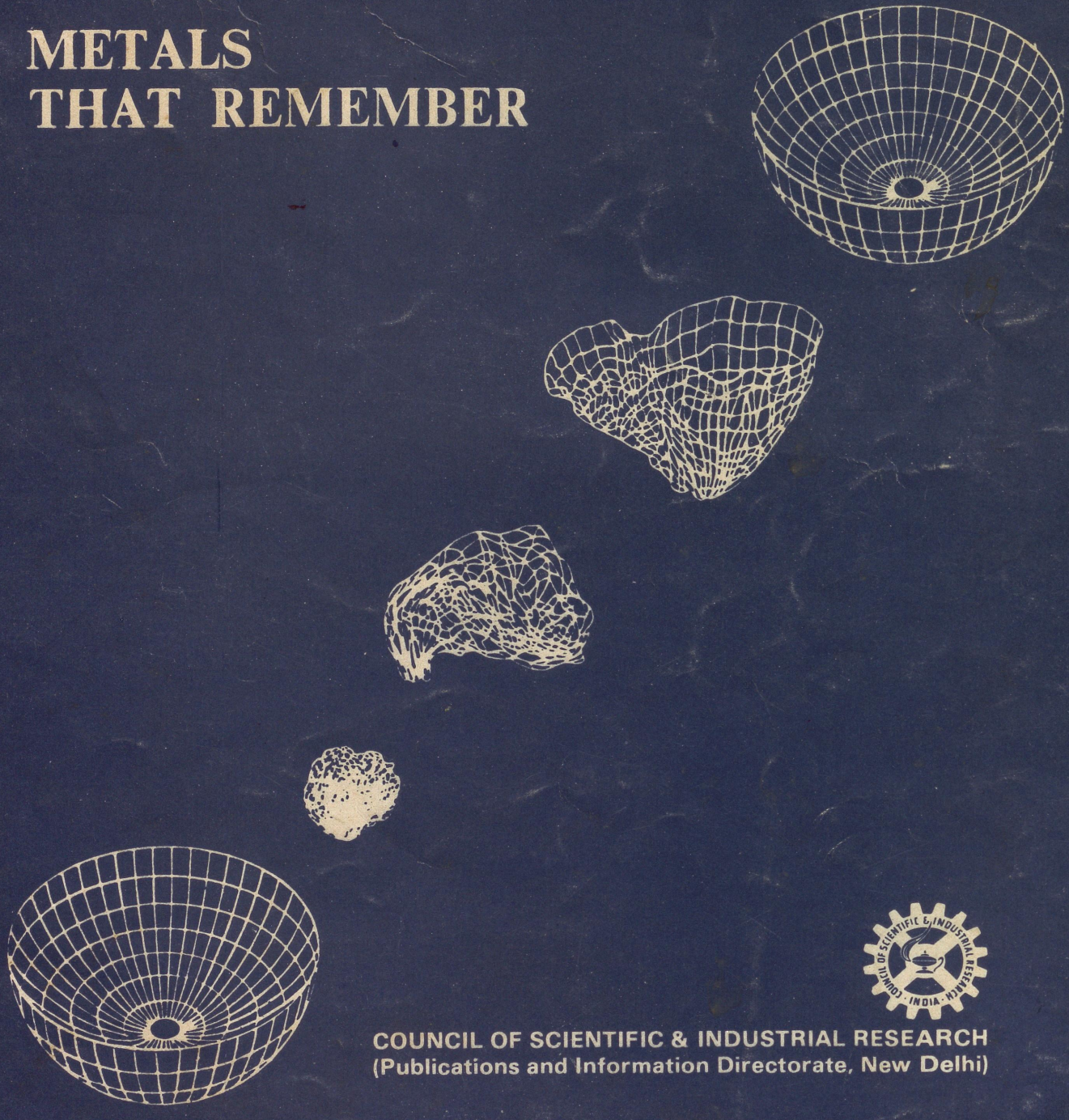
SCIENCE REPORTER

JUNE 1982
RUPEE ONE

METALS THAT REMEMBER



COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
(Publications and Information Directorate, New Delhi)

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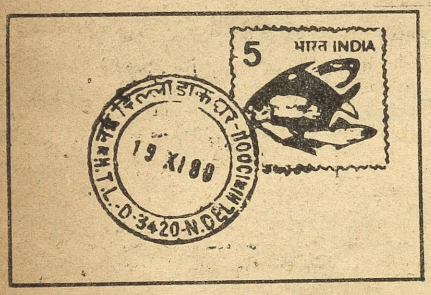
How does the tongue tell us the taste? • How does a Prism produce rainbow colours? • How does owl see at night? • Why do watches have jewels? • Why does man grow old? • How are hails formed? • How did universe come into existence? • Why don't we feel earth's motion? • How are seasons formed? • How were the weekdays named? • Why was the Great Wall of China built? • Why can't animals talk like us?



LETTERS

Festival dates and the national calendar

Sir, I have read with interest the article **Our national calendar** by Amalendu Bandyopadhyay (*S.R.*, Jan. 1982). While the article comprehensively restates the history of the Indian National Calendar System, the author is completely silent about the perpetual dispute between the obscurantist and the scientific interpretation of the *malamasa*/*kalamasa* of the Hindu Calendar System. A clear exposition of the issues involved from the Positional Astronomy Centre would be of considerable interest to the lay public who is prone to accept the conclusion without understanding the logic of the issues involved. This would be particularly so in view of the controversy that is currently raging about the correct days of Diwali, Dussehra, etc. this year.

A. BANERJEA
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In the luni-solar Indian Calendar of 1904 Saka Era (1982-1983 A.D.), there will occur a decayed (*kshaya*) month accompanied by two intercalary (*mala* or *adhika*) months within the span of six months. According to modern scientific calculations, the lunar month of Magha is *kshaya* month and the preceding Asvina and following Phalguna are *mala* months. One decayed month occurs on average after 63 years, but one may occur as early as after 19 years and as late as after 141 years. The last time a decayed month occurred was in 1885 Saka Era (1963 A.D.), i.e., 19 years ago. The occurrence of a *kshaya* month is rather infrequent and months of the year containing a *kshaya* month are regularised by considering one of the *adhika* months as a normal month. Most of the sashtric rules support the view that the intercalary month coming before the decayed month (Asvina in this case) is to be treated as a normal month and that the month following it (Phalguna in this case) as a intercalary or *adhika* month.

This system has been followed in the Govt. of India publication *Indian Astronomical Ephemeris* (IAE) for 1982 and, accordingly, the dates of some important festivals for the year 1982 are as follows:

Durga Puja	—September 24-26
Dussehra (Vijaya Dashami)	—September 27
Diwali (Kalipuja)	—October 16
Guru Nanak's Birthday	—November 1

There is another old, orthodox school of Panchang making according to which Pausa is *kshaya* and Asvina and Phalguna are *mala* months this year. Their difference of opinion stems from the fact that they propose to follow different methods of arranging the lunar months in the year containing a decayed month. Accordingly, the old school Panchang makers have shown the dates of Dussehra and Diwali as October 27 and November 15 respectively, one month later than those shown in the IAE, but they are incorrect.

AMALENDU BANDYOPADHYAY
Director
Positional Astronomy Centre
Govt. of India
New Alipore, Calcutta-700053

Language of science

Sir, I was rather amused to read the comments of Partha P. Lala of Calcutta on a statement which he claims I have made in my article on Nobel Prizes (Ref. *Language of science*, Letters, p. 132, *S.R.*, March 1982). First of all, I must say that he has quoted my statement "English is the language of science" out of context. If he cares to read my statement again, it is: "The recognition of Fukui's work and the Nobel Prize awarded to him clearly show that English is the language of science". Does he still consider me in the wrong? Can Lala give me a single instance of a scientist, who has received world acclaim by writing his scientific work in Bengali, or for that matter in any Indian regional language? Even Acharya Satyendra Nath Bose, whom he has quoted to show that only a fool can make the statement which he claims I have made, had written his classic paper in English. Had he written the paper in Bengali, Albert Einstein, who had subsequently got the paper in English translated into German for publication in a German research journal, would not have been able to appreciate the paper, what to speak of getting it translated into German! Even Rabindra Nath Tagore received the Nobel Prize in literature only after his works in Bengali were translated into English. Lala has stretched his imagination too far when he has attributed his own deduction "Pythagoras, Archimedes, Copernicus or Galileo should not be considered as scientists because their language was not

English!" to my above, misquoted statement.

DILIP M. SALWI
Scientist
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Lavender oil tree

Sir, The article on the Indian lavender oil tree by M.L. Thakur (*S.R.*, March 1982) is a welcome feature as there is an upsurge of interest in the country at present in the non-edible oilseed resources of tree origin, particularly in the context of replacing the use of edible vegetable oils in the industrial sectors like soap, cosmetics, etc., when there is a greater demand for the latter in the household consumption. But the following additional information on some of the economic factors involved may provide right incentive to the grower besides its publicity.

(1) A population of 300 trees (10 year old) in one hectare area yields about 1500 kg of fruits which has an oil production potential of 25 kg/ha. The yield increases gradually as the tree continues to bear fruit for 50-60 years.

(2) It can serve as a substitute for lavender oil the import of which increased from 3 tons in 1975-76 (valued at Rs. 5,81,840) to 20 tons in 1979-80 (valued at Rs. 20,95,575).

(3) Due to higher ester content, the Indian lavender seed oil is considered superior to that of the seed oil produced in Mexico (the country from which the tree was introduced into India) and hence more valuable for perfumery.

D. SARVESWARA RAO
Publications & Information Directorate (CSIR)
New Delhi-110012

Marine foulers

Sir, I read with interest the article **Menace of the marine foulers** by R. Santanam *et al.* (*S.R.*, Feb. 1982). I furnish below some more information on the subject for your readers.

Apart from slowing down the vessel and increasing the fuel consumption, the fouling produces noise and when it dies, it releases organic sulphur compounds and H_2S which are active corrosion accelerators. Generally the fouling on naval vessels is more than on other sea going vessels. This may be because the naval vessels are less active and remain at the port for longer periods.

In addition to copper and tin salts, mercury salts are also used in anti-fouling paints.

P.V. SATYAPRASAD
Naval Dockyard
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Aflatoxin B_1 in maize

Sir, The article **Mycotoxins, the poisons from fungi** by Anil K. Kush and Ashok V. Gupta (*S.R.*, January 1982) was interesting and informative. However, I would like to add that recently aflatoxin B_1 has also been found to contaminate maize under field conditions.

M.K. RAI
Department of P.G. Studies And Research in Bio-Sciences
University of Jabalpur
Jabalpur-482 001 (M.P.)

STARS AND PLANETS *(Continued from page 328)*

Spica (*Chitra*) around local midnight of 21st. It moves from Virgo (*Kanya*) to Libra (*Tula*). Its visual magnitude varies from +0.4 to +0.7.

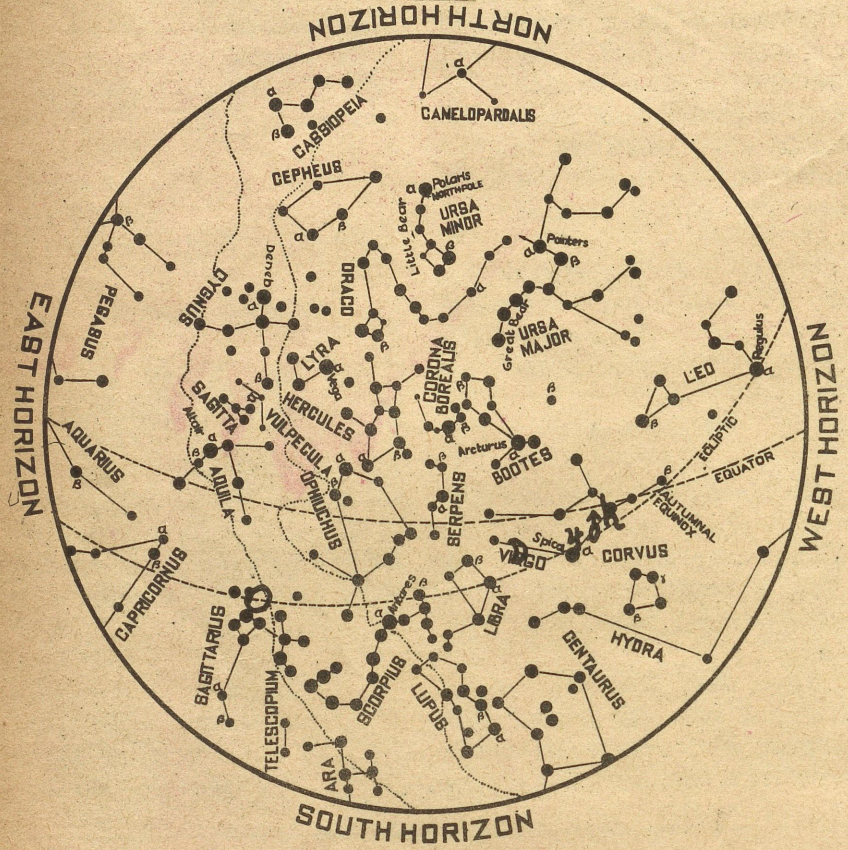
Jupiter (*Brihaspati*), visible in the evening sky, sets at about local midnight during the first half of the month and about an hour before it during the second half being at quadrature with the sun on 24th. It is in Libra (*Tula*). Its visual magnitude is about —1.7.

Saturn (*Sani*), visible in the evening sky, sets at about local midnight during the first half of the month and about one and a half hours before it during the second half being at quadrature with the sun on 8th. It is in Virgo (*Kanya*). Its visual magnitude is about +1.0.

(*Source:* Director, Positional Astronomy Centre, P-546, Block-N, New Alipore, Calcutta-700053)

STARS AND PLANETS

JULY 1982



Planetary positions for July 1982

Date / *Planets*	*1ST*		*10TH*		*20TH*	
	R.A.	*Decl.*	*R.A.*	*Decl.*	*R.A.*	*Decl.*
Mercury	5h 06m	20.3°N	6h 04m	22.8°N	7h 30m	22.9°N
Venus	4h 20m	19.9°N	5h 05m	21.6°N	5h 56m	22.6°N
Mars	12h 47m	5.3°S	13h 02m	7.1°S	13h 21m	9.2°S
Jupiter	13h 55m	10.5°S	13h 56m	10.6°S	13h 58m	10.8°S
Saturn	13h 01m	3.8°S	13h 02m	4.0°S	13h 04m	4.2°S

Adopted from figures supplied by Positional Astronomy Centre.

The moon

FULL moon occurs on 6th at 1.02 P.M. and new moon occurs on 21st at 0.27 A.M. I.S.T. The moon passes about a degree south of Venus on 19th, half a degree south of Mercury on 20th, about three degrees north of Saturn on 26th, six degrees north of Mars and about four degrees north of Jupiter on 27th. The lunar crescent becomes first visible after the new moon day in the evening of 22nd. The moon is at apogee or farthest from the earth on 5th and at perigee or nearest to it on 20th.

The earth is at the aphelion or farthest from the sun on 4th.

There will be a total eclipse of the moon on 6th, which will not be visible in India. There will also be a partial eclipse of the sun on 20th, not visible in India.

There will be an occultation of the planet Neptune by the moon, in the night of 4th. The phenomenon will be visible in India except in the northern part. At Bombay, the planet remains covered by the moon from 9.52 P.M. to 10.50 P.M., at Calcutta from 10.30 P.M. to 11.55 P.M. and at Madras from 10.08 P.M. to 11.29 P.M. I.S.T.

The planets

Mercury (*Budha*), visible in the morning sky, rises about one and a half hours before sunrise during the first half of the month. Thereafter it is too near the sun to be visible being in superior conjunction with the sun on 25th. It moves from Taurus (*Vrisha*) to Cancer (*Karkata*) through Gemini (*Mithuna*). Its visual magnitude varies from +0.3 to —1.2.

Venus (*Sukra*), a morning star, rises about two hours before sunrise during the month. It passes about 4° north of the star Aldebaran (*Rohini*) on 4th. It moves from Taurus (*Vrisha*) to Gemini (*Mithuna*). Its visual magnitude is about —3.3.

Mars (*Mangala*), visible in the evening sky, sets about half an hour before local midnight during the first half of the month and about one and a half hours before it during the second half being at quadrature with the sun on 9th. It passes about three degrees south of Saturn on 10th and about one and a half degrees north of the star

(Continued on page 327)

METALS THAT REMEMBER

Nitinol, a "rubber-like" metallic material with high specific strength and corrosion resistance, finds a wide use in technical and medical fields for its "shape-memory" property

A. MANI

NITINOL is a nickel-titanium (equiatomic Ni-Ti) alloy material well-known for its mechanical "shape-memory" effect (SME). It possesses a peculiar physical property, viz., mechanical-memory. If the material is deformed at low temperature, it "remembers" the original shape when heated. During the change in shape of the material, considerable force is exerted which can perform useful work. It can be exploited for different kinds of technical as well as medical applications.

In general terms, "shape-memory" materials are not thermostatic bimetals: the physical change in SME materials is produced by a transformation in crystal structure of the homogenous alloys, unlike in bimetals. Again, SME is produced over a relatively narrow temperature range in contrast to the bimetals which change shape gradually over a broad temperature span.

What is SME ?

"Shape-memory" effect is basically the effect of martensitic transformation, that is, the diffusionless (second-order) transformation (shear movement of atoms) from the parent crystal structure of a material into a new (lower symmetric) crystal structure called martensite phase and/or vice versa. In the case of reverse transformation, the low temperature deformed martensite will regain its high-temperature parent structure (original shape) when heated; deformation strain of upto 9% may completely be recovered. It is now well-established that the martensitic transformation is essential to SME. The alloys exhibiting SME are known as "marmem (*martensite memory*) alloys".

The SME had been noted as early as 1938 when Alden B. Greninger and V.G. Mooradian (USA), and G.V. Kurdyumov (USSR) simultaneously showed the "shape-memory" in brass (copper-zinc alloy) to form martensite while cooling from high temperature parent beta-phase. Later, Thomas A. Read, (USA) reported SME in gold-cadmium alloys. However, it was only in 1963 that the SME phenomenon came to worldwide attention through W.J. Buehler's (U.S. Naval Ordinance Laboratory) work on SME in Nitinol.

Martensite phase

It is well-known that a crystal of the parent phase (cubic, B_2 type) will transform into as many as 24 orientations of martensite on cooling between M_s and M_f; M_s—Martensite-start temperature; M_f—Martensite-finish temperature; A_s—austenite-start temperature; A_f—austenite-finish temperature; austenite structure=parent structure) but when the multi-orientation configuration of martensite is deformed, a single orientation of martensite (monoclinic in NiTi) eventually results by means of a deformation process called twinning (two different orientations of martensite) and the movement of certain martensite interfaces. At this stage, the specimen permits maximum elongation in the direction of the tensile axis. But in the reverse transformation, the single crystal of martensite obtained from deformation below the M_f temperature transforms to a single orientation of the parent phase on heating, as a consequence of the relative

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symmetries involved to maintain ordering. In this case, "unshear" movement reverts the deformed specimen to its original shape.

NiTi alloys, when excessively deformed beyond the limit of SME recoverable strain (say, 30% strain), show psuedo-elastic or super-elastic behaviour. During the super-elastic behaviour, the specimen continues to elongate as if it were being plastically deformed, but when the stress is removed, the martensite plates that have formed revert to the parent phase and the specimen contracts to its original dimension showing no plastic deformation. This allows Nitinol to possess "two-way" SME.

The martensite crystal structure which is necessary for the effect can be produced in two general ways: (i) by subjecting an alloy to a stress magnitude of which is related to temperature, or (ii) by rapidly quenching a suitable alloy to some critical temperature. The macroscopic behaviour of the SME can best be understood by means of crystallographic history of a spacecraft antenna shown in Fig. 1.

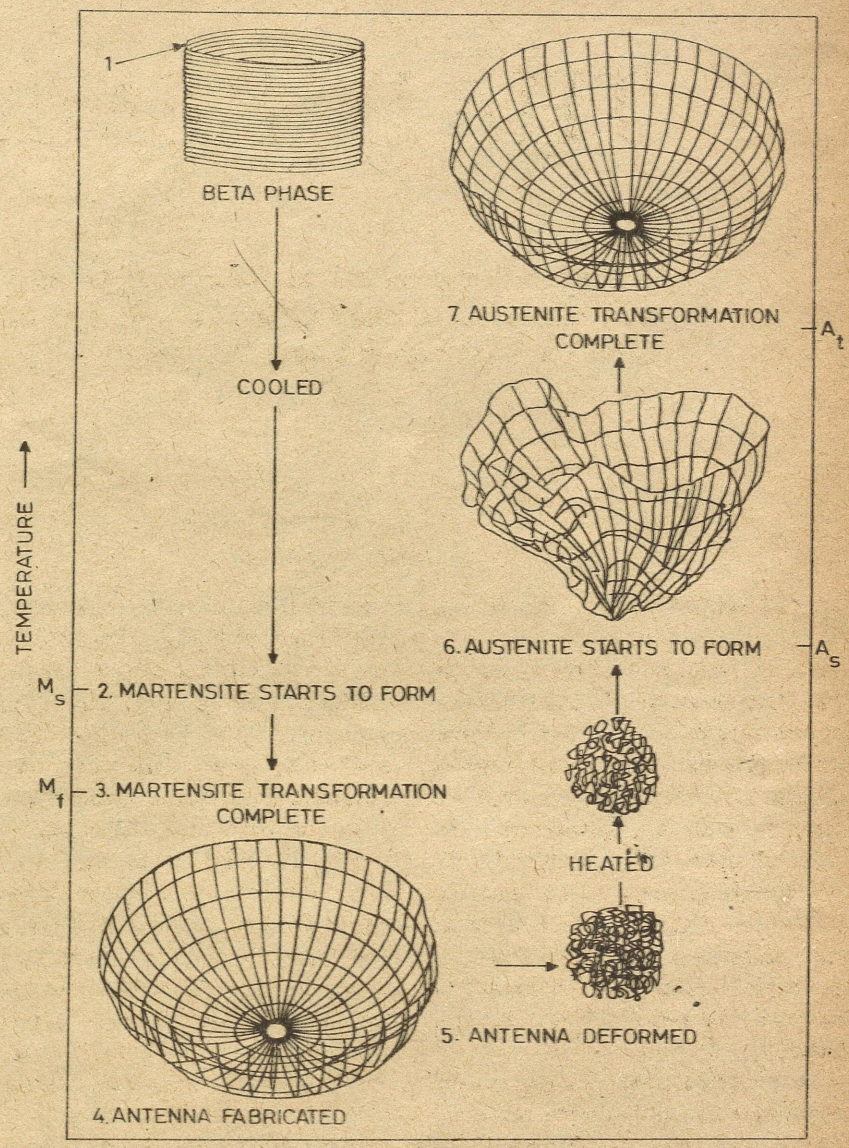

Fig. 1. Crystallographic history of the spacecraft antenna shows the role of temperature in the shape-memory effect. The construction material, Nitinol wire in a large coil, is raised to a temperature of 650 degrees C and is stabilized so that the crystal structure of the material is entirely in the beta, or "parent," phase (1). This phase is often the crystal structure austenite. The wire is now cooled. At the temperature M_S (60 degrees C) the new crystal phase martensite starts to form, replacing the beta phase (2). At M_f (52 degrees) the transformation to martensite is finished (3). While the Nitinol wire is held at a temperature below M_f it is cut into short lengths, which are gently bent to form the segments of the intended hemisphere (4). Where the segments cross one another they are fastened by tack welding. One can now crush the antenna into a small volume (5). In order to restore the original shape the crushed structure is heated. At temperature A_S (71 degrees) austenite begins to replace martensite (6). On reaching A_f (77 degrees) the antenna has unfolded completely (7). In this particular case what the shape-memory alloy "remembers" is not the actual configuration of the antenna but the gentle curves of the coiled wire from which the antenna was constructed. As the wire tries to straighten itself it is constrained to the shape of a bowl by the multiple welds at the crossover points (*Courtesy*: L.M. Schetkry)

Technical applications

The heat shrinkable property of NiTi alloy is used in mechanical and electrical connectors, couplings, etc., as CRYOFIT couplings and CRYOCON devices; and also as actuators. A large stress (as high as 100,000 psi) in NiTi alloys generated during the SME can be used in heat engines to convert low grade abundant heat into mechanical work.

CRYOFIT couplings. A CRYOFIT joint is a hollow cylinder which has been expanded in its martensitic range (low temperature) and which shrinks down on the tubes to be joined as it is heated through its A_s to A_f range. During installation, a pre-expanded part is removed from

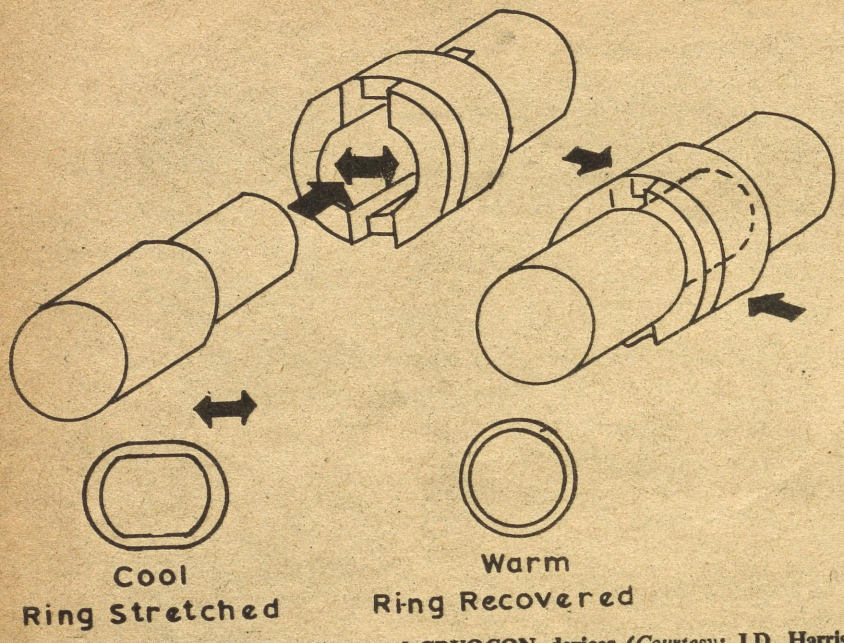

Fig. 2. 4. NiTi CRYOFIT couplings and CRYOCON devices (*Courtesy*: J.D. Harrison and D.E. Hodgson)

liquid nitrogen in which it had been shipped and stored, and then the ends of the hydraulic tubing to be joined are inserted. As the assembly heats to room temperature, the coupling contracts and effects a permanent tube union.

