from the precipitate of iodide, obtained above, was acidified with dilute hydrochloric acid and treated with a concentrated solution of bismuth iodide. The yellowish-orange micro-crystalline precipitate of the bismuth iodide double salt was filtered and washed with acidulated water. The double salt was macerated with 50 per cent aqueous potassium hydroxide and extracted with ethyl acetate. The ethyl acetate solution was washed with a small quantity of ice-cold water, dried over anhydrous sodium sulphate, concentrated on the water bath to a small volume and kept in the cold, when crude gindarine was obtained in the form of prismatic rods melting at 175°C. The crude base thus obtained was purified through the sparingly soluble iodide, repeated crystallization of the iodide from water (norit), liberation of the base from the pure iodide and subsequent repeated crystallization from benzene, when it was finally obtained in the form of colourless silky needles melting at 193°C.

*Isolation of Gindarine, Gindarinine Nitrate & Gindarinine from the Air-dried Tubers* — 8.5 kg. of air-dried, finely powdered tubers were repeatedly percolated with alcohol, and the syrupy concentrate obtained on removal of the solvent *in vacuo* was worked up in a similar manner as adopted in the case of the fresh tuber. The initial crystallizate (104 gm.) in this working was found to consist of a mixture of the naturally occurring salts of gindarine (30 gm.) and gindarinine (74 gm.) which were separated from each other through repeated fractional crystallization from dilute methanol. The combined mother liquors were treated with ammonia when a further quantity of crude gindarine was obtained as the free base (80 gm.). The final filtrate and washings were basified with 30 per cent sodium hydroxide and the base

extracted out with ether. At this stage a part of gindarinine crystallized out forming a middle layer between the ethereal layer and the alkaline layer. The crystals were filtered and washed with cold water (6.5 gm.). The ethereal layer was washed with a small quantity of water, dried over anhydrous sodium sulphate and concentrated on the water bath. The concentrate yielded a second crop of crystals (4.5 gm.) of gindarinine. The total yield of gindarinine after purification carried out as in the case of the crude base from the fresh tubers was 10 gm. (0.12 per cent on the weight of the air-dried powdered tuber).

*Characterization of Gindarine* — Gindarine is sparingly soluble in petroleum ether and ether, soluble in acetone and ethyl acetate in the hot and more readily in methanol and alcohol. It crystallizes from these solvents in the form of colourless rectangular or hexagonal prismatic plates and prismatic rods melting at 147°C., the form of crystals mainly depending upon the solubility of the base in the particular solvent and conditions of crystallization. On slow crystallization from alcohol, it forms prismatic hexagonal plates with a slightly greenish tinge. It shows  $[\alpha]_D^{25} = +26.1^\circ$  in chloroform solution. It does not give any colouration with ferric chloride in alcoholic solution. Comparative colour reactions of gindarine and gindarinine are noted in Table I. Found, C, 70.9; H, 7.1; N, 4.0; N-CH<sub>3</sub> (Herzig and Meyer), nil; OCH<sub>3</sub> (Zeissel), 31.9 per cent; M.W. (cryoscopic in benzol), 340; C<sub>21</sub>H<sub>25</sub>O<sub>4</sub>N requires C, 70.9; H, 7.0; N, 4.0; OCH<sub>3</sub> (for 4 methoxyls), 35.0 per cent; M.W. 355.

TABLE I — COLOUR REACTIONS OF GINDARINE & GINDARININE

REAGENTS	GINDARINE	GINDARININE
1. Conc. H <sub>2</sub> SO <sub>4</sub>	No colour, pink colour on heating	Colourless, changing to light yellow and no change on treating and dilution with water
2. Conc. H <sub>2</sub> SO <sub>4</sub> , KClO <sub>4</sub>	Yellow to golden yellow	Brownish yellow, fades on keeping
3. Conc. HNO <sub>3</sub>	Golden yellow	Golden yellow
4. Erdmann's reagent	Light yellow, no change on heating or dilution	Yellowish green changing to bluish green, on warming to deep blue, and on dilution changes to violet and finally to purple
5. Frohde's reagent	Yellow changing to light green	Steel grey changing to deep bluish green, on heating to marine blue, and on dilution to dirty green changing to brownish yellow

The naturally occurring gindarine salt after repeated crystallization of the initial crystallate from dilute alcohol was finally obtained in the form of slightly greenish yellow hexagonal plates and prismatic rods, m.p. 222°C. (decomp.). Found : C, 60.3 ; H, 6.1 ; N, 6.7 ; OCH<sub>3</sub> (Zeissel) 27.6 ; C<sub>21</sub>H<sub>25</sub>O<sub>4</sub>N.HNO<sub>3</sub> requires C, 60.4 ; H, 6.1 ; N, 6.9 ; OCH<sub>3</sub> (for 4 methoxyls), 28.7 per cent. The salt did not give any depression in melting point with gindarine nitrate prepared by the addition of potassium nitrate to a solution of the base in dilute acetic acid. The nitrate is readily soluble in dilute methanol or alcohol, fairly so in acetone and ethyl acetate in the hot, sparingly soluble in water and insoluble in ether or petroleum ether.

The hydrochloride was prepared by the addition of ethereal hydrochloric acid to an alcoholic solution of the base, when it came out as a snow-white flocculent precipitate. The precipitation was completed by the addition of ether. On crystallization from hot alcohol it formed colourless needles and prismatic rods melting at 245°C. (decomp.). It is fairly soluble in alcohol and in water in the hot, insoluble in ether or petroleum ether. The hydrochloride is also polymorphous in character like the base, the form of the crystals depending on the nature of the solvent and conditions of crystallization. Found : Cl, 9.3 ; C<sub>21</sub>H<sub>25</sub>O<sub>4</sub>N.HCl requires Cl, 9.1 per cent.

The hydroiodide, obtained by the addition of potassium iodide to a solution of the base in acetic acid, was crystallized from hot dilute acetic acid, when it came out as colourless rods and plates melting at 228°C. (decomp.). It is fairly soluble in hot alcohol, very sparingly so in water.

The hydrobromide separated out in the form of colourless rectangular plates on cooling a solution of the base in 1 per cent hydrobromic acid. It begins to darken in colour from 232°C. and melts with decomposition at 240°C. It is readily soluble in alcohol or methanol in the hot, sparingly so in water and insoluble in ether or petroleum ether.

The picrate was obtained by the addition of aqueous picric acid to an aqueous solution of gindarine hydrochloride as a brilliant yellow flocculent precipitate, which crystallized from dilute alcohol in bright-yellow silky needles melting at 188°C. (decomp.).

The chloroplatinate was obtained on addition of an aqueous solution of platinum chloride to a solution of the hydrochloride in 2 per cent hydrochloric acid, as a golden yellow flocculent precipitate which, when washed with water and dried on a porous plate, formed a light orange-yellow crystalline powder melting with decomposition at 212°C. It is sparingly soluble in water, insoluble in alcohol and acetone even in the hot. Found : Pt, 17.7 ; (C<sub>21</sub>H<sub>25</sub>O<sub>4</sub>N)<sub>2</sub>.H<sub>2</sub>PtCl<sub>6</sub> requires Pt, 17.5 per cent.

The sulphate was obtained in the form of colourless hexagonal plates by the addition of ether to a solution of the base in alcoholic sulphuric acid. It is exceedingly soluble in water and alcohol, m.p., 218°C. (decomp.).

The methiodide was obtained by treating 1.0 gm. of gindarine in dry chloroform solution with 3 c.c. of methyl iodide in the same solvent, and leaving the reaction mixture overnight at the room temperature. The methiodide precipitated out as a colourless crystalline powder on addition of ether to the reaction mixture. On crystallization from a mixture of chloroform, acetone and ether, it was obtained as colourless prismatic rods melting at 248°-49°C. (decomp.). It is easily soluble in chloroform, alcohol, acetone and in water in the hot. Found : C, 52.4 ; H, 5.6 ; N, 2.5 ; OCH<sub>3</sub> (Zeissel) 23.8 ; N-CH<sub>3</sub> (Herzig and Meyer) 5.8 ; I, 26.2 ; C<sub>21</sub>H<sub>25</sub>O<sub>4</sub>N.CH<sub>3</sub>I requires C, 53.1 ; H, 5.5 ; N, 2.8 ; OCH<sub>3</sub> (for 4 methoxyls), 24.9 ; N-CH<sub>3</sub> (for 1), 5.8 ; I, 26.1 per cent.

*Characterization of Gindaricine* — Gindaricine forms colourless silky needles melting at 193°C. (decomp.).  $[\alpha]_D^{20} = +137.0^\circ$  in alcoholic solution. It is readily soluble in alcohol, chloroform, acetone and ethyl acetate, fairly soluble in benzene, sparingly so in ether, petroleum ether and water. It crystallizes from benzene in aggregates of prismatic rods and clusters of needles. It gives a dark-blue colouration with ferric chloride in alcoholic solution. Found : C, 72.6 ; H, 6.4 ; N, 4.6 ; OCH<sub>3</sub> (Zeissel) 18.8 ; N-CH<sub>3</sub> (Herzig and Meyer) nil ; C<sub>18</sub>H<sub>19</sub>O<sub>3</sub>N requires C, 72.7 ; H, 6.3 ; N, 4.7 ; OCH<sub>3</sub> (for 2 methoxyls), 20.8 per cent.

The hydrochloride was prepared by the addition of ethereal hydrochloric acid to a solution of the base in absolute alcohol, when it came out as a snow-white silky crystalline mass in the form of scattered prismatic rods and needles. On crystalliza-



tion from alcohol it formed colourless silky needles melting at 232°C. It is readily soluble in water, sparingly so in alcohol in the cold, and fairly soluble in the hot. Found: Cl, 10.7;  $C_{18}H_{19}O_3N.HCl$  requires Cl, 10.7 per cent.

The picrate was obtained as bright-yellow prismatic rods and plates on the addition of ethereal picric acid to an alcoholic solution of the base. It is easily soluble in alcohol, and water in the hot and sparingly so in the cold. It melts with decomposition at 150°C.

The chloroplatinate was obtained as a cream-yellow flocculent precipitate on the addition of platinic chloride to a well-cooled solution of the hydrochloride in water. On keeping for some time it turned crystalline (star-like aggregates). It is appreciably soluble in hot water, and insoluble in alcohol. It melts with decomposition at 230°C. Found: Pt, 19.3;  $(C_{18}H_{19}O_3N)_2.H_2PtCl_6$  requires Pt, 19.4 per cent.

*Characterization of Gindarinine Nitrate*—After repeated crystallization from dilute methanol, pure gindarinine nitrate was obtained in the form of lemon-yellow needles melting at 248°C. (decomp.). It is readily soluble in alcohol, methanol and water in the hot and insoluble in ethyl acetate, ether and petroleum ether. Found: C, 60.3, 60.4; H, 5.5; N, 6.2;  $OCH_3$  (Zeissel), 29.4;  $N-CH_3$  (Herzig and Meyer), nil;  $C_{21}H_{22}N_2O_7$  requires: C, 60.8; H, 5.3; N, 6.7;  $OCH_3$  (for 4 methoxyls), 30.0 per cent.

The hydrochloride was obtained as orange-yellow needles on the addition of concentrated hydrochloric acid to an aqueous solution of gindarinine nitrate. On crystallization from

dilute methanol, it formed clusters of orange-coloured needles and prismatic rods melting at 215°C. with decomposition. It is readily soluble in alcohol, methanol and in water in the hot, and insoluble in ether or petroleum ether.

The hydroiodide was prepared by the addition of potassium iodide to a solution of gindarinine nitrate in acetic acid. On crystallization from dilute alcohol it formed golden-yellow silky needles, which sintered at 220°C., softened at 235°C. and melted with decomposition at 245°C. It is fairly soluble in alcohol, acetone and water, and readily soluble in aqueous acetone, dilute alcohol and methanol.

The picrate was obtained by the addition of aqueous picric acid to a dilute alcoholic solution of gindarinine hydrochloride as a brilliant lemon-yellow crystalline mass, which crystallized from alcohol in lemon-yellow needles melting at 220°C. (decomp.).

The chloroplatinate was obtained as a cream-yellow crystalline mass on the addition of an aqueous platinic chloride to a well-cooled solution of gindarinine hydrochloride in dilute hydrochloric acid. It is soluble in alcohol, and water in the hot, and melts with decomposition at 276°C.

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# Studies in the Conessine Series: Part 10— Action of Fuming Nitric Acid on Conessine

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The base obtained from conessine by the action of ice-cold fuming nitric acid may be represented as  $C_{21}H_{31}N_2O_4N(CH_3)_2$ , corresponding to dihydro-apoconessine-nitrosate. The change is brought about by the splitting of the ring nitrogen atom along with its N-methyl, and subsequent formation of the nitrosate.

FROM the results of previous studies<sup>1</sup> on the action of concentrated sulphuric acid, nitric acid, potassium permanganate, chromic acid and bromine on conessine, Siddiqui and co-workers showed that the carbocyclic nucleus of conessine, suggested by Spaeth and Hromatka<sup>2</sup>, to consist of condensed hydro-aromatic ring systems, was extremely resistant to the action of these reagents. On the other hand, pyrolysis of conessine-hydriodide carried out by Siddiqui and Sharma<sup>3</sup> yielded a hydrocarbon, conesen,  $C_{21}H_{30}$ , due to the thermal instability of the basic nitrogen atoms in the conessine molecule. For the same reason dehydrogenation of conessine is extremely difficult, and extremely low yields of basic products (0.3 per cent) are obtained. In regard to the results of dehydrogenation of conesen, we are in complete agreement with Haworth and co-workers<sup>4</sup> and due to the inexplicable difficulties encountered in the purification of the lower melting hydrocarbon as also noted by Haworth *et al.*, this line of attack was not pursued further by us. However, in order to obtain degradation bases of conessine with the nitrogen atoms intact, it was considered desirable to study the action of fuming nitric acid on conessine under more drastic conditions than hitherto employed, and the present communication deals with the results of these investigations.

