

Journal of Scientific & Industrial Research



152

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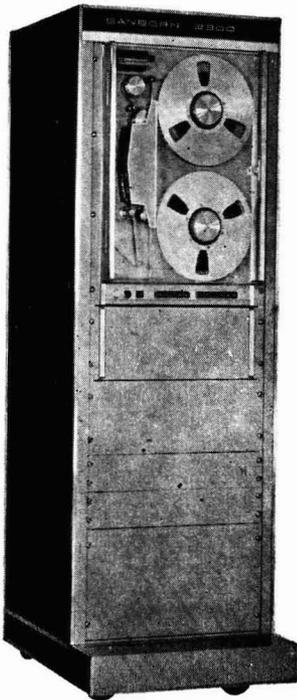
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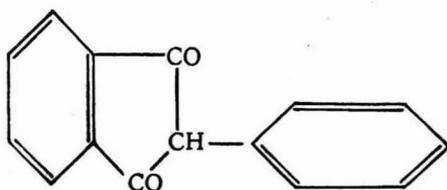
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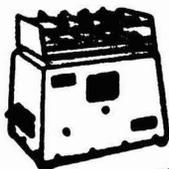
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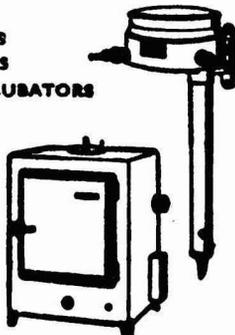
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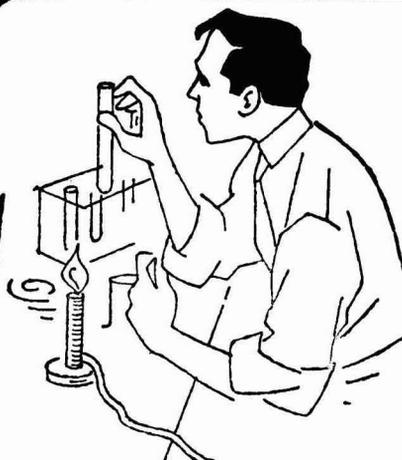
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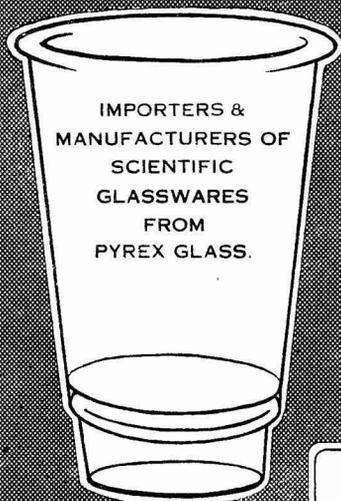
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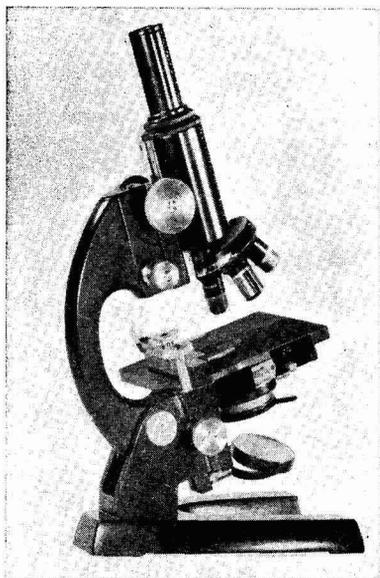
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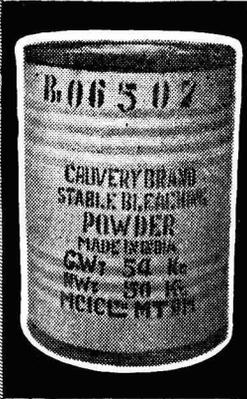
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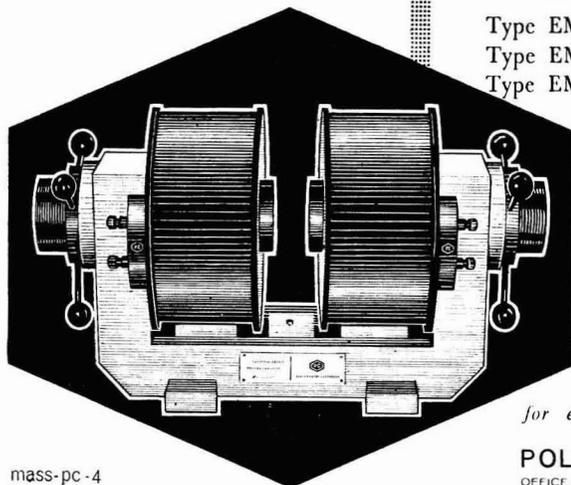
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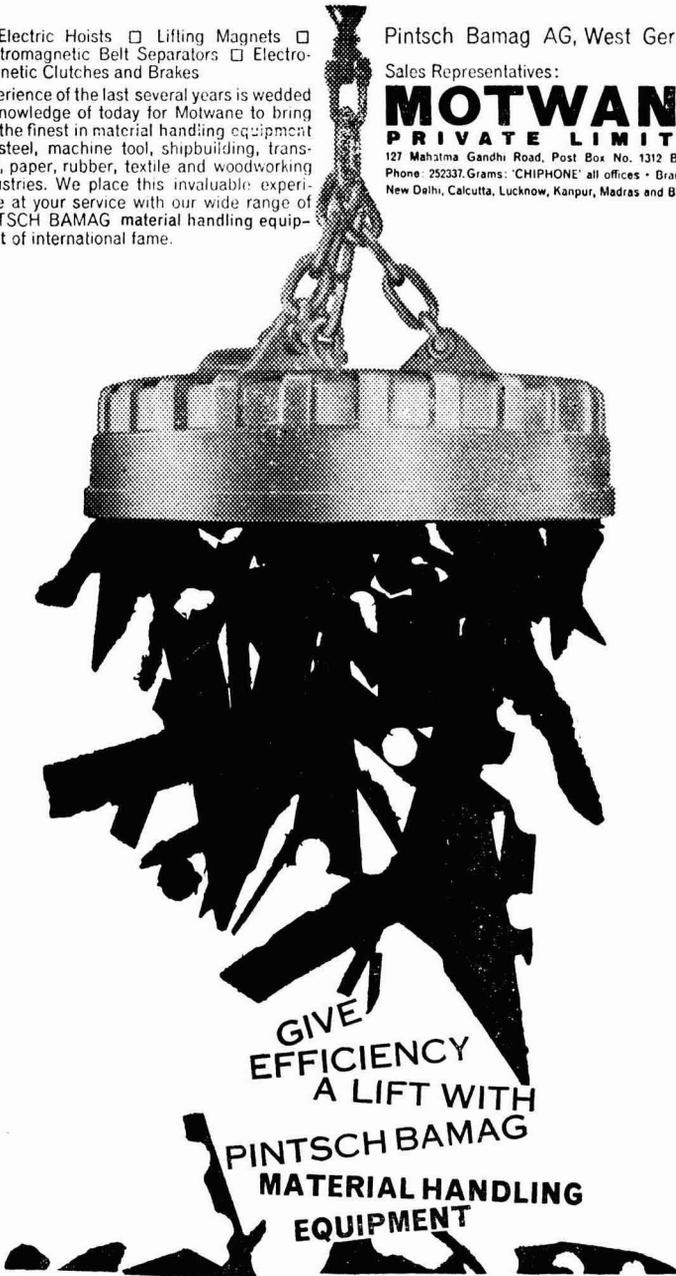
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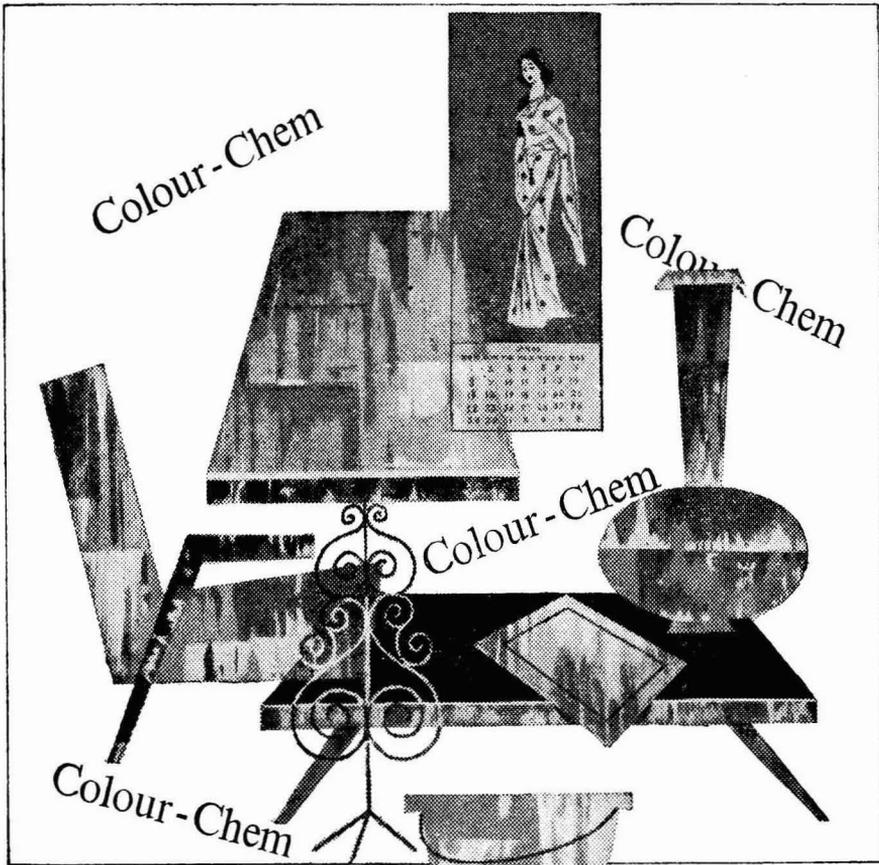
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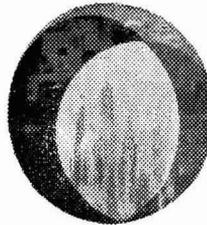
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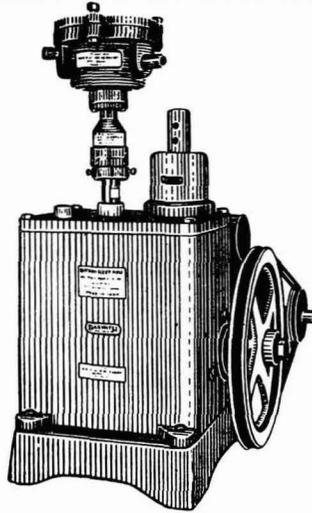
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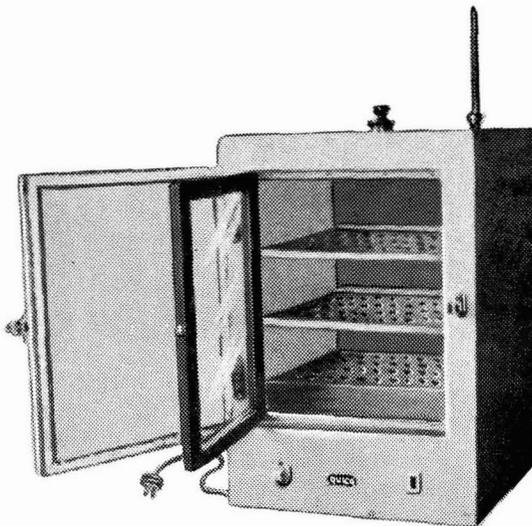
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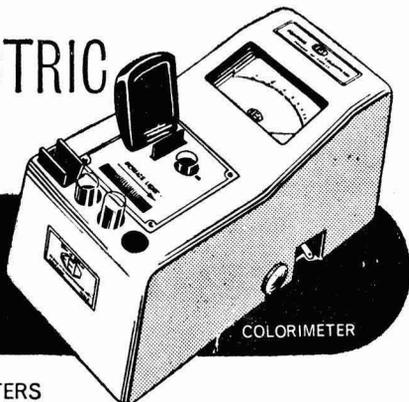
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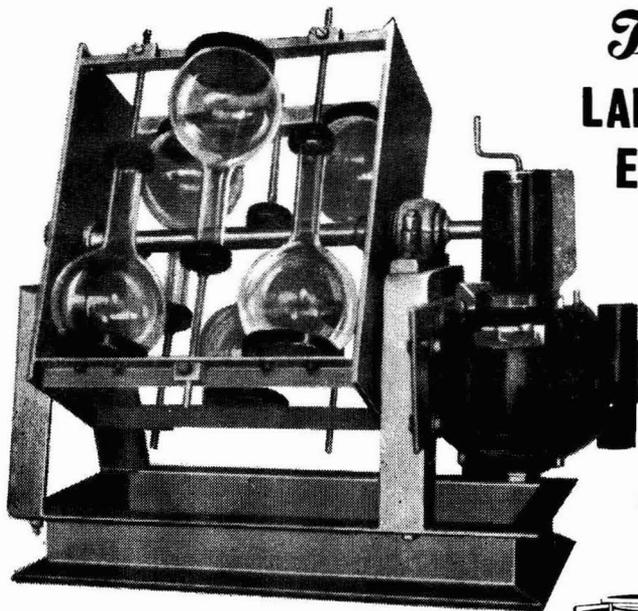
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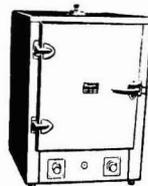
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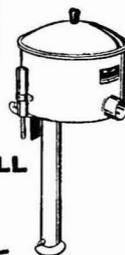
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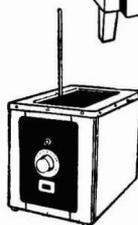
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Current Topics

Teaching & Training in Experimental Botany

UNLIKE the two earlier Summer Schools in Botany which were devoted to subjects of classical botany, the third Summer School in Botany (see page 7), organized at Ootacamund, Nilgiris, during June-July 1965, was mainly concerned with experimental botany embracing plant physiology, cytology, cytogenetics, experimental taxonomy and plant pathology. The meeting provided a unique opportunity for the university teachers and research workers to meet and discuss problems of common interest. The participants not only benefited by this intimate contact and discussion but also emerged much stronger in the plans and programmes for future experimental work and study. The most gratifying achievement of the summer school was that the participants appeared anxious and eager to pass on the fruits of their discussions and deliberations to their fellow workers and colleagues working in similar or related fields in other institutions. Side by side with the scientific programme aimed at a collective criticism and appraisal of the experimental work presented in the papers, the participants had an opportunity of bringing to the open many problems confronting them in the teaching of experimental botany to graduate and post-graduate students. Some tentative conclusions have been reached as a result of the deliberations at this summer school in regard to these problems, and it is hoped that before long it would be possible to evolve methods by which the teaching of experimental botany in Indian universities could be properly oriented.

The impact of important discoveries in physical sciences on biological sciences need not be over-emphasized. The rapid advances made in the new and exciting fields of molecular biology, biochemistry and biophysics are making constant demands for reorientation of the training methods in biological fields. A biologist today should have a good grounding in chemistry, physics and mathematics, not to mention the special fields of statistics and biometry. When we are out to train a well-rounded biologist or botanist, we are faced with these many alternatives in the choice of the right border-line science(s). This problem has been repeatedly discussed on many occasions in countries like USA and UK. In the light of the many advances in biological research as a whole, and with the collaboration of physical sciences, the future pattern of organization in Indian universities should be the formation of an integrated and full-fledged department of 'life sciences' comprising the departments of botany and zoology

with strong wings of biochemistry, biophysics and biometry. This integration is urgently indicated in our country as this would greatly improve the pattern of training of biologists apart from conserving our resources by avoiding needless duplication of apparatus and other major items of equipment which are in short supply. Many border-line subjects such as biochemistry, organic chemistry, physical chemistry and biophysics, and the general principles of common areas of genetics could be taught to both botanists and zoologists with better advantage in such a set-up. It is precisely in these fields the most exciting discoveries have been made in recent years and the frontiers of our knowledge are expanding at a rapid pace. Apart from the mere material advantage accruing out of setting up such integrated departments of 'life sciences' in the universities, there is a larger aspect that comes to one's mind in advocating this arrangement. It would be mutually advantageous for the various 'ists' to come into a hotch-potch with all the barriers between them faded, if not totally removed, and inculcate the necessity for a cooperative endeavour to tackle various problems of life. To my mind such collaborative work would yield quicker and more fruitful results than the compartmentalized treatment of integrated problems involving living things. There is, indeed, much to say in favour of introducing short- and long-term elective courses in these border-line areas. This will not only create a sense of unity among the younger life science workers, but also equip them to stand up to the many challenges that are posed in unravelling the mysteries of Nature.

Speaking of biological sciences in India, there is an immense scope for development, especially in the experimental aspects. We should foster pure basic research that provides the essential pool of new knowledge upon which we could draw for future developments and practical applications. These programmes of research should be objective in their scope, having a full appreciation of the needs of the country. Botany, apart from forming a basic science in the field of agriculture, also offers scope for further exploitation of the plant world by way of finding new and hitherto unrecognized sources of food. When there is land hunger, we could profitably look to the sea which offers, as it were, an inexhaustible source of food. But before one embarks on exploitation of the sea for its algal flora, we must have a correct picture of the nature of the flora, their abundance, seasonal fluctuations in their occurrence and the maximum limits of exploitation to which one can go without causing devastation. Likewise, plant physiologists could tell us the optimum levels of irrigation based on critical studies of the water

requirement of particular crops that would aid in the conservation of water resources, the effects of various growth regulating substances, and fungicides and insecticides which are often employed without much regard to their effects on the crop plants themselves under particular conditions. Plant pathologists could work out methods to reduce or completely prevent crop losses due to diseases. Microbiologists could likewise explore and give new sources of food and drugs.

While India suffers from deficit of food quantitatively, there is also a qualitative deficiency. The protein content of our food is very inadequate compared to the standards of more fortunate countries. This deficiency could be overcome by concerted attempts at finding crop plants suitable for extraction of proteins and by working out methods for the preparation of protein concentrates without sacrificing their nutritive value. Research work done in UK and USA has shown that undoubtedly we have to look towards plant sources for any large-scale increase of our protein requirements. Along with these attempts, we have to devise means by which the protein content of the existing crop products could be increased by improving or selecting protein-rich strains. This could be done by inducing mutations by radiation and other mutagenic agents.

As an academic man, my foremost concern is to provide the country with adequate number of technical personnel to handle the enormous problems that face us. It is here, the urgency of training a well-rounded biologist comes in, and with proper facilities for a feed-back of those trained, we could achieve our goal of sufficiency in technical manpower. But before we launch on this, we have to give serious thought as to the nature of training we wish to give our students of biology. We have to draw freely from the experience gained in other countries of the world that launched on similar programmes decades ahead of us. Among botanists, today we find, on the one hand, 'classical botanists' quite unconcerned with the exciting new developments in fields such as molecular biology, biochemistry and microbial genetics, and, on the other, the molecular biologists whose views are dominated by too much physical sciences. Life is unique and so are its problems. Some of these can be understood or solved with the help of physical sciences, but these are only severely limited. We need people trained in the various areas of botany having a whole view of plant life. Unfortunately, the exigencies of specialization necessarily narrow down one's scope and view, but this should not be permitted to dampen our enthusiasm to train our young botanist in such a way as to make him self-reliant to tackle modern problems. We may, therefore, have to evolve for ourselves a balanced course of training for botanists in our universities. This training programme should also include a practical course in instrumentation, glass blowing and familiarity in workshop practice.

We are at the moment seized with the need to increase the scope and content of the curricula of Indian universities pertaining to the teaching of many facets of experimental botany as obtained in the advanced countries. This cannot be achieved

overnight or at one particular level. There is hardly any difference of opinion among those handling every aspect of biology teaching and research as to the need for a sound knowledge of statistics and biometry. Formal teaching of these subjects for biologists must be made compulsory. But this again will become realistic only if our school mathematics teaching is strengthened. This would not only give confidence to the young to proceed to graduation with a sound background but also help them in later years should they go in for research and opt to teach in advanced subjects at the Master's degree level.

With the advent of more modern methods of communication, such as radio, movie and television, we may have to attempt at a general uplifting of the level of knowledge right from the school stage. The time has come when we in India should take a fresh look at the phenomenal developments that have taken place in the scientifically advanced countries of the world. As a prerequisite for introducing the improved syllabus in schools and colleges, we have to seriously think of the problems of finding teachers who can embark on the task with confidence. Unless we can find the wherewithal to train such teachers effectively forthwith, it is bound to leave a lacuna which would be difficult to fill. After all, for the success of our programmes much depends on the teachers who form the vital link in the feed-back. There could be little doubt that any delay in introducing our young minds to the vast treasure-house of knowledge will only subject them to the hazards of intellectual starvation. We should embark on the production of films depicting the various developments in the different branches of science, similar to the ones produced by the Encyclopaedia Britannica Films Inc., Wilmette, Ill., USA, and the British Council. As a first measure, the Ministry of Education might explore the possibility of obtaining the screening rights of these superb educational films in India and have them dubbed in various Indian languages. Apart from producing better students who could then be put to a higher level of training, these films would also serve a larger interest of science. The advancement of science or the cause of science depends not only on professional scientists but also on the public image of science. In a democratic set-up like ours, a public opinion sufficiently enlightened should be groomed to get greater support to scientists. These films together with other improved methods of communication, such as television and radio and popular science journals, would serve as the machinery that would weave science into contemporary culture in India. If this closely connected pattern is not evolved, scientists will become isolated in their shells and become impervious to the urgent needs of society.

One of the striking points that emerged from the individual discussions among the participants of the summer school was the difficulties arising out of acute shortage of specialized equipment, apparatus and certain fine biochemicals. This severely limits the proper training of our research students and it may well mean that many creative ideas in critical areas of experimentation will languish much to the detriment of Indian science. Unfortunately,

in the past, Indian technology has not gone hand in hand with advances in pure sciences. This may have to be remedied quickly and a liaison between the engineer-technologist and the scientist will have to be pressed into service, and the necessary climate created for the repair, maintenance and designing of many sophisticated instruments so vital for research. In this age of science the competition

among nations is a competition of intellect and if we have to survive we have to make proper investment in science. Unless this is realized, we will be generations behind the other nations of the world.

T. S. SADASIVAN

*University Botany Laboratory
Madras 5*

Symposium on the Technology of Rice & Rice Products

THE Indian Central Oilseeds Committee made a suggestion in 1964 that the Central Food Technological Research Institute (CFTRI) should hold a seminar on problems relating to rice bran oil industry in India. Further discussions indicated the necessity for extending the scope of the symposium to cover the production, processing, storage and marketing of rice besides utilization of the byproducts of rice. With the concurrence of the Executive Committee of the Institute it was decided to hold a symposium on the Technology of Rice and Rice Products at Mysore. The Association of Food Technologists, India, evinced keen interest in the organization of the symposium and came forward to be the joint sponsor with CFTRI. Over 150 delegates including research workers, technologists, representatives of industry, government organizations and extension groups participated in the deliberations of the symposium.

Dr S. Husain Zaheer, Director-General, Council of Scientific & Industrial Research, inaugurated the symposium on the morning of 19 August 1965. In his welcome address, Dr H. A. B. Parpia, Director, CFTRI, stressed the importance of rice in the food economy of India and the need for developing rice technology on proper lines. He also emphasized the need for correct identification of the national food problems and the active collaboration of agricultural scientists, technologists, rice millers and machinery manufacturers for solving them. He pointed out that efficient utilization of the byproducts is also very necessary for improving the economy of the rice industry.

Dr Zaheer referred to the low yields of rice per acre in India and stressed the need for increasing production by adopting proper agricultural practices.

The deliberations of the symposium were held under 4 sessions devoted to: Chemistry and nutrition; Milling and processing; Rice products and byproducts; and Handling, storage, packaging and marketing. Forty-two papers were presented and discussed.

Chemistry and Nutrition

Dr R. H. Richharia [Central Rice Research Institute (CRRI), Cuttack], who presided over this session, referred to the improved varieties of rice developed at Cuttack and other centres in India.

Indo-japonica varieties, in particular, possess high potential for increased yields and respond effectively to heavy nitrogen application. By adopting suitable cultural practices, plant protection measures and rotation programmes, the yield of rice can be raised from 1 ton to about 5 tons/hectare. In this connection, he also stressed the importance of mechanizing the cultivation of rice and developing varieties having good milling quality.

Dr J. T. Hogan (Southern and Western Utilization Research Laboratories, US Department of Agriculture) reviewed the recent research in rice technology in USA. He made special reference to the preparation of high protein rice flour suited for the feeding of children and the processing techniques for improving the cooking characteristics of rice. Other studies in their laboratories related to the physico-chemical properties of rice. Heat-treatment of rice for accelerated ageing and the improvement of protein content of rice through the application of nitrogenous fertilizers were considered to be problems of special interest to India.

A few papers presented related to the effect of environmental, genetic and agricultural factors on the chemical composition of rice. S. Patnaik (CRRI) reported the results of studies on the influence of time of nitrogen application on the protein content of rice grain. It has been found that by applying the fertilizer at the time of puddling, within the lower and upper critical limits of fertilizer level (20-60 kg. N/hectare), there is hardly any increase in the protein content of the grain, although the grain yield continues to increase. A satisfactory practice recommended for increasing grain yield is to split and apply one part of the fertilizer during the initial growth stage (at puddling) and the rest just before ear emergence (boot stage). A greater proportion of the nitrogen absorbed from the fertilizer applied during the reproductive stage is found in the grain, thereby increasing its protein content. Thus, fractional application in two stages not only increases the efficiency of the fertilizers but also makes the grain more nutritive. S. D. Agashe, G. R. Tatwawadi and M. V. Apte (Agricultural Department, Maharashtra) reported that the fat content is more in the late varieties of rice than early varieties, the effect being more pronounced in coarse varieties than fine ones. The same trend is

observed in mineral content. The protein content of early and coarse varieties is higher than in the late and fine varieties. The protein content of late fine varieties can be increased by the addition of nitrogenous fertilizers spread over till maturity. P. K. Kymal stressed the need for developing varieties with high protein and thiamine contents.

From studies on the influence of individual processing steps on thiamine retention in milled parboiled rice, P. V. Subba Rao and K. R. Bhattacharya (CFTRI) have found that while the effect of soaking as such is not appreciable, soaking under conditions that lead to bursting of the grain causes considerable loss of vitamin B₁ by leaching. Steaming has a measurable, but not a pronounced, destructive effect on thiamine. Milling results in additional loss of about one-fourth of thiamine present in the paddy. Milling retention of vitamin B₁ continues to be low in soaking the grain as long as soaking is carried out at low temperatures, but it increases markedly when the paddy is soaked at 70°C. and above. Steaming always results in increased retention of vitamin B₁, irrespective of the temperature of soaking. It has been suggested that the decreased milling loss of vitamin B₁ in parboiled paddy is associated with the gelatinization step. The higher vitamin B₁ retention in milled parboiled rice is possibly caused by an embedding of the inner bran and scutellum layers on to the endosperm as a result of gelatinization. The presence of greater amounts of bran pigments in milled parboiled rice as compared to milled raw rice supports this hypothesis.

A new heat processing method for the enrichment of rice reported by K. R. Bhattacharya (CFTRI) consists in heating the powdered paddy directly with the rice, heating the mixture in a closed container and allowing it to cool slowly. The washing loss of the fixed nutrients is low (20-30 per cent) and no protective coating is necessary. The process enables satisfactory enrichment of rice with calcium (as carbonate or phosphate), thiamine (as hydrochloride or mononitrate) and nicotinic acid. With riboflavin, the washing loss is high (60 per cent), but the calcium salt of riboflavin-5-phosphate in the presence of calcium carbonate gives satisfactory results, the washing loss being reduced to 20 per cent. Special advantages of the process, besides its simplicity, are: (1) it enables enrichment of rice with calcium, in which rice is very deficient, and (2) it gives an acceptable rinse-resistant grain enriched with riboflavin.

Milling and Processing

Dr Dorris D. Brown (Ford Foundation), who presided over this session, indicated the possibilities of increasing the yield of rice by modernizing the rice milling machinery and adopting improved harvesting procedures. As outlined by him, the conditions necessary for obtaining maximum milling yield of rice are: development of varieties that give high yields of brown rice; harvesting of paddy at moisture levels of 20-24 per cent; careful drying to less than 14 per cent moisture; proper storage to prevent insect and rodent damage; parboiling of paddy and its mechanical drying; and use of modern efficient milling machinery. According to Dr Brown,

adoption of these procedures can help in increasing the milling yield of rice by 6-8 per cent.

K. V. Deodhar (C.G. Dandekar Machine Works Ltd, Dandekarwadi, Bhiwandi) reviewed the present position of milling industry in India.

S. Govindaswami and A. K. Ghosh (CRRI) reported interesting observations on moisture heat balance during harvest, drying and storage of paddy. It has been found that harvesting paddy approximately 30 days after flowering in the early and 40 days in the case of medium and late varieties at a moisture level of 20-23 per cent is very important. Crop with this optimum moisture level should not be left for more than 5 days in the open and 11-13 days in shade. Threshing of paddy and further slow drying to a moisture content of 11-13 per cent gives maximum recovery of head rice. K. R. Bhattacharya and P. V. Subba Rao (CFTRI) presented two papers on the effect of processing conditions (soaking, steaming and drying) on the quality of parboiled rice. It has been found that soaking, consistent with maximum rapidity, can be best carried out either (i) at a constant temperature of 65-70° or (ii) by starting the process at about 75° and allowing the mass to cool naturally as the soaking proceeds. Open steaming for 3-4 min. gives satisfactory gelatinization of the soaked grain. The cooking quality of rice is mainly affected by the conditions during the steaming step, increasing the degree of steaming (and heating of the steamed paddy) giving increasingly hard cooking rice. The desirable processing conditions for obtaining a soft-cooking rice are: soaking at temperatures below 70°, minimum duration of steaming, and quick cooling of the entire batch of steamed paddy. E. K. Jayanarayanan (Central Research Laboratory, Dyer Meakin Breweries Ltd, Gaziabad) reported that raw rice amylase favours browning of parboiled rice by the formation of reducing sugars during steeping. Sodium bisulphite inhibits the browning of parboiled rice, but adversely affects its vitamin content. From studies on the effect of degree of milling of rice on its water absorption and cooking quality, H. S. R. Desikachar, S. N. Raghavendra Rao and T. K. Ananthaclhar (CFTRI) have concluded that satisfactory cooking quality can be obtained even at 2 per cent level of polishing.

During discussions on the rural processing of paddy it was generally felt that while hand-pounder need not be discouraged, the subsidy given to it may be used better for research and modernization of the rice mills. P. S. Sarda (Sarda Rice & Oil Mills, Ahmedpur, W. Bengal) discussed the application of the hot soaking method of parboiling in rice mills and stated that increased out-turn of rice (lower breakage) and reduced labour costs are the advantages offered by this process.

Products and Byproducts

Dr H. A. B. Parpia (CFTRI), who presided over this session, stated that byproducts are the life-line of any food industry. He quoted instances of how efficient utilization of wastes from fish and pineapple industries in USA and Philippines substantially added to their economy. He said that the utilization of available rice bran in the country

can yield about 3 lakh tonnes of oil which can also be used, after refining, for edible purposes. Proper recovery and utilization of rice germs are also necessary.

The present status and potentialities of rice bran oil industry in India formed the subject of three papers presented by K. S. Murti (Tungabhadra Industries Ltd, Kurnool), H. G. R. Reddy (Directorate General of Technical Development, Ministry of Industry and Supply, New Delhi) and B. H. Krishna (CFTRI). In their paper, R. T. Talwarkar, N. K. Garg and C. R. Krishna Murti (Central Drug Research Institute, Lucknow) discussed the extraction procedures for the preparation of pharmaceuticals like vitamin E and B concentrates, fatty acids, β -sitosterol, lecithin and phytin from rice bran. By the action of phospholipase A and D on rice bran phosphatides and extraction of the phosphatides by thin layer chromatography, it has been established that lecithin comprises the major portion of rice bran phosphatides. A laboratory method for the separation of rice germs from bran was described. The need for scaling up the process for immediate adoption in rice mills was stressed. B. P. Baliga, N. Desikachar and M. B. Ichaporla (Research Laboratory, Tata Oil Mills Co. Ltd, Bombay) presented data on amino acid, vitamin and mineral contents of commercial rice bran and rice polishing. The possibilities of improving the nutritive value of rice byproducts through fortification with lysine threonine and vitamin B₁ were discussed.

Five papers were concerned with the preparation of precooked dehydrated rice and canned rice and rice products. L. A. Ramanathan, B. S. Bhatia and P. K. Vijayaraghavan (Defence Food Research Laboratory, Mysore) presented process details and economics of the production of precooked dehydrated rice on pilot plant scale. Nagaratnamma Krishnamoorthy and G. S. Siddappa (CFTRI) presented three papers on the canning of rice and rice products. It has been observed that precooking of rice in water and draining to get an initial moisture content of about 56 per cent in the drained rice, so that the moisture content in the canned rice is 70-72 per cent, is necessary to get a uniform canned product free from stickiness, mashiness and free water. While filling the can, the ratio of precooked drained rice to added hot water should be nearly 2:1. Prolonged exhausting has a slight deleterious effect on the whiteness of canned rice. Heat penetration studies have shown that for sterility, processing for about 71-73 min. at 250°F. for a 2-5 lb. can and for 63-65 min. for a 1 lb. can is necessary. For preventing internal rusting in canned rice, the initial vacuum in the can must not be less than 19-20 in. Among the important commercial varieties of rice studied, viz. *jirige sanna*, *bangara sanna*, *pachodi* and *basumati*, only *bangara sanna* and *pachodi* give a good canned product in respect of uniformity of cooking, freedom from stickiness of the cooked grain, internal rusting of the can, colour of the product and its taste as well as smell.

The observations made by the chairman led to much useful discussion on the need for better

utilization of rice bran in the country. A suggestion was made for mobilizing all available bran in the country for the extraction of oil which can be used in the soap industry. Stress was laid on the extraction of edible oil of high quality by inactivating the lipase in bran soon after milling by suitable heat treatment. Installation of economic rice bran oil extraction units on a cooperative basis was suggested. Since a minimum of 10 tonnes of bran is necessary per day for each of such units, its collection could be organized on cooperative basis from 5 to 6 mills situated in the area. Oil obtained by solvent extraction technique is used in several parts of the world without any hazards to the health of the population. Many speakers suggested that extracted bran should be utilized for the production of compounded animal feeds. The present quality of rice bran, of which a large quantity is exported, is far from satisfactory and, in recent times, several consignments have been rejected on grounds of high contents of husk, silica and heavy insect damage. In order to improve the quality of bran, suggestions were made to improve the milling procedure, discourage the use of hullers which mix husk and bran, and to adopt suitable methods of fumigation for preventing insect infestation.

Handling, Storage, Packaging, Marketing and Grading

The Chairman, Shri K. R. Sontakay (Grain Conservation & Warehousing Industries Private Ltd, New Delhi), drew attention to the main problems of rice storage in India, viz. (i) pests on rice, their distribution and seasonal behaviour; (ii) control of the degree of milling and the storage properties of undermilled rice; (iii) effects of long storage on general quality of rice; and (iv) improved storage conditions in godowns and warehouses.

In comparative studies on the storage quality of brown and undermilled rice, organoleptic evaluation of raw and cooked rice samples conducted by T. K. Ananthachar, S. N. Raghavendra Rao and H. S. R. Desikachar (CFTRI) has yielded interesting results. Some samples which had a very pleasant smell in the raw state (especially brown rice) were found to be unacceptable after cooking since they were extremely bitter. They had also high free fatty acid values. The bitterness disappeared if the brown rice was milled to remove the bran layers. The disagreeable smell in some samples in the raw state disappeared after cooking. Samples stored in cloth bags which allowed aeration had less smell than those stored in bottles. The results of studies on deteriorative changes in the lipid fraction of rice were presented by C. M. Sowbbagya and K. R. Bhattacharya (CFTRI). While raw rice has been found to develop free fatty acid rather rapidly during storage, evidently by the action of the bran lipase, it is quite resistant to oxidative rancidification. Cured rice shows less fat hydrolysis, but a little more oxidative rancidity. Parboiled rice undergoes little fat hydrolysis, but is susceptible to rather rapid and high oxidative rancidification; rice milled from soaked (at 70°C.) and dried paddy is more or less prone to

autoxidation. Light and heat both accelerate oxidative deterioration, while heating (up to 60°C.) also accelerates fat hydrolysis. Drying hastens oxidative, but decreases hydrolytic lipid change. Susceptibility of raw milled rice to lipid autoxidation increases considerably when it is cooked and dehydrated or ground to a fine powder. Direct steaming (but not heating at 100°C. even for a much longer time) also has nearly the same effect. Freeze drying hastens autoxidation slightly. Peroxide value increases after an initial lag period to a maximum and then decreases. Carbonyl value increases a little beyond the peroxide value, but remains high for a long time.

Problems of bulk handling and storage of rice were reviewed by S. V. Pingale and his colleagues (Ministry of Food and Agriculture). It has been observed that in bulk storage, insect infestation is restricted to the topmost layers. Two papers related to the preharvest and postharvest handling of paddy and its subsequent storage in rural conditions.

The total losses occurring in paddy stocked in rural structures as a result of damage by insects, rodents and fungi has been estimated at about 11 per cent.

In a paper by Majumder *et al.* it was stated that insect infestation in paddy starts even in the field about a week prior to harvest. This could be controlled by preharvest prophylactic spray and fungal damage of rice in humid areas could be prevented by suitable fumigation treatments and aseptic balloon storage. In the paper presented by S. K. Majumder, A. Bano, M. K. Krishnakumari and J. S. Venugopal (CFTRI), the use of tricalcium phosphate and activated clay mixture was advocated for protecting grains during domestic storage. Problems relating to laboratory storage of brown and undermilled rice and lipid deterioration in raw, parboiled and heat-treated rice were also discussed. The need for increasing the storage life of brown and undermilled rice was brought out during the discussions.

The commercial classification of rice for marketing aroused interesting discussion. While the need for fixing and enforcement of standards for improving the market quality of rice found general appreciation, stress was laid on the specific need for rigorous fixation of standards for the foreign matter found in rice. In view of the difficult food situation existing in the country, and difficulties of marketing, suggestions were made to have only two grades for the marketing of rice.

Concluding Session

The concluding session, presided over by Shri T. A. Pai (Chairman, Food Corporation of India), was most interesting and lively, because the chairman in his characteristic, forthright way posed the pertinent problems from the point of view of the producer, distributor and consumer. The special responsibility of the Food Corporation and the ways and means in which experts can render assistance to the corporation were pointed out by him.

Eight resolutions recommending suggestions for implementation regarding the various aspects of rice production, processing and utilization were also discussed and adopted. These related mainly to the development of rice varieties with good cooking and milling qualities and possessing higher nutritive value; fixing of standards for harvesting, threshing and drying of paddy, rice milling machinery and factory sanitation; development of improved parboiling practices; fuller utilization of byproducts of rice industry; and adoption of modern practices during the handling, storage, packaging and marketing of rice.

An exhibition was arranged in connection with the symposium wherein rice milling machinery, byproducts of rice milling, traditional and recent processed rice products and different types of rice cookers were displayed. The Department of Agriculture, Government of Mysore, and the Central Rice Research Institute, Cuttack, also displayed high yielding and improved paddy varieties recently developed by them.

Summer School in Experimental Botany

T. S. SADASIVAN

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THE Summer School in Experimental Botany was organized this year from 28 June to 10 July 1965 at Ootacamund, Madras State. The school was formally inaugurated by Prof. T. S. Sadasivan, Director, Centre for Advanced Studies in Mycology and Plant Pathology and University Botany Laboratory, Madras, on 28 June 1965. In his opening address, Prof. Sadasivan pointed out the rapid advances that have been made in biological sciences in this century especially after World War II. The technological advances in physical and chemical sciences had made available powerful tools in the hands of scientists who could usefully employ these in the study of biological phenomena. He traced how the development of radioisotopes, sophisticated electronic equipment and other aids have led to the phenomenal spurt in activity in the field of biology. He commended the idea of such periodical get-together of university teachers and other active scientists in the field of botany inasmuch as it could promote a social integration of scientists from different parts of this vast country. This, he said, is a prerequisite for any large-scale social integration of scientific knowledge. When we in this country are attempting to put our agriculture on a proper scientific basis, the need for fostering and maintaining an increased tempo of biological research, especially in the field of botany, becomes very important. Prof. Sadasivan reminded the audience of the onerous task ahead of the experimental scientists in this field in rising up to the demands of the nation and exhorted them to build up a pool of necessary basic knowledge from which alone could stem major technological advances in agriculture, forestry and related fields.

The inaugural address was followed by an informal discussion of the many problems facing the university teachers in effectively teaching experimental botany, to graduate and post-graduate students. The consensus was that despite the eagerness on the part of teachers to do so, there were some bottlenecks in putting this in practice. With a paucity of equipment, apparatus and essential chemicals, the students could not be initiated well in experimental botany. The standard of practical lessons by necessity falls very much short of the theory of instruction. This state, if continued for long, would leave our student population bereft of any enthusiasm for pursuing experimental botany. We should find ways and means to remedy this situation. While this is so in well-established centres of graduate and post-graduate education, the clamour for opening more and more centres is going on. This large-scale instruction of increased number of students in these scientific subjects will necessarily water down even the existing poor standards. Apart from pointing out these pitfalls, the participants agreed to evolve novel

methods of teaching this science and thereby counter, at least in part, this trend of decline of standards.

The papers presented were divided into groups pertaining to an area of experimental botany. Enough time was given for the full development of the author's theme and this was followed by a frank and full-scale discussion regarding the techniques employed and the significance of the results obtained. These discussions were frank, pointed and very useful.

Cytogenetics

Dr Balam Majumdar, Bose Institute, Calcutta, presented his studies of mutations in rice induced by ^{32}P and X-rays. These studies were aimed at evolving and selecting rice mutants for early flowering, high yielding capacity, straw stiffness and, possibly, higher protein content in the grain. He reported the selection of three mutants, namely 'Black Mutant' (selection No. 1), 'Marichbati awned' (selection No. S. 236) by treating Marichbati variety with ^{32}P irradiation. The third mutant 'White Dular' (selection No. S. 240) was induced in the variety Dular following 50 Kr X-ray treatment. These three mutants were compared with parent lines over two years and in 1962 with other local varieties. The 'Black Mutant' was found to produce higher number of tillers and panicles and the yield was higher when compared to its parent. However, this mutant had certain unfavourable qualities as well, such as late flowering and weaker straw. The second mutant 'Marichbati awned' did not vary much in agronomic characters from its parent variety. The third mutant 'White Dular' was lower yielding but exhibited more straw stiffness. Cytological studies also were undertaken and in all these mutants the chromosome number $2n = 24$ with normal cell division, although in 'White Dular' some irregularities were evident in mitosis.

Following a discussion of Dr Majumdar's paper, Dr C. S. K. Raju, Andhra University, Waltair, presented a paper on 'Chromosome engineering and plant breeding'. He described the principles involved and techniques adopted in effecting a transfer of entire chromosomes or chromosome segments from wild relatives. This incorporation of the chromatin of the wild genome into genomes of domesticated plants have yielded significant results both in terms of advancement of the cytogenetic theory as well as in terms of improvement of crop plants, Dr Raju observed. On the theoretical side much useful information on the behaviour of chromosomes in hybrid and polysomic situations had been obtained. On the practical side, gene transfer and chromosome substitution in tobacco resulted in TMV resistance, and rust-resistant gene transfer in wheat are but two of the examples that are very

significant. He further traced such experiments that have been on in Prof. Mangelsdorf's laboratory at Harvard University for the past 25 years in hybrid maize and brought out the significant results of such genome transfers in maize from wild relatives. Dr Raju also discussed the bearing of Prof. Mangelsdorf's work upon the understanding of the evolution of cultivated maize.

Dr Raju was followed by Dr Rabindra Krishna Basu of Bose Institute, Calcutta, who presented the results of his experiments in the quest of high yielding mutations in jute. This was attempted by treating the populations of five varieties of jute to X-radiation and ^{32}P radiation. The high yielding capacity of an established X-ray mutant compared against the mother line was tested for five years in two locations. Evidence presented proved that the higher yield is not due only to increased plant size. There was also an increase in the number of fibre cells per unit area in the mutant.

The general idea that emerged from a discussion of these papers was that these lines of research held out great promise in our quest for improvement of crop plants and could lead to much technological advances in this direction.

Physiology of Fungi and Bacteria

The next series of five papers were largely concerned with the physiology of fungi and bacteria of interest to plant pathologists. Prof. Sadasivan spoke on the 'Advances in problems of plant protection' from the viewpoint of inducing a defence reaction somewhat related to the antibody reactions in warm-blooded animals. He traced the recent developments in the fungal and bacterial classifications by techniques of serology with the use of adjuvants to overcome the poor antigenicity of fungal material and use of phages to classify the bacterial strains. He also referred to the interesting changes in the proteins of the host plants as revealed by the detection of change in isozyme patterns and reported in Black-rot of sweet potato and *Phytophthora*-rot of potato. The discussion revolved round the two fundamental issues: (i) Do plants have anything like antibody defence mechanism?; (ii) Is there a possibility of inducing lasting immunity in plant tissues?

Dr A. Appa Rao, Andhra Pradesh Agricultural University, Hyderabad, drew attention to the phenomenon of adaptation of fungi to toxic metabolites. With the advent of chemotherapy and introduction of antibiotics in medicine and the organic insecticides and fungicides for plant pest control, the phenomenon of adaptation has come to receive much attention. There are now numerous reports of various types of acquired resistance of fungi to several fungicides *in vitro* and *in vivo*, although the latter is less frequent. The problem is one that deserves serious attention and the success of our programmes aimed at controlling these plant pests largely depends on our understanding the mechanism of these adaptations. Dr Appa Rao illustrated that the suggestion often made of the use of alternate fungicides with different active chemical ingredients to circumvent adaptation did not work always. He cited the case of a strain of

Sclerotium rolfsii which was adapted to copper sulphate was not resistant to cheshunt compound although the strain adapted to cheshunt compound was resistant to copper sulphate. Similar results were also obtained with *Ceratostomella paradoxa* where a strain resistant to copper sulphate was found to tolerate higher levels of mercuric chloride but not copper Sandoz. Although the mechanism underlying this phenomenon of adaptation is still incompletely understood, there is no doubt about its far-reaching significance in problems of pest control.

Dr P. N. Rao, Osmania University, Hyderabad, gave a paper entitled 'Nutritional studies on *Leptosphaerulina ricini* with reference to carbon and nitrogen requirements'. Among the hexoses D-mannose was found to support the best growth followed by glucose, fructose, galactose, while sorbose was inhibitory. Among the pentoses, L-arabinose promoted maximum growth. The disaccharides maltose and lactose were satisfactory as carbon sources. Polyhydric alcohols were poor sources and sometimes inhibitory. Organic acids, amino acids were poor as sole carbon sources. Nitrogen sources varied in their efficacy. The organism could utilize ammonium nitrate and organic nitrogen. Among 23 sources tried asparagine proved the best source followed by ammonium nitrate and ammonium chloride. The fungus made excellent growth when supplemented with mixed nitrogen and carbon sources. Dr Rao discussed the importance of these observations.

Dr S. Suryanarayanan, University of Madras, described the results of his studies on 'Lipid metabolism in uredospores of a rust fungus'. Uredospores are rich in lipids and spore oil constitutes nearly 20 per cent of the weight of spores. Germinating uredospores register an RQ of about 0.7 indicating that lipids are the major endogenous substrate. β -Oxidation appears to be the major pathway of fatty acid degradation, although α -oxidation seems to be involved to a certain extent as in wheat stem rust uredospores. Acetyl units derived from fatty acid oxidation may enter tricarboxylic acid and glyoxylate cycles. This was supported by studies using specifically labelled pelargonate, valerate, propionate and acetate. Enzymes related to both the TCA and glyoxylate cycles have been previously demonstrated in uredospores. Since the uredospore respiration was malonate resistant, there was doubt regarding the operation of TCA cycle. However, the results of tracer experiments strongly suggest the operation of both TCA and glyoxylate cycles in the energy metabolism of uredospores. The acetyl carbons enter a variety of compounds in the amino acid, organic acid and, to a little extent, protein. But a net synthesis of protein does not occur which seems to be the bottleneck in the culture of rusts apart from their hosts.

Dr M. V. Nayudu, Sri Venkateswara University, Tirupati, then spoke on some 'Problems in nutrition of phytopathogenic bacteria'. While most of these bacteria grow well on simple synthetic media, and isolates of *Xanthomonas vasicatoria*, *X. malvacearum* and *X. citri* showed little growth on nitrate or ammoniacal nitrogen containing medium. L-Glutamic acid

alone supported some growth with or without the addition of thiamine, folic acid and calcium. Other amino acids tried supported meagre growth or none at all. When 15 amino acids were added in the proportion in which they are obtained in caesin hydrolysate, the bacteria grew very well. This suggested some chemical interaction of other amino acids with L-glutamic acid.

These studies of Dr S. Suryanarayanan and Dr M. V. Nayudu are, of fundamental nature, pre-requisite to an understanding of host-pathogen inter-relationship.

Nitrogen Fixation

Dr D. Subramanian, University of Madras, presented some of the recent evidences obtained to indicate the requirement of ATP in the cell-free fixation of nitrogen by extracts from *Clostridium pasteurianum*. Although the involvement of ATP was suggested before by earlier workers, the actual site of its action was not resolved. Tentative suggestions included that ATP was involved in the formation of an activated oxidized 'nitrogenase', or an activated state of reduced 'nitrogenase'. But these suggestions implied only one site of ATP action and that the site of nitrogen reduction. No conclusive evidence for these involvements of ATP has, however, been obtained. In their studies, Dr Subramanian reported, evidence was obtained for two sites of ATP action and that one of these may be concerned with the electron transport between hydrogen and ferredoxin.

Speaking about the intermediate products during the process of nitrogen fixation by a blue-green alga *Westiellopsis prolifica* Janet, Dr Harihar Patnaik, Ravenshaw College, Cuttack, presented the evidence obtained by using ^{15}N in short-term experiments for the secretion of amides, ammonia and some polypeptides. The principal products were, however, found to be ammonia and amides. These compounds were seen to be absorbed readily by the organism. The predominant labelling of ammonia suggested its key role.

Dr Nomita Sen's studies on *Chlorella pyrenoidosa* seemed to indicate that when the organism was grown under light-limited conditions for photosynthesis, there was an increase in the final yield when the cultures were supplemented with the addition of glycollic acid, glyoxylic acid, glycine and glucose. These effects of low concentrations of glycollic acid appeared to have resulted from the reduction of the lag period rather than the increase in the related growth constant. However, low concentrations of glycolate did not have this effect in the dark. The alga showed a low QO_2 value and a limited response to added organic acids. The increase in final yield without any increase in respiration seemed to suggest that the alga could utilize suitable organic substances directly in light for synthesis of nitrogenous substances leading to protein synthesis.

Growth Metabolism and Development

Prof. J. J. Chinoy, Gujarat University, dealt with his study of correlations between growth, metabolism and development in relation to

environment and highlighted their importance in elucidating the mechanism underlying inheritance of quantitative characters. He found correlations between development on the one hand and different components of growth, rates of mineral and organic metabolism as well as rates of production and utilization of regulatory substances such as ascorbic acid.

The photothermic quantum determined as a product of summation of mean temperature and total photoperiod was found to increase with the length of growth period of a variety and was constant for a variety grown under varying photoperiods. The photosensitivity of a variety was found to increase under vernalization and was the highest for early varieties and progressively lesser for late ones.

Genic analysis of individual characters were seen to follow multiple factor hypothesis but the correlative data indicated pleiotropy of flowering genes.

Prof. K. K. Nanda, Panjab University, presented a paper entitled 'Some investigations on growth and development of plants'. He said that in wheat various growth characters are correlated with the length of the vegetative period, while the number of ears produced on the plant, the number of spikelets and grains, the thousand-grain-weight and yield are correlated with temperature of the ripening period.

Some of the physico-chemical changes which occurred during the transformation of the growing apex from the vegetative to the reproductive state appeared to be crucial. The increased activity in the growing apex synchronized with the increase in the concentration of ascorbic acid and a decrease in auxin. This change was brought about in the shoot apex much earlier in a variety subjected to long day and vernalization than under normal and unvernallized conditions.

Dr M. M. Laloraya, Allahabad University, gave an account of his 'Correlative studies on plant growth and metabolic activities'. In an attempt to understand the mode of action of growth regulatory substances such as gibberellins and kinetin, the changes they induce in protein and nucleic acids of tissues have been studied. It was shown that gibberellic acid affects the internal distribution of translocated nitrogen when stimulating the hypocotyl growth in lettuce seedlings. Similar trends were noticed in protein and RNA. The growth effects of gibberellin was observed to have no direct relationship, either with the loss of protein from the cotyledons or to the extent of enhanced synthesis in the hypocotyl. Indeed, inhibitors of protein synthesis such as chloramphenicol, fluorophenyl-alanine and ethionine and of nucleic acids like 5-fluorouracil failed to inhibit the GA-induced growth.

Inhibition of longitudinal growth of lettuce hypocotyl by kinetin was associated with increased protein synthesis. In intact seedlings, as well as in excised sections, the protein/soluble-N ratio was always higher in kinetin-treated plants as against a low protein/soluble-N ratio in gibberellin-treated seedlings. In contrast, inhibitors of nucleic acid synthesis such as 5-fluorouracil brought about an

inhibition of kinetin-induced expansion of cotyledons in pumpkin seedlings. The inhibitors of protein synthesis such as chloramphenicol, puromycin, fluorophenylalanine and ethionine had no effect on this expansion. It was concluded that while the growth regulating activity of different substances was exerted via different mechanisms, it could be generally concluded that they act by affecting the turnover rate of protein rather than just affecting their synthesis.

Prof. Nanda presented another paper embodying the data of his studies of the effects of gibberellin on *Salmalia malabarica* Schott. & Endl. He found that gibberellin accelerated the elongation of the stem and this effect was proportional to the concentration. The greater effect of higher concentrations of gibberellins was due to the larger number of internodes affected. The initial increase in the rate of extension growth, however, was soon followed by a rapid fall and this fall was more and lasted longer in plants treated with higher concentration of gibberellin.

The amount of reserve food material in the internodal cells was highest in untreated plants and decreased as the concentration of gibberellin applied increased. The enhanced internodal growth went hand in hand with the disappearance of starch from these internodal cells. It appeared, therefore, that enhanced extension growth caused by gibberellin was perhaps a consequence of the enhanced activity of hydrolytic enzymes causing rapid mobilization of materials.

Dr M. M. Laloraya also presented a paper entitled 'Some new considerations on the mechanism of auxin action'. He placed before the audience the significance of 5.44 Å., the distance involved in the presence of a strong negatively charged group from a weak positively charged group at an unobstructed distance as obtained in the auxin molecule and the coincidence of this with the distance involved in the formation of hydrogen bonds. He suggested that the primary action of auxin was to disrupt the hydrogen bonding in the macromolecules of the cells, notably nucleic acids, proteins and cellulose micelles. This mechanism, he observed, could eminently explain the many varied effects produced by auxin treatment.

Taxonomy

Prof. T. V. Desikachary, University of Madras, spoke about 'Experimental approach to blue-green taxonomy'. He emphasized that while it is obviously necessary to keep taxonomic practices at a level of easy adaptability for ready reckoning of the taxa, an equal need existed for the use of more and more tools for critical evaluation of taxa of doubtful status. He felt that there is need to adopt newer methods and these would naturally outstep simple herbarium methods into fields of experimental study. This latter step would certainly help in critical evaluation of taxonomic criteria and help stabilizing taxa with as little subjective errors as possible. The need for this experimental approach was all the more in the taxonomy of blue-green algae where there were extreme instances of lumping and splitting. He illustrated these

points with the studies on the morphological variations encountered in culturing blue-greens in various well-known synthetic media.

Dr Bhoj Raj, Osmania University, Hyderabad, gave a general review of 'Sporoderm stratification and its significance in taxonomy'. With the aid of phase contrast, ultraviolet and electron microscopes, finer details have been recognized and a better understanding of sporoderm stratification had become possible. The importance of sporoderm stratification as an aid in taxonomy by taking into account the presence or absence of a layer, its thickness and stainability, etc., had been discussed with particular reference to the families Compositae and Acanthaceae.

R. Sundara Raghavan, Botanical Survey of India, gave an interesting account of the revision of Commelinaceae based on cytotaxonomic studies carried out at Poona. During the current revision, he said, different populations have been studied both in their natural habitat and under experimental cultivation laying emphasis on those characters that were not reflected faithfully in herbarium specimens coupled with extensive cytological observations. He brought out with care the various existing difficulties in classification of members of this family. This synthetic approach had already resolved many of the uncertainties and at present 77 species (including one new species) under 10 genera were recognized.

Dr E. R. S. Talpasayi, Banaras Hindu University, speaking about the heterocysts of blue-green algae said that much new information had become available regarding the morphology, physiology and cytochemistry of these structures. Electron microscopic studies revealed photosynthetic lamellae, membrane systems and a variety of granules. Cytochemical studies indicated the presence of ascorbic acid and tetrazolium reductase. These and other observations suggest that heterocysts are metabolically active and not 'moribund'. There seemed to be circumstantial evidence to suggest that heterocysts produced substances controlling growth, cell division and other developmental processes of the blue-green filament. The factors in the environment such as presence of ammonium ions, concentrations of phosphate, shortage of molybdenum, etc., controlled the frequency of their occurrence. Germination of heterocysts could be experimentally induced by temperature treatment or supply of glucose and ammonium ions although the percentage germination was low.

Miscellaneous Papers

Dr G. V. Joshi, Wilson College, Bombay, gave an interesting account of his studies in photosynthesis in *Ulva lactuca* using ¹⁴C. The products of photosynthesis were analysed as usual, chromatographically. A large amount of radioactivity was located in sugar phosphates which was not usual in terrestrial plants. The reduction of phosphoglyceric acid appeared to proceed rather slowly as this compound also registered a high activity. Glutamic acid was the highly labelled compound among the amino acids. In addition to proline which also was prominent there were seven organic acid components.

Estimation of radioactivity in the ethanol insoluble fraction showed that carbohydrates accounted for 40 per cent of radioactivity while proteins registered 54 per cent suggesting that in *Ula lactuca* protein synthesis proceeds at a faster rate than carbohydrates in light. Preliminary results suggested that the photosynthetic products were somewhat different in *Ula lactuca* which thrives in a marine environment.

Dr Hardev Singh, Delhi University, described the results of 'In vitro studies on a callus of *Ipomoea pentaphylla* infected with *Albugo*'. Local infection on the leaves resulted in the formation of white sori on the lower surface while infection of the stem results in galls. The galls were of two types, bud gall and cerebriform gall, and these showed systemic mycelium. The shoot-like bud gall arose on the internodes. Factors affecting the formation

of conidia and oospores of the fungus were studied. The callus that contained the developing oogonia grew much faster compared to the one which contained only vegetative mycelium. The behaviour of calli obtained from different parts of the bud gall was variable. Addition of 2,4-D inhibited the growth of the fungus in the host tissue.

Dr N. Shankla, University of Jodhpur, described the effects of kinetin on mature excised embryo of *Merremia dissecta* (Jacq.) Hallier f. Embryos excised 25 days after pollination could be cultivated without any dormant period. In general, kinetin was deleterious for embryo growth. At higher concentrations, the cotyledonary leaves got proliferated into a coralloid structure. It was, however, interesting that *in vitro* the leaves opened and showed their characteristic dissected shape only in those cultures fortified with some kinetin.

Gregor Mendel Memorial Symposium

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ON 8 February and 8 March 1865, Gregor Mendel presented before the Natural Science Society in Brno his findings on the laws of heredity. An international symposium was organized by the Czechoslovak Academy of Sciences with the co-operation of the International Union of Biological Sciences, Unesco, the International Atomic Energy Agency and the Council for International Organization of Medical Sciences at Brno from 4 to 7 August 1965 to commemorate the centenary of Mendel's discovery. The symposium was attended by about a thousand geneticists from 40 different countries. The largest groups were from the United States and the USSR with about 100 and 80 delegates respectively. The Czechoslovak Academy of Sciences and the Government of Czechoslovakia spared no efforts or expense in making the symposium both highly successful and enjoyable. In addition to the scientific sessions, an excursion had been organized to the village Hyncice in the district of Kraraskao which is the birth-place of Mendel and where he had his early education. Visits were also organized to the Moravian Museum where a Mendel Memorial Archives has been set up. On 7 August a special function was held at the monastery where Mendel worked for the presentation of Mendel Memorial Medals to a group of geneticists who had been selected for the award by the Czechoslovak Academy of Sciences. The author was selected for this honour in the company of Professors C. Stern, T. M. Sonneborn, C. Zirkle and R. D. Owen of USA, C. H. Waddington and F. A. Crew of UK, M. Jacob of France, A. Muntzing and A. Gustafsson

of Sweden, H. Stubbe and G. Melchers of Germany and N. P. Dubinin and N. V. Cicin of USSR.

This symposium can be regarded as a significant turning point in the history of genetics, because what has come to be known during the last two decades as 'Mendelian genetics' and 'Soviet genetics' merged into one at this meeting. For the first time in post World War II genetic history, leading Soviet geneticists like Prof. N. P. Dubinin and Prof. B. L. Astaurov attended an international gathering of geneticists. A section of genetics under the chairmanship of Prof. Dubinin has recently been created by the USSR Academy of Sciences, which symbolizes the rebirth of Mendelian genetics in the Soviet Union. All the delegates welcomed this unique opportunity of sharing ideas and experimental results with the leading Soviet geneticists and it can be confidently hoped that this fusion of strength would give added vigour to the growth of genetics.

The Mendel symposium was opened on the morning of 4 August 1965 by Prof. F. Sorm, President of the Czechoslovak Academy of Sciences. Following the formal opening, four scientific sessions dealing with the (i) Origin of Mendelism, (ii) Establishment of genetics, (iii) Modern developments in genetics, and (iv) Applications of genetics to human welfare were held.

Origin of Mendelism

Prof. B. Nemeč of Czechoslovakia discussed the reasons for the neglect of Mendel's findings for over 35 years. Darwin's observations on adaptation

and ecotypic variation as well as the Lamarckian ideas on the inheritance of acquired characters tended to cloud thoughts on heredity during the period when Mendel lived and worked. It is probably due to the overwhelming impact of Darwin's exposition of the mechanisms underlying the origin of species that contemporary biologists failed to recognize the significance of Mendel's findings. Mendel himself seems to have recognized this position as is clear from the following extract of his letter to Nägeli. "I knew that the results I obtained were not easily compatible with our contemporary scientific knowledge and that under these circumstances the publication of one such isolated experiment was doubly dangerous; dangerous for the experimenter and for the cause he represented." Nägeli was convinced that if Mendel extended his work to other species he would have got different results as indicated in his reply quoted below: "Your intention of extending your experiments to further plants is excellent and I am convinced that in other varied forms you will obtain substantially different results." Unfortunately, Mendel chose an apomictic plant (*Hieracium*) for his further studies and this led him to difficulties in extrapolating his observations from pea to *Hieracium*.

Prof. F. A. Crew dealt with the topic 'Mendelism comes to England'. He mentioned that Prof. R. C. Punnett, who along with W. Bateson established the foundations of Mendelism in England, could not come to the meeting owing to a chronic disability. He referred to the fact that Bateson who had been working on the inheritance of characters since 1887 and who had also published in 1894 a book entitled *Materials for the study of variation* had not heard of Mendel's work until, while traveling in a train to London in 1900 to address a meeting of the Royal Horticultural Society, he read a paper of Correns relating to Mendel's work. Bateson immediately got the solution to many of the problems which were then worrying him and chose to speak at the meeting on Mendel's work rather than present the paper which he had earlier prepared for the occasion. It was not easy in those days to get Mendel's views accepted because of strong opposition from eminent biometricians like Karl Pearson and Weldon. The ideas of Francis Galton as well as of Karl Pearson made it very difficult for Bateson even to get his views published in scientific journals. In fact in 1903, the editor of *Nature* returned a manuscript of Bateson with the note that he was not prepared to continue the discussion on Mendel's principles and, therefore, returns herewith the papers recently sent him by Mr Bateson! The experimental work of Bateson and Punnett together with the work of Morgan and his school in the United States had by 1915 established beyond doubt the validity and wide applicability of Mendel's laws of inheritance and the name 'genetics' given by Bateson to this science in 1905 was universally adopted. After seeing the work of Belling during a visit to the United States, Bateson recognized the importance of cytology to complement genetical observations and a post of cytologist, to which Dr C. D. Darlington was appointed, was created at the John Innes Horticultural Insti-

tution. Bateson worked hard under difficult circumstances to spread the meaning and message of Mendel's findings and Prof. Crew remarked that the epithet "A great man imposes on posterity the duty of understanding" is applicable to him.

Prof. Stubbe of Germany who acted as the chairman of this session referred to the great contributions of Prof. Nemeč and some of the early pioneers in spreading an understanding of the significance of Mendel's experimental findings.

Establishment of Genetics

Prof. B. L. Astaurov of USSR referred to the contributions of Vavilov, Navashin, Karpachenko and many of the early Russian geneticists in extending genetical principles in a wide range of organisms. Vavilov developed his concept on the centres of origin of crop plants on genetical ideas and this provided a scientific basis for the search for new genes. Russian workers took a leading part in establishing gene banks and in the use of genetical principles in the improvement of both domesticated plants and animals. Prof. N. P. Dubinin gave a summary of the work done in USSR on the gene as a unit of mutation. He showed how Kozjinsky in a book on *Heterogenesis or saltation* published in 1897 had put forward ideas similar to those of Hugo de Vries. The Russian work on mutagenesis has revealed that genes are physical and chemical systems having a biological organization and are hence amenable to various types of manipulations. Prof. C. Zirkle of the United States referred to the fact that although the basic facts of heredity were known for over a thousand years, it was only Mendel who could interpret the data on the right lines. He also referred to the cytological work of Rosenberg in the genus *Drosophila* which sparked off a large volume of work on cytology as related to taxonomy in the first decade of this century.

Modern Development in Genetics

Prof. J. H. Lewis of the United States dealt with the recent work on the analysis of genetic loci. He mentioned that studies on recombination still provide the most potent tool for an understanding of the gene. He referred to studies on the fine structure analysis of genes and mentioned that starting with the codon which along with muton constitutes the smallest unit, recon, cistron and operon represent progressively larger units. The operon signifies a specific part of a chromosome which constitutes a coordinated unit of transcriptional activity, and is the largest of the structural units. He also referred to the concept of pseudoallelism, an understanding of which is very important from the evolutionary and developmental angles, and showed how a pseudo-allele may comprise units with similar functions (example, lozenge locus in *Drosophila*) or units with separate functions (example, bithorax in *Drosophila*). The bithorax locus is similar to an operon. A new cycle of understanding between genetics and biochemistry has developed and recent work, such as the study of Holley and his colleagues leading to the determination of the complete nucleotide sequence of an alanine transfer RNA, is an example of the sophistication in genetic

analysis which has resulted from this synthesis [see *Science*, **147** (1965), 1462].

Prof. F. Jacob, who shares with Prof. J. Monod the credit for propounding the operon concept, gave a lecture on the coordination of genetic activity in the bacterial cell. The high resolving power of genetic analysis renders bacteria and viruses to be invaluable material in genetic research. He referred to the fact that transforming DNA and transduced DNA cannot replicate unless it is integrated in the DNA template. The enzyme DNase as well as the template are both essential for replication. The replication and expression of a structural gene depend on its location and the nature of the adjacent genes. The way in which the molecules combine and associate themselves with each other and how they give signals to their associates are problems which are yet to be solved. Prof. G. Melchers of Germany, who spoke on virology and genetics, showed that the tobacco mosaic virus is a very useful material for studying the mutations induced at the molecular level, e.g. the conversion of cytosine into uracil leads to a change in the ratio of chlorotic versus necrotic spots in the tobacco plants. Thus, quantitative tests can be carried out and it has been possible to establish the sequence of amino acids in the polypeptide chain in many cases. Prof. Melchers also discussed problems in coding and supported the view that the code may be degenerate.

Prof. M. R. Irwin of the United States dealt with the principles of immunogenetics and showed how some out of the 13 cellular antigens identified in cattle are very complex, while others are simple. Studies on the antigenic types of *Paramecium* have helped to elucidate some of the problems in gene expression.

Prof. C. H. Waddington discussed problems in genetics and evolution and showed how through genetic assimilation, characters which were originally 'acquired' characters in the conventional sense may become converted by a process of selection acting for several or many generations of the population concerned into 'inherited' characters.

Special Applications of Genetics

Prof. Å. Muntzing of Sweden referred to some of the genetic principles which have had a great impact on plant breeding. He stressed the role of recombination of genetic factors, exploitation of heterosis and of modern cytogenetic tools, such as the induction of polyploidy and mutations, in the development of new strains. Prof. N. V. Cicin of USSR dealt with the unusual possibilities opened

up by distant hybridization. He referred to the branched wheats selected from crosses between *Triticum* and *Agropyron* and indicated that some of them are fit for commercial cultivation. The third paper in this session was given by Dr M. S. Swaminathan of India who spoke on the application of genetic principles to crop improvement in the tropical regions. He cited examples from the manipulation of single genes as in the case of the Norin dwarfing gene in wheat, the Chu-Wu-gin dwarfing gene in rice, and the genes conferring male sterility in *Sorghum* and *Pennisetum*, to show that great spurts in yields can be accomplished through genetic manipulation in conjunction with changes in agronomic practices. He also referred to the fact that a wide genetic base in a hybrid or variety enlarges its limits of adaptation. Thus, the germplasm complexes built in India in maize have proved to be best yielders in Thailand and Indonesia. The hybrid *Sorghum* variety CSH 2 developed in India has given the highest yield in Brazil. Cytogenetic tools such as polyploidy and mutation have helped in the development of varieties like Pusa Giant Berseem in *Trifolium alexandrinum* and NP 836 in wheat. A combination of techniques such as polyploidy and mutagenesis helps in rectifying the defects caused by one of them, as has been done in the improvement of the number of secondary branches in autotetraploid *Brassica campestris* var. *toria*. Plant breeding based on genetical principles has thus opened up new vistas in crop production in India.

Prof. I. M. Lerner of the United States dealt with genetics and animal breeding and said that at long last the concept that breeding and science cannot be combined has vanished from the field of animal science. Prof. C. Stern of the United States traced the growth of human genetics and referred to the fact that the suggestion made by the late Prof. J. B. S. Haldane in 1930 that leucocytes should be used in cytogenetic work has proved to be an invaluable one. The exploitation of this suggestion, has, however, started only recently. Prof. L. Gedde dealt with the use of the Mendelian unit of inheritance in gemellology (i.e. study of twins). This type of research has helped in the understanding of the relative roles of the environment and heredity on the expression of characters.

At the concluding session held on 5 August, tributes were paid to the organizing committee for the excellent arrangements made for the symposium. During the symposium, a solemn Mass was celebrated on 5 August at the Roman Catholic Church in Brno where Mendel was abbot and also a Requiem Mass on 7 August.

Photoplastic Stress Analysis: Requirements & Properties of Photoplastic Materials

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THE current trend in the design of structures is to incorporate a suitable portion of the plastic range of materials in the design so that the safety factor is minimized and thereby economy is achieved besides light weight of construction. Hence a knowledge of the stress distribution in materials, when they are in a plastic condition, is essential. The theoretical approach for evaluating the stress distribution is still in a state of development. The application of the classical methods of the theory of elasticity to certain important practical problems is no longer considered adequate by engineers. Problems of this kind arise in connection with the determination of local stresses produced by abrupt change in cross-section. The stress concentration factors, determined by the methods of elasticity, have been found to be much higher than those actually observed in the case of materials like steel which pass through a plastic stage prior to failure. A knowledge of this difference between the theoretically deduced and observed values of stress concentration factors is extremely important in the determination of allowable stresses for alternating loads. Further, in many problems of structural stability, determination of the basis of ultimate loads requires the study of stresses and strains over regions which are beyond the scope of the classical theory of elasticity. Hence the subject is being approached in recent years from a study of the double refraction effects in transparent materials when they are loaded such that they get into the elastoplastic condition. This type of analysis of stress distributions in loaded members by model studies in transparent materials is called photoplastic stress analysis. Thus the subject of photoplasticity deals with the study of stress distribution in transparent materials under stresses beyond the elastic limits, by an extension of the photoelastic method, i.e. by the study of the birefringence and isoclinic parameters at arbitrary points in the model.

The present paper gives a brief account of the basic principles of photoplastic study and reviews the results of recent studies in the choice of materials suited for photoplastic studies.

General Principles and Requirements of Photoplastic Materials

The experimental data available for obtaining stress distributions in photoplasticity are the same as in photoelasticity, i.e. the birefringence and the isoclinic parameters at arbitrary points in the model.

The requirements of photoplastic materials are: (i) they should experience appreciable birefringence under load; (ii) they should have a well-defined yield point, and undergo large deformations at nearly constant stress once the yield point is reached; and (iii) the stress-strain characteristics should be almost

similar to low carbon steels most often used in engineering structures.

When the stresses are elastic, the stress-optic law is linear for all model materials. When the stresses become plastic this law becomes, in general, non-linear and different for each material. Thus the law must be determined for the particular type of model material which is to be used in the tests. In addition, it must be ascertained whether the isoclinic parameters, which give the directions of principal stresses in the elastic state, also give these directions in regions where plastic flow has occurred.

Solutions of problems in stress distribution, whether elastic or plastic, must satisfy three conditions: (a) equilibrium, (b) boundary values, and (c) compatibility. The fulfilment of these conditions is all that is required of the stress distributions in the model. It is significant to observe that solutions obtained experimentally automatically satisfy compatibility. If the results are to be applied to metal prototypes, the problem of transition must be considered. In the plane elastic state of stress, the transition from model to prototype is easy, since, except in special cases of little practical importance, the conditions which must be satisfied are those of similarity of geometrical shape and loading. In order to make the transition when the stress distribution involves plastic flow at least three more conditions must be met: (a) the stress-strain curves of the materials used in the model and the prototype must have the same shape, and if points in the model undergo unloading as well as loading both during increasing as well as decreasing stress, the stress-strain curve shapes should agree; (b) the law of yielding must be the same for both materials; and (c) Poisson's ratio in the plastic range must be the same for both materials. Additional conditions, such as the law of continued yielding, must be satisfied, but these are exceedingly complex and are not fully understood for metals.

Nylon Copolymer as Photoplastic Material

Just a few years back, Hetenyi¹ tried nylon copolymer, supplied to him by the Dupont Co., for photoplastic studies. The only form in which this material was available was in thin sheets of approximately 0.0108 in. in thickness, which made it necessary to limit the experimentation to tension tests only. The stress-strain-optical birefringence characteristics of this material as observed by Hetenyi are reproduced in Figs. 1 and 2 for two different levels of relative humidity, viz. 14 and 46 per cent respectively, at 72°F. It is seen from a comparison of the two figures that the properties of the material are considerably influenced by humidity conditions. Pronounced yield point in the stress-strain curve and correspondingly well-defined slip bands in the test

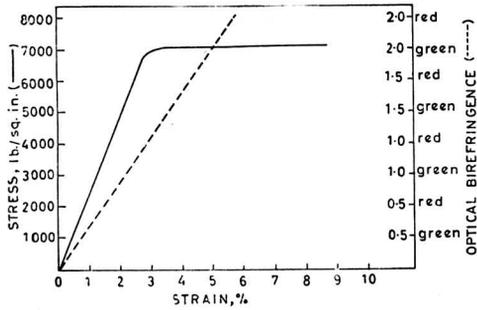


Fig. 1 — Stress-strain-optical birefringence characteristics of nylon copolymer at 72°F. and 14 per cent relative humidity [Gage length, 3 in.; cross-section, 0.25 in. \times 0.0108 in.; value of elastic constant (E) = 320,000 lb./sq. in. Optical birefringence is expressed in terms of number of fringes observed as the strain is varied]

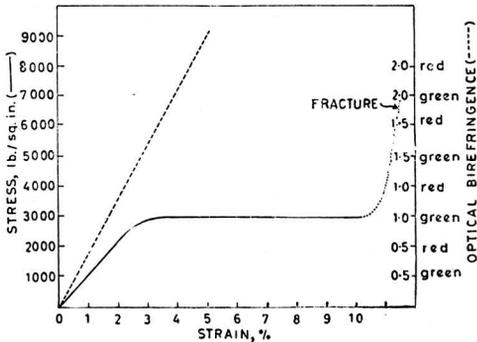


Fig. 2 — Stress-strain-optical birefringence characteristics of nylon copolymer at 72°F. and 46 per cent humidity [Gage length, 3 in.; cross-section, 0.25 in. \times 0.0108 in.; value of elastic constant (E) = 130,000 lb./sq. in. Optical birefringence is expressed in terms of number of fringes observed as the strain is varied]

pieces were obtained only in tests made under low humidity. The most striking property of the material pointed out by the characteristics presented in these figures is in the completely linear strain-optical relationship extending far beyond the yield point. Though the strain-optical proportionality factor, like any other property of the material, was found to be dependent on humidity, at any humidity level, this relationship was very nearly constant. By adjusting the tension of the specimens so that the extension was maintained at a prescribed level, it was observed that the optical effect remained always the same, even though the load corresponding to this extension was slowly decreasing with time. There was no creep observable in this strain-optical relation and, therefore, the isochromatic patterns obtainable in the tests may be regarded, in the elastic as well as the plastic regions, as representing strain distributions.

Chemical properties — A knowledge of the molecular structure of the nylon copolymer used in the tests of Hetenyi is necessary for a better understanding of the

observed yield phenomena. Commercially available nylons are, in general, simple linear polymers obtained through the reaction of diamines with dibasic acids. The two most frequent types of these simple polyamides are the 6-6 nylon (made with hexamethylenediamine and adipic acid) and the 6-10 nylon (made with hexamethylenediamine with sebacic acid). In each of the above cases the first one of the two numbers used in the specification denotes the number of carbon atoms in the diamine chain and the second one indicates the number of carbon atoms in the acid chain employed in the reaction. In contrast to these simple polymers, the nylon used by Hetenyi¹ is a copolyamide, obtained through the polymerization of hexamethylenediamine with a mixture of 30 per cent adipic acid and 70 per cent sebacic acid, the result of which may be described following the above notation as 6-6/6-10 nylon. On account of this polymerization, the product contains base units of different lengths, causing a shift of the attraction centres along the chain axes and leading to defects in the dipole layers of the copolymer. There is a striking resemblance between the inherently defective molecular structure of these amorphous copolymers and the structural defects assumed in the well-known dislocation theory generally accepted at present as affording the best explanation for yielding processes in crystalline media. This seems to indicate a possibility that the basic reason for the occurrence of a pronounced yield point and the accompanying plastic flow phenomena may be essentially the same in amorphous as well as crystalline materials.

Other Materials Suitable for Photoelastic Studies

Polystyrene can be considered as a suitable material for photoelastic studies and a typical stress-strain curve reported in literature² is given in Fig. 3. Polystyrene is quite tough under tension, and strong under compression. Its resistance to corrosive chemicals is good, and its water absorption negligible even after long immersion. The clear material has a brilliant clarity and will transmit light, even around corners, because of internal reflection. Its properties are not affected greatly at low temperatures and it has excellent moldability and good dimensional

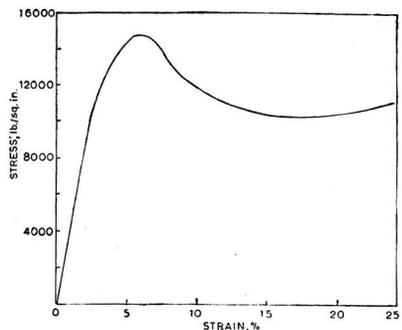


Fig. 3 — Compression stress versus strain curve for polystyrene

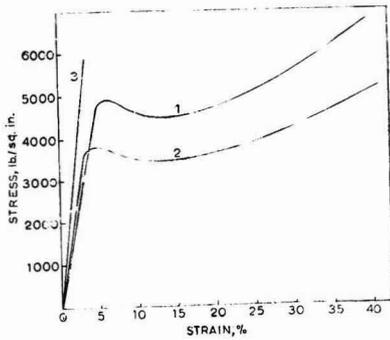


Fig. 4—Tensile stress versus strain curves for cellulose nitrate (curve 1), cellulose acetate (curve 2) and polystyrene (curve 3)

stability. One restriction that should be imposed on polystyrene for its use in photoplastic studies is that it should be studied in compression tests only. It has linear stress-strain relationship up to about 12,000 lb./sq. in. at 77°F. and has a modulus of elasticity 4.5×10^6 lb./sq. in.

The advantages claimed by Hetenyi in the use of nylon copolymer in investigations in photoplasticity are that it has (i) a pronounced yield point and (ii) a plastic region in its stress-strain relationship. Two other materials, viz. cellulose acetate and cellulose nitrate, appear to be much more promising for use in the study of photoplasticity due to the fact that they have more clearly defined yield points and undergo large deformations at nearly constant stress once the yield point is reached. The stress-strain curves for these substances reported in literature² are reproduced in Fig. 4 along with the similar curve

for polystyrene over the same region for comparison. Frocht and Thompson³ have reported details of their study regarding the use of cellulose nitrate in photoplastic studies. All the studies made so far indicate that cellulose acetate, cellulose nitrate, nylon (some type of copolymer) and polystyrene may be tried as materials for use in photoplastic studies.

Summary

The recent trend in the design of structures is to incorporate a suitable portion of the plastic range of materials in the design with a view to reducing the safety factor and thus achieving economy besides reduction in the weight of the construction. Photoplastic studies are best suited for forming a clear picture regarding stress distribution in materials in the plastic condition and will help to solve design problems in this range. The requirements and characteristics of materials suitable for photoplastic study and the conditions to be satisfied during a photoplastic study, in order that the data obtained may be useful in design problems, are pointed out. The results of recent studies in the use of nylon copolymer and cellulose nitrate as materials in photoplastic studies are reviewed. The possibility of using cellulose acetate and polystyrene in such studies is pointed out.

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Third Symposium on Earthquake Engineering

The Third Symposium on Earthquake Engineering, sponsored by the University of Roorkee, will be held during November 1966. The discussions at the symposium will cover the following fields: Analysis of structural response and design of structures for earthquake forces; Design of dams and other appurtenant works in seismic zones; Soil and foundation behaviour during vibrations; Seismicity, wave propagation and ground motion; Instruments

for earthquake engineering and seismological studies; Geological studies of tectonic features influencing occurrence of earthquakes; Recent strong earthquakes and resulting damage; and Housing in seismic zones. Correspondence regarding the symposium should be addressed to Dr Jai Krishna, Professor and Director, School of Research and Training in Earthquake Engineering, University of Roorkee, Roorkee, U.P. (India).

Anti-amoebic Drugs—A General Survey

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SINCE the discovery of emetine¹ as a specific therapeutic agent against *Entamoeba histolytica*, a great deal of effort has been expended in attempts to find a more effective drug that would be free from the serious toxic side effects associated with emetine. In recent years these efforts have been partially rewarded by the discovery of an amazing variety of substances like vioform, chloroquin, biallylamicol, entobex, entamide, etc. In spite of the reported success of some of these compounds as effective suppressive agents, means of complete eradication of this organism from the infected individuals have so far proved elusive. The failure of these drugs in many cases, considered to be due to their inability to reach the inaccessibly situated amoebae, constitutes the challenging evidence of the complexity of the problem of the chemotherapy of amoebiasis. An ideal anti-amoebic agent, which would be effective against this pathogen irrespective of whether it occurs in the lumen of the colon, the wall of the colon, or extra-intestinally in the liver, lungs, etc., is yet to be discovered. The progress in the field of anti-amoebic drugs has been reviewed earlier by Druey², Anderson³ and Elslager and coworkers^{4,5}.

Earlier attempts to discover new therapeutic substances for the treatment of the amoebic infections were directed mainly towards the clinical evaluation of a few compounds of plant origin like emetine, the total alkaloids of Kurchi bark, etc. Later on, with the elucidation of the structural formulae of these active principles, particularly that of emetine^{6,7}, and the development of the techniques⁸⁻¹¹ for the *in vitro* and *in vivo* screening of amoebicides, the syntheses of a large number of compounds, the so-called 'open models' of emetine, were undertaken. Also, during this period development in the chemotherapy of other diseases led to the introduction of drugs like the halogenated hydroxyquinolines, and the arsenicals as amoebicidal agents. More recently, a group of substances resulting from large-scale screening programmes have been found to possess exceptionally high amoebicidal activity. In the present survey these compounds are discussed under the two headings, the Natural Products and Synthetic Drugs.

Natural Products

Emetine

Of all the drugs used in the chemotherapy of amoebiasis, emetine, the principal alkaloid from *Cephaelis ipacacuanha*, has perhaps the longest history of use in various forms, and is unique for its specific action on *Entamoeba histolytica*. It stands foremost among the compounds whose high anti-amoebic action *in vitro* is also retained *in vivo*. It serves as a standard drug for comparison. In spite of its pre-eminence over all the known drugs for its

intense amoebicidal action and the reported wide distribution in animal tissues¹², in human amoebiasis, this drug rarely eliminates the amoebic infection especially in asymptomatic and chronic cases and its serious toxic side effects on heart muscles have limited its use as a safe drug.

Conessine

This well-known alkaloid from *Holarrhena antidysenterica* is the second most important plant principle which has attracted attention. Its performance as an amoebicidal agent is somewhat inferior to that of emetine, though it has been claimed that in cases of acute intestinal amoebiasis, associated with secondary infections, or in cases refractory to emetine, this drug may be considered more satisfactory¹³. However, its value as a safe drug is also limited owing to its serious neuropsychiatric effects¹⁴.

Glaucarubin

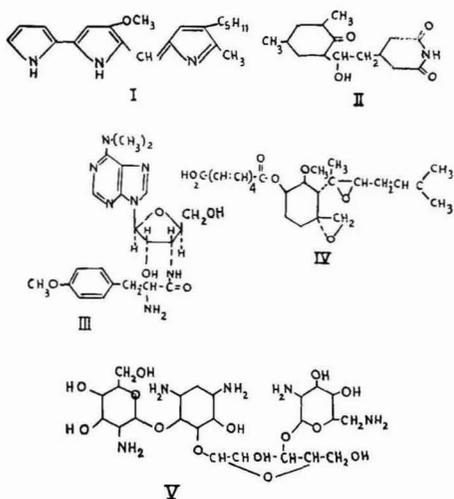
Glaucarubin (glaumeba) is the only other amoebicidal plant principle whose chemical identity is clearly established¹⁵. It is a glycoside isolated from *Simarouba glauca* and is an α -hydroxy- α -methylbutyric acid ester of a hexahydroxylactone. It is about half as active as emetine *in vitro* and its action on the parasite is a direct one. It has given promising results in experimental amoebiasis^{16,17} and in clinical trials with considerable freedom from toxicity¹⁸.

Of the several other plant materials reported to possess anti-amoebic properties, *Brucea sumatrana* is better known. The Chinese anti-amoebic preparation *Ko-sam* or *Ya-tan-tzu* is derived from this plant. The active principle in this case seems to be a glycoside, yatanoside¹⁹. Other plants like *Stephania rotunda* and *Stephania hernandii* and *Castela nicholsonii*²⁰ are reported to be in use in India and in Mexico for the treatment of dysentery. *Anemone chinensis* has also been claimed to possess amoebicidal properties *in vitro* and *in vivo*²¹.

Antibiotics

Following the discovery by Hargreaves²² that bactericidal substances like sulpha drugs and penicillin were valuable adjuncts in the treatment of chronic amoebiasis, a number of antibiotics have been screened for anti-amoebic activity. Of these the more important ones are prodigiosin, cycloheximide, puromycin, the chloro- and oxytetracyclines, erythromycin, bacitracin, fumagillin and paramomycin.

Among these prodigiosin²³ (I), cycloheximide^{24,25} (II) and puromycin²⁶ (III) are of academic interest only. They display exceptionally high *in vitro* amoebicidal action²⁷ which is of the order of a few $\mu\text{g./ml.}$ But they are all marked by high toxicity which has prevented their use in clinical practice. Cycloheximide is the most active compound tested in rats¹.



The chloro- and oxytetracyclines, erythromycin and bacitracin are effective suppressive agents in fairly high doses²⁷⁻³⁰.

Fumagillin³¹ (IV) is unique among the amoebicides for two reasons. Firstly, it has an unusual structure for an amoebicide. Secondly, its activity *in vitro* exceeds that of all known amoebicides including emetine. It is inert towards bacteria and could have proved very useful for intestinal infections had it not been for its somewhat high toxicity. It is, however, still considered useful when other agents have failed to act in intestinal infections.

Paramomycin^{32,33} (V) can be considered better than fumagillin to the extent that its high amoebicidal action is matched by its high activity against a large number of enteric bacteria. It is strongly amoebicidal at 2 $\mu\text{g./ml.}$ in *in vitro* tests and strongly antibacterial at 70 $\mu\text{g./ml.}$ In human beings it is well tolerated due to an almost total lack of absorption following oral administration. Among the antibiotics, this is perhaps the best amoebicidal agent so far known.

Synthetic Drugs

Emetine Analogues

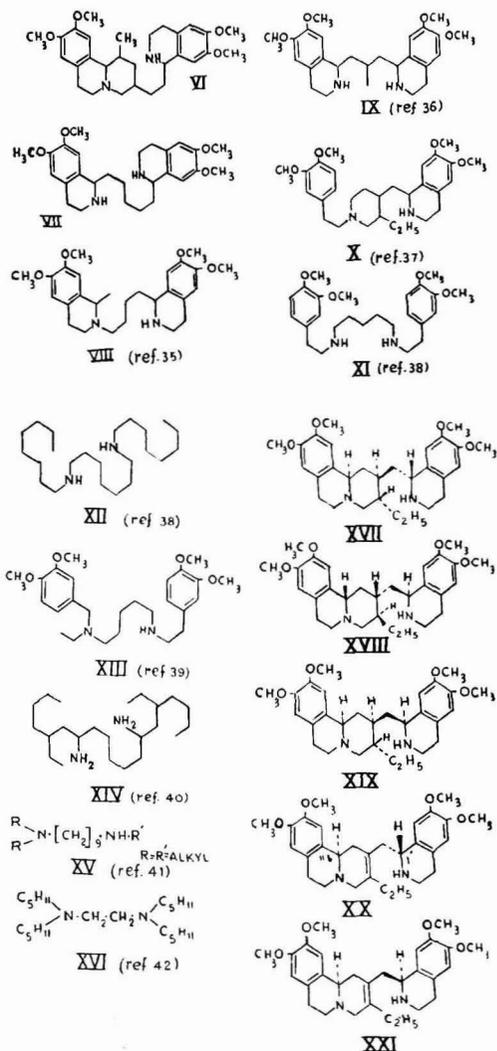
Emetine is one of the most specific anti-amoebic agents known. Its comparatively large molecular structure offers considerable scope for structural variations and a study of structure-activity relationship. This approach, which may be expected to lead to simple non-toxic analogues of emetine, has been actively pursued by many workers during the last three decades. As a result, a large number of compounds have been synthesized and screened for anti-amoebic activity. The list of such compounds is so large that only a few representative types will be dealt with in this review.

The chemical structure of these compounds (VII to XIV) could be derived from emetine by opening the C-C bonds of emetine at appropriate points. The bisquinolyl-alkanes (VII), for instance, were synthesized by Child and Pyman³⁴ on the basis of the structure (VI) proposed for emetine⁴. In these

compounds the number of carbon atoms between the nitrogen atoms was varied from 3 to 9. But all these compounds were found to be inactive.

Further developments in this direction were based on the correct structure (XVII) of emetine proposed by Robinson⁷. These structures have no more than the diamine structure in common with emetine and (XIV), (XV) and (XVI) are simple aliphatic diamines. Some representatives of these types showed high *in vitro* activity, but all of them proved inactive in experimental amoebiasis. It is interesting to note here that all these compounds, in common with many aliphatic diamines, were inactivated by serum in *in vitro* tests, a fact which seems to have been not well appreciated during this period.

Hexahydroquinine⁴³, an example of an emetine analogue derived from a cinchona alkaloid, is reported to possess interesting *in vitro* and *in vivo* activity. The design of this structure is claimed to be based

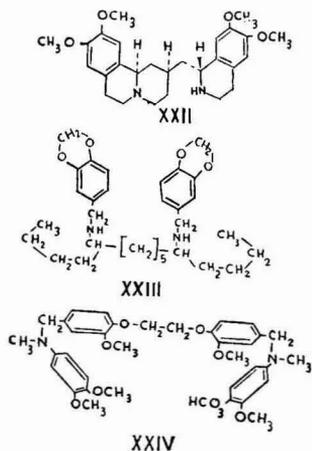


on the assumption that the bonding species in this compound, namely the two nitrogen atoms, have the same distance as in emetine, and that they would be expected to interact with suitable anionic sites on the bio-receptor separated by an equal distance.

Returning to emetine analogues, it becomes somewhat clearer why these compounds fail to simulate emetine in their biological activity when we consider the stereochemistry of the latter which was recently elucidated. It was, thus, found that the biological activity of emetine (XVII), in common with many other natural products, was stereospecific⁴⁴. Thus (+)-emetine (XVIII) and seven of its other diastereoisomers, out of a total of sixteen of them including isoemetine (XIX) which were synthesized recently, are not only not active but significantly less toxic. Similarly, the desethylemetine (XXII) is also inactive. The 2-dehydroemetine⁴⁵ (XX) which has the same stereochemistry at centres 11b and 1' is highly active. But its diastereoisomer, the isodehydroemetine (XXI), is again inactive.

In spite of this discouragement, further reports on yet newer analogues of emetine continue to appear in literature. These compounds can be more appropriately designated as high molecular weight diamines. The guiding assumption would now seem to be that the biological activity of emetine is more specifically related to the charge potential and sterical factors in the vicinity of the tertiary nitrogen atom and at the site of action, rather than to the presence of two different types (as described above) of bonding species in the molecule. It is interesting to note here that the tertiary nitrogen atom in emetine is surrounded by three asymmetric centres and a ring of π electrons (cf. XVII). The above assumption appears to be the keynote to considerable success achieved in subsequent development in this field as in the case of the syntheses of MA 307 and Lily 09518.

MA 307 (XXIII)⁴⁶ is an outstanding compound among a series of high molecular weight diamines. It is not far from emetine in its performance *in vitro* and *in vivo*, and is reported to be non-toxic. Interesting information regarding the structure-activity relationship in this series is available. It has



gone through clinical trials successfully and it is effective in both acute and chronic forms of amoebic infections. It can be administered orally too. With the synthesis of this compound the dream of Pyman, the pioneer in this field, has been somewhat realized.

Lily 09518 (XXIV)⁴⁷ is another of a series of 44 compounds which has gone through extensive trials in animals and is reported to be under clinical trials.

Dehydroemetine (XX)

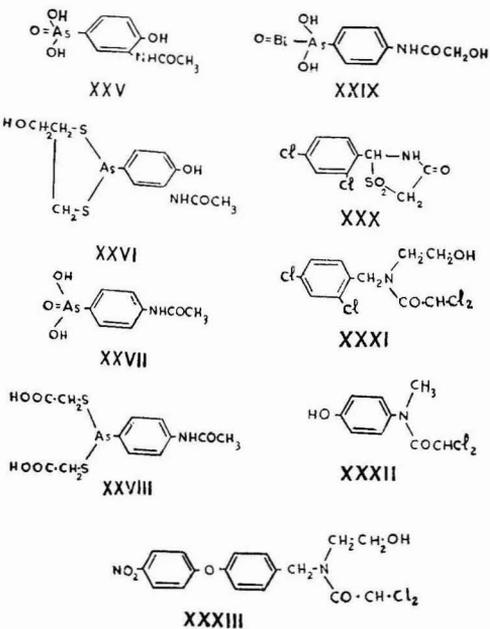
This synthetic product, as mentioned earlier, conserves all the anti-amoebic activity of the naturally occurring emetine as it corresponds to the latter in its stereochemistry at its two asymmetric centres. Its *in vivo* activity is twice that of emetine and it is somewhat better tolerated by the cardiovascular and neuromuscular systems. It is technically more easily synthesized and it finds much favour as a substitute for emetine.

Arsenicals

The introduction of arsenic compounds (XXV to XXIX) in the chemotherapy of amoebiasis followed, as mentioned earlier, developments, in other fields. Of these, carbarson (XXVII) is most commonly used. The other compounds described here are somewhat more toxic. But glycocharson or milibis^{48,49} (XXIX), a mixed arsenic-bismuth compound, has received attention in recent years owing to its low toxicity which arises out of the fact that it is not absorbed from the intestine.

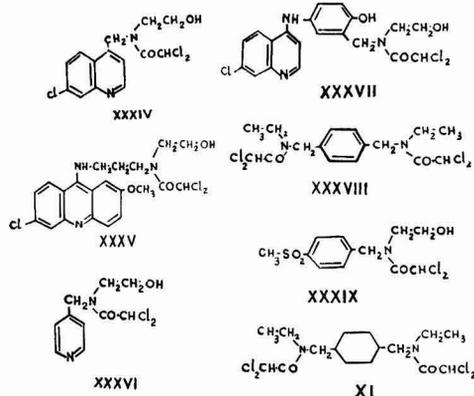
Haloacetamides

This group of amoebicides is the outcome of pure empirical screening of thousands of compounds for



their biological activity. The starting point of this series was the observation that the dichlorophenyl thiasolone (XXX) showed some activity in infected hamsters⁵⁰⁻⁵². Out of a number of compounds derived in pursuing this observation chlorbetamide⁴⁰ (XXXI) also known as mantamide (Win 5047) and entamide⁵³ (XXXII) were chosen for introduction as new amoebicidal drugs. They are, however, considered useful only in chronic intestinal amoebiasis. It is also claimed that these compounds are of low toxicity in human beings and are easily metabolized in the system. Chlorphenoxamide (mobinol)^{54,55} (XXXIII), another member of this group of compounds, is an active contact amoebicide and is not absorbed in the gastro-intestinal tract. Recently, the benzoate and the 2-furoate of entamide have also been developed as effective amoebicides⁵⁶⁻⁵⁸.

It is interesting to note here that the dichloroacetamide group, which constitutes the active moiety in these compounds, is itself associated with high *in vitro* activity⁶⁹ and a large number of compounds carrying this moiety are known⁶⁰⁻⁶³ (XXXIV to XLI). Some of these derivatives (XXXVIII and XLI, $n = 8$) are not only active anti-amoebic agents but are also effective anti-spermatogenic agents⁶⁰⁻⁶³.

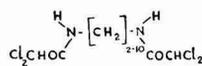


Camoform (Biallylamicol, PAA 701)

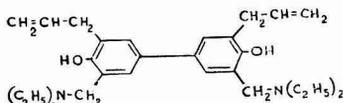
This compound (XLII) is unique in some respects. It has been known in the chemical literature long before its anti-amoebic action was discovered⁶⁴⁻⁶⁷. Its performance in intestinal infections is not outstanding. But it is considered superior to many drugs in hepatic amoebiasis. It is non-toxic and is retained in the body tissues, particularly in the liver, over a long time in the unchanged form. Unlike other drugs, it was not subjected to any structural variation. Its prophylactic action against hepatic and pulmonary amoebiasis in hamsters and the reported synergistic action with antibiotics like bacitracin in intestinal amoebiasis in rats are its other interesting features. More recently, structural variations, involving the two diethylaminomethyl functions in its molecular structure, are reported^{68,69}; but such variations did not improve its anti-amoebic action.

Entobex

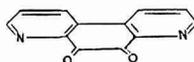
Another amoebicidal agent recently introduced in the treatment of amoebiasis is entobex^{70,71}, a



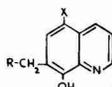
XLI



XLII



XLIII



XLIV R = N-(C₂H₅)₂, NH-(CH₂)₃N-(C₂H₅)₂
X = Cl, ALKYL, ETC.

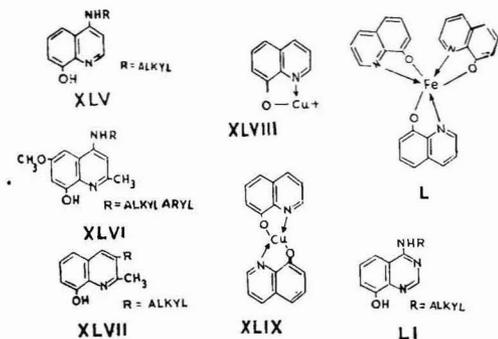
4,7-phenanthroline-5,6-quinone (XLIII) for which combined antibacterial and amoebicidal action is claimed in *in vitro* and *in vivo* tests. It is claimed that this compound through a selective bacteriostatic action leaves the coliform flora of the animals undamaged. The drug is reported to cause gastrointestinal side effects⁷². A monosemicarbazone of this drug is also reported to be an active amoebicide⁷¹.

8-Hydroxyquinoline Derivatives

The three derivatives of 8-hydroxy-7-iodoquinoline, chiniofon, vioform and diiodoquin, have been in use in the chemotherapy of amoebiasis for a long time. The first two of these compounds have been used as antiseptics for many years. In amoebiasis the use of these halogenated 8-hydroxyquinolines is limited to the intestinal infections only as they are poorly absorbed in the intestines. Other derivatives of 8-hydroxyquinolines which have found place in more recent anti-amoebic preparations are 5,7-dichloro-8-hydroxyquinoline (siosteran), and 5,7-dibromo-8-hydroxyquinoline and 8-benzyloxy-5,7-dibromoquinoline (intestopan).

Though the amoebicidal action of some of these halogenated hydroxyquinolines was known over a long time, no attempt was made till recently to effect structural changes in these compounds. The first cogener of this series has a diethylaminomethyl group in the place of the usual iodine atom in the 7-position, the object of this replacement being improved absorption in the intestine⁷³. Further changes through structures like [XLIV; R = N-(C₂H₅)₂, X = alkyl] led finally to KAN 322 [XLIV; R = NH-(CH₂)₃N-(C₂H₅)₂, X = Cl]⁷⁴. This compound has two basic nitrogen atoms in the side chain and is reported to be effective in both intestinal and hepatic amoebiasis.

The exceptionally high *in vitro* and *in vivo* activity exhibited by compounds like (XLIV) have conclusively disproved the classical assumption that the iodohydroxyquinolines owe their anti-amoebic action to the presence of the somewhat labile iodine atom at the 7-position of their molecular structures. This opened a new lead to the synthesis of a variety of



8-hydroxyquinoline derivatives^{75, 76} represented by (XLV), (XLVI), (XLVII), etc.

The synthesis of these compounds were based on the view⁷⁷ that the amoebicidal activity of these derivatives might be, in some way, related to their ability to form metal chelates (XLVIII, XLIX and L) in the biophase which property has been shown to be responsible for their well-known antibacterial action⁷⁸. In the design of these new structures, a methoxy and an alkyl group were chosen as the lipophilic functions in the place of the strongly electronegative halogens, as the latter would tend to contribute towards increased acid ionization constants for these compounds, a factor considered to be responsible for the poor absorption of the conventional halogenated hydroxyquinolines. Similarly, the placing of various substituted amino functions in the position 4- of the molecular structures of these new derivatives would be expected to contribute towards a fairly high range of stability constant values for their metal chelates in the biophase mediated by the increased basic strength of the ring nitrogen atoms, and thus provide an ideal chelating agent which could compete successfully with the various natural chelating agents normally present in the biophase.

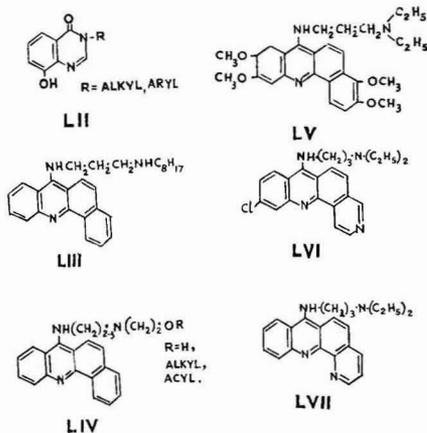
Preliminary report^{79, 80} on the *in vitro* and *in vivo* activities of some of these compounds indicated that two members of the series (XLVI; R = *p*-chlorophenyl, and *p*-methoxyphenyl) show significant activity. The 8-hydroxyquinazolines and quinazolones⁸¹ (LI and LII) showed weakened *in vitro* and *in vivo* activities as anticipated from the reduced basic strength for the *peri* nitrogen atom in these compounds.

Amoebicidal Antimalarials

Foremost among the antimalarials which are useful as amoebicidal drugs are chloroquin and camoquin. These compounds are effective against hepatic amoebiasis⁸² but useless in intestinal amoebiasis. At present chloroquin has become a substitute for emetine in the treatment of amoebic hepatitis. The usefulness of these compounds in liver amoebiasis is related to their high degree of absorption in the liver in which their distribution is five hundred times more than that in the lumen of the colon. Daraprim and quinacrin, the two other well-known antimalarials, are not effective in human amoebiasis, though, in experimental animals, they showed high suppressive action against hepatic infection⁸³.

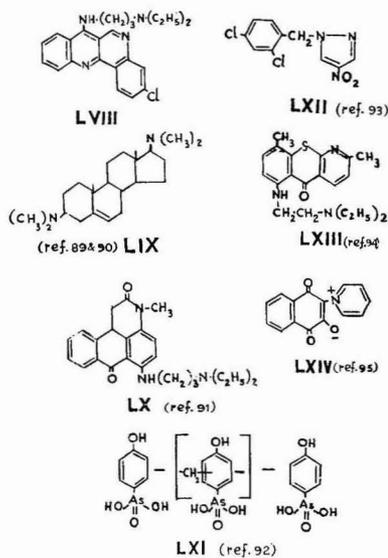
Benzacridines

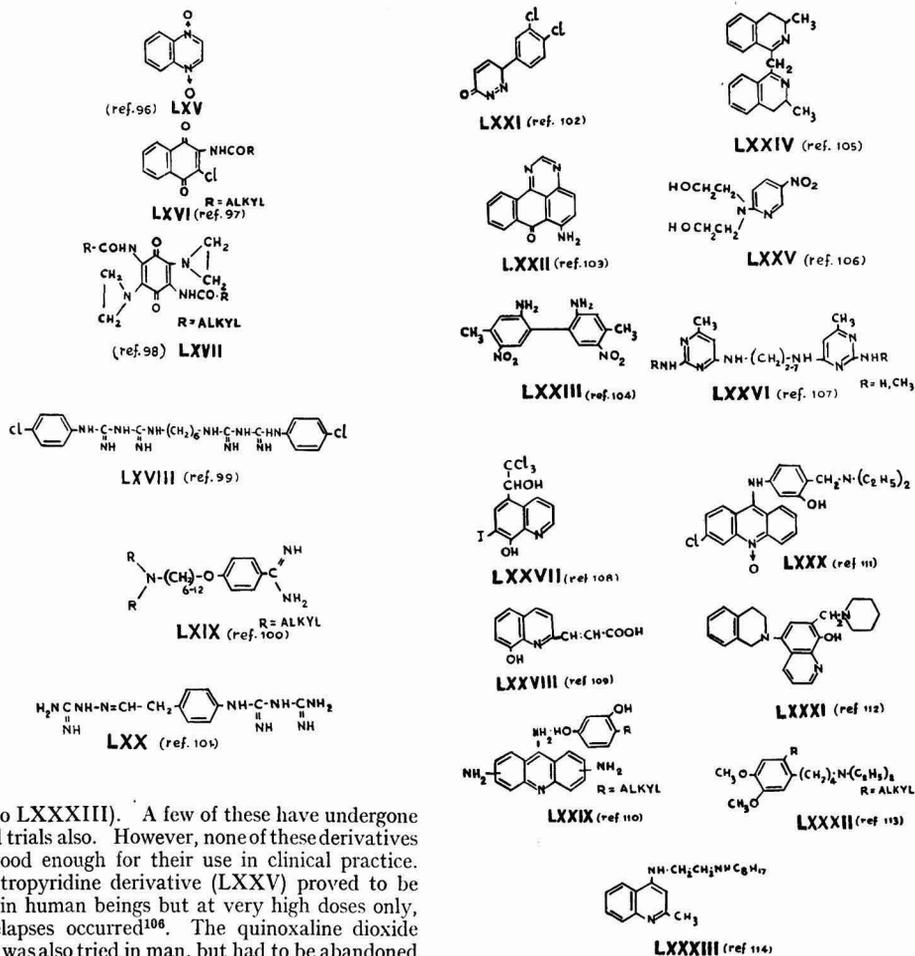
PA 2056 (LIII) is the most promising member of a large number of 7-aminobenz[*c*]acridines (LIII to LV) which have been screened for their anti-amoebic activity⁸⁴⁻⁸⁷; PA 2056 is almost as potent as emetine *in vitro*. It is moderately effective against intestinal amoebiasis but eight times more active than chloroquin in hepatic amoebiasis. It has a direct effect on the amoeba. It is reported to be useful in clinical trials also. Some aza analogues of these compounds (LVI, LVII and LVIII) have been synthesized recently, but they were comparatively very much less active *in vivo*⁸⁸.



Miscellaneous Compounds

To this group belongs a variety of unclassified compounds synthesized as possible anti-amoebic agents. The number of these compounds is so large that only those compounds which have been screened for their *in vivo* and/or *in vitro* activity are included here





(LIX to LXXXIII). A few of these have undergone clinical trials also. However, none of these derivatives were good enough for their use in clinical practice. The nitropyridine derivative (LXXV) proved to be useful in human beings but at very high doses only, and relapses occurred¹⁰⁶. The quinoxaline dioxide (LXV) was also tried in man, but had to be abandoned in view of its serious toxic side effects⁹⁶. The quinaldine derivative (LXXXIII) had an *in vitro* activity of 1 µg./ml.¹¹⁴. Polybenzarsol (LXI), a formaldehyde condensation product of 4-hydroxyphenylarsonic acid, is reported to be of low toxicity⁹².

TABLE 1 — *In vitro* AMOEBICIDAL ACTIVITY OF SOME WELL-KNOWN AMOEBICIDES

GROUP I: AMOEBICIDAL BELOW 10 µg./ml.		
Fumagillin	Prodigiosin	Entamide
Paramomycin	Cycloheximide	Chlorbetamide
Emetine	PA 2056	Chlorphenoxamide
Dihydroemetine	KAN 322	
GROUP II: AMOEBICIDAL AT 10-200 µg./ml.		
Chloroquin	Arsenicals	Puromycin
Entobex	Halogenated	Conessine
MA 307	hydroxyquinolines	Camoform
GROUP III: AMOEBICIDAL ABOVE 500 µg./ml.		
Tetracyclines	Bacitracin	Erythromycin

(LXXVII) which is more active *in vitro* than the conventional halogenohydroxyquinolines is also of low toxicity in guinea-pigs¹⁰⁸. The steroidal base (LIX) representing a conessine analog was not sufficiently active in low doses^{89,90}. Of the two biguanide derivatives (LXVIII and LXXII) reported to be active amoebicides, chlorhexidine (LXVIII) is a well-known antibacterial agent. It is reported to be highly active in experimental amoebiasis⁹⁹. Clinical trials for this compound have been suggested.

To sum up, some of the more important of the well-known amoebicides are arranged (Table 1) on the basis of their *in vitro* action to give an overall picture of their relative amoebicidal action. In group I are found compounds which have specific action against *Entamoeba histolytica*. In group II are found the moderately active agents which include all the known amoebicides which are highly effective in hepatic amoebiasis. Their activity is also direct. In group III are included compounds which are feebly active against the parasite and are well-known antibacterial agents. Their anti-amoebic action is almost indirect.

It is noteworthy that the compounds like chloroquin and camoform which are highly active against *Entamoeba histolytica* in the liver are only moderately active against the amoebae when they live in association (*in vitro*) with bacteria. It is likely that this difference in the activity of these compounds may be related to the fact that in liver these drugs are able to interfere more effectively with an essential metabolic pathway which has acquired considerable prominence for the parasite owing to the absence of the associate organism in that organ.

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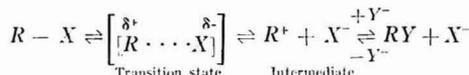
Carbonium Ions & the Transition State in Some Rearrangements

S. V. ANANTAKRISHNAN

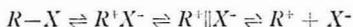
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WHILE a considerable degree of order in understanding the reactivities of aromatic systems is noticeable in quantitative studies, aliphatic and alicyclic systems have most often presented problems of predictive enigma. Varying qualitative pictures have resulted from a widespread of reaction rates. Still, using reasonable assumptions a possible order is unfolding itself. Intense study has centred round carbonium ions as intermediates in solvolysis and rearrangement studies in aliphatic systems as well as small ring systems including bridged ones.

Where a carbonium ion is envisaged in a postulated mechanism, one has to consider the formation of the ion, recombination and product formation. The Hughes-Ingold definition of molecularity directs attention to the number of molecules necessarily undergoing covalency change excluding the participation of solvent. In solvolysis, considerable solvent forces are involved and heterolytic reactions may be represented thus¹



In solvents of low dielectric constant, the intermediate is possibly an ion pair with properties different from those indicated by Bjerrum². They are more appropriately defined by Fuoss³ as two counter ions in contact as attractive forces $> \frac{1}{2}kT$ are possible in benzene at less than 500 Å. A better picture of the system is possibly that of Winstein *et al.*^{4,5}



This includes a step in which there is the intervention of solvent molecules. However, much more information than we have at present is needed before the planarity of the carbonium ion postulated by Ingold from kinetic evidence can be considered proven⁶. The basic *s*, *p* hybridizations have the property that, in each hybrid, atomic orbitals are equivalent. This does not exclude intermediate hybridizations with non-equivalent orbitals which need to satisfy only the condition of orthogonality⁷. The shape of the carbonium ion has to be related to the 'mixing coefficient' in the hybridization. A natural corollary is the possibility that any change in the system of a transient intermediate need not be localized so that the postulate of non-classical carbonium ions is not an abnormal phenomenon.

It is possible to examine molecular rearrangements as a class from the basis of equilibrium kinetics and the assumption of the Maxwell-Boltzmann distribution law. If one or more transient intermediate species are present, the reaction profile may be represented as shown in Fig. 1.

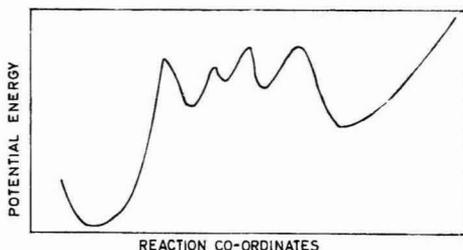


Fig. 1 — Potential energy profile

The minima in the region of higher potential energy depend on the stability of the transition state. The composition of the final reaction product will be governed in part by the magnitude of the activation energies for any given transient. Available experimental data, however, are inadequate for computing the activation energy or even the lifetime of the particular species leading to a specific product. An examination of a few well-known rearrangements and the probable linear free energy relationships may be of interest in reconciling conflicting viewpoints.

This difference in approach can be noticed whether one considers solvolysis, eliminations or rearrangements. The difference in the proportion of olefine formation between *t*-butyl chloride and 2,3,3-trimethyl 2-butyl chloride has been interpreted by Brown⁸ as a function of strain release, while Ingold *et al.*⁹ provided an alternative electronic interpretation. Similar differences in point of view are also noticeable in bimolecular eliminations. Brown interprets elimination conforming to Sayetseff rule to possible hyperconjugation stabilizations of one of the transition states¹⁰. While the status of hyperconjugation is uncertain in the ground state, this is not improbable in the transition state where the molecule can be thought of as being in the excited state. This is, however, more effective in carbonium ions or anions than in neutral molecules¹¹. One is thus in a position of uncertainty regarding the stability of alternative transition states and the question of steric effects on Hofmann elimination becomes a moot point.

An aspect of solvolysis that has received attention is the participation of a neighbouring group in a possible non-classical carbonium ion in the transition state and stereospecificity in migration during a rearrangement. Stereospecificity, however, need not necessarily involve either a concerted process or a bridged carbonium ion as is often assumed. If the potential barrier to rotation about a C-C bond is such that the rate of rotation is not fast relative to rate of migration, stereospecific rearrangement may

be expected. The required free energy change ΔF_m^\ddagger is generally unknown so that it is not possible to predict when this value is less than ΔF_0^\ddagger . In the few instances where the geometries similar to a carbonium ion are to be expected, Wilson¹² has shown that rotational energy barriers are small. While the work of Cram and his coworkers¹³ lead to the conclusion that both classical and non-classical carbonium ions can be possible intermediates, tracer studies in Oak Ridge show that bridged ions are not essential for stereospecificity¹⁴. Neighbouring group participation is not completely ruled out and in fact both kinetic and stereochemical evidence offer support for such participation.

The postulate of a carbonium ion transition state has played a significant part in the pinacol and Wagner-Meerwein transformations. Oxygen exchange studies and the correlation between water activity and product ratio have provided evidence for the carbonium ion intermediate¹⁵, but the exact mechanism is by no means an agreed picture. It is natural to link the phenomenon with the migratory aptitude of groups in the system $\text{ArAr}'\text{C}(\text{OH})-\text{C}(\text{OH})\text{ArAr}'$. While the relative figures for *p*-substituted groups are consistent with a picture treating the phenomenon as analogous to electrophilic aromatic substitution, *o*-substituted phenyls present differing pictures. While Ingold¹⁶ considers these as instances of steric hindrance, the observation of Winstein¹⁷ indicating interaction of *o*-anisyl oxygen with the developing carbonium ion cannot be overlooked. A fuller reinvestigation is called for. A feature of the rearrangement for which clear answers are still needed is the stereochemical consequence at the migrating group. Is there a retention of configuration of the migrating group?

The Wagner-Meerwein rearrangement is the classic example where a cationic intermediate has been in the picture almost from the start, while the kinetics of the transformation has been reasonably established by the Bartlett school^{18,19} and by Wilson *et al.*²⁰, but these do not give any information as to the structure of the intermediate. The latter authors formulated an intermediate of the non-classical carbonium ion type which has been shown by Winstein²¹ to be an essential feature of all 1-2 rearrangements (Fig. 2, camphene system).

In several instances, Brown²² has been able to account for observed quantitative data without recourse to the concept of non-classical cation by consideration of the strains involved in various transition states. Brown *et al.*²³ are also critical of one of the postulates of the non-classical carbonium ion theory that participation should become less important the more stable the carbonium ion.

Any analysis based on products at anyone temperature is, however, an inadequate guide. Neighbouring group interaction, angular deformation vibration and solvation energies are all important factors. Any change in the hybridization of carbon, as has to be envisaged in the formation of classical or non-classical carbonium ions, should modify the rate process and in its turn is related to angular deformation energy. Changes in vibration frequencies of the bonds involved are widely dispersed

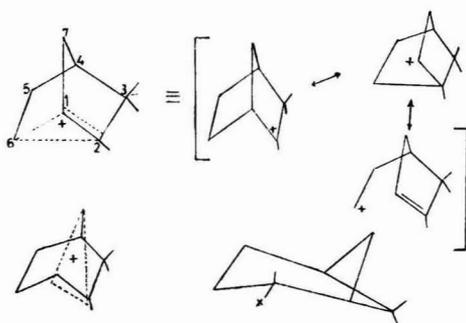


Fig. 2 - Intermediates in fused ring systems

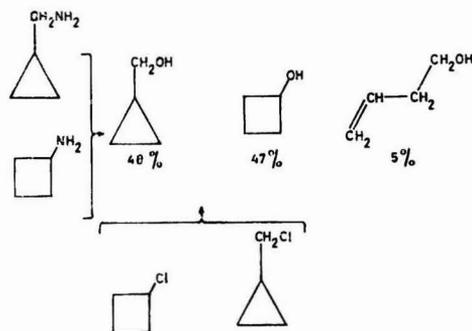


Fig. 3 - Deamination and solvolysis of 3- and 4-membered ring systems

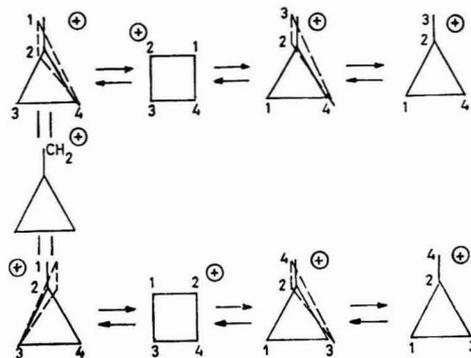


Fig. 4 - Transition states in the rearrangements

and can readily cause a wide spectrum of rate constants and product ratio. Even non-bonded interactions cannot be ignored in any assessment of data. A further factor contributing to the activation energy of the transformation is the potential energy barrier to rotation about a single bond. The torsional strain introduced by this factor can have very large effects on rates.

Turning to another aspect of rearrangement, one may consider that simple small ring systems may provide clues to a better understanding of the

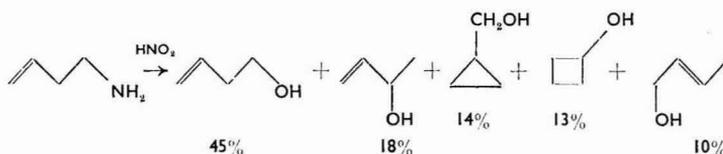


Chart 1

problem. Even here we find that the position is by no means simple. We observe ring expansions, ring contractions and change to open chain structures. These interesting reactions are observed in solvolysis and deamination reactions, and practically identical products are obtained²⁴⁻²⁷ (Fig. 3). The formation of identical products has been explained by resorting to an intermediate carbonium ion with a certain degree of delocalization of charge leading to the postulate of a non-classical bicyclobutonium ion²⁸. These rearrangements are capable of representation as a Wagner-Meerwein type (Fig. 4). The use of labelled carbon has shown that a common tricyclic intermediate is not likely. A further point of interest is the relationship of these cyclic compounds to an open chain olefinic compound²⁶. The deamination of allyl carbonylamine gives a complex mixture (Chart 1). These have been accounted for on the basis of varied structures for the intermediate carbonium ion.

A difficulty in all these rearrangement studies is the paucity of rate data and information that can enable one to probe into the transition state. Linear free energy relations are not readily available. In any event these are essentially empirical and cannot be an end in themselves. The free energy terms may show additive behaviour, but since they invariably involve also the entropy term, the position is by no means simple. If all extraneous effects like solvation energy are assumed constant under a given set of experimental conditions, linear free energy values may be expected to throw some light on reactivity. The introduction of a substituent unaffected during the various transformations coupled with linear free energy data may be expected to enable us to understand the course of these reactions better. There is no doubt about the need for the postulate of a carbonium ion, but when one moves into the picture of a non-classical ion one feels the need for further work before excluding alternative interpretations like those of Brown⁸. A better understanding of the phenomenon of steric hindrance and the associated physical picture is clearly called for even in this well-trodden field.

Summary

The role of carbonium ions in the transition state involved in deamination and solvolytic reactions is briefly reviewed. The complex rearrangements

noticed generally involve a common intermediate. Alternative interpretations cannot be ruled out and there is scope for further study.

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Molecular Sieves

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MOLECULES of different sizes and shapes can be separated from one another by means of suitable adsorbents, known as molecular sieves. Molecular sieves are crystalline aluminosilicates or zeolites. The sieve-like properties of these zeolites are mainly due to their unique molecular architecture. Observing the sieve-like properties, McBain in 1926 first proposed the word 'Molecular Sieves' for zeolites which were only 'boiling stones' (from the Greek *zeo*, meaning to boil, and *lithos*, meaning stones) to the mineralogists of the eighteenth century. These boiling stones, which received little attention two hundred years ago, mark a milestone in the chemical technology of the twentieth century.

Structure of Zeolites

The fundamental building block of all zeolites is an aluminosilicate framework composed of $(\text{Si}, \text{Al})\text{O}_4$ tetrahedra (Fig. 1). The aluminium ion, with one positive charge less than silicon ion, can satisfy only three negative charges of the four oxygens which surround it. The net negative charge is balanced by the cations, such as Na, K or Ca, situated in cavities within the framework. The arrangement of the framework of silicon-oxygen and aluminium-oxygen tetrahedra leads to form a honey-combed structure with relatively large cavities. The shape and size of these cavities depend on the type of zeolite. For example, in the zeolite chabazite¹ in the natural form, six silicon and aluminium ions, with their associated oxygens, form a tight hexagon. Two of these hexagons face each other to form a flattish prism and eight such prisms linked

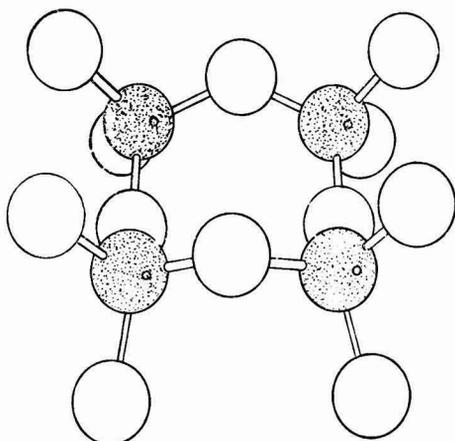


Fig. 1—A model showing the arrangement of tetrahedra in four-unit rings [The rings when joined together are responsible for the molecular architecture of various molecular sieves. Empty circles represent oxygen atom and shaded circles, metal atom]

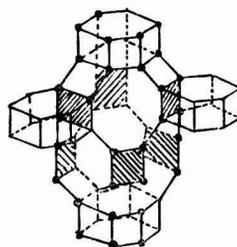


Fig. 2 - Framework of the zeolite chabazite

together enclose a ellipsoidal cavity with longest diameter about 11 Å. Each cavity is linked to six adjacent cavities by six distorted 8-membered ring windows 3.9 Å. in diameter (Fig. 2).

This feature is also characteristic of a number of other minerals, e.g. feldspathsoids. But the zeolites differ from other groups of minerals by the presence of water molecules within the structural channels. These water molecules are relatively loosely bound to the framework and can be removed without affecting the stability of the zeolite structure. The empty space thus formed is then available for the adsorption of any molecule small enough to penetrate into the lattice.

Synthesis of Zeolites

No systematic investigation on zeolites was reported until Barrer²⁻⁵ in the early 1940's carried out work on the adsorption properties and synthesis of zeolites. Attracted by the manifold applications of the zeolites, Milton and his coworkers⁶ at Union Carbide Corporation's Linde Division initiated in 1948 a study of synthesis and characterization of zeolites. Various methods have been developed and patents are still being filed which claim the synthesis of new types of crystalline zeolites. The method employed by Union Carbide's Linde Division Research Laboratory is based on the use of a freshly prepared highly reactive, aluminosilicate gel. Typical gels are prepared from aqueous solutions of sodium aluminate, sodium silicate and sodium hydroxide. The sodium zeolites result when the gels are crystallized at temperatures ranging from room temperature to 150°C. at atmospheric or autogeneous pressure. Synthetic zeolites containing Ge^{4+} and Ga^{3+} substituted for Si^{4+} and Al^{3+} have been prepared^{7,8}.

Adsorption by Molecular Sieves

Molecular shape and not molecular volume is the controlling factor in the adsorption of molecules in the crystal lattice. Linde A type zeolite (calcium form) sorbs *n*-butane, but not isobutane. The distinctive shapes of the streamlined *n*-butane molecule

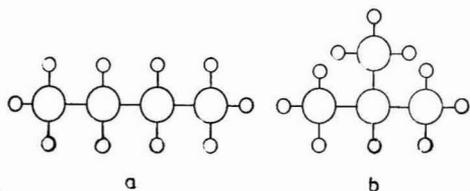


Fig. 3 — Distinctive shapes of (a) normal butane molecule, and (b) isobutane molecule

and fatter isobutane molecule are shown in Fig. 3. Whereas isobutane is rejected by the 5A sieves, normal hexadecane which has a far greater molecular volume but smaller critical dimension is sorbed. Factors other than critical dimensions, like polarity and unsaturation, as well as pressure and temperature may influence adsorption properties.

The critical dimension of a molecule is the diameter of the circumscribed circle of its cross-section of minimum area⁹. These are calculated from available bond lengths, bond angles, and van der Waals' radii¹⁰. Critical dimensions of some typical substances are given in Table 1.

Chemical factor in adsorption — Though the geometrical factor plays the vital role, polarity and unsaturation sometimes influence the adsorption power of zeolites. The zeolite crystals have a strong affinity for water molecules and adsorb them in preference to any other molecule. The attraction between water and zeolite is due to the polar nature of water molecule and charges on the surface of zeolite cavities. Zeolites are so avid for water that they can reduce the proportion of water in a gas or liquid to as low as four parts per million. This provides the basis for a highly efficient drying technique.

Similarly, zeolites have special affinity for unsaturated hydrocarbons rather than saturated hydrocarbons. For example, ethane and ethylene differ little in their physical properties and their molecules are almost of the same size. If a mixture containing equal parts of ethane and ethylene is passed through a bed of type A zeolite, about 80

per cent of the molecules that enter into the crystal lattice will be ethylene. Zeolites prefer unsaturated hydrocarbons because the molecules of these substances contain loosely bound electrons which give them polar characteristics resembling those of water molecules¹¹.

Another example where the chemical factor dominates the geometrical factor in the adsorption process is the adsorption of vapours of C_6H_6 and $n-C_6H_{14}$ on the molecular sieve Linde 13x. Benzene is adsorbed predominantly owing to the interaction, supplementary to the electrokinetic one, between the π -bonds of its molecules and the ionic lattice, chiefly with the cations of the zeolite channels¹².

The electron distribution in the adsorbed molecules sometimes changes due to interaction with surface charges of the cavity. The infrared spectra of benzene adsorbed on 13x and 10x type zeolites were compared with those of liquid benzene and of the zeolite themselves. The marked changes in the intensity of the adsorption bands and the appearance of bands that are not present in normal benzene indicate a change in electron distribution¹³.

Effect of temperature and pressure on adsorption — It is possible to force otherwise non-adsorbable molecules into the zeolite cavities at elevated temperatures and pressures. When quenched the gas remains trapped¹⁴.

Desorption

The recovery of adsorbed molecules from the adsorbent is a troublesome job. The following methods are now commonly employed for desorption of adsorbed molecules.

Increase of sieve temperature — Esso Research & Engineering Co. use this technique for the recovery of chlorine obtained by the oxidation of HCl and then adsorbed on molecular sieve 13A. Chlorine is completely desorbed at 840-905°C. at atmospheric pressure. Chlorine of 98 per cent purity is obtained.

Reduction of pressure — The application of the above method is limited by the fact that at higher temperatures cracking of hydrocarbons occurs, which causes deposition of coke and fouls the sieves. Sometimes isomerization of alkenes with shift of the double bond to the middle of the chain occurs. Thus desorption is generally done at lower temperatures under reduced pressures. This method has been used by Esso Research & Engineering Co. and Union Carbide Corporation.

Use of low molecular weight straight chain compounds — This method has been successfully used by British Petroleum Co. Ltd, and Esso Research & Engineering Co. One technique, followed by British Petroleum Co. Ltd, consists in treating the sieve purged with nitrogen after sorption, with butane, pentane or heptane. The sieve is regenerated by heating with oxygen. Lower boiling olefin (e.g. propylene) has been used as desorbant by Esso Research & Engineering Co.

Characteristic Properties of Molecular Sieves

Ion exchange — The cations in zeolites exchange with other cations in aqueous solutions under optimum conditions. Cation exchange involving Li^+ ,

TABLE 1 — CRITICAL DIMENSIONS OF SOME TYPICAL SUBSTANCES

Adsorbate	Critical dimension A.	Adsorbate	Critical dimension A.
H ₂ O	3.15	Ethylene oxide	4.2
CO ₂	2.8	Ethane	4.2
CO	2.8	Ethylene	4.25
O ₂	2.8	Acetylene	2.4
Ar	3.84	Propane	4.89
		Propylene	5.0
N ₂	3.0	Butene-1	5.1
		<i>n</i> -Butane	4.89
NH ₃	3.8	<i>n</i> -Pentane	4.89
		Cyclopropane	4.75
CCl ₂ F	6.9	Isobutane	5.58
CCl ₂ F ₂	4.93	Benzene	6.8

K^+ , Tl^+ , NH_4^+ , Ca^{2+} , Mg^{2+} , Rb^+ , Cs^+ , Sr^{2+} , Pb^{2+} , etc., has been studied^{15,16}. Among organic ions exchanged are $MeNH_3^+$, $EtNH_3^+$, $PrNH_3^+$, $n-C_6H_{13}NH_3^+$, $Me(CH_2)_4CH(CH_3)NH_3^+$, Me_3NH^+ , Me^4N^+ and Et_4N^+ . Of these, all except the last two show some exchange, but the amount was small for the larger ions^{15,16}. Various uses of zeolites based on ion exchange property are known.

Fluorescence—Some zeolites have been found to possess fluorescence characteristics. The zeolitic fluorescence is sometimes destroyed by heating to a high temperature, but is regenerated by heating to a low temperature after the adsorption of water vapour through the channel¹⁷.

Electrical conductivity—The electrical conductivity of zeolites is due to the migration of the positive cations through the channel structure. The conductivity depends on the size and charge of the cation, on the size of the zeolite channels and on the location of cation sites¹⁸. In general, activation energies for conduction and the specific resistivities are smaller for the zeolites than for other crystals.

Uses of Molecular Sieves

Uses based on ion-exchange property—Although large-scale application of synthetic zeolites as ion exchangers has not yet been possible, some interesting uses are known. One of these is in the removal of radioactive species from radioactive waste¹⁹. Molecular sieve type A has a high affinity for radioactive strontium. Other materials are very selective for caesium. Therefore, processes for the removal and recovery of radioactive species can be developed. Another important use of molecular sieves as ion exchangers is in the preparation of surgical cotton²⁰.

Uses based on water-adsorbing capacity—Molecular sieves can scavenge small residues of water from a liquid or gas and thus can be used successfully in the drying process. Molecular sieves are also being used as 'moisture indicators'^{21,22}. It has been observed that zeolites with univalent cation Ag and bivalent Ni or Co cation change colour in the presence of water. For example, Ag A-zeolite is light yellow-red in the anhydrous state after activation. Its colour changes from yellow through pink to grey with change in water vapour content. Thus, they can be used as reliable indicators of small amounts of water. They can be directly inserted at various locations and the colour change observed visually.

Another important use of molecular sieves is as stabilizers in polyurethane varnishes²³. The sensitivity of polyurethanes containing NCO groupings causes premature gelation of polyurethane varnishes and inhibits the use of pigments which introduce water in such compounds. Polyurethanes may be stabilized by the incorporation of zeolites.

Uses based on property of sorting molecules according to their size and shape—Zeolites are being used in the separation and purification of chemicals. A few typical examples are given below:

1. Low octane number *n*-aliphatic hydrocarbons are removed from kerosines and gas oils using zeolites as molecular sieves and plants for the

recovery of *n*-paraffins from petroleum distillates using molecular sieves are now being designed by various refineries, in particular by British Petroleum Refinery.

2. The use of molecular sieves in the removal of H_2S , thiols and water from light hydrocarbons is recognized as a standard procedure²⁴.

3. Isobutene can be separated completely from 1-butene and *trans*-2-butene and partly from *cis*-2-butene using a Ca-A zeolite²⁵. However, unsaturated hydrocarbons tend to isomerize on prolonged contact with zeolites. Similarly, butenes are selectively removed from isobutylene streams by passing the mixture through a zeolite molecular sieve having a pore diameter of 5 Å.

4. Heterocyclic nitrogen compounds can be separated employing molecular sieves²⁶. In one case, a mixture of 55 per cent 4-methylpyridine and 45 per cent 3-methylpyridine in the vapour phase was passed over a molecular sieve type X of pore diameter 10 Å. at 200°C. The unadsorbed phase contained 57 per cent of 4-methylpyridine and 43 per cent of 3-methylpyridine. By repeating the procedure in successive unadsorbed phases, a 4-methylpyridine concentration of 96 per cent was obtained in 9 stages.

5. Esso Research & Engineering Co. use molecular sieves substituted with metallic ammine complexes for the separation of doubly branched aliphatic hydrocarbons from their mixtures with less highly branched chain hydrocarbons. Thus, $Co(NH_3)_6^{2+}$ form of an aluminosilicate can separate dimethylbutane and methylpentane.

Uses as catalytic agents—The following are some typical examples of the use of zeolites as catalytic agents in different types of reactions:

(i) Cracking²⁷—*n*-Dodecane at 500° on Ca-A zeolite gives ethylene, propylene, *n*-butylene, coke and higher boiling point products.

(ii) Oxidation²⁸—Methanol on Ag zeolite gives formaldehyde.

(iii) Hydrogenation²⁹—Benzoquinone in hydrogen atmosphere gives hydroquinone and quinhydrone, using a zeolite rod impregnated with 1 per cent Pd black.

(iv) Isomerization³⁰—1-Butene and 2-methyl-1-butene isomerize to 2-butene and 2-methyl-2-butene respectively on 5A zeolite.

(v) Polymerization³¹—Isobutene at 150-200° produces a highly branched product comprising 50 per cent trimer, some dimer and traces of tetramer. The zeolite-catalyst is 5 Å. molecular sieve.

(vi) Decomposition³²—Decomposition of ozone is catalysed by molecular sieves.

Metal-loaded zeolites act as catalysts for some reactions. For example, hydrogen-acetone vapour mixture, when preheated and passed over nickel-loaded zeolite, is converted to isopropyl alcohol to the extent of 75 per cent. Ammonia has been prepared by passing a stream of H_2-N_2 (74:24, vol./vol.) mixture at 440°C. and 35 atm. pressure over Fe-loaded zeolite for 23 hr³³.

Miscellaneous uses—Molecular sieves find use as refrigerant filters³⁴, sizing agents for paper to improve wettability³⁵, filters for tobacco smoke³⁶,

and for juice clarification in sugar industry³⁷. Chemically loaded molecular sieves are used as curing agents for elastomers and resins³⁸.

Ultramarine pigment has been prepared by mixing a zeolite or mixtures yielding zeolite with selenium and an organic alkali metal compound (e.g. salts of carboxylic acids) and heating to 500-900°C. for 20 min. to 3 hr. Heating in the absence of air results in a brown pigment and introduction of air produces a maroon-coloured pigment³⁹.

By incorporating a synthetic inorganic zeolite into a stereotype mat, improved moist plasticity, uniform shrinkage and ready release of moisture during drying are obtained⁴⁰.

Zeolite gels with Al_2O_3 and SiO_2 in the proportion 1:2 to 1:1.5 and suspended in a substantially non-lubricating carrier liquid have been applied to the top of the rails and to the wheels to increase the friction and decrease slippage of locomotive wheels⁴¹.

A new sampler, utilizing molecular sieves to adsorb CO_2 from the atmosphere at altitudes up to 50,000 ft, is operable from jet aircraft and capable of collecting 10 litres of CO_2 in 1 hr. The material collected is used to obtain accurate measurements of the ^{14}C concentration in the testing of nuclear weapons as distinguished from the natural steady state ^{14}C level produced by cosmic rays⁴².

Chlorine adsorbed on zeolite is used as chlorinating agent for hydrocarbons⁴³.

Molecular sieves are also used in preparing frost-resistant concrete⁴⁴, in gas chromatography⁴⁵, as fertilizer for soil improvement⁴⁶, in preparing stable mineral-supplement feed containing vitamins⁴⁷ and in cryogenic pumping⁴⁸.

Acknowledgement

The author is greatly indebted to Prof. Santi R. Palit and Dr Mukul Biswas for their constant encouragement and keen interest during the preparation of this paper.

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REVIEWS

SPACE PROBES AND PLANETARY EXPLORATION by William Corliss (D. Van Nostrand Co. Inc., New York), 1965. Pp. ix+542. Price \$ 7.75

This is an excellent book, written with the object of explaining the equipment and techniques used for the exploration of the space beyond the realm of the artificial earth satellites. The age of space probes dawned in 1958 with the successful launching of Pioneer 1, and since then many advances have been made in the methods of propulsion, navigation, tracking and control, which have made the Ranger and Mariner missions successful.

The book is divided into three parts. Part I very clearly states the scientific objectives of the investigation of interplanetary space and briefly reviews the history and present status of interplanetary exploration. The complex problem of integrating the launch vehicle system, space craft system (including power, guidance and control, scientific instruments and communication) and earth-based facilities system is also discussed in this section.

Part II is packed with information about space dynamics, space communication, data handling, navigation, guidance and control of space craft, necessary earth-based facilities and details about design of the space craft and launch vehicles. Wherever necessary the information is presented in well-organized tables, graphs, diagrams and mathematical formulae. The last chapter of this section discusses the characteristics and design of some of the successfully launched specific space probes and some probable probes of the near future.

Part III deals with the scientific instruments used for experimentation in space. The instruments for measuring the interplanetary medium, instruments for investigating planetary atmospheres and crust, and instruments for detecting the life are well described.

At the end of the book there is a bibliography containing over 500 references cited in the text. This is an up-to-date and exhaustive list of current significant contributions to this field and will serve the purpose of a good source of reference.

The text is written in a simple language; however, the level of presentation is kept such that it demands a scientific or engineering background on the part of the reader. The book is written under the sponsorship of, and published in cooperation with, the National Aeronautics and Space Administration of the USA.

P. D. BHAVSAR

ADVANCES IN ATOMIC AND MOLECULAR PHYSICS: Vol. 1, edited by D. R. Bates & Immanuel Estermann (Academic Press Inc., New York), 1965. Pp. x+408. Price \$ 13.50

This publication will provide the students coming out of the university with the necessary background for starting research in the highly developing field of statistical spectroscopy. This is a collection of

reprints and original papers with a learned introductory review article by the late Dr C. E. Porter.

Illustrating the application of statistical concepts to the complex sequence of prime numbers, Dr Porter has lucidly discussed how the statistical approach may prove useful for the study of the spectroscopy of a quantum system on account of the high complexity of the system. He has discussed the invariance of the Hamiltonian under various types of transformations explaining in detail the time reversal invariance and its connection with the three groups of compatible canonical transformations—orthogonal, unitary and symplectic. The average properties of spectroscopic quantities of major importance have been enumerated and discussed; these averages form the scale for the fluctuation effects. The basic distribution functions have been developed for the Gaussian ensembles and for the three possible symmetry situations—orthogonal, unitary and symplectic. For the actual Hamiltonian matrix of infinite dimension a model Hamiltonian matrix of finite dimension has been considered, the model is expected to retain the essential features of the actual one. The distribution functions have been derived on the assumption that they have to be invariant function of the Hamiltonian and independent in the matrix elements. In the calculation of the volume element, the symmetry property of the Hamiltonian plays an important role; expressions for the volume element have been derived for all three symmetry situations. Distributions of eigen values and eigen vectors can now be easily determined and these in turn can be utilized to obtain the distributions of important physical quantities like energy level spacings, level widths and expectation values, etc.

The research papers collected include important contributions of E. P. Wigner, C. E. Porter, A. Bhor, L. Landau, F. J. Dyson, M. L. Mehta, N. Ullah, R. G. Thomas and many others. The publication will be highly useful to those who intend to pursue research in statistical spectroscopy.

N. C. SIL

PROGRESS IN INFRARED SPECTROSCOPY edited by Herman A. Szymanski (Plenum Press Inc., New York), 1964. Pp. 298

The volume contains under one cover eight instructive articles dealing mainly with different aspects of infrared spectroscopy. In each paper fresh ground has been covered and new and useful information has been provided.

In the paper on polarized infrared spectroscopy, the useful applications of polarized infrared rays in the analysis of crystalline solids has been dealt with. The most important feature of this discussion is the experimental details which are seldom found in one article. Infrared analysis of polymeric materials is a rapidly growing subject and is fast competing in more than just a complementary manner with other powerful tools of analysis, such as X-rays,

etc. This aspect of infrared spectroscopic study has been dealt with in most of the chapters of the book. An exhaustive review of the recent infrared work done on the study of proteins is given in the first chapter.

The major portion of the book is covered by an informative article on the infrared spectra of crystals. A theoretical discussion of normal vibrations of crystal, followed by a narration of the normal modes of oscillations in different crystals, such as gypsum, infrared dispersion by ionic crystals, combinations and overtones in crystals containing molecular groups, ends in an inevitable reference to the never ending problems of alkali halide crystals.

Since last one decade, there has been a spurt in the investigations on the chemistry of phosphorus compounds because of their wide range of utility. In the chapter on infrared correlations for organophosphorus compounds, an up-to-date review of the infrared spectroscopy of neutral and acid types of organophosphorus compounds is presented.

Arsenic trichloride as a solvent is a useful guide to research workers in the field of infrared spectroscopy.

The paper on infrared spectroscopy of biological materials is very brief for this very important modern research topic. Gallstone and lipids are the only two biological materials discussed. An addition of a few more macromolecular materials would have enhanced the utility of the volume.

The chapters on visible and ultraviolet spectroscopy throw new light on the subjects.

P. G. PURANIK

EFFECTS OF RADIATION ON SEMICONDUCTORS by Viktor Sergeevich Vavilov; authorized translation from the Russian by A. Tybulewicz (Consultants Bureau Inc., New York), 1965. Pp. xi+225. Price \$ 15.00

Since 1947 when radiation effects in semiconductors were first observed by Lark-Horovitz and coworkers, considerable effort has been spent in investigating radiation effects in a variety of semiconductors, elemental and compound, in a number of laboratories the world over. The major aim of these studies is to obtain a quantitative description of lattice damage or, alternatively, to use energetic radiation as a technique for the introduction of lattice defects in order that their properties might be studied in detail. Apart from their purely scientific value, results of researches on radiation effects in semiconductors are essential for the resolution of such important practical problems as, for example, direct conversion of solar and nuclear radiation energy into electrical power, design of new electromagnetic radiation sources (masers and lasers) using semiconductors, the application of semiconductor electronics to nuclear power engineering, etc. Although considerable progress has been made in the field, much still remains to be done before the various goals are reached. The present book, written originally in Russian, is devoted to the effects of electromagnetic and corpuscular radiations on semiconductors.

The book which is in the nature of a review monograph deals with the absorption of electromagnetic radiation, photoionization and ionization by charged

energetic particles, and with recombination processes which restore an excited crystal to its original equilibrium state. An entire chapter is devoted to radiative recombination and maser action. Defect formation in semiconductors by hard radiation and experimental data on changes in the physical properties of semiconductors due to such defects constitute the last chapter.

The monograph is well planned and the subject matter presented with clarity. Theory and experiment are both emphasized. The work suffers somewhat from the circumstance that it is three years out of date, for the Russian text which appeared in 1963 reviewed the literature up to 1962 and no attempt has been made in the translation to bring the material up to date. The book includes a fair amount of Russian work and may be recommended to those interested in semiconductor physics and radiation effects in solids.

S. R. MOHANTY

INTEGRATED CIRCUITS: DESIGN PRINCIPLES AND FABRICATION edited by Raymond M. Warner & James N. Fordemwalt (McGraw-Hill Book Co. Inc., New York), 1965. Pp. xxix+385. Price \$ 12.50

Based on an intensive course on integrated circuits, conducted by the staff of Motorola's Semiconductor Products Division, this book is the first of the two volumes on one of the most rapidly advancing fields of technology. The other volume deals with integrated circuit analysis and design. Prepared by leading workers in the field, the book is a useful and timely arrival.

It has been divided into three parts. Semiconductor and transistor fundamentals are discussed in Part 1. Chapter 1 introduces the physical properties of semiconductors. The concepts of a p-n junction are developed in Chapter 2, which discusses junction theory and properties of junctions. Diffusion of impurities, measurements on diffused layers and properties of diffused junction form the material for Chapter 3. A set of graphs giving useful data has been included. Chapter 4 discusses the transistor as a device and the relationship of the transistor characteristics to its structure.

Part 2 deals with the design of different types of integrated circuits and the functions of the different components which form a part of the circuit. Chapter 5 explains the difference between monolithic and hybrid circuit design and describes the structure of a monolithic circuit obtained by three different techniques, viz. (i) epitaxial-diffused process, (ii) diffused-collector process, and (iii) triple diffusion process. A comparative assessment is also made. A novel method of fabricating isolated regions incorporating a silicon-dioxide layer is described in Chapter 6.

Chapter 7 deals with the design aspects of diodes and transistors within the monolithic integrated circuit. The design and performance of a field effect transistor and other junction-type field effect devices are discussed in Chapter 8. Being a majority carrier device, it is less sensitive to carrier lifetime effects and is hence free from degrading effects of nuclear radiation. Although presently used in hybrid circuits, this device and the insulated field

effect transistor have a promising future in monolithic circuits. In Chapter 9, design and operation of other active devices like the tunnel diode, backward diode, unijunction transistor and p-n-p-n switch are discussed with reference to use in monolithic integrated circuits. Passive components comprising resistors and capacitors, in both the p-n junction and thin film form, are discussed in Chapter 10.

The fabrication of integrated circuits is discussed in Part 3. Chapter 11 describes the crystal growing and epitaxial processes. Unlike diffusion, sequences of n and p layers can be grown epitaxially without impurity compensation. Chapter 12 describes in brief the sequence of steps used in wafer processing. Special aspects like gold diffusion for reducing the carrier lifetime, oxide-silicon interface effects like channelling and the formation of pinholes are also considered in this chapter.

Chapter 13 deals with thin film components on glass or ceramic substrates for hybrid circuits and on silicon-dioxide layer for compatible circuits. Thin film deposition techniques have been discussed, along with techniques of photomasking and selective etching. Design and performance of compatible integrated circuits and the effect of temperature on the circuits during processes like die bonding, wire bonding and packaging are also described. A wafer which contains several circuits has to be separated into individual chips or dice by scribing and cleaving, or etch cutting, or ultrasonic dicing. Separation of wafer into chips, and other aspects of assembly processing are contained in Chapter 14. Some difficulties in this technology have been discussed. Chapter 15 describes the most commonly used package systems, and procedures for testing them. As the book has tried to cover a wide range of topics, there has been a natural tendency to present each topic in a concise form. This has deprived the reader of details of some of the recent advances in integrated circuit principles and fabrication procedures.

The treatment of some of the topics is bit too concise, although the references given at the end of each chapter should serve to give further details. Chapters 1, 2 and 4 could have been condensed so as to expand the other topics in the book. Numerous illustrations and graphs and a systematic presentation of the various topics makes the book very readable. The printing of the book is good. For those who have embarked on a programme of work in this field, it is an excellent source book and for those already working in this field, it is a good reference book.

AMARJIT SINGH & B. R. MARATHE

PROBABILITY AND ITS ENGINEERING USES by Thornton C. Fry (D. Van Nostrand Co. Inc., New York), Second Edition, 1965. Pp. xv+462. Price \$ 15.00

The first edition of this book was published in 1928. In view of the rapid and extensive advances that have taken place in the theory of probability and its applications in engineering problems in the last thirty-five years, the author has revised the first edition by including new materials on Random walks, Markov processes and Foundations of statistics. Much of the old material has been completely rewritten.

The first six chapters give an elementary but very sound introduction to the theory of probability. Chapters VII, VIII, IX and XI deal with problems covered in books on statistics. In Chapter X, we have a very brief introduction to matrix methods and Markov processes. In Chapter XII, the author discusses the probability theory as applied to congestion problems, particularly with reference to telephone systems. This chapter is almost 'the same as in the previous editions, but merits special mention in view of the fact that the author is an authority in this field on account of his long association with the Bell Telephone Laboratories. A large number of examples has been given at the end of each chapter and this increases the value and utility of the book as it enables the students to have a better understanding of the subject. The book is undoubtedly a good reference for engineering students, graduate engineers and others interested in the theory of probability and statistics.

P. V. KRISHNA IYER

TERNARY EQUILIBRIUM DIAGRAMS: INTRODUCTORY MONOGRAPHS IN MATERIAL SCIENCE by D. R. F. West (Macmillan & Co. Ltd, London; *Distributors*: Macmillan & Co., Bombay, 1965). Pp. ix+81. Price 13s. 6d. or Rs 10.80

This book has been brought out as an addition to the 'Introductory Monographs in Material Science' series. The present monograph on ternary equilibrium diagrams was originally intended as an introductory text for the undergraduate and post-graduate students of metallurgy, with special emphasis on systems encountered in ceramic technology and the practical situations explained through phase diagrams and space models of the phase changes that occur during heating and cooling of solid solutions. The importance of the principles of solidification reactions in relation to solid state constitution has been explained through use of liquidus and solidus projections.

The book reviews fundamental principles of phase rule studies and ternary phase model with elementary treatment of phase equilibria. Various multi-phase systems have also been considered and the principles explained through clear illustrations, with special reference to space models, projected views and isothermal sections of the phase diagram. It is assumed that a previous knowledge of binary phase equilibrium is possessed by the reader.

This book should be useful in understanding the methods used in representing the phase equilibria of binary, ternary and quaternary systems encountered in the field of ceramic technology and metallurgy.

G. S. LADDDHA

CHELATING AGENTS AND METAL CHELATES edited by F. P. Dwyer & D. P. Mellor (Academic Press Inc., New York), 1964. Pp. xv+530. Price \$ 17.00

This book is primarily aimed to provide a reference work for senior students and research workers in the chemistry of metal chelates and deals in ten chapters with historical background and fundamental concepts, nature of metal ligand bond, bidentate chelates, design and stereochemistry of multidentate

chelating agents, optical phenomena in metal chelates, oxidation-reduction potentials as functions of donor atom and ligand, metal chelates of EDTA and related substances, enzyme-metal ion activation and catalytic phenomena with metal complexes, metal chelates in biological systems and physical and coordination chemistry of the tetrapyrrole pigments. The chapters present critical reviews of the different aspects with up-to-date references to recent literature. The bias of the book is mainly on the structure and properties of metal chelates.

A large number of books dealing with the chemistry of metal chelates are already available, but in an expanding field of this nature there is always a need for more, particularly if they incorporate new directions of investigations and recent developments in the field. This book does satisfy this need to a great extent.

The study of metal chelates is generally directed to three principal ends, viz. (1) search for specific analytical reagents; (2) thermodynamics of chelation and correlation of stability with properties of metal ions and chelating agents; and (3) investigation of the role of metal chelates on the life processes of plants and animals.

The last three chapters of the book do give a detailed account for (3) above and would be greatly helpful to medical and biological research workers. Probably with a better understanding of chelation in life processes it may be possible to attain analytically useful specificity in chelation, which at present appears to be unattainable.

In Chapter 2, the classification of metal ions in A, B and C groups, originally introduced by Schwarzenbach, has been placed on a more quantitative footing by introducing a new parameter which takes into account the charge to radius ratio and the ionization potential.

It would have been better if a consolidated account of (2) above had been given in a separate chapter, though these aspects have been discussed in the book in Chapters 2, 6 and 7.

The discussion about chelates of aminopolycarboxylic acid is usually restricted to their behaviour in solution only. Chapter 7 deals largely with the properties of chelates isolated in the solid state and serves to modify the commonly visualized simple picture of EDTA as a hexadentate ligand occupying all the coordination positions of the metal ion. The chapter on background and fundamental concepts, however, does not do enough justice to the enormous amount of previous work about metal chelates in solution, particularly since all life processes involving chelation take place in solution only and this aspect of chelation is assuming greater importance.

The book is certainly a valuable addition to the literature on chelates and chelating agents.

V. T. ATHAVALA

AN ANTHOLOGY OF FOOD SCIENCE: Vol II—
MILESTONES IN NUTRITION by Samuel A. Goldblith & Maynard A. Joslyn (AVI Publishing Co. Inc., Westport, Connecticut), 1964. Pp. xv+797
The book, spread over 14 sections, is, as the title suggests, a collection of original papers reprinted from various journals. The authors have aimed in

this unusual and commendable task to provide a perspective view of the origin and growth of the science of nutrition. The choice of papers has been almost exclusively restricted to the early phase in the development of nutritional science and comprises research papers relating to the History of metabolism; Feeding of purified diets and the discovery of the vitamins; Individual vitamins, A, D, B₁, C, riboflavin, nicotinic acid and the multiple nature of vitamin B complex; Essential fatty acids by Burr and Burr; Amino acids and proteins; Minerals, and a concluding section on the Future of nutrition.

On the subject matter, there can be no criticism at all, because they are reprints of original publications and relate to outstanding and established concepts which have come to stay. So, any remarks about the book can only advert to the question as to how the authors of the book have been definitive in carving out this anthology. A coverage of this type is bound to bristle with difficulties regarding the selection of papers from a whole host of them, and criticisms like certain omissions are easily made, but are not justified. Since the avowed intention of the authors in bringing out this book is to focus attention on the historical development of the science of nutrition, omission of recent advances is perhaps justifiable since they would find their place later in subsequent recorded history.

The bevy of papers relating to pioneering researches assiduously assembled in this book gives an insight into the working of great minds and should inspire neophytes in scientific research. For them, the authors have thus rendered a great service in providing an easy and ready access to these worthy archives. Particularly instructive is the first chapter on the history of metabolism by Graham Lusk reprinted from *Endocrinology and metabolism*, Vol. 3, 1922, pp. 3-78, which is indeed a rich piece studded with quotations like

"Eskimo and Lapp live as they did a thousand years ago and have no history"

— Voit (p. 20)

"You who are not yet a Socrates ought to live as one who wishes to be a Socrates"

— Prof. E. H. Starling (p. 20)

with Lavoisier's life (p. 35 *et seq.*) as a man of science and of Cavendish's described as the most wealthy of learned men and the most learned of the wealthy (p. 45); that "scientific greatness depends primarily upon the quality of the intellectual protoplasm of the brain, upon the advantages offered to the functioning of that brain by a favouring mental environment, and on the possession of a good conscience" (Lusk, p. 46); and that "science knows no country. If the two countries or governments are at war, the men of science are not. That would, indeed, be a civil war of the worst description. We should rather through the instrumentality of men of science soften the asperities of national hostility" (Davy, p. 46). It is revealing to know that Napoleon, during the winter of 1797-98, attended the regular course of chemical lectures delivered by Berthollet (p. 46). The comment on Justus von Liebig *vis-à-vis* the rise of German

science that "Liebig had been a dunce at school and was laughed at by his teacher when, as a boy, he expressed his determination to become a chemist" (p. 60) must inspire many a young aspirant to a career in science, for it was this dunce at school who at the young age of twenty-one came to be appointed Professor of Chemistry at Giessen in 1824 (p. 61). No good student of science going through the pages of Hopkin's paper that was to make him the leader of biochemical thought in the present century can remain unmoved by the spark of genius prevailing this paper and that is true of everyone of the papers in this galaxy found by Goldblith and Joslyn. One cannot say that the same results carried in text-books as a bland summary would have equal exhilarating effect on young impressionable minds. It is in this context that the present publication of Goldblith and Joslyn, didactic in aim, has an especial appeal.

The book is dedicated to Samuel Lepkovsky "in recognition of his pioneering and his continuing contributions to nutrition". As with his photograph here, each research paper carries a photograph of the investigator together with a short bibliographical sketch of him. For each group of papers, the authors of the book have included their own introductory remarks, pertaining to main features of the papers grouped. There is an occasional paper in German calling for knowledge of this language. It would appear that in reprinting papers included in the book, the authors have been very exact. It is only on this basis that one is able to understand the difference in the founts which for a casual reader appear as non-uniform printing.

It would be a useful addendum to this book, if popular lectures or speeches by the same savants of science on subjects in their field of specialization are collated in a supplementary volume. It is to be hoped that future editions of the present volume would include classical work of Osborne and Mendell, and of Rose on essential amino acids and papers relating to nutritional disorders.

M. SRINIVASAN

UNIVERSITY INSTRUCTION IN GEOLOGY by T. Neville George (Unesco, Paris), 1965. Pp. 171

Under the joint sponsorship of Unesco and the International Union of Geological Sciences, a comparative survey of curricula and methods of instruction in geology in the universities of Czechoslovakia, Federal Republic of Germany, France, UK, USA and USSR has been undertaken by Prof. Neville George of Glasgow in collaboration with Professors Zdenek Pouba (Prague), Andreas Pilger (Clausthal), Pierre Bellair (Paris), J. F. Kirkaldy (London), Sheldon Judson (Princeton) and G. P. Gorshakov (Moscow). The volume brings out the common factors, as also variations and differences which are due to accidents of local geologic setting, industrial and economic history of the region, public interest in geology, educational philosophy and organization, interests of the teachers, etc. Though the survey is restricted only to the six countries listed above, it covers different types of educational organization, ranging from largely centralized

systems in USSR, Czechoslovakia and France, through partly centralized, partly autonomous system in UK to individualistic and autonomous systems in West Germany and USA.

The author traces the growth of geology as a university subject of instruction and lists the institutions offering courses in geology in the six countries. He discusses the content of geology in the school curriculum and has a good word to say about geology instruction in some of the French and American schools. He considers geology as a suitable subject to be taught at high school level for two reasons: firstly, it is unique among observational sciences as a discipline with multiplicity of contacts with other sciences like physics, chemistry and biology and hence constitutes a particularly convenient discipline to encourage the growth of truly generalized science; and secondly, the curiosity it stimulates in young pupils can often be satisfied with intelligible and direct answers without recourse to abstract theory. The entrance requirements for undergraduate courses and the pattern of degrees are explained in the chapter devoted to 'academic structure'. An exhaustive survey of undergraduate curricula in geology and geophysics is made in the next chapter. The hours devoted to geology vary from 2400 hr during the five-year undergraduate course in Moscow to 1250 hr during the four-year undergraduate course in Princeton. The variation partly reflects the relative importance accorded to cognate sciences (like physics and chemistry) necessary for a full understanding of geological principles. Though the syllabi outwardly appear to be the same in most university institutions, there is a wide variation in the type of knowledge imparted to the undergraduate, depending upon the predilections and scholarship of the teacher. For instance, petrology can be taught with emphasis on petrography or petrogenesis. As for the curriculum of applied geology in universities and technical institutions, while most institutions do make a reference to the practical applications of geology, only a few, like the Charles University, Prague, Imperial College of Science and Technology, London, and Princeton University, Princeton, USA, provide instruction at a truly professional level in certain special branches like hydrogeology, pedology, petroleum geology, mining geology, engineering geology, photo geology, etc.

The laboratory work for undergraduates usually consists of map work and structural interpretation, mineral and rock description, study of fossils, etc. The author strongly recommends that the initial descriptive approach (for instance, petrographic approach in the case of petrology) should slowly mature into an analytical approach, leading to an understanding of the physico-chemical processes which manifested themselves in a given set of petrographic characters. As regards field work, the author favours the arrangements in vogue in USSR and USA, where some institutions have fully equipped, permanent field camps in geologically interesting areas where intensive training in field work can be given for about three months. A comprehensive list of books in different branches of geology, applied geology and geophysics is

provided. The author makes out a case for new books in sedimentology and palaeontology which give coherent accounts respectively of significance of mineral assemblages and palaeoecological implications of fossil assemblages. He thinks the teacher should guide the undergraduate in the choice of reading material (books, periodicals and memoirs).

A separate chapter is devoted to the post-graduate (diploma and master's degree) curricula in geology, geophysics, geochemistry and applied geology and the requirements for doctorate degree (Ph.D. of UK and USA, Dr rer. nat. of West Germany, Candidatus of Czechoslovakia and USSR, etc.). Under forms of instruction, the author refers to the place of lecture, tutorials and seminars and examinations.

There are two appendices: Appendix A dealing with undergraduate laboratory and field equipment and Appendix B referring to the place of laboratory technicians in the geology departments.

The volume is a comprehensive, penetrating and perceptive analysis of curricula and methods of instruction in geology and deserves to be carefully read by all teachers and educationists interested in geology.

U. ASWATHANARAYANA

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- METABOLISM OF STEROID HORMONES by R. I. Dorfman & F. Ungar (Academic Press Inc., New York), 1965. Pp. viii+716. Price \$ 32.00
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- THE UPPER ATMOSPHERE METEOROLOGY AND PHYSICS by Richard A. Craig (Academic Press Inc., New York), 1965. Pp. xii+509. Price \$ 12.00
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- THE DYNAMICS OF CONDUCTION ELECTRONS: Documents on Modern Physics Series, by A. B. Pippard (Gordon & Breach Science Publishers, New York), 1965. Pp. 150. Price \$ 1.95 (paper); \$ 4.95 (cloth)
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NOTES & NEWS

digital information [*Proc. Inst. elect. electron. Engrs, N.Y.*, **53** (1965), 637].

X-ray spectra by mesons

An interesting experiment, in which X-rays produced by mu-mesons are used in place of the conventional electrons for investigation on structure of atomic nuclei, has been tried at the European Organization for Nuclear Research (CERN), Geneva. Studies with these 'muonic' X-ray spectra can be made at low energies by using the CERN synchrocyclotron. The beam of negative mu-mesons is slowed down by the target consisting of the material under study, e.g. gold, lead, bismuth. When a meson is decelerated by the target atom, it is captured by the field of the nucleus and orbits round it like an electron, dropping into lower and lower orbits emitting the characteristic radiations. The mu-meson ultimately decays or is captured. The muonic X-ray spectra closely resemble the optical spectra caused by electron energy transitions, but have the advantage that the mu-meson orbits are closer to the nucleus or even actually within it. They can thus yield information on the structure of the electrical charge surrounding the nucleus and also on its shape if it is not spherical [*New Scientist*, **23** (1965), 36].

Stimulated Compton scattering by electrons

Scattering of electrons by standing light waves, produced by a laser beam, has been observed by scientists at the Department of Chemistry and the Institute of Atomic Research, Iowa State University. The experiment is considered to be the first direct observation of 'stimulated Compton scattering'—a phenomenon predicted by Kapitza and Dirac in 1933. According to Kapitza and Dirac a standing light wave with periodic maxima of photon density could act as a diffraction grating for an electron beam. An electron absorbs a photon when it is incident on the vertical Bragg planes of the standing wave from a vertical reflector. Then stimulated emission induced at 0° or 180° by the incoming or

High efficiency gas laser

A laser using a mixture of nitrogen and carbon dioxide gases that generates 16 W. of power at 10.6μ , the highest continuous output so far observed at infrared frequencies, has been developed at Bell Telephone Laboratories by Dr C. K. N. Patel. The laser has an input-to-output efficiency >4 per cent which is about 40 times the efficiency of helium-neon lasers. The new laser is of interest because light at a wavelength of 10.6μ is not absorbed much by the atmosphere.

The laser operates by the transfer of vibrational energy of nitrogen molecules (excited by an electrical discharge in nitrogen gas or in air) to molecules of carbon dioxide. Both gases flow continuously through an interaction zone where lasing action takes place. The development of this high powered infrared gas laser was made possible when it was discovered that the transfer of energy from vibrationally excited nitrogen molecules to carbon dioxide molecules could not only be accomplished but resulted in extraordinary efficiencies. This is, in part, attributable to the lower lying energy states of the nitrogen molecule. The lifetimes of the vibrationally excited states in nitrogen are very long, for example, 10,000 times longer than the lifetime of the metastable states of helium under similar physical conditions. This results in getting more than 30 per cent of the vibrationally excited nitrogen molecules to give off their energy to carbon dioxide and initiate lasing action.

The laser tube is 25 mm. in diameter and 2 m. long. A concave and a convex mirror at opposite ends of the tube form the laser cavity. The mirrors are spaced 240 cm. apart and are coated with vacuum-deposited gold. The laser beam is emitted through a 12.5 mm. hole at the centre of the concave mirror. By increasing the diameter and length of the laser tube it is expected that output power of

hundreds of watts may be obtained.

High power gas lasers of this type may find application in communications, in spectroscopy and in the study of non-linear optical phenomena in the infrared region. [*News from Bell Telephone Laboratories, dated 15 June 1965*].

Piezoelectric crystal as a variable ultrasonic delay line

A novel approach to the problem of the design of a variable ultrasonic delay line has been suggested from the laboratory for Electronics Inc., Waltham, Mass. According to the suggestion, it will be possible to design such devices using a bar of a piezoelectric crystal. In recent years considerable attention is being given towards development of high resolution variable ultrasonic delay lines. Such devices would combine the major advantages of conventional fixed ultrasonic delay lines—high operating frequencies, wide band response, etc.—with the added feature of a resettable and continuously variable delay.

The theory of operation of the device is as follows: When an electric signal is applied to a transducer attached to one end of a rectangular bar of piezoelectric material, an acoustic wave is transmitted through the medium and the wave could be reconverted to an electrical signal at the output end using another transducer. Since the medium is a piezoelectric material, the acoustic waves should set up potential differences between properly positioned electrodes; in effect the piezoelectric bar acts as its own transducer. If the electrodes are free to move along the surface of the bar, a variable delay line is achieved. Since the material is homogeneous and continuous, the delay change is continuous and capable of infinite resolution. Experiments conducted with a lead zirconate titanate crystal showed that the suggestion is practicable and that it will be possible to design devices useful either with r.f. signals or with

outgoing wave trains produces horizontal changes in the electron momentum which gives rise to zero- and first-order Bragg reflections. The stimulated Compton scattering is observed to predominate over ordinary Compton scattering only at very high intensities. In the above experiment, a 1-65 kV. electron beam was passed at right angles through the cavity of a ruby laser containing 99 per cent reflecting mirrors. The scattering angles were measured by scanning the electrons past the slit of a scintillation detector. The scattering angle is found to be the order of 10^{-4} radian. It was observed in this experiment that the probability with which electrons are deflected by the laser modes was remarkably high. Owing to the limitations of the apparatus used these workers could not ascertain unequivocally whether the scattering angles followed Bragg's law strictly. The apparatus is being modified to provide a quantitative test for the theoretical relation giving the probability for stimulated effect derived by Kapitza and Dirac [*Phys. Rev. Lett.*, **14** (1965), 851].

Study of plasma characteristics by optical scattering

A suggestion that optical scattering can be used as a technique for plasma diagnosis has been made from the Department of Electrical Engineering, California Institute of Technology, Pasadena, California.

It is known that when a pulse of intense light from a laser passes through a plasma, a very small fraction of the light is scattered out of the beam by free electrons. According to the Thomson's theory of optical scattering, the intensity of scattering indicates the number of scatterers and the Doppler broadened spectrum of the scattered light indicates their velocity distribution. It is on this principle that the suggestion has been made. Since this technique makes measurements possible even within a small volume (1 mm. \times 1 mm. \times 1 cm.), it should be applicable even in the case of plasmas which cannot be diagnosed by conventional methods because of such

limitations as geometry, duration, or degree of ionization. However, the low intensity of the scattered beam even with intense laser light poses difficult problems in detection.

An apparatus has also been designed based on this principle and it is found capable of measuring electron densities as low as 10^{13} electrons/cm.³ in a cold plasma. The apparatus consists essentially of a giant pulse laser which sends the illuminating pulses, a scattering chamber in which the electrons in the plasma (caused by cold cathode discharge in helium by 2 μ sec. electric pulses) scatter the light and additional set-ups for measuring the characteristics of the scattered and direct beams. The scattered power was found to be linearly proportional to the incident power and the electron density was measured as a function of time in the after glow. The density calibration was obtained by the Rayleigh scattering method, using argon at a pressure of 1 mm. Hg. The accuracy of the absolute electron density measurement depends on the precision of the measurement of the calibration of gas pressure [*J. appl. Phys.*, **36** (1965), 1836].

A new phase in tantalum films

A new phase found in tantalum films has electrical properties significantly different from those of normal tantalum. The new material, named beta tantalum, differs from normal tantalum in that it has a higher density (ρ) and resistivity (R), and a lower temperature coefficient of resistance (α); it becomes a semiconductor at a much lower temperature (T_{tr}) (Table 1). X-ray studies indicate that beta tantalum has a more complicated (tetragonal) crystal

structure than normal tantalum (b.c.c.).

Thus far, beta tantalum has been observed and produced only in film form. Most of the experimental data have been collected from films produced by cathode sputtering, although beta tantalum has also been observed in films made by evaporation and chemical vapour deposition processes. When the films are formed in a sputtering system containing $10\text{-}30 \times 10^{-3}$ torr of argon, beta tantalum is frequently observed when the total pressure of other gases in the vacuum system is less than 1×10^{-5} torr. Beta tantalum changes to normal tantalum when heated in vacuum to about 750°C.

Beta tantalum, like normal tantalum, can be used to make capacitors for electronic thin film circuits because it readily forms oxides and can be anodized by usual techniques. It can also be used as a thin film resistor because of its high resistivity and low temperature coefficient [*News from Bell Telephone Laboratories, Release dated 12 July 1965*].

Molecular configuration by circular dichroism

The circular dichroism (CD) shown by many inorganic complexes has been recently shown to yield information — obscured in absorption spectra — about electronic transition. Thus CD curves have been successfully used to determine the crystal field symmetry and absolute configuration of transition metal chelates, especially isomeric complexes of Co (III) with EDTA ion. The main advantages occurring from the CD data are that CD bands in the visible region for transition metal complexes are generally much narrower than are absorption bands, and can be either positive or negative; overlapping bands of opposite sign can be resolved more readily than curves of the same sign.

As an example, stereochemical study of $(-)\text{[Co(EDTA)]}^{546}$ has been undertaken. Absorption spectrum of this complex in the visible range exhibits two apparently symmetrical bands which indicate a cubic crystal field about the cobalt ion — the highest

TABLE 1 - PHYSICAL PROPERTIES OF NORMAL AND BETA TANTALUM

	Normal tantalum	Beta tantalum
ρ , g./cm. ³	15.6	15.9
R , μ ohm-cm.	24-50	180-220
α , p.p.m./°C.	± 500 to $+1800$	-100 to $+100$
T_{tr} , °K.	3.3	0.5

possible symmetry. Optical rotatory dispersion (ORD) curve, however, shows two components within each of these bands suggesting a tetragonal crystal field. The CD curve reveals a third component in each band, representing the maximum splitting of energy levels, and indicating the actual molecular symmetry of the complex. The signs of CD components and their location within the absorption bands permit assigning a D configuration. The compounds studied so far are asymmetric, thus optically active, thereby limiting the scope of CD technique. To overcome the difficulty work is progressing for developing magnetic CD techniques, since in magnetic field any sample becomes optically active [*Chem. Engng News*, **48** (18) (1965), 40].

pD scale

New developments have been reported by scientists working at NBS Institute of Materials [*Tech. News Bull. nat. Bur. Stand.*, **49** (1965), 87] for establishing a pD scale for measuring the acidity or basicity of a deuterium containing solution. The pD of a solution is measured comparing the deuterium ion activity of the solution with that of a reference solution whose deuterium ion activity has been precisely measured by an e.m.f. method in cells free from the uncertainties of a liquid junction. The calculated ion activity of the reference solution at a specified temperature and concentration gives a pD value which is used as a reference point on the pD scale.

pD values of two reference solutions, one containing equimolar mixture of KD_2PO_4 and Na_2DPO_4 in heavy water and the other, an equimolar mixture of sodium acetate and deuterio acetic acid ($DC_2H_3O_2$) in heavy water. The pD values for these buffers are the first two reference points on the pD scale.

pD measurements can be made with the glass electrode, using the same equipment as that used for pH measurements, since the surface potential of the glass electrode responds to changes in pD when the electrode is immersed in heavy water. The pH assembly can, therefore, be adjusted to read

correctly the known pD at the two reference points, and the pD values of the unknown solution that lie between these points can be interpolated. However, since the scale is not necessarily linear between reference points, pD values at some distance from a reference point will tend to be less accurate. To overcome the difficulty additional reference points are being determined.

A new boron hydride

A new, unstable boron hydride, B_8H_{18} , with the highest hydrogen content for any known octaborane, has been synthesized by treating tetramethyl ammonium triborohydride-8 with polyphosphoric acid. Volatility of the compound suggests either a B_7 , B_8 or B_9 hydride. The ^{11}B nuclear magnetic resonance spectrum requires a molecule containing an even number of boron atoms. The compound has a molecular weight 96-113 and shows hydrogen-boron ratio between 2.24 and 2.29, thus excluding either a B_7 or a B_9 hydride. Of the possible octaboranes, both octaborane-16 and octaborane-20 are incompatible with the experimental hydrogen-boron ratio. Two possible structures have been suggested: (i) a bitetraboronyl molecule formed by condensing two tetraborane-10 molecules at B-2, and (ii) a belt-line icosahedral fragment formed by removing B-5 and B-10 from the decaborane-14 structure. These two structures find support from the NMR data and differ only in the placement of two bridge hydrogens [*Chem. Engng News*, **43** (15) (1965), 46].

Ring contraction in phosphorus-nitrogen ring system

The reaction between phenylmagnesium bromide and octachlorocyclotetraphosphazetetrane has provided evidence, for the first time, of a specific ring contraction of an eight-membered phosphazene ring. In the above reaction two isomeric compounds having the formula $N_4P_4(C_6H_5)_4Cl_4$ have been isolated. One melting at 181° is formed on carrying out the reaction at room temperature and the other melting at 212.5° is

formed at temperatures above 100° .

The lower melting isomer on hydrolysis gives a mixture of triphenylphosphine oxide, phenylphosphoric acid and phosphoric acid in the ratio 1:1:2. The higher melting isomer on hydrolysis results in the formation of diphenylphosphinic acid and phosphoric acid in 1:1 ratio.

It has been shown that triphenylphosphine oxide cannot arise from an eight-membered phosphazene ring; therefore, the structure 2,2,4,4-tetrachloro-6-phenyl-6-(2',2',2'-triphenylphosphazene-1'-yl)-cyclotriphosphazatriene has been suggested for the lower melting isomer. Further proof for this structure was provided by similarity of the infrared spectrum with those of closely related compounds and its unambiguous synthesis. The higher melting isomer has been conclusively shown to have an eight-membered ring structure [*Chem. Engng News*, **43** (26) (1965), 42].

Synthesis of tetraphenylporphine by electrical discharge

Yet another evidence for the hypothesis of chemical evolution is provided by the synthesis of tetraphenylporphine by electrical discharge. The synthesis is achieved by producing an electrical discharge between an electrode (connected to a Tesla coil) and the surface of the aqueous suspension of pyrrole and benzaldehyde. The electrical discharge for 2 hr in a reducing atmosphere consisting of methane, ammonia, and hydrogen with water and organic vapours gives the sample latent ability for synthesis during extended storage — thus the system is self-perpetuating. Exposure to electrical discharge for 2 hr in an oxidative atmosphere is also conducive to autocatalysis, but the rate of synthesis is lower. Four hours in oxidative atmosphere just about prevents synthesis by autocatalysis. This synthesis of porphine is a direct proof for the concept that porphyrins or porphine-like substances can be synthesized from simple compounds which were available during chemical evolutionary period [*Chem. Engng News*, **43** (15) (1965), 54].

Cell wall analysis to classify actinomycetes

Actinomycetes, owing to their dualistic nature in showing bacterial physiology and fungal morphology, have been alternately considered either as bacteria or as fungi. These are generally classified according to their morphological characters, but there are many complications with this mode of classification. For example, some variants of the genus *Streptomyces* may be indistinguishable from those of *Nocardia* and vice versa.

Previous studies on the cell wall of actinomycetes have established that the cell wall composition is akin to that of gram-positive bacteria and that there are two types of cell wall among aerobic actinomycetes. One could be called the streptomycetes type, containing the LL-isomer of α, ϵ -diaminopimelic acid as major component and few sugars as minor components. Arabinose is never found in this type. The other, *Nocardia* type, contains a preponderance of the meso form of α, ϵ -diaminopimelic acid as major constituent; among the sugars arabinose is always present. These studies have prompted Dr H. A. Lechevalier and Mary P. Lechevalier at Rutgers Institute of Microbiology to use chemical analysis of the cell wall to establish the generic classification of actinomycetes.

Cell wall preparations from various types of *Streptomyces* and strains of *Microclavosporia* contain major amount of glycine and LL- α, ϵ -diaminopimelic acid. Similarly, strains of *Micromonospora* and that of most Actinoplanceae contain glycine and meso- α, ϵ -diaminopimelic acid, strains of *Dermatophilus*, *Thermoactinomyces*, *Microbispora* and *Nocardia* of the maduracpelleterii type contain meso- α, ϵ -diaminopimelic acid; and strains of *Thermomonospora*, *Micropolyspora*, *Pseudonocardia* and *Nocardia* of asteroides type contain meso- α, ϵ -diaminopimelic acid, arabinose and galactose. Basing on the above analysis and morphology, the Rutgers workers propose a classification for euactinomycetes (actinomycetes forming well-developed mycelia) [*Chem. Engng News*, 43 (21) (1965), 51].

Nature of genetic code proved

Biochemists, headed by Dr H. Gobind Khorana, at the University of Wisconsin's Institute of Enzyme Research, have obtained a direct proof for the nature of genetic code in protein synthesis. While trying to answer the questions—(1) Are the genetic code 'words' spelled out by nucleotide pairs or triplets? and (2) Does the code overlap, that is, do nucleotides 1, 2 and 3 specify the first amino acid; nucleotides 4, 5 and 6 the second amino acid and so on?—they have achieved protein synthesis using synthetic DNA by the following two methods.

Long-chain ribopolynucleotides of repeating AAG (adenine, adenine, guanine) trinucleotide sequence were prepared using short synthetic deoxypolynucleotide chains with repeating TTC (thymine, thymine, cysteine) trinucleotide sequence as templates and RNA-polymerase (extracted from living cells) catalysing the reaction with triphosphate ATP and GTP as substrates. These ribopolynucleotides were, in turn, used to direct the synthesis of polypeptides in the cell free protein synthesizing system. In the other method, they used short-chain deoxypolynucleotides with repeating dinucleotide sequence as templates, to make high molecular weight DNA-like polymers (polydeoxy TC: AG and TG: AC), by the catalytic action of DNA-polymerase, an enzyme isolated by Dr A. Kornberg. Again RNA-polymerase was used in the presence of substrates and under the direction of DNA-like templates to synthesize ribopolynucleotides of strictly alternating dinucleotide sequence (poly-UC, -UG, -AC, -AG). These in turn directed the synthesis of copolypeptides of known structures.

When trinucleotides were used, the resulting proteins contained only homopolypeptides. Thus, poly-AAG directs the cell free synthesis of polylysine, polyarginine and polyglutamate. This is consistent with the triplet, non-overlapping nature of the code. On the other hand, ribonucleotides with repeating dinucleotide sequence direct the synthesis of

copolypeptides with two amino acids in alternating sequence. Thus, poly-UC brings about the incorporation of cysteine and valine. The incorporation of one amino acid requires the presence of the other; so their incorporation is interdependent. This can only be explained by a triplet, non-overlapping code: in poly-UC (uracyl, cysteine) the sequence UCUCUC gives two codons, UCU and CUC. A doublet code would give only one codon, UC. Similarly, poly-UG directs the cell free synthesis of cysteine-valine copolypeptide, poly-AC leads to the synthesis of threonine-histidine copolypeptide and poly-AG incorporates glutamic acid and arginine.

The Wisconsin scientists found that in some instances more than one triplet specifies a certain amino acid. This is reasonable because there are 64 different code 'words' possible with four nucleotide bases in RNA. By contrast there are only 20 amino acids. The translation of the four-letter alphabet into the 20-letter alphabet occurs via the genetic code 'word' [*Chem. Engng News*, 43 (8) (1965), 41].

Estimation of molecular size of peptides

A new peptide-mapping technique combining gel filtration on a micro scale with paper chromatography has been reported from the University of Leeds. When phenol-acetic acid-water (PAW) (1:1:1, wt/vol./vol.) is used as solvent for gel filtration on 'sephadex' cross-linked dextran gels, the technique can be used to estimate the molecular size of peptides. It may also find application in detecting differences in the composition of digests from genetically related proteins and for assessing the homogeneity and approximate molecular size of naturally occurring peptides.

The sample (10-50 μg .) dissolved in a solution (10 μl .) of dinitrophenyl-ethanolamine (visual marker 0.2 mg./ml.) and β -alanine (reference standard 0.8 mg./ml.) in PAW is applied to the top of the sephadex column. Another piece of tubing is coupled above the column and a head of 15-20 cm. of PAW is maintained above

the column for about 4 hr at room temperature. In this time DPN-ethanolamine usually moves about 21-24 cm. down the column. The yellow colour is spread over approximately 2 cm. The tubing is marked every 2 cm. from the top of the column. A sheet of Whatman No. 3 MM paper is marked into 2 cm. divisions along a line 9 cm. down from the narrow edge. The paper is folded along this line. Each 2 cm. zone from the column is cut out and the contents extruded on to the corresponding division on the paper. Zones from the column are applied in sequence. After 1 hr the chromatogram is eluted overnight with a suitable solvent for the peptides. Peptides are located by means of ninhydrin and they are identified from their R_f values.

The molecular weights of open chain peptides with molecular weights in the range 400-2000 can be determined from the equation $Kd^3 = 1.111 - 0.017$ (mol. wt)³ where Kd is the distribution coefficient [*Nature, Lond.*, **206** (1965), 1128].

Revised method for the determination of total cholesterol

A simple and rapid method for the determination of total cholesterol has been described by Wong *et al.* [*Life Sci.*, **4** (1965), 431] of the University of Illinois School of Medicine, Chicago. The dependability and reproducibility of cholesterol estimation by this method is comparable to other methods.

Blood specimens are allowed to stand overnight, instead of heating them in a flask on a water bath, for precipitating proteins. The aliquots to be analysed for total cholesterol are evaporated to dryness and extracted with pure chloroform. The extract is subjected to the Liebermann-Burchard colour reaction and the intensity measured on a spectrophotometer at 660 μ , the wavelength of maximum absorption. In this method the procedure employed for the extraction of total sterols from serum or plasma by Sackett [*J. biol. Chem.*, **64** (1925), 203] is modified.

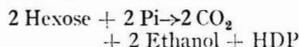
The modified method has the following advantages over the

other methods for the determination of total cholesterol: (i) the method permits the analysis of over 100 samples per day, (ii) the method is not costly since it does not require digitonin precipitation of cholesterol, and (iii) due to its basic simplicity and fewer steps involved, the possibilities of error are minimized. The percentage error in estimation of the samples containing cholesterol in the concentration range 100 g. was 1.5 and in the concentration range 300-1000 g. was 0.4-0.6.

A new fermentation pathway in yeast extracts

A new fermentation pathway proposed by workers at the University of Louisville, Kentucky, differs radically from the presently accepted pathway in that it does not require adenosine phosphate for the fermentation, but instead attaches importance to fructose-1,6-diphosphate (HDP).

In the new scheme (Fig. 1) HDP is continuously formed from hexose and then degraded with fresh hexose, thereby accepting phosphate to form hexose monophosphate (HMP) and then HDP. 2-Deoxy-D-glucose acts as a phosphate acceptor in the breakdown of HDP. The process continues as long as free hexose and inorganic phosphate (Pi) are available. The proposed mechanism involves the conversion of four hexose molecules to four HMP molecules with simultaneous fermentation of one molecule of HDP. Reactions involved in the mechanism may be represented by the equation



The validity of the equation has been confirmed by experiments

conducted on dialysed extracts containing, if any, negligible amounts of adenosine phosphates [*Life Sci.*, **4** (1965), 827].

Progress Reports

National Bureau of Standards

The combined annual report for 1964 of the four institutions under the control of the US National Bureau of Standards, viz. The Institute for Basic Standards (IBS), The Institute for Materials Research (IMR), The Institute for Applied Technology (IAT), and The Central Radio Propagation Laboratory (CRPL), presented in the publication entitled *Technical highlights of the National Bureau of Standards* shows that the research activities of these institutes have been well oriented towards applying the achievements in physical and engineering sciences in the field of technology. Even though, a large part of the research activities was directed towards developments of immediate application in industry or setting up of new standards, a substantial part of the activities has also been directed towards fundamental studies.

The CRPL has continued to conduct a broad range of studies directed towards the efficient use and conservation of the radio spectrum besides effective continuation in various operational programmes of the IQSY. Observations made from 22 locations across the continent on the total eclipse of the sun on 20 July 1963 have shown a well-marked geographical pattern of variation in the F region of the atmosphere with eclipse time, and maps of this variation are being prepared for use in testing theories of the physical process of the ionosphere.

The Information Technology Laboratory (ITL) of the IAT has conducted investigations leading to the development of new and better tools for information processing. The ITL has offered assistance to several government agencies in problems of computer programmes and information processing covering a wide range of activities. A clearing house for Federal Scientific and Technical Information was established in February 1964 to assist industry

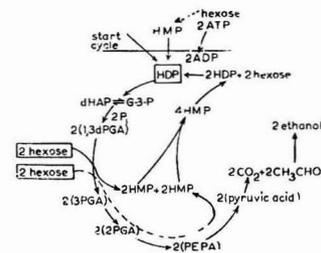


Fig. 1 — Proposed fermentation pathway

and the technical community for obtaining information on government activities in the physical and engineering sciences.

In the field of basic measurements and maintenance of standards several new facilities have been established and new developments made with a view to improving the precision of the standards maintained.

In a study of oxidation processes, several new techniques, involving gas chromatography and polarography, have been developed for measurement of the oxygen consumption of polymers as a function of temperature. An analytical method called double radioisotopic dilution which uses radioisotopic tracers for the analysis of small quantities of the elements has been developed to aid in precision chemical analysis and the method has sensitivities of 0.1 mg./g. of sample for the analysis of such elements as silver, cobalt and iron. Other methods of analysis completed during the year include a new procedure for the determination of rhodium in uranium alloys, and a method for the analysis of zirconia-yttria refractory materials.

Two new research techniques which have made possible the effective study of the excitation of atoms and molecules in the intermediate energy range (10-1000 eV.) has been developed. An ellipsometer technique developed helps in the determination of optical constants of iron single crystal surfaces in ultra-high vacuum as a function of wavelength in the region 360-700 nanometers. Under the standard materials programme an X-ray fluorescence spectrographic method of analysis, giving highly accurate results, was developed for the analysis of brass standard reference materials in solution form. Another advance in spectrographic analysis was the development of a device for the spark excitation of atomic emission spectra in atmospheres other than air. With this device, analysis can be performed in controlled argon atmosphere as rapidly as in air.

A new form of plasma — the brush cathode plasma — which is both stable and uniform and which lends itself to precision measurements of its characteristics, has

been developed and extensive studies are under way. As a result of investigations made on the polymer absorption process, a new theory has been worked out for low-surface coverage adsorption. During studies made on crystal growth and characterization, techniques have been developed for the production of sizeable single crystals of sparingly soluble salts by inter-diffusion.

In the section of Applied Mathematics of IBS, numerical analyses have been carried out over several fields such as asymptotic expansions, eigen value determination, quadrature and interpolation, etc. Other areas of investigation included linear programming and its extensions, graph theory, game theory, stochastic processes and mathematical models of distribution networks.

Information obtained from a preliminary study on the feasibility of measuring or compensating the drag on a manned satellite will be helpful in determining atmospheric densities and the figure of the earth and would eventually be useful in the design and operation of zero-G laboratory.

During studies involving high precision measurement of ion mobilities in gases a new method of measurement of ion molecule reaction rates has been developed and using this method the rate of the three-body reaction of atomic helium ions to form ions of diatomic molecule has been determined to an accuracy of a few per cent.

A dynamic theory of the nuclear rotation was developed in which the rotation-vibration model and the hydrodynamical dipole-oscillation model are unified. Calculations are in progress to determine the nuclear energy levels and wave junctions according to the shell model for nuclei with atomic weights between 17 and 40.

A general theory which could explain the dislocations caused in the solute atoms due to alloying is being developed and it is expected to explain many of the mechanical properties of materials. A new comparative method for measuring the thermal conductivity of insulation and building materials has been developed based on the flow of heat in a conductive disk hot plate and is much simpler

than the standard hot plate method. During the course of investigations on the design of advanced programming techniques for improving communications between people and computers, between data acquisition devices and computers and between computers and devices they control, a new language called SYNCRETIC has been developed. The language is computer independent and is under trial. A newly developed machine programme for automatically assigning descriptors to technical articles called SADSACT (self-assigned descriptors from self and cited titles) is being tested. The programme learns associative links by inspection of previously formed pairs and then selects descriptors for word comprising new items. Automatic searching for chemical information requires that chemical structures be represented in a manner capable of being encoded in digital form for computer manipulation. Work in this direction has led to the development of HAYSTAO, a computer programme for searching chemical data by means of structure fragments encoded in digital form. Work in transforming the alphanumeric notations into a form that computer programmes can use directly is in progress. Theoretical studies of long-wave propagation have been made with a view to having a better understanding of the effects of the anisotropy of the ionosphere and of ions on long-wave propagation. These studies indicate that the well-known 'wave hop' theory can be extended to account for the observations made near regions of the grazing incidence and in the shadow region. A quantitative investigation of ionization produced in the lower ionosphere by solar protons has been made. Observations made so far indicate that measurements of radio wave absorption at very high geomagnetic latitudes can provide a reasonably accurate estimate of the flux of solar protons with energy 5 MeV. Radiation from a finite source in a compressible electron plasma has been studied by means of theoretical model — a perfectly conducting sphere excited uniformly by an annular slot. The results obtained may have possible applications in the design of antennas for space vehicles.

New Periodical

Journal of Materials

This new quarterly journal, to be started by the American Society for Testing & Materials from April 1966, is intended to help in the dissemination of new information in the field of materials technology and to meet the expanding needs of engineers and scientists concerned with materials. The journal will carry articles in the field of materials technology and materials evaluation methods. The annual subscription for the journal is \$ 15.00.

Dr D. S. Datar

Dr D. S. Datar has been appointed Director, Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar.

Dr Datar (b. 17 July 1911) had his early education at Hyderabad and Poona, and obtained M.Sc. degree in physical chemistry from the Osmania University. Later, he worked at the Indian Institute of Science, Bangalore, and was awarded the Ph.D. degree by the Bombay University in 1942. He joined D.A.V. College, Sholapur, in 1940 and was Head of the Department of Chemistry during 1942-46. Subsequently, he joined the then Central Laboratories for Scientific & Industrial Research, Hyderabad, as Scientific Officer and became Assistant Director in 1954. He was appointed Deputy Director-in-Charge, CSMCRI, Bhavnagar, in October 1962.

Dr Datar has worked on heavy chemicals, fertilizers, ceramics, X-rays and physical chemistry while at RRL, Hyderabad. After joining the CSMCRI, he formulated the research programme of the institute project-wise. Some of the projects on which work has been initiated or intensified are desalination of sea water, experimental salt farm, separation of

FORTHCOMING INTERNATIONAL SCIENTIFIC CONFERENCES

<i>Date</i>	<i>Conference</i>	<i>Place</i>
9-11 February Spring 1966	International Solid State Circuits Conference International Seminar on Physics: Measurements in Operating Power Reactors	Philadelphia Europe
21-24 March	Fourth International Aerospace Instrumentation Symposium	Cranfield (UK)
26 March to 2 April	Third International Conference on Stress Analysis	Berlin
28 March to 2 April	Third International Conference on Measurement of Tensile Strength	Berlin
March-April	Second General Assembly Meeting, International Biological Programme	Paris
11 April	Second International Oceanographic Congress	Moscow
17-20 April	Second International Conference on Electron and Ion Beam Science and Technology	New York
18-20 April	International Colloquium on Transport Phenomena and Phase Changes in Porous and Colloidal Media	Paris
18-20 April	Fifth International Pressure Die Casting Conference	London
19-21 April	International Conference on Non-linear Magnetism	Stuttgart
25-29 April	International Symposium on Radioecological Concentration Processes	Stockholm
April	International Conference on Electronic Commutation	Paris
April	Ninth International Congress of Therapeutics	Bologna and Salsomaggiore Paris
2-9 May	Seventh Congress of the International Commission for Optics	Paris
3-8 May	International Symposium on Mechanisms of Action of Fungicides and Antibiotics	Reinhardtsbrunn (Germany)
9-14 May	Sixth International Symposium on Condensation Nuclei	Albany
16-26 May	Third International Congress on Metallic Corrosion	Moscow
21 May to 4 June	International Silk Congress	Mediterranean
21-27 May	Fifth International Congress of Precast Concrete	London
22-27 May	Fourth Congress of the International Association for Cereal Chemistry	Vienna
23-28 May	Second International Congress on Hormonal Steroids	Milan
24-26 May	Second International Symposium on Ultrasonic Testing of Materials	Berlin
28 May to 6 June	Second International Congress on the Sea	Treboul-Douarnenez (France)
May	International Symposium on the Dynamics of Chemical Reactions	Padua (Italy)

potassium sulphate, magnesia, bromine and bromo compounds from sea water, utilization of seaweed as food, and cultivation of marine algae. He has published over 110 papers and has 24 patents to his credit. He is a member of

several scientific organizations, including the Indian Institute of Chemical Engineers. He is a member of the Board of Directors, Hindustan Salts Ltd, Jaipur, and Development Council for Inorganic Chemicals, Government of India.

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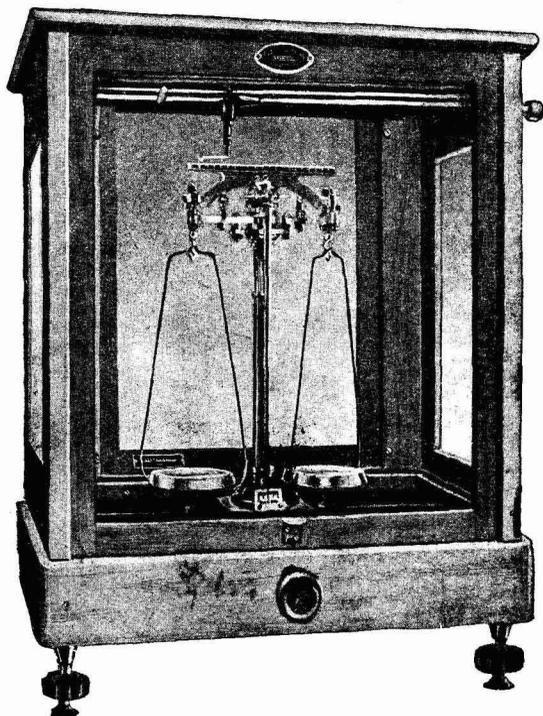
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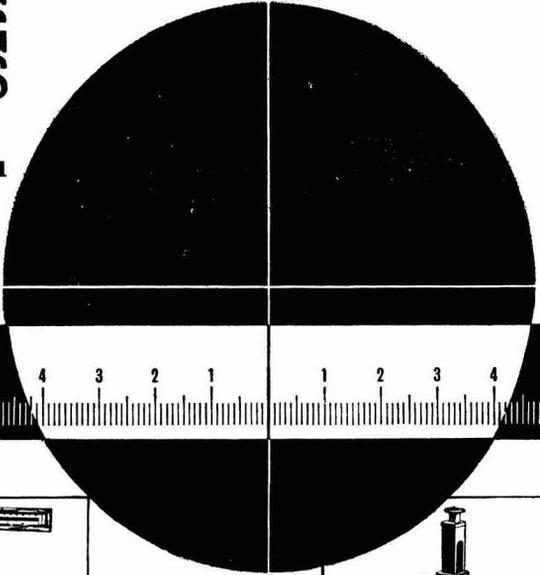
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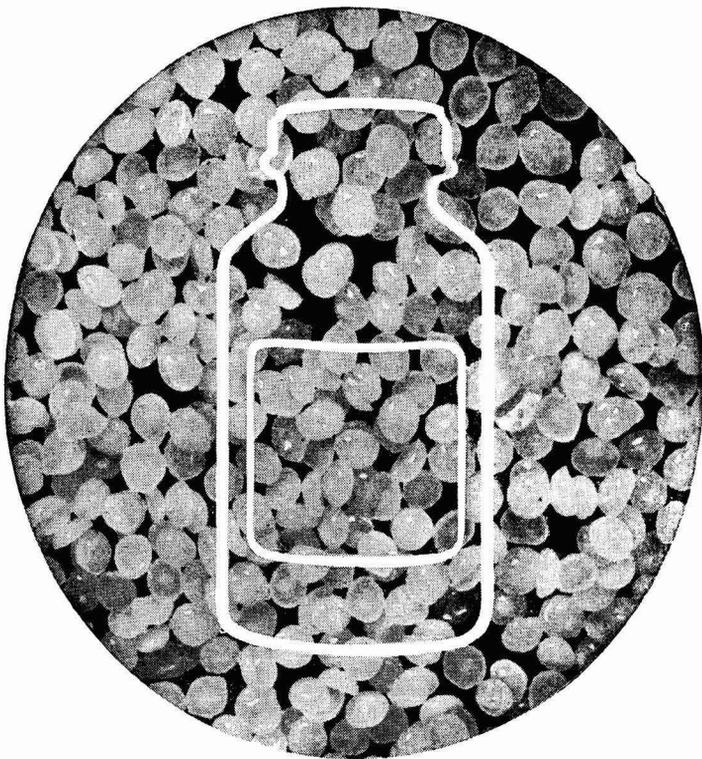
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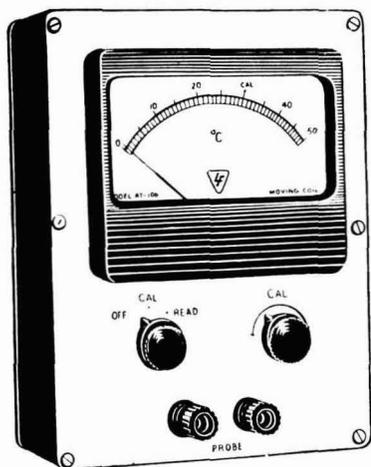
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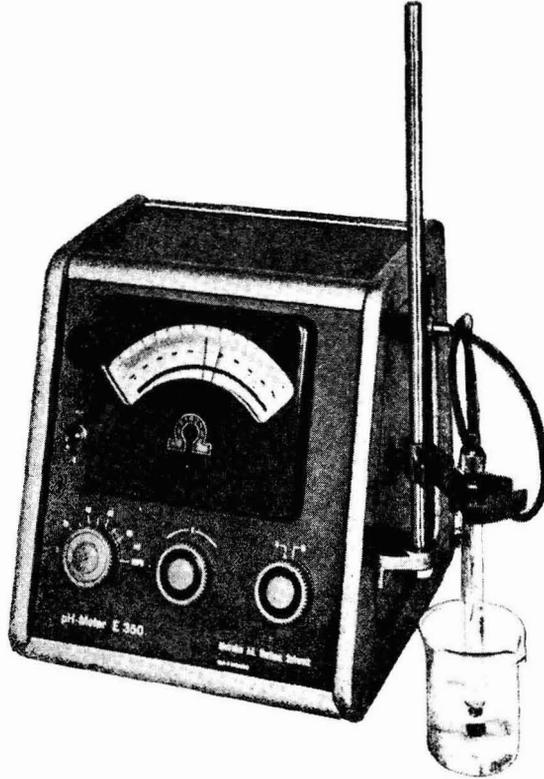
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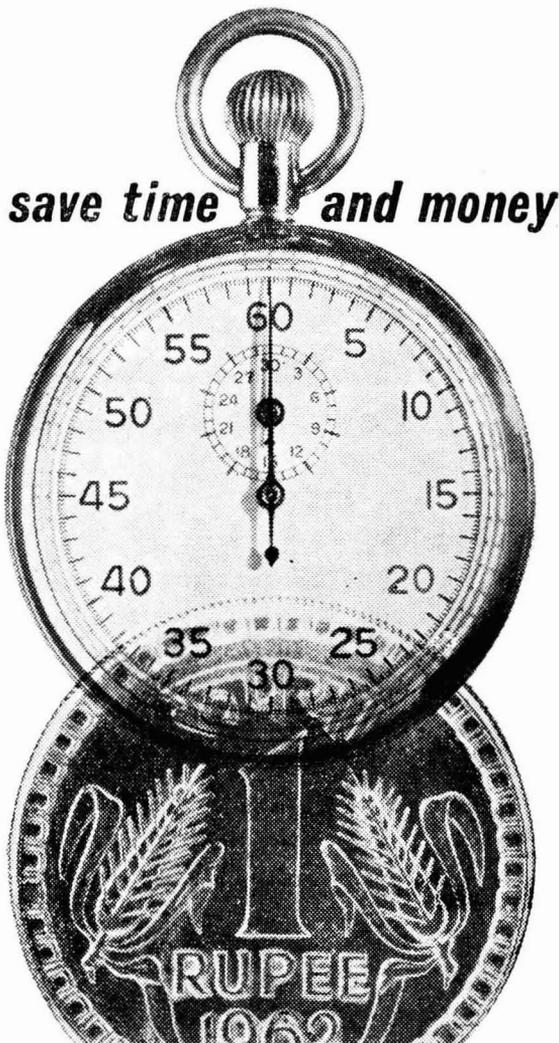
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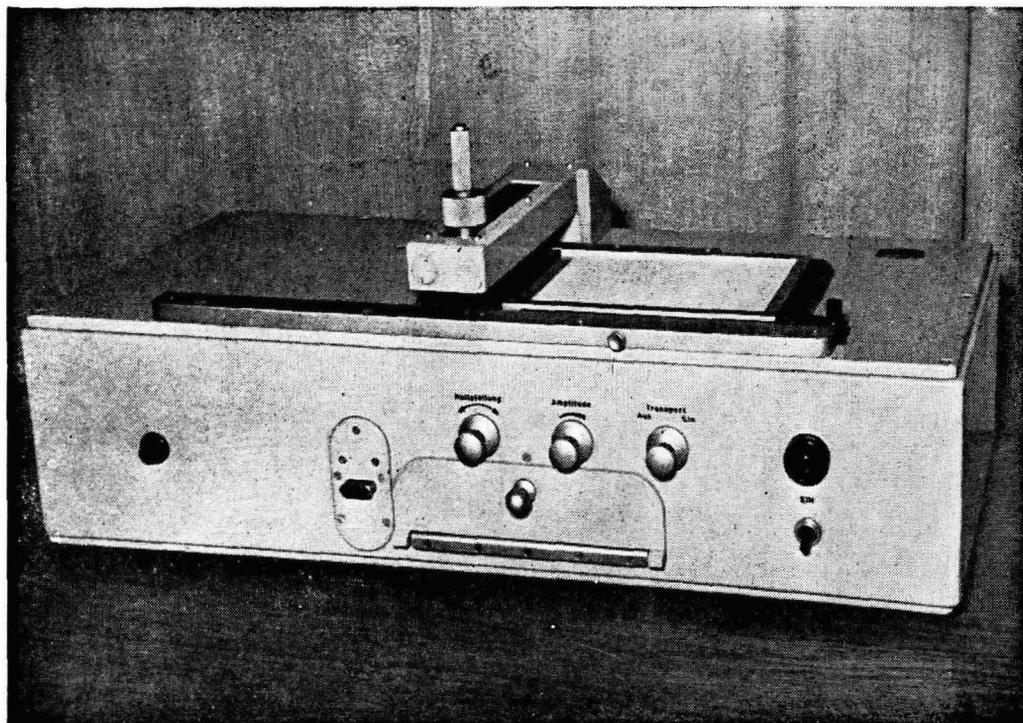
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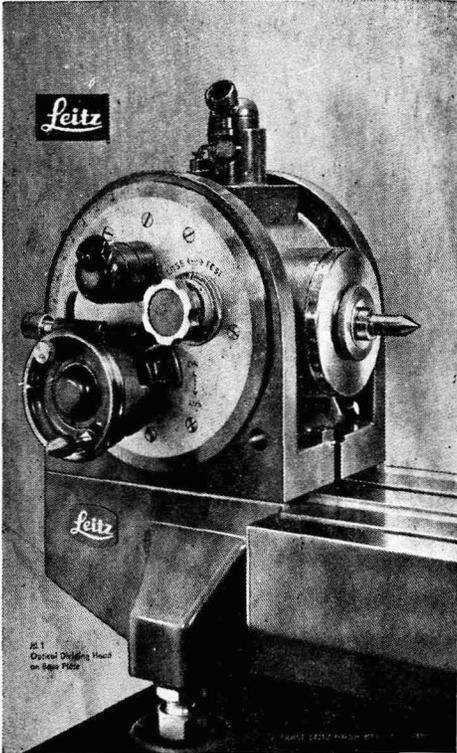
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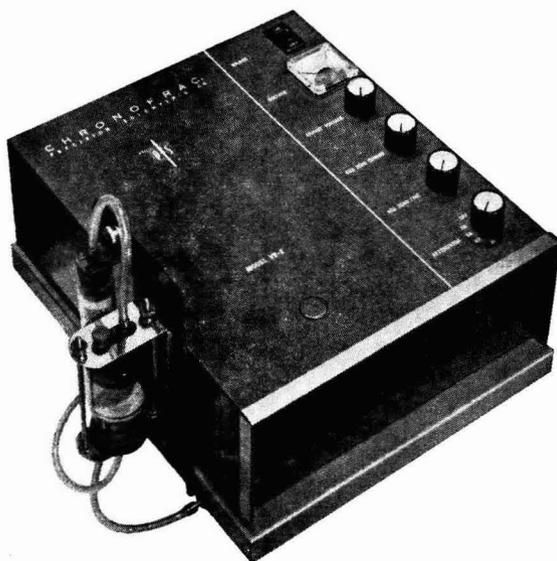
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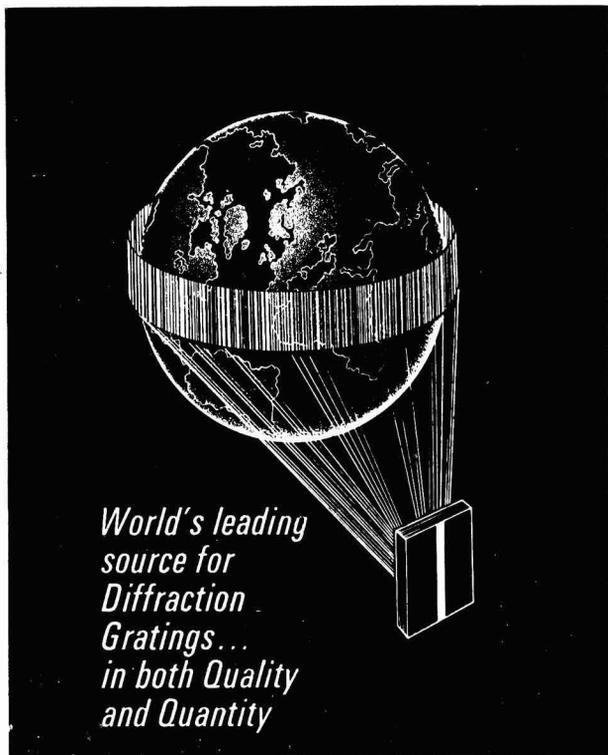


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