The use of SME for couplings, has a number of advantages. Both the couplings and the installation tools have low profile which allows high tube density and installation in confined spaces. The installation tools are inexpensive. No special tube preparation is required. Also no special skills are needed for installation. Assembly time is short. Since no heat (other than ambient) is used, the tubes are neither degraded by a heat-affected zone nor there are flame hazards.

Almost immediately after the invention of SME in Nitinol, it was used to solve problems of coupling of hydraulic-fluid lines in F-14 jet fighter built by the Grumman Aerospace Corporation (USA). Nitinol fittings are well-suited for broken subsea piping, because of better performance, longrun and speedy with less-risk installation than other techniques. Nitinol fixers have been used extensively for plumbing on sub-marines and surface-ships in the past few years by the British Navy as well as by the U.S. Navy.

CRYOCON devices. In electrical pin-and-socket contact, the pin can be inserted or withdrawn without any force when the device is cooled, but when the contact is at or above room temperature the pin cannot be removed. Cryocon sockets have the tangs bowed outward and a NiTi ring is slipped around the outside of tangs. If the socket is cooled through its M_s-M_f range, the force exerted by the tangs causes the NiTi ring to expand, which permits insertion or retraction of the pin with zero force. As the assembly heats through the A_s-A_f range, the NiTi ring recovers toward its original diameter covering a firm gripping of the pin by the socket (Figs. 2, 3 & 4).

These electrical contact devices, (a) provide gas tight contact surfaces, (b) are free from chatter or contact bounce in shock or vibrating environments, (c) impart great mechanical strength, and (d) have stability in resistance and/or voltage drop and zero insertion force. They are considered to be advantageous over the conventional contact devices.

Contact/actuating devices. (a) An early application of Nitinol was a

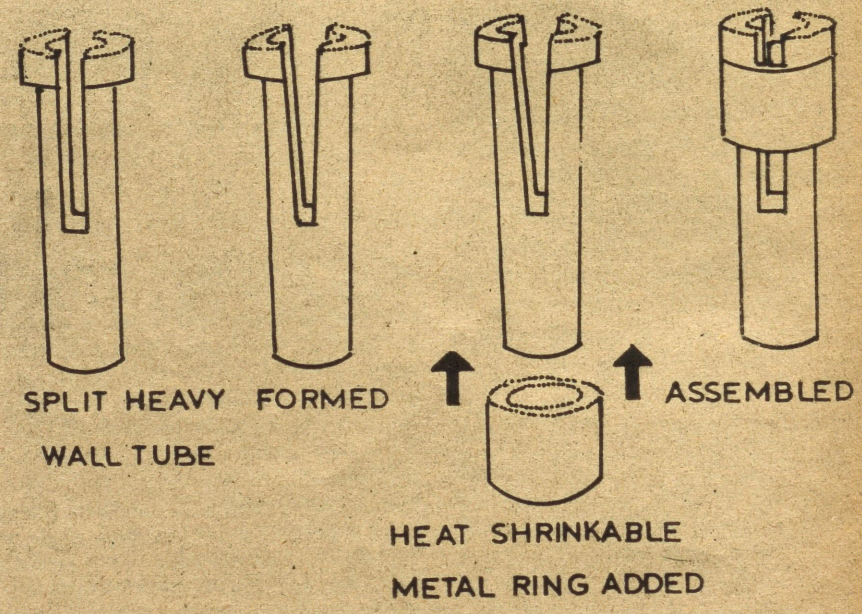

Fig. 3. CRYOFIT couplings and CRYOCON devices

latching device for a British satellite in which a torsion tube of Nitinol triggered a release mode. The release had to be rapid and reliable in order to avoid any dynamic air-balance that might affect the stability of the spinning itself.

(b) An electrical connector which forms a high compression fit, and which can be quickly released and recoupled, has been fabricated from a Nitinol alloy. This device is in the shape of a ring that closes the fingers on a pin connector. The connector is opened by chilling it with a blast of a cold fluorocarbon gas from an air aerosol can; it closes when it is warm.

(c) Pen drives in recording exploit SME of Nitinol wire which respond to the amount of heat supplied by a small induction coil which, in turn, is energised in response to the voltage input to the recorder. The Nitinol wire exerts a much larger force than a galvanometer drive does, so that the mechanism requires fewer bearings and pivots. Since 1972, more than 600,000 of such drives have been in service in the USA.

Thermostatic valve made of Nitinol is useful for radiators in a home or office heating system. The temperature at which the valve opens can be set by turning a knob that alters the compression on a conventional spring acting against an SME spring. It is attained as the force exerted by the SME spring increases when its temperature rises to enable the valve to open.

SME springs can be used to regulate the clutch system that couples and uncouples the radiator fan in an automobile cooling system. Conventional devices operate through a viscous fluid clutch controlled by a bimetallic spring. The SME alloy clutch eliminates the need for fluid seals and provides a more

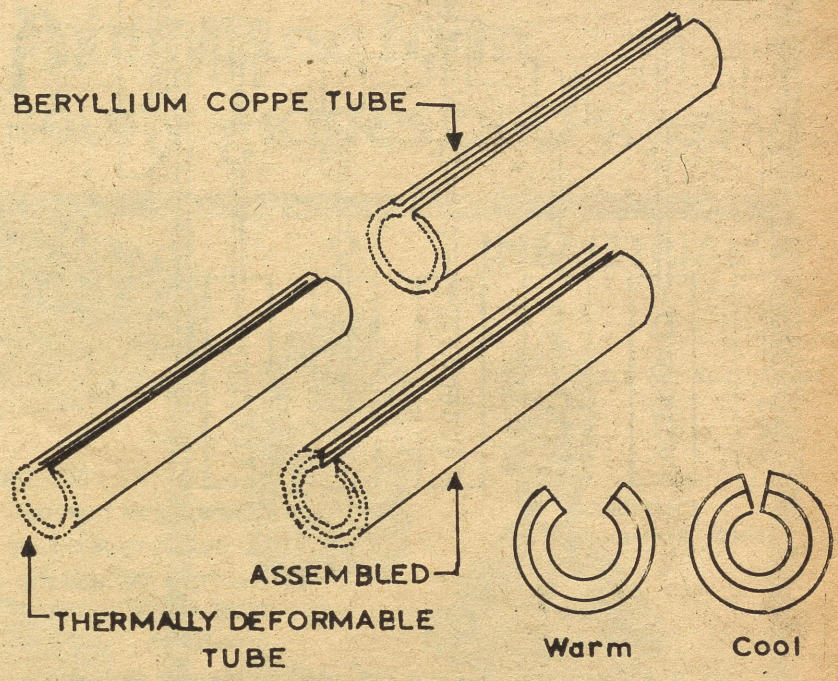

Fig. 4. CRYOFIT couplings and CRYOCON devices

flexible speed control. Automotive engineers are exploring the possibility of using SME systems to replace small electric motors, solenoid-actuated valves and various engine control devices. Another promising application is a variable-jet carburettor to provide optimum fuel economy over a range of air and fuel temperatures.

Researchers at the Polytechnic Institute of New York have developed "blind plugs" of NiTi to be used as remotely activated, internally placed seals for old under street gas lines in New York city.

In electronic industry, Nitinol is used in the manufacture of an integrated circuit package. In this device, one of the lead wires is made from NiTi which is soldered to a second electrical lead. Upon subsequent heating, the leads separate as heat-recoverable material moves away from the connection. Thus, it is possible to replace or repair the device from a printed circuit board without damage to either component. Multiple bonds can be produced simultaneously between solder pads on a semiconductor chip and fingers extending from the frame member. The SME and reverse SME have been used to control movement of these fingers.

Several copper-zinc-aluminium (Cu-Zn-Al) SME alloys are being developed which may find use in devices such as couplings, retainers and clamps, including plugs for nuclear reactors which will eliminate welding. A range of Cu-Zn-Al SME alloys has been developed for use in thermostats, controls heating and cooling equipment, automotive control devices and actuators for equipment ranging from greenhouse windows to fire doors.

The Cu-Zn-Al SME alloys are less expensive than Nitinol. They, however, have some disadvantages such as (i) limited maximum operative temperature, (ii) less corrosion-resistance, and (iii) less specific strength than NiTi alloys.

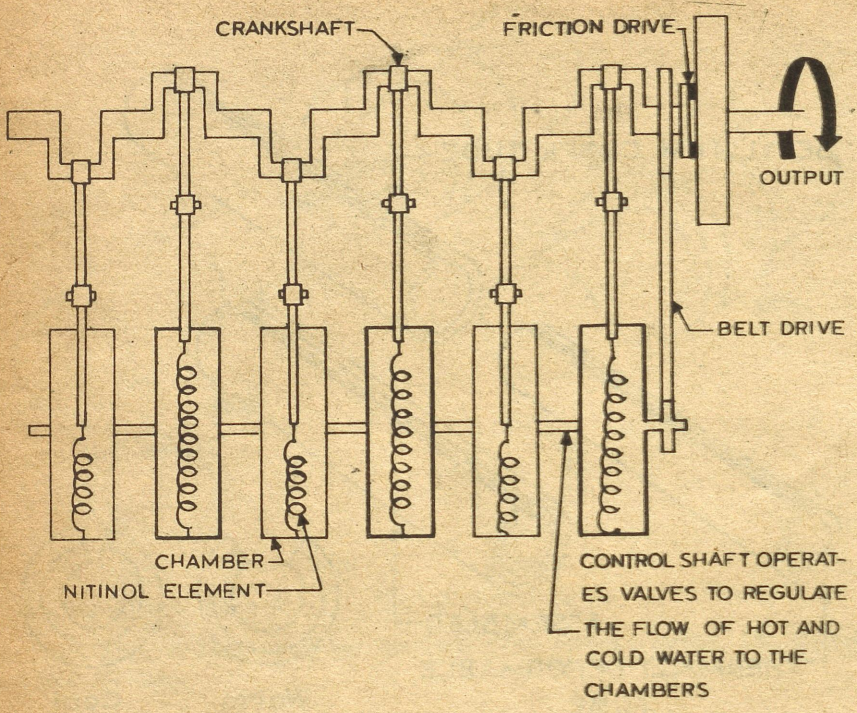

Fig. 5. Nitinol heat engine-Crankshaft model, a schematic diagramme

Nitinol heat-engines

The first successful application of NiTi SME material for continuous conversion of low-temperature thermal energy across a small temperature (ΔT) to mechanical work was demonstrated at the Lawrence Berkeley Laboratory (USA) in August 1973. The LBL prototype Nitinol heat engine employs twenty, 15cm loops of Nitinol wire (1.2 mm dia) as its working elements. The loops are supported by wheel and crankshaft assembly so that the spokes work back and forth in reciprocation relative to the wheel as the system revolves. It operates at 60 rpm 80 rpm in a bath containing water at 48°C and 24°C. No damage to Nitinol wire elements is done even for more than 17×10^6 revolutions. Power output yields about 0.2 watts.

Another type of Nitinol heat engine (Fig. 5) developed by US Navy uses industrial waste and unfocused solar radiation. It resembles an internal combustion engine. In operation, Nitinol springs are heated with 98°C water so that they regain their memory shape. This causes the crankshaft to turn which, in turn, stretches alternate Nitinol springs out of their memory configuration as they are cooled. The crankshaft turns a control shaft through a belt drive to regulate flow of hot and cold water through the Nitinol chambers.

The practical aspects of using SME heat engines working at low-temperatures are promising. Since sources of low heat are so widespread, economical conversion of even a fraction of it could have a significant impact on the world energy supply. Such sources include oceanic thermal gradient or geothermal hot springs, outlets of industrial cooling system etc. Among small-scale applications are the operation of solar-powered refrigerating units, agricultural irrigation pumps and auxiliary electrical power generating equipment.

The only disadvantage of the system is its low-efficiency (3%-5%). However, research on Nitinol base alloys with a narrow working range of temperature to improve their efficiency is in progress. According to a recent report, efficiency upto 45% can be achieved in Nitinol base alloys.

Medical applications

The SME in NiTi has been used with advantage in the Harrington rod treatment of scoliosis, to correct developing deformity in the growing spine. NiTi is initially soft and ductile in low temperature martensite phase, but after it is deformed due to strain which is recoverable by SME behaviour (that is, heating above A_f), it can withstand stresses greater than stainless steel now used in surgical treatments. It has sufficient tissue compatibility and good corrosion-resistance. Hence a NiTi Harrington rod (0.63 cm dia), originally straight but with an imparted curvature (4 cm radius of curvature), has the ability of straightening the spine to its original shape after the surgical operation, by mere external heat application (raising the temerapture by 3°C to 5°C above body temperature.

Artificial limb-joints are fast becoming common. In a large joint, such as the hip, the artificial ball and socket are now usually joined to the bone by a cement. This has problems of misalignment and even bone fracture. The recent fastening method relies on SME "butterflies" that are attached to the part of the artificial joint inserted into the central hollow of the bone. The "butterflies" are inserted cold and expand to form a tight lock on reaching body temperature.

The SME can be conveniently used for filtering blood clots out of the circulatory system before they can do serious harm. Most clots of dangerous size form in legs and lower trunk and travel through veins to the heart and lungs. The clots can be

(Continued on page 341)

HOW SPONTANEOUS ARE "SPONTANEOUS" MUTATIONS ?

ANISUR R. KHUDA BUKHSH A. KHUDA BUKSH

The dilemma whether the so called "spontaneous" mutations are the result of some error in genome duplications or are the effect of mutagenic environmental processes on organisms remains unresolved

OVER a century ago, when evolutionary ideas were gradually blossoming, a short-legged ram, unlike any of the other sheep, was born into the flock of a New England farmer named Seth Wright. This ram transmitted the short legs to his progeny and so was derived a prize breed of sheep, the ancon breed. The short-legged breed was highly welcome as it could not jump over the stone fence so common in England then. This breed, however, disappeared after a couple of decades as suddenly as it had appeared. Thereafter, the same kind of short-legged breed suddenly reappeared in Norway and, from this, a new strain has since been developed. Charles Darwin, the English naturalist who is regarded as the father of modern evolutionary theory, observed such a sudden change of characters, and designated them as "Sports". It was in the early part of twentieth century (1901-1903) that a more elaborate study of such drastic changes of phenotypic traits was made by a Dutch scientist, de Vries and it is he who must be credited with bringing these discrete changes to limelight by assigning them a major role in evolution and coining the term 'mutation' for them. Since then, mutations that cause distinct phenotypic changes have been sporadically observed in diverse organisms —the valuable 'platinum' mutation in the fox, the streptomycin-resistance in bacteria and the haemophilia mutation (bleeder's disease) that Queen Victoria bestowed so liberally among her descendants, are a few among many.

Types of mutation

In a broad sense, mutation means any change in hereditary material and does not arise as a simple consequence of recombination of genes. A mutation occurs when the sequence or the number of nucleotides in a nucleic acid is altered and the new sequence or number is passed from aparent to offspring. Mutations are broadly classified as being either point mutations or gene mutations affecting short regions of a chromosome (e.g., the substitution of one base by another or the deletion or addition of one or several bases), or as being chromosomal mutations or aberrations affecting longer pieces of chromosomes or total chromosome number of the species. Some treat the 'position effects', that is, the altered effect of genes due to changed position, as the third category of mutations. Clearly, many mutations will be intermediate between the extremes and the classification is arbitrary. The other way of classifying all mutations is to classify them as 'spontaneous', when the cause is unknown, and as 'induced' when mutation rate is strikingly enhanced by the treatment of some external agents—the mutagens.

Some phenotypic changes altered by mutations

Mutants (individuals having

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mutation) may differ from the parental strain in all types of traits, external or internal, morphological, physiological or biochemical. *Drosophila,* the common fruitfly (also called vinegar fly), exhibits a wide range of visible mutants. They differ from the wild type in colouration, or form of the eyes and the body, wings, bristles, legs, size of the body and its parts, sexual character, fertility, longevity, serological properties and behaviour (reactions to light and gravity, courtship and mating habits). Some mutations cause transformation of one organ to another (called homeosis), e.g., antennae of Drosophila transformed into legs, balancers into second pair of wings, etc. Mutations may change food requirements of the fungus *Neurospora* and block certain important biochemical reactions in cellular metabolism. Bacterial mutants may lose or acquire virulence or become sensitive or resistant to antibiotics like penicillin or sulfa drugs and to attacks by bacteriophages. They may also attain or lose the ability to grow on food media adequate with or deficient in certain constituents depending upon the type of mutation they undergo.

Mutation may occur at any stage in the development of the organisms. A dominant mutation in one of the two daughter chromosomes formed at the first division in a fertilized egg will give a mosaic or fractional mutant having about half of normal body and the other half carrying the mutation. Mutation may take place in somatic cells, as is suspected in the origin of some malignant tumours, whereby a group of cells will be genotypically different from other cells in the same individual.

Detection of mutations

Though some mutations are manifested in the alteration of some phenotypic traits (visible mutations) or chromosomal configurations, a large number of them, particularly the point mutations, remain concealed unless detected by precise tests. In fact, these small mutations outnumber the visible ones. Since most mutations are recessive and deleterious in nature, their detection often necessitates the progeny study of two or more generations. The recessive mutations can only be expressed in homo- or hemizygous state. To know if the parents acquired any lethal mutation (mostly recessive), one has to check the whole generation of the descendants.

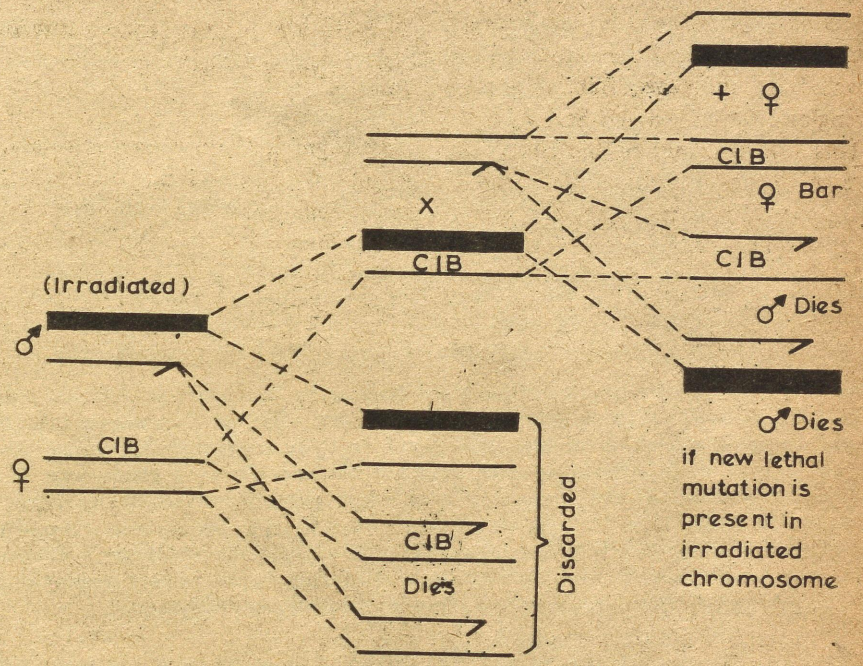

Fig. 1. The CIB method for detecting lethal mutations in the X chromosome in *Drosophila melanogaster*

In Drosophila, the CIB method (Fig. 1), which makes use of an X chromosome that contains the dominant gene Bar (B, narrow eyes), a recessive lethal (1, no expression in heterozygotes) and a crossover suppress (C, an inversion which eliminates crossing over), is an effective method for detecting lethal mutations in the X chromosome. Another strain, the "Muller-5', has also been used to measure the frequencies of mutations in the X chromosome of Drosophila. This strain carries X chromosome that bears Bar and white-apricot genes. Included with these genes are inversions that suppress recombination between the Muller-5 chromosome and any wild type X chromosome. Muller-5 females mated to wild type males will produce F_1 females in which crossing over in X chromosome does not take place (Fig. 2). Such F_1 females consequently produce two types of males, Muller-5 and wild type, the latter inheriting an X chromosome produced by the male grandparent. If these wild type X chromosomes bear any lethal mutation, the F_2 wild type males will not appear. In this way, numerous wild type X chromosomes can be tested for the possible lethality.

The lethal mutations in the autosomes of Drosophila can be tested

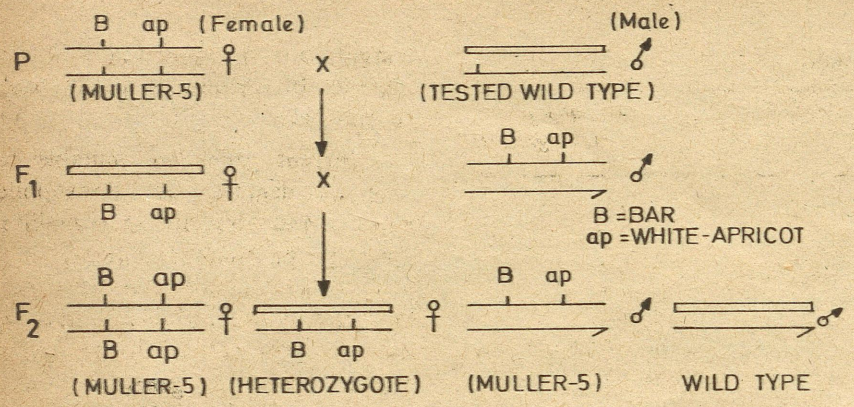

Fig. 2. Mating system used to detect recessive lethals on the X chromosome. The wild type parental male, may, as a result of mutation, produce many kinds of X chromosomes in his sperms, some of which bear recessive lethal genes. An F_1 female is protected against sex-linked recessive lethals by the presence of lethal free Muller-5 (Bar-apri) chromosome and will produce Muller-5 and wild type male offspring in equal proportions if the wild type chromosome is fully viable. If the wild type chromosome carried by an F_1 female bears a recessive lethal, no F_2 wild type males will appear. To ensure a test of the complete wild type X chromosomes, the Muller-5 chromosome bears a number of inversions which prevent crossing over between the two X chromosomes in the F_1 female Adopted from Strickberger.

by the use of a remarkable 'balanced' strain of flies having the dominant genes Curly (Cy, wings curled upwards) and Lobed (L, abnormal shape of the eyes) in one of the second chromosomes and Plum (Pm, a brownish eye colour) in the other second chromosome (Fig. 3). Both chromosomes also contain inversions that suppress crossing over.

Spontaneous mutations in some organisms and their rates

Apart from *Oenothera* and *Drosophila*, spontaneous mutations have been observed in corn, snapdragon, mice, bread molds, man and many other plant and animal species. The surest way to find mutants is to examine a large number of a given species in the laboratory or in field cultures.

In the bacteria *E. coli*, resistance to bacteriophages arises by mutation and this mutation has been estimated to occur at the rate of about 2.45×10^{-8} per bacterium per generation. Similarly some pathogenic bacteria are said to attain resistance to antibiotics like penicillin or streptomycin or sulfa drugs by mutations. In some cases, resistance to these antibiotics gains momentum with gradual increase of dose of the antibiotics and the sum total of successive mutations renders the bacteria a high degree of resistance.

Though mutation in any one gene, as a rule, is a rather rare event, it is quite substantial when total frequency of mutation in all genes is considered. Thus, the sex-linked lethals amount to some 15 per 10,000 spermatozoa in *Drosophila melanogaster*, i.e., 0.15% per generation and that in the second and third chromosomes (autosomes) about 0.5%. The mutation rate in the 4th 'dot' chromosome is relatively

Table 1. Spontaneous mutation rates at specific loci for various organisms (compiled from Strickberger, 1970; Sinnott, Dunn and Dobzhansky, 1958; and Rothwell, 1978)

Organism	*Trait*	*Mutation per 100,000 gametes*
Bacteria		
E. coli	to streptomycin resistance	0.00004
	to phage T1 resistance	0.003
	to leucine independence	0.00007
	to arginine independence	0.0004
	to tryptophan independence	0.006
Salmonella typhimurium	to threonine resistance	0.41
	to tryptophan independence	0.005
Diplococcus pneumoniae	to penicillin resistance	0.01
Neurospora crassa	to adenine independence	0.0008-0.029
	to inositol independence	0.001-0.010
	(one *inos* allele, JH5202	1.5)
Drosophila melanogaster	males	
	y+ to yellow	12
	w+ to white	2.9
	bw+ to brown	3
	e+ to ebony	2
	ey+ to eyeless	6
	lz+ to lozenge	2.9
	ct+ to cut	15
	vg+ to vestigeal	3
	f+ to forked	3
Corn	Wx to waxy	0
	Sh to shrunken	0.12
	C to colorless	0.23
	Su to sugary	0.24
	Pr to purple	1.10
	I to i	10.60
	R^r to r^r	49.20

Table 1 (Contd.)

Organism	*Trait*	*Mutation per 100,000 gametes*
Mouse	b+ to brown	0.85
	p+ to pink eye	0.85
	s+ to piebald	1.70
	d+ to dilute	3.40
Man	epiloia	0.4-0.8
	England	
	retinoblastoma	
	England	1.2
	USA, Michigan	2.3
	USA, Ohio	1.8
	Germany	1.7
	Switzerland	2.1
	Japan	2.1
	aniridia	
	Denmark	0.5
	USA, Michigan	0.5
	achondroplasia (chondrodystrophy)	
	Denmark	4.2
	North Ireland	14.3
	Sweden	7.0
	Japan	12.2
	partial albinism with deafness	
	Holland	0.4
	albinism	2.8
	colour blindness (total)	2.8
	infantile amaurotic idiocy	1.1
	ichthyosis	1.1
	haemophilia	3.2
	Pelger's anomaly	
	Germany	2.7
	Japan	1.7
	neurofibromatosis	
	USA, Michigan	13.0-25.0
	micropthalmos-anopthalmos	
	Sweden	0.5
	Huntington's Chorea	
	USA, Michigan	0.5

small because of its size. Therefore, about 1.2% of gametes produced by a normal *Drosophila* fly bear a newly arisen lethal mutant. Less drastic mutations, the sub-vital ones (also called detrimental mutations), which produce slight but perceptible deleterious changes, arise more often than do the lethals (about 3 to 5 times more common than lethal ones). So, taking into consideration all forms of mutations including those of structural rearrangements, as many as 5% of all gametes of Drosophila contain one or more newly arisen mutants of various kinds in each generation.

Different genes are mutable to different degrees. In Drosophila mutations to white and to vermillion eyes appear quite commonly, but many other mutants have been seen to arise only once. Similarly, in corn, the gene (for colour) is relatively mutable while the genes for waxy (wx) and shrunken (sh) endosperm are relatively stable (Table 1).

It is not easy to estimate the rate of mutation for most genes of man. In case of man, the hereditary diseases or abnormalities are, in most cases, indicators of mutations. For example, knowing the frequency of haemophilic males in the population (males are mostly the victims of this disease, while the female acts as a heterozygote carrier), one can estimate the number of mutations and it varies in different populations between 1 and 5 per 100,000 X chromosomes per generation (i.e., mutation frequency between 1×10^{-5} and 5×10^{-5}.

Disorders such as phenylketonuria, sickle-cell anemia and alkaptonuria result from distinct changes in the normal or standard allele in each case. The rate of mutation for phenylketonuria and Huntington's disease is estimated at one in 10,000 persons or so.

At least 5% of the human babies born have some kind of genetic defect. In fact, the number of genetic defects is much higher if embryos and foetuses are considered in addition to those babies who survive to be born. A quarter of the fertilized eggs will never result in full-term babies. Those changes involving entire chromosomes or sets of chromosomes affecting many genes comprise a sizable chunk of all mutations. Chromosome abnormalities are many in the spontaneously aborted embryos. Further, chromosome aber-

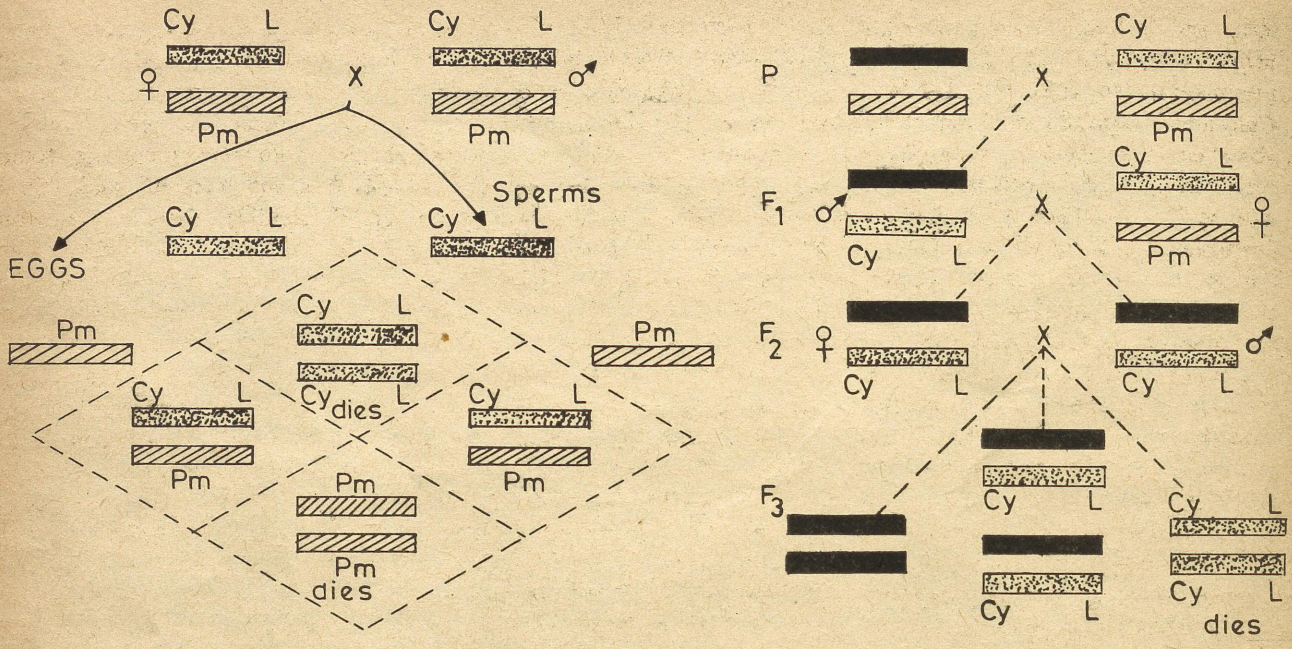

Fig. 3. A "balanced lethal system". Each chromosome carries a dominant marker and inversions that prevent recombination. Although half the progeny dies, the strain breeds true because all the surviving offspring are like their parents. This method is used to detect new lethal mutations in the second chromosome of *Drosophila melanogaster* (Taken from Sinnott, Dunn and Dobzhansky)

rations are responsible for most congenital defects (defects present at birth) suffered by humans (Table 2). In the United States alone, about 20% of the spontaneous abortions are due to disorders produced by chromosome aberrations. Incidentally, women over 40 years of age run a higher risk of bearing a Down's offspring (1 in 40) than women of 20 years or so (1 in 3000).

Three very unusual disorders are known which seem to combine the two major types of genetic defect—gene mutations and chromosome aberrations. They are Fanconi's anemia, Bloom's syndrome and the Louis-Bar syndrome.

In human beings, over 1000 conditions are known to be caused by single mutant genes. The mutation rate itself in a species is believed to be controlled by certain genes which keep it at the optimum rate for the species. The detection of "mutator gene" in Drosophila supports this hypothesis. Anyway, notwithstanding some degree of variation in the mutation frequency of some genes (Table 1), it is estimated that about 40% of all gametes carry a newly arisen mutation in man. Some data put the figure still higher and suggest that every 2 out of 3 persons may be suspected to carry some sort of newly arisen deleterious mutation. It would be only fair to say that these values are considered too high by some geneticists who believe that average mutation rate is below 4×10^{-5}, accepting an estimated 10,000 genes per person (others believe the number of genes to be far more than 10,000).

Table 2. Some congenital diseases associated with chromosomal abnormalities

Disease	*Chromosome abnormality*
Turner Syndrome	XO, only 2% of all XO manage to survive full-term; frequency 1/500 male births.
Klinefelter Syndrome	Extra X, in male-XXY, XXXY, XXXXY; frequency 1/3500 male births.
Down's Syndrome	Trisomy Chromosome 21; frequency 1/500 infants; found in about 20% of early abortuses.
	Trisomy Chromosome 22 with more or less similar effect.
Abnormalities of faces, skeleton & brain	Trisomy 13 and 18.
Cri-du-chat Syndrome	Deleted Chromosome 5; Cat-like cry.
	Deleted Chromosome 4; without cat-like cry.
Chronic Myeloid Leukemia	One of the two members of a Group G chromosomes next in size to the smallest 22
Leukemia	Philadelphia Chromosome; deletion of approximately one half of the long arm of the chromosome 22.

Possible causes of spontaneous mutations

Although spontaneous mutations are those which naturally occur, it is more due to our sheer ignorance of the causal factor that we call them "spontaneous". All organisms are being exposed, knowingly or unknowingly, to diverse mutagens around them. Even natural radiations may play a role in the origin of these so-called spontaneous mutations. A significant amount of UV light comes with the sunrays. Too much sunbath may also cause mutation as is evident from the enhanced rate of skin cancer observed in white people who take to too long an exposure to sunlight. The somatic mutations also hasten the aging process. Moreover, mutations have also been linked with a deviation from the temperature range that is typical of the species group.

In these days of industrialization, list of mutagenic chemicals present in the environment is endless. To this has been added a new class of mutagens. Prof. G.K. Manna and his collaborators (1975, 1980) at the Department of Zoology, Kalyani University, India have extensively studied the mutagenic action of several bacteria and their toxins, pathogenic fungi, etc., on mammalian model and were tempted to call them together with some other micro-organisms like mycoplasma, rickettsia and viruses 'the living mutagens'. Ironically, some life-saving drugs are also potent mutagens. So, one really wonders if the "spontaneous" mutations represent error in genome duplication or else they are the nett result of all mutagenic pressures of environment upon organisms. Lastly, there seems to exist an apparent relationship between malnutrition and increased mutation frequency.

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METALS (*Continued from page 334*)

blocked by a mesh made of about 2 mm of a continuous length of Nitinol wire. The wire can be straightened out when it is cooled below the martensite transformation temperature, chosen to be well below body temperature. As the wire is chilled to maintain its straightened condition, it can be inserted through a catheter in an arm vein into the heart. As the wire warms up, it assumes its screen-like form.

An orthodontic dental arch wire made of a NiTi alloy is now replacing the traditional stainless steel arch wire. Since its introduction about three and a half years ago, over 5000 of the estimated 6500 orthodontists in the US have used this device for straightening teeth.

It is proposed to use NiTi wire strands as a contractile artificial muscle for an artificial heart. This is an attempt to replicate the contractibility of the left heart ventricle. Such artificial hearts are envisioned to be activated by electrical heating and programmed timing cycles involving various groups of contractile elements. Using NiTi elements attached to an elastometer chamber, significant pumping speeds have been obtained.

Bone plates from NiTi alloys for compression fixation of bone fractures and a variety of intrauterine contraceptive devices (IUCDs) have been fabricated.

Further extensive research and development on NiTi and NiTiX ternary alloys, Cu-Zn-Al alloys and other SME alloys are being carried out. Many more SME alloys are expected to come in practical use in near future.

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SCREEN PROCESS PRINTING: A Versatile Printing Method

The process finds application in printing words, drawings and images on unusual surfaces like glass dials, milk bottles, toothpaste tubes, rubber balls and plastic laminates

M.K. SHARMA

SCREEN process printing, grown out of the craft printing process known as silk-screen printing, is a remarkably versatile method that enables one to print designs and images, including line and halftone images, on any type of surface, regardless of the size, shape, or material composition of the surface. The screen process permits printing of matter that cannot be printed by conventional press processes. For instance, one cannot print words, drawings, line images or halftones on milk bottles, toothpaste tubes or rubber balls with a conventional press; but this work is a child's play with a screen stencil. Most printing presses cannot accommodate large-size billboard signs, yet, screen stencils can be made to any desired size. Furthermore, printing of printed-circuit patterns and metal nameplates are jobs that can be done efficiently only by screen process printing.

The screen process printing method (Fig. 1) is based on the simple principle of using a stencil that has open and closed areas. The image on the screen stencil is a porous and open area, while the screen background is solid and nonporous. If coloured ink or any other liquid medium such as dye and water colour, paint, cellulose, fluorescent pigments, chlorinated rubber, etc., is rubbed or drawn across a screen stencil, the ink passes through the unprotected image areas on to the paper underneath. The non-image areas are represented by the solid or masked portions of the stencil which stop the transfer of ink.

History

Ancient silkscreen printing and the modern printing method of screen process are perfections of the early stencil printings used since ancient times. Primitive man may have learned the art of stencilling by dabbing coloured dye round his hands and through his fingers on to a flat surface underneath. Another theory is that the technique was learnt from insects eating leaves, finishing only when the fine vein "stencil-like" structure was left. Early studies of native life on the Fiji Islands have shown that the islanders cut stencils from banana leaves and then applied vegetable dye through the image areas on to cloth.

Oriental artists employed stencilling techniques to print beautiful designs on textiles and fibrous paper. The Japanese became extremely adept at cutting stencils. The centres of circular letters and other loose design shapes were held in position by ties of fine human hair. The product of the silk-worm was used by the craftsmen to weave a fine mesh of silk which formed a support for these delicate stencils.

It is difficult to isolate one man's work and equate it with the monumental achievements of Johann Gutenberg of Germany (Letterpress printing in 1450), Alois Senefelder of Germany (Lithographic printing in 1798) or Karl Klic of Czechoslovakia (Gravure printing in 1890). Nevertheless, the use of a silkscreen stretched across a frame to form a support for a "tireless" stencil, is generally attributed to Samuel Simon of Manchester, England, who introduced this method in 1907.

It was the use of this silk mesh, now replaced by wire, nylon, dacron or man-made fibres, that has led to

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the development of silkscreen printing. Under the new title of screen process this method of transferring ink to paper or any other surface is now regarded as the fourth major printing process after letterpress, gravure and lithography.

Process of screen printing

The image-bearing stencil for screen process printing may be produced by painting-out the unwanted areas of the mesh, hand-cut on special laminated foil or paper, coating light-sensitive emulsion on to screen mesh, carbon tissue method, or by the recent procedure of exposing a photographic stencil film.

Stencils can be hand-cut out of paper but it is easier to cut them from the stencil material of a special nature, consisting of a plasticized shellac coating on a translucent temporary paper support. The design is cut with a sharp knife through the shellac film only, and the areas required to print are peeled off. The material is then applied to the screen with a hot flat iron, after which the paper support is removed, leaving the shellac stencil firmly adhering to screen.

The screen itself can be coated with a photo-sensitive colloid such as dichromated glue, gum or gelatin, or a gelatinobromide or chloride photographic emulsion. This is exposed under the positive and leaves a light-hardened stencil after the unaffected areas are washed away in the development process.

The most common form of photo-stencil is produced by a variation of carbon process. The carbon tissue may be dichromate sensitized and printed while still wet, or it may be replaced by a special type of pigment paper already sensitized and mounted on its temporary support.

Photographic stencils may also be made on a special type of permeable membrane which is rendered less permeable by the action of light and so can be used for printing continuous tone images in coloured dyes.

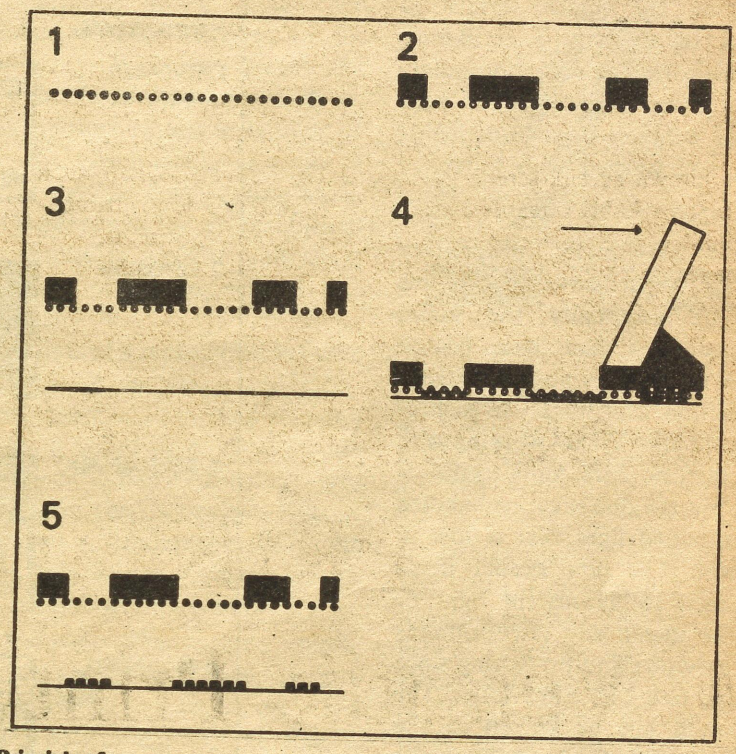

Fig.1. Principle of screen process printing; 1. Uncoated screen, 2. Coated screen with masks; 3. Positioning the paper, 4. Spreading the colour with a squeegee; 5. Removing the screen

Photo-stencil

Let us now describe in detail the modern method of making a photo-stencil with the help of photographic stencil film. In this procedure of making photo-stencil, a photographic positive of the original picture is placed on the light-sensitive stencil film in front of a light source. The non-image areas become hardened and after being transferred to the underside of the mesh, become the means of blocking the ink, so that the latter only penetrates through the image areas which remain open. The reproduction sequence is carried out stage by stage as shown in Fig. 2.

Screen

The screen used for the finished stencil is stretched across a wooden frame of desired length and width, which is generally made of lumber strips. The screen mesh is mounted on the frame in such a manner that it is tense and even, and free from ripples to provide a smooth printing surface.

The screen must be absolutely clean before the image is applied. If a new piece of screen material is used, after mounting on its frame, it is cleaned with a cleaning solvent, followed by a wash in detergent and a diluted solution of sodium hypochlorite and finally it is washed with water. If an old screen is reused, ink and gelatin of previous stencils must be removed so that the new stencil adheres properly. The old screen is soaked in hot water for several minutes and then swabed with an etch bath until the stencil is softened. Following etch bath

application, the screen surface is scrubbed lightly with a scrubbing brush while rinsing with hot water. Finally, the screen is sponged with a diluted solution of sodium hypochlorite and washed with water.

Stencil film

There are many proprietary brands of light-sensitive stencil films which are essentially the same, consisting of a film base coated with an emulsion whose sensitivity and reaction are similar to dichromated colloids. When working with such a film, no dark room facility is needed but the film must be handled under subdued light that is low in ultraviolet. The film should never be exposed to fluorescent light or day light under any circumstances before exposure and processing since they are rich in ultraviolet. The film should not be kinked as the emulsion may delaminate from the base and inhibit exposure of the damaged area.

Exposure

A good photographic line or halftone film positive of the subject matter to be printed is taken. This positive should have been produced by conventional lithographic methods or a contact autopositive on thin base material. The halftones should have pinpoint dots in the highlights, and the shadows should be barely closed in. A halftone screen with approximately 26 lines per cm should be used when preparing halftones for transfer to screen film. Coarse screens are recommended, since halftones reproduced on a screen film require unusual care in selection of inks, printing surfaces and techniques.

The screen film can also be exposed directly from artwork drawn on translucent material such as tracing paper, cloth and linen, provided inked areas are thoroughly opaque.

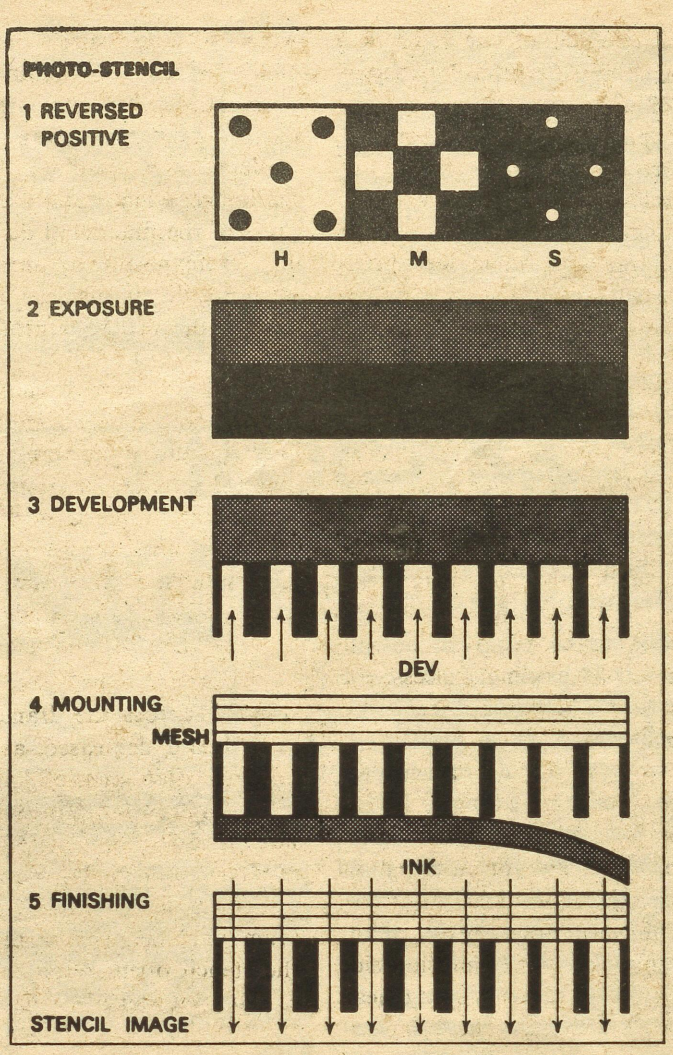

Fig. 2. Preparation of a photographic stencil

A sheet of light-sensitive stencil film of required size is placed with its base-side, which is the side (nonemulsion) having the lighter shade, in contact with the emulsion of a reversed photographic positive. The sandwiched positive original and the film is put in a vacuum or pressureback printing frame with the positive image toward the glass of the frame, that is, with the original nearest the light source. This combination is exposed to an ultraviolet light source and thus the screen film is exposed through its base-side. Light sources vary considerably in their spectral output, especially carbon arcs, therefore it is important to establish the correct exposure level. A test strip is made to determine the correct exposure time.

The light rays pass through the transparent non-image areas of the positive and harden the stencil film forming a negative image.

Hardening

Although the light-sensitive stencil film has become light-hardened, it must go through a process of chemical hardening. This is carried out by evenly immersing the photostencil film, immediately after exposure, in a bath of 1.2% hydrogen peroxide. As hydrogen peroxide comes in varying strengths, the

required strength of the hardening solution should be carefully prepared by dilution with water.

The photostencil film contains the correct type and amount of special chemicals right in its emulsion which hardens the non-image areas on the film, when the film is immersed in hydrogen peroxide solution. The hardening solution is used in a tray at a temperature of about 20°C. If the film has been exposed correctly, adequate hardening takes place between 1 to 1½ min. The film should never be removed from the tray while hardening. The solution is agitated by rocking the tray back and forth. Hardening of the exposed film ensures that non-image areas on the film will stand up to developing process.

Development

The soluble image areas are now ready for development. After hardening, the film is placed, emulsion up, in a sink on a sheet of glass, plexiglass or lucite. A gentle stream of warm water between 40°-45°C is sprayed on the emulsion side of the base film, using a spray head attached to a hose. The temperature of the water should not exceed 45°C, otherwise adhesion problems may arise when applying the film to the screen mesh. On the other hand, the stencils should also not be chilled with water below 10°C, as it can reduce adhesion of the stencil to the mesh.

During washing, the image areas gradually dissolve, leaving the hardened non-image areas on the film base. Unexposed portions of the film are usually washed off in less than a minute, leaving the area completely clean. The washing is continued for at least 30-60 seconds after the image area appears free of emulsion; this is especially important when making fine detail stencils.

The stencil is properly prepared when all the film's unhardened emulsion has been removed by the water spray. With line images, the detail should look clean and open. Underexposure results in tanning of the image, which results in a loss of some of the fine detail during wash-off. Overexposure or an insufficient wash results in unclear and slight closing up of the reproduced fine lines.

The dots of a reproduced halftone image should be sharp and clear. Overexposure or an incomplete wash presents a veiled or mottled muddy appearance in the dark areas when viewed over the transmitted light of a light table. Underexposure results in the loss of the smallest gelatin dots in the wash-off step.

Mounting The screen mesh, stretched across the frame, is pretreated and degreased, as described earlier. After wash-off, the film is ready for transfer to the screen mesh. This is done immediately. For best results, the stencil is applied to a wet screen as this helps to prevent scumming, i.e., partial blockage of the stencil open areas.

The wet stencil is placed on the underside of the wet screen, emulsion side to mesh. The excess water from the base support is blotted off with one or two sheets of newsprint or paper towel. The screen with the stencil is then positioned on a raised pad or platform slightly smaller than the inside of the frame, ensuring that the surface is free from high spots. The platform should, however, be larger than the reproduced image area. Using a roller, four or five sheets of clean newsprint or paper towel are firmly applied to absorb all surplus moisture; excessive pressure will cause squelching of stencil edges. A slight stain should be present on the first few sheets of newsprint or paper towel. Failure to remove moisture adequately from the open areas may cause scumming.

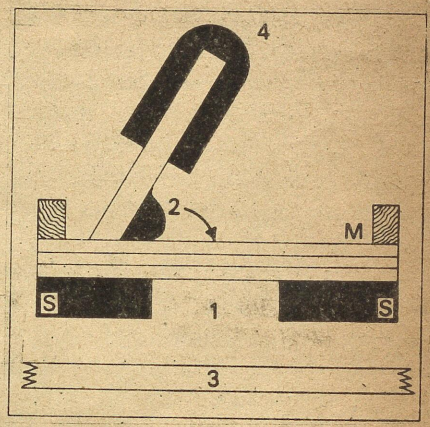

Fig. 3. Printing by screen process. 1. Image, 2. Ink, 3. Paper, 4. Impression; M. Mesh, S. Screen

Drying Ideally, the drying operation is commenced with the screen on its raised pad or platform. Drying can be quickened by using a fan or by combining a fan with a heat-producing infrared lamp, though temperatures above 35°C will cause edge curling and loss of adhesion. If using a heating lamp, it is placed away from the screen and the fan is put so that it blows across the top of the screen. When the exposed surface of the stencil is thoroughly dry, the frame is turned over and the stencil's back is dried.

After drying is complete, the stencil becomes firmly adhered to the mesh. Once this has been established, the stencil's base film is carefully peeled off, leaving the stencil-that is the non-image areas—blocking out the mesh.

Mask out. Finally, the surrounding areas between the edge of the stencil and the frame are masked out with tape, so that the only openings through the mesh are in the image areas. The pinholes, if any, are spotted out with a filler.

Printing

Screen process printing relies on a direct, stencil-like method of transferring ink or other liquid media on to paper, or any other

material such as metal, wood, glass, rubber, plastic, leather, textile, fabric, etc. Printing is usually based on the simple squeegee-wiping method, while the frame can be made to fit most shapes, flat, or curved.

In the process of screen printing (Fig. 3), ink is held in the top of a frame which has the fine screen mesh with stencil, stretched tautly across its underside and secured around the outside edges with clamps or staples. A sheet of paper is positioned at the side lays and the frame, mesh and stencil lowered on to its surface. With one wipe of a squeegee blade the ink is forced through the mesh and stencil on to the paper underneath.

In this way images can be readily produced and if more than one colour be required, either side by side or superimposed, it is necessary to prepare the requisite number of stencils and to see that they are in "register".

Large-scale print production by the screen process, such as that employed in printing images on rubber balls, toothpaste/shaving cream tubes, milk bottles, different types of containers, posters, billboard signs, printed circuits and the like, are handled by special automatic machines capable of high-volume output. The screen printing of textiles is carried out on long tables, the screen being moved along step by step to successive positions. The screen can be wrapped round a cylinder for rotary printing. On the other hand, images reproduced on a screen mesh by a reproduction technician, are applied to a surface by hand, since the screen-stencil is usually employed in printing a limited number of items.

The effect produced by this printing process may be admirable. In one class the nature of the ink—its pigment, the medium and the effect when dry—permits a rendering entirely different from other ordinary printing methods. Given a suitable pigment and medium, an effect can be obtained similar to a drawing in the so-called "pastel" pigments.

It is the printing method that allows such a thick layer of ink to be deposited and this causes a bold edge to build up around the printed areas which is responsible for the "well defined" look of screen process printing. This type of printing may by identified by looking for the following characteristics with a magnifying glass: (a) The thickness of the printed ink image detected by touch of the fingers. Fairly coarse halftone screens, (b) Occasionally the mesh pattern seen in the printed image, (c) The overprinting of white ink on top of other colours, and (d) The printing of bold, brilliant colours on all kinds of surfaces.

Conclusion

Screen process printing could be renamed "versatile" printing because it is capable of printing so many different types of work on all kinds of flat and curved surfaces. Direct application of ink through the stencil and fine mesh on to the surface of the material is the key factor. The work can range from large posters containing huge letters printed in fluorescent ink from hand-cut stencils to the finest printed circuit for some complicated electrical devices and also for commercially applying decoration, trade marks, and instructions for all types of manufactured goods.

Screen process with its recent influx of finer meshes, photographic stencils and automatic printing machines positioned in production lines, is developing at a rapid pace. It takes in its stride the printing of such things as glass dials, bottles, containers, textiles, and laminated plastics.

Further reading

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Corrigenda

1. Ref: S.R., April 1982, p. 227, **Electrochromic materials for display devices,** third column, First para, **Read** Mo_3O **Far** Mo_3O.
2. Ref: S.R., April 1982, p. 248. **The author of Forensic science quiz is: Satyananda Moharana, Scientifi Officer, State Forensic Science Laboratory, Bhubaneswar (Orissa).**

Product of interaction between nitrites and secondary amines, when both the constituents are simultaneously present in the body, nitrosamines have been found to induce cancer of the oesophagus, liver and lungs

NITROSAMINES: The Nasty Carcinogens

M. Z. HASAN S. P. PANDE

INCREASE in the incidence of oesophageal cancer has become a matter of world-wide concern. High incidences of oesophageal cancer have been observed among African natives drinking locally distilled spirit. Oesophageal cancer is also one of the most frequently occurring malignant tumours among people in China. A few high incidence regions were recently identified in northern China. These areas were characterised by poor availability of fresh vegetables in daily diets and a widespread habit to use sour preserved vegetables. In another epidemiological survey in Greenland, higher incidences of oesophageal cancer were observed. Medical records of hospitals in India also show high incidence of oesophageal cancer. In most of these cases, a particular group of chemical compounds have been implicated with the development of oesophageal cancer. These are the so called potential carcinogens—the nitrosamines.

What are nitrosamines?

Nitrosamines are organic compounds formed by the interaction of nitrite or oxides of nitrogen with substances susceptible to N-nitrosation. They are usually formed by the interactions of nitrite and secondary or tertiary amines under acidic conditions. Recent studies have also shown that certain naturally occurring quarternary ammonium compounds can also react with nitrites to form nitrosamines. The formation of nitrosamines may be represented as in Fig 1.

In general, the nitrosamines are chemically stable. They undergo photo-decomposition when exposed to ultraviolet radiation. Nitrosamines are unstable at alkaline pH and may decompose quite rapidly even at neutrality. Some potentially toxic nitrosamines are given in Table 1.

Occurrence

Nitrosamines have been found in tobacco smoke, grains and alcoholic beverages. Higher concentrations of these compounds have been found in nitrate treated meat, fishmeal and curing mixtures containing spices and nitrites. Traces of nitrosamines have also been detected in air of highly polluted areas during night. These compounds are probably formed in air by the reaction of gaseous dimethyl amine with gaseous nitrous acid. The chances of the presence of nitrosamines in sunlight are remote as both nitrous acid and nitrosamines are unstable in sunlight. Nitrosamines have also been detected in preserved cheese and cooked bacon.

Nitrosamines have not been extensively used in industry. Industries like those manufacturing rubber, lubricating oils, explosives, dyestuffs and pesticides have, however, patented some of the nitrosocompounds. Nitrosamines have been used as solvents in the plastic and fibre industry, as an additive for lubricants and in condensers to increase dielectric constants. Nitrosomethyl urea and nitrosoethyl urea are used in chemical laboratories for synthesis of diazomethane. These compounds are also being used as industrial solvents, as nematocides and in the synthesis of rocket fuel.

Certain substances have been shown through epidemiological studies in selected population groups to act as cancer inducers in humans. They are called carcinogens. Any group of chemical carcinogens significantly implicated in humans must be both widespread and multipotent. Nitrosamines are such chemicals which are now well documented carcinogens. R.N. Magee and J.M. Barnes from Middlesex Hospital, London, England, were per-

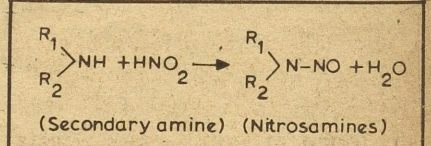

Fig. 1

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haps the first to report hepatic cancer in rats by nitrosodimethylamine in 1956. However, intensive laboratory studies and epidemiological surveys carried out in the last two decades have confirmed the carcinogenic potential of nitrosocompounds.

Table 1. Some potentially toxic nitrosamines

Nitrosamines	*Molecular formula*	*Toxcc effects*
Nitrosobenzyle	C_6H_5NO	A suspected carcinogen
N-Nitrosodimethyl amine	$C_2H_6N_2O$	Irritant, highly toxic, possibly carcinogenic, has caused fatal disease in human
P-Nitrosodimethyl aniline	$(CH_3)_2NC_6H_4NO$	Irritant, allergen, a suspected carcinogen
N-Nitrosodipheny amine	$C_6H_5NHC_6H_4.NO$	Details unknown, as suspected carcinogen
N-Nitrosomethy urea	$CH_3NHCONH.NO$	Allergen, known to cause contact dermatitis, a suspected carcinogen
N-Nitrosomethy urethane	$CH_3N.NO.COOC_2H_5$	Irritant, a suspected carcinogen
P-Nitrosophenol	$C_6H_4OH.NO$	Irritant, sensitizer, a suspected carcinogen
N-Nitrosopiperidine	$C_5H_{10}N_2O$	Potential carcinogens
N-Nitrosopyrrolidine	$C_4H_8N_2O$	

Formation of nitrosamines

Nitrosamines are formed both in the environment and in the gastrointestinal tract of humans. There have been considerable interest in the possibility that nitrosocompounds can be formed in the stomach. Secondary amines have been shown recently to react with nitrite to form nitrosamines in defined pH and other conditions similar to those found in mammalian stomach. The formation of nitrosamine depends on nitrites, secondary amines and acidic pH. This consideration has directed the attention of environmentalists and toxicologists towards the environmental distribution of nitrites and secondary amines as essential precursors of nitrosamines.

Nitrites. Nitrates are widely distributed in plants and forage and nitrites are readily formed from them. Excessive use of nitrate fertilisers, use of herbicide, 2,4-dichlophenoxyacetic acid and molybdenum results in accumulation of nitrate in plants and forage. Contamination of water with nitrates results from sewage discharges, intensive use of nitrate fertilisers and rising water tables, which leach soil nitrate into well water. Nitrates can be reduced to nitrites by reductase present in a wide range of saprophytic and parasitic bacteria. Large concentration of nitrites is found in stored green vegetables, especially spinach, celery and green salad as a result of bacterial reduction of nitrate. Further, nitrates and nitrites are used as preservatives in meat and fish. It seems most likely that nitrite ions enter in sufficient quantity in the stomach of both vegetarian and non-vegetarian people.

Secondary amines. Limiting factor in the formation of nitrosocompounds seems to be the availability of nitrostable secondary amines. The secondary amines, particularly dimethyl amine and diethyl amine, occur in fish meal, fish products, cereals, tea, tobacco and tobacco products. Cooking of protein foods might produce free amino acids such as proline, arginine, hydroxyproline, pyrrolidine, arginine and piperidine. Various flavouring agents are prepared from secondary amines. Bread flavourings are prepared from pyrrolidine and piperidine and meat flavourings are prepared from free amino acids including proline. These additives could be nitrostable themselves or contain the unreacted amines. Some toothpastes contain the derivatives of sarcosine; nitrososarcosine being carcinogenic. Some drugs too are secondary amines, such as piperazine used in the treatment of worms.

Tobacco contains several secondary amines particularly pyrrolidine. They could be released and ingested when tobacco is chewed, particularly when mixed with lime. Cigarette smoke contains many secondary amines, including pyrrolidine and piperidine. These amines could be dissolved in the saline during smoking and converted into nitrosamines in the stomach.

Nitrosamine formation in foods

Cooking of protein foods produces free amino acids. The diamines putrescine, supermidine and cadverine, present in partially decayed meat and fish, are converted by heating into pyrrolidine and piperidine, and finally undergo nitrosation to form corresponding nitrosamines.

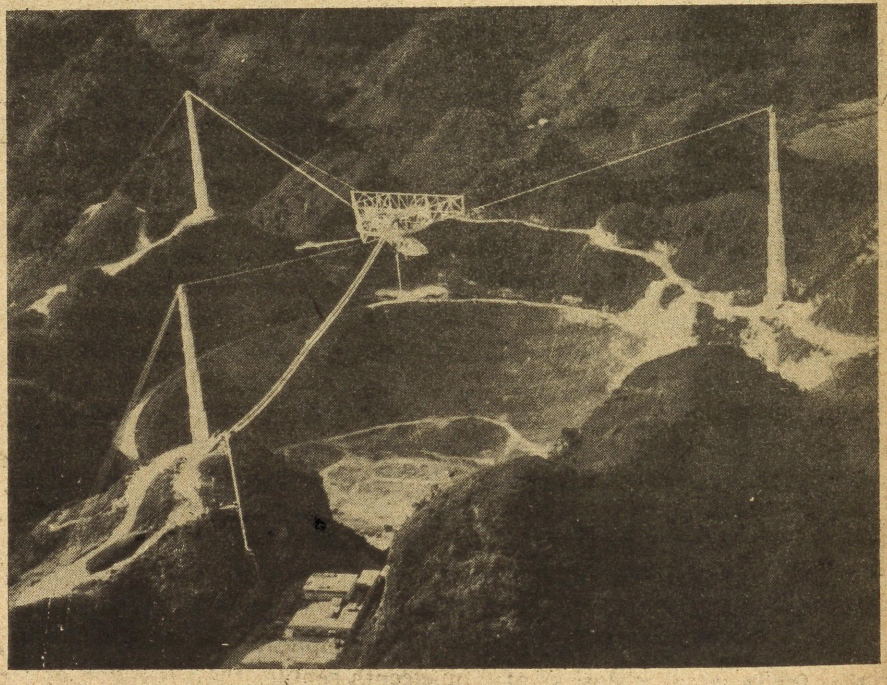
SCIENCE SPECTRUM

Gravitational waves are real

SIXTYSIX years ago, Albert Einstein predicted the presence of gravitational waves—waves generated when a mass is accelerated just as electromagnetic waves are generated when an electrically charged particle is accelerated. These waves are a direct consequence of Einstein's General Theory of Relativity. Even though Einstein had predicted the presence of the waves, he was not sure whether they would ever be detected. Even today, gravitational waves remain as elusive as ever. The detectors built to date are not sensitive enough to detect them. Besides other disturbances, even the thermal motion of atoms in a detector, which cannot be avoided, contaminate the incoming gravitational waves. In the light of these uncertainties, the proof of the existence of gravitational waves is a welcome news. The experiment, which proved the existence of these waves, also shows that other rival theories of gravitation are wrong.

The experiment was performed at the 305-m Arecibo Radio Telescope, Puerto Rico, U.S.A., and the object of the experiment was a binary pulsar designated as *PSR 1913+16*. A pulsar is a heavenly body which emits pulses of radio waves with precise regularity. The regularity of the pulses is so high that the pulsar can be regarded as good as a clock. A pulsar is basically a dense ball of neutrons only 20km-30km in diameter but as massive as the sun. It spins about itself like a top upto 30 times a second and converts its kinetic energy into a highly narrow beam of radio pulses in some as yet unknown manner. It is only when the beam sweeps across the line of sight of an observer on earth that the blinking radio waves are observed. *PRS 1913+16*, which is in *Aquila* constellation, was discovered at Arecibo Radio Telescope in 1974, seven years after the first pulsar was discovered at Cambridge, U.K.

When the radio pulses of *PSR 1913+16* were observed carefully, their regularity or frequency was however found to be inconsistent; it was varying cyclically over a period of 7.75 hours. It became apparent in due course that the variation in frequency of the pulses was due to the Doppler effect. The frequency of the pulses increased and decreased just as the pitch of the whistle of an approaching and receding train becomes high and low due to the Doppler effect. In other words, the pulsar was approaching the earth and then receding away from it. It was actually circling its companion, which, though as heavy as the pulsar, may not be emitting light or radio waves. It is, of course, possible that this companion could be another pulsar whose radio beam does not cross the earth.



Arecibo Radio Telescope, Puerto Rico, U.S.A., was used to confirm the presence of gravitational waves. It is a telescope which can measure the radio ticks with an accuracy of 20 millionth of a second! (*Courtesy*: U.S.I.C.A.)

Further studies indicated that the pulsar went around its companion in a highly elliptical orbit about a million kilometers in diameter. Moving at an average speed of 400 km/sec, the speed of the pulsar varied considerably. Not only the speed of the pulsar rose and fell by a factor of four in one orbit, the changing distance between the pulsar and its companion consequently changed the local gravitational field considerably. Here was thus an ideal case where two superheavy bodies were being regularly accelerated and decelerated, and the generation of gravitational waves was therefore possible. But, then, one might ask: Why had two massive binary stars, which are available in abundance, not earlier been used to prove the existence of gravitational waves?

Theoretically, when gravitational waves are generated in a binary pulsar, or for that matter a binary star, there would be a decrease in their orbital energy. The orbit of the binary would begin to shrink and the pulsar, or the star, would take lesser time to circle its companion. In course of time the two bodies would spiral down to collide with each other. Here the biggest problem is how to measure the minute shrinkage in the orbit of the two stars, or pulsars, which is beyond the limit of measurement of the present telescopes. An orbiting pulsar has one great advantage over other heavenly bodies in that its radio pulses can be regarded as the ticks of a clock. These radio ticks can be used to determine shrinkage in orbit of the pulsar and thus existence of gravitational waves and that is exactly how it was done. Soon after the binary pulsar *PSR 1913+16* was discovered in 1974, efforts to test the fundamental theories of physics began at the Arecibo Radio Telescope, a telescope which can measure the radio ticks with an accuracy of 20 millionth of a second! It was only after six years of continuous monitoring of the binary pulsar that the generation of gravitational waves was confirmed (*Scientific American*, October 1981).

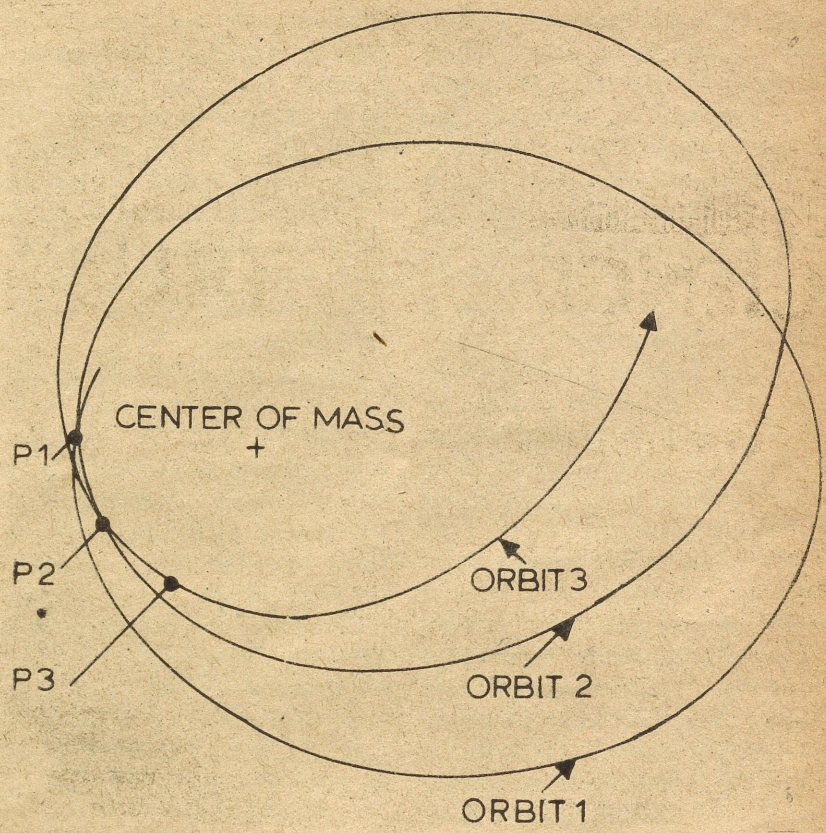


Fig. 1. Advance of periastron in the orbit of PSR 1913+16

To understand how the measurements were conducted, consider the elliptical orbit of the pulsar around its companion. The point in the orbit of the pulsar when it is closest to its companion is called "Periastron". This periastron is similar to the perihelion, the point in an orbit of a planet, say, Mercury, around the sun when it is closest to the latter. The similarity between the periastron of the pulsar and the perihelion of mercury does not end here. It has far more implications. In the mid-nineteenth century the perihelion of mercury was found to be shifting in the same direction as the direction of motion of the planet around the sun. The shift was very small, only 43 seconds of arc over a period of a century. However, Isaac Newton's gravitational theory was not able to account for this shift. It was only after Einstein's Theory of Relativity was applied to the motion of Mercury that the small shift was accounted for. But in recent times, other gravitational theories have also been forwarded, which account fully for the shift in mercury's perihelion.

In case of the orbiting pulsar, the periastron should also shift with every orbit of the pulsar when the orbit itself is shrinking due to the generation of gravitational waves. How did the astronomers measure the small shift in periastron? The precise radio ticking of the pulsar was first plotted with respect to time. From this plot various orbital parameters of the pulsar,

namely, the orbital period, etc., were found as mentioned above taking full help of the Doppler effect. Now, consider, for instance, that the pulsar clock takes 12 hours to go once around its companion. It strikes 4 O'clock, say, when the pulsar is at periastron. Apparently, due to the shift in the periastron position, the clock will show a slightly different time on every orbit (Fig. 1). Over a period of six years, the shift in the position of periastron will accumulate and so will be the time in the clock. Such an accumulated time will be easier to measure.

The pulsar clock gained more than one second of time over a period of six years. In practice, however, these measurements were not so easy to make because other relativistic effects that affect the time of the pulsar clock had also to be taken into consideration. According to the Theory of Relativity, a clock moving at a high speed, as the pulsar clock, slows down in comparison to a clock on the slow-moving earth. The effect is called "Time-dilation". Secondly, as the pulsar clock is moving in a very high gravitational field, the time it shows to an observer in the weak gravitational field of earth is always less. This effect is called "Gravitational red-shift". The corrections for these relativistic effects were made in the time shown by the pulsar clock before the shift in the periastron was calculated.

Monitoring of the binary pulsar for six years has shown that the periastron shifts by exactly the same amount as predicted by Einstein's Theory of Relativity. The amount of shift does not at all agree with the shift calculated on the basis of other rival theories of gravitation. How precise must have been the measurements can be estimated from the fact that on every orbit the orbit of the pulsar shrinks by 3.1 mm and its orbital period decreases by 6.7×10^{-8} seconds!

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Gunn diode oscillators

FROM the early 1950s attempts were made to put a bulk semiconductor material (having no p-n junction) in use for the generation of high-frequency oscillation in microwave range ($\sim 10^9$ Hz). The search resulted in the discovery of transferred electron (TE) devices. These include Gunn diode, named after J.B. Gunn who in 1963, while investigating the bulk n-type GaAs material with Ohmic contact (Fig.1), observed much to his astonishment that whenever the applied voltage exceeds several thousand volts per cm, random noise-like oscillations appear in the sample current. At its early stage of development the oscillation frequencies of the Gunn diode were in the range of 0.5 GHz to 6 GHz (1GHz=10^9Hz). Nowadays, however, the Gunn diode is effectively used even in 100 GHz range.

Oscillation mechanism of Gunn diode

A Gunn diode oscillator is essentially a negative resistance oscillator (like that of a dynatron oscillator) and its current density (J)—electric field (E) characteristic exhibits a negative differential conductance (n.d.c) region (Fig.2) over which the current density decreases rather than increases with increasing electric field values. It was proposed that any negative conductance device is inherently unstable, so that the electrical inhomogenity, once produced, grows in time. Consider, for example, a GaAs sample with Ohmic contact. Now, suppose that because of non-uniformity in carrier concentration or because of random fluctuations in inherent noise a space charge layer is formed, say at point P (Fig.1) inside the sample. This space-charge will grow in time and a high field domain, surrounded by low field regions, is formed at P (i.e., at the cathode side) provided the product of carrier concentration (n) and sample length (L) exceeds 10^{12} cm^{-2}. The domain consists of mobile charges and thus drifts towards the anode where it gets extinguished and a new domain is formed. This formation and extinction of domain continues giving rise to an oscillatory variation of sample current as shown in Fig.3. The frequency of oscillation (f) is related to the sample length L in the manner $f=10^7/L$. The origin of negative differential conductance (n.d.c.) region in J-E characteristic may be attributed to two different causes discussed below.

Negative differential conductance

The current density (J) of a bulk n-type extrinsic semiconductor is proportional both to the carrier density (n) and to the average drift velocity (v), i.e., J=e.n.v.; where e is the charge of each majority carrier. The differential conductivity is defined by

$$\sigma_D \equiv \frac{dJ}{dE} = en\frac{dv}{dE} + ev\frac{dn}{dE} \quad \ldots (1)$$

where E is the strength of applied electric field. σ_D differs,

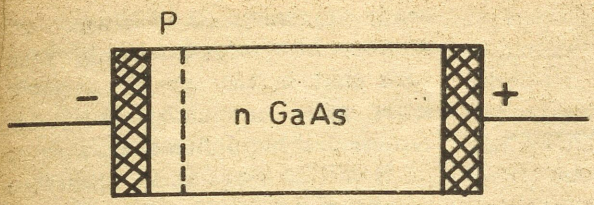

Fig. 1

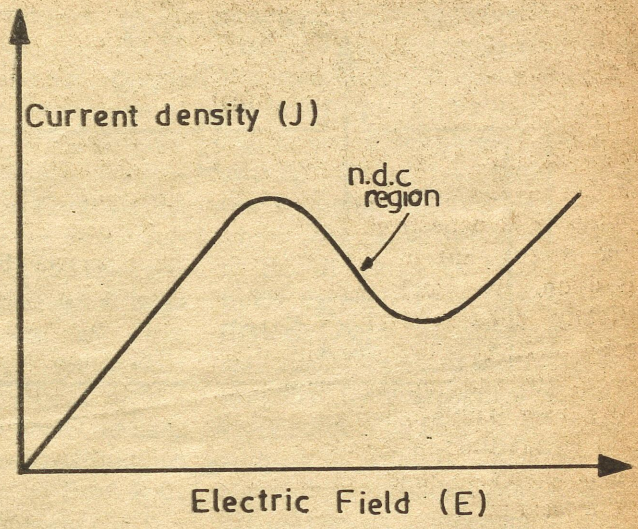

Fig. 2

however, from the total conductivity $\sigma = J/E$. From above we see σ_D decreases depending on whether

$$\frac{dv}{dE} < 0$$

or $$\frac{dn}{dE} < 0 .$$

The decrease in carrier density (n) with field strength (E) is best realised in 'electron capture mechanism' first proposed by Ridley and Watkins in 1961. According to this mechanism for a greater field strength, the charge carriers gain sufficient energy to overcome the repulsive barrier surrounding the impurity centres, get trapped there and become immobile. Thus the number of electrons available for conduction is drastically reduced. However, at a very high field, the free electrons knock out the trapped electrons by impact ionization. The trapping effect is very slow and the device potential is limited.

The origin of decrease in drift velocity (v) with increasing electric filed (E) lies in the transferred electron effect as was first proposed in 1961 by Ridley and Watkins and independently by C. Hilsum. It is well-known that the atomic energy levels within a crystal superpose to form bands both conduction and valence. The electrons in a partially filled conduction band contribute to current flow. In metal, the conduction and valence bands normally overlap so that a huge number of free electrons are available for conduction at room temperature. But in insulators and semiconductors, the two bands are separated from each other by energy gaps that are very large for insulators compared to semiconductors. For semiconductors such as germanium and silicon, the energy gap is approximately equal to 0.75 eV to 1.1 eV.

There are semiconductor materials whose conduction bands have two or more valleys having different carrier mobilities (mobility is the average drift velocity gained per unit applied electric field). Thus whenever the carrier is brought from a lower valley with high mobility to a higher valley with less mobility, the drift velocity of the carrier decreases thereby decreasing the current density also. For better understanding, let us refer to the energy band diagram of GaAs

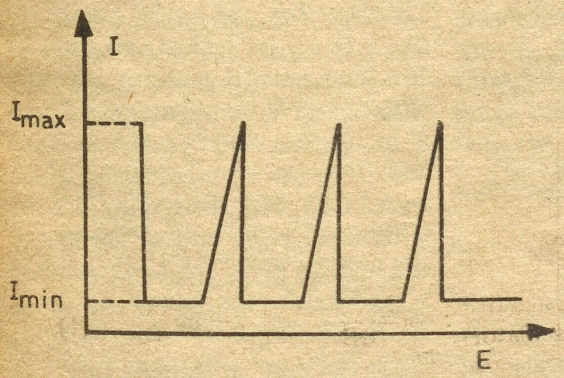

Fig. 3

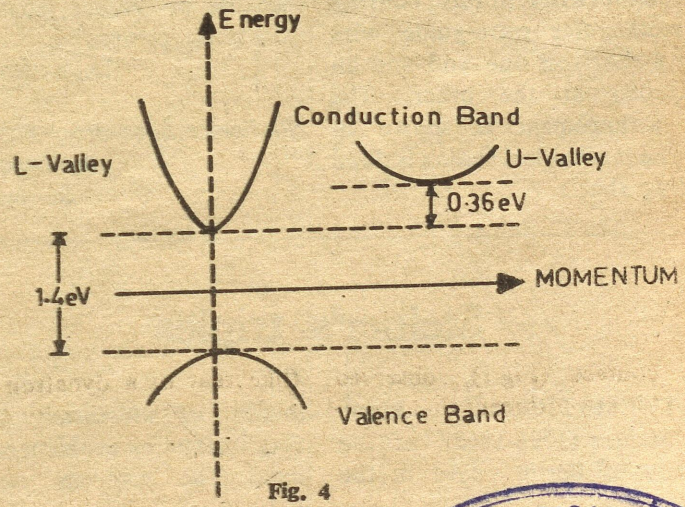

Fig. 4

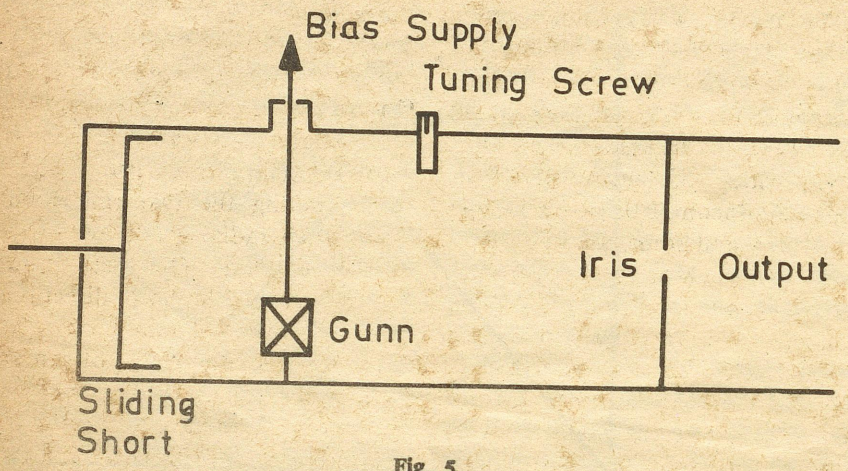

Fig. 5

sample in momentum space (Fig.4). In conduction, band L and V stand for lower and upper valley respectively. The difference in energy between the two is 0.36 eV, much greater than the average thermal energy of 0.025 eV. Thus, at room temperature, most of the electrons remain at the lower valley in absence of any electric field, the mobility at the lower valley is 8000cm²/VS and that at the upper valley is 150 cm²/VS. When the applied electric field exceeds a certain critical value (corresponding to 0.36 eV energy), the carriers are transferred from the lower to upper valley.

Basically, a gunn oscillator circuit consists of a resonant cavity and an arrangement for biasing the diode. The resonant cavity, in turn, consists of a rectangular wave-guide with a sliding short on one end and an iris coupler at the other. The circuit arrangement is shown in Fig.5. The mechanical tuning is done by sliding shorts.

The theoretical limit for the output power from a single Gunn device has been estimated at about 4W at X-band (8-12 GHz). Experimentally only 1.5 W has been achieved so far at X-band and only 0.5 W at Ku band (12-18 GHz). In pulsed mode operation, the output power goes upto 6 kW at 1.75 GHz, 2 kW at 7 GHz and 150 W at 16 GHz.

Because of its versatility and low noise level, the Gunn oscillator finds application in portable continuous wave Doppler radar, signal generators, satellite communication and in various military equipment. At present, the TE devices are almost made from GaAs. However, InP and certain alloys have been found to be more useful because of higher efficiency and low noise power.

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Steiner's triples

MATHEMATICIAN Jacob Steiner (1796-1863) of the University of Berlin posed in the middle of nineteenth century a very interesting problem on arrangement. The problem is: in how many ways can a set of N letters or numbers be arranged in sets of three such that in the sets all possible letter pairs or number pairs are represented but not more than once.

It will be found that the problem admits of no solution for the sets of letters (A, B, C, D,), (A, B, C, D, E,), (A, B, C, D, E, F,) and some other such sets.

In other words, it will be impossible to find sets of three letters from A, B, C, D, E, and similar sets of four, five six etc. letters such that every letter occurs in pairs with other letters (i.e., no possible letter pairs are omitted) but not more than once.

The problem admits of solution for 3,7,9,13, and a few other numbers of letters. That is, there are solution for sets of letters like (A, B, C) (A, B, C, D, E, F, G), (A, B, C, D, E, F, G, H, I,), (A, B, C, D, E, F, G, H, I, J, K, L, M), and a few others.

It may be noted that there is only one such triple namely (A, B, C) for the set of 3 letters A, B, C. For 9 letters A, B, C, D, E, F, G, H, I, there are 12 such triples. These are (A, B, C), (A, D, E), (B, D, I), (C, D, H), (A, F, H), (B, E, F), (C, E, G), (D, F, G), (A, G, I), (B, G, H), (C, F, I), (E, H, I). It may be noticed that any letter A for example occurs with every other eight letters but only once in a triple. Likewise for the other letters B, C, D, E.....I. As a matter of fact A occurs with B and C in (ABC) with D and E in (ADE) with F and H in (AFH) with G and I in (AGI) and there are no other triples which contain A. The same thing will be noticed for other letters. The reader will find it a great fun to find out the 7 triples for the letters A, B, C, D, E, F, G.

For the case of thirteen letters A, B, C, DEF GHI JKLM there are two solutions. They are given here.

In both solutions, the triples below are common.

(A B C)
(A D E) (B D F)
(A F G) (B E G) (D C H)
(A H I) (B H J) (D G I) (G C K)
(A J K) (B I L) (D J M) (G H M)
(H E K) (F I K)
(A L M) (B K M) (D K L) (G J L)
(H F L) (C E L)

For the first solution, we include with the above 22 triples the triples,

(C F J) (E F M)
(C I M) (E I J)

For the second solution, we take the following triples along with the above 22 triples.

(C F M) (E I M)
(C I J) (E F J)

They give two solutions of 26 triples of which 22 are common to both the solutions.

Steiner's triples belong to a special class in the general theory of arrangements which the modern statisticians call Incomplete Block Design and which find some use in agricultural trials such as testing the relative yield potentialities of a large number of varieties of rice or wheat. It is worthwhile noting that in the theory of Incomplete Block Designs many Indians have made significant contributions under the leadership of Prof. R.C. Bose (*S.R.*, August 1966).

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The Connaught Place dilemma

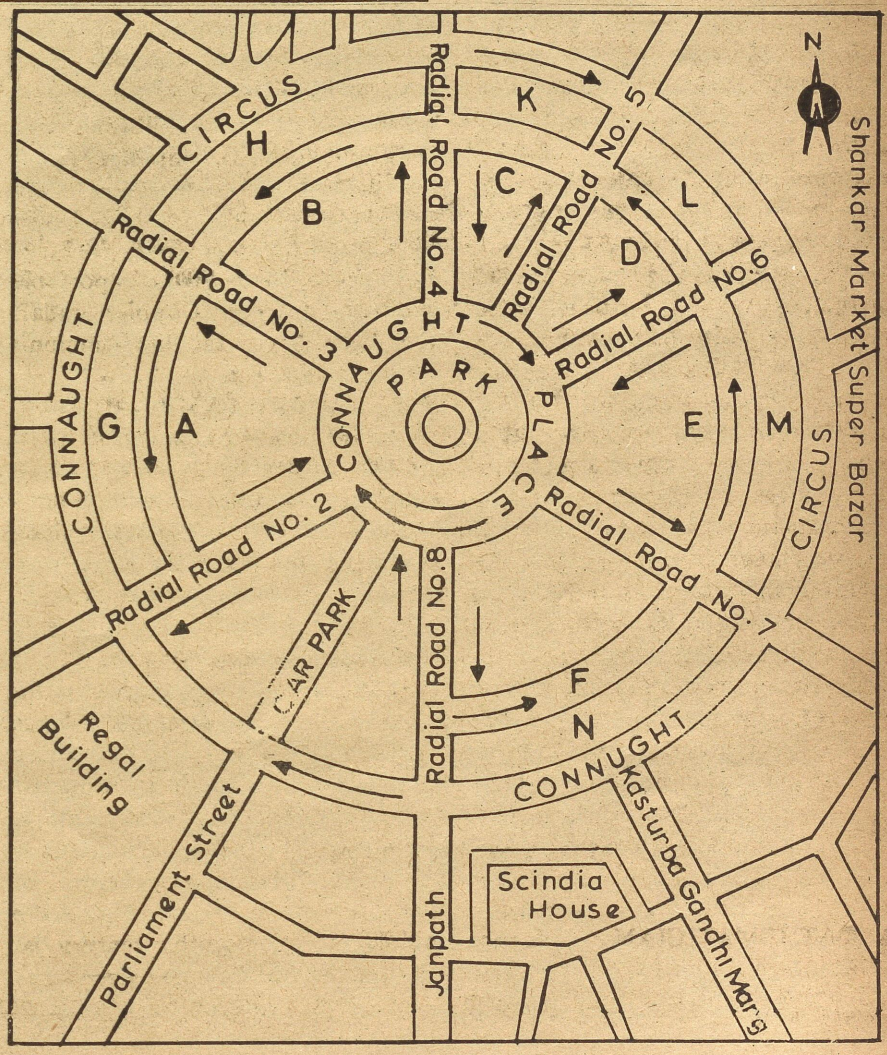
HERE is a simple real life problem and its solution which makes use of no more than school geometry. Negotiating Connaught Place, drivers in Delhi regularly encounter a small dilemma. While going from one point to another on the outer circle, they face two options:

(i) They can drive all the way along the outer circle; and (ii) They may, instead, move to the inner circle, drive along it and come out at the relevant point on the outer circle. Which route is shorter?

Since Connaught Place is not the only place where one faces this dilemma and since petrol is so dear, it is worthwhile explaining the problem in more general terms. There are two ring roads centered at the same point, as shown in Fig. 1. On both roads, traffic is allowed in one direction, leftwards (shown by arrows). There are many radial roads linking the two ring roads. Three such radial roads are shown in the diagram. On these roads, traffic may ply in both directions. For the sake of simplicity you may assume (without loss of generality) that there are radial roads at every point. You have to travel from point A to point B. There are two alternative routes that you can take:

(i) ADB;
(ii) AadbB.

Given that you wish to take the shorter route, which one should



New Delhi's Connaught Place. Traffic here moves as shown by arrows. The shortest distance between any two points depends not only on whether they are more, or less, than 1, 3 the circumference of the outer circle/ but also on whether the starting point is at a 'no entry' road. This restriction makes some outer circle routes shorter even though the two points may be more than 1/3 circumference apart

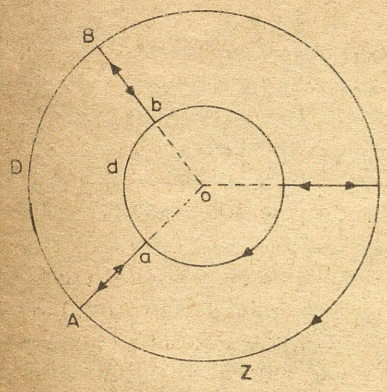


Fig. 1

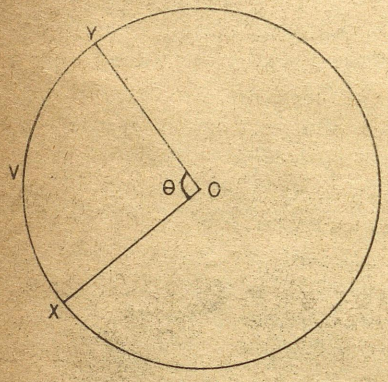


Fig. 2

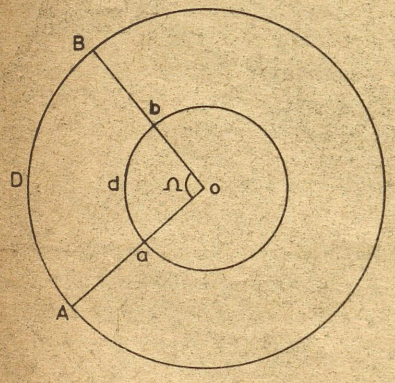


Fig. 3

you opt for? Clearly, if B is very near A, then it is better to remain on the outer ring. If howerver B is very far away, for instance, at Z, then the second option is better: to move along the inner circle and emerge at B. All this is anyway obvious to anybody who has driven around Connaught Place. The question is: what is the critical distance of B from A where it becomes preferable to take the inner road.

The answer

I give the answer first and then its derivation. The critical distance is $360/\pi°$ (i.e., approximately 114.6 °) which is almost $\frac{1}{3}$ a circle. What is somewhat surprising is that this answer does not depend on the sizes of the two circles.

So the rule to follow is simple. If you are travelling less than $\frac{1}{3}$ the circle, then remain on the outer road. For any greater distance, take the inner circle. And this is valid, not only for Connaught Place, but for any two roads which are concentric circles, irrespective of their radii.

Before giving a formal proof of this, one may suggest a pragmatic way of checking this answer. Take taxis to Connaught Place a few times; and you will find that taxi-drivers invariably do precisely the opposite of what I suggest above!

The proof

Consider the circle in Fig 2. Let its radius be r. What must the angle θ be for the arc XVY to be = X'OY. Given that the angle is measured in radians, XVY=θr. Clearly, XOY=2r. Therefore XVY =XOY, if θ=2. In terms of degrees, this is $(180/\pi)$ 2=114.6.

To resolve the dilemma all one needs now is some commonsensical reasoning. The proof is completed by showing (in Fig. 3) that if Ω=114.6°, then ADB=AadbB. LetΩ=$(180/\pi)$2=114.6° in Fig. 3.

Then, given the above result,

adb=aob ..(1)

and ADb=AOB..(2)

Now, AOB=Aa+aOb+bB

=Aa+adb+bB, by using(1)

Then using (2), ADB=AadbB.

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Solar energy, the third eye and ectotherms

IT is incredible that animals, diversified a million ways in the quest for evolving energy systems—abstraction, storage and release—did not exploit the solar energy as did the green plants and as has been contemplated by man. Let us assume, they did not. But is the evidence conclusive?

The capability of plants to fix carbon dioxide in sunlight is their unique attribute and nothing comparable has been encountered among animals; carbon dioxide is the starting molecule (compound) in plant metabolism, whereas in animals it is one of the end-products of catabolism, which must be eliminated. In fact, this forms the core of the carbon dioxide cycle in our ecosystem.

Krebs (1941) stated that carbon dioxide is an essential compound in the metabolism of all cells. Since then carbon dioxide fixation for synthetic purposes has been established in representatives of 14 phyla of animals (Hammen, 1963). Similarly, a vast literature has been accumulated to show the influence light exerts on the regulation of maturity, reproductive activity, circadian rhythms, migration of animals, etc. The mechanism by which light activates these processes is not very clear. We only know that light stimulates the epithalamus and hypothalamus parts of the brain.

Alternatively, if we assume that animals exploit solar energy, we are

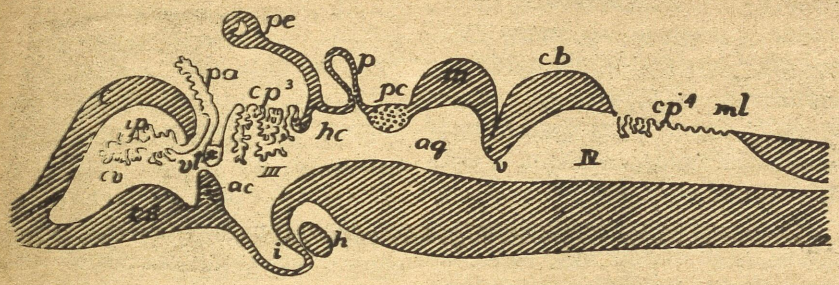

Fig. 1. Diagrammatic longitudinal section of brain. ac, anterior commissure lamina terminalis; aq, aqueduct; c, cerebral hemisphere; cb, cerebellum; cp, chorioid plexus; cs, corpus striatum; cv, cerebral ventricle; h, hypophysis; hc, habenular commissure; i, infundibulum; ip, inferior chorioid plexus; m, mesencephalon; ml, myelencephalon; p, pinealis; pa, paraphysis; pc, posterior commissure; pe, parietal eye; v, anterior medullary velum; vt, velum transversum with aberrant commissure; III and IV, third and fourth ventricles

obliged to delineate both the structures capable of photosensitivity with a potential for the collection and conversion of solar energy, and the purpose and pathway for its utilization.

Among animals, the eye doubtlessly is a photosensitive structure evolved particularly for vision. Notwithstanding the attributes of photoreception to such structures as ocellus, pigment spot, simple eye, etc., in invertebrates and the pineal complex in vertebrates, the role these structures play has not been characterized with any degree of precision. However, from amongst the above mentioned only the pineal complex of the vertebrates displays some semblance of homogeneity of form, function and location (Fig. 1). It was first observed in the extinct ostracoderms—the ancestors of fishes—and has since survived through the different vertebrate groups to man. Arising as a dorsal diencephalic outgrowth, its history is one of structural modification and functional change.

The functions of the pineal complex are as problematical as is its confusing nomenclature, viz., epiphysis cerebri, parapineal, parietal, median or the 'third eye'. Galen (130-200 AD) believed it to function in relation to the art of thinking. Descartes, in the 17th century, supposed it to be the "seat of soul". Towards the end of the 19th century when it was discovered that lesions in the pineal body in children are attended with premature pubescence, its role was suggested to be associated with the development of the genital apparatus. Presently, it is also considered as an endocrine gland producing melatonin and seretonin which act upon gonads and melanophores. Since production of these hormones is governed by light, it is thought of as a peculiar "biological clock" in the organism.

Unlike some other endocrine glands, the origin or the derivation of the pineal complex is shrouded in mystery. Its homologues in echinoderms, hemichordates or other protochordates have yet to be discovered, though the eyestalk of crustaceans and the eyespots in the nerve cord of some cephalochordates provide some analogs.

The paired median ocelli or eyes are also known to be present in some arachnids (spider group). It is doubtful if they form an image in scorpions. Their function in the extinct scorpion-like eurypterids is unknown. In existing xiphosurs (king crabs), e.g., *Limulus,* which also possess lateral eyes at its simplest, it has been found that in both kinds of eyes (median and lateral). single axon discharge can be measured. However, studies on the influence light exerts on their diurnal rhythms, though few, do indicate a light-based rhythmic pattern (Barrington, 1968; Kaestner, 1968).

The evidence indicates that the two main components of the pineal complex—the pineal and parapineal —represent phylogenetically the ancient eyes that were present in all the major groups of ancient fishes, amphibians and reptiles. The median eye of *Sphenodon* is reminiscent of this archaic feature. Unlike

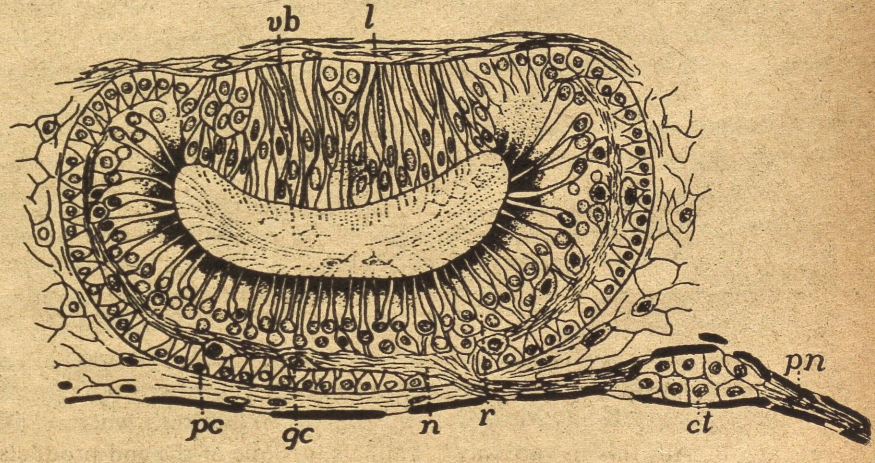

Fig. 2 Parietal eye of *Anguis fragilis;* ct, connective-tissue cells around nerve; gc, ganglion cells; l, lens; n, nerve fibres; pn, parietal nerve; pc, pigment cells; r, retinal cells; vb, vitreous body

the lateral eyes, the median eye does not form an image and is devoid of pigment; nevertheless, it possesses a lens and the integument overlying it is light transparent (Fig. 2).

The origin and development of pineal is very chequered and a subject fit for extensive study. It first appears as a median sense organ in aquatic pregnathostomes. In lampreys and ancient fishes, it develops eye-like structure which in higher fishes is not retained. But with the advent of ancient amphibians, who were trespassing land, the pineal reappears with light sensitivity and corresponding eye-like structure, however, again disappearing in the modern amphibia. Since reptiles have evolved from the ancient and ancestral group of amphibians and are fully terrestrial, they have retained the ancestral eye-like structure losing it secondarily in crocodiles.

It is therefore reasonable to suppose that the pineal complex was primarily evolved to sense the thermal cline of the water inhabiting ectotherms. As they stepped on to the colder land, it became a sort of heat collecting organ utilizing solar energy. However, during the Mesozoic era, the limitations of the pineal became demonstrable as group after group of mighty reptiles succumbed to overheating (*cf.* Bogert). Geological evidence on temperature change during Mesozoic is not conclusive. Experimental evidence shows that reptiles cannot withstand prolonged exposure to even comparatively slight increase in temperature. Apparently, only heating of the body for temperature maintenance was not the solution. Birds and mammals discovered the thermostatic mechanism of endothermy rendering the pineal vestigeal or glandular.

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The dangerous acid rain

NATURAL rain is not neutral in pH (i.e., pH 7.0), because carbon dioxide of the atmosphere dissolves in water to produce a weak acid—carbonic acid. As carbonic acid is weak in nature, it dissociates only slightly and at normal atmospheric concentration and pressure lowers the pH of rain to about 5.6 . Natural rain has a pH of about 5.6 . Rainfall having pH values less than 5.6 is known as 'Acid rain'.

Deposition of an acid does not come to earth only through rains. Some of the acids and numerous toxic chemicals spewed from smoke-stacks and tail pipes are deposited on lakes, streams, vegetation and fields without being washed out of the air by rain or snow. This is called dry deposition of acid. Scientists working in this field actually prefer two terms; one is 'dry deposition' and the other 'wet precipitation'. Wet precipitation is the amount of acid that comes down through rains, snow, sleet, hail and even fog.

Both these phenomena, wet precipitation and dry deposition, are parts of the same problem. The correct name of the problem should probably be 'acid deposition', rather than acid rain. So acid rain is a general term. There can be acid snow, acid hail and sleet and even in some cases acid fog.

The increased acidity of rain, snow, or fog is related to the production of industrial pollutants. The two strong acids, namely, sulphuric and nitric acids, are precursors to lowering pH of the precipitation. Sulphur dioxide here comes mainly from coal and oil-fired power generating plants, industrial boilers and smelters. Oxides of nitrogen come mainly from automobile exhausts, high temperature combustion engines and chemical fertilizer factories.

These gases are transported in the atmosphere by winds. Probably photochemical reactions (sunlight, oxidants and catalysts) are involved in converting these gases into acids. Acids formed by these complex processes are not yet fully understood. In eastern United States, on an average, about 60 to 70 per cent of acidity in rains is contributed by sulphuric acid and about 30 to 40 per cent by nitric acid. Organic acids such as citric, isocitric, fulvic and malic had been isolated from rains, but they contribute very little to the total amount of dissociated hydrogen. These acids become water-borne in rain drops.

Nature can also produce acidity in rains. Lightning bolt can form oxides of nitrogen which in turn form nitric acid. Nitrous oxide evolved from bacterial decomposition of soil organic matter can ultimately be converted into nitrous and nitric acids. Recently, it has been known that biological processes in the ocean can produce dimethyl-sulphide which may initiate production of sulphuric acid. Gases such as hydrogen sulphide and sulphur dioxide, which come out as a result of volcanic eruptions, may produce sulphuric acid in the atmosphere. These natural phenomena contribute towards lowering of pH in rains. However, it is believed that the amount of acid produced in

atmosphere by nature is insignificant when compared to the amount produced from man-made sources.

Acid rain has made thousands of lakes fishless in Scandinavia, Canada and the United States. It can damage vegetation, and wildlife, corrode steel structures, bridges, buildings, statues and etch car finishes and harm human health too.

The most important point to note is that acid rain is not a problem of a single country, because acid rain-forming oxides may be carried away hundreds and thousands of kilometers by wind. For example, airborne pollution of England and Germany was deposited as acid rains in Sweden and Norway.

The most serious adverse effects of acid rain have been on the aquatic ecosystem especially in places with thin soil and granitic rocks. Thin soil horizons and granitic rocks have got little buffering capacities to acidic inputs of acid rains. Acid precipitation makes aluminium soluble from the surrounding soils which is then transported to aquatic environment. Soluble aluminium may be toxic to fish and other aquatic organisms. Organo-alumino complexes however appear to be less toxic to fish than soluble, free (aquo) aluminium or aluminium complexes with inorganic ligands such as hydroxide, fluoride and sulphate. Aluminium compounds accumulate in gills of the lake fish; to overcome effects of aluminium accumulation, fishes exude mucus in such large amounts that it ultimately kills them.

Liming of acidified lakes is one of the remedial measures. This costly measure has been tried in Sweden, Norway, Canada and the United States; however beneficial effects are purely temporary.

Dry airborne sulphur pollutants —usually sulphates (before being converted into sulphuric acid), are associated with respiratory diseases like chronic bronchitis, asthma and emphysema. An American epidemiologist of Brookhaven National Laboratory (U.S.A.), Leonard Hamilton, estimated in 1975 that "acid sulphates from fossil fuel—emissions are responsible for 7,500 to 120,000 deaths a year".

Acid rain waters in reservoirs and pipelines may leach heavy metals into public drinking water systems and can pose danger to public health. Minute quantities of mercury too in acidic rain water may be converted into toxic methyl-mercury.

Acid precipitation can have a variety of effects on terrestrial vegetation. Nutrients from foliage may be leached, lesions on leaves lead to formation of spots of dead tissues, and cause erosion on the external surfaces. It may also affect photosynthetic process and growth of young tissues.

Effects of acid rain on soil are scarcely known. They may be many. Some examples are : decreased rate of decomposition of forest floor litter, inhibition in nitrogen fixation, enhanced rate of weathering of soil minerals, etc. It is believed by soil scientists that acid precipitation mobilizes many toxic metals including mercury and lead. Long-term effects of acid rain may render our soils unproductive and useless. Cities like Calcutta, Bombay, Baroda and suburbs of Delhi probably experience acid rains because of the industries and automobiles. However, research is needed to know the truth.

In India, probably, there exist no government regulations to check or regulate sulphur dioxide emission from industries. We need to set up emission control standards to keep our environment clear and clean for protection of our natural resources like lakes, soils and vegetation.

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Nutritive value of *Spirulina*

SPIRULINA maxima is a spiral-like blue-green alga which grows naturally in the alkaline lakes of South America, Africa and China. In India, the genus *Spirulina* occurs in stagnant waters of Calcutta (West Bengal), Hyderabad (Andhra Pradesh), Berhampur (Orissa) Fatahill (Assam) and Delhi. It also occurs in salt pans of Tirupati (AP), on seashore near Colaba in Bombay and on wet soil in Madras (Tamilnadu). It is a cork screw shaped, filamentous, spiral-like blue-green alga that was previously described as *Spirulina platensis*. Lakes where *Spirulina* grows are of high alkanity and make life almost impossible for the other organisms, whether plant or animal. At pH 11, *Spirulina* thrives and grows almost as monoculture. In certain lakes it accounts for 99 % of the algal population. Vacuoles in the cells of the *Spirulina* make the filaments float in the lake as the mats from which collection is easy. The sunlight beaming down strongly on the sandy beaches provides a quick and cheap source of drying.

Spirulina can be cultured in open ponds or as a closed system in polythene tubes. Places particularly favourable for the growth of *Spirulina* are unused salt ponds, hydroelectric basins, large bodies of warm water from cooling plants, and places rich in carbon dioxide.

The alga contains a high proportion of protein, even higher than soyabeans. The protein is of high quality and contains methionine, tryptophan and other essential amino acids. It is however relatively deficient in lysine. *Spirulina* contains 65% of protein, 19% carbohydrates, 6% pigments, 4% fats, 3% fibre, 3% ash alongwith other products. *Spirulina* could also be used as a meat substitute or a protein complement in artificial milks and soups.

Spirulina contains almost all pigments such as chlorophyll, carotenoids, phycobilines, xanthophylls and violaxanthines. Experimental studies made in the U.S., Japan and Mexico have shown that *Spirulina* enhanced the colour of yolk or the flesh of fish when added to the diet of hens or fish. The *Spirulina*-based diet has no observable ill effects or abnormalities in the animals. The alga could also be used as a source of ribulose biphosphate carboxylase, an enzyme present in great abundance in all photosynthetic organisms. South Africans use *Spirulina* as food. It is also drawing attention of scientists in Japan, Israel and the U.S.A. to use it as a source of protein for human consumption.

Unlike the other unicellular algae such as *Chlorella* and *Scenedesmus*, which are used as human food or animal feed, the *Spirulina* is a prokaryote which lacks the highly organised cell-structure of higher organisms and the cell wall is made up of non-cellulosic material and is easily digested. Animals cannot make full use of protein and other cell components of *Chlorella* and *Scenedesmus* as they have thick cell, walls composed of cellulosic material which cannot be easily digested by them.

As the *Spirulina* is a photosynthetic organism, requirements for its growth are carbon dioxide, water, inorganic salts and light. Under optimal conditions, the yield of *Spirulina* is impressive which is 10 times higher than that of wheat. The high nutritive value of *Spirulina* may be an answer to food and energy problems of the world, especially the third world countries.

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Marijuana—drug or a poison

THE marijuana plant is the common Indian hemp, *Cannabis sativa*. It has been cultivated through centuries for its fiber and rope making products. History also records its early use in many countries for medical as well as personal and religious purposes. There are three main varieties of the plant for fibre, seeds and marijuana. Seeds contain 33% oil which is used in the manufacture of paints, varnishes, soaps; when purified it is used for cooking. In India it is practically naturalised in the sub-Himalayan tract and is in abundance in waste lands (Fig. 3) from Punjab eastwards to West Bengal and Bihar and extending southwards to Deccan.

Fig. 1. A leaf of *Cannabis sativa*

Active ingredient

The major psychoactive ingredient in marijuana plant is delta-9-tetrahydrocannabinol (THC) This substance, isolated in 1965, permitted more biochemical studies about its effects. Yet THC is only one of over 50 chemicals found in marijuana, most of them also cannabinoids, possessing drug characteristics of their own.

Marijuana's leaves, stems, seeds and flowering tops contain varying amounts of THC and can be dried and crushed into a variety of forms for smoking, drinking, eating and for injecting into the bloodstream. Smoking is the most popular form

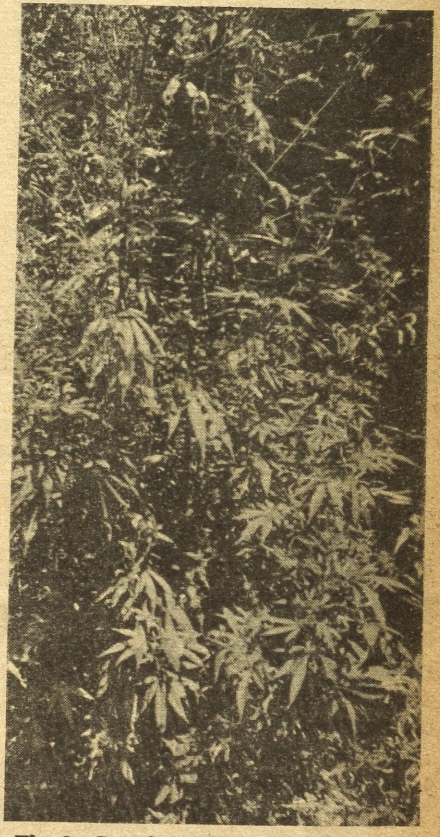

Fig. 2. *Cannabis sativa* growing in waste lands

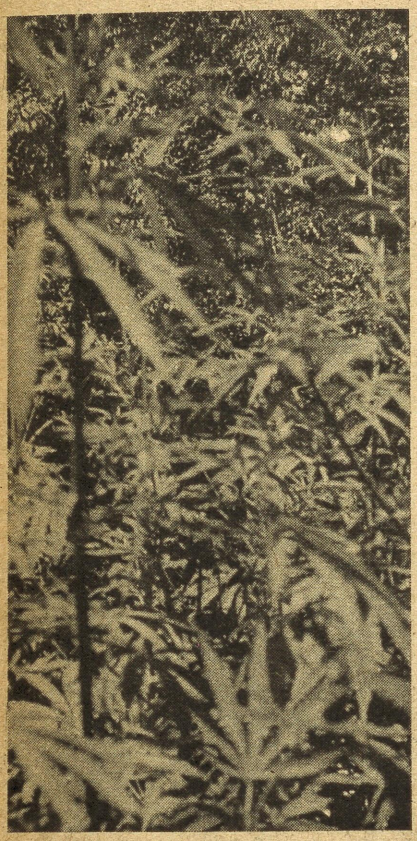

Fig. 3. A close view of *cannabis sativa* plants

to get an 'effect'. The potency of marijuana depends on several factors. First, there is a significant variation in THC content among marijuana plant varieties. The amount of THC also varies as a result of how much sun, moisture, temperature and care a plant receives. Secondly, the larger leaves (called *bhang*) has a THC content of 1% or less. The inflorescence and small leaves (called *ganja*) may contain 4% to 8% THC. Tne most potent preparation is *charas* (hashish) which is obtained from the resin excreted by flowers and fruits and possesses a THC content of 5% to 20%; the best yield is produced by the unfertilized female flowers. Hashish oil contains nearly 20% to 90% THC. The main countries producing the drug are the Middle East and India.

Uses

In the last fifteen years, marijuana has risen from relative obscurity to become one of the most feared drugs of the world, after alcohol, nicotine and caffeine. The largest consumer is the U.S.A., where over 43 million Americans have confessed to have smoked marijuana at least once. Its uses have also increased in countries like Britain, Germany, France and Australia and many other nations.

In India, cannabis was not so popular but a recent report says that consumption of *Charas* has doubled between 1975 and 1979. The non-medical use of *Dannabs* is prohibited in India, but it is illegally used in many states. Why is marijuana so popular, especially among the younger generation? Because, to many of them, it is an "escape drug"; it makes them feel "euphoric". It is also sometimes used as a substitute for tranquilizers, sleeping pills or other medication. Some use it in place of alcohol or as an aid to stop drinking. Others believe that marijuana can expand their mental power, improve artistic or other skills, or revive failing sexual powers.

Biological effect

With the present state of our knowledge, little can be said about the long-range effects of marijuana on human health, although certain health hazards have been well established. High potency marijuana produces weakeness, degenerative respiratory and lung damage and long-lasting neurological problems. Much more information is needed to know about the long term effects of marijuana used at low doses.

Marijuana is not just a relaxing, calming or euphoric drug. It can act primarily as a hallucinogen, or stimulant, a depressant, or an intoxicant, and sometimes as a combination of all four. One common psychological effect associated with marijuana usage is acute panic or anxeity reaction. This is particularly true of inexperienced users. Temporary effects often include reddening of eyes and face, markedly increased or decreased apetite, dryness in the mouth and throat and a feeling of coldness. The pulse rate may also increase.

A drug of addiction

Until recently, marijuana was not considered an addictive drug. Unlike the addictive substances like nicotine in cigarettes, which is rapidly eliminated from the body in fluid wastes, THC is eliminated slowly. As a result there are no withdrawal symptoms. THC has an affinity for fatty and brain tissues, where slow metabolism causes long retention. When THC levels drop in the blood stream, stored THC in the body fat comes into circulation reducing severe withdrawal symptoms. Actually months of abstinence are required to eliminate accumulated THC in the body.

Other serious health hazards

Studies show that long-term smoking of cannabis, particularly *hashish*, irritates throat and tissues more quickly than cigarette smoking. Pharyngitis, bronchitis and other obstructive lung diseases occur more frequently among the heavy marijuana smokers. One major reason for this irritation is marijuana's chemical make up. THC and other similar substances in marijuana smoke are more tightly bound on the surfaces of the carbon particles than is nicotine in cigarette smoke. To release the active substances in marijuana and get an effect, smokers inhale smoke deeper and hold it longer. Regarding other health hazards, preliminary research has shown possible adverse effects

of marijuana on such areas as the body's immune response, basic cell metabolism and sexual functioning.

Marijuana researchers point out that it may possibly damage chromosomes also. Birth defects and deformed babies could also be the result. Some researchers regard marijuana to be mutagenic. However, they all agree that more information is required to prove whether marijuana causes mutations and malformation.

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Yoghurt

It is believed that if a man regularly consumes 250 gm to 600 gm yoghurt daily from his childhood, he can expect to lead a healthy, buoyant and youthful life upto the age of 70 to 80 years. It decelerates clock of aging, if not reverses or stops it. It also lowers blood cholesterol level and, therefore, improves functioning of cardio-vascular system making the heart strong.

Russian scientist Metchnikoff in his book *'The Prolongation of Life'* had described that the Bulgarians, who ate large quantities of yoghurt every day, lived to a ripe old age. He suggested that negative bacteria in the colon were the main cause of aging and disease, and that eating curd, with its abundance of helpful bacteria, could turn back the clock controlling geriatricological processes.This fact was further demonstrated by an accidental observation in Masai Tribesmen in Africa by George V. Mann of Vanderbilt University, Nashville, Tennessee, U.S.A. He and his associates found that blood cholesterol in these tribesmen, who incidentally consumed large quantities of yoghurt and/or fermented milk products daily, was uniformly low and that frequency of coronary artery disease was at its lowest ebb. They also observed that their life span was fairly long and they led an energetic life till the very end.

Yoghurt is produced on fermentation of milk by two thermophilic (high-temperature tolerating) bacteria, viz., *Streptococcus thermophilus* and *Lactobacillus bulgaris*. The latter rapidly grow at optimum temperature through the process of symbiosis. The final product is highly viscous, slightly sour, with its characteristic "Curd" flavour and taste. During fermentation of milk, the composition of the minerals remains unchanged while proteins, carbohydrates, vitamins, and to some extent, fat constituents are subjected to changes which produce special physiological effect.

Nutritional value

Milk is fairly sterile in the udder of healthy animals. It has a pH of about 6.8 and is rich in protein, carbohydrate, fat and vitamins. Because of this, milk is a fertile bed for growth of bacteria and therefore many diseases can be transmitted through it. In contrast, yoghurt has a low pH and so retards growth of disease-producing organisms. Dietary and therapeutic qualities of yoghurt and/or acidophilus milk are determined by micro-organism and substances formed as a result of biochemical processes accompanying milk souring. These substances are lactic acid, alcohol, carbon dioxide, antibiotics and vitamins. Yoghurt, as such becomes more nutritive and easily digestible.

Proteolysis

The biological value of protein increases significantly during yoghurt manufacture from a value of 85.4% to 90%. This increase is due to breakdown of protein into peptones, peptides and amino acids. The contents of essential amino acids such a leucine, isoleucine, methionine, phenylalanine, tyrosine, threonine, tryptophane and valine increase which make it more useful.

Hydrolysis of lactose

Lactose in milk is hydrolysed by metabolic activity of bacteria and, therefore, yoghurt is easily tolerated by persons who lack lactose enzyme in their gut. Such persons often suffer from lactose intolerance diarrhoeas when they consume milk. Lactose hydrolysis takes place due to B-galactosidase production by lactic acid bacteria releasing 2.5% lactose, 0.8% galactose, 0.03 glucose and a good amount of lactic acid. The lactic acid so produced reduces the pH of curd and, therefore, it does not allow growth of pathogenic organism while retaining or rather enhancing its nutritive value. In addition, lactic acid in curd provides optimum pH for absorption of certain minerals, viz., calcium, iron, phosphates, etc., and knocks down colon bacteria responsible for putrefaction and flatulance.

The amount of free fatty acids in curd is considerably increased as compared to milk because of bacterial action. It is by virtue of this fact also that curd is easily digested.

Vitamins

There is more than two-fold increase in vitamins of B-group especially thiamine (B_1), riboflavin (B_2) and nicotinamide as a result of biosynthetic processes during milk fermentation.

Therapeutic uses of yoghurt

Yoghurt improves appetite due to its pleasant, refreshing and pungent

taste and is highly nourishing and invigorating not only to healthy persons but also to the ill and infirm. Curd and acidophilus milk are easily absorbed and better assimilated than whole milk. Assimilation of milk is 32% an hour while that of fermented milk products is 91% during the same period. Better assimilation of curd is due to the presence of partial predigestion of proteins, lactose and lipids by symbiotic bacteria. A cup of curd contains more amino acids and vitamins, fewer fats and calories and no/or little lactose as compared to a cup of milk. It is a rich source of calcium essential for body growth. Yoghurt contains sufficient amount of indispensable amino acid, methionine, which removes excessive fat from the liver and enhances bile secretion and other life-saving hepatic

Normalization of bowel function is achieved by curd. It retards putrefaction in colon and presents flatulance. Our large intestine is populated by "flora", a garden of friendly bacteria which serve important physiological functions. However, this garden is trampled by infections, drugs and many factors, known and unknown. The bacteria in yoghurt are believed to restore helpful bacteria, if they are destroyed.

Curd is, therefore, an important therapeutic adjuvent in gastro-intestinal disturbances, hepatitis, nephritis, diarrhoea, colitis, anaemia and anorexia. It provides wonderful relief to patients of chronic diarrhoea, sprue and ulcerative colitis. It has been speculated that lactobacillus and acidophilus bacteria present in yoghurt may possibly play a role in the prevention of one of the most common and deadly types of colon cancer.

G.V. Mann, an Amercan national working in the field of nutrition, conducted a study in which 26 men and women ate a little more than two quarts of yoghurt daily. Their cholesterol levels took a dive. The protective factor in yoghurt responsible for lowering chlolesterol is being intensively investigated. Some research workers attribute a yoghurt constituent orotic acid to inhibit a rat liver enzyme requird for biosynthesis of cholesterol. Curd not only improves the function of heart but its regular use considerably reduces the frequency of atherosclerosis and heart attack.

Yoghurt possesses potent anti-tumour activity according to Shahani, Professor of Food Sciences at the University of Nebraska, U.S.A. He and his team investigated that when mice with tumour transplants were fed yoghurt mixed with their drinking water, and control mice were given only water, the mice who got yoghurt averaged a 28% inhibition of tumour cell growth. The other group showed rapid tumour growth. Research workers at Nebraska, U.S.A. further demonstrated that consumption of yoghurt has definite inhibitory action against certain types of cancer cells. This fact was further demonstrated by scientists at the Bulgarian Academy of Sciences who found that they could cure several types of experimental cancers with injctions of *Lactobacillus bulgaris* (LB), an important component of curd. They injected extracts of LB into mice who had incurable tumours. Of the 455 mice injected, 136 were permanently cured. They conclusively demonstrated that yoghurt bacteria have been effective in treating cancer of colon and skin in human beings.

Yoghurt has natural "antibiotic" properties. It may retard or prevent the onset of diseases. Pathogenic bacteria are not able to survive in curd because of its low pH and other adverse factors for their growth. Consumption of less than 1 litre of yoghurt per day will not affect human health adversely, but more may involve the risk of acidosis.

There is yet an unidentified factor present in yoghurt which retards aging and longivates life. The nutritional and therapeutic effects of yoghurt do not depend so much on the living bacteria but on their metabolites.

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Interesterification of Oils

OILS are fatty acid esters of glycerine. In the case of common human dietary fats and oils, the component fatty acids consists of chains of 16, 18, 20 or 22 C atoms. Depending upon the type of linkage between the C atoms, fatty acids are classfied into saturated and unsaturated fatty acids. In saturated fatty acids, the C atoms in the chain are linked to each other by means of single bonds alone, while in the case of unsaturated fatty acids, there are one or more double bonds between the C atoms. Body fats of marine animals and seed oils have generally a larger proportion of unsatuated fatty acids. They tend to remain liquid at room temperature and owing to the presence of the relatively unstable double bonds, they are also more likely to react with atmospheric oxygen and turn rancid. Oils with a high content of unsaturated fatty acids have therefore shorter storage life than oils with a high content of saturated fatty acids.

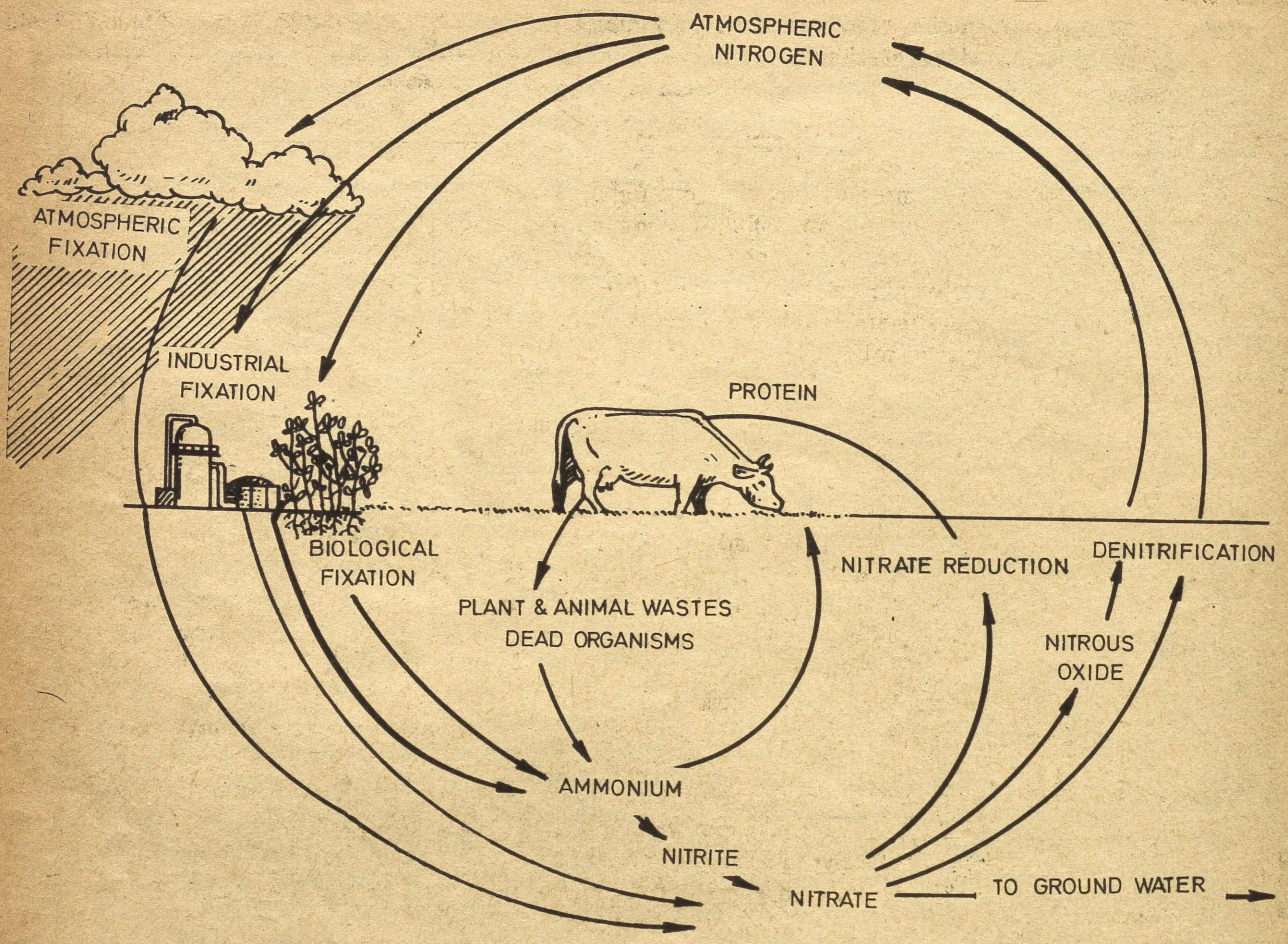

Fig. 1. The nitrogen cycle

nitrogenous fertilizers. But chemical fertilizer prices have been going up fast. With growing demand, production of fertilizers has increased from about one million tonne (which accounts for 1% of all fixed nitrogen) in 1950 to 40 million tonnes (15% of the total fixed nitrogen) in 1975. By the year 2000, the industrial fixation of nitrogen may well exceed 100 million tonnes. But the expected demand then will be twice that figure. This is where the need for natural organic nitrogen comes in.

Nitrogen cycle

Nature has a rather neat nitrogen cycle (Fig. 1) that supplies each living organism with its nitrogen requirement to live and grow. Essentially nitrogen enters soil and is taken up by plants. Plants are later eaten by animals. In the end of the cycle, nitrogen returns to the soil through decomposition of dead plants and animals.

With the advent of modern technology in agriculture, man needs a higher crop yield from a less land area. This calls for a much faster cycling of nitrogen than nature can handle. And so the farmer has to add nitrogen to the soil in the form of fertilizers rather than waiting for nature to supply it in the natural course. Another problem is that fixed nitrogen in the soil is depleted by "non-fixing crops". This nitrogen is drained into the water table or laid down in mineral sediments. Finally, in the organic decay process nitrogen gas and oxides of nitrogen including ammonia are released into the air.

Balance sheet of nitrogen cycle

The present balance sheet of nitrogen indicates that nitrogen is now being introduced into the biosphere in fixed form at the rate of some 92 million metric tonnes per year (Fig. 2A), whereas the total amount being denitrified and returned to the atmosphere is only about 83 million tonnes per year (Fig. 2B). The difference of some nine million tonnes per year may represents the rate at which fixed nitrogen is building up in the biosphere : in the soil, in rivers, in lakes, in ground-water reservoirs and in the oceans.

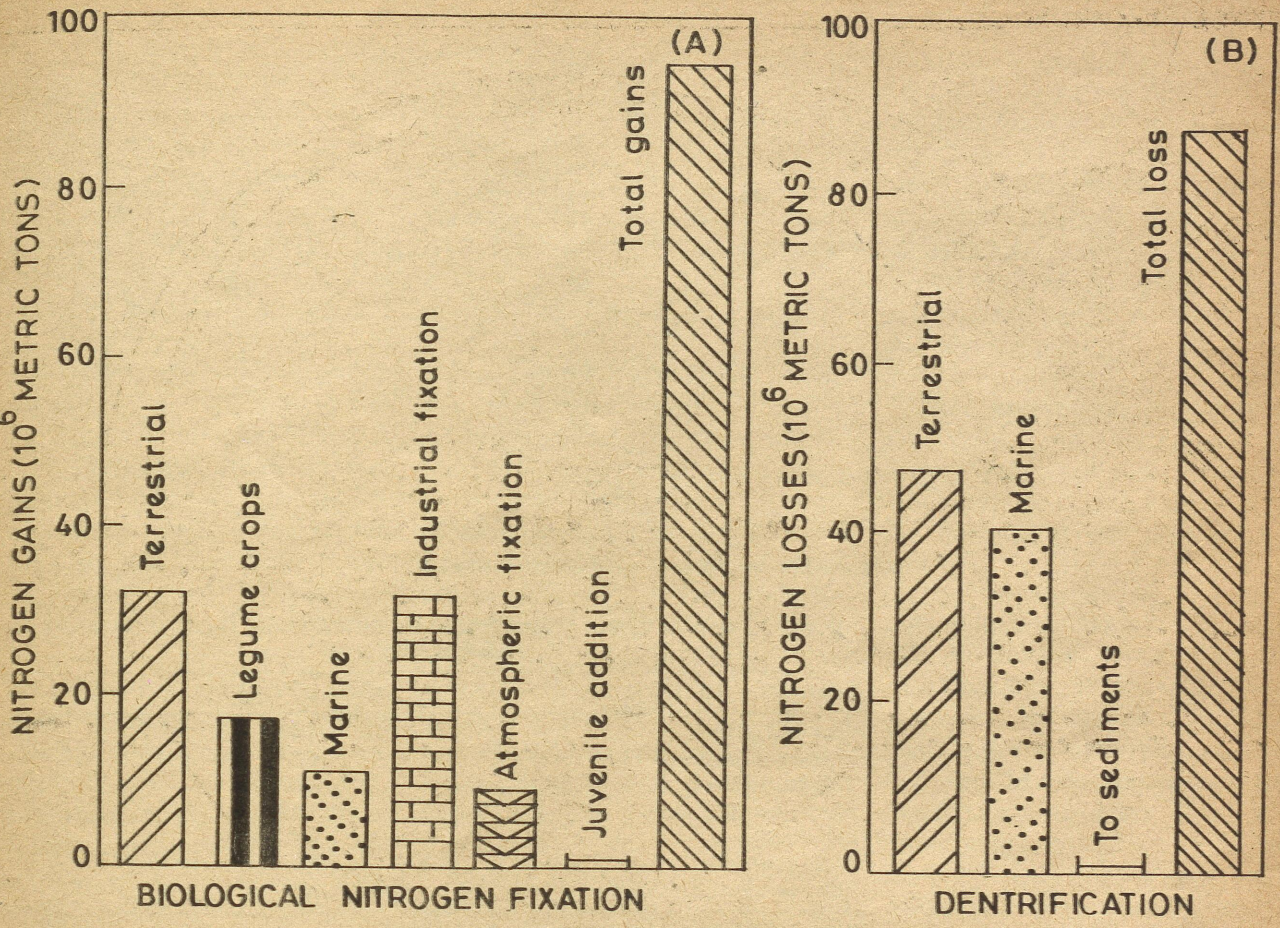

Fig. 2. The balance sheet of nitrogen cycle

Biological nitrogen fixation

A nitrogen molecule is made up of two nitrogen atoms joined by covalent bonds. Until the atoms are pulled apart, they are useless for any living system. A lot of energy is required to break the bond, and so, for all practical purposes raw molecular nitrogen is inert and useless. But there are a few species of plants which with the help of certain bacteria can fix atmospheric nitrogen (Fig. 3). Leguminous crops that fix atmospheric nitrogen in the soil have long been known and employed in agriculture around the world.

Legumes like peas, beans, cowpeas, clover and alfalfa provide the greatest source of fixed nitrogen for for the soil. A healthy crop of alfalfa can be extremely productive fixing over 375 kg of nitrogen per hectare annually. It is also possible to inoculate soil or seeds with phosphate-dissolving and nitrogen-fixing bacteria, such as *Rhizobium* and *Azotobacter* which dramatically improve plant growth.

Energy cost of nitrogen fixation

Increased awareness of the importance of *Rhizobium* legume symbiosis in agriculture has prompted scientists from diverse disciplines to consider the possibility of enhancing the efficiency of symbictic nitrogen fixation in legumes. Efficiency of symbiotic nitrogen fixation in biological systems is the effectiveness with which energy is used for a particular process. Energy. efficiency is calculated by relating energy use to minimum energy cost under defined conditions. *Rhizobium* cells that reduce nitrogen in root nodules are termed bacteroids. Estimates of nitrogen fixation cost in bacteroids involve the limited

Table 1. Possible stochiometry of two nitrogenase-nitrogenase reductase reactions

I	$N_2 + 12\ ATP + 6e^- + 8H^+ \xrightarrow{Mg^{+2}} 2NH_4^+ + 12ADP + 12\ Pi$	
II	$4\ ATP + 2e^- + 2H^+ \xrightarrow{Mg^{+2}} H_2 + 4\ ADP + 4\ Pi$	
III	$N_2 + 16\ ATP + 8e^- + 10\ H^+ \xrightarrow{Mg^{+2}} 2\ NH_3 + H_2 + 16\ ADP + 16\ Pi$	

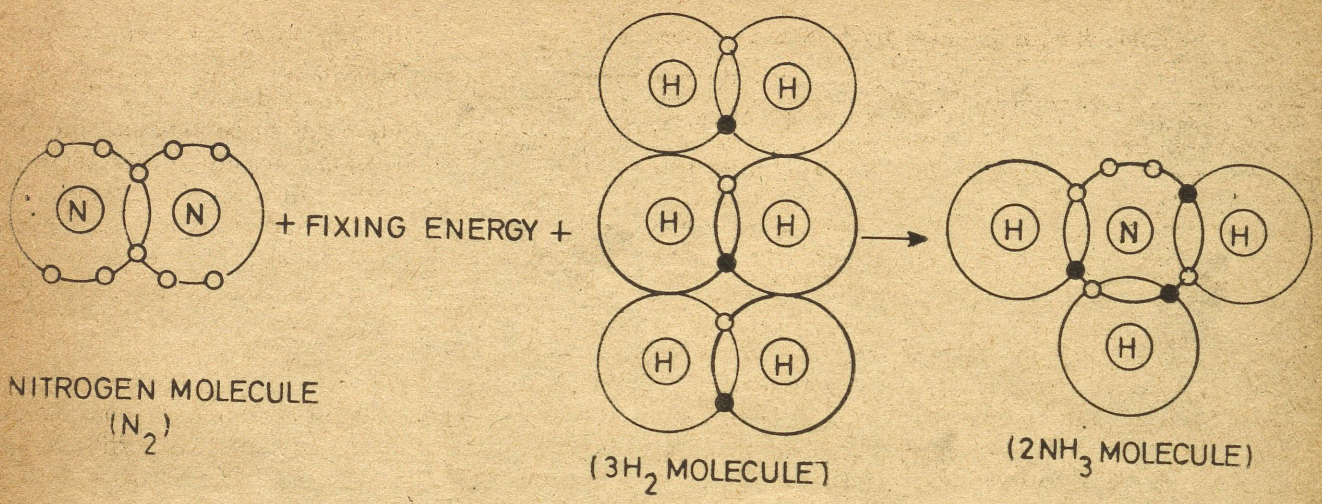

Fig. 3. The overall process of nitrogen fixation

process of nitrogen reduction to NH^+_4 and related matters of H_2 metabolism (Table 1). Although the bacteroidal efficiency of nitrogen fixation is difficult to calculate, the whole plant energy cost of nitrogen fixation has been estimated and Table 2 presents data on whole plant energy cost of nitrogen fixation expressed in terms of carbon utilization.

Calculation of nitrogen fixation efficiency in plant communities requires data on energy used for nitrogen fixation and minimum energy cost under defined conditions. Table 3 shows that substantial quantities of nitrogen can enter through symbiotic nitrogen fixation by temperate legumes.

Table 2. Whole plant energy cost of symbiotic N_2 fixation in nodulated legumes

Plant species	*gC / gN*
Medicago sativa L.	2.9[a]
Trifolium subteraneum L.	0.3[a]
Trifolium rapens L.	6.6
Glycine max (L.) Merr.	19.4
Lupinus albus L.	4.0-6.5
Pisum sativum L.	5.9
Vigna unguiculata (L.) Walp.	6.8

[a]Assumes 40% C in carbohydrate or dry matter.

Table 3. Community efficiency of symbiotic N_2 fixation by temperate legumes in the field

Plant species	*Kg N_2 fixed/ha Yr*[a]
Medicago sativa L.	300
Glycine max (L.) Merr.	75-114
Phaseolus vulgaris L.	25-30
Vicia benghalensis L.	100
Vicia faba L.	326-648
Triticum aestivum L.	69
Pisum sativum L.	69
Pisum sativum L. with *Avena sativa L.*	52
Trifolium subteraneum L.	58-183
Trifolium hirtum L.	107
Trifolium pratense L.	163

[a]One growing cycle per year assumed

Biofertilizers and organic farming

Algae are a lower group of chlorophyllous plants (Thallophytes), either single-celled or filamentous. They are good solar energy converters with high photosynthetic efficiency. They vigorously multiply in light, whether artificial or natural, and can be harvested at a rate of 10 gm (fresh wt.) or more per square meter per day. Algae can be grown in any pond or still water body and they thrive on every sort of organic material including sewage and waste.

Some algae have long been known to fix atmospheric nitrogen in the soil. Certain blue-green algae are efficient in fixing nitrogen in rice fields. They can fulfil as much as 30% of the demand of nitrogen against chemical fertilizers (*S.R.*, April 1972). These blue-green algae are able to flourish in water and

Table 4. N_2 fixing capacity of some algal species

Algal species	*Amount of fixed Nitrogen*
Aulosira fertilissima	8.7 mg/100 ml culture/75 days
Tolypothrix tenuis	9.6 mg of N_2/100 ml of culture/20 days
Tolypothrix tenuis	0.24 gm of N_2/m^2/12 hr (=975 kg of N_2/hectare/Year).
Nostoc punctiforme	12.01 % of N_2/dry wt. of algae
Anabaena cyindrica	0.9 gm of N_2/m^2/12 hrs. (=3600 kg of N_2/hectare/Year).

can, therefore, be used for paddy cultivation.

The Indian Agricultural Research Institute, New Delhi, has developed an algal culture bank from Indian soil. It is able to provide algal starter culture in 400 gm packets for Rs. 4.00 per packet. This can be mixed in a tray of 2 × 3 meters dimension with soil and water. After an initial growth period, a daily harvest of 1.5 kg to 2 kg of algae can be obtained. Any pond or water reservoir in a rural area can be similarly inoculated with algal culture with dung, sewage or other organic wastes to cultivate algae. After harvest, algae can be sun dried and kept as ground powder in bottles or polyethylene bags for use. Extensive field trials conducted by the Tamil Nadu Agriculture Department have shown that with algal supplementation, even at a very low level of nitrogenous fertilizer application, the crop yield is comparable to that with a higher level of nitrogen without an algal application. The saving is of the order of 25 kg of nitrogen per hectare. Some of the best known and cultivated algal species in India and their nitrogen fixing capacity are presented in Table 4.

Azolla is almost as effective as blue-green algae in supplying nitrogen to paddy soil. It grows naturally in wild profusion as a weed in paddy fields. The plant only needs to be ploughed into the fields. It is sensitive to temperatures above 30°C. *Azolla* contains 3% nitrogen and is applied at the rate of 10 tonnes 15 tonnes per hectare. This means it can be used as a green manure.

Algal cultures, both land-based and marine, could become an important source of biofertilizer. No time should be wasted in transferring this technology from laboratory to land which will go a long-way in augmenting the income-generating potential of our farmers.

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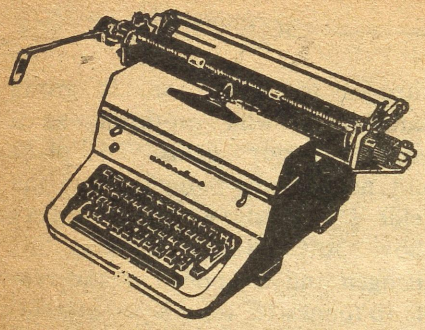

NEWS & NOTES

Swirling masses of warm water in the midst of cold sea

COMMENCING April 1982, a team of U.S. scientists, funded by the U.S. National Science Foundation, is investigating puzzling "rings of warm water" that spin off the Gulf Stream and become swirling masses of warm water entrapped in the cold waters of the north-eastern coast of the United States.

Gulf stream rings, a common feature of the north-west Altantic, are spawned when huge eddies twist away from the main stream as it winds on its path away from North America at Cape Hatteras, North Carolina. Once in a while, the meandering eddies form a loop that gets detached from the stream and moves independently as a large spinning mass of the Gulf Stream, 160km-320km in diameter, entrapped by strong currents of the ocean waters that are different from the water inside the ring. If the ring forms to the north or west of the Gulf Stream then the trapped waters originate in the Sargasso Sea and the rings have a warm core and rotate clockwise, whereas the rings formed south or west of the Stream contain cold waters of the continental slope and rotate counter clockwise.

The NSF-funded study concenrates on the warm core rings that are surrounded by strong currents of 3.2km-6.4km per hour, and involves about 60 scientists from the Woods Hole Oceanographic Institution, the Massachusetts Institute of Technology, Harvard University, Texas A & M University and the University of Rhode Island. Four cruises are planned in all, one each in April, June, August and late September this year. The four ships taking part in the exercise—the 177 ft *Oceanus*, the 245 ft *Knorr*, the 177 ft *Endeavor* and the 187 ft *Albatros IV*—are supplemented by polar orbiting satellites and a NASA aircraft in an effort to collect data necessary to piece together the physical, chemical and biological processes taking place inside the warm rings.

These rings have important effects on the coast as well as marine life. Behaving much the same way as storms, the rings carry tropical fishes from the Sargasso Sea area to the coastal waters of Long Island. They also transport rich nutrients to the coastal areas. From the coastal waters, the rings move back to open waters, carrying with them offshore pollutants.

Biologists believe that the enclosed waters of these rings can transport entire ecosystems to a new and alien environment and they are interested to know the response and adaptability of these ecosystems to the new environments. Such information will be of considerable value to the fisheries industry.

Though about three-fourths of the sufrace of the Earth is covered by the oceans, scientific knowledge of the oceans has not kept pace with our knowledge of the land-oriented sciences. True, there is a considerable body of literature on phenomena such as ocean currents and marine life. But, with offshore drilling for oil and scanning the ocean bed for minerals and other treasures of the seas assuming great importance, oceanography is coming to the fore. Even in India, a late starter in oceanography, the National Institute of Oceanography and the Engineers India Ltd. conduct cruises in the coastal waters of India to collect useful data.

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Research and Specimen Cell at P.I.D.

THE Publications & Information Directorate has set up a Research & Specimen Cell as an adjunct to the *Wealth of India*, and encylopaedia of Indian Raw Materials, with the following objectives:

1. To collect and house economically important raw materials of plant, animal and mineral origin of the country in one place.
2. To collect and maintain a herbarium of economic plants described in the *Wealth of India*.

3. To help in the identification of economic plants for writing articles in the *Wealth of India*.

Presently, the Cell houses a herbarium comprising more than 3000 species of plant specimens and about 1300 samples of economic raw materials of plant, animal and mineral origin. Most of the specimens have been received by way of donations from various Govt., semi-Govt., and private institutes and organisations. Collections of specimens from different regions of the country have also been made by the staff of the Cell.

The acronym *RHMD* standing for the Raw Material Herbarium and Museum (of the Publications & Information Directorate, Hillside Road), New Delhi, has been allotted to the Cell by the New York Botanical Garden, Bronx, New York, for easy reference in literature and correspondence and for inclusion in the *Index Herbariorum*.

K. RAMACHANDRAN
Project Coordinator, Publications & Information Directorate, New Delhi

Machine tool design and research conference

THE tenth All India Machine Tool Design and Research (AIMTDR) Conference will be held at the Central Mechanical Engineering Research Institute, Durgapur, from 20 to 22 December 1982.

The scope of the conference includes: Machine tools—design, manufacture and performance, Precision and special machine tools, Reconditioning of machine tools, Manufacturing systems; Automation; Computer-aided design (CAD); Computer-aided manufacture (CAM); Robotics Adaptive controls; CNC; Microprocessor control; Metal-cutting and metal-forming processes; Unconventional machining processes; Analysis of production systems; and Metrology.

Technical papers are invited for presentation at the conference.

Further details of the Conference may be obtained from: The Organizing Secretary, Tenth AIMTDR Conference, Room No. A/102 Metrology Section, Central Mechanical Engineering Research Institute, Durgapur, 713209.

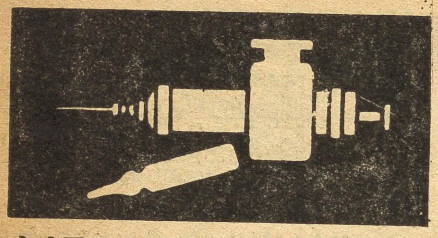
Awards under ISCA young scientists programme

THE Indian Science Congress Association has introduced a programme for the benefit of young scientists from the 68th Session of the Science Congress held in January, 1981. The programme enables the young scientists to present their proposed research work with opportunities to exchange ideas in the relevant scientific problems with their counterparts and specialists. Only ISCA members are eligible for consideration for the Award. The upper age limit for the Award is 30 years as on 1st January of the session. The eligible members desiring to be considered under the programme are required to furnish an attested copy of the certificate indicating their age. This certificate could be sent while forwarding papers/abstracts for presentation at the Annual Session of the Science Congress. Full name, designation and address, along with the date of birth and age on the top of the first page of the full paper and on the top of all the three copies of the abstracts, will have to be given.

The papers/abstracts will be screened by the Sectional Presidents and Recorders concerned, with the help of three members of the concerned Sectional Committee (specialists) after their presentation during the session. The concerned Screening Committee will then recommend not more than three names of young scientists in order of preference, along with citations pertaining to the merit of each paper. Final selection will be made by a Committee specially constituted by the General President.

The Awards will be announced by the General President at the meeting of the General Committee when the Certificate of Merit and the Cash Award (Rs. 500/-) will be handed over to the recipient with the citation. A further amount of Rs. 2,500/- towards incidentals, etc., will be sent to the Awardees later from the headquarters of the Association. The total number of Awards are twenty.

The Awardees will be provided with the admissible travelling and daily allowances by the ISCA (second class concessional both ways rail fare, daily allowance of Rs. 20/- for eight days from 2nd to 9th January).



MEDICAL NOTES

New light on anticancer vaccine

CERTAIN animal cancers are known to be caused by viruses. However, such links have not been proved with any human cancer. Recently, conclusive evidence has been obtained implicating viruses to Burkitt's lymphoid tissue.

Indirect evidences indicate a strong link between Epstein-Barr virus and a form of cancer, the naso-pharyngeal disease. This disease is the most common cancer among men and the second most common among women in southern China. If this is proved, then vaccine to protect those at risk from becoming infected by the virus would be of enormous value.

In 1981 the British Doctor Dennis Burkitt gave the first description of this cancer, which now bears his name. Its distribution pointed to a virus as the cause. After two years of work, Professor Epstein and his colleague Ynoane Barr, then working at the Middlex Hospital in London, identified a new human herpes virus in Burkitt's lymphoma tissue. The virus was named after them as Epstein-Barr or EB virus.

According to the latest reports about 80% of western population and upto 90% of the population of developing countries is infected with EB virus. The infected people shed the virus into their mouth fluids. The fluids infect others with EB virus. The African EB virus infection occurs in infancy. In western countries, infection may not occur until adolescence. Hence, there is an incentive to develop a vaccine to protect against it.

Professor Epstein's Laboratory observed that though the virus remains in the body throughout life, only some people become susceptible to it. It is now clear that EB virus is kept under control by antibodies which can neutralize it. By a cell-mediated response the thymus-derived lymphocytes, known as T-cells, recognize EB virus coded antigens on the surface of infected cells and destroy these cells. Professor Epstein's team developed a system to show how T-cells recognize infected B-lymphocytes, the cells which become malignant in Burkitt's lymphoma. They have now a population of T-cells which has learned to recognize infected B-cells. If these T-cells are brought in contact with infected B-cells, they multiply rapidly in culture, just as they do to fight an outbreak in the body. This shows that EB virus infection is kept under control by memory T-cells, which have learned to recognize the virus and remain on guard throughout life.

The scientists have also shown that it is not just the virus-coded antigens which make infected B-cells recognizable by T-cells. The B-cells also possess certain antigens of their own, members of the group known as HLA antigens, which make the infected B-cells much easier for the T-cells to recognize and provoke more rapid multiplication of T-cells.

Armed with the above data Professor Epstein's group and two other laboratories in the U.S.A., the Harvard Medical School and the Mayo Clinic, are working for the development of a vaccine to protect against all the possible harmful effects of EB virus. The researchers have separated four high molecular weight polypeptides which they have shown to be antigenic and to stimulate antibody production. If the test proves safe, we will soon have a vaccine against this cancer.

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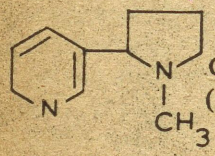
Hard facts about smoking

SMOKING is perhaps the most socially sanctioned of all health hazards. The medical world has done its best to root out this evil, but the increasing statistics has always let them down. It would be futile for smokers to rely upon any magic bullet from the medical world to come to their rescue. But yes, magical results can be achieved if one utilizes his will. This power can be triggered by knowing some hard facts on smoking not how to smoke or what brand to smoke, but to have an insight on what happens inside the victim's own system. It is evident that statistics has not impressed the smoker nor have the mandatory warnings on cigarette packets. Lets hope some bare facts do. Why one starts smoking can be left to the psychologists, but when one does start, let him be aware of its effects at the

chemical and biochemical levels.

An innocent looking cigrette yields more than 500 compounds, particulate as well as gaseous. Some of them include nicotine, pyridine, volatile acids, tarry and phenolic substances, furfural, acrolein, many nitrogenous bases, Polonium-210 and nickel; the last two being accused of inducing lung cancer. The most notorious of them is nicotine, a natural liquid alkaloid formed from a combination of a pyridine and pyrrolidine ring. An average cigarette contains 6mg to 8 mg of nicotine while a cigar 15 mg to more than 40 mg. Fortunately, all of the nicotine is not absorbed by the system:



$C_{10}H_{14}N_2$
(±) Nicotinc

Complex and unpredictable changes occur not only because of action of nicotine on body, but also due to the fact that it possesses both stimulant as well as depressant actions. It stimulates autonomous as well as Central Nervous System, followed by depression. Other important actions include, elevated blood pressure, vasoconstriction, increased blood flow, increased motor activity of the bowels, stimulation of salivary, sweat, bronchial and lachrymal glands, increased respiration rate followed by a fall in rate, emesis and antidiuretic action. Tolerance to many effects of nicotine develops when the compound is taken repeatedly, but repeated use of tobacco manifests in the problem of chronic toxicity.

Initiation of cigarette smoking leads to excessive coughing and sputum production, shortness of breath and eventually in permanent changes in the lung structure, some of which are irreversible. Smokers also have a higher incidence of cancer of the lung and oral cavity than non-smokers. Respiratory disorders not only occur in smokers but also involve their cohabitants to appreciable levels.

Smoking also results in higher levels of carboxyhaemoglobin (COHb) due to excessive intake of carbon monoxide (CO) from combustion of tobacco. Higher levels of COHb reduce oxygen transport by the circulatory system and percentage higher than 6% interfere with the mental alertness and judgement of the subjects in driving, etc.

Gastrointestinal disorders associated with smoking include gastritis, epigastric discomfort, cigarette induced heartburns and possibly gastric and duodenal ulceration.

Women smokers not only risk their own health but also risk the health of their progeny. It has been observed that infants born to such mothers weigh less and the death rate is comparatively higher than infants of non-smoking mothers. Nicotine is also secreted in milk of lactating mothers which, in turn, adversely affects the infant.

The common man may be aware of the toxicity of the cyanides, but it would surprise him to know that nicotine is equally notorious as fatal dose of nicotine is as low as 60 mg. It has been estimated that 3,60,000 people die annually in the United States alone because of tobacco use. Calculations also indicate that one's life is shortened by about 14 minutes for every cigarette smoked, while II smokers die of cancer of the lung out of each non-smoker who dies from the same cause.

Now, before you reach out for your next cigarette, think and think hard taking it as a challenge. May be you prove the strongest opponent nicotine has ever met with.

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Female fertility drops after 30

A French research group studied the fertility pattern of 2193 women who were married to sterile men and who were trying to be pregnant through artificial insemination with donor system between 1973 and 1980 at 11 centres (Semen banks). Women were inseminated in 12 ovulation cycles over a period of one year and were monitored by pregnancy tests at frequent intervals. According to the results of the study recently published (*New Engl. J. Med.*, Feb. 12, 1982) the ability of women to become pregnant decreased sharply from the age of 31 to that of 35. The cumulative pregnancy rate for 12 cycles of insemination was 73% for woman under 25 and 74% for women aged 26 to 30. The pregnancy rate for women 31 to 35 was 61%. It dropped to 54% for women over 35. This study was more reliable in that it was not complicated by such unknown factors as the degree of the husband's fertility, frequency of the couple's sexual relations and latent disease. The implication of this study lies with women who should reconsider the decision to postpone conceiving in the interest of career development. In the developed countries, more working women are waiting longer to have babies so that they can establish their careers.

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SCIENCE FOR THE YOUNG

The biosphere

BIOSPHERE, is defined as that part of the earth in which life exists. The term was introduced as a concept by an Austrian geologist Edward Suess in 1875. It includes atmosphere, surface of land, top few millimeters of soil and upper water of oceans, lakes, and rivers which receive direct solar energy. This is the largest self-sufficient biological system in which communities of organisms and their abiotic components interact by many kinds of reciprocal relationships, both structural and functional. A limited uniform sector of this biosphere is known as ecosystem such as a forest, a lake, a meadow or an ocean. Different ecosystems together form a diverse mosaic in the biosphere. The principle by which all these ecosystems operate also hold equally well for the biosphere as a whole.

Origin and extent of biosphere

There are a number of paleological evidences given by research workers regarding the origin of biosphere, but most of the detailed history consists of a series of blanks. However, analysis suggests that modern biosphere probably evolved about 2 billion years ago with the evolution of marine organisms. They could fix solar energy in organic compounds and release free oxygen from water. Accumulation of free oxygen for hundreds of thousands of years gradually built an atmosphere which screened out the harmful sun's rays and opened the land for living organisms. Perhaps about 400 million years ago, colonization of land started. The first eukaryotic cells appeared some 1.2 billion to 1.4 billion of years ago. New species evolved deriving energy from efficient respiratory mechanism and evolution enabled these species to recycle mineral nutrients and to release more oxygen for supporting more life forms. Gradually each landscape developed flora and fauna adapted particularly to the place. The rise of modern eukaryotic cells is a major consequence of the new conditions imposed by oxygen containing environment. The new arrays of plants and animals used solar energy, mineral nutrients and water to stabilize environment and biosphere we know today (Fig 1).

The life forms extend to different heights at different places forming somewhat an irregular envelope over the earth known as "Parabiosphere". Though green plants can live upto a height of 6200 meters, birds can fly up to 2000 meters height and bacteria can live in 10,000 meter deep marine trenches, it is true that abundant active life is restricted to a narrow band over the surface of earth. Trees stand not more than 70-100 meters tall and sink their roots a few tens of meters into the earth. Similarly in water, the layer penetrated by light supporting a dense population is ordinarily upto a depth of 30 meters and utmost to 100 meters. Today, of course, life can exist in a space capsule or a space suit far outside the natural biosphere. Such artificial environment can be regarded as a small volume of the biosphere nipped off and projected temporarily into space.

Components and energy flow

Each ecosystem of the biosphere, terrestrial or aquatic, consists of two important biological components—producers and decomposers between which exists a whole chain of consumers. Green plants (and also some bacteria) are producers and about 99 % of the total mass of living beings (the biomass) on earth is made of plants (Phytomass). Consumers are heterotrophic group feeding directly or indirectly upon producers. Decomposers reduce plant and animal refuse to the level of its basic inorganic components.

All life on earth is supported by solar energy flowing into the biosphere. Distribution and total amount of energy fixed on earth is a limiting factor on forms and amount of life on it. Biosphere receives solar energy in the range of wavelength 290 nm to 3000 nm (1nm or nanometer=10^{-9} meter). Some rays are absorbed by ozone, oxygen and water vapours of the atmosphere. Only an average of 47% reaches earth's surface, the rest is reflected back in to the outer space. Radiation reaching ground or plant cover is composed of direct sunlight (24%), diffuse radiation from cloud (cloud light) (17%) and from sky (sky light) (6%). In water, intensity of radiation decreases exponentially with increasing depths. Layer of water

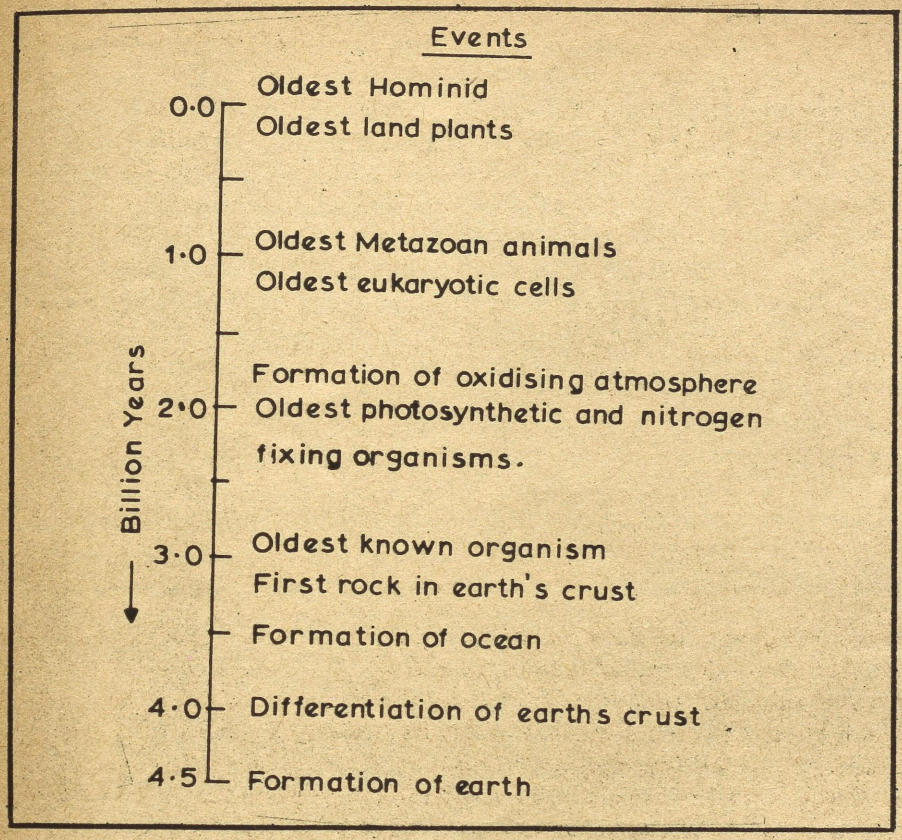

Fig. 1

above the limit for existence of autotrophic plants is called euphotic zone. This zone is deeper in open sea than in lakes.

The primary producers convert light energy into potential chemical energy which flows throgh subsequent consumer levels in the food chain. Raymond L. Lindeman (1942) of Yale University initiated study of energy passage through a natural community. Subsequently E.P. Odum (1968) at the University of Georgia outlined the principle and model of energy flow which operates according to the laws of thermodynamics. The flow of energy is unidirectional; energy input in a trophic level (consumer level) is equal to the output from that trophic level. The net production in the trophic level (P) is equal to net energy assimilated (A) minus the loss due to respiration. Unlike the flow of energy, flow of matter in the ecosystem is cycled. Cycling of bioelements like C,S,P,N,H_2O, etc., takes place at three different levels: in the plant, in the system and in the biosphere.

Productivity of biosphere

Primary productivity of an ecological system or community is the rate at which radiant energy is stored by producer organisms in the form of organic substances. A number of attempts have been made to estimate the primary productivity of biosphere as a whole. A very large part of the earth is in the low production group as water (in deserts) and nutrients (in ocean) are in limited supply. Higher primary productivity is limited to the regions offering an optimal condition of water, warmth, and nutrients to vegetation. On land, this is found in the tropics and in water, in the zone between 40° and 60° north and south latitudes. The most abundant production is found in the transitional zones where land and water meet, i.e., in shallow waters near the coasts, in rain forests, water meadows, etc., Although the land area comprises about 25% of the total earth's surface, it out-produces the ocean. According to an estimate (Leith, 1971), plants fix annually about 155×10^9 tons of carbon over the whole earth—95×10^9 tons (61%) on land and 60×10^9 tons (39%) in bodies of water. Intensive cultivation can achieve more yields than the natural primary productivity of a particular area, but on an average, it is too insufficient due to inadequate techniques of cultivation, incomplete use of land and failure to use better varieties.

Man's impact on biosphere

Like other animals, man depends on environment and becomes an environmental factor with respect to other members in an ecosystem. He intervenes in natural processes and creates new habitats to his own liking. The recent dramatic change in human population has necessitated evolution of modern agricultural practices of food production by use of chemical fertilizers, irrigation, etc., which in turn affect natural cycling of energy and matters. Besides rapid industrialization, nuclear explosions and radio-active fallouts have disturbed the biosphere. Density of man is now one person to about 4 hectares of land or even less. When domestic animals are included, the density is still more, equivalent to 0.7 hectares per individual. Besides, man and his domestic animals consume 6% of the net production of biosphere. If the population doubles by the next century and we continue to eat and use animals,

there will be less than half hectare to supply all the needs of 50 kilograms of each consumer. This indicates the necessity of population control and biosphere management.

Conclusion

A better biosphere requires management of different resources, wildlife, and use of land. Now the length of life of the biosphere as an inhabitable region for organisms has to be measured in decades rather than in hundreds of million of years. And this is all due to our own fault. But still we can strive and work for a better, ecologically balanced biosphere.

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The world of chemists

SCIENTISTS in the last half of 18th century took up chemistry as a true science unmixed with other dogmas like Elixir of life, Philosophers' stone and Universal solvent. Whereas the alchemists discovered only working apparatus like retort, flasks and beakers, the latter scientists worked with devotion to reveal the secrets of the properties of matter. Devotion of these chemists to science may be illustrated by following examples.

Henry Cavendish (1731-1810) was the richest man of England of his time but was so much engrossed in chemical problems that he bothered little about his money in the Bank of England. The bankmen had been instructed not to bother him about the money in the Bank. Whereas his family men desired him to be a politician or a minister, he was always busy with his flasks and test tubes caring little that other people laughed at his poor clothes or shoes. Once his maid-servant asked him (through the door separating his laboratory from the rest of the house), "Sir, as per your order on the slip on the hall table, you have ordered for one leg of mutton for dinner". "So, I have", said Cavendish feeling disturbed. "But, Sir, some of your friends from the Royal Society are expected here for dinner", "Well, what of it" stammered Cavendish. "But Sir, one leg won't suffice five" repeated the maid. "Then have two legs" was the Cavendish's order. She did not dare disturb him any more.

He was so much un-worldly that beggars and borrowers made him an easy mark. He used to hand them over blank cheques. He was once approached by his sick librarian for help. Cavendish was too impatient to listen to details of his plea but asked him if ten thousand pounds would do and gave him the cheque, whereas only one hundred pounds would have done. One evening, Cavendish returned from the Royal Society and started studying. He was tired and ill. He rang the bell and summoned his servant and ordered him to inform his brother Fredrick about his own death. The servant returned after half an hour to find his master dead.

Joseph Priestley (1773-1804) was the Priest (Minister)-in-charge of Mill Hill Chapel at Leeds (England). In addition to supporting his family with the meagre income, he devoted his extra time and energy to research in chemistry. He used to go to a brewery adjoining his house and would identify the gas evolved in fermentation from large vats. He knew little chemistry but could find that the gas could extinguish burning chips of wood and could be obtained by heating limestone. He was awarded a 'Gold Medal' for preparing a very weak acid solution of this gas—carbon dioxide—in water now called soda water. People raised eyebrows for his involvement in experiments with bottles and flasks but he did not bother. Seated on a chair and playing on flute he observed that a mouse in common air (in a cylinder) died whereas the one in oxygen did not. Soon he found that oxygen is supporter of life. It is now used in hospitals to save patients experiencing difficulty in breathing.

John Jacob Berzelius (1779-1848) was a Swede. His step-father did not give him facility for study butəq' went ahead with private tuitions. While at the university he begged permission of his teacher Afzelius, to work overtime in the laboratory. Although he was refused permission, with the connivance of the laboratory caretaker he managed to work overtime in the laboratory. Afzelius noticed him working very systematically. He called Berzelius and fired him for disobedience. Berzelius was afraid of being expelled when Afzelius, who was jesting, said "Hereafter you must use the front entrance of the laboratory and you can do so even in my presence".

Berzelius worked hard to give the present system of symbols to the elements and compounds. Overwork made Berzelius develop periodic nervous headaches. He would

(Continued on page 379)

FOR HER

Mother's milk

TILL the end of the nineteenth century, babies had to depend on mother's milk, there being no alternative food. Later, commercial food became available and artificial feeding became increasingly popular. By 1974 less than a third of mothers in the United States and European countries breast-fed their babies. Though nutritional, caloric and chemical nature of the artificial formulae are almost similar to mother's milk, work in immunology has shown that the formulae lack certain proteins that serve to protect the breast-fed babies from infection. Gastroenteritis is much more frequent in formula-fed babies, not only for the obvious reason that there are many opportunities for the food to become contaminated during preparation, storage and feeding, but also because of lack of certain proteins that have immunological properties. Studies made some decades ago in Europe and North America and an analysis of more recent experience in developing countries indicate that breast-milk-fed babies have a lower death rate than formula-fed babies.

Surveys made by the Pan American Health Organisation in El Salvador, Jamaica, Columbia and Brazil suggest that infants who were breast-fed for six months or less were from 6 to 14 times as likely to die in the first year as infants who were breast-fed for more than six months. However, recent analyses have shown that excellent health care and sanitation compensate for drawbacks of artificial formula. But in most of the developing countries sanitation and medical care are insufficient and so the protection afforded by breast milk is of paramount importance.

Among the proteins that are lacking in commercial formulae are immunoglobulins, including antibodies to a wide range of antigenic substances. Of the various classes of immunoglobulin molecules, immunoglobulin G, designated as IgG, is transferred via the placenta during pregnancy and the infant at birth has a full complement of IgG, which protects the baby against viral and bacterial infections to which the mother has developed immunity. The donation is sufficient for as long as a year, during which time the child's immune system develops capacity to make its own IgG. Two other immunoglobulins, IgA and IgM, do not cross the placental barrier in significant amount. Their absence is compensated for by breast milk which contains both. IgA is received in high doses from colostrum (first milk produced after child birth) and in lesser amounts from milk the mother produces later in the baby's life. This IgA remains highly unabsorbed on the inside surface of the gut and may well have a role in protecting against absorption of foreign proteins by preventing them from sticking to cell walls. IgA in an infant's intestinal tract is, therefore, an excellent source of protection against gastroenteritis, a major cause of death among infants in poor countries. Artificial formulae cannot provide this protection. The immunoglobulin in cow's milk is mainly redundant IgG and even it loses potency, particularly when heat treated.

Several other components of breast milk have immunological properties. Lactoferrin, an iron-binding protein in whey, inhibits bacterial growth. It is particularly effective against *Escherichia coli*, a common cause of infantile diarrhoea. Breast milk has more lactoferrin per unit volume than cow's milk. These and other anti-infective agents are usually absent or less active in artificial formulae and cow's milk, particularly when heat treated. Their precise clinical role is as yet unknown but it is surely not coincidental that in the developing countries there is a close association between formula-fed on one hand and diarrhoea, other infections and protein-caloric malnutrition on the other.

Apart from immunological properties, breast milk has a unique property which no formula can emulate. Breast milk produced when a baby begins to feed is quite different in composition from that at the end of feeding. In breast milk, fat content increases five times and protein nearly doubles during the course of 15 minutes feed. According to Barbara Hall of the Nuffield Institute of Comparative Medicine, London, these changes form part of a system to control appetite. As the milk becomes more concentrated towards the end of a feed from one breast, the baby's hunger is satisfied and he stops sucking. Neither the baby's exhaustion nor that of the milk supply is the reason for this. He will happily start sucking again on the dilute milk initially produced by the other breast, thus satisfying himself. Such appetite control is not possible with any artificial milk because of its uniform composition.

Another utility of breast milk is that it contains epidermal growth factor (EGF) (molecular weight =

6000). EGF is mainly responsible for the growth of infants.

There are a number of artificial baby feeds available in the market and their manufacturers advocate highly in favour of their products. But people should not be tempted by these advertisements and must realise that mother's milk is the best food that nature provides to infants.

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Predigested milk

MILK has an important place in our diet. It is very rich in protein, calcium, vitamins and milk sugar, and provides these nutrients in a proper balance. It is nearly the most perfect food, ideal for the expectant mothers, infants, growing children, adults and the aged. No other single substance can serve as a complete substitute for milk. Moreover, in India, milk is the only source of animal protein for the vegetarian section of the population.

The principal sugar of milk is lactose, though small amounts of glucose, galactose and other sugars are also present. Lactose is a disaccharide in which its monosaccharide units, galactose and glucose, are joined together in β $(1 \rightarrow 4)$ linkage. Lactose has many nutritional and functional attributes, but its presence in milk can create problems to some. Lactose is normally hydrolyzed in the small intestinal lumen by lactase. Lactase activity is highest at birth, but decreases in childhood. It breaks down lactose into glucose and galactose which are absorbed and metabolized. Some races and populations cannot utilize milk due to lactose malabsorption. A good many adults and quite a few children cannot tolerate milk. In India, lactose malabsorption is found in 60% of people. In them the undigested lactose passes down to the lower region of gastrointestinal tract, where it is fermented by colonic bacteria. This leads to bloated feeling, belching, flatulence and general intestinal discomfort.

Efforts are being made to fight malnutrition in general, and protein malnutrition in particular, in developing countries by increasing the consumption of milk. India now produces 30 million tonnes of milk and imports 15 thousand to 20 thousand tonnes of milk powder. Per capita consumption of milk is 120 gm as against a requirement of 500gm/day. With "Operation Flood" entering the second phase, both milk production and per capita milk consumption are believed to be increasing. The fact that 60% of the Indian population is lactose-intolerant, puts serious constraints on milk consumption in our country.

High incidence of lactose intolerance in the majority population of the world, specially of India, prompted us to study ways and means to alter or remove lactose from milk by a method which should be economical and retain in full the nutritional value of milk for lactose-intolerant individuals. Lactose can be removed from milk by gel filteration by vitamins, and minerals are as well removed alongwith the lactose. Fermented milk has been suggested as a possible solution. However, 80% to 90% of lactose remains in these products. The only approach for production of lactose-reduced (predigested) milk with nutritional integrity fully maintained would be to hydrolyse lactose in milk by the enzyme lactase.

Lactase occurs in many plants (almonds, peaches, apricots, alphaalpha, etc.), animals (rats, dogs, rabbits, cow, sheep, etc.) and microorganisms. Microorganisms are considered potentially most suitable as a source of the enzyme because of being inexpensive and easy to produce. Properties of the enzyme, from various sources vary widely. In our laboratory 109 strains of yeasts, molds and bacteria were screened for lactase activity to select potential sources of the enzyme for industrial exploitation. Lactase has been produced from cultures of yeasts (*Kluyveromyces fragilis*), bacteria (*Streptococcus thermophilus* and *Lactobacillus bulgaricus*) and fungi (*Alternaria palmi*) on whey (a by-product of cheese-industry) at a very low cost. Molds exhibited lowest enzyme activity but highest cell yield. Bacteria, on the other hand, produced the lowest cell yield and the highest enzyme activity. Yeast is considered to be the best source of lactase. Besides it has the same pH optima as that of milk.

Reduction of lactose from milk

The solution to the problem is simple—rather than having the enzyme in the body and breaking down the lactose, the enzyme could be added to milk prior to consumption. In our laboratory, complete hydrolysis of 1 litre of whole milk was achieved by incubating 1250 units of enzyme (*K. fragilis*) in 1 litre of milk for two hours at 30°C and one and a half hrs for skim milk. 70% hydrolysis, however, was achieved within half an hour. 50% of hydrolysis was achieved when the same amount of enzyme

was incubated at freeze for 12 hrs. The enzyme seems to be safe for use in foods. The drawbacks of this method are the relatively large amounts of enzyme needed and the necessity to incubate milk in tank either for a few hours at 30°C for twelve hours in a refrigerator. In the U.S.A. an enzyme is made available to consumers in powdered form in small envelopes. By adding the enzyme the day before consumption, the lactose in a glass of milk is hydrolyzed overnight.

To economize this process, attempts have been made to immobilize the enzyme on inner surface of nylon tubing. This method has two advantages. Firstly, the same enzyme can be used as long as it is stable and secondly no enzyme is added to milk.

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SCIENCE FOR THE YOUNG (*Continued from page 376*)

shut himself up for days together, ate nothing, and saw no one. Never ending work, no relaxation and a lonely life deteriorated his health. He was fiftysix when he realised that life without a companion is a drudgery. So he married a girl of twentyfive who was the daughter of his friend Poppins, a town-planner. The girl readily agreed because Kings and Crown Princes were amongst his students.

Martin Hall (1863-1914), son of a priest, was born at Oberlin near Ohio in America. Professor Jewett (Professor of Chemistry at Oberlin College, Oberlin, USA) states that a boy of fourteen used to come to the chemical laboratory to buy a few cents worth of glass tubing or something of that sort and went off with them. The boy was Martin Hall who discovered electrolytic process for extracting aluminium from alumina at an early age of 22 years. Once when Professor Jewett was talking to his students in the laboratory, he remarked, "Anyone who invents the method of making aluminium on commercial scale will serve the world and lay up a great fortune for himself". Young Martin Hall turned to one of his classmates and said, "I am going for that metal". After graduation, he took the crude apparatus (cups, tumblers, etc., with pieces of carbon in them) to his house. After six months, he came with little globules of aluminium in the palm of his hand and reported "Professor, I have got it".

On his death in 1914, his own college in Oberlin received one-third of his estate which amounted to $ 12,000 to $ 15,000. A life-size aluminium statue of this great chemist decorates the chemical laboratory at Oberlin.

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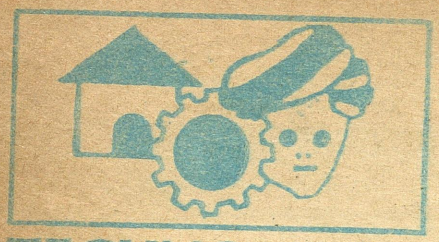

TECHNOLOGY FOR VILLAGES

Low-Cost Solar Cookers for Villagers

THE solar cookers currently available in the market priced above Rs. 300/- are not within the reach of the rural poor. If solar energy utilization is to be propagated in rural areas, designs using low cost materials are required. As is well-known, a solar cooker is essentially a container with heat absorbing material insulated from the outside. A cover or glazing is used to trap the solar energy. The glazing is transparent to low wavelength (0.3-3.0 um) radiations which are absorbed by the heat absorbing material inside. IR radiations of higher wavelength emitted by the absorbing material does not pass through the glazing. The solar energy remains trapped as heat within the container used for cooking purposes. The efficiency of heat trapping depends on glazing as well as insulation.

To reduce the cost of the cooker, all the material components should be cheap and the design should be such that the labour input is minimum.

Keeping these in view, a solar cooker has been designed by the Centre for Rural Development and Appropriate Technology, I.I.T., Delhi. The cost of this solar cooker is arround Rs. 20/- excluding cooker vessels and can easily be fabricated by an unskilled rural woman. Preliminary studies in summer has indicated that the temperature within the container reaches upto 110°C within an hour and this is sufficient for cooking dal, rice and vegetables.

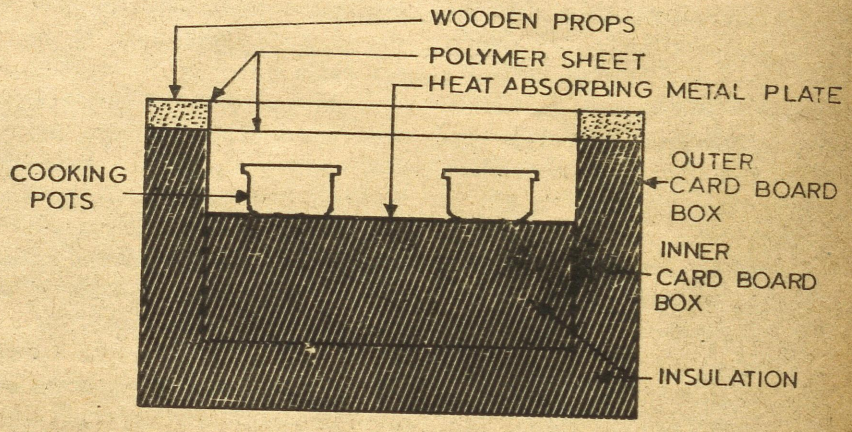

Fig. 1

The cost may be further reduced if waste materials are used for insulation. Further information for those interested in field level testing can be had from Head, Centre for R.D & A.T., IIT, Delhi.

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NITROSAMINES (*Continued from page 351*)

Further reading

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2. Magee, P.N. and Barnes, J.M., Carcinogenic nitroso-compounds, *Adv. Camcer, Res.*, **10**, 162-246 (1967).
3. *IARC, Evaluation of carcinogenic risk of chemicals to man*, IARC Monographs, Volume 1, International Agency for Research on Cancer, Lyon (1972).
4. Bogovski, P., Walker, E.A. and Davis, W. (Eds.), *N-Nitrosocompounds in the environment*, International Agency for Research on Cancer, IARC Scientific Publications No. 9, Lyon (1975).

BOOK REVIEWS

THE YOUNG SCIENTIST BOOK OF SPACEFLIGHT *by* Kenneth Gatland, **THE YOUNG SCIENTIST BOOK OF JETS** *by* Mark Hewish, and **THE YOUNG SCIENTIST BOOK OF ELECTRICITY** *by* Philip Chapman, *Madhuban-Usborne* (Available from: *Vikas Publishing House Pvt. Ltd.*, 5 Ansari Road, Daryaganj, New Delhi-110002), pp. 32 each, Rs. 20 each.

GONE are the days when children's science books were written in short sentences and had few illustrations. The books brought out nowadays, like the ones under review, have lavish full page multicolour illustrations and also do-it-at-home experiments as the main attractions for children. Although the sentences are not short, the text matter is short and to the point. There are also small box items touching upon various interesting sidelights of the subject under discussion. The authors are all experts in their subject. For example, Kenneth Gatland is Chief Editor of the popular *Spaceflight* magazine of the British Interplanetary Society. Mark Hewish is also a popular science writer of some repute. For children such books are a treat which, this reviewer is sure, they would prefer to ice cream. An adult also likes the beautiful illustrations and crisp language of the books, which would help him pass his idle hours.

All the interesting facts and principles relevant to the subject have been mentioned in a straightforward language. Not only do they tell about the history of development of the subject but also about the possibilities that it offers in the near future. A list of materials needed for experiments, a chronology of important events and a glossary of difficult terms are also given.

The only objection is the high price of the books, which would prevent many parents from buying them for their children. But it must be emphasised, that the books are 'worth more than their weight in gold'.

DILIP M. SALWI

PTERIDOPHYTA—A NEW LOOK *by* O.P. Sharma, *Pragati Prakashan*, Begum Bridge, P.B. No. 62, Meerut, 250 001, Pp. 278, Rs. 11.60.

PTERIDOPHYTES—an interesting group of plants which originated in the Silurian Period link bryophytes and gymnosperms. The independent sporophytic stage which predominates the gametophytic stage is considered as a 'quantum evolutionary jump'. Pteridophytes have invaded the terrestrial habitats by developing tissue system for water conduction. The present book filters out important and interesting features in these extremely interesting group of plants which will enliven the interest of students.

The author has aptly chosen to divide the chapters under two sections 'the general treatment' and 'the group-wise treatment'. In the general treatment five chapters have been included. Interesting chapters like Apospory and Apogamy, Telome Theory, Stelar System and Heterospory and Seed Habit are well discussed by putting the contributions of various pteridologists in a crisp way. Group-wise treatment includes five chapters where about a dozen genera have been dealt with. Generic studies include systematic position of the genus, distribution, morphology, anatomy and the life history. The important features in each chapter have been printed in bold to catch the attention of students. Bibliography at the end of each chapter will encourage the students and the research workers to unearth more information on the subject of their interest. The illustrations are well drawn.

To make the book more exhaustive few more chapters could have been included in the general section like Origin and Evolution, Distribution of Pteridophytes, Chromosomes and Polyploidy, etc. Pteridophytes are known to possess very high chromosome number, of particular interest is *Ophioglossum reticulatum* which contains 1,260 chromosomes in the sporophyte which is the highest number ever recorded in the plant kingdom. Pictorial life cycle diagram in generic studies would have given an idea about the important developmental phases at a glimpse. In the bibliography the citation of the journals needs standardization. The printing errors (few), the binding and get up of the book will hopefully improve in the next editions.

On the whole the book is interesting and will meet the major requirement of the undergraduate students.

B. SUBRAMANIAM

FORTRAN PROGRAMMING *by* A.K. Jain and M.N. Keshava Rao *Nem Chand & Bros.*, Roorkee, 1982, xii + 270, Price not given.

THIS book is an introductory text on Fortran programming describing the various aspects of the language spread over twenty chapters and four appendices. As is customary with this type of texts, portions are graded indicating for first reading, skipping and advanced level reading.

In the first two chapters, an attempt has been made to initiate

the beginner reader to the terminology and concepts like types and functional structure of computers, hardware, software, machine language and procedure-oriented languages, etc. Chapters 3 and 4 are devoted to the explanation of coding conventions of Fortran statements, constants and variables while chapter 5 deals with Fortran expressions.

There is an abrupt switch over to the topic of flow charts in chapter 6. This should have been made as Chapter 3 or given as an appendix removing the discontinuity. Chapters 7-14 are devoted to the topics like assignment, I/O, Format, Control and DO statements; dimension variables; subprograms, COMMON and EQUIVALENCE statements. The I/O instructions for random access mode are also included.

In the later chapters the authors introduce concepts of efficiency in execution time, memory, etc., multiprogramming, time sharing and multiprocessing very briefly.

Chapter 18 deals with data organization on magnetic tapes, viz., blocking, labels and physical characteristics of magnetic tapes. The next chapter describes the creation and editing of data and program files with reference to the DEC-20 Computer.

The concluding chapter gives a few illustrated examples of computer programs on matrix methods, solution of unsymmetric equations, eigenvalue problem, numerical integration and differential equations.

On the whole the book is useful for beginners in Fortran language. The get-up is reasonably good but the price is not mentioned. A more careful copy editing could have avoided some looseness in the running text.

D.S.R. MURTY

CONCEPTS OF ECOLOGY *by* R.L. Kotpal and N.P. Bali, *Vishal Publications*, 6 U.B. Bunglow Road, Delhi 110007, 1981 (Third Edition), pp 256, Rs. 14.50

THE book has five sections: (i) General Principles of Ecology (9 Chapters); (ii) Population and Community Ecology (4 Chapters); (iii) Habitat Ecology (3 Chapters); (iv) Conservation Ecology (4 Chapters); (v) Laboratory and Field Manual. The authors have taken pains to provide selected articles and books for further reading after each chapter.

They have also worked hard in selecting illustrations and Tables from different scientific books and journals. The book is all right on these two counts. However, mere access to literature does not guarantee the worth of the book. After going through the book one carries the impression that the authors, even if they have read all the cited references have utterly failed in synthesising and presenting the subject in understandable form. The questions given after each chapter are stereotype and reflect upon the authors' indifference towards them.

The language used in the book (apart from quotes and otherwise) is atrocious. Wherever the authors have tried to use their discretion in selecting diagrams, etc., more often than not they have erred. Even in this third edition too many "typographical" mistakes are present. While talking about photosynthesis they have given following equation:

$$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6H_2O$$

This relationship seems to be very recent as the reviewer does not know it! The present age according to the authors "Can rightly be called as atomic age". There are many contradictions in the book for instance, the text and figure No. 2.7. Vagueness is the most common thing in the book for instance, 'Lakes and human activities in India'. Of all the sections, the one on Laboratory and Field Manual is most carelessly written. This shows nothing but utter disregard for experiments by the authors themselves.

The impression which one carries after going through the book is that text book writing is a specialized job and to do justice to it one has to be a specialist.

NIKHIL KUMAR

Books Received

1. **GEMINI GOD** *by* Garry Kilworth, *Penguin Books* (Available from: *Penguin Overseas Ltd.*, 706 Eros Apartment, 56 Nehru Place, New Delhi-110019), Pp. 240, Rs 31.00.
2. **SCIENCE AND THE FACTORS OF INEQUALITY** *by UNESCO* (*Oxford & IBH Publishing Co.*, 17, Park Street, Calcutta-700016), pp. 273, (Price not mentioned).
3. **PHYSICS OF CRYSTALS** *by* S. Bhagavantam and S. Radhakrishna, *Macmillan India*, 4 Community Centre, Naraina Industrial Area, