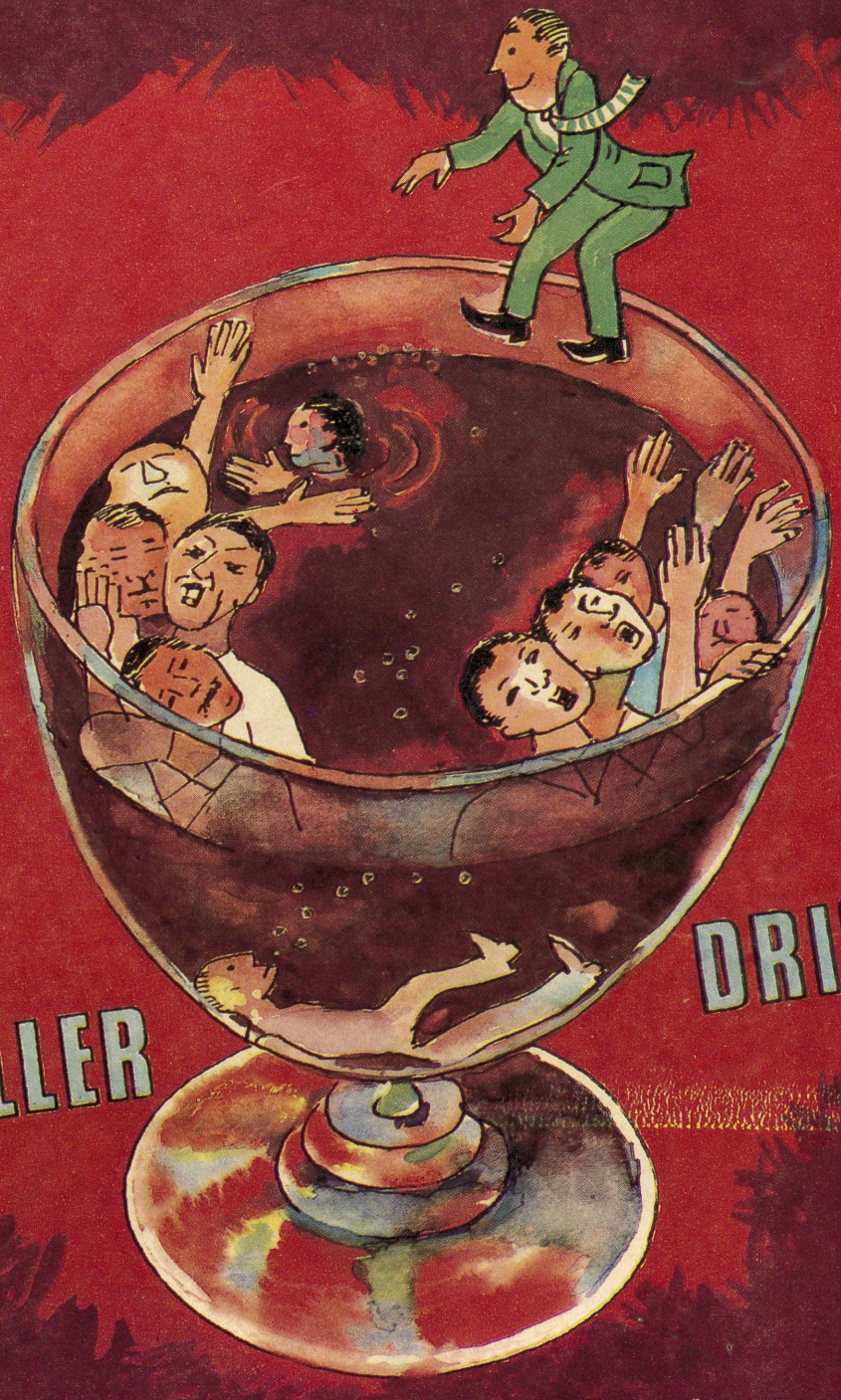
DECEMBER 1989

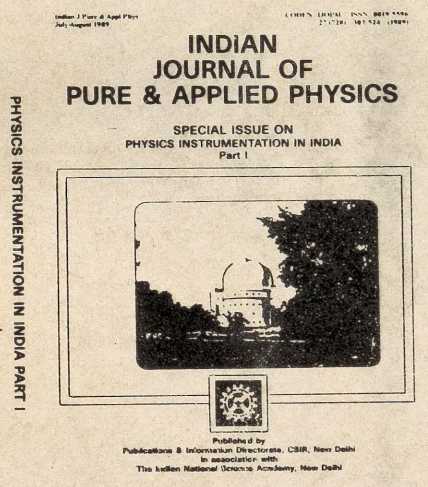
ISSN 0036-8512
RUPEES 3.00

SCIENCE REPORTER



THE KILLER DRINK

NEW PUBLICATIONS



Physics Instrumentation in India : Parts I & II

The *Indian Journal of Pure & Applied Physics* has brought out the above publication in two parts in October 1989. The publication contains 50 articles written by specialists associated with sophisticated instrumentation of several prestigious scientific projects in India. Information contained in this publication will be highly valuable to scientists in all disciplines as instrumentation is an integral part of all research activities. Dr. K R Rao of the Bhabha Atomic Research Centre, Bombay, as Guest Editor, has guided in the compilation of this issue.

Part I deals with projects in :

Astronomy & Astrophysics
Condensed Matter Physics
High Pressure Physics
Oceanography and Biophysics

Part II deals with projects in :

Elementary Particles; Accelerator & Nuclear Physics; Plasma Physics; Reactor-based Research; Laser Physics; and Electronic Instruments

The instrumentation design and techniques reported will be found useful by *chemists, engineers, biologists*, etc. also and hence this publication will be a *valuable addition to all libraries.*

Price for both Parts I & II :

Rs. 200.00
(for orders within India)

£ 22/ $ 34/
(for orders from abroad)

Orders enclosing bank drafts for the price mentioned above, drawn in favour of Publications & Information Directorate, and giving the address to which the copies are to be sent, should be directed to :

The Senior Sales and Distribution Officer,
Publications & Information Directorate (CSIR),
Hillside Road, New Delhi 110 012.INDIA

A FABULOUS DISCOUNT OFFER FOR SUBSCRIBERS

Get up to 11 issues of Science Reporter FREE !

You can save upto Rs 33, that is, the cost of 11 issues of your favourite popular science monthly, now in a new attire with colour pages and attractive features, if you order a subscription for 3 years.

You can also order a 2-year subscription at a saving of Rs 22 over the bookstall price.

Even with a 1-year subscription at Rs 30 you still save Rs 6.

To book your subscription fill in the subscription form given on the last page of this issue and send it with your remittance in the form of M.O./Cheque/Demand Draft for the appropriate amount to:

The Senior Sales & Distribution Officer
P.I.D., Hillside Road
New Delhi 110012

If for some reason you do not want to send money now, you may receive the first copy by V.P.P. (for the entire amount of subscription you desire to enter). Please tick the appropriate box in the subscription form.

RATES :

3-year	Rs 75.00 . .	(Saving of Rs 33)
2-year	Rs 50.00 . .	(Saving of Rs 22)
1-year	Rs 30.00 . .	(Saving of Rs 6)

The M.O /D.D./Cheque should be made payable to :

Publications & Information Directorate (CSIR)

(Please add Rs 5 as bank charges for outstation cheques)

SCIENCE REPORTER

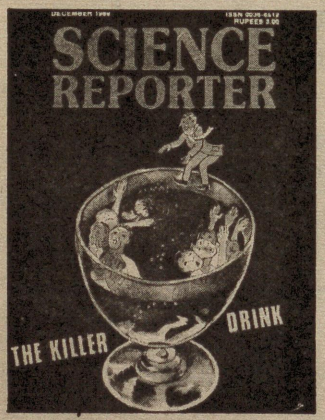
Vol. 26 No. 10. December 1989

Publications and Information Directorate (C.S.I.R.)

Phones
Editorial : 573-0146
Sales & Production : 573-0147

Science Reporter is published monthly. Publications and Information Directorate (CSIR) assumes no responsibility for statements and opinions advanced by contributors and the editorial staff.

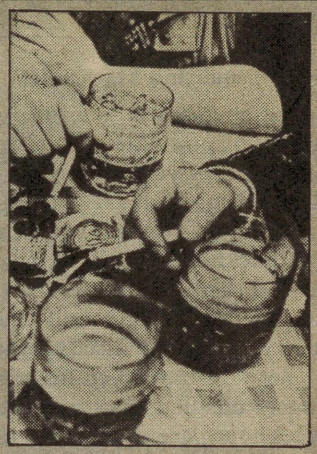
Annual Subscription
Inland Rs. 30.00
Foreign (By surface mail) US $8.00



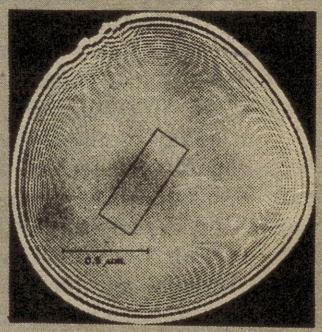
Design by K. B. Dhingra

Articles

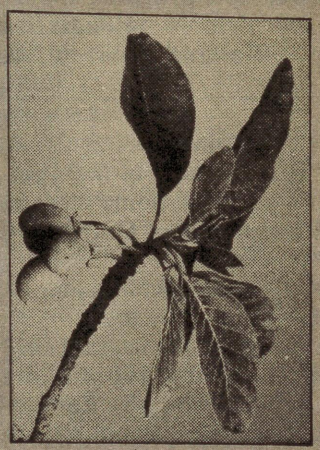
Departments



Page 542



Page 552



Page 570

Page 584

LETTERS

Sensationalising blackholes

Sir, Sensationalisation is a notorious enemy of popular science. It is a pity to see that your highly valued magazine is not free from it. V. Venkateswara Rao's **Evolution of stars: backholes** (*S.R.*, June 1989) could easily have avoided the subtitle. The article gave only one-fourth of its length to discuss blackholes. The author allowed his readers to carry on their misconception that blackholes are dead stars. They are not. A blackhole, like a "perfectly black body" or a "point mass", is but a conceptual model. A star never becomes a blackhole, it only *approaches* its state. The reason is that the time dilation becomes continually more intense as the stellar matter collapses. Theoretically, it will take an eternity to *all* of the star to shrink within its gravitional radius. Russians have a better name; they don't talk about a blackhole, they call a dead star approaching a blackhole, state a "frozen star".

Niladri S. Kar
Sankrail, Howrah 711313

Computers

Sir, I am a reader of *S.R.*, for the last two years. Some readers of *S.R.* are aspirants of CSIR/UGC joint examination 1989. In this examination, computer is an essential subject.

The first part of the serial on computers **In the world of Basic-1** (*S.R.*, Sept. 1989) *by* V. Ramshesh is written in a simple and elegant manner. It is highly informative and deserves all praise. In fact, it is the need of the hour. If the author touches upon all the aspects of the syllabus of the computer section of CSIR/UGC joint examination 1989, it will be highly appreciated. Some references may also be mentioned at the end of each topic so that readers can refer to them for obtaining further information.

Brij Mohan Sharma
Deptt. of Bio-Sciences
Jammu University

Bird migrations need further study

Sir, I thank R. Chakrabarti for his article **Mystery of Migration** . The article is useful and educative to not only science students but also others who are always eager to know about the mystery of bird migration. In the north-east India, including Assam, a lot of migratory birds come every year. There is a need to study these birds. Ornithologists should visit the region for detailed study of bird migration.

Pradip Das
Deptt. of Anatomy & Histology
College of Veterinary Sciences
Assam Agricultural Univ.
Guwahati-22 Assam

Diabetes

Sir, Many thanks for publishing **The riddle of diabetes** by K.C. Kanwar and others (*S.R.*, September 1989) which was interesting lucid and informative. The article gives enough details on how diabetes can be detected and controlled. But the authors did not mention anything about the hereditary pattern of diabets.

I resquest you to publish more articles on several common diseases such as low and high blood pressure, heart diseases, etc.

The article **Rita Levi-Montalcini and chick embryos** was very inspiring.

Shurbhi "Priya"
D/o W.P. Sinha
Gandak Colony
Chapra Saran 841301

Indoor-pollution

Sir, I have been reading *S.R.* for the last ten years. The articles are very interesting and informative. Thanks for publishing the useful article **Indoor-air-pullution** *by* Vikas Kumar (*S.R.*, June 1989), a subject of interest to me.

I request you to publish articles dealing with building construction and related issues.

Khaja Fakruddin
21-7-573, Ghansi Bazar
Hyderabad-500002

More on barium

Sir, I have been reading *S.R.* for the last one year. Thanks for publishing **Ozone depletion means danger** (*S.R.*, July-August 1989) *by* A. Husain, P.C. Joshi and P.K. Ray which cleared all my notions about the subject.

Iam a research scholar and my research work is on barium chemicals. I request you to publish the latest information on the applications of barium in medical science and agriculture and on new techniques involved in mining barium and its pollution hazard, etc.

Jyotsna Agarwal
Research Scholar
R.R. College
Alar (Rajasthan) 301001

Gout

Sir, I am a regular reader of *S.R.* As I am a student of pharmacy, I read with interest **What is gout** by K.G. Prasannan (*S.R.*, July-August 1989). It was a useful and educative article for medical as well as pharmacy students. The article informed which drugs are to be used and how drugs treat gout.

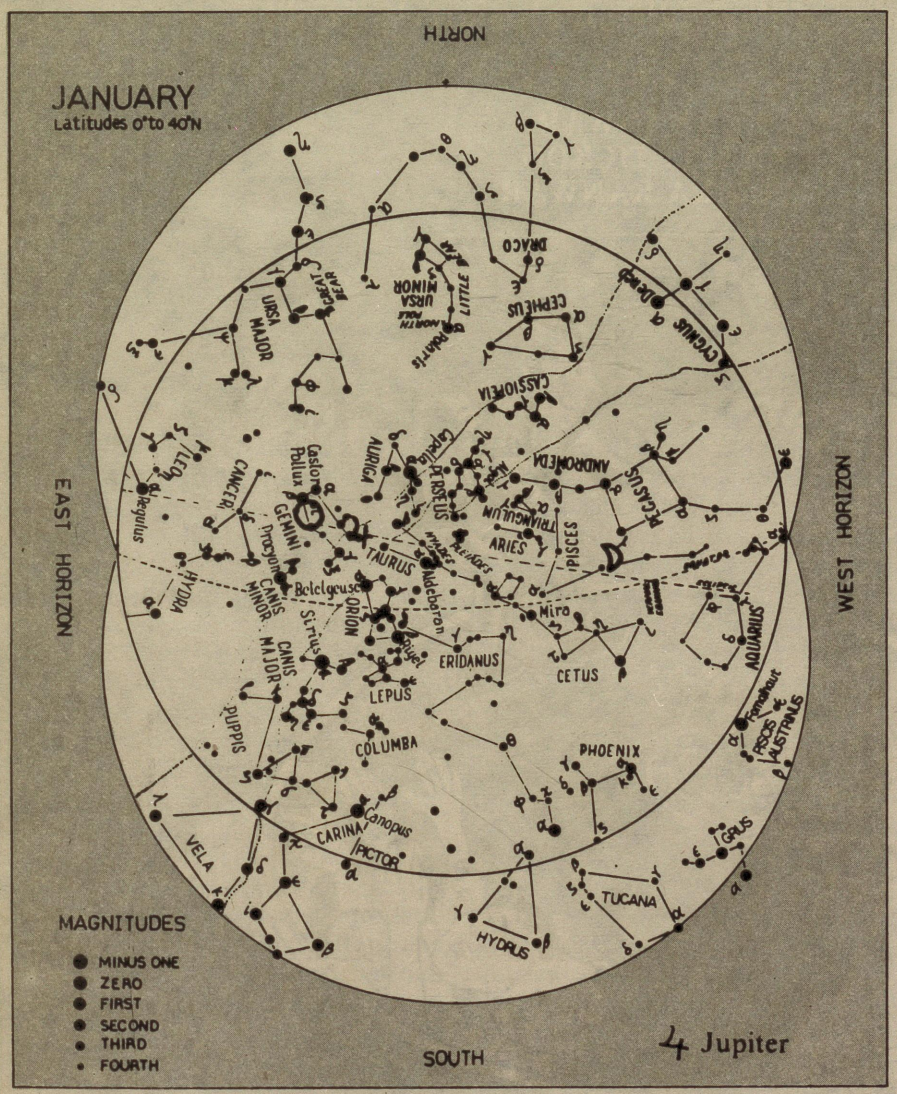
So, I expect that from time to time you will publish articles related to chemotherapeutic drugs.

Soumitra Sarkar
College of Pharmaceutical Sciences
Berhampur-760002(Orissa)

Biogas

Sir, Thanks and congratulations for publishing **Biogas from solid waste** *by* G.K. Roy (*S.R.*, June 1989). This article was educative and interesting. Actually, biogas generation from solid waste is an economically viable proposition especially for rural India. I request you to publish more articles on Biogas which will be helpful to people living in rural areas.

Bijaya Kumar Behera
Utkal University
Bhubaneswar
Puri (Orissa)



Planetary positions for January 1990

Date	*1ST*		*10TH*		*20TH*	
Planets	*R.A.*	*Decln.*	*R.A.*	*Decln.*	*R.A.*	*Decln.*
Mercury	19h 51m	20.5S	19h 13m	19.3S	18h 41m	20.2S
Venus	20h 33m	17.0S	20h 20m	15.4S	19h 55m	14.4S
Mars	16h 32m	21.9S	16h 59m	22.8S	17h 30m	23.5S
Jupiter	6h 23m	23.2N	6h 18m	23.3N	6h 12m	23.3N
Saturn	19h 08m	22.2S	19h 12m	22.1S	19h 17m	22.0S

Adopted form figures supplied by Positional Astronomy Centre, Calcutta

The moon

THE full moon occurs on 11th at 10.27 a.m. and the new moon occurs on 27th at 00.50 a.m.I.S.T. The moon passes about three and a half degrees north of Jupiter on 10th, four degrees south of Mars on 23rd, about five and a half degrees south of Mercury and three degrees south of Saturn on 25th and about nine and a half degrees south of Venus on 26th. The moon is at perigee or nearest to the earth on 8th and is at apogee or farthest from it on 19th. The lunar crescent becomes first visible after the new moon day in the evning of 28th. An annular eclipse of the sun occurs between 10-43 p.m. on 26th and 3-18 a.m. on 27th. It is not visible in India. The earth is at perihelion or nearest to the sun on 4th.

The planets

Mercury *(Budha),* is too close to the sun to be visible during the first half of the month. During the second half of the month it is visible in the morning sky rising about one and a half hours before sunrise. It is in inferior conjunction with the sun on 9th and becomes direct on 20th. It moves from Capricorn *(Makara)* to Sagittarius *(Dhanus).* Its visual magnitude varies from +2.2 to 0.0.

Venus *(Sukra),* visible in the evening sky, sets about an hour after sunset during the first half of the month. Thereafter it comes too close to the sun to be visible being in inferior conjunction with the sun on 19th. During the last quarter of the month it is visible in the morning sky rising about an hour before sunrise. It moves from Capricorn *(Makara)* to Sagittarius *(Dhanus).* Its visual magnitude is about −4.4.

Mars *(Mangala),* visible in the morning sky, rises about two and a half hours before sunrise during the month. It moves from Scorpio *(Vrischika)* to Sagittarius *(Dhanus).* Its visual magnitude is about +1.5.

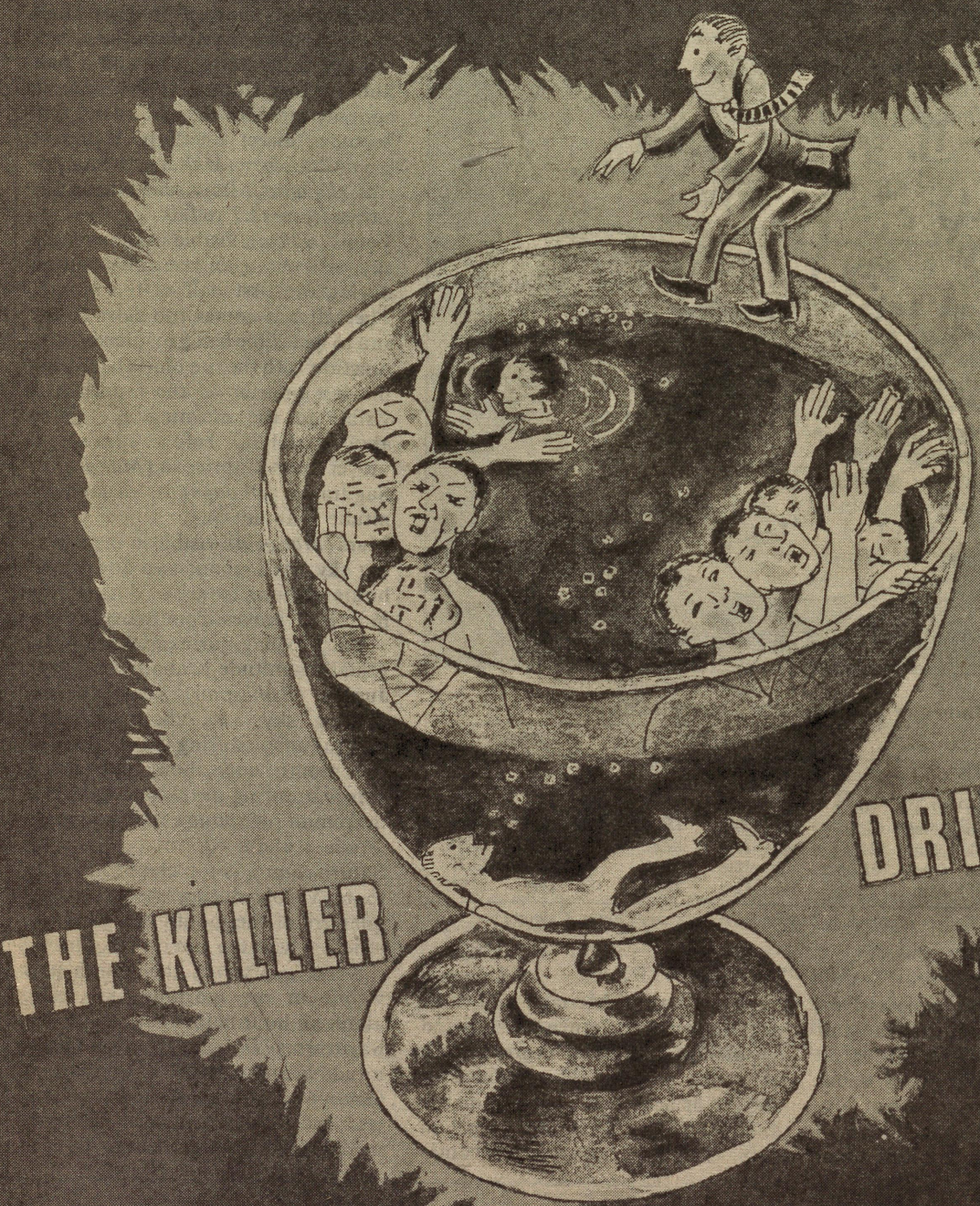
Jupiter *(Brihaspati),* visible in the evening sky, sets about an hour before sunrise during the first half of the month and about two hours before it during the second half. It is in Gemini *(Mithuna).* Its visual magnitude is about −2.7.

Saturn *(Sani),* is too close to the sun to be visible during the first three quarters of the month being in conjunction with the sun on 7th. During the last quarter of the month it is visible in the morning sky rising about an hour before sunrise. It is in Sagittarius *(Dhanus).* Its visual magnitude is about +0.6.

(*Source:* Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta-700 053)

Often considered a status symbol, alcohol not only ruins the health of the addict, it also wrecks families

K.C. KANWAR
ANJALI TICKOO
JYOTIKA KANWAR



THE KILLER DRINK

ALCOHOL in general comprises a large number of colourless, organic liquids, all of which are toxic to varying degrees. But the term 'alcohol' usually refers to ethyl alcohol or ethanol which is somewhat less poisonous than other alcohols and is the sole active ingredient of all the alcoholic drinks. The excessive consumption of alcohol gives rise to alcoholism.

Alcoholism and alcoholics both constitute a grave social problem. In the USA alone, with population less than 1/5 of ours, between 5 and 6 million persons suffer from alcoholism. The problem is no less serious in India. Indian studies have shown that the percentage of college or university students drinking now is surprisingly higher than it was 5-10 years ago. Alcoholism alone, and in conjunction with other drugs of the day, is threatening virtually all campuses of the Indian universities. Since alcoholics are generally adults with families, many more people are affected than the total number of alcoholics. The social and economic costs of alcoholism are therefore staggering. Millions of working hours are wasted. Money spent in drinking bouts, in accidental injuries and damages, and in hospitalization and treatment of alcoholics is tremendous indeed. Further, alcoholism is one of the major causes of traffic accidents costing thousands of lives and incapacitating many more who survive.

Alcoholics affect society in many other ways too. Thousands of children with congenital abnormalities are born to alcoholic parents; women drinking during pregnancy contribute significantly towards congenital abnormalities. Children of alcoholic patients suffer psychological and even behavioural disorders. Alcoholics are prone to suicide, homicide, accidental death and injury, varied chronic diseases, and to lowered productivity in their respective places of work.

Alcoholics never realize that alcoholism is a disease which needs treatment. They rarely seek medical help voluntarily. But thanks to modern research, our understanding of alcohol-related diseases and our capacity of coping with them effectively is far better now than before. At present, there exists an international awakening to combat alcoholism—a debilitating multidimensional global scourge.

Alcohol undoubtedly brings a lot of money into the government coffers, but alcohol-related problems take away much more. Nations pay incalculable cost by way of lost productivity, in health and medical expenses, and deaths and injuries in alcohol-related traffic accidents and accompanying monetary compensation, etc. Rehabilitation of broken families and abused children also have social costs.

How much alcohol is enough? What is a 'sensible' limit of drinking and how much is 'too much'. What do we mean by one standard drink. There are no clear-cut answers to these questions. According to Health Education Council, London, one standard drink means 'a half pint of beer or lager, a single measure of spirits (whisky, gin, rum, vodka), or a glass of sherry—each contains roughly the same amount of alcohol providing 180 blank calories.

The limits of 'safe' drinking varies with individuals and are primarily related with their weights. Further, men and women, because of overall difference in the water content in their bodies, are differentially sensitive to alcohol. The water content of the male body approximates 55%-65% of the body weight, while in women it ranges between 45%-55% of the total body weight. Thus alcohol when consumed gets more diluted in men than in women. Further, in general, a person who is heavier can metabolize alcohol faster than a person who weighs less. Women in general weigh less than men and this is another factor why women are more susceptible to alcohol. Even if a woman weighs exactly the same as a man, the same amount of alcohol would make her more tipsy and for a longer time.

Even when alcohol intake is moderate, caution is warranted. One or two standard alcoholic drinks a day perhaps do not pose any serious health hazard, but certainly they are not nutritionally essential or even psychologically or physiologically advantageous, except adding a few calories. Even here caution is warranted. Most drinkers are unaware of the fact that alcohol is harmful in many conditions like epilepsy, liver disorders and ulceration of stomach or duodenum. Further, it is risky to take alcohol with sedatives. Tranquilizers and antihistamines marijuana, barbiturates and other sleeping pills when consumed with alcohol form a dangerous combination. Use of alcohol as restorative tonic for heatstroke is also dangerous.

The level of alcohol tolerance varies from individual to individual, but immediate intoxication is experienced by one and all who takes it in excess, whether or not one is a habitual drinker. The severity of symptoms, however, depends on the individual threshold and amount of alcohol circulating in the system. The symptoms range from unsteady walk and impairment of mental processes to complete loss of muscular coordination and complete mental blackout or coma. Extreme and heavy alcohol poisoning may even lead to death. The symptoms gradually disappear as the alcohol is slowly metabolised in the body whereafter hangover follows.

Compulsive use of alcohol over a period of time leads to many complications including personality disorder. The habitual drinkers with passage of time become increasingly suspicious and resentful. In chronic alcoholics, there is loss of appetite, even leading to malnutrition, especially vitamin deficiency. General health declines. They become prone to many diseases. Gradual abstinence from alcohol can reverse these symptoms but only to some extent.

Causes of alcoholism

Even though indictment of alcoholism as a pernicious life-threatening disease has come only in the past 20-25 years, its destructive potentialities have been known to mankind for centuries. Alcoholism is rightly considered a serious threat to health, social status and harmonious family

Tobacco and drinks—the deadly duo

life. It is established that about over 10% of the casual alcohol takers become addicts and end up as alcoholics. A person who experiences personality changes after only a drink or two, or one who becomes aggressive or exceedingly argumentative, or perhaps boisterous soon after moderate drinking are more prone to alcohol addiction.

Some authors consider alcoholism as a mental disorder. Psychiatric imbalances, if not actual psychiatric disease, characterize many alcoholic victims.

The basic probiems with all alcoholics is the irresistible tendency to drink more and more till they become compulsive drinkers. Cutting down consumption in such addicts becomes increasingly difficult, and in many cases impossible without outside help. Compulsive alcoholics drink excessively and frequently even at odd times. On the top of it, such persons vehemently rationalize and defend their aberrant behaviour. A person who is nervous and finds difficulty in adjusting to life falls easy prey to alcoholism.

Alcoholics never realize that alcoholism is a disease which needs treatment. They rarely seek medical help voluntarily for their rehabilitation. Society must consider alcoholism as a disease rather than a sin. Alcoholics deserve sympathy rather apathy.

How alcohol affects the body

Alcohol is a food like sugar, providing only calories and nothing else. The absorption of alcohol in the gastrointestinal (GI) tract is rapid and starts as soon as it is gulped. Alcohol taken during or after a meal is absorbed more slowly than when taken on empty stomach. Blood soon carries alcohol from GI tract through liver to other organs.

A person becomes intoxicated when alcoholic content of blood is about 0.1 per cent of the total blood. Beyond this limit, alcohol acts as anaesthetic agent adversely affecting perception and also seriously impairing other faculties, especially the thinking ability. The movements appear clumsy and the reflexes are slowed—ability to react quickly is lost thus rendering driving in such states hazardous. Alcohol concentration higher than 80 mg/100 ml in blood is considered unsafe for driving. Still higher alcohol intake causes nausea and vomiting. Hangover

symptoms comprise headache, stomach upsets and overall fatigue.

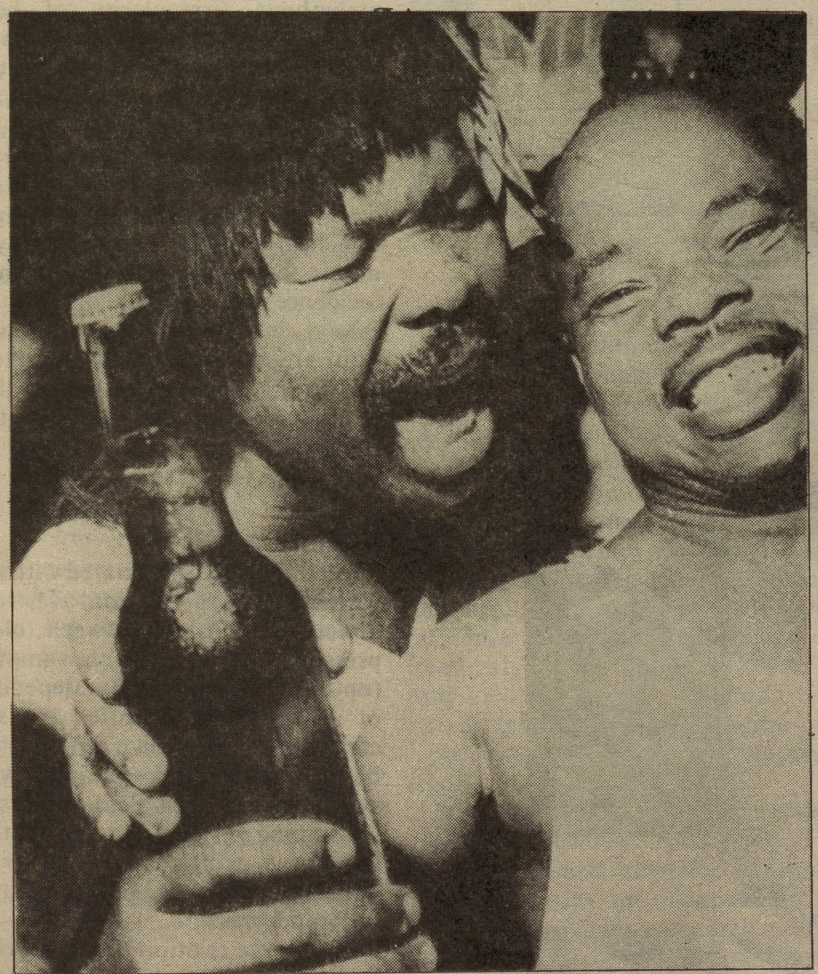
Biomedical consequence

Alcohol is as addictive as narcotics, but it can be obtained legally and without difficulty by any adult. However, this in no way alters the seriousness of its side-effects. Mortality rates for alcoholics today are higher than before. Males outnumber females in the use and abuse of this beverage.

Alcohol related problems are global but these do not receive adequate attention, not even in the developed countries. In USA, cancer costs society less than alcoholism, yet cancer research receives about 40 times more money. This perhaps is the overall scenario in other countries too.

The consumption of alcoholic beverages has long been associated with merriment. But in fact alcohol is hardly a stimulant; it acts more as an anesthetic like ether or chloroform. One of the first areas of the body to show the depressing effect of alcohol is the first portion of the brain which caters to the centres that govern self-control and finer judgements. As these faculties are dulled, the drinker feels liberated, free of societal and moral constraints. The efficiency of the central nervous system as a whole is impaired.

As the level of alcohol in blood rises further, coordination diminishes as manifested in clumsy walking. Still further rise of alcohol in blood leads to slurred and incoherent speech, and blurring of vision as a result of impaired focussing. With more and more alcohol pumped into the system, the impulse to continue drinking becomes increasingly stronger. Finally when alcohol level in the blood rises still higher, vital brain centres are affected which impair life-sustaining functions such as breathing and other reflex actions.



The alcoholic lift provides only a temporary rosy glow to life. The side effects of alcohol are serious indeed

It is true that habitual drinkers apparently develop increasing tolerance. Physiologically speaking, it means that they need to drink more to get the same degree of 'kick'; however tolerance does not mean that they are immune to alcohol damage. With heavy and regular alcohol use, a vicious circle sets in and there probably occurs a change in the basal metabolism of the brain cells which now become dependent on alcohol in order to function optimally. This leads to frightening withdrawal symptoms which comprise nervousness, delirium and even hallucination experienced by the drunkard who otherwise is sobering up.

Alcohol, even otherwise, is a highly reactive compound and its continuous presence in the body fluids damages other body tissues and organs. Medical consequences of alcohol are, therefore, many and diverse. All biological systems are affected by alcohol though to varying degrees. Here, only a few systems or organs which bear the brunt of alcoholic onslaught are discussed.

Liver cells break down alcohol but are gradually yet irreversibly damaged in the process because of alcoholic insult. Cirrhosis amongst alcoholics and its relation to the volume of alcohol abuse is well established. Even otherwise, liver impairments of varied types (fatty liver, alcoholic hepatitis, hepatic iron storage disease) are significantly higher amongst alcoholics. Pancreas, like liver, is also severly impaired by both chronic and acute alcohol administration. Pancreatitis is one of the more frequent causes for hospitalization in alcoholics following bouts of drinking. Alcoholic pancreatitis which is accompanied by severe pain makes the patient 'as uncomfortable as any patient in medicine'. Superimposed on the abdominal pain is often copious vomiting and malodorous diarrhoea. Progress in the understanding of alcoholic pancreatitis,

specially its pathogenesis, has so far been tardy and so is its management.

Cardiovascular disorders

In healthy humans, 2 to 5 ordinary alcoholic drinks (35 ml-75 ml alcohol), taken daily and at a stretch, result in increased heart-beat, raised blood pressure (more so systolic than diastolic) and increased cardiac output. However, following severe intoxication, these effects are reversed; the dull nervous system is believed to cause low blood pressure, slow heart rate and ultimately, though rarely, fatal cardiac arrest. Blood pressure elevation in heavy drinkers reportedly occurs because of alcohol withdrawal rather than direct action of alcohol.

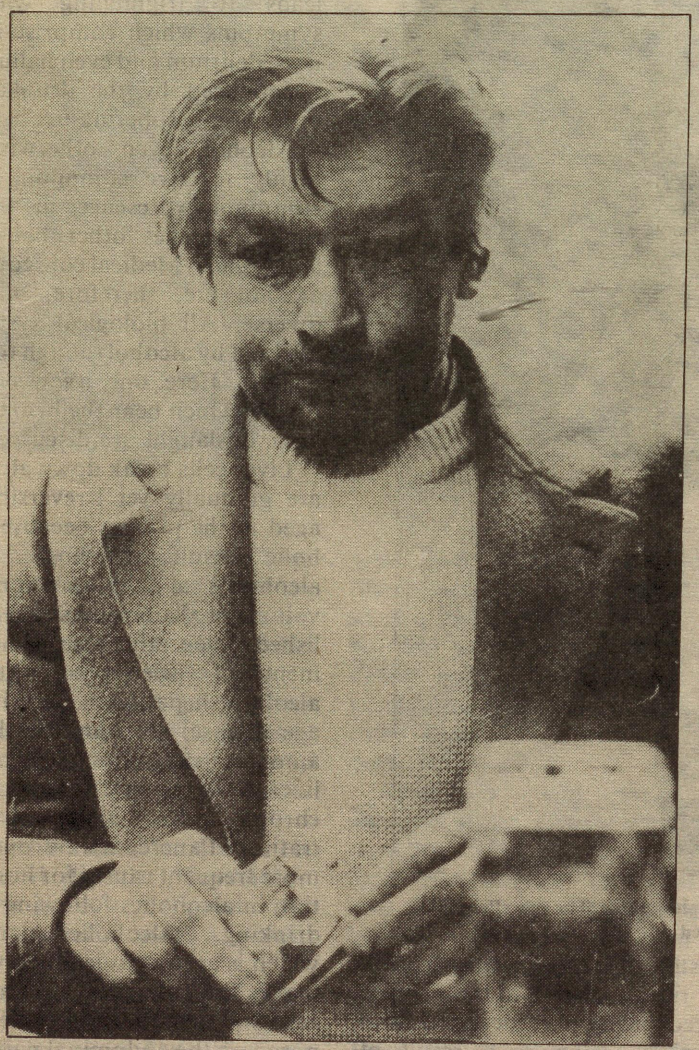
Data to date on how alcohol affects coronary circulation are inconsistent. Generally speaking, it is believed that mild to severe alcoholic intoxication impairs heart muscle pumping action (myocardial contractility). Heart muscles tend to accumulate fat and suffer depleted activities of enzymes particularly of oxidative metabolism. The changes in heart muscles following chronic alcohol exposure are similar to cardiomyopathy among non-users.

Primary myocardial diseases

Relationship between chronic excessive alcohol use and heart muscle failure is well accepted and sufficiently established. Cardiomyopathy cases comprise about 2%-3% of patients hospitalized for heart disease, and out of these some estimates suggest that over 80% are heavy drinkers. It is estimated that 80g of ethanol a day (= 6 standard drinks) over a period of years is required to produce cardiomyopathy experimentally. However, it is believed that even smaller doses for longer periods produce the same effect. Alcoholic cardiomyopathy seems to subside in many cases when alcohol is discontinued.

Heavy drinking induces cardiac arrhythmia (irregularity of heart beat). It is possible to induce experimentally tachycardia (rapid beating of heart) in experimental animals following alcohol ingestion.

The clinical picture of a heavy alcoholic is a person with chronically weakened and dilated heart. Congestive heart failure, chronic arrhythmia, abnormal ECG and high incidence of embolic complication (blood clots obstructing the circulation) are characteristics of alcoholic addicts. These developments in alcoholics do not attract medical attention before irreparable damage has occurred.



Alcohol, like other drugs, leads to many complications including personality disorders. Compulsive use of alcohol over the years turns a debonair into a haggard (Photographs courtesy. ***World Health,*** **June 1986 & June 1989 issues)**

Hypertension

Alcohol is also associated with prevalence of hypertension. There is direct relationship between blood pressure and alcohol consumption (upto 6-8 drinks a day) independent of smoking, use of coffee and salt, etc., which in their own right push up blood pressure and seemingly work synergistically with alcohol. Persons consuming on an average less than one or two drinks daily, however, do not show any apparent adverse effect on blood pressure.

A positive relation between drinking and incidence of stroke has been reported. The relationship is stronger for hemorrhagic than thrombolic strokes. A bleeding tendency due to alcohol has been implicated as a possible additional explanation.

Substantial alcohol use has been reported to be associated with a higher incidence of conditions such as phlebitis and varicose vein.

Effect on male hormone

Numerous studies show that acutely or chronically administered alcohol lowers levels of serum testosterone—the hormone which regulates male libido or sexual urge in the males of all species including man—thus jeopardising masculinity. Heavy alcoholic males invariably show varying degrees of impotence, loss of libido accompanied by testicular atrophy, and varied clinical symptoms of hypogonadium and even feminization as manifested by breast enlargement and loss of facial hair as a result of diminished testosterone levels.

It is well documented that testosterone degradation is enhanced in chronic alcoholics primarily because of increased synthesis of the liver enzyme called 5-alpha reductase which destroys the hormone by converting it into dihydrotestosterone. There is evidence to show that prolonged administration of alcohol to males causes their estrogen (female sex hormone) levels to rise and that this increase correlates with an increase in the level of liver enzyme called hepatic aromatase which is involved in the conversion of androgens to estrogens. Further, amongst male alcoholics, there is an increased rate of conversion of testosterone and androstenedione to their respective estrogens. It is suggested that signs of feminization in male chronic alcoholics are due to simultaneous reduction in androgens and increase in estrogens.

Acute or chronic alcohol administration also depresses testosterone synthesis in the testes. Effect of alcohol on male reproductive performance has been found by a few to be biphasic—low doses increased testosterone levels and high doses depressed them.

Alcohol taken in moderation is widely believed to be mildly aphrodisiac inasmuch as the 'shy man' may, under the influence of alcohol seemingly perform better sexually because his inhibition, has fear and his scruples are significantly lessened. This is temporarily manifested in sexual vigour which in fact is the expression of failing and falling masculinity.

Drink clean water. It is better and safer than drinking alcohol

Even protagonists who recommend alcohol for restoration of masculinity admit that over-indulgence in alcohol leads to failing sexual performance by the male which might finally lead to chronic impotence and occasionally sexual perversion superimposed upon the general physiological and mental disintegration. Even otherwise, in addition to testicular atrophy, a significantly higher incidence of sperm abnormalities are frequently encountered in chronically alcoholic men who in addition also suffer loss of libido, failure of erection, ejaculation and copulatory vigour.

Depleted testosterone synthesis amongst alcoholics is said to be related with the direct action on testis of acetaldehyde—the metabolic product of ethanol and not ethanol itself. But this is hardly comforting. After all, the damage is there whether due to alcohol or its metabolic product.

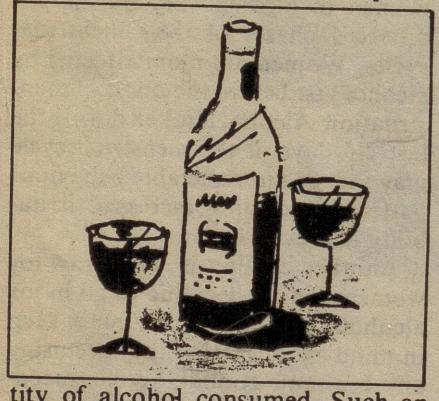
Alcoholic women are at a slightly higher risk of varied alcohol-related physiological consequences. Alcohol concentration in a woman's blood rises quickly and stays higher for a longer period, even if she drinks the same amount as a man of the same weight range. Further, responses of women to alcohol vary during the different phases of their menstrual cycles. Women are more affected by alcohol just before the onset of menstruation. Alcohol if taken during the last 2-3 days of the menstrual cycle may induce unpredictable behaviour patterns, including increased irritability and even violence.

Another caution is warranted for women. Before deciding to go in for alcoholic beverages, they must keep in mind as to whether they are using any hormone containing contraceptive pills. Such pills have a high estrogen content, and estrogen is known to interfere with alcohol metabolism.

Alcohol and cancer

Epidemiological studies have established the role of alcohol in the etiology of cancer. Heavy alcohol consumption has been related to an increased risk of cancer at various sites in the human body, particularly malignancies involving the mouth, pharynx, larynx, oesophagus and other points of the gastrointestinal tract as well as liver. In USA, a broad-based survery in 1977 revealed a significant positive association between alcohol intake and cancer of oral cavity as against a less striking

positive association between alcohol and cancer of esophagus, stomach, colon, liver, breast, thyroid gland and malignant melanoma. Alcohol-related cancers of the upper digestive tract occur with greater frequency in men than in women. Further, alcohol and tobacco work synergistically in the pathogenesis of cancer of the upper digestive tract. About 550 men and 100 women with oral cavity cancers were interviewed and it was discovered that consumption of alcohol, specially whisky, was an important factor and that smoking played a synergistic role, i.e., when both habits are combined the risk is significantly higher than for either alone. A study was done again in USA on 3716 cancer patients for possible synergisism between tobacco and alcohol usage in the causation of cancers. In this survey, dose response relationship for liquor at constant tobacco usage in both men and women was achieved, indicating that risk for each type of cancer increased with quantity of alcohol consumed. Such an increase in risk with alcohol consumption was not observed among non-smokers. However, alcohol and tobacco are not the only factors involved in cancers of upper respiratory and digestive tracts. The major effect of alcohol in the pathogenesis of mouth and larynx cancers seems to be associated with nutritional deficiencies. Iron deficiency invites these cancers even in the absence of smoking and drinking.



Association between liver cancer and alcohol consumption is related to cirrhosis because liver cancer very often is accompanied and preceded by cirrhosis or hepatic infection. Although primary liver cancer is rare in the western countries, it is one of the most common malignancies in Asia, Africa and Latin America. Modus operandi of alcohol in the causation of liver cancer is different from that of the direct action suspected in cancer of respiratory and digestive tracts.

In liver, alcohol seems to act like other liver-damaging agents. Alcoholic liver injury has a deleterious effect on liver cell organelles including impairment of mitochondrial function. Higher intake of alcohol in association with liver disease and malnutrition seem to work synergistically.

Alcoholic patients with cancer have poorer chances of survival and greater chances of developing other primary tumors than do other patients with the same cancer. This is specially true of the cancer of the upper regions of GI tract, larynx and lungs. Such a tendency is enhanced significantly if patients had been heavy tobacco and alcohol addicts before the first cancer appeared.

Teratogenic effects

Birth defects and predominance of mental retardation among children of alcoholic women have led to intensive researches to determine possible relationship between such defects and the consumption of alcoholic beverages by pregnant women. There is established relationship between maternal drinking during pregnancy and an increased risk of poor pregnancy outcome i.e., increased risk of miscarriages and giving birth to underweight and deformed babies.

The greatest harm a woman can do by consuming alcohol is not to herself but to her yet unborn child. If the mother is on a drinking spree, the fetus too is subject to the same alcohol concentration as of the mother. If the mother is tipsy, her unborn boby becomes tipsy too. Elimination of alcohol from the body in the fetus is much slower than in the mother because of lower concentration of alcohol-metabolizing enzymes in the developing liver of the fetus. A fetus subjected to heavy alcohol concentration is likely to develop into a baby born with a small head, limb abnormalities, facial irregularities, heart and genital defects and abnormal growth of blood vessels. Offspring of alcoholic mothers may be at risk of lower birth-weight, lower intelligence, learning defects, and cardiac defects. Increased incidence of still-births and infant deaths has been documented amongst alcoholics. Alcoholics are more likely to be smokers, use caffeine and other drugs, exhibit malnutrition and lead a life-style distinct from the non-alcoholic population. Any of these factors could also affect pregnancy complications, but undoubtedly alcohol is the main culprit.

Epidemiological data point to an alcohol-related incidence of congenital birth defects, birth anomalies and altered development. Twice as many infants born to heavy drinking women were found to be abnormal compared with infants born to women who drink rarely or moderately. It has been reported that 32% of infants born to heavy drinkers had congenital abnormalities compared with 14% in the moderate drinkers and 9% in the abstinents. The best advice to women is to avoid alcohol totally during pregnancy and if this is not possible, better do not get pregnant at all.

Further reading

1. Editors: Frank A. Seixas, Kenneth, Williams and Suzie Eggleston, *Medical Consequences of Alcohol* Annals New York Academy of Sciences, Volume 252, pp. 5-399 (1975).
2. Editor, John R. DeLuca (Ed.) *Alcohol and Health*, DHHS Publication No. (ADM) 81-1080; U.S. Department of Health & Human Services, National Institute in Alcohol Abuse & Alcoholism (1981).
3. *Alcoholism: Disease of Denial.* University of Cape Town Summer School, Printed by Board of Extra Mural Studies, University of Cape Town (1977).
4. *Alcohol and Alcoholism* R. Popham (Ed.), University of Toronto Press, Toronto (1970).

Sh. Kanwar and Ms. Anjali Tickoo are with the Deptt. of Biophysics, Punjab University, Chandigarh; Ms. Jyotika Kanwar is with Christian Medical College, Ludhiana.

In the World of BASIC-IV

IN the earlier part, it was seen that when an appropriate print command was given the result was printed out as soon as the Return was pressed. But that is not the sole purpose of a computer. It should be able to handle a series of input statements and finally process them.

There is no difficulty here as a computer has been structured to operate under two modes: (1) Prompt Mode and (2) Program Mode. When a single print statement is given, the computer is in prompt mode. In a program mode, the computer will accept all the input statements and wait patiently for the program to be executed. This is achieved easily by numbering each statement and giving a particular command called RUN when one wants to execute the program.

NEW, CLS, END COMMAND

Before taking up a program there are some preliminary steps that need to be learnt. As a first step, bring the cursor to the left corner (it may be on any line) and type:

NEW

Then press Return and the word OK will appear below. The command NEW tells the computer that a new program is being fed and any old program must be cleared (in fact, it clears from RAM). This is necessary as a new program may overlap with an old one. Even when you are starting a fresh program it is better to type NEW and proceed. However, some computers have the facility to retrieve the previous program by typing OLD even after NEW is executed.

When the screen gets cluttered with various things, bring the cursor again to the left and type:

CLS

On pressing Return, the screen gets cleared, and once again OK comes. The word CLS means CLEAR SCREEN. These and other commands discussed here can also be given by pressing the function keys but there are some differences. It is preferable to give the command in the above manner.

How to run a program

To run a program, the different commands or statements have to be given numbers. Though these are statement numbers they are called "line numbers" in BASIC as in BASIC each statement has to be numbered. Take a simple program and do it step-by-step. First type CLS, press Return and then type NEW and again press Return. Type out the three lines as indicated below:

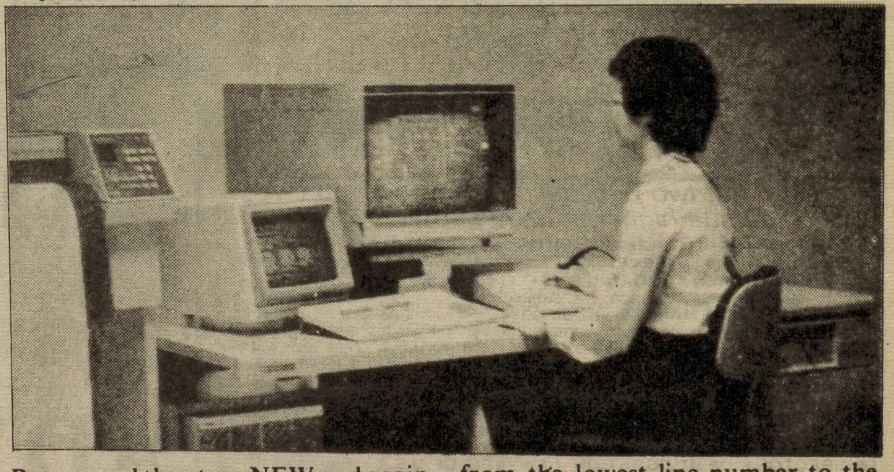
```
30 PRINT "HALLO!"
80 PRINT "THIS IS MY
   COMPUTER"
150 END
```

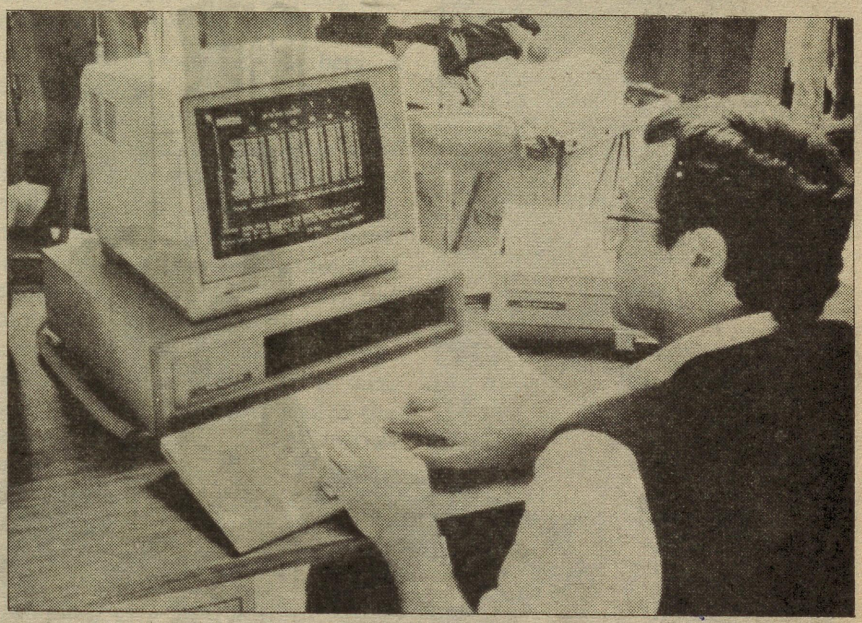
After typing these statements, press Return or Enter so that what is typed enters memory. Leaving a space after line number is not a must but is a good programming practice. Now even if Return is pressed, nothing will happen (only the cursor will come down). This is because it is still in the program mode and it is waiting for further commands. After completing all the statements either press a knob marked 'RUN' and press Return or type RUN and press Return. The following message will appear:

```
HALLO!
THIS IS MY COMPUTER
OK
```

Have a look at the program. The numeral appearing in the beginning is called line number and what follows it is the command. Three lines have been typed: in line 30, the command is to print HALLO!; in line 80 the command is to print "THIS IS MY COMPUTER"; finally, in line 150, the command is END.

When the command RUN is issued, the computer sorts out the program and executes it sequentially. In short, the program is executed from the lowest line number to the highest one till the END statement is reached. The statement END tells the computer that it need not proceed further. Why the line numbers have been given as 30, 80 and 150 and not 1, 2, 3 is that when a program is written, it is better to leave blank lines in between. It may become necessary to insert some statements afterwards and this is possible only if blanks are provided. The usual practice is to give line numbers as 10, 20 and so on. In this example line numbers have been deliberately given as 30, 80 and 150 since some additional lines are proposed to be inserted.





The END command enumerated above is very important. It is possible to have several END statements in the same program but each time an END statement is encountered the program will stop.

Various print commands

As soon as the above program is run, type three additional lines as shown:

```
100 PRINT "HOW DO YOU
LIKE IT?"
120 PRINT "WOULD YOU
LIKE"
130 PRINT "TO USE IT?"
```

On typing RUN and pressing Return, the following will appear:

```
HALLO!
THIS IS MY COMPUTER
HOW DO YOU LIKE IT?
WOULD YOU LIKE
TO USE IT?
```

Firstly, it can be seen that the computer is still remembering the old program; secondly, the new lines have been incorporated even though the program has been run once; thirdly, a sentence has been broken into two parts in lines 120 and 130, and the computer has faithfully broken it in the same way.

Retype lines 100, 120 and 130 as indicated below:

```
100 PRINT "I PURCHASED
IT TODAY"
120 PRINT "IT COST ME
Rs 25,000/ONLY
130 PRINT "LIKE TO USE IT?
```

On running the program, the screen will now display:

```
HALLO!
THIS IS MY COMPUTER
I PURCHASED IT TODAY
IT COST ME Rs 25,000/ONLY
LIKE TO USE IT?
```

It can be seen that what is typed in lines 100, 120 and 130 have replaced the previous contents. When something is typed again using the same line number, the computer throws out the old contents and stores the new ones. In other words, any line can be altered merely by retyping something using the same line number.

At this stage a small trick is introduced; retype lines 120 and 130 as follows:

```
120 PRINT "WOULD YOU LIKE";
130 PRINT "TO USE IT?"
```

On running the program, the text on lines 120 and 130 combine and appear on the same line as:

WOULD YOU LIKE TO USE IT?

In other words, when a semi-colon is given at the end of a print statement, the text appearing on the subsequent line is carried as a continuation on the same line. Before proceeding further restore lines 120 and 130 as originally written without a semi-colon on line 120.

CLS, blank lines

By now, the screen must have got cluttered and the lines may appear too close. Type the following three lines.

```
20 CLS
40 PRINT
110 PRINT
```

When the program is now run, the screen clears itself and two blank lines are introduced, one after HALLO! and the other after I PURCHASED IT TODAY. The statement in line 20 asks the screen to be cleared and in lines 40 and 110 the command PRINT is not followed by any message. As far as the computer is concerned, a Print command has been given and when the computer reaches that line, it searches for the contents but unable to find any leaves a blank line. This is a very good device for providing blank lines wherever required.

REM statement

What is now required to complete the program is an additional statement called REMARK statement. This is abbreviated as REM. Here a suitable name is given to the program. The important point about an REM statement is that, it is not taken into account when the program is executed. Usually, the REM statement is the first statement in any program. So type an additional line 10:

```
10 REM FIRST PROGRAM
```

Now you may run the computer and see for yourself that this will not alter the output. More than one Remark statement can be given. In fact, it is advisable to give as many Remark statements as possible.

(Continued on page 558)

ELECTRON MICROSCOPE TURNS 50

A.V. MOHARIR

The extremely small-wavelengths of the electron beam used in an electron microscope has extended the limits of observation to sub-molecular levels

IN 1876, the emphatic and bold declaration of Ernst Abbe that light is a form of wave motion, whose half wavelength sets an impenetrable limit for resolution of any optical magnifier took the scientific world by surprise. Optimistic and eager microscope designers and manufacturers branded Ernst Abbe as a "Crazy fanatic" who wanted to put optical microscopy in fetters! The resolution limit set by Abbe's theory was equally nerve-breaking and disturbing to Abbe himself, as he immediately realised that such a limit would make it almost impossible to see the molecular and atomic phenomena in any kind of material under microscope. And most prophetically he wrote, "... perhaps in the future the human spirit may succeed in using some processes and some forces which will allow man through utterly different ways to overcome the limits which now seem to us impassable. That is my opinion. But I believe that the instruments that will assist our senses some day, with more efficiency than the present day microscopes, to explore the ultimate elements of the physical world, will have nothing in common with them but their name". Later events proved that Abbe was right and realization of structures beyond optical microscope resolution limit became only possible when three discoveries in physical sciences were announced: (i) wave particle the aspects of nature of electrons (matter waves) by Louise de Broglie of France in 1924, purely on theoretical considerations; (ii) focussing lens effect of electrostatic and electromagnetic fields with rotational-symmetry on an electron beam by H. Busch in Germany in 1926; and (iii) experimental demonstration of the wave-particle nature of electrons like that of visible light, independently by G.P. Thompson in England and by C.J. Davisson and L.H. Germer in

the U.S.A. in 1927. Interestingly, neither Louise de Broglie nor H. Busch or others indicated the slightest possibility of improving microscopy by replacing a light beam with very short-wavelength matter waves.

The real developments in the field known as 'Electron Optics' started in the third decade of the 20th century in Germany. They culminated in the development of a first ever two-stage magnifying electron microscope on April 7, 1931 as an extrapolation of research on cathode ray oscillography by Max Knoll and Ernst Ruska. It was shown to the public on June 4, 1931 in a lecture at the Crantz Colloquim of the Technical University, Berlin. The manuscript of this lecture dated June 3, 1931 is a historically preserved document in view of the famous Rudenberg patents controversy.

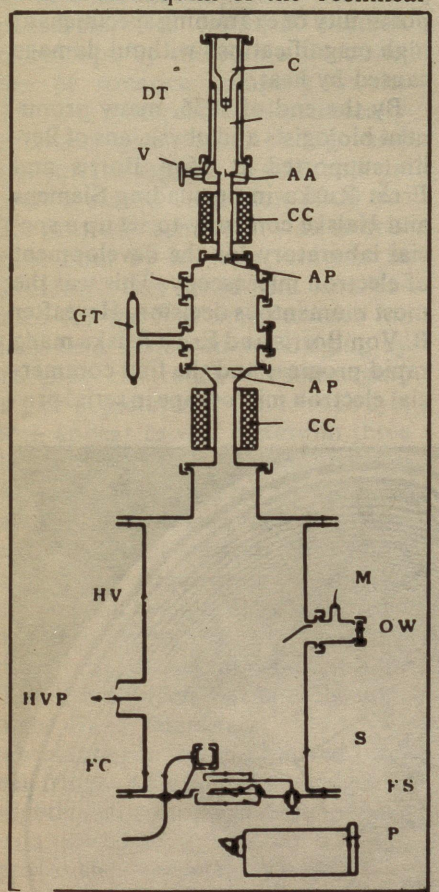


Fig. 1. Schematic diagram of the first two stage electron optical apparatus set up by Max Knoll and Ernst Ruska. AA-Anode aperture, AP- Aperture, C-Cathode, DT-Gas discharge tube, CC-Concentration coil, FC-Faraday cage for measurement of electron beam current, FS-Fluorescent screen (Glass plate for observation of the image), HV-Region of high vacuum, HVP-Pipe connection to high vacuum pump, M-Manifold connection to vacuum gauge, OW-Observation window, P-Photographic apparatus, S-Observation screen, V-Air inlet valve

In patent laws R. Rudenberg, a contemporary of Ernst Ruska in Germany, is frequently described as the inventor of electron microscope as he was the first to apply for a comprehensive patent covering certain design aspects of the instrument. However, it has now been established beyond doubt the R. Rudenberg did not at all contribute theoretically or experimentally towards the development of electron microscope! In fact, R. Rudenberg, though attended the lecture and subsequent demonstration of the instrument by Knoll and Ruska at the Crantz Colloquium, did not participate in the discussion that followed soon after. The curious history of the patents application of Rudenberg is very interesting and Max Knoll and Ernst Ruska had to wage a patient and agonizing battle for 22 long years before the original priority for the invention of electron microscope could be legally restored to them.

The schematic diagram of the two-stage electron optically magnifying instrument, the forerunner to all the electromagnetic type electron microscopes of today is shown in Fig 1. This equipment, though magnified images of thin metal grids only 17 times using electrons, established the basic principles of electron optics, and proved that axially symmetric electromagnetic fields of solenoids focus and defocus electrons as glass lenses do with visible light and that magnified images of specimen can indeed be made. However, unlike its optical counterpart, electron optical images can only be observed on fluorescent screens owing to insensitivity of human eye to electron matter waves and the damaging nature of accelerated electron beams. Later, circumstances forced Ernst Ruska to work alone on the electron microscope project and, drawing inspiration from the theoretical work of H. Busch, produced a much improved apparatus in 1933. He incorporated pole pieces which he had patented earlier in ironcored electromagnetic lenses. This equipment is shown in Fig. 2.

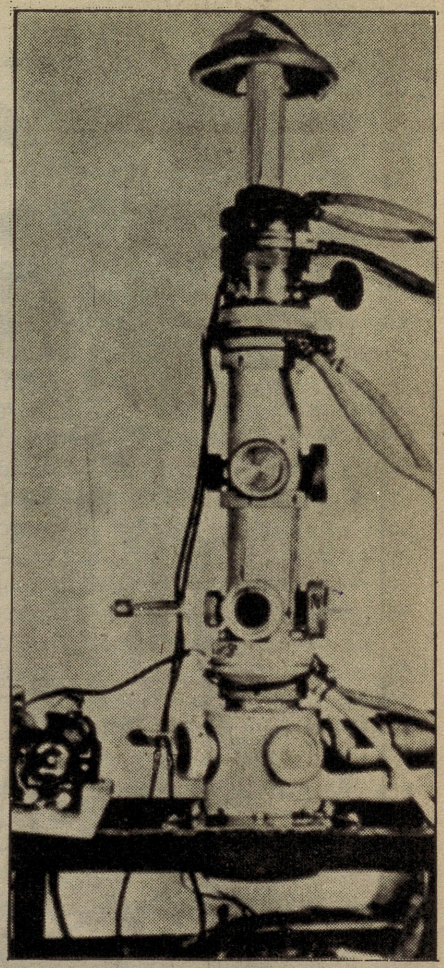


Fig. 2. The first electron microscope built by Ernst Ruska 1933 to surpass the optical microscope in resolving power

Elaborate experiments to test the applicability of Abbe's theory to electron optical image formation were conducted at the A.E.G. laboratories in Berlin. These efforts not only helped in obtaining information about the local crystalline state within a thin specimen but also demonstrated that the image formation in electron microscope indeed took place in accordance with Abbe's theory. In the meantime, Max Knoll and Ernst Ruska, assuming the validity of Abbe's theory on optical resolution to matter waves of electrons, unbelievably came up with a theoretical resolution limit of 22 A· (2.2 nm) for electron microscope, which could be practically achieved only forty years later.

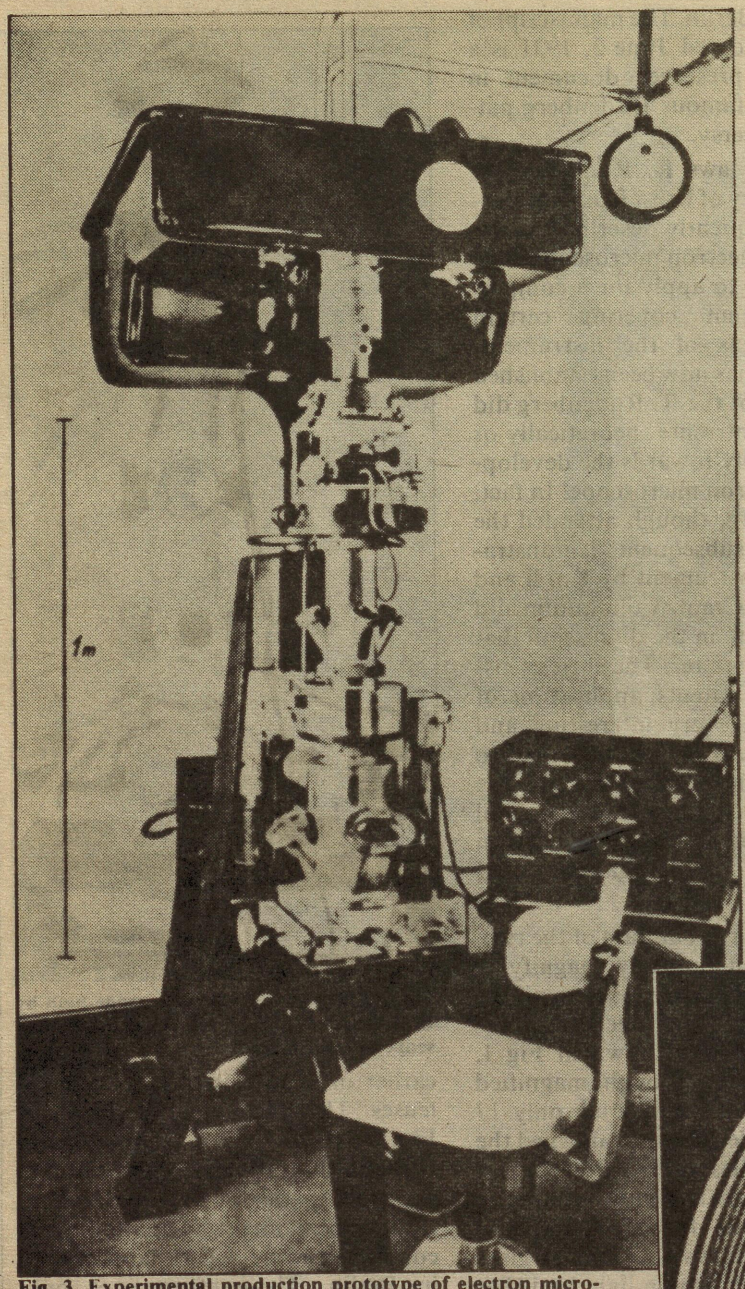


Fig. 3. Experimental production prototype of electron microscope built by B. Von Borris and Ernst Ruska at the Siemens, Berlin, in 1938

The prototype electron microscope of Ernst Ruska did not receive immediate financial support for its further development because of several reservations against it, particularly the damaging effect of electron heat on specimens. In 1935, the construction of the first specially ordered commercial electron microscope was undertaken. This instrument was subsequently installed in 1936 at the Imperial College, London.

During this period, Heinz Otto Muller and Friedrich Krause, using the instrument Ernst Ruska had built in 1933, obtained excellent electron micrographs of biological specimens that earned the confidence of microscopists and biologists in particular. Also, by now, much of the understanding was gained about the physical nature of electrons and the formation of images by them. And it was realised soon that image contrast could arise not only from absorption of the incident electron energy within the irradiated specimen but also from the differentially scattered transmitted electrons by the atoms constituting the specimen. This important point removed all doubts about the possibility of examining specimens at high magnifications without damage caused by heat.

By the end of 1936, many prominent biologists and physicians of Berlin supported B. Von Borris and Ernst Ruska in persuading Siemens and Halske company to set up a special laboratory for the development of electron microscopy. This was the most momentous decision. Hereafter B. Von Borris and Ernst Ruska made rapid progress and the first commercial electron microscope in serial pro-

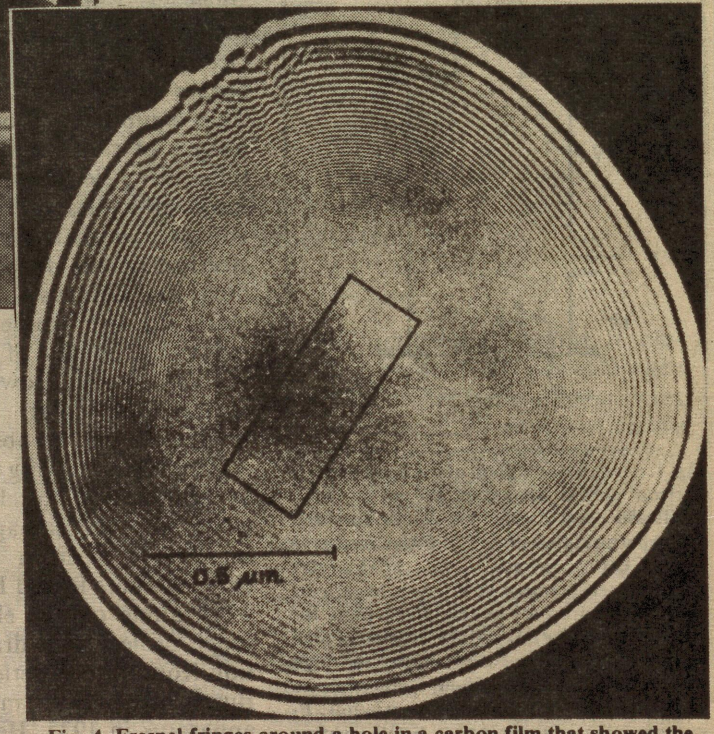
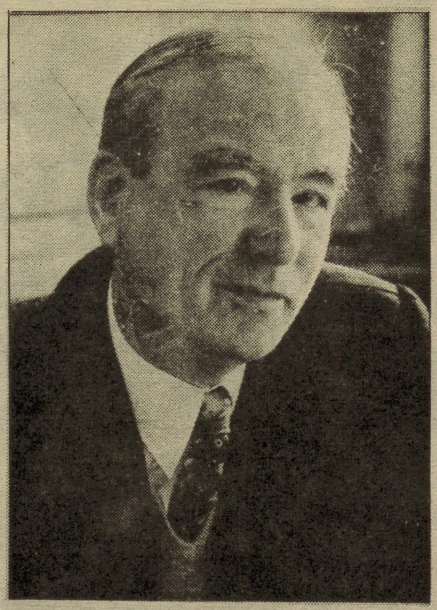


Fig. 4. Fresnel fringes around a hole in a carbon film that showed the analogous behaviour of electron waves to that or ordinary light

duction went into operation at the end of 1939 at Siemens and Halske (Fig. 3). The present year therefore marks the 50th anniversary year of the commercial beginning of electron microscopy and rightfully the starting point of the human foray into the vast, fathomless and unknown ocean of ultrastructure of matter of biological and material origin.

Developments in electron microscope design and instrumentation continued in Germany, France, Holland, Japan and the United States of America despite the outbreak of the Second World War. Most spectacular of these developments was the manufacture of model-B electron microscope by the Radio Corporation of America company in the U.S.A. It incorporated electronically stabilized acceleration voltage and lens current supplies in solenoids. In 1940, a record resolution of 30 Å (3.0 nm) was achieved by an instrument built by M. Von Ardenne in Germany. This instrument incorporated for the first time facilities for dark field illumination (imaging by scattered electrons), stereo-imaging (a pair of pictures shown to each eye; both appear as one picture in three dimensions), electron diffraction (focussed image of scattered electrons through a specimen), and two condenser lenses instead of only one, to strongly concentrate and reduce the electron beam probe size incident on specimen and improve illumination at higher magnifications on the fluorescent screen. At about the same time, Hans Boersch at the A.E.G. laboratories in Berlin observed Fresnel fringes (Fig. 4) at the edges of slightly defocussed images in the electron microscope and conclusively proved the close analogy between the wave nature of electrons (matter waves) and that of electromagnetic light radiation. Observation of these fringes has since become a part of the routine procedure adopted for the correction of astigmatism (an image aberration arising as a result of assymetry in the magnetic field of objective lens) in high resolution electron microscopes prior to observing specimens.



Ernst Ruska

With rapid advancements in design and instrumentation and ingenious developments in art and science of preparation of specimen of diverse origin for observation under electron microscope, the initial reservations and psychological inhibitions against electron microscopy changed quickly into respectful awe and admiration. However, the very physicists, who created the science of electron microscopy and strove to develop it theoretically and practically into a convenient, reliable and routine tool for the benefit of biologists, metallurgists, industrialists and others, were themselves disillusioned with the limited direct applicability of the instrument to problems in physics. The visual information in microscopic images barely satisfied the physicist's thirst for knowledge about composition and structure of specimens. This instead led them to extract more and more information from the interaction of an electron beam with a specimen. The last three decades have seen tremendous developments in instrumentation along these lines. As a result, the developments of the scanning electron microscope (SEM), the electron probe X-ray micro-analysers (in the form of energy dispersive and wavelength dispersive spectrometer systems) and of a range of cognate instruments and accessories that provide functional and structural information about a specimen have followed.

On the basis of the knowledge of interactions between the electron beam and specimen as illustrated in Fig. 5, a number of different ways (analytical modes as signals of var-

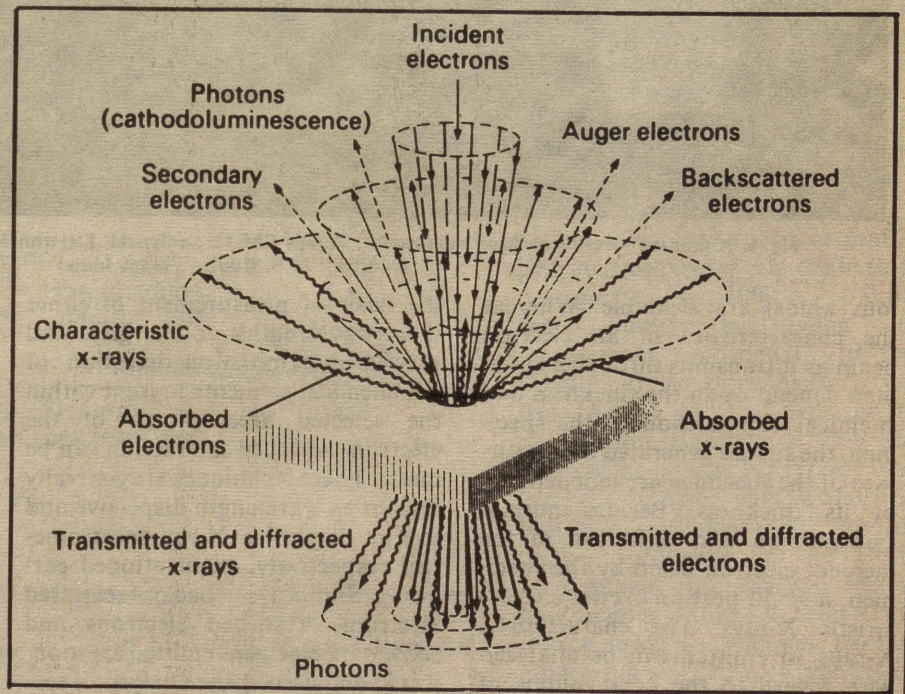


Fig. 5. Electron beam specimen interaction and emission of various modes of signals

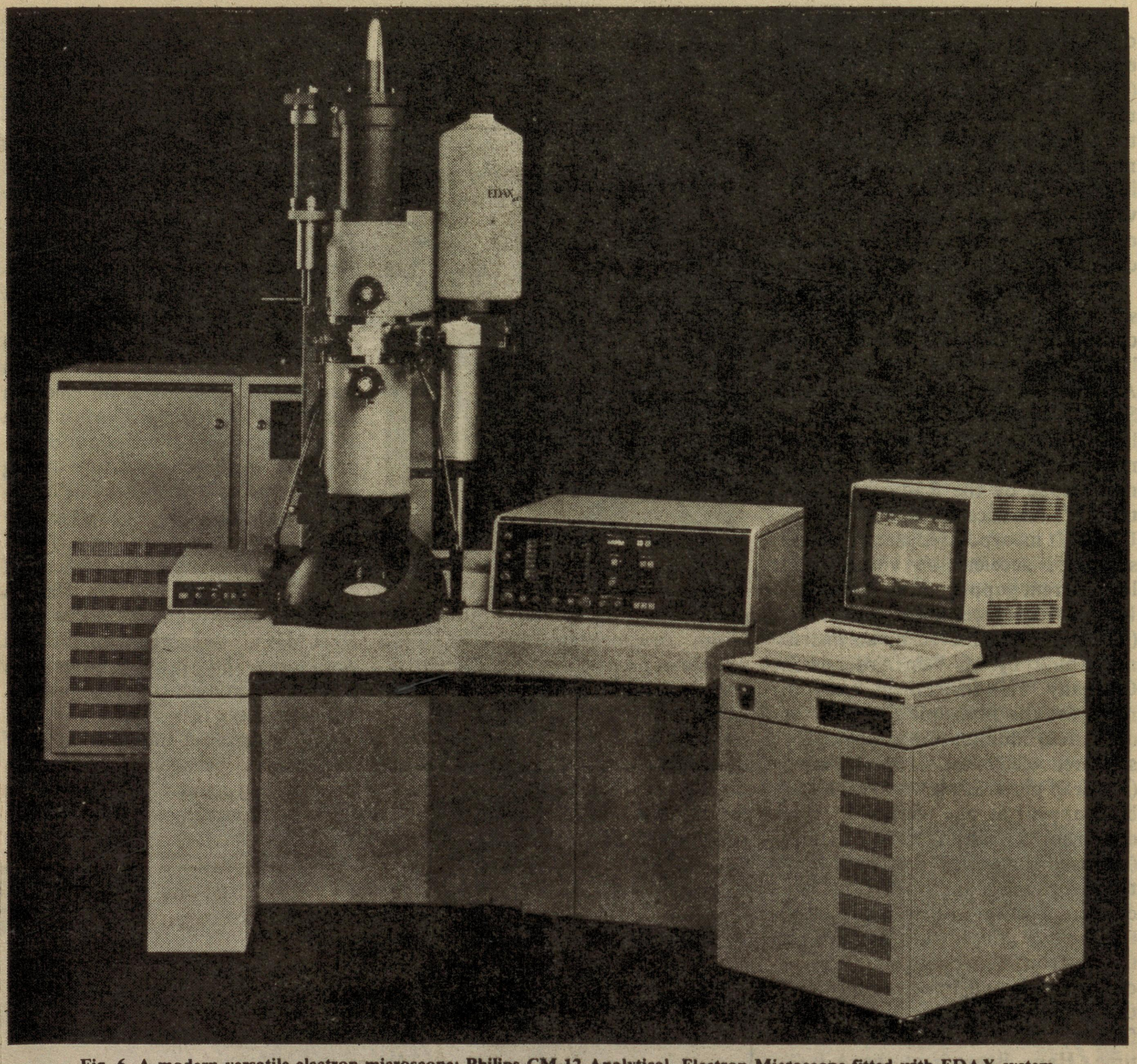


Fig. 6. A modern versatile electron microscope: Philips CM-12 Analytical Electron Microscope fitted with EDAX system (courtesy: M.S. Gupta, Philips India)

ious kinds) are available. Whereas the characteristics of an electron beam as it transmits through a specimen depend upon the thickness and chemical composition of the specimen, the signals generated on the surface of the specimen are independent of its thickness. Besides normal transmission and reflection of the incident electron beam by the specimen, a small portion excites characteristic X-rays. The characteristic X-rays so emitted can be analyzed with regard to the area/volume of their origin within the specimen on the basis of measurement of either their wavelengths or energies, and precise determination/detection of the chemical elements present within the selected area/volume of the electron-specimen interaction can be made. These techniques are generally known as wavelength dispersive and energy dispersive X-ray spectrometers respectively, as mentioned earlier. Similarly, back scattered electrons, absorbed electrons and secondary electrons emitted are monitored and used in the analysis of surface composition, charge and topography. The diffracted electrons, on the other hand, provide crystallographic and compositional information about the specimen.

A complimentary analytical tool to energy dispersive X-ray spectrometer with particularly high detection efficiency (Lithium through Chromium) within biological and non-biological materials has recently come up by the name of Energy Loss Spectrometry (ELS) in the domain of electron microscopy. The electron energy loss spectrometer (ELS) technique consists in col-

lecting and analyzing the inelastically scattered electrons through the specimen.

A modern versatile electron microscope (Fig. 6) incorporates built-in or optional facilities to qualitatively or quantitatively detect the emitted signals in various modes and to provide maximum possible information about a specimen under observation. It is however left to the skilled microscopist to finally integrate and coordinate all the information so gained. In this context, a fair measure of the credit for popularization of electron microscopy in biology and medicine goes to the ingenious developments in the art and science of specimen preparation for electron microscopy. L.A. Marton in Brussels, M. Von Ardenne in Germany, D.G. Drummond, V.E. Cosslett and Desmond H. Kay in England, Cecil E. Hall in the U.S.A. and innumerable others, pioneered the early specimen preparative techniques. Identification of: (i) a fixative to preserve the natural state of the biological specimen and render it resistant to changes due to dehydration and heating; (ii) an embedding medium to replace the volume originally occupied by water in the specimen without causing damage to the structure and yet consistent and firm enough for cutting thin sections; (iii) cheaper cutting edge sharp and durable; and (iv) an ultramicrotome precise enough to permit cutting of sections thinner than 1000 Å (100 nm) were some of the needs of electron microscopy, considering the poor penetrating power of electrons. The introduction of potassium permanganate, glutaraldehyde and osmium fixation. fractured glass edges as knives for ultramicrotomy, development of a precision ultramicrotome, use of evaporated carbon films as substrates, use of uranyl and lead salts and phosphotungstic acid for negative or positive staining of tissues are some of the landmarks which led to the wide spread use of electron microscopy.

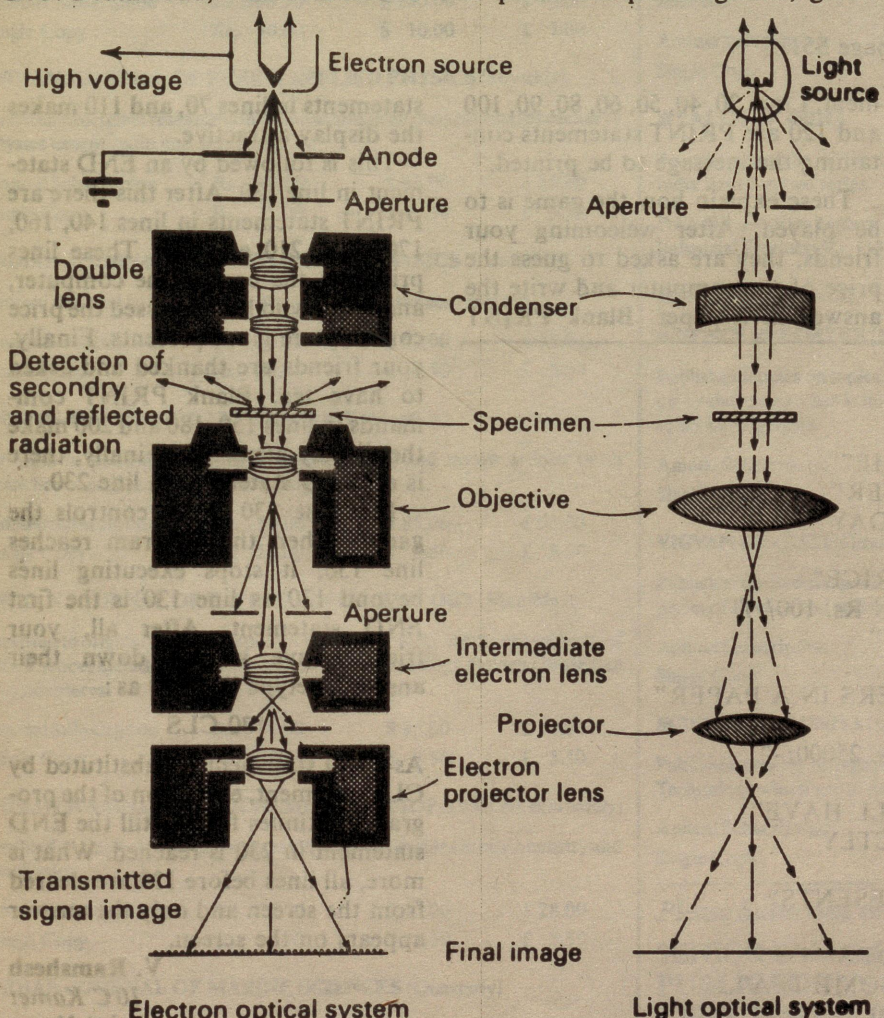


Fig. 8. Constructional similarities between light-optical and electron-optical microscope systems

Increasing popularity of electron microscopy triggered fresh researches and developmental work in several areas, e.g., development of ultra-fine-grain electron sensitive photographic emulsions for recording electron micrographs of very high resolution, development and design of very clean efficient and non-contaminating vacuum pumping systems and electronically controlled automatic functional systems, besides considerable efforts have gone into the development of miniaturized sensitive detectors for various signals emitted from the specimen and their incorporation in instrument design without disturbing the general electron optics. Recent introduction of computers in image analysis and processing for filtering the noise from recorded images in electron microscopes and developmental efforts in electron holography have brought the science and instrumentation of electron microscopy on the brink of routine atomic levels of resolution.

Whereas an electron microscope is analogous to optical microscope in constructional details (Fig. 7), it suffers from limitations in that no hydrated and live specimens in thickness greater than 1000 Å (100 nm) can be observed in it owing to the requirement of a deep (10^{-6}-10^{-8} torr) vacuum in the entire electron path from source to specimen and the observation screen and the poor penetrating power of electrons. However, the desire to observe and study biological specimens in-vivo and also thicker specimens has led to the development of mega-volt electron microscopes with considerable penetrating power and energies. The most pioneering work in very high voltage electron microscopy has been done

by Ernst Ruska and Gaston Dupoy of France. Here, again, in spite of initial difficulties encountered in stabilizing very high voltages and current supplies, high voltage electron microscopy (HVEM) has established itself as an essential tool in material, metallurgical and biological researches. Their prohibitive costs have however kept their total number in the world very limited.

Scientists have always endeavoured and are still endeavouring by every means at their disposal to gain the knowledge of the infinitely small. And in this foray into the vast ocean of the infinitely small world, the classical electron microscopy has enabled the human spirit to cover a considerable distance. Thanks to these instruments and to those selfless 'Rishis', who pioneered the science of electron microscopy and converted the speculative contemplation of the micro-world into a grand reality.

Further Reading

1. Hawkes P.W., 'Complementary account of the history of electron microscopy and appendix' in *The Beginings of Electron Microscopy* Edited by P.W. Hawkes, Academic Press, Inc. 1985, pp 589-618.
2. Moharir A.V., 'Electron Microscope, How did it evolve?' *Science Reporter,* Vol. 14 (1977) 280-294.
3. Ruska Ernst, 'The Emergence of the Electron Microscope' *J. Ultrastructure & Molecular Structure Res.,* Vol. 95 (1986) 3-38.
4. Moharir A.V., and Prakash Nam, 'Formvar holey films and nets for electron microscopy', *J. Physics (E) Sci. Instr.* Vol. 8 (1975) 288-290.
5. Ruska, Ernst, *The early developments of electron lenses and electron microscopy,* (Translated into english by T. Mulvey) Hirzel, Stuttgart, 1980.
6. Ruska Ernst, 'The development of the electron microscope and electron microscopy' *1986 Noble Award Lecture, Rev. of Modern Physics,* Vol. 59 (1987) 627-638 and also *Bioscience Reports,* Vol. 7 (1987) 607-629).

Dr. Moharir is Scientist, Nuclear Research Laboratory, Indian Agricultural Research Institute, New Delhi 110012

COMPUTERS (Continued from page 551)

A small game

By adding a few lines to the above program and employing some tricks, you can play a small game with your friends. First clear the screen, type the lines as indicated in Program 1. It can be seen that line 10 is an REM statement, line 20 is an CLS statement. Lines 30, 40, 50, 60, 80, 90, 100 and 120 are PRINT statements containing the message to be printed.

These explain how the game is to be played. After welcoming your friends, they are asked to guess the price of the computer and write the answer in a paper. Blank PRINT statements in lines 70, and 110 makes the display attractive.

This is followed by an END statement in line 130. After this there are PRINT statements in lines 140, 160, 170, 190, 210 and 220. These lines print out the cost of the computer, and those who have guessed the price correctly are given presents. Finally, your friends are thanked and asked to have tea. Blank PRINT commands in lines 150, 180 and 200 make the display attractive. Finally, there is an END statement in line 230.

It is line 130 which controls the game. When the program reaches line 130, it stops executing lines beyond 130 as line 130 is the first END statement. After all, your friends have written down their answers, retype line 130 as:

130 CLS

As END statement is substituted by CLS statement, execution of the program continues further till the END statement in 230 is reached. What is more, all lines before 130 are cleared from the screen and only the answer appears on the screen.

```
 10 REM GAME
 20 CLS
 30 PRINT "HALLO! FRIENDS"
 40 PRINT "WELCOME TO A GAME"
 50 PRINT "THIS IS MY COMPUTER"
 60 PRINT "I PURCHASED IT TODAY"
 70 PRINT
 80 PRINT "IF YOU GUESS ITS PRICE"
 90 PRINT "CORRECTLY (WITHIN Rs. 100/-)"
100 PRINT "YOU GET A PRESENT"
110 PRINT
120 PRINT "WRITE YOUR ANSWERS IN A PAPER"
130 END
140 PRINT "WELL IT COST ME Rs. 25000/-"
150 PRINT
160 PRINT "LET ME SEE, WHO ALL HAVE"
170 PRINT "GUESSED IT CORRECTLY"
180 PRINT
190 PRINT "HERE ARE YOUR PRESENTS"
200 PRINT
210 PRINT " ****** THANKS A LOT ******"
220 PRINT "LET US NOW HAVE SOME TEA"
230 END
```

Program 1. A Small Game

V. Ramshesh
10C Kamet
Anushakti Nagar
Bombay-400094

CSIR SCIENTIFIC PERIODICALS

JOURNAL OF SCIENTIFIC & INDUSTRIAL RESEARCH (Monthly)

Future issues of JSIR will carry peer-reviewed evaluative review articles in the following areas: (i) R&D management & related aspects, (ii) S&T resources, (iii) S&T policies strategies and programmes, (iv) perspectives in S&T including futurology, (v) International collaboration in S&T, (vi) Information sciences and allied matters, (vii) Ethics in S&T, (viii) Philosophy of Science and history of science, and (ix) Research announcements.

Annual Subscription	Rs. 200.00	$ 70.00	£ 45.00
Single Copy	Rs. 20.00	$ 7.00	£ 4.50

INDIAN JOURNAL OF CHEMISTRY (Monthly)

Section A: Devoted to papers in inorganic, physical, theoretical and analytical chemistry.

Annual Subscription	Rs. 300.00	$ 100.00	£ 70.00
Single Copy	Rs. 30.00	$ 10.00	£ 7.00

Section B: Devoted to papers in organic chemistry, including medicinal chemistry.

Annual Subscription	Rs. 300.00	$ 100.00	£ 70.00
Single Copy	Rs. 30.00	$ 10.00	£ 7.00

INDIAN JOURNAL OF PURE & APPLIED PHYSICS (Monthly)

Devoted to original research communications in all conventional branches of physics except radio and space physics.

Annual Subscription	Rs. 250.00	$ 85.00	£ 55.00
Single Copy	Rs. 25.00	$ 8.50	£ 5.50

INDIAN JOURNAL OF RADIO & SPACE PHYSICS (Bimonthly)

Journal devoted to ionospheric, atmospheric and space research

Annual Subscription	Rs. 125.00	$ 42.00	£ 28.00
Single Copy	Rs. 25.00	$ 8.50	£ 5.50

INDIAN JOURNAL OF TECHNOLOGY (Monthly)

Devoted to publishing original research papers and review articles in all branches of engineering and technology.

Annual Subscription	Rs. 250.00	$ 85.00	£ 55.00
Single Copy	Rs. 25.00	$ 8.50	£ 5.50

INDIAN JOURNAL OF EXPERIMENTAL BIOLOGY (Monthly)

Devoted to original research papers of experimental nature in various facets of Life Sciences including instrumentation and methodology. Reviews in areas of topical interest and book reviews are also published.

Annual Subscription	Rs. 250.00	$ 85.00	£ 55.00
Single Copy	Rs. 25.00	$ 8.50	£ 5.50

INDIAN JOURNAL OF BIOCHEMISTRY & BIOPHYSICS ((Bimonthly)

Devoted exclusively to original research communications in biochemistry and biophysics.

Annual Subscription	Rs. 125.00	$ 42.00	£ 28.00
Single Copy	Rs. 25.00	$ 8.50	£ 5.50

INDIAN JOURNAL OF MARINE SCIENCES (Quarterly)

Devoted to research communications in various facets of marine research, viz. biological, physical, geological and chemical oceanography.

Annual Subscription	Rs. 125.00	$ 42.00	£ 28.00
Single Copy	Rs. 35.00	$ 12.00	£ 8.00

Research & Industry (Quarterly)

A journal for entrepreneurs and technologists publishes reports on research with potential for industrial application, technology digests, technoeconomic news, technical literature review and special issues on advances in emerging technologies.

Annual Subscription	Rs. 125.00	$ 42.00	£ 28.00
Single Copy	Rs. 35.00	$ 12.00	£ 8.00

INDIAN JOURNAL OF FIBRE & TEXTILE RESEARCH (Quarterly)

Devoted to research/review papers in the fields of fibers and textiles.

Annual Subscription	Rs. 125.00	$ 42.00	£ 28.00
Single Copy	Rs. 35.00	$ 12.00	£ 8.00

MEDICINAL & AROMATIC PLANTS ABSTRACTS (Bimonthly)

Carries informative abstracts of current research on Medicinal & Aromatic Plants published in Indian and Foreign journals. Each issue carries about 400 abstracts.

Annual Subscription	Rs. 225.00	$ 75.00	£ 50.00
Single Copy	Rs. 45.00	$ 15.00	£ 10.00

WEALTH OF INDIA

An encyclopaedia of the economic products and Industrial Resources of India issued in two series.

Price full set : Raw Materials Rs. 2816.00
Industrial Products Rs. 1153.00

POPULAR SCIENCE

SCIENCE REPORTER (Monthly)

Publishes articles on topics of latest Scientific and Technological interest with up-to-date researches at home and abroad in a language understandable even to lay intelligentsia.

Annual Subscription	Rs. 30.00	$ 8.00	£ 5.50
Single Copy	Rs. 3.00		

VIGYAN PRAGATI (Hindi-Monthly)

Publishes up-to-date, profusely illustrated popular articles on various disciplines of science and technology for common man's use.

Annual Subscription	Rs. 22.50	$ 5.50	£ 3.50
Single Copy	Rs. 2.25		

SCIENCE-KI-DUNIYA (Urdu-quarterly)

Publishes articles in popular style on recent developments in Science and Technology which are of common man's use.

Annual Subscription	Rs. 5.00	$ 1.50	£ 1.00
Single Copy	Rs. 1.50		

Please Subscribe & Contact:

SENIOR SALES & DISTRIBUTION OFFICER
PUBLICATIONS & INFORMATION DIRECTORATE (CSIR)
Hillside Road, New Delhi 110012 (INDIA)

The Deadly Metals

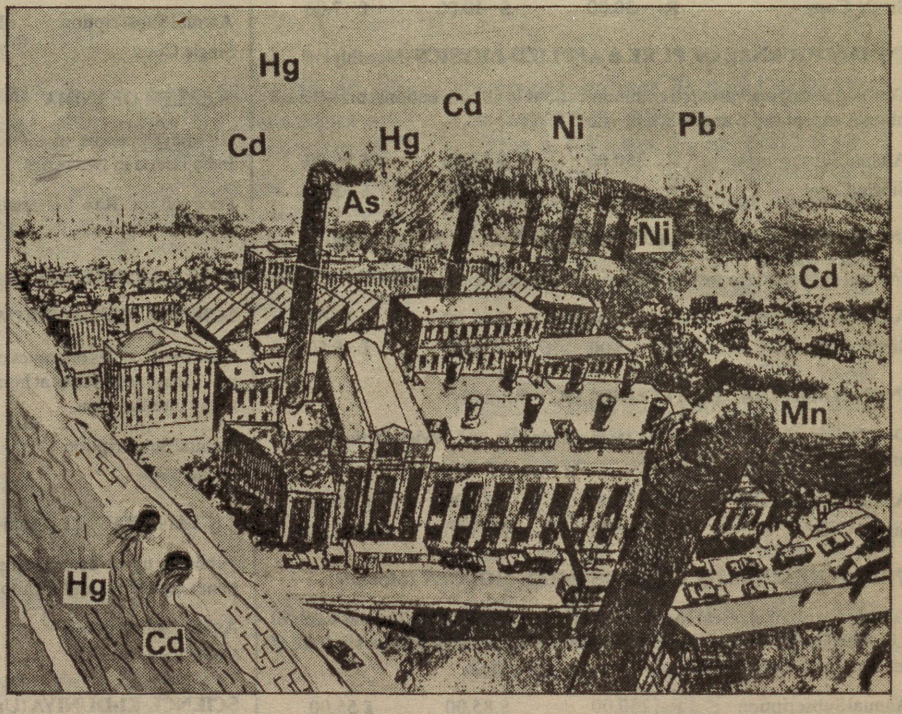
HEAVY metals are a key component of modern civilization. The wealth and power of many great kings of the past can be attributed largely to the possession of metals like iron, gold, silver, copper, etc., in one form or the other. Today, we are no less dependent upon these, because they play important role in all branches of our life, agriculture, engineering, science, architecture, and medicine.

The heavy metals have a density at least five times that of water. They are normally regarded as ones having an atomic number of 22 to 92. Their common feature in relation to biological life is that in excessive quantities they are poisonous and cause death of most living organisms.

An important property of heavy metals we must be aware of when dealing with them as environmental contaminants is that they are immutable. They can neither be created for destroyed nor can one heavy metal be transformed into another. This means that once a metal is mobilized in the environment, its total amount remains the same, regardless of form, until it is mobilized again. Its form may be altered by biochemical process to that a particular salt in the form of which it originally entered the environment no longer exists, but the total amount of metal present as other compounds or ions remains unchanged.

Heavy Metals in the Environment

Heavy metals in the atmosphere comes from a wide variety of natural and man-made sources. Heavy metal pollution of the environment has been rapidly increasing due to human activities like application of fertilizers, pesticides, dumping of mining waste and industrial effluents, etc. Similarly, the major source of atmospheric pollution due to toxic heavy metals are transport, industries, power generation and fossil fuel burning. Increasing contamination of air, water, soil and food by heavy metals has become a threat to the continuous existence of countless species of plants and animals of the ecosystem and may ultimately threaten the very survival of the human race. Some of the heavy metals such as lead, mercury and cadmium have never been identified as essential elements nutritionally and physiologically in either humans or other organisms. These toxic heavy metals enter into our body through the food we eat, the water we drink and the air we breath. Heavy metals in their pure state present little hazard. It is the soluble compounds of the heavy metals which create the problems in the environment. Some of the organometallic compounds such as methyl mercury and tetraethyl lead are the most toxic compounds known.



Toxic Metals and Human Health

Some of the heavy metals such as cobalt, chromium, copper, iron, manganese, selenium and zinc are believed to be essential for human health. It is not always possible to draw a clear distinction between essential and toxic metallic elements, since all are probably toxic if ingested in sufficient amount. Non-essential metals, particularly mercury, cadmium and lead are extremely toxic at relatively low concentrations; their toxic effects presumably being caused by their chemical similarity to more common available essential metals. A non-essential metal may substitute for an essential metal at one point in a metabolic pathway and, because of small chemical differences, through further chemical reaction block the complete pathway. Because certain metals are required in life processes, most organisms and human beings have a capability of concentrating them.

The Convict Metals

The need for mercury in human metabolism has never been identified. It is strictly a poison, having a serious neurophysiological effect when present in the methyl mercury form, attacking the central nervous system. The tragedy of Minimata and later, Niigata, in Japan has made mercury famous. In these two areas there were 50 deaths and over 100 permanently disabled victims of mercury poisoning. The "Minimata disease" was caused by the consumption of mercury-contaminated fish taken from Minimata Bay in Japan. Metallic mercury in its liquid form is of little or no significance as a threat to health. Inhalation of metallic mercury vapours can cause acute or chronic effects. Many salts of mercury such as mercuric chloride and organic compounds of mercury are acutely toxic and can even cause death.

Cadmium is a poison with properties similar to mercury. The current concern about cadmium in the environment arose out of reports of Itai-Itai disease in Japan. Cadmium can cause damage to the kidneys, lungs and bones. In acute exposure, death may occur. Cadmium, however, is a rare element and its use in India is limited.

The toxicity of lead has, in contrast to mercury and cadmium, been known to man from Biblical times. A recent source of lead in our atmosphere are the anti-knock compounds, usually tetraethyl lead, used in high octane petrol. Lead plumbing may become a major source of lead uptake by people living in soft water areas (low in calcium concentrations). Plumbism, a disease caused by acute lead poisoning, has been known for centuries. Lead can cause brain damage, disorders of central nervous system, anemia and serious behavioural problems. Acute encephalopathy (brain damage) is one of the most serious consequences of plumbism, since permanent impairment of the central nervous system may occur particularly in young children.

The Suspect Metals

These five metals (chromium, vanadium, manganese, nickel and arsenic) are suspects against whom there is mounting evidence of toxic effects on human health. These metals are recognised as important industrial substances. They are widespread in plants and animal tissue. All compounds of arsenic are toxic and in sufficient amount will cause illness or death. The word arsenic is virtually synonymous with poison. It is believed that present level of arsenic in the environment does not cause any impairment of human life or damage to ecosystem. Arsenate has low order of toxicity compared to arsenite compounds. Arsenic is included in the list of pollutants suspected to be carcinogenic.

Vanadium is released into the atmosphere from fossil fuel burning. It is used in heavy industries and also as catalyst in chemical industries. It is highly toxic to man and other living organisms. Vanadium causes irritation of the respiratory passages, affects central nervous system, and inhibits cholinesterase activity.

Manganese is relatively a common element and India is one of the leading producers of manganese ore. Manganese is found in both plants and animals. Exposure of Mn metal and salts occurs through inhalation of dust in industrial plants which make steel, alloys, glass and varnishes. Although manganese is the least toxic of all the essential elements, higher concentrations can cause growth retardation, non-specific anemia, 'metal fume fever', and neurological disorders. Long-term exposure leads to 'manganesms', a disease of central nervous system involving psychic and serious neurological disorders.

The occupational risks due to chromium salts are well known. Trivalent chromium is less toxic than hexavalent forms. Chromium is considered to be only a mild industrial hazard. Humans can tolerate 500 mg of Cr_2O_3 daily. The major sources of chromate pollution are plating plants. Chrome leather tanning and chrome steel manufacture are important sources of chromium pollution.

Nickel is widely used in electroplating, steel and alloy industries and in manufacture of electronic devices. Nickel poisoning can occur industrially following inhalation of gaseous nickel carbonyl and nickel oxide or sulphide dusts. Exposure to industrial nickel dust can cause dermatitis.

Cobalt, zinc, copper and tin are also toxic but they are found in very small quantities in the atmosphere. Zinc chloride is very toxic and high concentrations of zinc chloride fumes can cause death. Thallium, selenium, antimony and beryllium are metals of known toxicity, but occupational poisoning from these elements are rare.

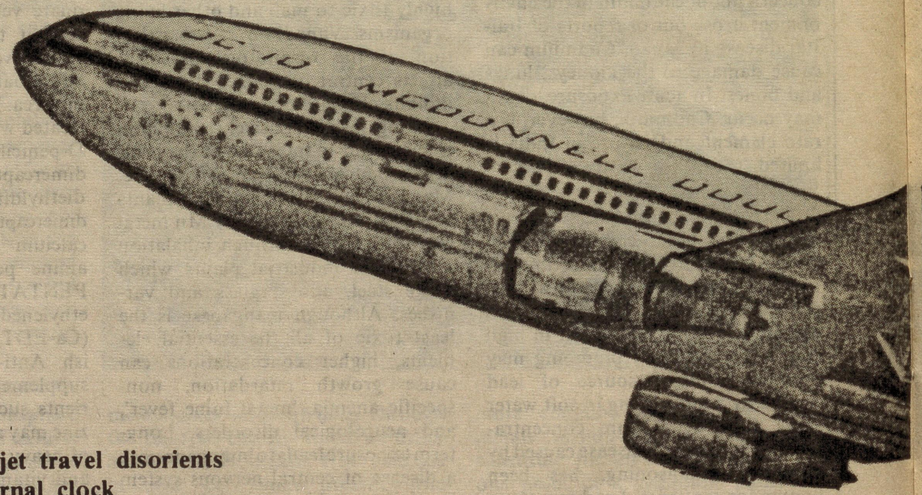
Preventive Measures

The recommended preventive measures include removal of the patient of metal poisoning from the site of exposure, provision of adequate ventillation and exhaust system at the workplace, wearing of protective masks, gloves and clothing and a bath before leaving the working area. The metal poisoning may be treated with chelating agents such as D-penicillamine (AR + AMIN), 2, 3-dimercaptopropane sulfonate (DMS), diethyldithiocarbamate (DDC) and dimercaptopropane sulfonate (DMPS), calcium trisodium dimethylenetriamine penta acetic acid (DITRIPENTAT), calcium disodium ethylenediamine tetra acetic acid (Ca-EDTA), 2, 3-Dimercaprol (British Anti-Lewesite, BAL). Dietary supplementation of essential nutrients such as calcium, selenium or zinc may also reduce the lethal effects of heavy metals. Diet rich in protein and vitamin C have shown the protective effects against copper toxicity.

P.K. Ray
Director
B.S. Khangarot
Pool officer
Industrial Toxicology Res. Centre, Lucknow-226001

THROWING LIGHT ON JET-LAG

BAL PHONDKE



Long distance jet travel disorients the body's internal clock leaving the traveller tired and listless. There is a simple way to prevent it.

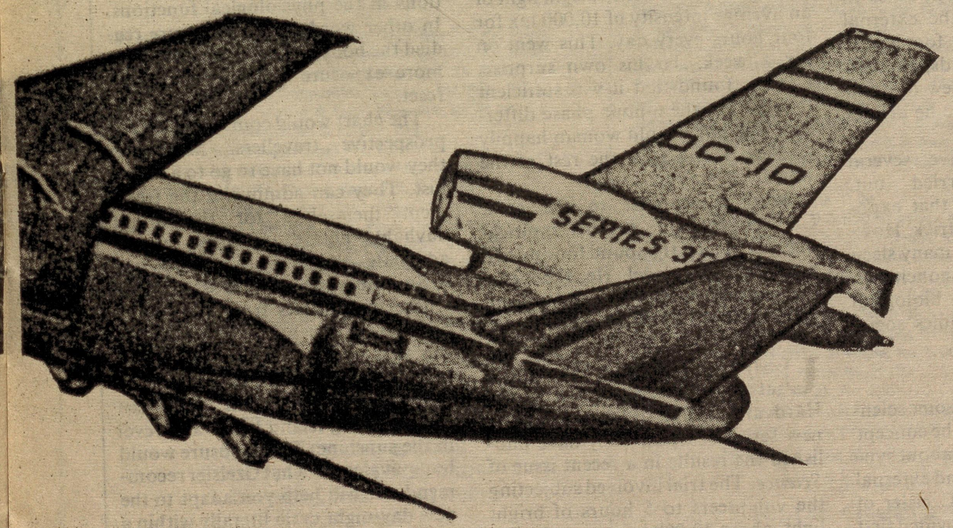
The jet-lag occurs because built in our body is a pacemaker, a mechanism which regulates several physiological functions of our body in a cyclic manner

"BOEING Boeing", that earthy comedy hit of 1960s had depicted, in a hilarious fashion, the love life of a latter day Casanova thrown completely out of gear by the introduction of the speed-hungry jet aircraft. One may not lose much sleep over his peculiar problem. However, the travails of a modern business traveller who had welcomed the jets under his wings cannot be winked away. For they are indeed of the type that would compel both the patient and the doctor to spend sleepless nights.

The present day jet aircraft cruises at a speed that can compare favourably with the speed of rotation of our earth. That allows a busy executive the luxury of losing very little of his valuable time in travel. One can appreciate his anxiety of getting down to business without delay. The keenness of his mind, however, is not matched by that of his body. Since the speed of his "magic carpet" competes with that of the rotating earth he is able to cross several time-zones in quick succession. That precisely becomes his undoing for his body takes time to adapt to these changes leaving him disoriented in the mean time. He suffers from jet lag.

Say, he leaves India at mid-night. His body is accustomed to rest at that time. He gets that aboard the plane which takes him to the far away United States of America in mere twenty-three hours. So when he lands in New York, it is once again close to mid-night back home and his body once again craves for sleep. But it is bright day time in New York and he has to get to work. He tries to drive himself hard. His body, however, gets confused not knowing whether it is day or night. Consequently, it cannot cooperate with his mind and he feels listless, tired, even dizzy. He may have a headache. This is jet lag.

The jet lag occurs because built in our body is a pacemaker, a mechanism which regulates several physiological functions of our body in a cyclic manner. These internal body clocks are normally synchronised



When you go to Los Angeles, where time differs from the Indian Standard Time by 14 hours, spend the first couple of days on arrival roaming through the city for six to eight hours

with the external clock set by the day-night cycle at the place of one's residence. If the body is transported to another place with a different day-night cycle the body clock, called the circadian rhythm in the scientific parlance, can get reset to the new cycle. But that takes some time. Till that resetting takes place there is a mis-match between the internal and external clocks. This mis-match upsets the regulatory mechanism controlling our physiological functions like regulation of body temperature or secretion of certain hormones. As a result the body machine which normally behaves in a very ordered fashion runs as if it had developed some problems. That is jet lag.

HAVING understood the characteristics of the jet lag and the mechanism of its on-set scientists were of course keen to find out if the natural process which resets the body clock can be mimicked. That would allow the new internal body clock to get synchronised with the external clock before a person sets foot in that time-zone. In other words, the traveller can adapt to the new day and night routine even before he arrives there.

Towards this objective several experiments were carried out. Initially, it was thought that exposure to light might do the trick. However, in the mid-seventies many sleep researchers came to the conclusion that the resetting of the biological clock is done through peoples' social contacts.

UNDAUNTED by that some scientists persevered with the concept of light exposure bringing about synchrony between internal and external clocks. In 1978, Charles Czeisler of the Harvard University provided first compelling evidence that the biological clock is indeed sensitive to light. He demonstrated that if a person is exposed to a light intensity of 200 lux, which is roughly equal to that of an ordinary well-lit room, then his internal clock gets adjusted to a periodicity of 24 hours. Normally, the body temperature or secretion of certain hormones or the sleep-wake pattern vary in a cycle with a periodicity of about 25 hours. Thus even a brief and relatively mild exposure effects a change of one hour.

Enthused with this observation, Czeisler along with his team undertook extensive experimentation with light-exposure. The real break came in 1986.

An old woman who had a serious sleep disorder was referred to Czeisler. Her internal clock was 6-hours out of phase with the external natural clock. When it was around 10 in the night and time to go to sleep her body told her that it was 4 in the morning and time to wake up. Czeisler exposed her to bright light of an average intensity of 10,000 lux for four hours every day. This went on for a week. To his own surprise, Czeisler found that it was sufficient to wipe out the 6-hour phase difference and put the old woman happily to sleep along with the rest of the world.

Being a scientist to the core, Czeisler decided to put this empirical observation on the sound footing of a mathematical model. He, therefore, teamed with Richard Kronauer who developed a theoretical model.

USING this, the team of scientists at a couple of hospitals of the Hardvard University conducted a new series of trials. They have published the results in a recent issue of *Science*. The trial involved subjecting the volunteers to 5 hours of bright light, about 10,000 lux, every day for three consecutive days.

The scientists divided their volunteers in different groups. Though all were exposed to bright light for 5 hours, for some the exposure was given during what their body clock told them was day; for others the exposure was during night time.

THE results were nothing less than dramatic. Just this single session lasting over three days reset the person's internal clock by as much as twelve hours especially if the exposure to light was given during what the person's body perceived as night time. The change was less pronounced if the exposure was during day time. The scientists, have now been able to draw a complete phase-response course indicating the extent to which the clock can be reset by varying durations of exposure and at various times of the day-night cycle.

The scientists also noticed that the exposure of the first two days merely reduced the amplitude of the oscillations in the physiological functions. In other words, these exposure readied the body clock for resetting. One more exposure and the clock was reset.

The chart would come in handy for prospective travellers. Moreover, they would not have to go to a therapist. They can administer the treatment themselves for the bright daylight nature provides us is adequate.

So when you go to Los Angeles, where time differs from the Indian Standard Time by 14 hours, spend the first couple of days on arrival roaming through the city for six to eight hours. Better still, go to the famous Long Island beach and revel in the sunshine. The exposure would be equivalent to what Czeisler recommends. It will help you adapt to the new day-night cycle literally within a day. □

Molecule Linked to Common Diabetes

US researchers in Minnesota have found a molecule that may be important in the development of the most common variety of diabetes.

According to a report in the *New England Journal of Medicine,* the molecule is the main component of the tangled fibers that appear in diabetics and may choke off the cells of the pancreas that make the hormone insulin.

Insulin is crucial to the body's ability to absorb and use sugar as fuel; a shortage of insulin characterizes the disease. The tangled fibers, known as amyloid deposits, occur in the cells called the islets of Langerhans.

The molecule that makes up the amyloid, dubbed the islet-amyloid polypeptide, has been identified and characterized over the last two years by Dr. Kenneth H. Johnson and Dr. Timothy D. O'Brien, veterinary pathologists at the University of Minnesota. Their findings have been confirmed by a team of doctors at the University of Uppsala and the University Hospital at Linkoping, in Sweden.

The amyloid tangles were spotted as early as 1900. But because they also appear in smaller numbers in healthy people and animals, they were not considered central to the disease.

Now it appears that the amyloid may be more important than previously thought, Dr. O'Brien said. In laboratory cultures, the polypeptide has been found to cut down the ability of cells to take in the sugar they need for energy.

The scientists say it may block the action of insulin in two ways: chemically turning off insulin at its site of action in muscle cells, and physically destroying the islet cells where insulin is made.

The polypeptide "may be a principal factor in the reduced uptake of blood glucose by skeletal muscle" the researchers noted in the *Journal.*

Diabetes affects millions of people in both India and the United States. The disease can lead to blindness, nerve and kidney damage, and amputations as the result of gangrene of the feet.

Dr. O'Brien said that the next step in the research is to use animal models to try to determine whether the polypeptide contributes to the progression of the disease, or whether it is actually the prime agent of the disease. □

Fighting Cancer with Light

US drugmakers are turning to photoactivated chemicals to formulate highly specific weapons against a variety of serious diseases, including cancer. Picking up strings from an ancient Egyptian remedy for skin ailments, several pharmaceutical companies in America are now carrying out advanced clinical tests on new drugs that can be targeted to destroy several types of cancer.

Scientists say these light-activated drugs may one day also be used to kill contaminants, such as the AIDS virus, in donated blood. "The advantage of light-activated drugs is that you can control them a lot more effectively than other drugs," says Richard L. Edelson, head of the dermatology department at the Yale School of Medicine, where these drugs are being tested for their effectiveness against cancer. "As soon as you turn the light off, the drug reverts to a harmless state."

Ancient Egyptian physicians had noted that a weed that grows along the Nile increased a person's sensitivity to light and had used it to treat vitiligo. Today, several thousand years later, the active compound in the weed has become a model for this new class of drugs.

The first successes in this area were achieved by the scientists of the American company Johnson & Johnson who developed Photofrin, a derivative of natural substances called porphyrins which are normally harmless components of the hemoglobin in red blood cells. When exposed to sunlight, porphyrins emit an intense red fluorescence that produces ozone which destroys cells. In 1985, another American pharmaceutical company, Cyanamid, backed a Vancouver-based drug firm and began clinical testing of the drug on cancer patients at more than 50 centers.

Unlike radiation or chemotherapy, light-activated drugs kill only the

cancerous cells and leave healthy ones intact. This enables frequent administration without the drastic side effects of other therapies.

"Theoretically, the power of this technology for killing cells it truly remarkable. It could eventually be far more effective than chemotherapy," says Dr. Eli Glatstein, chief of radiation oncology at the National Cancer Institute (NCI).

What makes these drugs so effective are lasers and fiber-optic probes that can deliver specific wavelengths of light needed to set off the drugs directly on cancerous tissue. For this, the drug is first injected into the patient where it collects in tumor cells, since they retain it more readily than healthy cells. Two days later, a beam of low-powered laser light is channelled through a fiber-optic probe to the cancer site, where it activates the drug.

The wavelength of light that activates Photofrin penetrates only a few millimeters and cannot be effective in deep tumors. In the tests so far conducted, it has been successful against some kinds of bladder, skin, lung, and esophagus cancers, even though it has a few side effects. Due to increased photosensitivity, patients run the risk of severe sunburns and need to stay away from direct sunlight during the treatment and for at least a month after.

Sensing the potentiality of the new drug, scientist at NCI are planning to develop photo-activated drugs that have their own source of light. The objective is to eliminate lasers by binding the drug to a light-emitting substance called luciferin, the luminiscent compound that lights up fireflies. When the drug is concentrated luciferin can be turned on by injecting an enzyme into the patient, enabling tumors to be accessible anywhere in the body without surgery.

Light-activated drugs could also be put to several other uses. Leading blood banks in America are attempting tie-ups with drug-makers to develop a system to clean blood of AIDS and hepatitis viruses. They plan to do this by mixing blood with the light-activated drug and subjecting it to a burst of light. This could save millions of dollars by avoiding wastage of tainted blood.

This new class of drugs, scientists hope, will one day be a potent weapon against many more ailments, including sexually-transmitted diseases, and also be used for unclogging arteries and as an alternative to bypass surgery. □

Drug Combination Found to Aid Colon Cancer Patients

A study at the U.S. National Cancer Institute (NCI) has shown that two drugs, administered after surgery, can save the lives of many patients from a fatal form of colon cancer.

Announcing the results of the study in the first week of October in Washington, D.C., NCI director Samuel Broder said a national study involving patients with so-called stage three type of colon cancer that had spread to nearby lymph nodes showed increased survival rates when treated with a well-known anti-cancer drug in combination with levamisole, a drug used to treat intestinal worms in farm animals.

The new drug therapy is given to try to eradicate remaining undetectable cancer cells following surgery and thus prevent the spread of the disease.

"This combination is something that every physician and surgeon should be aware of," Broder said. "Although this therapy does not cure all patients, it has significantly improved the outlook for patients whose surgically-removed colon cancer was at an advanced stage."

Broder said a specific description of the new treatment is being communicated to doctors in the United States. The Institute estimates that more than 110,000 new cases of colon cancer will occur in the United States in 1989, and at the current rate, 44,000 people will die of it.

The director of the cancer study, Dr. Charles Moertel, said it showed that therapy with the drug combination appears to reduce the risk of dying from cancer by one-third among patients with stage three colon cancer. In the study, 49 per cent of such patients were alive five years after therapy compared to only 37 per cent of similar patients who received no drugs. Both patient groups had been treated with surgery prior to the study.

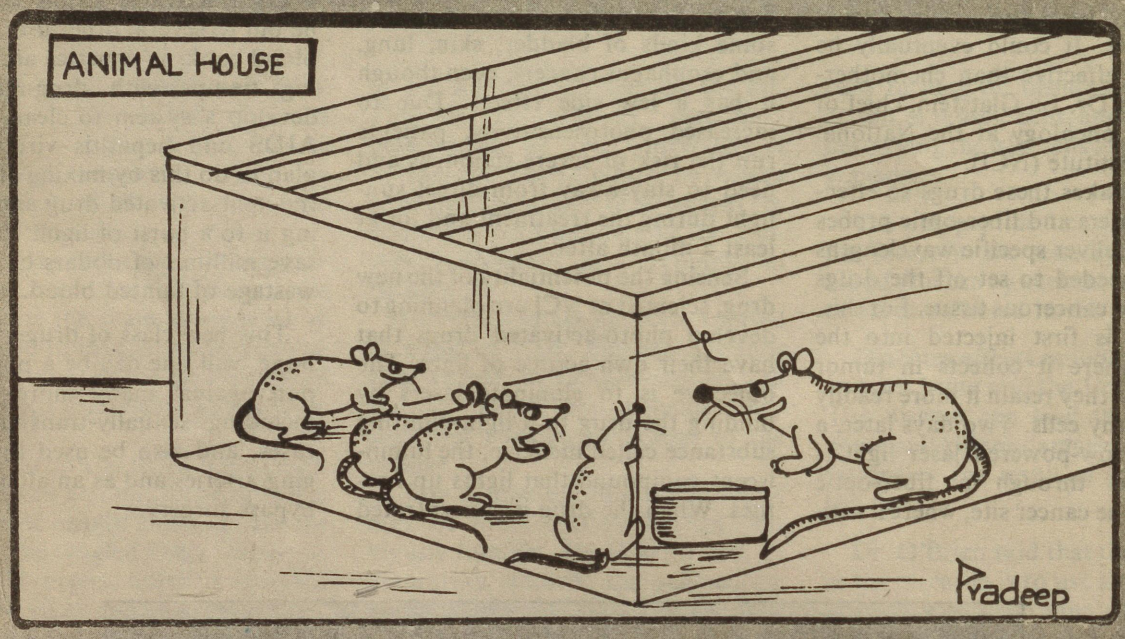
Moertel said the combination of levamisole and the anti-cancer drug 5-fluorouracil is started three to five weeks after surgery and is continued for about a year. He said that the drug combination has not been proven effective against colon cancers at an earlier stage in the disease or in those cases where surgeries occurred at a much earlier time.

Based on evidence that levamisole may have an effect on the body's immune system, scientists have been investigating its anti-cancer potential in numerous clinical trials over the past decade.

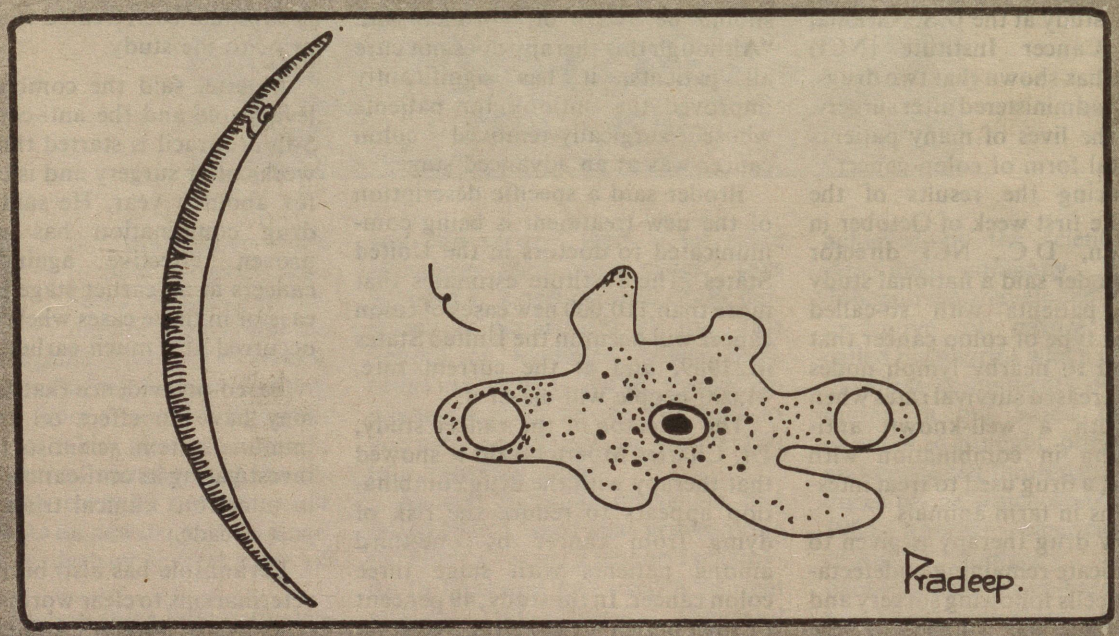
Levamisole has also been used by veterinarians to clear worms from the intestines of domestic animals for the past 20 years, and, in Europe, it is commonly used to treat worm infestation in humans. □

CARTOONS

Pradeep K. Srivastava



"Besides air-conditioned accommodation, nutritious food and academic environment, the best thing is that there is no fear of cat here"



"Ascaris! What do you do—Exercise, Yoga or Meditation? I really envy you. What a slender and slim body!"

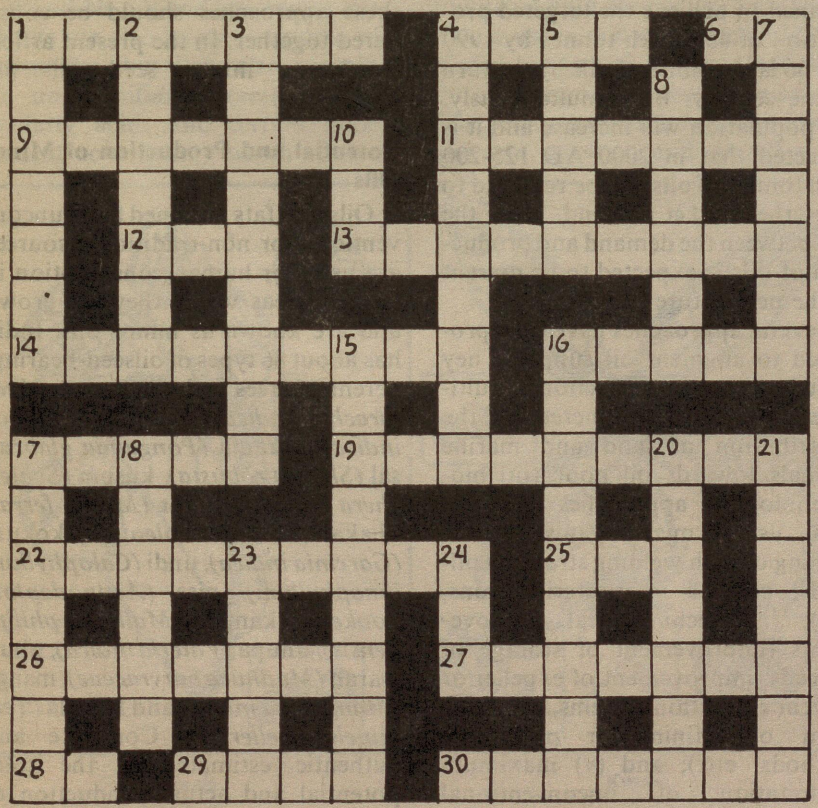
Crossword Puzzle

Across

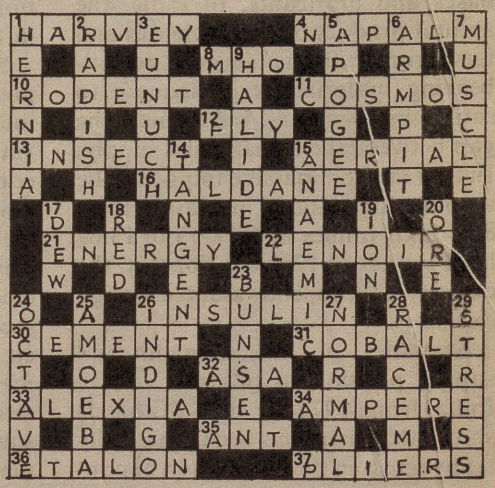
1. Curative treatment. (7)
4. Amount of medicine to be taken at one time. (4)
6. Iron symbolically. (2)
9. Name given to many plants with prickly stems, leaves, etc., and white, yellow or purple flowers. (7)
11. Horizontal stem of some plants on or just below the ground. (7)
12. Dried leaves of the plant *Thea sinensis*. (3)
13. Amphibious animal of the crocodile family. (9)
14. Family of worms living in the soil. (9)
16. Peg with slotted head and a spiral groove cut round its length. (5)
17. Surname of the English physicist who invented the mass spectrograph. (5)
19. An instrument for measuring the pressure of gases. (9)
22. A molecule having three atoms, e.g., ozone. (9)
25. A wet solid. (3)
26. The c.g.s. unit of magnetomotive force. (7)
27. A process which disturbs the functions of body. (7)
28. Chemical symbol for sodium. (2)
29. Filamentous outgrowth from an epidermal cell—a special characteristic of mammals. (4)
30. Extremities of the major axis of the orbit of a planet or comet. (7)

Down

1. A thermionic valve having a cathode, an anode, a control grid and a screen grid. (7)
2. One of the three electrodes in a transistor. (7)
3. Any connection between the skin of a young lamb with wool in little curls and the river port on the Volga?
4. An alloy much used in aeronautics due to its strength and lightness. (9)
5. Pointed organ, often poisonous, of some insects. (5)
7. Arc of hair above the eye. (7)
8. Cementing material used for joining bricks, stone, etc., in buildings. (6)
10. Prefix denoting 10^{18}. (3)
15. An instrument for measuring osmotic pressures. (9)
16. Association of dissimilar organisms to their mutual advantage. (9)
17. Substance capable of stimulating the formation of antibodies.
18. Trihydric alcohols derived from aliphatic hydrocarbons. (6)
20. Surname of the discoverer of hydrogen peroxide. (7)
21. A bone disease owing to vitamin D deficiency. (7)
23. Greek letter between eta and iota. (5)
24. Marine edible fish chiefly found in North Atlantic ocean. (3)

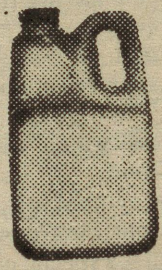


Vijaya Khandurie
23L, Sector IV
D.I.Z. Area
Shahid Bhagat Singh Marg
New Delhi-110001



Solution to Pwzzle in *S.R.* November 1989

COOKING OILS: Future Hope



C.R. MAITY

OILS and fats play an important role in agricultural and industrial economies of a country. They are not only one of the most expensive basic nutrients in our diet but is also used as valuable industrial raw materials for the production of soap, paints, varnishes, toilets, hair oils, plastics, candles, pharmaceutical bases and lubricants. In India, the annual production of edible oils and fats from various sources of oil-bearing materials is inadequate to satisfy the demand. And to meet the gap between the demand and supply, India relies on massive imports. The amount of import increased from 8.21 lakh tonnes in 1978-79 to 13.68 lakh tonnes in 1984-85. For this, the country has to spend valuable foreign exchange.

Statistics on the demand and supply position of oils and fats in India from 1978 to 1985 (Table 1) shows that there has been practically no progress in the production of non-petroleum oils though oil production rose from 21.5 lakh tonnes in 1967 to 32.4 lakh tonnes in 1985. It has been planned to achieve the targeted production of 45.5 lakh tonnes by 1990 and 66 lakh tonnes of oils by the turn of the century. But simultaneously, the population will increase and it is expected that in 2000 AD 125-200 lakh tonnes of oils will be required to meet the market demand. Thus the gap between the demand and production of oils is expected to be present in the near future as well.

Several approaches have been proposed to augment oil supply. They include (i) more production of cultivated oil seeds; (ii) increasing the contribution of land and marine animals towards oil pool; (iii) biotechnological approaches (production using microorganisms, the cloning of high yielding strains of oilseeds, enzyme inter-esterifications, etc.); (iv) technological improvements (improvement of storage of oilseeds, improvement of expeller or solvent extraction systems, improvement of refining or processing methods, etc.); and (v) maximum exploitation of unconventional minor oilseeds. It is obvious that all these approaches should be considered together. In the present article tree-borne minor seed oils are considered.

Potential and Production of Minor Oils

Oils and fats obtained from unconventional or non-traditional sources are used for human consumption in limited areas where they are grown and are known as minor oils. India has about 86 types of oilseed-bearing, perennial trees including neem *(Azadirachta indica)*, mahua *(Madhuca indica)*, karanja *(Pongamia glabra)*, sal *(Shorea robusta)*, kusum *(Schleichera trijuga)*, nahor *(Mesua ferra)*, khakan *(Salvadora oleoides)*, kokum *(Garcinia indica)*, undi *(Calophyllum ionophyllum)*, pisa *(Actinodaphné hookerii)*, kamala *(Mallotus philippensis)*, dhupa *(Vateria indica)*, phulwarah *(Madhuca butyraceae)*, mango *(Mangiferra indica)* and beheda *(Terminelia bellerica)*. Complete and authentic estimates of the total potential and actual production of

these minor oilseeds and oils are not available as enumeration surveys have not yet been carried out in several parts of the country. However, based on the surveys conducted by the Indian Central Oilseeds Committee, Hyderabad, Hindustan Lever Ltd., Bombay, Oil Technological Research Institute, Ananthpur, and Khadi & Village Industries Commission, Bombay, some statistics on total potential and production of minor oilseeds and oils in available (Table 2). It is found that annual potential of minor oils exceeds 12 lakh tonnes while the actual production is approximately 1.38 lakh tonnes. Thus, only a little over 11% of the total potential is being used. The main difficulties regarding the exploitation of these minor oilseeds are: (i) scattered availability of the oilseeds of tree origin; (ii) problem of proper collection; (iii) storage; (iv) inadequate road communications and lack of enterprising and financially strong collection agencies; and (v) scarcity of oil crushing or solvent extraction plants for the minor oilseeds.

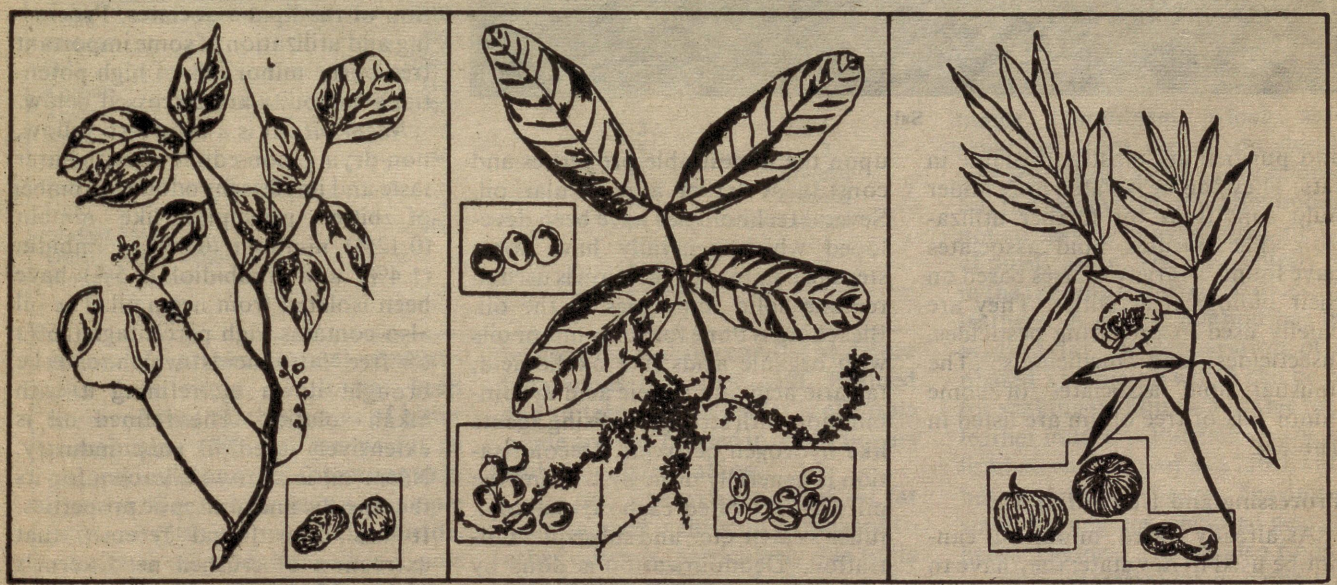
Table 1. Production and imports of edible oils and fats by India

Year	*Production (Lakh tonnes)*	*Imports (Lakh tonnes)*	*Approximate cost (Rs. in million) of the imported oils and fats*
1979-80	23.47	11.49	6,171.8
1980-81	25.16	10.47	5,160.0
1981-82	30.51	9.98	4,496.9
1982-83	27.79	11.50	5,044.6
1983-84	32.99	16.34	13,190.0
1984-85	32.40	13.68	11,221.3

Composition

Like edible oils and fats, minor oils and fats are also largly composed of triglycerides, but they also contain high unsaponifiable fraction, high free fatty acids and certain toxic chemical constituents which render them non-edible. The triglycerides constitute the major fatty acids which determine the quality of the oil. The composition of many minor oils and fats resembles that of edible oils and generally contains normal fatty acids like palmitic (16:0), stearic (18:0), oleic (18:1) and linoleic (18:2) acids. Besides usual fatty acids, the saponifiable portion of some minor oils contains long-chain fatty acids, hydroxy-, keto-, epoxy- and other oxygenated fatty acids and cyclopentyl fatty acids.

The major problem in the commercial exploitation of minor oils is the presence of undesirable properties and principles such as deep colour, unpleasant odour and taste, high contents of free fatty acids, high unsaponifiable fraction and presence of unusual lipid associates. This limits their use in raw state. It should be pointed out in this context that the unusual components present in some of the important edible oils, like malvalic acid, gossypol and related pigments in cottonseed oil, sesamol and sesamolin in sesame oil, allyl isothiocyanate and erucic acid in mustard oil and rapeseed oil, and aflatoxin in groundnut oil are well known, but the problem is not so acute as the toxins are present in minute quantities and can be removed easily by refining and bleaching the oil. On the other hand, the unusual constituents present in the minor oils and fats cannot be removed by conventional bleaching and refining though special processing methods have recently been developed. Chemically, these secondary constituents are steroids, terpenoids, flavonoids or neoflavonoids, alkaloids, toxic pigments, resins, gums, cyanolipids, longchain fatty acids, hydroxy-, epoxy-, keto- or other oxygenated fatty acids, etc. These lipid associates are more or less non-fatty in character and are mainly responsible for the undesirable properties of the crude fats. They are comparatively more soluble in water-miscible solvents and when isolated



Karanja **Kusum** **Nahor**

Sal

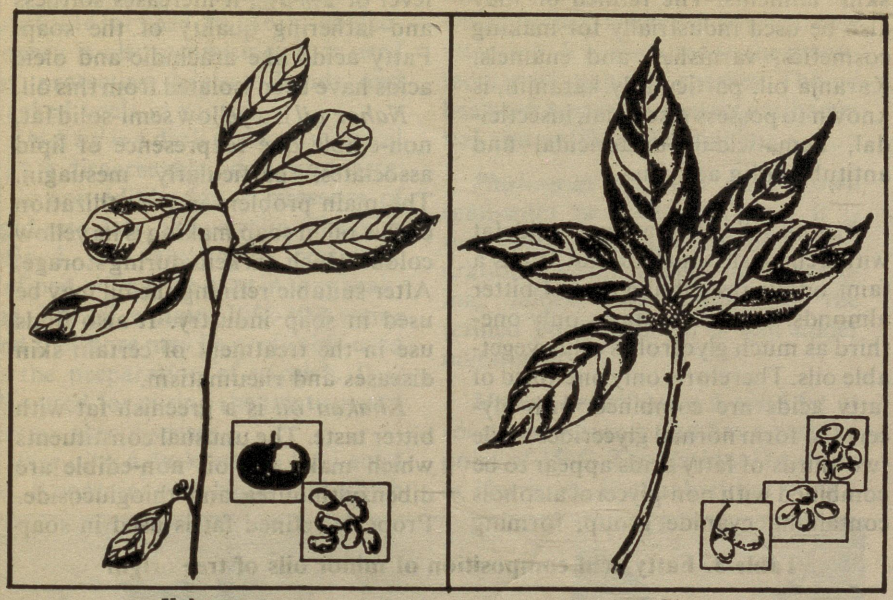
and purified are mostly insoluble in fats. They can be isolated only under mild conditions for further utilization. The purified lipid associates have found a variety of uses based on their biological activities. They are chiefly used in preparing pesticides, insecticides and medicinals. The unusual lipid associates of some minor oils of tree origin are listed in Table 4.

Processing and Utilization

As already stated, minor oils cannot be used in raw state; they have to be processed before their utilization. The processing method depends upon the undesirable properties and constituent (s) of a particular oil. Several technologies have been developed which generally have some steps in common. Filtration is used to remove solid impurities in the oil. Bleaching is done for some minor oils with organic acids like oxalic acid, tartaric acid and maleic acid in combination with strong oxidising agents like hydrogen peroxide. Decolorisation is generally done by treating the oil with activated carbon, charcoal, fuller's earth, etc., and subsequent filtration. Deodourization is done by passing hot and cold air stream alternately in a closed system under vacuum. Deacidification or lowering of free fatty acids of minor oils is performed with the help of cheap and harmless chemicals like sodium chloride, sodium silicate, sodium hydrogen sulphite, boric acid, etc. Many a times deacidification is done by treating the oil with dilute alkali solution in several successive steps. Many minor oils contain wax which can be separated by keeping the oil at low temperature; the oil can then be easily pumped out. Sometimes hydrogenation is necessary to upgrade some minor oils. This is done by passing hydrogen gas through oil in presence of a metal catalyst like finely divided nickel, palladium, etc. Often this process increases the acceptability and palatability by changing the oil to a semi-hard form and helps in the conversion of toxic constituent(s) to non-toxic substance(s). On the contrary, during hydrogenation some natural *cis*-fatty acids change to *trans*-form which is harmful. The metal catalyst should however be removed completely; otherwise the whole mass would be toxic.

THE minor oils after suitable refining can be put to several industrial and edible uses. However, the cost factor has always been a handicap in this respect, although it can be overcome by making maximum use of the seed cake and by exploitation of the lipid associates. Processing and utilization of some important tree-borne minor oils of high potential availability are discussed below.

Neem oil : It is a brownish yellow, non-drying, non-edible oil with bitter taste and unpleasant odour. Anumber of bitter principles like nimbin (0.12%), nimbinin (0.01%), nimbidin (1.4%) and nimbidiol (0.5%) have been isolated from neem oil. The oil also contains high percentage (25%) of free fatty acids which can be brought down by refining it with alkali solution. The refined oil is extensively used in soap industry. Neem oil is also well known for its therapeutic and antiseptic properties. It has been found recently that extraction of crushed need kernels with a polar solvent like ethanol and subsequent extraction with hexane



Kokum

Pisa

gives a colourless and odourless oil which has no bitter taste. Chemical and nutritional studies indicate that neem oil from which the bitter principle has been removed has a chemical and nutritional quality comparable to other edible oils.

Recent investigations carried out at the National Botanical Research Institute, Lucknow have lead to the isolation, characterisation and utilization of various unusual constituents from neem oil. It has been observed that nimbin series of bitter constituents (2% fat) are useful as general antiseptic and for curing skin diseases. The odouriferous principle of the oil (5%) is a potential pesticide.

Table 2. Estimated potential and actual production of tree borne oil seeds and oils (in thousand tonnes)

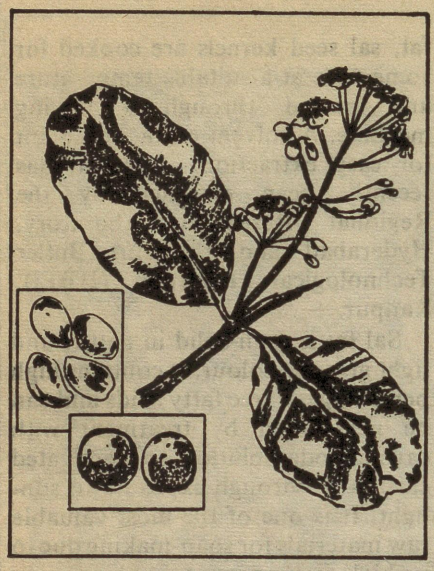
Seed	Total potential		Actual production
	Seed	Oil	Oil
Neem	418	83	30
Mahua	490	171	25
Sal	5504	688	21
Karanja	111	30	10
Kusum	90	30	8
Nahor	5	2	1
Khakan	46	15	3
Kokum	5	2	Limited
Undi	4	2	Limited
Mango kernel	400	30	Limited
Others of tree origin		12	4
From crops and fruits		156	36
Total :		1,221	138

Mahua oil : Mahua oil is a pale yellow, semi-solid fat. Mahua fat is more akin to tallow in properties than many other fats and almost the entire production of this oil is used for making washing soap. Its use in high quality washing or toilet soaps is limited as soaps made from mahua oil are prone to rancidity. It is also used as a lubricant and ointment base. In northern India, it is used in wool mills for making the wool smooth for spinning. Mahua fat can be used for making candles and pure fatty acids like oleic acid. Refined and suitably processed fat is of edible grade and can be used in confectionery and chocolate making.

Sal fat: The extraction of sal fat from sal seed is difficult compared to other oilseeds, particularly due to its high starch content. To extract the fat, sal seed kernels are cooked for some time at a suitable temperature and passed through a flaking machine. A solvent extraction plant for easy extraction of sal fat has recently been designed by the Regional Research Laboratory, Hyderabad and Harcourt Butler Technological Institute (HBTI), Kanpur.

Sal fat is semi-solid in nature and light green in colour. It contains high percentage of free fatty acids and can be neutralised by treatment with caustic soda solution and activated carbon or through exposure to sunlight. It is one of the most valuable raw materials for soap-making due to its high melting point and large content of short-chain fatty acids. Suitably refined sal fat can substitute the expensive coconut oil to some extent. Besides, sal fat resembles cocoa butter in its characteristics and is used as a cocoa butter substitute. Refined sal fat is also used for the production of vanaspati. Sal fat is rich in stearic and oleic acids, therefore purer samples of these fatty acids can be isolated from it. These pure fatty acids are in great demand for preparation of cosmetics, surfactants, cleansing agents and in industries like textile and rubber.

Karanja oil : It is yellowish brown in colour and turns reddish brown on storage. Several flavonoids including karanjin, pongamol, karanja chromene, dimethoxy kanugin, isolonchocarpin, pongapin, etc., have been isolated from the oil. Karanjin is the major component which slowly separates from the oil on standing and therefore can be easily removed, but the removal of other flavonoids is not so easy by conventional methods of purification. The oil is chiefly used in the tanning industry for dressing of leathers. A simple method has been evolved for the preparation of sulphated karanja oil which can be used for making fat liquors suitable for the leather industry. Purified and neutralised oil can be used as a lubricant for heavy lathes, chains, bearings of small gas engines, enclosed gears and heavy engines. The oil also finds use in the preparation of washing soaps



Undi

and candles. However, soaps made from the crude oil are of low quality with unpleasant colour and odour and they darken during storage. As such, its use in high-quality washing or toilet soaps is limited.

Karanja oil has to be refined by a special treatment to remove colour, odour and lipid associated before its use in soap making or hydrogenation. Crude oil can be refined by cold extraction with alcohol and subsequent alkali refining and bleaching. Alcohol percolation through the seeds prior to pressing has also been suggested. It may also be refined by treatment with sodium chlorite and then with alcoholic caustic soda in three stages in concentration of 0.3%, 0.2% and 0.1%. Recently, the authors have evolved a technique for refining the oil and showed that after refining it can be put to a variety of uses. The purified oil can be used upto the extent of 25% in soap making without affecting the quality of the soap and at present it is extensively used for this purpose. Alcoholic alkali extraction of karanja oil and subsequent deodourization could lead to edible grade oil. The oil is highly valued for medicinal purposes due to presence of a number of biologically active flavone compounds. Besides being antihelminthic, it is reported to have a curative value for eye diseases, rheumatism, leucoderma, scabies, herpes, itching wounds and some skin ailments. The refined oil may also be used industrially for making cosmetics, varnishes, and enamels. Karanja oil, particularly karanjin, is known to possess piscicidal, insecticidal, nematicidal, bactericidal and antituberculin activities.

Kusum oil: It is a semi-solid fat with yellowish white colour. It has a faint odour resembling that of bitter almonds. The oil contains only one-third as much glycerol as other vegetable oils. Therefore, only one-third of fatty acids are combined with glycerol to form normal glycerides while two-thirds of fatty acids appear to be combined with non-glycerol alcohols containing cyanide group, forming cyanolipids. Scientists from Hindustan Lever Research Centre, Bombay have characterised the cyanolipids and also suggested a refining method. Due to presence of cyanolipids, the oil has some medicinal properties, especially as a cure for itch and ache. It does not get rancid easily, and when used in the soap making at the level of 2%-5%, it increases softness and lathering quality of the soap. Fatty acids like arachidic and oleic acids have been isolated from this oil.

Nahor oil is a yellow semi-solid fat, non-edible due to presence of lipid associates, particularly mesuagin. The main problem in the utilization of this oil in soap making is its yellow colour which darkens during storage. After suitable refining the oil may be used in soap industry. It also finds use in the treatment of certain skin diseases and rheumatism.

Khakan oil is a greenish fat with bitter taste. The unusual constituents which make the oil non-edible are dibenzylthiourea and thioglucoside. Properly refined fat is used in soap making and in the preparation of candles. The oil has some medicinal values for the treatment of rheumatic pains and in preparations of suppositories. It is also used as a base for ointments.

Kokum oil is a light brown-coloured oil and contains 10% of an acid identified as hydroxycitric acid.

Table 3. Fatty acid composition of minor oils of tree origin

Seed	Oil content (%)	Fatty acids (%) 16:0	18:0	18:1	18:2	Others
Neem	20	13-15	14-19	50-60	8-16	Arachidic 1-3
Mahua	35	23-25	19-30	36-43	11-16	
Sal	12	2-8	34-48	35-42	2-3	Arachidic 12-13
Karanja	27	6	7	61	14	Arachidic 4-5 Others 6-8
Kusum	33	5-8	2-6	60	3-4	Arachidic 20-25
Nahor	40	8	10	66	11	
Khakan	33			12	1-2	Lauric 53 Myristic 28 Capric 6-10
Kokum	26	8-9	10-15	55-56	10-20	
Undi	60	15-18	6-12	48-53	15-24	
Pisa	48			4		Lauric 96
Dhupa	27	8-10	48-56	30-35	0-4	
Phulwara Kernel	55	56-61	1-3	31-36	3-5	
Mango kernel	10	3-18	40-45	40-45	1-13	
Beheda kernel	40	35	8	24	31	

Table 4. Unusual constituents of some minor oils of tree origin

Seed oil	Unusual constituents
Neem	nimbin, nimbinin, nimbidin, nimbidol and odorescent sulphur compounds
Sal	2-(cis-9, 10-epoxy stearate)-1,3 distearate and 2-(threo-9, 10-dihydroxy stearate)-1, 3 distearate
Karanja	Karanjin, Karanja chromene, pongamol, dimethoxy kanugin, isolonchocarpin and pongapin
Kusum	cyanolipids [RO-CO. CH_2-C (=CH_2)-CH (CN). OCOR'] and β-methyl α-teronic acid
Nahor	mesuagin
Khakan	dibenzylthiourea and thioglucoside
Kokum	hydroxycitric acid
Undi	calaustralin and toxic resin

It is used in soap making and as a substitute for ghee. Its use in confectionery is also promising. It is used for protecting bruised hands and cracked heels in winter.

Undi oil is a dark green, viscous oil with a disagreeable odour and taste. It is non-edible due to presence of lipid associate, calaustralin. The oil is refined by alcoholic treatment. Refined oil may be used in soap making. The oil contains 10%-30% resins and therefore may be profitably used in the preparation of varnish. It is also used for curing rheumatism and certain skin diseases.

Pisa oil is a dark-brown semi-solid fat. It contains 96% lauric acid which may be commercially isolated from the oil. It may be used as a substitute for coconut oil in soap industry.

Mahua fruiting branch

Kamala oil is a semi-solid fat of dark-brown colour. The refined oil is used in the preparation of varnish which is somewhat inferior in hardness and drying to those made from tung oil. It has potential for use in wrinklefinish paints as it gels rapidly. A technology has been developed to make a water thinnable coating composition from pine resin and kamala seed oil.

Dhupa oil is a light-coloured oil without any objectionable odour and taste. It contains no unusual constituent and therefore may be used for edible purposes. The composition of the oil resembles cocoa butter for which it has attracted considerable attention. It is also used in the manufacture of soap and candles. The oil has been known to possess antibacterial and antifungal activities.

Phulwarah oil is a dark-brown semi-solid fat. After refining, it is used in soap making and candle preparation. The oil also has some medicinal values. The edibility of the refined phulwarah oil is still under investigation.

Mango kernel oil is a solid fat at room temperature and has a melting point of 35° C. The National Institute of Nutrition, Hyderabad has done a great deal of work on mango kernel fat. It has been found that the fat is edible and can substitute cocoa butter profitably without any adverse effect.

Beheda kernel oil is a light-brown coloured oil without any objectionable odour and taste. The refined oil appears to be a good source of linoleic acid and edible fat. It is used by tribals for cooking. It may also be used in soap making and for isolation of pure linoleic acid.

BESIDES the minor oils of tree origin, several unconventional oils from cultivated crops and fruits and fats and oils which are already available as by-products of existing industries should be considered. The more important among them are: rice bran oil, linseed oil, castor oil, corn oil, mesta (ambadi) oil, jute seed oil, tobacco seed oil, cassava (tapioca) seed oil, rubber seed oil, watermelon seed oil, custard (sitaphal) seed oil, grape (anabshati) seed oil, lime seed oil and sweet orange (mandarin) seed oil. Among the above mentioned oils, the by-products of cotton and rice, namely, cottonseed and rice bran, make handsome contributions to oil supply and have great potential to meet edible oil needs. At present, the actual production of cottonseed oil is 2.33 lakh tonnes but there is scope for getting 5.4 lakh tonnes of oil from about 40 lakh tonnes of seed available annually. The potential for rice bran oil is 4.5 lakh tonnes against the present production of 1.5 to 2 lakh tonnes per year. Both cottonseed oil and rice bran oil are edible after easy refining. Besides, castor oil (production 1.8 lakh tonnes in 1984-85) and linseed oil (production 1.3 lakh tonnes in 1984-85) are the major non-edible oils with high potential.

Future prospects

In view of the present oil famine it is necessary to extract every drop of oil from every available source. It is obvious that the role of minor oils of tree origin for augmenting edible oil supplies is negligible today. But if properly exploited, these oils can bridge the gap between supply and demand to a great extent. Besides, there is obvious need for further investigations to utilise the less exploited oilseeds and to search for newer ones.

Further reading

1. Vimal, O.P. and Naphade, K.T. (1980), *J. Sci. Ind. Res.*, **39:** 197-211.
2. Mandal, B. and Maity, C.R. (1985), *J. Sci. Res. Pl. Med.*, **6:** 10-20.
3. Rao, M.V. (1986), *NCDC Bulletin*, **20:** 10-15.
4. *Proceedings of the Symposium on Production and Utilization of Forest Products*, Vol. III, 1979, RRL, Jammu.

Dr. Maity is Head, Biochemistry Deptt., Burdwan Medical College, Burdwan-713104

Uses of Metallic Soaps in Industry

MANY metal carboxylates have been known from ancient times. The oldest organic derivatives of metals and the alkali metal carboxylates are commonly called "soaps". These soaps are soluble in water with which they readily produce "foam", commonly used for washing or cleansing purposes. These useful properties of ordinary soluble soaps also appear to have been noticed as early as in the second century.

Carboxylates of metals other than alkali metals are generally insoluble in water and are called "metallic soaps". Metallic soaps are simple carboxylates of alkaline earths and other polyvalent metals with the general formula $M(O_2CR)_n$, where M is a metal in oxidation state n and R is an organic radical containing at least 6-7 carbon atoms.

The techniques employed in industry for the preparation of metal soaps may be classified as precipitation and fusion methods. The precipitation method involves the reaction of a soluble salt of the metal with a solution of the alkali soap in water. The fusion method generally involves either, (i) a neutralization reaction between the oxide or hydroxide of a metal with a fused fatty acid, or alternatively, (ii) a metathetic displacement reaction in which the carbonate or some other salt of the metal such as acetate, is treated with fatty acids in the fused state. The main advantage of the fusion method is the possibility of getting directly anhydrous samples of metal soaps. For preparation of metal soaps, which are susceptible to hydrolysis during the precipitation reaction or during the process of drying the hydrated soap initially obtained, the precaution is often taken in the laboratory of carrying out the reaction in an inert non-aqueous medium, such as benzene, in place of the fusion method generally employed in the industry.

The metallic soaps are soluble in a wide variety of pure and mixed organic solvents and yield liquids, gels and dispersions with characteristic colloidal properties. The solubility depends on temperature, the metal involved and the solvent employed. But the nature of acid radical, its carbon chain length, degree of unsaturation, etc., are also of considerable importance.

The physical properties of the solutions of metal soaps in organic solvents can be interpreted in terms of the micellar theory. A micelle is an aggregate of three or more soap molecules existing in the liquid thermodynamically stable equilibrium. The main cause of micellization is the energy change due to dipole-dipole interaction between the polar head group of the surfactant molecules. In certain cases hydrogen bond formation between head groups may also occur.

Uses

The first use of metal soap in the form of lead linoleates appears to have been made quite early in paint mummification. Lubricating properties of these metallic soaps were also noticed as early as 1400 B.C. when lime soap-thickened lubricants were reported to have been used for chariot wheels. However, actual manufacture of lubricating greases involving lime soaps started around 1854. A continuous search for better lubricants for the new and more complex mechanical devices was introduced gradually after the Industrial Revolution.

A grease consists of a mineral oil which has been gelled or thickened by the addition of a soap. Most commercial greases are based on the soaps of the alkali and alkaline earth metals and of those of lead and aluminium. But greases containing soaps of other heavy metals such as zinc, mercury, manganese, iron, cobalt and nickel have been prepared and used for a variety of purposes. The greases usually contain between 5% and 25% of one or more of the soaps and other material. The frequently incorporated include water, glycerol, naturally occurring waxes, esters and glycerides of fatty acids, inorganic gillers, oxidation and corrosion inhibitors, etc. This wide variation in their chemical composition is reflected in the diversity of the physical properties of commercial greases. The effectiveness with which a grease will act as a lubricant depends on various properties, including its rheology (study of elasticity, viscosity and plasticity) chemical stability, ability to adhere to metal surface, to withstand physical changes or denaturation arising from high temperature and pressure to which it may be subjected during its service life.

The applications of metallic soaps also depend largely on their physical state, stability and chemical reactivity, together with their volatility and solubility in common organic solvents and their mixtures. A wide variety of metal soaps find important applications in a number of industries, viz., soap, textile, paper, cement, ceramic, petroleum, paints, varnishes, pharmaceutical, PVC and vegetable fat industries. Carboxylates of Na, K, Mg, Ca, Ba, Zn, Al, Sn, Pb, Mn, Fe, Co, Ni and Cu have generally been commercially employed in these industries. Their appreciable solubility in organic solvents and availability at a reasonable cost make them potentially useful as waterproofing materials, flattening and softening agents, hydrogenation catalysts, greases, lubricants, driers, cosmetics, pesticides, PVC stabilizers, etc. Alkaline earth and magnesium soaps have been utilized in polyethylene molding composition and as anticaking agents for fertilizer powder. Both aluminium carboxylates and basic aluminium carboxylates have been used as textile finishing, gelling and therapeutic

agents. Palmitate and stearate of chromium, titanium and zirconium have been used as waterproofing agents, while titanium stearate has been utilized as a flameproofing agent and as a polymerization catalyst. Laurate and palmitate of titanium find extensive applications as greases and lubricants. Zinc stearate finds a number of uses as flattening and sealing agent in pharmaceutical, paper and textile industries and as lubricants in paints and varnishes. Many of these soaps were widely used for solidifying incendiary fuel in the Second World War. The lanthanum, cerium, praseodymium, neodymium, thorium, uranyl, samarium and gadolinium soaps of saturated and unsaturated fatty acids have been prepared and attempts are being made to find out their applications in different industries.

Surfactants play an important role in many human endeavours ranging from very mundane to highly sophisticated. Micellar solutions and microemulsion media offer an interesting and fecund arena for doing some very fascinating chemistry. For example, micelles have been shown to be helpful in converting solar light into chemical fuel, and such a direct energy conversion is of tremendous value. In the last few years there has been a great deal of research activity in investigating the role of surfactancts in enhanced oil recovery. The use of microemulsions as fuel and as solvents for coatings all open up intriguing possibilities. The rates of organic reactions have been shown to be accelerated by many orders of magnitude by carrying out reactions in appropriate micellar media.

S.K. Upadhyaya
Assistant Professor
Department of Chemistry
S.S.L. Jain P.G. College
Vidisha 464001 (M.P.)

Scientists Detect Substantial Antarctic Ozone Depletion

US researchers have observed a depletion of the life-protecting ozone layer over Antarctica that may equal the record-setting depletion that occurred two years ago.

Scientists at the National Aeronautics and Space Administration's (NASA's) Goddard Space Flight Center in Greenbelt, Maryland, said satellite data shows that ozone levels over Antarctica have been decreasing at about 1.5 per cent per day through September this year, nearly the same rate of decrease that resulted in a strong ozone "hole" over the southern continent in 1987.

Scientists reported earlier that the annual depletion of ozone over Antarctica may raise the risk of skin cancer as far north as southern Australia and New Zealand and could harm the microscopic algae that form the basis of the marine food chain in Antarctica. The ozone layer acts as a protective filter by absorbing ultraviolet radiation from the sun, which can cause skin cancer in humans and genetic mutations in some plants and animals.

Goddard scientists reported that the ozone concentration over Antarctica had decreased by about 30 per cent from the beginning of September. In 1987, the worst year to date, the ozone level over Antarctica declined by a total of 50 per cent by October 5. Last year the level decreased by only 15 per cent because of milder temperatures in the stratosphere.

"The ultimate depth of this year's ozone hole will depend on how long the current rate of decrease is maintained," Goddard scientist Arlin Krueger said.

The scientists reported that the powerful polar vortex, or circular air pattern, that formed over Antarctica in August was extremely cold and undisturbed. According to the current theory of the ozone hole, these are ideal conditions for the formation of polar stratospheric clouds that lead to ozone depletion. Holes in the ozone above the frozen continent develop during the Antarctic spring months when conditions are right.

NASA scientists have been monitoring ozone levels over the southern hemisphere using an instrument onboard the Nimbus-7 weather satellite for more than 10 years.

The protective ozone layer can be broken down through a chemical reaction initiated by certain man-made chemicals, principally chlorofluorocarbons or CFCs, used in refrigeration and foam production.

A recent study reported that record low ozone levels over southern Australia and New Zealand in 1987 were caused chiefly by the arrival of ozone-poor air masses from the Antarctic ozone hole.

The study, conducted by scientists at the Massachusetts Institute of Technology together with researchers from Australia and New Zealand, found that the ozone levels above the two countries appeared to be depleted by about 5 per cent in December 1987, the very time at which the Antarctic ozone hole was breaking up.

Margaret Kripke, an immunologist at the University of Texas, said that the ultraviolet radiation resulting from the ozone-depleted air over the southern hemisphere could raise the risk of skin cancer, but it is difficult to say by how much.

In another study funded by the National Science Foundation (NSF), scientists discovered that the 1988 springtime ozone hole over Antarctica allowed ground-level ultraviolet radiation to reach levels comparable to the peak of the Antarctic summer.

Based on this data, NSF geophysicist John Frederick calculated that during 1987, when a record ozone depletion was observed, the incident

(Continued on page 591)

Hasan Jawaid Khan

Life on Earth Keeps It Cool

IT is life on earth which has kept the planet cool, say David Schwartzmann of New York University and Tyler Volk of Howard University in Washington, D.C. If life had never evolved on earth, they say, the planet would be up to 50 degrees Celsius hotter. Living things have kept the planet cool by speeding up the weathering of silicate rocks. Such weathering removes the greenhouse gas carbon-dioxide from the air and thus cools the planet.

An atmosphere rich in carbon-dioxide had kept the young earth from freezing. When the earliest known fossils were laid down 3.6 billion years ago, the Sun was 20 per cent cooler than today. But as the Sun grew hotter, living things took more and more carbon-dioxide out of air. This reduced the greenhouse effect and prevented the earth's temperature from rising too high. Both Schwartzmann and Volk have studied Hawaiian basalt flows which strengthen the case for living organisms having a key role in stabilising the earth's temperature.

They found that the breakdown of rocks through chemical reactions on stone covered with lichen occurs 100 times more quickly than it does on bare rock. The chemical process of weathering cools the earth down by removing carbon-dioxide from air. Carbon-dioxide is involved in many chemical reactions that turn rock into soil and is then locked away in soil. The scientists believe that if living organisms enhance the weathering rate by a factor of 100 over bare rock, the planet may be kept 30° C cooler than what it is today. If the weathering rate is enhanced by a factor of 1000, however, the earth could be 45° C cooler.

Modifying Bacteria to Increase Livestock Productivity

MODIFIED bacteria, which form a new ecological niche, are being used in research to promote faster growth and increased efficiency in Australian wool, milk and meat production. Australian livestock is able to survive on relatively poor pastures and can digest fibrous plant material. As ruminants they obtain nutrition not directly from the plants they graze but from the digestion of rumen bacteria. This ruminant digestion system has not evolved for productivity but for the survival of the animal on rough and low quality pastures. Consequently, the rumen microbial population is unable to utilise higher quality pasture or protein supplements to best effect.

While ruminant growth depends on a balanced supply of amino acids, the rumen microbial protein from which these acids derive is often deficient in some of them. Scientists of the Department of Animal Science at the University of Adelaide's Waite Institute aim to upgrade the quality of protein produced by rumen microorganisms so that a balance of amino acids is supplied directly to the animal. It expects to do this by modifying certain species of rumen bacteria through the introduction of new genetic information that will direct the synthesis of nutritionally valuable protein. When introduced into the rumen, these modified bacteria should establish a new ecological niche and through their growth provide additional high quality nutrition, particularly the essential amino acids to the animal.

New Solution Detects Cholesterol Content

A solution developed at the Institute of Physico-chemical Medicine of the Academy of Medical Sciences in Moscow makes it possible to carry out effective tests for atherosclerosis-hardening and degeneration of arterial walls. More than half the people of the age between 35 and 55 die of infarctions and gangrene of extremities caused by atherosclerosis and degeneration of arterial walls. Since, no effective cure has as yet been found for the disease, its prevention and early diagnosis are particularly important. So if the disease is detected in the initial stages, some people can be helped by specially prescribed tests restricting the consumption of these fats; others by exercises, massage and acupuncture to prevent the disease from developing further. When the vessels are no longer able to perform their functions, a complete cure is practically ruled out.

The skin test developed at the Institute to indicate cholesterol content is done in the following way: three drops of the special solution of different concentrations, which responds to the presence of cholesterol in the skin cell membranes, are put on the patient's palm. A minute later, they are removed by a wad and a developer is applied to the same spots. Within a minute, the drops acquire a colouring the intensity of which shows the cholesterol content. If only one drop becomes coloured, it means that the patient is healthy; if two are coloured, he is in the risk group, and if three, he is sick and consequently needs a more thorough examination and urgent aid. The skin tests carried out in clinics on different groups of patients showed its high efficiency.

Teaching English to a Computer

WHAT is common between teaching a foreign student how to speak English and teaching English to a computer? Both the person and the computer are thrown into linguistic confusion when they encounter idioms, those free-wheeling expressions (such as "clutch at a straw" or "throw a book at") with meanings that should not be taken literally. Yet certain idioms can be puzzled out by the human learner of a second language, while the computer invariably remains hopelessly stuck. This is because computers, unlike people, cannot learn from experience, says Dr. Uri Zernik, a computer scientist from the General Electric Company's Research and Development Center in New York.

Dr. Zernik has constructed a computer program called RINA to model a person learning a second language. It is the first program of its kind that allows a computer to learn new phrases from experience. Dr. Zernik is equipping RINA with what he calls a "dynamic lexicon". Entries in the lexicon are not single words but entire phrases. RINA learns through failure to get things right by receiving further clues from the human user.

For instance, an exercise began when the human user typed in: "In 1977, Israel and Egypt buried the hatchet." With this limited information RINA's response was: "The nations buried a knife under the ground." But the program also recognised that this did not make sense. Next, the human user provided a modification: "No! Israel and Egypt were involved in a long conflict. In 1977, they signed a peace agreement." RINA then deduced that "bury the hatchet" is an idiom that means "to quit a dispute." It responded correctly: "They buried the hatchet; they terminated the conflict."

This new phrase was then automatically stored in RINA's lexicon for future use. Later, RINA encountered the same idiom in a different situation. This time the user typed in: "Doug buried the hatchet with his wife." RINA's correct response: "He terminated a dispute with her."

Dialysis to Treat Metal Poisonings

PATIENTS suffering from metal poisoning can now be treated more efficiently using a blood dialysis technique developed by scientists at the Technion, Israel's Institute of Technology. Conventionally, patients with metal poisonings are given drugs which attach themselves to the internal poisons and carry them out of the body. But, in addition to the poisons, they also latch on to valuable metals like iron, calcium and magnesium, often causing more damage than the poison. An additional drawback is that a single treatment of drugs takes between 24 hours and 48 hours and often it has to be repeated.

The hemodialysis method developed at the Institute takes three to five hours. The patient's blood is run through a dialysis machine and filters out medication and poisons.

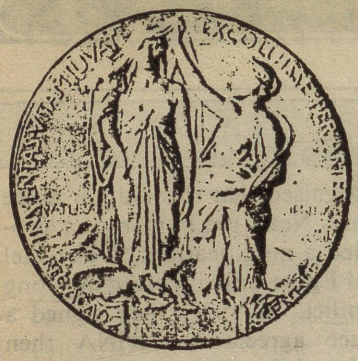
The Arctic Threatened

THE Arctic is suffering from the negative environmental effects of activities carried out in the bordering countries. Scientists have discovered that long-range transboundary air pollutants such as sulphur dioxide, nitrogen oxide, heavy metal particles and organic toxins are threatening the landmass and waters of the Arctic. Finland has, therefore, called upon countries bordering the Arctic circle to safeguard this extremely vulnerable environment which has a low capacity for recovery.

The Arctic seas are threatened by wastes discharged on the high seas and transported via currents in the Atlantic and the Pacific Oceans from oil drilling discharges and from maritime traffic and mining. Land-based pollutants such as fertilizers and pesticides, as well as radioactive emissions from nuclear plants, nuclear-fuelled vessels and nuclear accidents are also viewed as a threat.

Yeast Keeps Fruits Fresh

KEEPING fruits and vegetables fresh is a perennial problem with seemingly few effective solutions. Using chemicals to protect the fruits and vegetables once provided the solution, but increasing ecological awareness is causing concern about the efficiency of certain chemicals, and a few countries have even banned some of these. Now scientists at Israel's Agricultural Research Organization near Tel Aviv have isolated a form of yeast that occurs naturally on the skin of citrus fruits and protects them against fungi. The yeast has already been successfully tried on tomatoes and cucumbers. It was found that 96 per cent of the produce stays fresh after treatment with the yeast. It does not affect taste, and as it occurs naturally in large quantities in certain cheeses, people have been consuming large amounts of it for years.



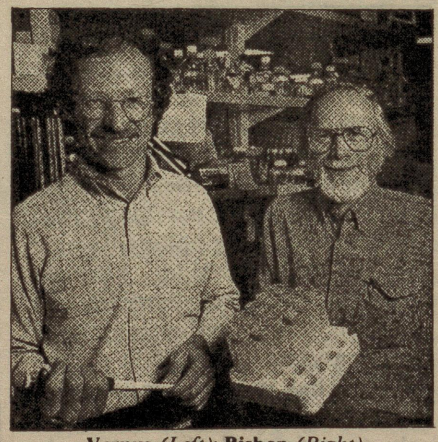
NOBELS IN SCIENCE 1989

P.S. SHANKAR

SEVEN scientists — five Americans, one Canadian-American and one West German—share this year's Nobel Prizes in science. The medicine prize recognises the researches uncovering the unsuspected cellular nature of oncogenes (cancer-causing genes), and the chemistry prize, the catalytic role of the genetic material RNA. Ingenious techniques which have led to the measurement of time and atomic events with unprecedented accuracy have been recognised in the physics award.

While the medical breakthrough may hold out promise in controlling, if not conquering, cancer, the award-winning work in chemistry (molecular biology, to be more precise) may shed fresh light on the evolution of life on Earth. The prize-winning works in physics, which have already shown their utility in the verification of quantum mechanics and in down-to-earth technological applications, have, in effect, proved that "physics, at bottom, is the art of measuring nature".

This year's Nobel prizes recognize researches on atomic clocks, cancer genes and RNA catalysts



Varnus *(Left);* **Bishop** *(Right)*

Medicine

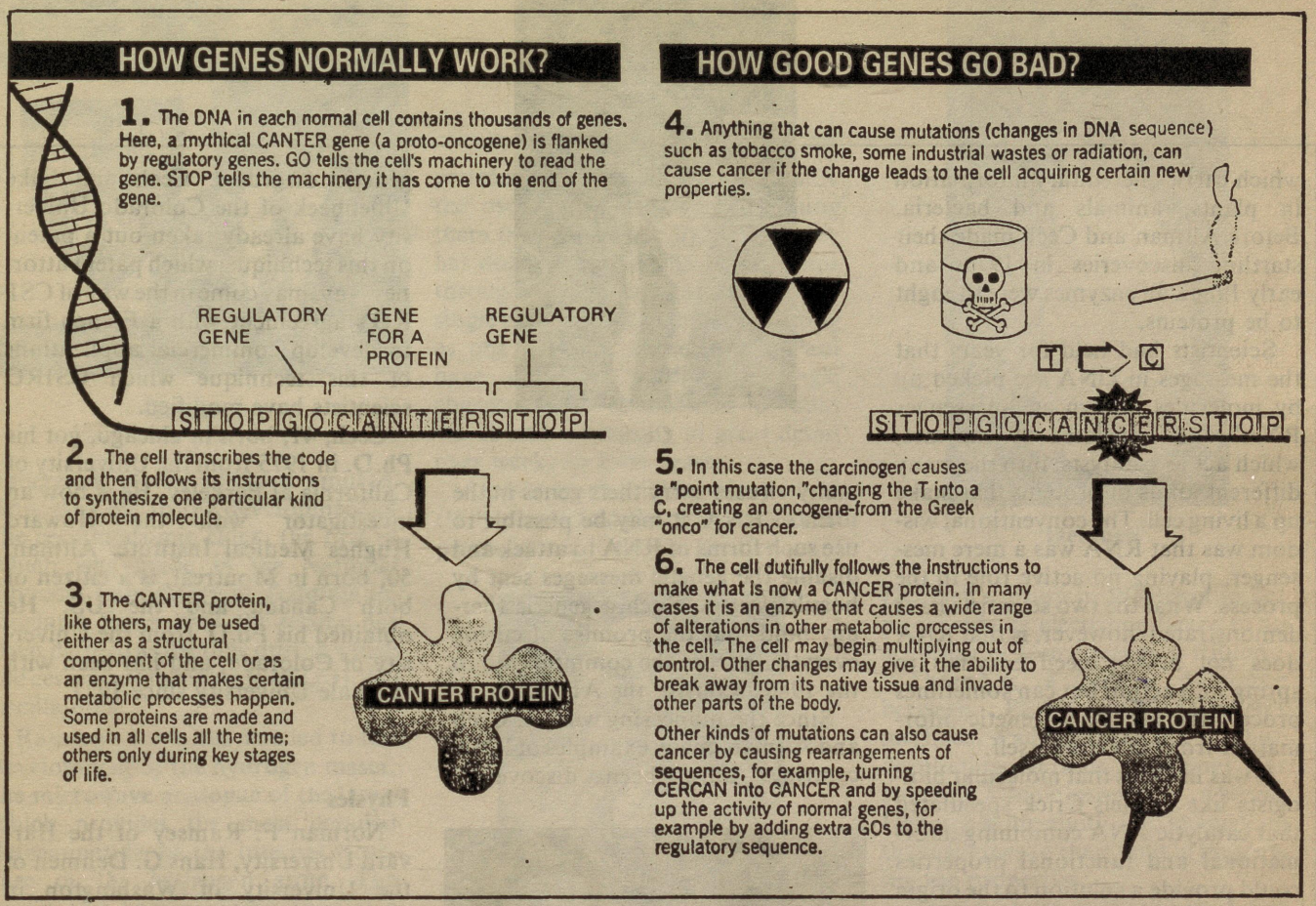
J. Michael Bishop and Harold E. Varmus of the University of California, San Francisco (UCSF) share the medicine (or physiology) prize for discovering the cellular origin of retroviral oncogenes. The discovery has transformed our understanding of the development of malignant tumours as well as of the normal processes of cell growth and differentiation. Furthermore, it has offered doctors new focal points for cancer prevention.

Bishop and Varmus's road to Nobel Prize was the landmark paper they published (jointly with Dominique Stehelin and Peter Vogt) in *Nature* in 1976. In this they showed that an oncogene in Rous sarcoma virus, which is responsible for causing cancer in chickens, is actually found in normal cells. Such sinister genes, they reasoned, must also have a role to play at times, such as the regulation of cell growth and development, in order to explain why they are conserved in the species. What, in effect, Bishop and Varmus did was to turn the oncogene hypothesis, which was the favoured hypothesis till then, on its head.

The Nobel Prize in medicine has twice before gone to research on tumour viruses. Francis Peyton Rous won the prize in 1966, for discovering, as far back as 1916, what is now called Rous sarcoma virus. In 1975, David Baltimore, Renato Dulbecco and Howard Temin shared the medicine prize for showing how tumour viruses commandeer the internal machinery of cells they invade to duplicate and package their own genes, creating new copies of the invading virus.

Varmus and Bishop's work has really established a new paradigm for our understanding of the causation of cancer, says Baltimore, who is currently heading the Whitehead Institute at the Massachusetts Institute of Technology. A member of the Nobel Assembly, Professor Peter Reichard, feels that the long-term hope springing from this piece of research is *not* that we will be able to cure all our cancer patients but that there won't be any cancer patients. According to another Assembly member Professor Goran Holm, however, it is possible to choose aggressive treatment for a cancer with a bad prognosis or leave a cancer with good prognosis alone.

Bishop and Varmus used a technique called nucleic acid hybridisation to isolate the piece of DNA that contained an oncogene known as *src* from Rous sarcoma virus. Later, they chemically constructed a "probe", a



piece of DNA with a genetic sequence that would attach to the *src* gene, allowing it to be easily identified.

A great deal of evidence has accumulated since 1976 which has corroborated the initial finding. Almost all tumour viruses have been derived from normal cellular genes. It has also been found that these proto-oncogenes are active in normal cells and their products are, indeed, involved in cell signalling, growth and differentiation.

Bishop, 53, and Varmus, 49, are physicans who received research training at the National Institutes of Health before joining UCSF. Varmus, born in Oceanside, N.Y., earned a master's degree in English at Harvard University before entering the medical school at Columbia University. Bishop, who grew up in rural Pennsylvania and attended Gettysburg College and Harvard Medical School, is also a literature buff. Both are known for their excellent scientific prose.

The two researchers are currently engaged in probing the role of oncogenes, by creating transgenic mice endowed with extra copies of such genes. Their work has touched upon neuroblastoma, a nerve-cell tumour. Bishop, in particular, is investigating the skin cancer squamous cell carcinoma, and T-cell leukamia. Varmus is studying the mouse mammary tumour gene INT-1 as well as the genetic code of HIV, the virus that causes AIDS.

The medicine prize has raised a bit of controversy. Dr Stehelin co-author of the *Nature* paper, who is with the Pasteur Institute at Lille, France, has expressed resentment at his being ignored by the Nobel committee.

Varmus and Bishop were recepients of Albert Lasker Basic Medical Research Award in 1982. This award is seen as a harbinger of the Nobel Prizes.

Chemistry

Thomas R. Cech of the University of Colorado and Sidney Altman of the Yale University got the chemistry prize for their independent discoveries that ribonucleic acid (RNA), a crucial genetic substance, is not merely a passive carrier of genetic information but could actively aid chemical reactions in the cells.

The discovery of the catalytic role of RNA has altered the central dogma of the biosciences. It would likely provide a new tool for genetic engineering, possibly creating new defences against viral infections.

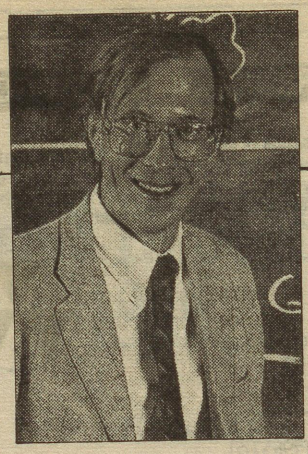
Cech and Altman forced chemistry textbooks to be rewritten when they showed that RNA could be a catalyst for, or trigger, chemical reactions. The researchers have found that RNA has the rudimentary ability to reproduce itself. An important implication is that the first living things might have arisen from RNA rather than DNA (deoxyribonucleic acid),

which carries hereditary information in plants, animals and bacteria. Before Altman and Cech made their startling discoveries in 1970s and early 1980s, all enzymes were thought to be proteins.

Scientists had held for years that the messages in DNA are picked up by molecules known as "messenger RNA" and translated by enzymes, which act as catalysts, into the many different kinds of proteins that make up a living cell. The conventional wisdom was that RNA was a mere messenger, playing no active role in the process. What the two scientists have demonstrated, however, is that RNA does not always need enzymes to spring into action but can sometimes process the necessary genetic information from DNA by itself.

It was in 1960s that molecular biologists like Francis Crick speculated that catalytic RNA combining informational and functional properties could provide a solution to the origin of life, that is, the proverbial 'chicken-and-egg' conundrum. Put differently, the mystery was whether the proteins or nucleic acids came first in the primordial soup. What Altman and Cech's discovery has shown is that our planet four billion years ago as possibly an "RNA world".

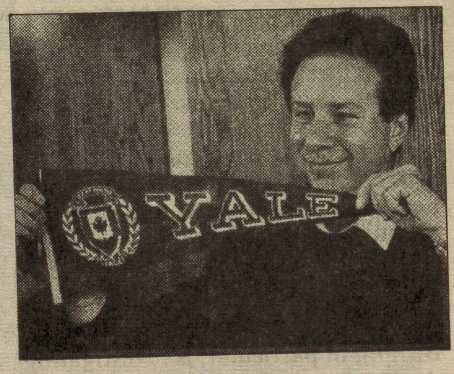
Though the two researchers made independent discoveries, it was Altman who had been vociferous about the catalytic role of RNA since the 1970s. Altman and colleagues, working with ribonuclease P, composed of a protein and an RNA, found that both components are essential for its enzymatic activity. It was for the first time that RNA had been observed to play a role in catalysis. Further work eventually led to the discovery of conditions in which the RNA component of ribonuclease P could, in the absence of protein, catalyse the maturation of tRNA (transfer RNA). The two researchers' work showed that RNA, acting as an enzyme, can cut other molecules of RNA. Since



Cech

many viruses carry their genes in the form of RNA, it may be possible to use such forms of RNA to attack and disable the genetic messages sent by hostile viruses. Such a genetic therapy holds out the promise of curing everything from the common cold to the 1980s scourge, the AIDS.

Since the pioneering work of Cech and Altman, many examples of RNA catalysis have been discovered.



Altman

Nearly 100 RNA enzymes, or "ribozymes", are known now.

Cech's work was done with RNAs from an oddball microorganism (protozoan) called *Tetrahymena thermophilis*. Sceptics were soon to point out whether the RNA-splicing he discovered was atypical. However, it was proved that the phenomenon was ubiquitous in the energy-producing organelles known as mitochondria, which produce RNA independently of the nucleus.

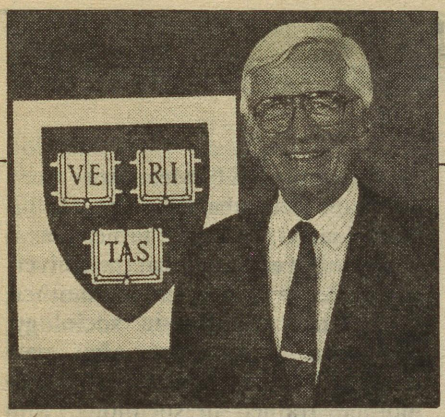
Altman and Cech's finding also forms the basis of a new technology called 'gene shears', to fight and treat genetic disorders. Cech and Olke Uhlenbeck of the Colorado University have already taken out a patent on this technique, which patent attorneys say, may come in the way of CSIRO's agreement with a French firm to develop commercial applications of this technique which CSIRO scientists have modified.

Cech, 41, born in chicago, got his Ph.D. in 1975 from the University of California at Berkeley. He is now an investigator with the Howard Hughes Medical Institute. Altman, 50, born in Montreal, is a citizen of both Canada and the US. He obtained his Ph.D. from the University of Colorado, and has been with the Yale University since 1971.

Physics

Norman F. Ramsey of the Harvard University, Hans G. Dehmelt of the University of Washington in Seattle, and Wolfgang Paul of the University of Bonn share the physics honours. Half the prize money goes to Ramsey, and the other half is shared by the other two. The prize is in recognition of their novel techniques with which to test the fundamental theories of matter and to provide accurate standards for measuring time.

Ramsey's prize is in recognition of the pioneering work he carried out at Harvard in the late 1940s and early 1950s. He perfected a method to study the structure of atoms by firing them through oscillating electromagnetic fields. Ramsey in effects refined I. I. Rabi's method for inducing atomic transitions, which consisted in passing excited atoms through a magnetic field and an electromagnetic radiation field of fixed frequency. Ramsey introduced a second radiation field, setting up an interference pattern with the first in which photons needed to induce an atomic transition existed only in certain places. The result was the increased



Ramsay

coherence of the photons emitted. This idea led to the development of the cesium atomic clock, the first of which was made in the National Physical Laboratory at Teddington, England. Since 1967, the second has been defined as the time during which the cesium atom makes 9,192,631,770 oscillations.

Ramsey's work has also led to the development of the hydrogen maser, the microwave analogue of the laser, which provides the most detailed determination of the internal structure of the hydrogen atom. The maser also became widely used as a reference source in interferometric techniques in radioastronomy. With recent refinements, the maser may be able to measure frequencies with a stability of one part in a billion billion (10^{18}). To put it differently, an atomic clock would have by now gained or lost less than a second had it been set running at the time of the dinosaurs.

Masers have also enabled scientists to track the infinitesimally slow drift of the continents across the Earth's surface and to check the predictions of Einstein's theory of relativity that gravity or acceleration will cause a clock to run slow.

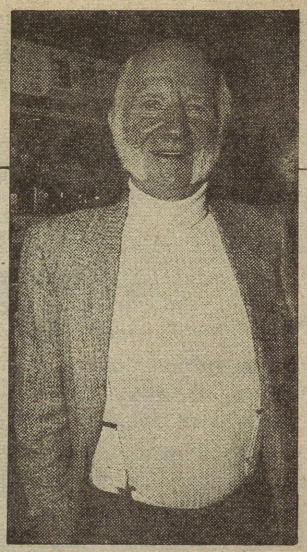
Paul and Dehmelt's prize-winning work relates to the development, independently, of the ion-trap method for separating ions, or electrically charged particles, so that they can be studied in detail. Based on their work, even more precise clocks are being developed.

Harvard physicist Nicolaas Bloembergen says that the physics prizes represent two ways to measure the oscillations of atoms: 'catching them (atoms) on the fly', as Ramsey has done by blasting beams of atoms through electric fields; or, 'catching a single atom and looking at it as long as one likes', as Dehmelt and Paul have done by cradling a single charged atom or electron in radio waves and examining in great detail over weeks or even years.

Atomic traps enable scientists to study atoms and electrons with great precision and to test the predictions of quantum electrodynamics theory and Einstein's theory of relativity.

Paul

In 1950s Paul developed in Bonn what is now known as the 'Paul trap' for trapping atoms and ions. He invented methods to focus ions using multipolar magnetic fields, separate ions of different masses, and store them in traps of electric fields with a pervading radiofrequency radiation field. Dehmelt and his colleagues are credited with the development of a different method, not known by their name though, but as 'Penning trap', which uses static electric and magnetic fields instead of an alternating field. They used this method in 1973 to capture and hold a single electron.



Dehmelt

Dehmelt's group in Washington has measured the electron g-factor to an accuracy of four parts in a trillion.

There is a subtle difference between Paul's and Dehmelt's methods. Paul's reputation owes to developing various machines for studying atomic properties, whereas Dehmelt's ingenuity lies in pushing the machines to their limit in measuring the properties.

Ramsey, born in Washington, has been with Harvard since 1947. According to Daniel Kleppner of MIT, Ramsey is a 'statesman of science' and a 'monumental figure in contemporary physics'. Kleppner is co-inventor with Ramsey of the hydrogen maser.

Paul, 76, was born in Lorenzkirch (now in GDR), and has been professor at the University of Bonn since 1952. Born in Gorlitz (now in GDR), Dehmelt, 67, went to the USA in early 1950s, working first at Duke and then the University of Washington. He won the 1970 Davisson-Germer Prize of the American Physical Society. Experts say that Paul and Dehmelt's development of ion traps is undoubtedly of Nobel quality, while Ramsey's prize might be in recognition of an outstanding physics career.

Sh. Shankar is a former editor of Journal of Scientific & Industrial Research. Present address: 139, Akash Darshan Apartments Mayur Vihar Phase-I Delhi 110092

Margaret Mead and the Samoans

HARDLY 24, yet keen to make a name in the field of anthropology, (the subject dealing with man, his culture, social system, life-style, etc.), Margaret Mead had decided that she would study only the primitive people of her choice. Her choice had fallen on Samoans, the people inhabiting remote islands in the Pacific Ocean, which nobody had studied till then. But her guide Franz Boas was against her choice because he feared for her safety in those remote islands. He tried his best to persuade her to visit some easily accessible local American Indian tribes but to no avail. Even when he declined to grant her money for the field trip she did not bow down. Her aim was clear: she would study only those people whom she could call her own. She asked her father, who had once promised to pay her for a world trip, to fund her trip. When he agreed and Boas realised she would go to Samoa in any case, he heeded and granted her all facilities and money for the field trip!

It was indeed an audacious step on the part of the young lady to go alone to study a primitive tribe. But her heart was set on it and she was confidant that she would be able to handle the people and obtain the necessary anthropological information. And she did come forth. with flying colours. Her experiences during the nine-month stay in that remote Pacific island of Samoa became immortal in the history of anthropology. Basically meant to be an anthropological report on Samoan people, those experiences written in novel form *Coming of Age in Samoa* were appreciated by not simply scholars but public at large. The book became an instant bestseller and introduced the fascinating world of anthropology to the common man. It even changed the course of American anthropology. In fact, she became a "visible" scientist and a legend in her own time. Her views, opinions and comments on various aspects of American life and the world at large were valued and treasured. When she died the World Almanac selected her as one of the 25 most influential women in the world.

Margaret Mead at 16

MARGARET Mead was born on December 16, 1901, at Philadelphia, U.S.A. Her father was a professor of economics at the University of Pennsylvania and her mother, though had a degree in sociology, had given up her career after marriage. However, it was her grandmother, trained in sociology, who exerted decisive influence on her tender mind. From the childhood she trained Margaret in observing not only nature and animals but also her (Margaret's) own siblings and family members. She also trained her in peeling apples and in embroidary but at the same time she inculcated in her the feeling that she should never feel handicapped to perform a task just because she was a woman. Meanwhile her father guided her on how to give a lecture and recite poetry, think clearly, and so on. Living in an academic world, she also learnt how academicians behave and play politics. Initially, Margaret was keen to become a painter but soon her interest shifted to literature. She began to write for school magazines and wanted to become a writer. However, her father was not keen that she should join college because of financial reasons, though he told her that there was no point in further study because she was already engaged to one Luther Cressman and would get married in due course. But her mother, who always preferred donating money for a fellowship to a poor student rather than buying a new carpet, prevailed upon her father to send her to college because she felt it makes a full human being.

At the age of 17, Margaret joined Barnard College with the intention to study literature and become a writer. Here she was taught by one of the giants of American anthropology, Franz Boas and his assistant, Ruth Benedict, who went on to make a name for herself in anthropology. These two persons influenced her thinking so much that she began to wonder whether she should become a psychologist, sociologist or anthro-

pologist. When she asked Ruth what she should do, she (Ruth) replied, "Professor Boas and I have nothing to offer but an opportunity to do work that matters". And Margaret selected anthropology because she wanted her own life to matter. Those were the days when anthropology was in its classical phase. Studies of primitive cultures were based on the travel accounts of explorers and the rumours that tourists heard. Moreover, primitive cultures were also fast vanishing due to the inroads of modernity. Boas was therefore keen to send his students on field studies of those fast vanishing tribes. He was particularly keen that somebody should conduct a study of adolescents in a primitive tribe because he wanted to find out whether they underwent the same psychological crises as American adolescents then did. In other words, he wanted to determine whether it is genetics or environment which has a role to play in moulding the psychology of adolescents. He suggested Margaret to study adolescents in some American Indian tribe but she had already made up her mind as narrated above. She went to the remote of island of Tau in the Pacific Ocean where Samoans live.

With a Samoan girl

WITH a portable typewriter, notebooks, carbon papers, a camera and other things, Margaret boarded the ship to reach Samoan people in 1925. She first reached Pago island, where in a hotel she learnt Samoan language and then shifted to the island of Tau. Here she lived in the house of a local doctor. But soon she became a part and parcel of the local Samoan community. She ate their food, wore their dresses, took bath in open air, learnt Samoan etiquette and even tended their children and the sick. She also took part in their rituals and customs. This involvement with her "own people" helped her not only to make friendship with young boys and girls but also to understand their life-style, psychology and sex life. She found that young Samoan boys and girls were carefree in matters of sex, had no sexual problems and had no intense involvement about anything. As a result, Samoan adolescents never experienced psychological crises at any time. "The girls' minds were perplexed by no conflicts, troubled by no philosophical queries, beset by no remote ambitions. To live as a girl with many lovers as long as possible and then to marry in one's own village, near one's relatives and to have many children, these were uniform and satisfying ambitions," wrote Margaret later.

In other words, she arrived at the conclusion that the American adolescents underwent crises due to cultural reasons which have nothing to do with genetics. When she returned home after a nine-month stay in Tau, she was supposed to write an anthropological report on her findings. But instead she wrote the book *Coming of Age in Samoa* which narrated her experiences in a novel-like style. In addition to her observations on Samoan adolescents, she also compared their psychology, life-style and behaviour with those of American adolescents. She went on to suggest that American youth should adopt some aspects of Samoan life. This suggestion was welcomed by the American youth who were already fighting against Victorian attitudes of their elders towards sex. Her book as a result became a center of controversy in the U.S.A. and was widely read. Years later, she was awarded the Kalinga Prize for science popularisation for this book and many other equally interesting anthropological books that she wrote. Meanwhile, in 1929, she received Ph.D.

from the University of Columbia for her findings on Samoan adolescents. She joined the American Museum of Natural History, an institution she worked for till her death in 1978.

DURING the ship journey back from Samoa, Margaret met Roe Fortune, a New Zealand psychologist. She decided to divorce her first husband and marry him because she thought he would be a better companion from career point of view rather than a sociologist which her first husband was. Earlier, she had a few miscarriages and had almost given up the idea of having a child and so career had become her only goal in life. With Roe Fortune she went to conduct field studies in the Admiralty Islands where Manus, the fishing and trading people lived. She had once read Sigmund Freud's theory that the mind of a primitive man is similar to that of a child in a civilized world in that he believes in magic and other non-rational things. She was keen to test this theory and to determine what is in the mind of primitive children. However, using the psychological tests that she had evolved on the basis of drawings of children, she found that neither primitive adult nor child held any magical or irrational notions about the world. This field work in the company of Roe Fortune was her most enjoyable and intellectually satisfying experience. She had become so emotionally tied up with the people and locale that she visited the island several times later. Her findings and experiences appeared in yet another bestseller *Growing Up in New Guinea.* It was the first time she had studied how children grow up and had compared the child-rearing practices of the Manus with people of other cultures. This work set a new trend in anthropology because till then no anthropologist had given importance to children and women in their studies. Later, she and her third husband (she divorced her second husband), the British biologist Gregory Bateson, whom she met during a field trip to Bali, were also jointly responsible for the development of visual anthropology. They took extensive photographs and films to document the vanishing cultures of various primitive tribes.

Mead showing a model of primitive village at American Natural History Museum *(U.S.I.S.)*

Short and heavy set, Margaret in her simple printed dress and with light brown hair symbolised the entire discipline of anthropology for the public. She was always ready to plunge into any intellectual debate. She particularly felt irritated whenever women tried to be anything but feminine. "I have always done a woman's job," she would say emphatically. Having been to more than 12 expeditions, authored 20 books and hundreds of scholarly articles, she had become a "guru" for the American youth of the 60s. In later years, she led an extremely busy public life. She used to appear in radio and TV programmes and used to give talks and lectures. Her opinion was sought on any subject under the sun—from world hunger to military duty to art and sex. She repeatedly emphasised that parents cannot prepare their children for the future and so they (children) had to create it for themselves. Though she herself never posed to be a reformer, she felt that a society could be reformed—not by a revolution overnight—by altering the parameters that condition social behaviour. To discover the ways and means to make the mankind healthy and happy was the reason why she had taken to anthropology.

IN the field of anthropology, Margaret founded the "Culture and personality" school of thought which examines the way in which a culture shapes the personality of an individual. Apart from introducing several procedures which have become standard for fieldwork in the subject, she also developed a new branch called "Ekistics" which deals with human settlements and their

improvement using the research findings in architecture, sociology and city-planning. In fact, she always stressed upon the role of subjects as diverse as physiology, ecology, nutrition, economics, etc., in gaining new insights into different cultures. Out of the royalties of her books, she established the Institute for Intercultural Studies where she helped young, struggling anthropologists to find their feet in the field. Somehow, her contemporary anthropologists always doubted her conclusions because they felt she arrived at them very fast. She was as a result always a controversial figure in anthropology. Recently, about a decade after her death, her book *Coming of Age in Samoa* came under a barrage of criticism from an anthropologist Derek Freeman who had studied Samoans for 12 years. He claims that Samoans are quite unlike what Margaret had described them in her book—easy-going, free of sex problems and mental traumas. An otherwise big admirer of Margaret, he has written a book on his own findings *Margaret Mead and Samoa.* He intends to produce a musical on her out of the royalties from the book. Margaret would have certainly appreciated the musical, though she would not have hedged a whit about her findings on Samoans.

Dilip M. Salwi

Numbers with Startling Characteristics

SOME numbers show amazingly striking features. They have some hidden characteristics which are indeed startling. Take, for example, the three digit-number 123 formed by using the consecutive digits 1, 2, and 3. This number shows the following hidden characteristics:

123 : multiple of 3
12 : multiple of 2
1 : multiple of 1

The three-digit number 123 is a multiple of 3. The two-digit number 12, obtained by truncating the last digit from 123, is a multiple of 2; and the one-digit number 1 obtained by truncating two-digits from the right of the parent number is a multiple of 1. Another three-digit number also exhibits the same characteristics:

321 : multiple of 3
32 : multiple of 2
3 : multiple of 1

The six-digit number 123654 using the consecutive digits 1-6 shows the same startling characteristics:

123654 : multiple of 6
12365 : multiple of 5
1236 : multiple of 4
123 : multiple of 3
12 : multiple of 2
1 : multiple of 1

So is the case with the six-digit number 321654. The eight-digit number 38165472 also exhibits the same behaviour. This number is a multiple of 8; the seven digit number 3816547 obtained by truncating the last digit is a multiple of 7; and so on. The nine-digit number 381654729 also shows the same hidden characteristics.

Is it possible to find a four-digit number using the consecutive digits 1-4 which shows the envisaged characteristics? The desired four-digit number must obviously be divisible by 4. So, the last two digits can either be 12 or 32. The sought for number must, therefore, be of the form —12 or —32. Using the remaining digits to fill the gaps, the numbers which result are 3412, 4312, 1432 and 4132. To satisfy the envisaged property, the three-digit numbers 341, 431, 143 and 413 formed by truncating the last digit 2 from the parent numbers must be multiples of 3; for which the test is that the sum of the digits must be divisible by 3. This is obviously not satisfied by any of these numbers. So, the inevitable conclusion is that the four-digit numbers satisfying the desired property do not exist. By similar reasoning it can be shown that five and seven-digit numbers exhibiting the desired characteristics also do not exist.

How could the six-digit numbers showing the hidden characteristics be obtained? Let the six-digit number be denoted by *abcdef*. As the numbers *abcdef, abcd,* and *ab* must be multiples of 6, 4 and 2 respectively, they must be even. It is therefore clear that the even digits 2, 4, 6 must occupy the places of *b, d, f* while the odd digits must go to the places of *a, c, e.*

To satisfy the said property, the number *abcde* must be a multiple of 5, so *e* must be 5. Also, the four-digit number *abcd* must be a multiple of 4 and so *cd* must be divisible by 4. As *c* has to be odd and *d* even, *cd* can only be 12, 16, 32 or 36. The six-digit number can then be either *ab*125*f*, *ab*165*f*, *ab*325*f* or *ab*365*f*.

For a number to be a multiple of 6, it must be even and the sum of its digits must be divisible by 3; whereas for a number to be a multiple of 3, the sum of its digits must be divisible by 3. Combining these tests it is clear that the three-digit numbers formed by the first three as well the last three digits must separately be divisible by 3. Considering the first and third possibilities *ab*125*f* and *ab*325*f*, the last digit can either be 4 or 6. The sum of the last three-digits in either case is not divisible by 3. Hence, these are not the numbers sought for. Coming to the second possibility *ab*165*f*, the last digit *f* can either be 2 or 4. But only $f=4$ makes the sum of the last three-digits divisible by 3. So, one of the choices for the six-digit number is *ab*1654. Since *a* has to be odd and *b* even, the only choices for *a* and *b* are: $a=3$ and $b=2$. The resulting number is therefore 321654.

Exploring the fourth possibility *ab*365*f* in the above manner, the following values are obtained: $f=4, a=1, b=2$ which lead to the desired number 123654. So, the two possible six-digit numbers satisfying the envisaged property are 321654 and 123654.

The eight-digit number conforming to the aforesaid property can also be obtained. Denote the number by *abcdefgh*. It is clear from the above considerations that digits in the odd places must be odd while those in the even places even. Further *e* must be 5 and *d* can either be 2 or 6. Also, $d+e+f$ must be divisible by 3, and so also be $a+b+c$. This leads to the following two possibilities:

*abc*258*gh*
*abc*654*gh*

For the eight-digit number to be a multiple of 8, the last three-digits should be divisible by 8. This leaves only one possibility for the first number and two possibilities for the second number:

*abc*258 16
*abc*654 32
*abc*654 72

It is trivial to find the digits which must go in the remaining places. The various possibilities are:

34725816
74325816
18765432
78165432
18365472
38165472

The first four possibilities are obviously ruled out because the condition that sum of the first three-digits must be divisible by 3 is not satisfied in any of these cases. This leaves out the last two possibilities. Of these, the number 18365472 does not satisfy the envisaged property, for the seven-digit number 1836547 is not divisible by 7. So, 38165472 is the only desired eight-digit number. It is interesting to note that just by affixing the digit 9 at the end of the number 38165472 generates a nine-digit number 381654729 which satisfies the envisaged characteristics.

P.K. Mukherjee
Physics Department
Deshbandhu College, Kalkajee
New Delhi-110019

Science Quiz

IN the quiz given below, the reader is required to fill in the blanks with appropriate words. The first letters of the answers will form the English alphabets in reverse order.

1. The mass of a neutrino is .....
2. ..... theory suggests that nuclear forces arise due to the exchange of mesons.
3. The electromagnetic radiations whose wavelength range is from 10 A.U. to 0.1 A.U. approximately are called.....
4. Heavy ..... is used as a moderator in nuclear reactors.
5. ..... is used to measure the rate of flow of a fluid through a tube.
6. Werner Heisenberg enunciated the ..... principle.
7. In a ..... wave the individual particles of the medium vibrate perpendicular to the direction of travel.
8. The total number of crystal systems is .....
9. The dust on the blades of a fan is not blown off because at the surface of the blades the ..... velocity of air is zero.
10. Pauli's exclusion principle states that no two electrons in an atom can have the same values for all the four ..... numbers.
11. In domestic gas lighters ..... materials are used for producing sparks for ignition.
12. An ..... has eight faces but only six corners.
13. The National Environmental Engineering Research Institute is located at .....
14. Fe_2O_3 and CrO_2 are widely used for producing ..... recording tapes.
15. In the modern electronic calculators and digital watches ..... crystals are used for numeric displays.
16. The ..... energy of a body is proportional to the square of its momentum.
17. ..... invented natural logarithms.
18. In rotational motion, moment of ..... of a body plays a role analogous to that of mass in linear motion.
19. The bonds between H_2O molecules in ice are known as ..... bonds.
20. The period of revolution of a ..... satellite is 24 hours.
21. ..... are used as cores of high-frequency transformers.
22. Maximum sunspot activity occurs once in ..... years.
23. The resistivity of a semiconductor ..... as the temperature increases.
24. In ..... crystals, light travels with the same speed in all directions.
25. ..... oxide and silica are mainly required for making heat-resistant glass.
26. To minimise reflection from the surface of a camera lens ..... coatings are used.

S. Sakthi Kumar
Lecturer in Physics
A.C. College of Engg.,
Karaikudi-623004

Answers to the Science Quiz

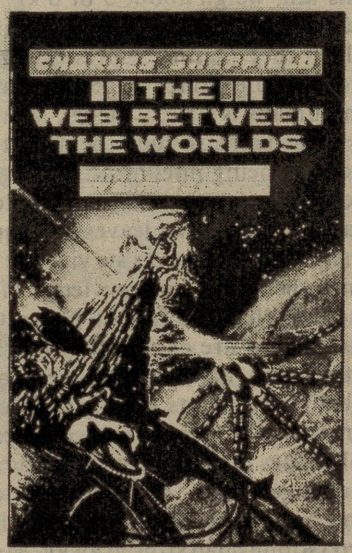
1. Zero; 2. Yukawa; 3. X-rays; 4. Water; 5. Venturimeter; 6. Uncertainty; 7. Transverse; 8. Seven; 9. Relative; 10. Quantum; 11. Piezoelectric; 12. Octahedron; 13. Nagpur; 14. Magnetic; 15. Liquid; 16. Kinetic; 17. John Napier; 18. Inertia; 19. Hydrogen; 20. Geostationary; 21. Ferrites; 22. Eleven; 23. Decreases; 24. Cubic; 25. Boric; 26. Antireflection

THE WEB BETWEEN THE WORLDS *by* Charles Sheffield *Sphere Books Ltd,* pp 257, £3.50 (Available from: *Penguin Overseas Ltd,* 706, Eros Apts., Nehru Place, New Delhi-110019)

THE interaction of society with science and technology forms the basic theme of science fiction. Depending upon their preferences, science fiction authors have specialised in stressing either technical aspects of inventions or the social aspect of the interactions. This gives rise to the so called "hard" and "soft" science fiction. "Hard" science fiction is usually quite difficult to write since it involves a good grasp of technology and the ability to create convincing characters and situations. Arthur Clarke, Larry Niven, Hal Clement and Robert L. Forward are usually considered the masters of this genre. Now they seem to have a competitor in Charles Sheffield.

The only way we now have of getting off earth and moving around in space is by means of rockets. This however is extremely inefficient and expensive, since tonnes of fuel have to be burnt to lift mere kilograms into orbit. The advent of the Space Shuttle has not really changed the situation. Once in space it may be possible to use sophisticated techniques such as solar sails, ion engines, etc., to get around (though they have not yet been tried out on adequate scale) but so far there is no alternative to good old rockets for the first job of getting into orbit.

The situation is bad but certainly not for want of ideas. An alternative to rockets in the form of a "space ladder" suspended from a statellite in geo-stationary orbit and connected to earth has been independently discovered at least three times in this century. As the stationary orbit has an orbital period of 24 hours, spacecraft in this orbit will hover over a point on the equator and hence can be connected to earth by means of a "ladder" or pole. Every element of the pole below the stationary orbit (a height of 35770 km) will exert a net downward force, as it is moving too slowly for centrifugal acceleration to balance gravitational attraction. Every element above this would feel a net outward force since here the centrifugal force exceeds gravitational attraction. By balancing the lengths above and below the orbit, a pole can be made to touch the earth but exert no downward force. It will now been



in static equilibrium revolving with earth. A ballast at the top can reduce cable length. The whole structure could be about 130,000 km long, and weigh somewhat less than a billion tonnes, not counting the weight of the ballast (which would be about a billion tonnes also). It can now be fitted with passenger cabins and freight cars and carry them up into the space to be released at different points on the top of the pole. The energy provided by the rotation of earth will be transformed into the kinetic of the freight, and depending upon where it is released, it can travel to the furthest ends of the solar system. The energy needed to operate the system is simply electrical energy sufficient to carry the spacecraft upto the top of the ladder and part of this can be recovered by descending freight or spacecraft. Electrical energy can be generated in plently from space solar satellites. To reach orbit, it will cost roughly Rs. 500 per kg, as compared to the Rs. 200,000 or so per kg that we have to spend now. All in all, a wonderful proposition. The major problem at present is that the materials we have at the moment are not strong enough. The strength of the cable material can be expressed in terms of the "support length", i.e., the maximum freely hanging length that a cable of constant diameter will support under one constant earth gravity. A space ladder material should have a support length of 4940 kms. The strongest materials at present, Kevlar and dislocation-free silicon and graphite whisker, have support lengths of 200, 660 and 1050 kms respectively. The best steel wire has a support length of 54 km, a factor 100 times too small. There is however hope that material strengths can be increased by more than a factor of ten in the next two decades, giving an ample margin for the construction of the space ladder should we wish it.

The concept has been variously called the space ladder, space elevator, Jacob's ladder, skyhook, anchored satellite, orbital tower, heavenly funicular and "beanstalk". The best name seems to be beanstalk, from the story of the Jack and the Beanstalk. Different authors have explored it in some detail. The best among them is still Arthur Clarke's *Fountains of Paradise* published in about 1972. Larry Niven's *Descent of the Ananzi* was also quite good, exploring the concept of a "Bolo" type satellite, a variant of the space ladder concept. The present book is extremely interesting and carries the idea forward for interplanetary transportation as well.

The story is set about a century from now, with large space manufacturing capability and a well utilised Asteroid Belt. Most of the metals

needed for earth are obtained by processing asteroids by means of solar energy. The main protagonist of the story is a young engineer, Robert Merlin who is a specialist in the construction of extremely large structures such as bridges across the straits of Gibralter, Tasmania, Taiwan and so on. He is also distinguished by having two artificial hands of great dexterity, to replace his own which he lost at birth in an air crash in which his mother was killed, while carrying him in her womb. He is approached by Regulo, a businessman-cum-engineer who lives in his own personal satellite in the solar system. He had won fame and wealth by carrying out the closest approach to the Sun ever made by a human being, when he survived by keeping in the shadow of a rotating asteroid which he was bringing to near earth region for processing. He is badly disfigured by this experience and has a strong aversion to sunlight. Regulo has a company handling approximately 50% of the earth space traffic. So he has a keen interest in devising alternate systems of transportation ahead of the competition. He sends his secretary to entice Merlin to come and visit at his temporary home in orbit (he is too weak to come to the surface of earth) where they discuss the details of constructing a space ladder. Regulo's main home is an "aquasphere" which he has constructed by collecting water from comets and in which a great biological genius named Morel has constructed a fully functional ecology. The bulk of the aquasphere consists of a fresh water sea, illuminated by sunlight and with a soil bottom constructed out of asteroidal debris. Regulo's quarters and the living system (for humans) in the satellite is the spherical core under the soil cover. Morel's main interest is a great squid named Caliban, which has modified to develop great intelligence and communicate directly with the computers of the satellite. Caliban has access to all the data coming into the satellite. The biologist is also involved in developing anti-cancer and anti-aging therapies which Regulo needs badly since he suffers from a particularly non-tractable cancer which debilitates him totally. To carry out his research involving specially intractable human diseases for which animal experimentation is inadequate, Morel has developed a special breed of human, who age at accelerated pace, on the grounds that the best experimental animal for human tissue/cell problems will be another human. The special breed, called "Goblins", are only about 50 cms tall, weigh about 5 or 6 kg, and have full life spans of only 3-4 years in which they mature, reproduce, grow old and die. Since experimentation on humans is strictly illegal, Morel is at great pains to hide them. But the Goblins being intelligent, manage to stow away occasionally on whatever transportation that leaves the Aquasphere. But they never survive the trip since they have no knowledge of the vacuum that the freight boxes they travelled in are exposed to. Merlin's father and mother who were both killed in accidents shortly before his birth turn out to have been former colleagues of Morel with whom he exchanged data and samples, and who happened to get a box in which two Goblins had stowed away. Morel has them killed (along with a lot of other people) to hide his secret. The younger Merlin has plenty of opportunity to rummage the Aquasphere after building and safely anchoring the space ladder, and since he knows about Morel's complicity in his parents' death, he has a motive too. He breaks into Morel's super secret lab, and discovers the Goblins. Morel tries to kill him, but is himself killed by Caliban whom Merlin allows to reach the lab by removing the access port, (which opens out into the water of the aquasphere), breaking his artificial hands in the process. Regulo, after being confronted with the evidence, commits suicide by jumping into a molten asteroid under processing, since he is as fully involved as Morel in the illegal experimentation on human beings. Regulo's secretary (who turns out to have been his daughter as well) and Merlin fell in love with each other and presumably live happily there after.

The story is very interesting but the characterisation is a bit poor. The characters, including the heros Merlin and Regulo, lack depth and do not make much of an impact on the reader. But for people who like "hard" scence fiction, this a fairly minor problem. There are a lot of quite nice concepts here, for instance, the idea that the space ladder concept can be modified for interplanetary transportation. The spacecraft discharged from the space ladder can be caught, and either accelerated further or decelerated as required, by means of a "centrifuge" which is essentially a bar some thousands of kilometres long, anchored in the middle on an asteroid and having a catching device at either end. The "spider" invented by Merlin for extruding dislocation-free silicon or graphite fibres, and to carry out required constructions from pre-stored AI programmes is another beautiful concept. There are descriptions of a cave 12 km deep in earth's crust existing in spite of all geodynamic theories (but finally closing up and killing a lot of people) and special types of drug addiction. The author is somewhat out of his depth when it comes to exploring the social implications of these. There are also a lot of loose ends, for instance, Caliban is supposed to communicate with the Goblins and help them escape but no where is a plausible means of communication shown. And the Goblins themselves are not really needed, since by the next century tissue culture and genetic engineering would be advanced enough so that experimenting on live animals may be unnecessary. But all this is detail, the basic story is quite readable, and this is a book well worth buying.

S. Mohan

BOOK REVIEWS

THE MAGIC OF GALAXIES AND STARS *by* L.E. Gurevich and A.D. Chernin, *Mir Publishers* (Available from: *U.S.S.R. Book Center,* Connaught Circus, New Delhi-110001), Pp. 199, Rs. 9.75.

COSMOLOGY is the science of the universe as a whole while cosmogony deals with the theory of creation of the universe. The modern development of cosmogony relates to the astronomical discoveries made during the past two decades or so, starting from the discovery of quasars in 1963 and microwave background radiation in 1965.

The book under review deals with the latest achievements of cosmogony, its problems and prospects. Going though six chapters, the first chapter of the book deals with the outlines of the modern astronomical understanding of the universe and the principal ideas of cosmology. Chapter 2 deals with the origination of the large-scale structure of the universe. Chapter 3 discusses the various hypotheses on the nature of galactic rotation, including the hypothesis which is currently being developed on the basis of gravitational instability in the expanding hot universe. The birth and evolution of stars and the evolution of stellar systems are given coverage in Chapters 4 and 5 respectively.

The mass of galactic coronas is believed to exceed the total mass of the stars they surround. This "hidden mass" poses a perplexing puzzle for astronomers. However, recent advancements in the field of elementary particles reveal that galactic coronas seem to be filled with neutrinos, which hold the key to the riddle. Chapter 6 discusses the "hidden mass", the neutrinos, and the bizzare concept of Einstein's vacuum. The book has been written in a lucid manner in a simple language. Those who want to know about the intriguing modern concepts of astrophysics would be interested in the book. A book worth buying for personal use as well as for school and college libraries.

P.K. Mukherjee

GAS DYNAMICS THROUGH PROBLEMS *by* Zoeb Husain, *Wiley Eastern Ltd.*, 4835/24, Ansari Road, Daryaganj, New Delhi-110002, Pp. 190, Rs. 50.00

THE study of Gas Dynamics, which deals with fluid flow at high speeds, has of late attained much significance, more so because of its engineering applications. A definite need is, therefore, being felt to introduce Gas Dynamics as a basic course in engineering at the undergraduate level of Indian universities. The book under review has been written as a supplement to any standard text-book on Gas Dynamics. However, topics mainly of interest to mechanical engineers have been given coverage in the book.

The book is divided into six chapters. Thermodynamics and Fluid Mechanics are discussed in Chapter 1 while Chapter 2 deals with one dimensional compressible flow. Chapter 3 deals with flow in duct of variable cross-sectional area, while flow in duct of constant cross-sectional area with friction (Fanno Line) and heat transfer (Rayleigh Line) respectively are given coverage in Chapters 4 and 5. The last chapter deals with the topic of Normal Shocks.

The book gives brief theory of the subject along with the derivation of relevant formulae and a large number of worked-out examples. The topics have been presented in a lucid manner and in an easy-to-understand language. The book will prove to be of immense help to engineering students taking courses in air-breathing engines, rockets, gas turbines, etc. The air tables given in the book and reference to literature included at the end will prove to be of further value to students.

P.K. Mukherjee

Books Received

1. **HANDLE CONCRETE WITH EAST** *by* P.S. Danke, *Vithal Publications,* A 1/7, Aayakar Housing Society, Near Bhavani Temple, Beyond Anand Nagar, Kotharud, Pune-411029, Pp. 30+Appendices, Rs. 50.00

2. **1000 MATHS QUIZ** *by* Dilip M. Salwi, *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, N. Delhi-110002, Pp. 144. Rs. 30.00

SCIENCE SPECTRUM (Continued from page 577)

ultraviolet radiation dose in Antarctica doubled. If this pattern repeats itself, he said, the 1989 springtime radiation level at ground level is almost certain to exceed that of the summer solstice.

Deneb Karentz, a marine biologist at the University of California, said that this increase in ultraviolet radiation is worrisome because "it is so sudden and occurs at a time when organisms are emerging from the dark winter period and thus have not had time to adapt to the sun being up."

Research in the tropics has shown that added amounts of ultraviolet radiation can kill phytoplankton in the sea. Scientists have expressed concern that if Antarctic phytoplankton are affected, so will the krill, the tiny animals that feed on them, and then fish, seabirds, seals and whales. □

TO OUR CONTRIBUTORS

SCIENCE REPORTER welcomes articles of absorbing interest on science and technology. Contributions published in the Journal will be paid for.

- Articles should be sent to the Editor, **SCIENCE REPORTER, PID (CSIR), Hillside Road, New Delhi-110012.**
- The form and manner of presentation of the subject should be easily understandable to the undergraduate level.
- The length of the article written exclusively for the Journal, may be about 2500 words.
- The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.
- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper of at least 10 cm×15 cm size.
- While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. **All weights and measures should be given in Metric Units.**
- A short note about the contributor should also accompany the article. The note should contain age, academic accomplishments, important assignments held, field of research and hobbies.
- Articles or illustrations published in the Journal can be reproduced with permission of the Editor.
- The Editor reserves the right to reject even invited articles without assigning any reason.

SUBSCRIPTION FORM

To The Editor

SCIENCE REPORTER

Publications & Information Directorate
Hillside Road, New Delhi 110012

Please enter/renew my subscription to SCIENCE REPORTER for 1yr/2yrs/3yrs

☐ I am sending Rs 30/Rs 50/Rs 75 by M.O./Cheque/DD No._____

Dated_____ marked payable to *Publications & Information Directorate (CSIR).*

☐ I would like to receive the first copy by VPP (for the entire subscription amount) (Tick the appropriate box)

Name (In capitals)_____

Full address_____

_____

_____

Signature

NOTE :

Please attach old address label for renewals
Please mention old subscription No. in M.O. coupon

It takes about six weeks to commence the supply of Science Reporter to new subscribers.

Registered with Registrar of Newspapers : R.N. 7440/64

JUST PUBLISHED

Source Book on Raman Effect

Volume I (1928-1957)

by

Prof. R S Krishnan

A Valuable Reference Book for physicists, chemists, biologists, engineers, scientometrists, science policy planners and general public interested in science progress. Indispensable for all libraries.

The author, Prof. R S Krishnan, is the leading Raman spectroscopist in India closely associated with the field from the early days following the discovery of Raman Effect. The 'Source Book' is the outcome of a project entrusted to him by the Department of Science & Technology, Government of India, to compile information on all papers published on Raman Effect and to properly classify and index them, for quick retrieval.

Material contained in Vol. I is not available in any data bank and hence unique. The growth of research in this field during the first 25 years after the discovery of Raman Effect is surveyed in Chapter 1. Complete bibliographic details of all papers in this field are given in Chapter 2 which is followed by exahustive indexes to facilitate information retrieval.

Price Rs. 250/- $ 75.00 £ 50.00

Orders for Vol. I accompanied by bank draft for the above price drawn in favour of 'PUBLICATIONS & INFORMATION DIRECTORATE' are to be sent to:

Sr. Sales & Distribution Officer
Publications & Information Directorate (CSIR)
Hillside Road, New Delhi-100 012 (INDIA)

DELHI POSTAL
Regd. No. D-(C)-66
U. No. 79

Printed and Published by Biman Basu, On behalf of Publications & Information Directorate (CSIR), Hill Side Road, New Delhi-110012, and Printed at Rajeshwari Photosetters (Pvt.) Ltd., New Delhi-110026