When conessine is dissolved in ice-cold fuming nitric acid and the solution carefully evaporated on a watch glass over a water bath, a pale-yellow brittle powder is obtained

which is soluble in water, ammonia or dilute caustic alkalies and gives, on concentration of its aqueous solution, a crystalline nitrate. The base liberated from the nitrate and a number of salts prepared from it are crystalline in character. The analytical data of the base are in agreement with the formula  $C_{23}H_{37}N_3O_4$ . It is saturated to bromine and does not give an immediate colouration with tetranitromethane in chloroform solution. The base contains one basic nitrogen and only two N-methyls as against two basic nitrogen atoms and three N-methyls present in the original base and may be represented as  $C_{21}H_{31}N_2O_4N(CH_3)_2$ , corresponding to dihydro-apoconessine-nitrosate. These changes have been, apparently, brought about by the splitting of the ring nitrogen atom along with its N-methyl and the subsequent formation of the nitrosate.

## Experimental

1.5 gm. conessine was dissolved in 5.0 c.c. of ice-cold Schering-Kahlbaums's fuming nitric acid (d, 1.48) on a watch glass and the solution was carefully evaporated to dryness on a boiling water bath. The pale-yellow brittle mass thus obtained (1.3 gm.) was extracted with water several times till only a negligible amount of brownish resinous mass was left behind. The yellow-coloured aqueous solution, after concentration and keeping in the cold, gave a white crystalline mass, sparingly soluble in water, which, on recrystallization from the same solvent, yielded colourless, pentagonal plates melting at 235°C. (decomp.); yield 0.35 gm. The mother liquors were made alkaline with caustic soda when a flesh-coloured precipitate, which yielded a small quantity of nitroconessine, was obtained.

In the course of attempts to increase the yield of the crystalline nitrate, it was noted that while repeated treatment of conessine in the above manner made little difference in the yields, slight changes in the density of

nitric acid considerably lowered the yield of the nitrate. The pure nitrate (m.p. 242°C. decomp.) obtained after a few crystallizations from water was dissolved in dilute acetic acid and the solution was made alkaline with ammonia. The white precipitate obtained was filtered, washed with water and dried on the porous plate. On crystallization of the dried base from methanol, it melted at 183°C.

*Dihydro-apoconessine-nitrosate*,  $C_{21}H_{31}N_2O_4 \cdot N(CH_3)_2$  — The base is sparingly soluble in ether and petrol ether, fairly soluble in acetone and methanol in the hot and exceedingly soluble in chloroform. It crystallizes from ethyl acetate or acetone in colourless rectangular plates. Found : C, 65.8 ; H, 9.2 ; N, 11.2 ;  $N-CH_3$  (after Herzig and Meyer), 6.5 ;  $C_{23}H_{37}N_3O_4$  requires : C, 65.8 ; H, 8.8 ; N, 10.2 ;  $N-CH_3$  (for 2 methyls), 7.1 per cent.

It does not give any colouration with tetranitromethane in chloroform solution but develops a pale-yellow colour on keeping the solution for 10 min.

The hydrochloride, prepared by the addition of ether to a solution of the base in alcoholic hydrochloric acid and subsequent crystallization of the precipitate from alcohol, acetone and ether mixture, came out in the form of colourless silky needles melting at 241°C. (decomp.). It is easily soluble in water, alcohol or methanol. Found : Cl, 8.1 ;  $C_{23}H_{37}N_3O_4 \cdot HCl$  requires Cl, 8.0 per cent.

The hydriodide was obtained as a white crystalline precipitate on the addition of a concentrated potassium iodide solution to a solution of the base in dilute acetic acid. On

recrystallization from water, it is obtained as colourless rectangular plates melting at 259°C. (decomp.). Found : I, 23.4 ;  $C_{23}H_{37}N_3O_4 \cdot HI$  requires I, 23.9 per cent.

The chloroplatinate is obtained as a light-orange coloured precipitate when a solution of platinic chloride was added to an aqueous solution of the hydrochloride of the base. It begins to darken from 235°C. onwards and melts at 259°C. with decomposition. Found : Pt, 16.1 ;  $(C_{23}H_{37}N_3O_4)_2 \cdot H_2PtCl_6$  requires Pt, 16.0 per cent.

The picrate is obtained as a bright-yellow crystalline powder by the addition of aqueous picric acid to an aqueous solution of the hydrochloride of the base. It shrinks at 156°C., sticks to the sides at 159°C. and melts down at 159°C.

The methobromide was prepared by the addition of ether to a solution of the base and methyl bromide in chloroform solution. After recrystallization from alcohol, acetone and ether mixture, it was obtained in the form of colourless silky needles melting at 261°C. (decomp.). Found :  $N-CH_3$ , 8.1 ; Br, 16.1 ;  $C_{23}H_{37}N_3O_4 \cdot CH_3Br$  requires  $N-CH_3$  (for 3 methyls), 9.0 ; Br, 16.0 per cent.

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# Chemical Examination of Depolymerized Castor Oil Gel

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**Depolymerization of castor oil gel at 350° to 370°C. gives a dark viscous liquid containing unsaturated derivatives of mono- and dicarboxylic acids, aldehydes and hydrocarbons.**

WHEN castor oil is subjected to prolonged heat treatment in the presence or absence of dehydration catalysts, it undergoes a series of changes, ultimately resulting in an insoluble reddish-yellow gel. No industrial uses existed for this material till Ranganathan and Siddiqui<sup>1</sup> recently developed a heat-treatment process for converting the gel into a soluble viscous liquid which could be utilized in the manufacture of varnishes, enamels, paints, adhesives, waterproofing compositions and like materials. The present investigation was undertaken with a view to examine the nature of the constituents of this depolymerized liquid product.

Bussy and Lecanu<sup>2</sup> observed that the gelatinous residue left over after the distillation of castor oil decomposes on further heating. A study of the decomposition products of glycerides and of metallic and organic derivatives of vegetable oils have been made<sup>3,4</sup> employing temperatures ranging from 500° to 600°C. or lower temperatures of the order of 200° to 300°C. with or without the addition of catalysts. In several of these cases it has been found<sup>5</sup> that the products of decomposition generally consist of hydrocarbons. Rice and Murphy<sup>6</sup> have studied the pyrolysis of substituted cyclohexenic compounds and have shown that in some cases there is a rupture of the ring itself. As the temperatures employed by Ranganathan and Siddiqui<sup>1</sup> were much lower than those used by previous workers, the chances of the rupture of the ring can be excluded.

As the usual Twitchell's lead salt alcohol did not give a satisfactory separation of the products of depolymerization, distillation under reduced pressure and fractional precipi-

itation methods have been adopted for the separation of various constituents.

2 kg. of castor oil gel was heated in a wide-mouthed, round-bottom flask in an air bath to 300°C. No noticeable change was brought about in the gel even on prolonged heating at this temperature. On raising the temperature to 350°C. for about 15 to 30 min. there was a sudden rise of temperature with evolution of vapours, and liquid patches formed on the surface of the gel. At 370°C. the entire gel was gradually transformed into a viscous liquid. This process took about 2 hr., and the resultant product was a dark viscous liquid having the following characteristics :

Refractive index (32°C.)	1.493
Acid value	75.5
Saponification value :	
½-hr. heating	180.5
4-hr. heating	198.2
Iodine value (Wijs)	67.9
Acetyl value	4
Diene value (Ellis and Jones)	nil
Water-soluble acids	1.0%
Water-insoluble acids	88%
Unsaponifiable matter	7.6%

1. *Oxidation Products* — The depolymerized material was treated with alkaline potassium permanganate by the modified Bertram's method. The residue of oxidized acids was only partly soluble in petrol ether, the rest being soluble in ether sulphuric, the two fractions having the following characteristics :

	Petrol ether fraction	Ether sulphuric soluble fraction
Yield of oxidized acids, %	13.5	41.46
Iodine value (Wijs, 2 hr.)	78.41	11.12
Saponification value (4 hr.)	200.6	244.5
Saponification equivalent	279.1	229.1

2. *Isolation of Free Acids from Depolymerized Castor Oil Gel & Their Separation by Twitchell's Method* — 50 gm. of the material was refluxed for 6 hr. with excess of alcoholic potash. The alcohol was distilled off and the soap dissolved in water. The unsaponifiable matter was extracted with

ether, and the soap solution decomposed with dilute sulphuric acid in an atmosphere of nitrogen. The fatty acids were extracted with ether and dried *in vacuo* at 100°C.; yield 43 gm. 40 gm. of the acids were subjected to Twitchell's lead salt-alcohol process as described by Hilditch<sup>7</sup>. A portion (A) of the lead salt was insoluble in hot alcohol and was separated from the soluble salts by decanting off the supernatant liquid and repeatedly digesting the residue with hot alcohol. The combined alcoholic solution was cooled overnight in a refrigerator and the insoluble lead salt which separated out at this stage (B) was filtered. The acids liberated from fractions A and B of the lead salt with dilute H<sub>2</sub>SO<sub>4</sub> were in both cases insoluble in ether, petrol ether, alcohol, ethyl acetate, chloroform and carbon tetrachloride, and only partly soluble in benzene. A part of the acids could not, therefore, be extracted with benzene and was left over undissolved with the lead sulphate. The alcoholic mother liquor of fraction B gave, on removal of the solvent, the residual lead salts, from which the acids were liberated with dilute H<sub>2</sub>SO<sub>4</sub> and extracted with ether. The characteristics of the total acids and of the various acid fractions are given below :

	Iodine value	Neutralization value	Neutralization equivalent
1. Total acids	70.3	184.2	304.2
2. Benzene-soluble acids from fraction (A)	41.6	269.5	207.8
3. Benzene-soluble acids from fraction (B)	45.8	168.1	332.9
4. Acids from the alcohol-soluble lead salt	28.0	189.9	294.9

3. *Preparation of Methyl Esters of the Total Acids & Their Separation* — A mixture of 200 gm. total acids, 800 gm. absolute methyl alcohol and 10 c.c. concentrated H<sub>2</sub>SO<sub>4</sub> was refluxed on water bath for 4 hr., in the course of which a portion of the methyl esters settled at the bottom. The methyl alcohol was distilled off, the residue was taken up in ether, and the ethereal solution, after being first washed with dilute sodium bicarbonate solution and then with water, was dried over anhydrous sodium sulphate. Methyl esters were obtained in nearly theoretical yield on distilling off the solvent from the filtrate and were separated in various fractions as follows.

(i) *Distillation Method* — 61.5 gm. of total methyl esters were distilled at a pressure of

8 mm. Only a very small fraction could be distilled up to a temperature of 260°C., beyond which the esters crack. The characteristics of the residue and the distillate are given below :

	Total methyl esters	Distillate	Residue
Quantity (gm.)	61.5	4.02	57.2
Saponification value	178.1	290.5	169.6
Saponification equivalent	315.0	192.9	330.7
Iodine value (Wijs)	63.4	63.64	64.75
Iodine value (Woburn's)	...	68.3	77.3

(ii) *Fractional Precipitation Method* — 300 gm. of the residual methyl esters left over after distilling off the comparatively more volatile fraction *in vacuo* were dissolved in 600 c.c. of benzene. To this solution was added a 1 : 1 mixture of acetone and 99.5 per cent methyl alcohol, equivalent to 10 times the volume of the esters, followed by the addition of a small amount of water till opalescence just developed. An additional measured quantity of water was then added and the mixture set aside for 2 hr. at room temperature (25°C.). The supernatant liquid was decanted and the heavier precipitated portion freed from solvent by evaporation on a steam bath *in vacuo*. This formed fraction I. Eleven further fractions were obtained by successive addition of measured quantities of water to the decanted liquid according to the procedure described above. From the final decantate, the last fraction (No. 13) was obtained through complete removal of the solvent. Of these fractions, the first was a dark-brown viscous liquid and the last a pale-yellow mobile liquid. The rest of the fractions showed a regular gradation of colour and viscosity. The physical and chemical characteristics of the various fractions are given in Table I.

The last three fractions (11 to 13), forming a total of 68 gm., were dissolved in 40 c.c. benzene and 250 c.c. of methyl alcohol and separated into 5 fractions by gradual addition of water. The chemical and physical characteristics of these fractions are given in Table II.

A portion of the fraction No. 3 (Table I) was hydrogenated in the presence of platinum catalyst, when it was found that 3.24 atoms of hydrogen are added on to a molecule of the ester (with reference to the molecular weight of the fraction), which is in close agreement with the results obtained for unsaturation by the iodine value (Wijs).

TABLE I

FRACTION NO.	AMOUNT OF WATER ADDED FOR EACH FRACTION	AMOUNT %	MOL. WT. (RAST'S)	SAP. VALUE 4 hr.	SAP. EQUIVALENT	IODINE VALUE (WIJS)	IODINE VALUE (WOBURN)	BASICITY	NO. OF IODINE ATOMS USED PER MOLECULE
1.	20	10.3	872.4	116.7	468.1	67.2	91.2	1.86	4.61
2.	20	3.14	768.5	132.3	423.3	66.3	79.56	1.82	4.01
3.	40	4.9	662.5	135.7	412.7	70.13	73.0	1.61	3.66
4.	40	5.47	610.0	140.0	400.0	74.60	...	1.53	3.58
5.	40	7.71	615.0	140.2	383.0	77.60	...	1.61	3.76
6.	60	9.34	610.1	149.5	374.5	78.3	...	1.63	3.76
7.	60	9.63	576.6	152.2	368.1	76.5	...	1.57	3.49
8.	60	6.33	531.0	170.4	328.7	73.24	...	1.62	3.06
9.	60	7.03	537.0	170.9	327.8	75.75	...	1.64	3.00
10.	60	5.48	514.2	177.7	315.2	67.97	...	1.63	2.76
11.	240	11.55	392.0	198.2	282.6	43.72	...	1.39	1.35
12.	240	5.33	345.3	209.7	267.1	40.77	54.59	1.31	1.11
13.	Evaporated	12.13	309.0	223.8	250.2	43.33	62.44	1.24	1.05

TABLE II

FRACTION NO.	AMOUNT %	MOL. WT. (RAST'S)	MOL. WT. CRYOSCOPIC	SAP. VALUE	SAP. EQUIVALENT	IODINE VALUE (WIJS)	IODINE VALUE (WOBURN)	BASICITY	NO. OF IODINE ATOMS USED PER MOLECULE
A	19.3	382.1	512.1	197.1	284.6	29.3	71.3	1.34	0.88
B	8.5	370.7	426.0	207.3	265.3	34.3	66.0	1.4	1.001
C	9.8	353.1	444.0	214.5	256.4	32.75	64.3	1.38	1.147
D	11.7	326.0	456.0	223.0	246.2	38.0	68.7	1.32	0.9543
E	40.1	305.0	484.3	225.6	243.6	34.87	109.5	1.26	0.8358

NOTE: The residue of 10.6 per cent of methyl esters could not be separated from the solution by further addition of water.

Discussion

1. The liquid product obtained through the depolymerization of castor oil gel by the method of Ranganathan and Siddiqui consists of a large proportion of carboxylic acids and their derivatives along with some hydrocarbons and aldehydes.

2. The results of Bertram oxidation method of the gel show that it is not possible to remove the entire unsaturated acids from the depolymerized material. The saponification and iodine values of the petrol ether-soluble fraction of the residual acids indicate that they may be the original unreacted portion. The low iodine value and high saponification value of the ether-soluble portion lead to the conclusion that cleavage by oxidation might have taken place at the double bond in the side chain. The iodine value 11.1 may be due to the presence of a sticky double bond in the cyclic nucleus of the acid molecules.

3. The usual Twitchell's lead salt-alcohol method does not give a satisfactory separation of the total acids, the unusual behaviour being attributed to the absence of saturated acids and probably also to the cyclic nature of the component acids.

4. The methyl esters of the carboxylic acids can be separated by the fractional precipitation into comparatively more homo-

geneous fractions. Such a graded separation is not practicable by distillation.

5. The values for molecular weights determined by Rast's method are generally much lower than those obtained with the cryoscopic method (TABLE II). This conforms to the observations of other workers that products like the acid esters associate in benzene.

6. The basicity of various fractions (TABLE I) varies from 1.85 to 1.24. These values, along with their molecular weights, show that the heavier fractions consist mostly of mixtures of esters of dibasic acid resulting from the cracking of polymeric and dimeric acid chains, while the lighter fractions probably have a larger proportion of monobasic acid esters.

7. The iodine taken up by heavier fractions approximately corresponds to 2 double bonds, while the lighter fractions show an iodine equivalent of only 1 atom. The lighter fractions, therefore, may be primarily mixtures of acids having a sticky double bond in the nucleus, which is known to be resistant to halogen, and hydrogen addition.

8. The present work supports the observation of Araki<sup>8</sup> that, on pyrolysis at low temperatures, viz. 350° to 370°C., decarboxylation of the acids takes place to a very limited extent.

**Summary**

The depolymerization of castor oil gel at 350° to 370°C. by the method of Ranganathan and Siddiqui gives a dark viscous liquid which consists of a mixture of derivatives of dicarboxylic and monocarboxylic acids of an unsaturated character. They may have been derived from cracked and uncracked products of monomeric, dimeric and also polymeric linoleic acid glycerides. The depolymerized castor oil gel, in addition, consists of 7 to 8 per cent of unsaponifiable matter composed mainly of aldehydes and hydrocarbons.

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## Investigation on Indian Radioactive Minerals: I — Samarskite

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The formula  $R_2^{II}[(Nb, Ta)_2O_4]_2 \cdot 2R^{III}(Nb, Ta)_2O_4 \cdot R^{IV}(Nb, Ta)_2O_7$  has been assigned to the radioactive mineral samarskite on the basis of quantitative chemical analysis.

THIS paper deals with the chemical examination of the radioactive mineral samarskite collected by G. H. Tipper<sup>1</sup> from Sankara Mica Mine of Nellore district, Madras Presidency. The mineral also occurs in the district of Bangalore and Mysore in Mysore State and in Burma. In this laboratory some radioactive minerals<sup>2-4</sup> were analysed in order to determine their geological age from Pb/U ratio. Karunakaran and Neelkantam<sup>5</sup> published an analysis of Nellore samarskite, but the result is far from complete for assigning a chemical formula to the pure mineral. With this end in view, a complete chemical analysis of the mineral was undertaken after a careful examination of the various analytical methods proposed from time to time.

From a survey of the existing literature on samarskite, the Indian specimen from Nellore seems to be the purest and best.

The radiograph of the mineral (FIG. 1) is perfectly homogeneous, showing its purity. The mineral is velvet-black, of high lustre, its streak is dark reddish brown, hardness 5-6 and specific gravity 5.6.

**Method of Analysis**

Considerable time had been spent in the study of analytical methods suitable for making a complete chemical analysis. Of

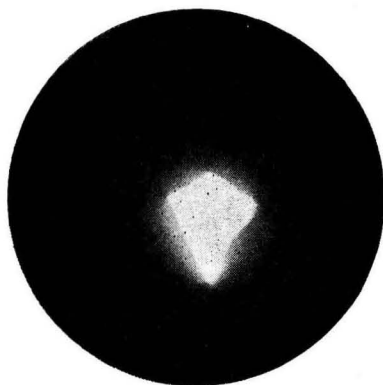


FIG. 1 — RADIOGRAPH OF SAMARSKITE.

all the methods<sup>6-9</sup> tried, the method of Schoeller and Powell<sup>9</sup> gives the most reliable result; the other methods sometimes give misleading values. In certain schemes of analysis, there is even no provision for determining some of the major constituents which leads one to get wrong values for the others. Experience with some methods again has shown that they are not so simple and clear-cut in their separations as the original description might lead one to suppose.

The mineral was crushed to pieces, selected crystals were freed from surface alteration matter, purified, powdered and passed through a 200 mesh sieve. The method of Schoeller and Powell was employed with some modifications. A complete scheme is appended. The alkalis were estimated by Lawrence Smith fusion method. Duplicate analyses were carried out and the mean values were used for the calculation of the chemical formula. No hexavalent uranium was found in the sample as was evident from its decomposition with hydrofluoric acid, when no uranium was detected in the soluble portion.

The analysis yielded the following results (TABLE I).

TABLE I—ANALYSIS OF SAMARSKITE FROM NELLORE

Nb <sub>2</sub> O <sub>5</sub>	44.54	ThO <sub>2</sub>	1.21
Ta <sub>2</sub> O <sub>5</sub>	8.03	CaO	0.81
TiO <sub>2</sub>	1.62	Y <sub>2</sub> O <sub>3</sub>	13.93
		(At. wt.=132.0)*	
SiO <sub>2</sub>	0.22	MnO	1.60
SnO <sub>2</sub>	1.48	PbO	2.04
Fe <sub>2</sub> O <sub>3</sub>	14.77	UO <sub>2</sub>	6.93
CaO	0.94	Na <sub>2</sub> O	0.29
MgO	0.03	K <sub>2</sub> O	0.21
Al <sub>2</sub> O <sub>3</sub>	0.79	Loss on ignition	0.29
		Total	99.73

\* The mean atomic weight was determined from the ratio: R<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>·8H<sub>2</sub>O : R<sub>2</sub>O<sub>3</sub> after converting the sulphate octahydrate to oxide.

### Chemical Formula

Samarskite was regarded for a long time as a pyroniobotantalate. Ramelsberg<sup>10</sup> gave the formula R<sub>3</sub><sup>II</sup>R<sub>3</sub><sup>III</sup>(Nb, Ta)<sub>6</sub>O<sub>21</sub> where R<sup>II</sup> = Fe, Ca, UO<sub>2</sub> and R<sup>III</sup> = rare earth metals. Groth regarded it essentially as a pyroniobotantalate of rare earth metals, R<sub>4</sub>[(Nb, Ta)<sub>2</sub>O<sub>7</sub>]<sub>3</sub>, the iron, calcium and uranium being more or less accessory constituents. According to Doelter<sup>11</sup>, it is, however, considered to be composed of orthoniobate of yttrium and pyroniobates of uranyl, calcium, iron, etc., so as to be Y<sub>2</sub>(Nb, Ta)<sub>2</sub>O<sub>3</sub>·R<sub>2</sub><sup>II</sup>(Nb, Ta)<sub>2</sub>O<sub>7</sub>.

(UO<sub>2</sub>)<sub>2</sub>(Nb, Ta)<sub>2</sub>O<sub>7</sub> where R denotes Ca as well as Fe. Hess and Wells<sup>12</sup> separated the mineral in two parts, the more radioactive part which makes up the larger part of the mass richer in U, Th, Fe, Ta and Ca, whereas the other part was richer in rare earths. The formula of the more radioactive part is essentially that of pyroniobate 2Y<sub>2</sub>O<sub>3</sub>·3Nb<sub>2</sub>O<sub>5</sub> or Y<sub>4</sub>Nb<sub>6</sub>O<sub>21</sub>, whereas the less radioactive part is nearer that of yttrium orthoniobate Y<sub>2</sub>O<sub>3</sub>·Nb<sub>2</sub>O<sub>5</sub> or YNbO<sub>4</sub>, with equivalent replacement of minor constituents. Imora and Hata<sup>13</sup> made a complete analysis of two Korean samarskite samples and gave a formula, R<sub>3</sub><sup>II</sup>[(Nb, Ta)<sub>2</sub>O<sub>7</sub>]<sub>2</sub>, 2R<sup>III</sup>(Nb, Ta)<sub>2</sub>O<sub>4</sub>, R<sup>IV</sup>(Nb, Ta)<sub>2</sub>O<sub>7</sub>. On calculation from the analytical data obtained by us, we arrived at the above formula given by the Japanese workers. Here the tetravalent radioactive constituents, viz. UO<sub>2</sub> and thoria take the form of pyroniobotantalate, while the other basic constituents, the orthoniobotantalate form. It corresponds to a composite salt consisting of two molecules of orthoniobotantalate and one molecule of pyroniobotantalate.

### Lead Content & Geological Age

The lead content of the mineral is much higher than that obtained by Sarkar and Sen Sarma<sup>4</sup>. The geological age of the mineral calculated by them from the Pb/U ratio is 836 million years, which is about the age of Gaya minerals. The Nellore samarskite is expected to be geologically much older. So it appears that the sample analysed by Sarkar and Sen Sarma possibly belongs to Gaya.

We extracted lead (as lead iodide) from several grams of the mineral and sent it to Prof. A. O. C. Nier of the University of Minnesota for the mass-spectrographic estimation of the lead isotopes. The geological age of the mineral will be published elsewhere.

Our grateful thanks are due to Prof. P. B. Sarkar for his keen interest and helpful suggestions and to the Council of Scientific & Industrial Research for financial help. Thanks are also due to the Director, Geological Survey of India, for supplying the mineral.

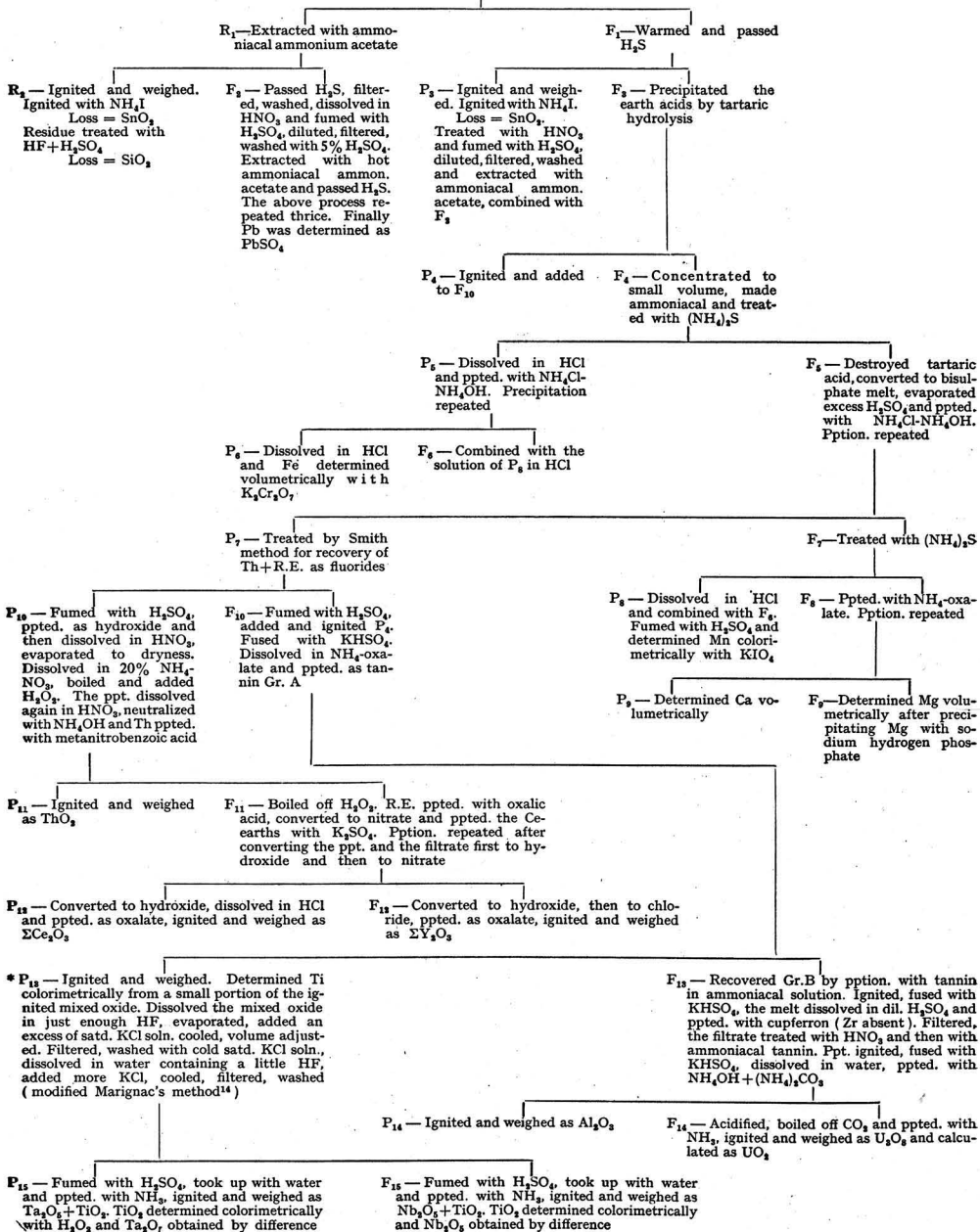
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AN OUTLINE OF THE SCHEME OF ANALYSIS

0.5 gm. mineral fused with NaHSO<sub>4</sub>, extracted with tartaric acid



\* Nb and Ta were also estimated by a modified method of Schoeller and Powell developed in this laboratory.



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## The Estimation of Coconut Oil in the Presence of Mineral Oils & Other Vegetable Oils

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The standard procedure for the estimation of coconut oil in adulterated samples by the determination of Reichert value (R) and Polenske value (P) gives erroneous results when the adulterant is a mineral oil. This has been traced to the interference of the mineral oil on the saponification of coconut oil. For ensuring complete saponification, it is essential that sufficient time should be allowed for the alkali to act on the oil mixture.

The percentage of coconut oil present in adulterated samples can be read off from standard curves in which the percentages of coconut oil are plotted against R + P values.

**M**INERAL oil, known in the trade as "white oil" has been imported in large quantities into India and being clear, colourless and odourless serves as an ideal and cheap adulterant for coconut oil. Though primarily intended as a vehicle for the preparation of hair oils and cosmetics, the unscrupulous merchants have been quick to use it to adulterate vegetable oils in general and coconut oil in particular. Realizing the grave consequences that are likely to follow from the continued ingestion of mineral oil by the public, the Government of India have recently banned its import into India, but considerable stocks have been distributed throughout the Madras province as is evident from the fact that samples of coconut oil and gingily oil collected under the Madras Prevention of Adulteration Act even from small towns have been found to be adulterated with white oil.

The qualitative detection of mineral oil is easily done by means of Holde's test<sup>1</sup> (cf. *Aids to the Analysis of Food & Drugs*, by Nicholls, 6th edition, p. 344). 10 drops of the melted fat are saponified in a flask under reflux with 5 c.c. of approximately N/2 alcoholic potash and to the clear hot soap solution water is added in successive quantities of about 1 c.c. The solution is carefully observed after each addition of water. In the case of vegetable oils the solution is clear after the addition of 5 c.c. of water, whereas in the presence of as little as 1 per cent white oil, the solution shows a faint opalescence. The turbidity is not appreciable for quantities less than 1 per cent, but is marked for quantities of 2 per cent and above. If the only vegetable oil present is coconut oil, the amount of white oil can be quantitatively estimated by determining the unsaponifiable matter. But the method is tedious and time consuming due to the formation of emulsions. Further the method does not identify the vegetable oil, or oils present in the mixture. The saponification value and the iodine value are useful in giving valuable preliminary information about the approximate proportion of vegetable oil and mineral oil, but the method of choice will be the one which estimates the coconut oil specifically.

Coconut oil (barring palm kernel oil) is unique in giving an average Reichert value of 8.0 and Polenske value of 16.0.

It would be expected that the determination of these figures in oil mixtures would straight-away give the percentage of coconut oil. Experiments show that this holds good in the case of mixtures containing coconut oil and a vegetable oil like groundnut oil which gives practically no Reichert and Polenske values. These values were determined according to the standard Polenske method using 5 gm. of the oil and glycerol soda for saponification. Table I gives the Reichert and Polenske figures obtained for some oil mixtures. It has been found convenient to take the sum of the Reichert and Polenske figures (R + P) as the basis for calculation purposes.

**TABLE I—REICHERT (R) & POLENSE (P) VALUES FOR COCONUT OIL-GROUNDNUT OIL MIXTURES**

COCONUT OIL, %	GROUNDNUT OIL, %	R	P	R + P	R + P (calculated)
0	100	0.2	0.1	0.3	...
5	95	1.3	0.6	1.9	1.2
10	90	2.0	1.0	3.0	2.4
20	80	3.5	1.8	5.3	4.8
30	70	4.6	2.9	7.5	7.2
40	60	5.6	5.1	10.7	9.6
50	50	6.1	6.0	12.1	12.0
60	40	7.1	8.0	15.1	14.4
70	30	7.7	10.0	17.7	16.8
80	20	8.0	12.0	20.0	19.2
90	10	8.2	13.7	21.9	21.6
95	5	8.7	14.5	23.2	22.8
100	0	8.6	15.4	24.0	24.0

If, on the other hand, instead of groundnut oil, mineral oil is present, saponification with glycerol soda does not go to completion as readily as in the case of vegetable oils or ghee. When ghee or a vegetable oil is mixed with glycerol soda and heated directly over the flame of a Meker burner, there is initially a frothing lasting for about 2 or 3 min. and the solution suddenly clears up showing the end of the saponification. In the case of mineral oil, there is more than one stage of frothing and the sudden clearing up is not observed. By continuing the heating for another 2 or 3 min. white fumes are evolved, but if the heating is discontinued at this stage, the resulting Reichert and Polenske values are sometimes too low and erratic. For example, a mixture containing 20 per cent coconut oil and 80 per cent mineral oil gave R + P values ranging from 0.5 to 10.0. Obviously the mineral oil interferes with the complete saponification of the coconut oil

and leaves one in doubt as to when heating has to be stopped.

The experiments were repeated by adding glycerol soda to the oil, keeping the flasks corked overnight and saponifying the contents the next day. After the initial simmering and frothing, a clear solution could be obtained, but to get concordant and reproducible values the heating was continued for a uniform period of 4 min. in each case. Table II gives the average figures obtained for coconut oil, mineral oil mixtures from four series of experiments using different mineral oils giving butyrorefractometric readings of 45.7, 63.2, 51.3, and 57.5 at 40°C. and coconut oil having a reading of 35.0. Though exactly reproducible values could not be obtained as in the case of Reichert Wollney value for ghee, duplicate estimations gave R + P values to an accuracy of  $\pm 1.0$  from the average figure given in Table II, column 5.

It may be pointed out that in the case of coconut oil-groundnut oil mixtures it makes no difference in the R + P values whether the oil mixture is saponified immediately after adding glycerol soda, or the next day after keeping the oil mixture in contact with glycerol soda overnight.

**TABLE II—REICHERT (R) & POLENSE (P) VALUES FOR COCONUT OIL-MINERAL OIL MIXTURES**

COCONUT OIL, %	MINERAL OIL, %	R	P	R + P	COCONUT OIL CALCULATED FROM R + P	APPARENT EXCESS OF COCONUT OIL, COL. 6 MINUS COL. 5
0	100	0.1	0.1	0.2	...	...
5	95	2.8	3.6	6.4	27	22
10	90	3.5	4.7	8.2	34	24
20	80	4.1	7.4	11.5	48	28
30	70	5.2	8.0	13.2	55	25
40	60	5.8	8.7	14.5	60	20
50	50	6.1	9.9	16.0	66	16
60	40	6.5	11.0	17.5	73	13
70	30	6.2	12.8	19.0	79	9
80	20	7.4	13.3	20.7	86	6
90	10	8.4	15.6	24.0	100	...
95	5	8.6	15.6	24.2	100	...
100	0	8.7	15.3	24.0	100	...

A comparison of Tables I and II above shows that in Table I the R + P value in column 5 increases proportionately with the amount of coconut oil, but in the case of mineral oil mixtures the R + P values in Table II are exaggerated, especially for mixtures containing less than 50 per cent coconut oil leading one to infer wrongly the presence of about 25 per cent more coconut

oil than is actually present. For mixtures containing more than 50 per cent coconut oil, the observed values are about 10 per cent higher than the actual amount present, but for mixtures containing small proportion of mineral oil, the R + P value is practically the same as for genuine coconut oil. In the latter case, the amount of coconut oil is calculated from the saponification value.

In order to seek an explanation for the peculiar behaviour of mineral oil, the R + P figure was determined by using instead of the usual 5 gm. smaller quantities of coconut oil, the other reagents used being the same as for 5 gm. The weights of oil correspond to the quantity present in 5 gm. of the mixtures given in column 1 of Table II. The values obtained are given in Table III.

TABLE III—R + P VALUES FOR VARIOUS QUANTITIES OF COCONUT OIL

WEIGHT OF COCONUT OIL, gm.	CORRESPONDING PERCENTAGE OF COCONUT OIL IN TABLE II	R	P	R + P
0.5	10	2.3	5.6	7.9
1.0	20	3.7	8.0	11.7
1.5	30	4.8	8.7	13.5
2.0	40	5.9	9.8	15.7
2.5	50	6.4	10.9	17.3
3.0	60	7.0	12.1	19.1
4.0	80	7.5	15.4	22.9

The R + P values in Table III correspond to the exaggerated values obtained for the respective percentages of coconut oil in Table II and not in Table I, showing thereby that in the presence of mineral oil the distillation of the volatile fatty acids tends to proceed as if only coconut oil is present; on the other hand, in the presence of the mixed fatty acids from groundnut oil the amount of volatile fatty acids distilled is proportional to the amount of coconut oil present.

In order to see whether there was any loss of mineral oil during saponification, 5 gm. of a mixture containing 4 gm. mineral oil and 1 gm. coconut oil was saponified as usual and allowed to cool. After acidifying with dilute sulphuric acid and extracting with petroleum ether, 90 per cent of the mineral oil could be recovered, thereby showing that the loss of mineral oil during saponification was only 10 per cent which cannot account for the increased R + P values obtained.

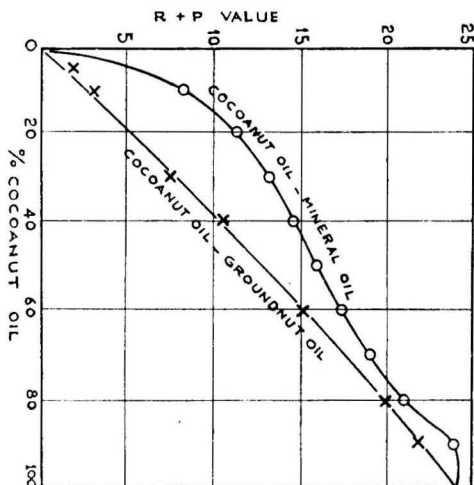


FIG. 1

Fig. 1 shows the curves obtained when the R + P values are plotted against the percentage of coconut oil when either groundnut oil or mineral oil is present as the adulterant. The percentage of coconut oil in an unknown mixture can be read off from the obtained R + P value.

The points of interest brought out by the above experiments are:

1. In the case of mixtures of coconut oil and another vegetable oil like groundnut oil, the saponification is effected in 2 to 3 min. and the R + P figures obtained are proportional to the amount of coconut oil.
2. Mineral oil (white oil) interferes with the complete saponification of the vegetable oil in the mixture, if the saponification is done immediately after the addition of glycerol soda.
3. If sufficient time is allowed for the alkali to act on the coconut oil, subsequent heating saponifies the oil completely.
4. In the case of mineral oil-coconut oil mixtures, the observed R + P value by adopting the method given in (3) above is about 25 per cent higher than the calculated figure for mixtures containing less than 50 per cent coconut oil and about 10 per cent higher when it is over 50 per cent. In such cases the actual percentage can be read off from a graph in which are plotted the percentages of coconut oil and the R + P values for known oil mixtures.

# Search for Plant Microfossils in the Magnesian Sandstone Beds of the Punjab Salt Range\*

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**The absence of microfossils in samples of magnesian sandstone collected from the Punjab Salt Range has been confirmed, and further experimental evidence adduced in support of the Tertiary age for the Salt Range.**

**T**HE controversy regarding the age of the Saline Series in the Punjab Salt Range is now about 60 years old.

The earliest worker on the geology of the Salt Range, Dr. Fleming (1853) of the *Geological Survey of India*, assigned it a Tertiary age, the same as that of Kohat Salt on the other side of Indus. But later A. B. Wynne (1878) and W. T. Blanford (1878) abandoned this view and the Saline Series was supposed to be of Cambrian age. Since then a number of geologists have contributed remarkably uniform views on this vexed problem. During recent years the controversy was again taken up by Dr. E. R. Gee on the one hand and the late Prof. Sahni and his co-workers on the other. Dr. Gee<sup>2-4</sup>, on the basis of his extensive field study of the area, upheld a Cambrian age for the Saline Series although earlier<sup>1</sup> he himself believed that this salt was deposited during Tertiary period. Prof. Sahni, however, approached the problem palaeobotanically and relying on the presence of plant fragments of the nature of cuticles, woody shreds, and also some Tertiary insect remains in the rock salt, salt marl, dolomites and oil shales of the Saline Series, ultimately decided in favour of a Tertiary age. The work on these lines produced a large amount of valuable literature which was discussed in two symposia<sup>5,6</sup> with the result that after the publication of these symposia, the consensus of opinion has turned round towards a Tertiary age for the Saline Series.

Recently Ghosh, Sen and Bose<sup>7</sup> have tried to re-examine the question of the age of the Saline Series. They have analysed samples

from the Saline Series and also from the Cambrian beds such as purple sandstone, neobolus shale, magnesian sandstone and salt pseudomorph shales which overlie the Saline Series. The reported discovery of post-Cambrian microfossils, especially in the Cambrian beds like purple sandstone, neobolus shale, magnesian sandstone and salt pseudomorph beds, has naturally aroused considerable interest; for, these finds are in contradiction to the findings of Sahni, his co-workers and others.

This note deals with the microfossil investigation of a sample of magnesian sandstone, carried out at the instance of Prof. Sahni in 1948. The work was done with a view to check upon the results quoted by Ghose, Sen and Bose on the recovery of a few carbonized wood pieces, with uni- to multi-seriate bordered pits, from magnesian sandstone sample 6292 collected from the eastern part of the Salt Range.

## Material

Sample S4 — a large slab of magnesian sandstone, with fucoid markings, collected by the Geology Department, Lucknow University, from Circuit House Hill, Khewra Gorge, Salt Range, Punjab, is bluish grey in colour, coarse grained, compact and hard.

*Technique* — The rock sample did not show any cracks or crevices. Small bits of rock were broken from inside all over the sample, ground and polished to avoid any foreign body sticking to the surface. These pieces were examined under a dissecting microscope for microscopic cracks. Pieces weighing about 8 gm. were taken up for each maceration. Each piece was exposed all over to a spirit lamp flame (wick of the spirit lamp is made of glass wool) for  $\frac{1}{2}$  min. and put in a clean maceration jar. To this jar about 20 c.c. of 4 per cent hydrochloric acid (filtered) was added and kept

\* An investigation carried out under the Scheme for Measurement of Geological Time.

covered under a bell jar. After a few days when the rock was completely broken down, the remaining acid was centrifuged out and the macerated material washed with filtered distilled water to eliminate all traces of the acid. This residue was treated with ammonia and the alkali was later eliminated by washing, and the material stained with a drop of safranin for 5 min. Excess of safranin was removed by repeated centrifuging. Finally the residue was spread out in smears on a number of clean slides under a glass cover. When the smear was dry the slides were mounted in Canada balsam.

Exactly similar procedure was adopted for maceration with hydrofluoric acid. The maceration was done in a platinum crucible. The excess of acid was neutralized by a concentrated solution of boric acid<sup>12</sup>.

Every possible chance of external contamination during maceration was avoided, care having been taken in the finer details of the procedure. Staining with safranin was done so as to distinguish all unstained contaminated plant matter in temporary and permanent preparations from the stained original microfossils of the rock. Before staining, great care was taken to avoid any possibility of contamination by external plant material. Occasionally a few dark grey or charred, also qualified as carbonized, pieces of organic fibres or tracheids may be found sticking to the slides due to imperfect cleaning of slides and coverslips. The original microfossils, on being treated with acid and alkali, become lighter in colour; moreover they are stained with safranin.

Over 60 permanent preparations and a number of smear slides were examined, but no microfossils were recovered. The results are negative and do not show any evidence of the existence of a land flora or of a post-Cambrian age for these rocks.

Great care must be taken in adopting this technique and much more caution is needed in the interpretation of the results. This technique if used with due care gives accurate results. By far the greatest danger in the use of this technique, even if practised with all due care, is the temptation to draw conclusions from scanty data.

#### Discussion

At the outset it is necessary to consider the implications of the investigations of Ghosh and others. In the Salt Range, a

set of four conformable Cambrian rocks lie unconformably over the Saline Series, i.e. purple sandstone, neobolus shales, magnesian sandstone and salt pseudomorph shales. These are, in turn, overlaid unconformably by the Talchir Boulder bed and other younger rocks.

Of the Cambrian rocks overlying the Saline Series, the neobolus shales contain Brachiopod and Trilobite shells; and in magnesian sandstone, *Stenotheca*, a mollusc of lower Cambrian age, is found. Hence, palaeontologically these rocks are of an undoubted Cambrian age. During Cambrian times there is no authentic record of the existence of land plants whatsoever. These rocks should, therefore, be completely devoid of microfossils of the nature of wood pieces or spores of land plants. Careful researches by Hsü<sup>8</sup> on purple sandstone and by Sahni, Lakhnupal and Bhardwaj on the salt pseudomorph beds<sup>14</sup> together with the findings of the author, have revealed that these rocks are totally devoid of any microfossils of a post-Cambrian age-index-value, i.e. pieces of tracheids, cuticles or spores. So far the results achieved by Lakhnupal on neobolus shale are also negative. But strangely enough, Ghosh and others claim to have recovered Tertiary plant microfossils from all the beds of the Cambrian series including the neobolus shale.

A perusal of the recent literature on this controversy will, however, reveal that the supporters of Cambrian school have all along relied on the stratigraphical evidence<sup>11,12</sup> and put forth numerous explanations to prove that the microfossils recovered by the palaeobotanists are simply contaminations. But at least with regard to the microfossils in the dolomites and the oil shales within the Saline Series, some of the leading supporters of the Cambrian school, like Gee, Coates, Crookshank, Ghosh and Pinfold have accepted their inability to advance any satisfactory explanation for their presence there. The evidence put forth by Sahni<sup>10,12</sup>, Sahni and Trivedi<sup>13</sup>, Trivedi<sup>15</sup>, Sitholey<sup>16</sup>, Lakhnupal<sup>9</sup> and Pratap Singh (in progress) from the Saline Series, especially the dolomites and oil shales, in the absence of any satisfactory evidence or explanation to the contrary, weighs heavily in support of the Tertiary age for the associated saline rocks. The results of Ghose, Sen and Bose are irreconcilable with our findings.

The full text of the paper by Ghosh, Sen and Bose containing details of the experimental technique employed has not been published so far and we, therefore, do not know what actual precautions they had taken to avoid external contamination.

At the end of their communication, Ghosh, Sen and Bose suggest that the conclusion drawn by Sahni on the age of the Saline Series should be revised in the light of their recent investigations. But they fail to realize that Sahni's microfossil evidence was not limited to maceration alone but was also extended to a study of microfossils lying *in situ* in numerous ground sections of the rocks investigated. It may be made clear that unless and until geologists have some satisfactory explanation for the process of contamination in such compact rocks as dolomites and oil shales, we have to abide by our findings.

#### Acknowledgements

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# Studies on Shark Liver Oil: II—Stability of Vitamin A

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Among the antioxidants tested for their effectiveness in minimizing vitamin A destruction in shark liver oil during storage, a mixture of isobutylgallate (0.2 per cent) and tartaric acid (0.01 per cent) was found to be the best. The protective action of the additive decreases with rise in the temperature of storage. Studies on molecularly distilled fractions of the oil show that vitamin A is relatively more stable in the 180°-220°C. fraction. The stability is correlated with the iodine number of the saponifiable fraction.

THE development of rancidity and the destruction of vitamin A in fats and oils proceed simultaneously<sup>1-9</sup> and is mainly due to oxidation<sup>10</sup>. The keeping quality of oils is consequently greatly influenced by the content of natural antioxidants<sup>11</sup>. Following the observations of Moureu and Dufraisse<sup>12</sup> that hydroquinone can increase the stability of oils, a large number of chemicals having similar antioxidative properties have been found and studied<sup>13-24</sup>. But the toxicity of many powerful chemical antioxidants prevents their use in edible products.

Most of the shark liver oils manufactured at present in India lose their vitamin A rapidly on storage<sup>25-27</sup>. Hence, a study of the methods of preservation of vitamin A in shark liver oil is of considerable importance to this growing industry. With this view, the comparative inhibiting properties of a few antioxidants used, either alone or in combination, with shark liver oil, stored at room temperature (28°C.) and at 50° ± 1°C. have been studied and the results are reported here.

## Experimental

The sample of shark liver oil used in this work was of the highest quality obtainable and had an initial vitamin A content of 26,000 I.U. per gram. It was filtered after neutralization and dried before use; acidity and moisture are known to lower the effi-

ciency of added antioxidants<sup>27</sup>. 10 gm. lots were taken into several clean, uniform, flat-bottomed, screw-capped bottles. Requisite amounts of antioxidants were weighed and incorporated with the oil after dissolving each antioxidant in a small quantity of a suitable solvent, generally alcohol.

Stability studies were carried out at (i) room temperature (28° ± 2°C.) and (ii) 50° ± 1°C. A thermostatically controlled incubator was used for the higher temperature. Samples of untreated oil were also kept at 0°C. in a refrigerator and at room temperature after wrapping the container bottle with brown paper so as to protect the oil from the effects of light. The antioxidant-treated samples at room temperature were also wrapped with paper so as to make possible comparison of results with those kept at 50° ± 1°C. The synergetic effects of certain mixtures of inhibitors have been reported by a number of workers, e.g. orcinol and phosphoric acid on lard<sup>28</sup>, hydroquinone and lecithin on halibut liver oil<sup>29</sup>, kamala dye and oleic acid on ghee<sup>30</sup>, and isobutyl gallate and citric acid on shark liver oil<sup>27</sup>. In the following studies, the effects of certain combinations of some of the best inhibitors reported for shark liver oil are presented.

The concentration of vitamin A was estimated<sup>31</sup> at weekly intervals during the first month of storage and, later monthly. Results are expressed as percentage loss (TABLES I-III).

As may be expected, the destruction of vitamin A was more in the oil exposed to ordinary conditions of light than when stored away from light (TABLE I). There was also more loss at higher temperatures<sup>22</sup>; this was true even in the presence of added antioxidants (TABLE III). Diphenylamine, vitamin E, ethyl gallate, thiourea and isobutyl gallate exerted inhibiting action in the initial stages (TABLE II). Except for tartaric acid, the combinations used with

**TABLE I — RELATIVE STABILITIES OF SHARK LIVER OIL SAMPLES : EFFECTS OF LIGHT & TEMPERATURE**

SAMPLE	TEMPERATURE, °C.	DESTRUCTION EXPRESSED AS PER CENT LOSS AT END OF							
		1 week	2 weeks	3 weeks	4 weeks	8 weeks	12 weeks	20 weeks	32 weeks
1. Oil, untreated (exposed to light)	28 ± 2	5.6	7.7	8.9	11.5	23.0	34.6	43.6	61.6
2. Oil, untreated (cut off from light)	do	4.6	4.6	7.7	8.9	19.2	27.8	37.8	52.7
3. Oil, untreated	0	nil	nil	nil	nil	1.9	3.0	...	10.5
4. Oil, untreated	50° ± 1	7.7	12.3	18.0	19.2	23.8	38.6	55.0	69.6

**TABLE II — RELATIVE STABILITIES OF SHARK LIVER OIL SAMPLES : EFFECTS OF ANTIOXIDANTS AT ROOM TEMPERATURE (28° ± 2°C.)**

ANTIOXIDANT	CONCENTRATION %	DESTRUCTION EXPRESSED AS PER CENT LOSS AT THE END OF							
		1 week	2 weeks	3 weeks	4 weeks	8 weeks	12 weeks	20 weeks	32 weeks
1. Gallic acid	0.02	nil	0.77	3.8	4.6	8.9	14.4	23.0	46.1
2. Hydroquinone	0.02	nil	...	2.7	4.6	9.6	11.5	18.0	45.1
3. Diphenylamine	0.002	nil	nil	1.2	3.8	4.6	11.6	18.0	45.1
4. Vitamin E	0.002	nil	nil	1.9	2.7	4.6	11.6	14.4	46.1
5. Lecithin	0.25	7.54	7.7	...	9.6	11.6	19.2	22.1	52.7
6. Ethyl gallate	0.02	nil	nil	1.2	2.0	5.0	7.7	11.6	42.5
7. Thiourea	0.02	nil	nil	1.2	2.0	10.0	11.5	19.2	46.1
8. Isobutyl gallate	0.02	nil	nil	0.81	...	2.7	4.7	12.3	...
9. Lecithin + hydroquinone	0.25 + 0.02	4.61	7.7	...	10.0	11.6	18.0	26.9	52.8
10. Isobutyl gallate + potassium dihydrogen phosphate	0.02 + 0.01	nil	nil	0.81	1.1	2.1	4.5	13.6	...
11. Isobutyl gallate + hydroquinone	0.02 + 0.01	nil	nil	1.8	2.7	...	5.8	12.5	...
12. Isobutyl gallate + tartaric acid	0.02 + 0.01	nil	nil	nil	1.8	2.0	2.7	8.0	...
13.* Isobutyl gallate + o-phosphoric acid	0.02 + 0.01	nil	nil	nil	2.7	...	...	...	...
14. Isobutyl gallate + lecithin	0.02 + 0.01	nil	nil	1.81	2.7	3.7	4.5	13.6	...

\* Discolouration of the oil and formation of black sediment.

**TABLE III — RELATIVE STABILITIES OF SHARK LIVER OIL SAMPLES : EFFECTS OF ANTIOXIDANTS AT 50° ± 1°C.**

ANTIOXIDANT	CONCENTRATION %	PER CENT LOSS AT THE END OF							
		1 week	2 weeks	3 weeks	4 weeks	8 weeks	12 weeks	20 weeks	32 weeks
1. Gallic acid	0.02	0.8	1.9	4.6	7.7	11.5	26.9	45.1	61.1
2. Hydroquinone	0.02	4.6	5.6	7.2	8.6	11.6	28.0	43.8	...
3. Diphenylamine	0.002	nil	2.6	3.6	4.2	8.9	19.2	43.8	58.8
4. Vitamin E	0.002	nil	0.77	1.9	3.8	8.9	19.2	40.0	59.6
5. Lecithin	0.25	5.6	7.7	7.8	10.0	14.4	26.9	44.6	60.3
6. Ethyl gallate	0.02	nil	0.77	1.9	4.2	7.7	19.2	45.1	59.6
7. Thiourea	0.02	1.9	5.6	7.8	7.7	11.6	18.0	43.1	55.3
8. Isobutyl gallate	0.02	nil	nil	3.5	5.0	6.3	8.0	19.3	...
9. Lecithin + hydroquinone	0.25 + 0.02	5.6	7.8	...	8.9	11.5	23.8	45.1	58.0
10. Isobutyl gallate + potassium dihydrogen phosphate	0.02 + 0.01	nil	nil	4.5	8.0	9.5	13.6	18.1	...
11. Isobutyl gallate + hydroquinone	0.02 + 0.01	nil	1.1	6.3	8.3	16.3	18.3	30.0	...
12. Isobutyl gallate + tartaric acid	0.02 + 0.01	nil	2.7	4.5	6.3	9.5	12.5	18.0	...
13.* Isobutyl gallate + o-phosphoric acid	0.02 + 0.01	nil	nil	1.8	6.3	...	...	...	...
14. Isobutyl gallate + lecithin	0.02 + 0.01	nil	1.1	6.0	8.0	9.5	13.6	20.3	...

\* Discolouration of the oil and formation of black sediment.

isobutyl gallate did not enhance its effectiveness against vitamin A destruction. Alkyl gallates, generally, could be used in practice without apparent harm, although no toxicity tests were carried out with this or the other antioxidants used.

*Accelerated Decomposition Tests with Molecularly Distilled Fractions of Shark Liver Oil*—The destructive action of ultra-violet light on vitamin A, first noted by Zilva<sup>32</sup> with butter and, later by Peacock<sup>33</sup>, Willmott *et al.*<sup>34</sup>, and others with cod liver oils, is very much more than the effect of exposure to daylight. Irradiation could, therefore, be employed to study accelerated decomposition for comparative purposes. Such results with samples of shark liver oil obtained as distillates at different temperatures in the cyclic still<sup>31</sup> are given in Table IV. 2.5 gm. lots of oil from each fraction, spread out evenly in a thin film in 10" petri dishes, were exposed to ultra-violet rays from a Hanovia unit for varying periods ranging up to 4 hr. when most of the samples had completely faded in colour. The decomposition of vitamin A is expressed as per cent loss (TABLE IV).

The stability of vitamin A in the various fractions could perhaps be positively correlated with the iodine value of the saponifiable fraction which could be gauged from a comparison of the values for the oil fraction and of its corresponding unsaponifiable matter. Thus, the stability of vitamin A is the most in the fraction 180°-220°C., the fraction below 180°C. coming next. The rate of destruction of vitamin A is the highest in the original shark liver oil and the fraction distilling between 220° and 240°C. These latter are also the fractions with the highest iodine values of the saponifiable matter. The melting point of total fatty acids is the highest in the fraction (180°-220°C.) yielding the maximum amount of vitamin A and there is close parallelism between the rate of destruction of vitamin A and the percentage of total unsaturated fatty acids.

### Summary

(1) Relative stabilities of vitamin A in shark liver oil are influenced by (a) light; (b) temperature and (c) antioxidants, either alone or in combinations at room temperature and at 50° ± 1°C.

TABLE IV—RELATIVE STABILITIES OF MOLECULARLY DISTILLED SHARK LIVER OIL FRACTIONS: EFFECT OF ULTRA-VIOLET LIGHT

FRACTION	INITIAL POTENCY, I.U./gm.	YIELD OF FRACTION, %	YIELD OF VITAMIN A PER FRACTION, %	DESTRUCTION EXPRESSED AS PER CENT LOSS AT THE END OF		
				1 hr.	2 hr.	4 hr.
1. Original shark liver oil	25,000	100.0	...	9.5	12.4	64.3
2. Distilled at below 180°C.	1,98,750	1.58	12.6	9.5	15.6	21.4
3. 180°-200°C.	7,25,000	2.47	72.6	6.3	12.7	13.8
4. 200°-20°C.	60,000	6.1	14.8	7.2	10.1	12.1
5. 220°-40°C.	4,000	10.5	1.6	1.7	11.7	44.4
6. Residual oil	...	77.38	...	...	...	...

Contrary to expectation, there is no marked relationship between the vitamin A potency and its rate of destruction during storage or as a result of accelerated decomposition and any of the following characteristics: free fatty acids, iodine value of unsaponifiable matter and peroxide number. Even the per cent unsaponifiable matter bears no relation to the vitamin A content of any fraction or its stability. It is possible, however, that stability is determined by the presence or absence of varying amounts of natural inhibitors whose quantities cannot be deduced from the data.

(2) Destruction of vitamin A was greater in the oil exposed to light than when stored away from light, and was more pronounced at higher temperatures.

(3) Of the antioxidants tried, the best combination was isobutyl gallate (0.02 per cent) and tartaric acid (0.01 per cent). The protective action of the antioxidants against vitamin A destruction was less at the higher temperature of storage although their general order of efficiency was the same at the two temperatures.

(4) Shark liver oil and various molecularly distilled fractions from it were subjected to

accelerated decomposition by exposure to ultra-violet light. The rate of destruction decreased with increasing temperature of distillation up to 220°C. The fraction collected above 220°C. was relatively more unstable than fractions collected up to 220°C.

(5) An attempt has been made to correlate stability results with the composition of the different fractions. Significant amongst the observations are: (a) lack of any relationship between per cent unsaponifiable matter and the vitamin content; (b) positive correlation between the iodine value of the saponifiable fraction and the stability of vitamin A in a particular fraction; and (c) parallelism between the rate of destruction of vitamin A and the per cent of the unsaturated fatty acids.

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## Foreign Fellowships & Scholarships

THE UNESCO HAVE RECENTLY ISSUED A publication entitled *Study Abroad* giving details of fellowships and scholarships offered by various countries and international organizations during 1949-50, 1950-51 and 1951-52.

Extensive surveys of programmes for short teaching abroad and workers exchange for educational and cultural purposes are also included. The publication can be had from UNESCO Office, University Buildings, Delhi.

# Letters to the Editor

## STUDY OF DIFFERENT METHODS FOR FERMENTATION OF SUGARS BY YEASTS

IN A NUMBER OF GENERA OF YEASTS, THE species are identified by sugar fermentations and Stelling-Dekker<sup>1</sup> used growth in Einhorn tubes to determine sugar fermentations. Generally 20 c.c. of a 2 per cent solution of sugar are used by the older workers (Henrici and Stelling-Dekker). Henrici<sup>2</sup> has repeatedly found yeasts to give a vigorous fermentation with large volumes (20 c.c.) while smaller volumes (2 to 3 c.c.) gave only slight or no fermentation due to the greater diffusion of oxygen which favours oxidation rather than fermentative respiration.

The present investigation was undertaken to determine optimum conditions for securing an economical, rapid and reproducible method of fermenting sugar by yeasts. A comparative study of the relative efficiency of the (a) Einhorn tube method and (b) Durham tube method and the new method developed by us is recorded here.

(a) *Einhorn Tubes (Old Type)*—The standard Einhorn tubes, as used by Stelling-Dekker, require 25-30 c.c. of reaction mixture (140 cm. × 15 mm.). For comparison we have used a smaller Einhorn tube holding only 4-5 c.c. of the reaction mixture.

(b) *Durham Tubes*—Henrici uses for these fermentation tests tubes of large diameter (100 mm. × 25 mm.) furnished with inverted Durham tubes (75 mm. × 10 mm.) containing 20 c.c. of medium.

Lindgren<sup>3</sup> has modified the method and uses test-tubes (100 mm. × 12 mm.) containing 3 ml. of a 4 per cent concentration of the carbohydrate and an inverted Durham tube (50 mm. × 7mm.).

For our work, we selected very small test-tubes (75 mm. × 10 mm.) with inverted inserts (Durham tubes) (25 mm. × 5 mm.) and 2 c.c. of a reaction mixture containing 2 per cent sugar was used for each tube.

## Material & Method

(a) The reaction medium of Spiegelman and Lindgren was employed for these studies and the medium was composed of

Yeast extract (Difco) ...	2 gm.
Ammonium sulphate ...	1 gm.
Peptone (Bacto. Difco's) ...	3 gm.
KH <sub>2</sub> PO <sub>4</sub> ...	2 gm.
MgSO <sub>4</sub> ·7H <sub>2</sub> O ...	0.25 gm.
CaCl <sub>2</sub> ...	0.13 gm.
Sodium lactate ...	1 c.c. of 50 per cent solution
Sugar ...	20 gm.

Total volume made up to 1,000 c.c. after adjusting the pH between 4.5 to 4.8.

The experiments were carried out with three different sugars—glucose, sucrose and maltose.

The following test organisms were used;

- (i) *Saccharomyces cerevisiae* 7 (N.C.T.C. 3006);
- (ii) *Torula utilis* 3 (N.C.T.C. 3055);
- (iii) *Saccharomyces carlsbergensis* (N.C.T.C. 3056); and
- (iv) *Torula lactosa* (N.C.T.C. 3057).

The organism taken from an actively growing slant was dispersed in saline and the turbidity adjusted to a constant in each case. The proportion of inocula was one-tenth the volume to be fermented in each case. Media was steam sterilized for an hour every 24 hr., for three successive days. After inoculation the tubes were incubated at 28°C.

The results indicate that the "new Einhorn tubes" and the "new Durham" tubes are more sensitive for the study of sugar fermentations. In addition they are less time-consuming and secure a great economy of the rare and expensive sugars now difficult to procure. We have adopted this method for a systematic study of the fermentability of sugars by yeasts and bacteria maintained in the *National Collection of Type Cultures (C.S.I.R.)*. Our grateful thanks are due to Mr. Sreenivasaya for his guidance and to the Council of

TABLE I

TYPE OF FERMENTATION TUBE	QUANTITY OF MEDIA, C.C.	PERIOD OF FERMENTATION, hr.	RESULTS
Einhorn tube (old type)	25 to 30	More than 48	In all the cases, fermentation was not complete at the end of 48 hr. and the side tube was only in one case completely filled with gas. The rest $\frac{1}{2}$ to $\frac{3}{4}$ full
Einhorn tube (new type)	4 to 5	24	The side tube was in most cases filled completely with gas within 48 hr. Maltose medium could be made to ferment in these tubes in contrast to the sluggish behaviour of the same medium when the 25 c.c. tube was used
Durham tube (new type)	2 to 2.5	24 to 48	Fermentation occurs within 24 hr. In the case of Torula where both types of Einhorn tubes indicated slight or no fermentation, these tubes showed active fermentation

Scientific & Industrial Research for financing a scheme of which this work forms a part.

T. N. RAMACHANDRA RAO  
V. S. KRISHNAMACHAR

Section of Fermentation Technology  
Indian Institute of Science  
Bangalore  
September 10, 1950

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FLY ASH SEPARATOR FOR GAS TURBINE

I HAVE READ WITH INTEREST THE ARTICLE OF Mr. S. Guruswamy on *Development of Powdered-coal Gas Turbine for Locomotive Purposes* \*. In this article the author considers that it is of primary importance to remove the ash from the products of combustion before the hot gases are led through the turbine blades ; and he has suggested that investigations have to be done on the behaviour of ash under varying load and combustion conditions and its removal. In this connection, the following information received from Dr. John I. Yellott, Director of Research,

\* *J. sci. industr. Res.*, 1949, 8, 486.

Bituminous Coal Research Inc., U.S.A., in September 1949 may be of interest to your readers. "I am enclosing a copy of our drawing D-365 (FIG. 1) which gives the essential information about the type of fly ash separator which we are using in our gas turbine experiments. This tube is manufactured by the *American Blower Corporation* of Detroit, and our negotiations with them have been carried on through Mr. H. O. Danz, who is the head of their dust collector section.

"The drawing shows the general appearance of the tube, which consists of an outer shell, 21" long by 8 $\frac{1}{4}$ " I.D. A spinner is placed at the inlet end which causes the dust-laden air to spin vigorously as it enters the tube. The dust is thrown out to the wall by the centrifugal action of the spinning air stream, and a small quantity of the air, ranging from 6 to 12 per cent of the total flow, is bled off through orifices at the discharge end of the tube. The cleaned air emerges through the 6" dia. outlet tube. The dust, now concentrated in a small portion of the air stream, is then collected in a secondary system, and most of the air which was thus used to convey the dust is returned to the hot air stream. We plan to use the tube at an air flow of about 1,000 c.f.m. at which condition the pressure drop, at full gas turbine pressure, will be about one psi.

"The expected collection efficiency of the tube is also shown, plotted against dust particle size in microns. You can relate this

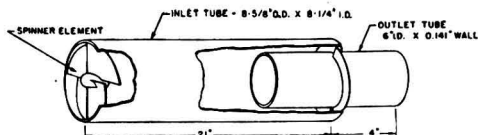


FIG. 1 — DIMENSIONS OF AMERICAN BLOWER CORP. SERIES 361 TYPE ST. SEPARATOR TUBE.

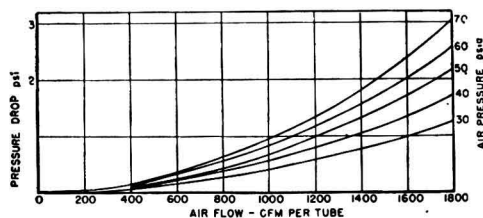


FIG. 2 — PRESSURE DROP ACROSS AMERICAN BLOWER CORP. TYPE 361 ST. SEPARATOR AT 1275 F. FOR VARYING AIR PRESSURES AND FLOW RATES.

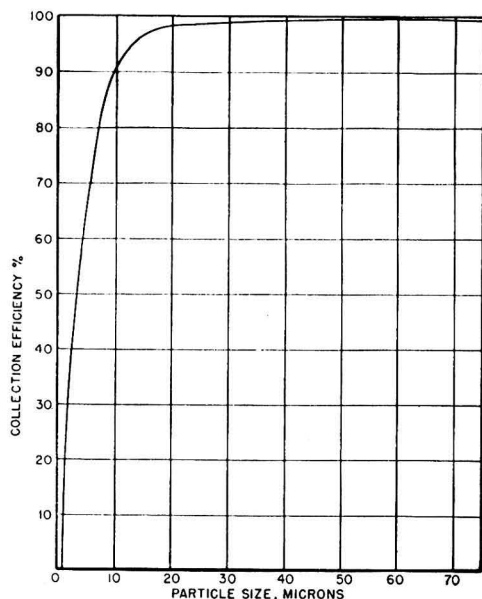


FIG. 3 — COLLECTION EFFICIENCY *vs.* PARTICLE SIZE FOR A. B. CORP. TYPE 57 SERIES 361 SEPARATORS. 425 CFM PER TUBE. AIR AT 147 PSIA, 70 F. 50 CFM SECONDARY FLOW, DUST ASSUMED TO BE SPHERES, SPECIFIC GRAVITY = 2.0.

to screen size by remembering that 42 microns is the diameter of the opening in the finest screen, 325 mesh.

“Our tests have indicated that the tube will collect most of the particles above 20 microns in diameter, and those which are smaller than this are not likely to do us much damage.”

J. C. GHOSH

Directorate General of  
Industries & Supplies  
New Delhi  
January 31, 1950

### SUITABILITY OF CEYLON GRAPHITE FOR CRUCIBLE MANUFACTURE

THE CONDITIONS FOR PREPARING CRUCIBLES from Ceylon graphite, which would satisfy the exacting requirements of industry, have been determined in our laboratories.

Two types of graphite are available from Ceylon, *viz.* hard lumps and soft flakes. The latter was selected for the trials, as they

resembled Madagascar graphite (particularly after roasting at 1,000°C.), which is extensively employed in the graphite crucible industry.

Hand-picked small lumps (fixed carbon, 93.98 per cent; volatile matter, 1.0 per cent; ash, 5.02 per cent) were selected from the average run-of-mine ore, and were crushed successively in a roller mill and a burr-stone mill to separate individual flakes. The flakes have an oily surface and are not easily wetted by clay. They were roasted in a muffle furnace (at 1,000°C.), cooled and sieved. Two grades of flakes, *viz.* -12 to +25 and -25 to +50 mesh were selected for the trials, the finer particles, which do not mould well, being rejected.

A mixture of high refractory kaolin and ball clay was used as binder. The results of analyses of the 2 clays are summarized in Table I.

TABLE I

	KAOLIN %	BALL CLAY %
SiO <sub>2</sub>	46.80	73.08
Al <sub>2</sub> O <sub>3</sub>	38.23	15.75
FeO and Fe <sub>2</sub> O <sub>3</sub>	0.27	0.62
TiO <sub>2</sub>	0.09	2.10
MgO	0.07	0.34
CaO	0.12	0.53
Na <sub>2</sub> O	0.07	0.15
K <sub>2</sub> O	0.21	0.28
Moisture	14.28	7.11

The clays were separately dried (at 100°C.) and ground to -100 mesh. Different proportions of the 2 clays were blended to obtain different degrees of refractoriness. Small crucibles of less than 30 lb. capacity require a binder of higher refractoriness than larger ones. Further, if the binder is too refractory, the crucible formed will be highly porous and the graphite burns off quickly.

Grogs were substituted for quartz in the batching, and were prepared from burnt (at 1,400°C.) bricks made of 3 parts of kaolin and 1 part of ball clay, sieved fractions -12 +50 were used. The grogs were soaked in water before use.

The clays were first mixed in a dry mixer of the cone type, with the addition of powdered felspar, talc, etc. Graphite was next added and finally wet grog, the mixing being continued. The mixture was then

transferred to a pug mill, sufficient water added, and the pugged mass covered with a wet gunny was aged in a dark place for about a month with occasional intermittent pug-ging and addition of water. The paste was divided into blocks, each block separately de-aired by throwing against a wooden board covered with cloth and pressed.

The pressed crucibles were allowed to dry for 3 to 4 hr. till they become sufficiently stiff; lips were formed and the surfaces polished. They were then dried at room temperature for about a week, and at 70° to 80°C. for a few days before glazing.

The glaze used had the following composition: ball clay, 19.5 per cent; felspar, 29.3; talc, 19.5; quartz, 19.5; red oxide of iron, 8.5 per cent; and manganese dioxide, 3.7 per cent.

The glazed crucibles were fired in a down-draft kiln, the crucibles being arranged inside saggars (containing saw-dust or powdered coal) in inverted position over small supports. Crucibles fired below 1,000°C. required annealing before use while those fired above that temperature could be used without annealing.

The quality of crucibles so prepared was tested by melting brass scrapings and noting

the number of heats they could stand. The composition of the crucibles which gave satisfactory performance is shown in Table II.

TABLE II

GRAPHITE	CAPACITY, 120 lb. %	CAPACITY, 30 lb. %
(-12 to +25) mesh	57	...
(-25 to +50) mesh	...	57
Grog, (-12 to +25) mesh	8	8
Ball clay	22	20
Kaolin	11	13
Felspar	2	2
No. of heats	38	34

The author's thanks are due to Dr. H. N. Das Gupta and to Prof. H. N. Bose for their interest in the work and for helpful suggestions.

K. K. MAJUMDAR

*Indian School of Mines &  
Applied Geology, Dhanbad  
September 28, 1949*

## Indian Institute of Fruit Technology

RESEARCH WORK RELATING TO FRUIT technology was started before the war in the Lyallpur Agricultural College. This work was partly financed from the funds of the Indian Council of Agricultural Research. During the war the testing of samples of fruit products supplied to the defence services, etc., was entrusted to this laboratory.

In 1946 a proposal to set up an Institute of Fruit Technology under the Ministry of Agriculture, Government of India, was considered and approved provisionally by the Government of India. In view of the changed conditions consequent on the parti-

tion and the non-availability of funds, this scheme never materialized.

A temporary laboratory on a small scale was set up at the Central College of Agriculture, Delhi, and classes for the training of students in fruit preservation and technique were being conducted. Besides running the training classes, this institution has also kept in touch with the fruit preservation industry and offered technical advice to it from time to time.

Since this institution has not been functioning satisfactorily, it has been merged with the Central Food Technological Research Institute, Mysore, under the auspices of the *Council of Scientific & Industrial Research*.



# AROMATIC PLANTS OF INDIA

## PART XIV

BY

S. KRISHNA & R. L. BADHWAR

FOREST RESEARCH INSTITUTE, DEHRA DUN

### FAMILY

47. Lecythidaceae
48. Lythraceae
49. Sonneratiaceae
50. Passifloraceae
51. Caricaceae
52. Cucurbitaceae
53. Begoniaceae



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Journal of Scientific & Industrial Research, Delhi

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# AROMATIC PLANTS OF INDIA

## Family XLVII — LECYTHIDACEAE\*

(Sapucaia-nut Family)

**T**HIS family comprises 18 genera and 150 species of tropical trees. Its members have the characters of Myrtaceae, but are without oil glands in the leaves, flowers, etc. The leaves are alternate and usually crowded towards the ends of the branchlets. The fruit is a berry or is fibrous, or in exotic genera woody and opening by a stoppel.

The Indian species belonging to this family are of little economic importance, but those of S. America are a potential source of timber supply because of their gigantic size. The Colombian mahogany (*Cariniana priformis* Miers), however, is the only timber from this family which has figured to any extent to date in the world's trade. The edible Brazil nuts of commerce (also called cream nuts or niggertoes) are obtained from *Bertholletia excelsa* Humb. & Bonpl. of S. America. They are collected to the extent of over 17,000 tons annually from the wild trees, and most of them are exported to Europe and the U.S.A. Similar nuts of finer quality and more delicate flavour are obtained from the sapucaia-nut or paradise-nut tree (*Lecythis zabucajo* Aubl. and *L. ollaria* Linn.). The sapucaia nuts are contained in a curious woody capsule (monkeypot) with a woody lid. The fruit of the West Indian tree *Grias cauliflora* Linn. is the anchovy pear, which is cultivated in the West Indies and eaten, often as a pickle. Some species belonging to the genera *Careya* and *Barringtonia* are used as fish poisons. Some plants, such as *Napoleona imperialis* Beauv. and *Couroupita guianensis* Aubl. (cannon-ball tree) bear ornamental flowers, and are cultivated in Indian gardens.

Seeds of this family yield fatty oils, while saponins and tannins have also been reported from several species.

The family is of little importance from point of view of essential oils. The cream or white, 2½ to 4 in. wide flowers of *Careya arborea* Roxb. (wild guava), a medium-sized tree of the Sub-Himalayan tract,

Bengal, Central, Western and Southern India, have an unpleasant smell. According to Watt the fruit of this plant, too, is aromatic, and the calyx, if placed in water, becomes coated with mucilage and emits a sickly odour. This is probably due to putrefaction.

The large, woody, globose fruit (known as cannon ball) of *Couroupita guianensis* Aubl. of Indian gardens has an extremely unpleasant smell when ripe.

### BARRINGTONIA Forst.

(After Daines *Barrington*, 1727–1800, English judge and naturalist.)

This genus comprises about 30 tropical trees, out of which 4 are found in India. Most of its members contain saponins, and, therefore, they are used as fish poisons. The saponin is found in the largest amount in the seeds, but the barks of some species also contain this to a fair extent. The woods of some species are useful, and the seeds of some yield fatty oil.

*B. acutangula* (Linn.) Gaertn. (Indian oak, *samudra-phal*), a small or medium-sized tree found in the coastal regions of India, particularly in Bengal, S. India and the Andamans (also cultivated in gardens for ornamental purposes), bears pink, ½ in. across, delicately fragrant flowers which are borne in long drooping racemes often 1 ft. or more long.

According to Gildemeister & Hoffmann, the essential oil from the Javanese *B. spicata* Blume contains methyl salicylate, but the present authors have not been able to trace any original reference for this statement.

### *Barringtonia asiatica* (Linn.) Kurz

*B. speciosa* Forst., Fl. Brit. Ind., II, 507.

(*Samudra-phal*)

This is a rather small or medium-sized tree 30 to 50 ft. high, with large obovate

\* The Lecythidaceae is included in the family Myrtaceae in the *Flora of British India*.

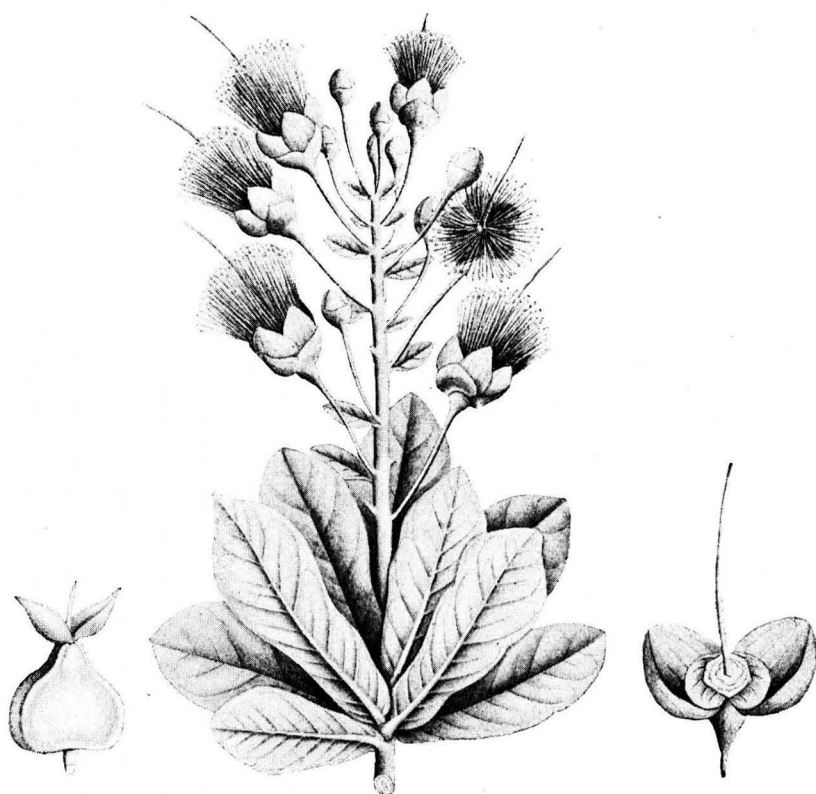


FIG. 52 — *Barringtonia asiatica* (Linn.) Kurz.

leaves often 15 by 7 in. The flowers, which are  $\frac{3}{4}$  in. in diameter, are arranged on short erect racemes, and the fruit is 3 by 3 in., quadrangular or nearly ovoid. It is a native of the Andaman Islands, Singapore, and Ceylon; it also occurs in the Southern Deccan Peninsula, but probably not in a wild state.

The bark, fruit, and seed of this plant are said to be used to poison fishes.

The bark is stated to contain a resin and a volatile oil (Watt). The seeds contain 3.27 per cent. of the glycosidic saponin barringtonin and 1 per cent. of a substance designated as barringtogenin (Wehmer).

## Family XLVIII — LYTHRACEAE \*

(Loosestrife and Henna Family)

This family comprises about 21 genera and 500 species of herbs, shrubs or trees, which are found in all zones except the frigid ones. Its members usually have opposite, simple, entire leaves, often showy

flowers with valvate sepals, free ovary, and capsular, many-seeded fruits.

The family is not of any great economic importance. From point of view of timber, several species of *Lagerstroemia*, particularly

\* The Lythraceae, as understood in this work, is exclusive of the families Punicaceae, Sonneratiaceae, and Oliniaceae.

FIG. 53 — *Lawsonia inermis* Linn.

*L. speciosa* (Linn.) Pers. (*L. flos-reginae* Retz.) are the most important members. *Lagerstroemia speciosa*, *L. indica* Linn. (Indian lilac), and species of *Woodfordia* and *Cuphea* are extensively grown as ornamental plants. Several species of *Lawsonia*, *Woodfordia*, and the American genus *Lafoensia* are the sources of vegetable dyes. The leaves of henna (*Lawsonia inermis* Linn., syn. *L. alba* Lam.), an ornamental and fragrant shrub, are widely used in the Orient for tinting the nails, palms, and hair. Plants used in indigenous medicine possess astringent, acid, emetic, cathartic or diuretic properties.

Some species contain essential oils, and that from the flowers of *Lawsonia inermis* is distilled to an extent in India. Geraniol is the only constituent which has been reported from the essential oils of this family.

It is said to have been obtained from *Physocalymma scaberrimum* Pohl, which is known as the Brazilian rosewood oil.

*Lagerstroemia parviflora* Roxb. (*lendi*), a large to medium-sized tree found almost all over India except the very dry regions, bears  $\frac{1}{4}$  to  $\frac{1}{2}$  in. across (according to the varieties), white, fragrant flowers in panicles. The Burmese *L. villosa* Wall. ex Kurz also bears white, slightly scented flowers.

#### LAWSONIA Linn.

(In honour of John Lawson, M.D., a Scottish naturalist and author of *A Voyage to Carolina* — 1709.)

This genus consists of one species, *L. inermis* Linn. (*L. alba* Lam.), which is described below.

**Lawsonia inermis** Linn.

*L. alba* Lam., Fl. Brit. Ind., II, 573.

(Henna, *Mehndi*)

This is an Old World tropical shrub about 6 ft. high, with opposite leaves, and large, terminal, pyramidal panicles of sweet-scented, white or pinkish flowers about  $\frac{1}{4}$  in. in diameter. The fruit is a capsule of the size of a pea.

The shrub is commonly cultivated in India often as a hedge plant and for the sake of its dye-yielding leaves and scented flowers, perhaps wild on the Coromandel coast and in the Deccan. The leaves are used for tinting nails, palms, and hair a caroty-red colour.

Henna has been used in Egypt to dye the hands since ancient times; it was also used in the preparation of mummies. According to Pliny, the port of Canopus, at the western side of the Nile delta, was full of these bushes which scented the town when in flower, and the flowers were used in perfumery. According to Watt, Olivier states that a fragrant water distilled from the flowers was known

to the Jews, and was employed in baths and in religious ceremonies. The ancient Egyptians also made a similar use of the flowers for the purpose of perfuming the oils and ointments.

The leaves of this plant are used not only as a cosmetic, but also in indigenous medicine for a variety of purposes.

The flowers yield on distillation a fragrant otto called *mehndi*. The distillation is said to be practised in Banaras and Lucknow. The odour of the essential oil, according to Burkill (1935. *Dictionary of the Economic Products of the Malay Peninsula*, 2: 1323), resembles that of the tea rose, and also suggests mignonette. According to Poucher, the flowers exhale an odour recalling lilac.

Holmes [1880. *Pharm. J.*, 10(3): 635] prepared an essential oil from the flowers, but its constants and chemical composition do not appear to have been reported.

By extraction of the dried flowers with benzene or alcohol, a resinoid is obtained; it has a very agreeable odour, somewhat phenolic and very tenacious (Naves & Mazuyer, 1947. *Natural Perfume Materials*: p. 272).

**Family XLIX — SONNERATIACEAE\***

(Sonneratia Family)

This family comprises 3 genera and 12 species of shrubs and trees, which are found in tropical Asia and Africa. Its members have opposite leaves, large flowers with indefinite stamens, and pulpy, often edible, fruit.

The family is an unimportant one from the economic point of view, except that some species furnish useful wood for local purposes.

*Duabanga sonneratioides* Buch.-Ham., a tall handsome tree of the Sub-Himalayan tract from Nepal eastwards to Assam, Khasi Hills, Manipur, Chittagong, and the Andamans, bears 2 to 3 in. wide flowers, which have an unpleasant smell. It has drooping branchlets owing to the weight of terminal corymbs of flowers.

\* The Sonneratiaceae is included in Lythraceae in the *Flora of British India*.

**Family L — PASSIFLORACEAE\***

(Passionflower Family)

This family comprises 18 genera and 380 species of herbs or shrubs of tropical and warm temperate regions. Its members are usually climbing by means of tendrils or rarely twining, and have mostly showy flowers distinguished chiefly by the fringed

corona on the throat of the calyx. The fruit is a berry or a capsule.

This family is hardly of any economic importance. The square-stalked passionflower or common granadilla (*Passiflora quadrangularis* Linn.) is cultivated in hotter

\* The Caricaceae, which is included in this family in the *Flora of British India*, is dealt with separately in this work.

parts of India for its flower and sweet acid fruit which are much esteemed. The fruit of *P. edulis* Sims (passion fruit), which is of the size of a hen's egg, is edible. The plant is sometimes cultivated in the hills and has 3-lobed, toothed leaves. Some species of *Adenia* are accredited with poisonous properties. Most of the plants of the genus *Passiflora* contain hydrocyanic acid.

No essential oil appears to have been isolated from plants belonging to this family. The smell of the foliage of *Passiflora foetida* Linn., a slender climber widely grown in Indian gardens and sometimes found wild near towns, is foetid, especially when bruised, and is enough to prevent animals from eating it. The plant is at once recognized by the moss-like pectinate involucre of leaves.

## Family LI — CARICACEAE\*

(Papaw Family)

This is a small family comprising 4 genera and 40 species of tropical trees. Its members have a milky juice, dioecious flowers, and fleshy baccate fruits.

The family includes the genus *Carica* whose milky juice is rich in the proteolytic enzyme papain, a valuable medicine. Some plants contain the alkaloid carpaine and the glycoside carposide.

### CARICA Linn.

(Named from an erroneous idea that it was a native of *Caria*.)

The genus comprises 30 species of chiefly tropical American half-woody trees. *C. papaya* Linn., which yields the well-known papaya or papaw fruit, is being cultivated in most warm countries, and is described below. *C. candamarcensis* Hook. f. (*C. cundinamarcensis* J. Linden), which yields a smaller but sweeter fruit (mountain papaw), has been cultivated in some tropical mountains; it is a montane plant.

### *Carica papaya* Linn.

Fl. Brit. Ind., II, 599 (without description).  
(Papaw, Papaya)

This is a well-known small, soft-wooded, short-lived tree with numerous leaf-scars on

the stem. The leaves are very large and like the palm of the hand. The flowers are pale yellow, fragrant, generally dioecious, but occasionally there are a few bisexual flowers on the male plant. The fruit is succulent, indehiscent, 1-celled, of the size of a melon, with soft yellow pulp, and the seeds blackish, covered with a loose hyaline skin or arillus. It is largely cultivated in Bombay, Bangalore, Bihar, Bengal, Dehra Dun, etc., for the sake of its luscious fruits. It does not grow well in the drier parts of India, but flourishes where rainfall is high and the climate hot.

The seeds yield on distillation an essential oil containing sulphur and nitrogenous compounds (Wehmer). This essential oil appears to be derived from the hydrolysis of a glycoside through the action of a ferment, in the same way as the volatile oil of mustard (Burkill, 1935. *Dictionary of the Economic Products of the Malay Peninsula*, 1: 454). The roots also contain the glycoside (Burkill, *loc. cit.*).

No essential oil is reported to have been extracted from the flowers.

\* The Caricaceae is included in Passifloraceae in the *Flora of British India*.

## Family LII — CUCURBITACEAE

(Gourd Family)

This family comprises 90 genera and about 750 species of chiefly herbaceous, tendrill-bearing vines, which are most abundant in

the tropics. The flowers are yellow or white, dioecious or monoecious, and the fruit is usually a berry, like the melon or cucumber.

The leaves and stems of a number of species, particularly when crushed, emit a nauseating, cucurbitaceous odour. The fruits of some also possess a similar odour.

A number of plants of this family yield vegetables and fruits which are in common use. Some of the more important of these are: *palval* (*Trichosanthes dioica* Roxb.), *lauki* or bottle gourd (*Lagenaria vulgaris* Ser.), *ghia-tori* or sponge gourd [*Luffa cylindrica* (Linn.) M. Roem., syn. *L. aegyptiaca* Mill. ex Hook. f.], *peṭha* or white gourd-melon [*Benincasa hispida* (Thunb.) Cogn., syn. *B. cerifera* Savi], *karela* or carilla fruit (*Momordica charantia* Linn.), *kharbuza* or sweet melon (*Cucumis melo* Linn.), *khira* or cucumber (*C. sativus* Linn.), *kumra* or squash gourd (*Cucurbita maxima* Duchesne), *kaddu* or pumpkin (*C. pepo* Linn.), *tarbuz* or watermelon (*Citrullus vulgaris* Schrad. ex Eckl. & Zeyh.), etc. It is curious that all the above species when in the wild state are stated to contain toxic bitter substances.

Some plants yield valuable drugs, and a few are cultivated for ornamental purposes. The fruit pulp of colocynth [*Citrullus colocynthis* (Linn.) Schrad.] is commonly used as a purgative. The foreign squirting cucumber [*Ecballium elaterium* (Linn.) A. Rich.] and the roots of bryony of Europe (*Bryonia dioica* Jacq.) have also purgative properties.

Very few of the wild species of this family are edible, and the bitter "varieties" particularly must be eaten with great caution. The fruits are often laxative, sometimes very bitter, strongly emetic, and cathartic. The roots are occasionally acrid and act as drastic purgatives. Some of the plants have anthelmintic and emmenagogue properties. The seeds of almost all plants yield fatty oils, some of which are edible and some possess medicinal properties.

Colocynth and roots of bryony have traces of an essential oil (Wehmer). Some of the important constituents isolated from plants of this family are: (a) bitter substances, such as those found in *Cucumis*, *Ecballium*, *Lagenaria*, *Luffa*, *Momordica*, *Trichosanthes*, etc., (b) saponins as in *Citrullus*, *Cucumis*, *Cucurbita*, *Lagenaria*, *Luffa*, etc., (c) glycosides, such as brionine, and (d) alkaloidal principles, such as those found in *Bryonia* and *Citrullus*.

## CUCUMIS (Tourn.) Linn.

(Etymology obscure.)

The genus comprises about 25 tropical and subtropical species of yellow-flowered, climbing or trailing herbs with simple tendrils, and is represented in India by 3 species. The cucumber (*C. sativus* Linn.) and the sweet melon (*C. melo* Linn.) are the most important species and are widely cultivated for their fruits. The fruits of several foreign species, such as those of *C. africanus* Linn. f.\* and *C. myriocarpus* Naud. are toxic.

### *Cucumis sativus* Linn.

Fl. Brit. Ind., II, 620.

(Cucumber, *Khira*)

This hispidly hairy climber is cultivated throughout India for the sake of its fruit — a well-known salad vegetable, also cooked and pickled. The seeds are eaten and are also accredited with medicinal properties; they yield a fatty oil.

The cucumber juice is used in the preparation of glycerine and cucumber hair creams. This is obtained by expression from the fresh fruits. After clarification, alcohol, benzoic or salicylic acid is added as a preservative (Poucher).

The peculiar odour of cucumber is also extracted with alcohol and used in blending certain bouquet perfumes. The extract is prepared by macerating the peeled and thinly sliced fruit in warm alcohol. If the odour is not sufficiently strong after a few days, the alcoholic extract is repeatedly poured over some more fresh slices, and the macerated residue is expressed. At the end of the operation the extracts are filtered. The excess of alcohol is removed and the cucumber concentrate obtained (Atkinson, 1915. *Perfumes & Cosmetics*: p. 162).

A perfume called *sasa atar* made from this plant is stated to have been exhibited in London as early as in 1881, at the Colonial or Indian Exhibition (Watt). It was presumably prepared from the fruit in a somewhat similar manner as the one described above.

\* The *Index Kewensis* cites Lindl. f. as the author of this plant. This is a misprint for Linn. f.



**Family LIII — BEGONIACEAE**

( Begonia Family )

This family comprises 5 genera and about 800 species of succulent herbs or rarely undershrubs which are found in all tropical moist countries, except Australia. *Begonia* is the most important genus embracing about 750 species with thick rhizomes or tubers, more or less unequal-sided leaves, monoecious, usually showy flowers in dichotomous cymes, and winged capsules.

The family is of little direct economic importance, except that many species of *Begonia* are highly ornamental and great favourites of the modern foliage cultivator. Some species, such as *B. minor* Jacq. (*B. nitida* Dryand.), are also grown for the beauty of their flowers. The most important species which have been hybridized for numerous beautiful-leaved horticultural

varieties are the Indian *B. rex* Putz. and *B. griffithii* Hook.

The succulent stems of some begonias have a pleasant flavour, and are used as potherbs. When fresh, they have a peculiar acid taste. The leaves of some foreign species are also eaten.

The juice of the ornamental *B. rex* is poisonous to leeches, and may, therefore, be used to kill them when they are encountered in the nostrils of animals.

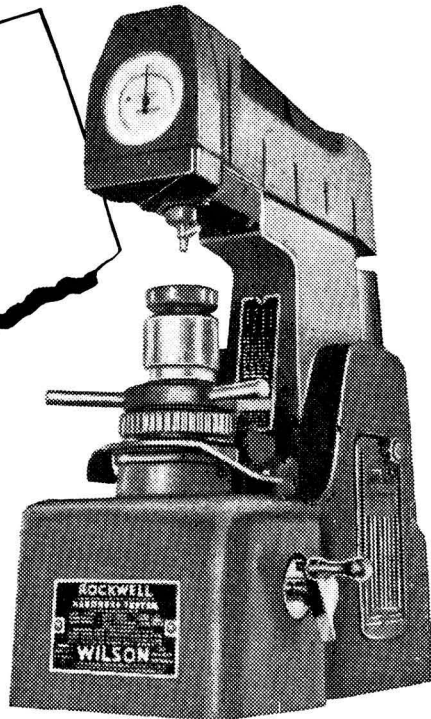
*Begonia roxburghii* A. DC. of Khasi Hills, Konkan, and North and East Bengal is a stout, succulent plant which bears white or very pale pink fragrant flowers in short dichotomous few- or many-flowered cymes; its roots are fibrous (not tuberous).

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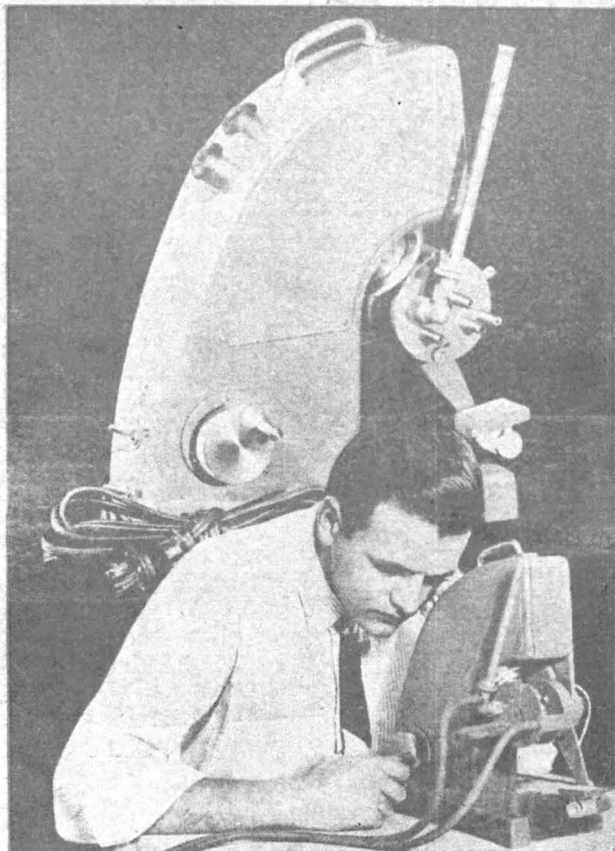
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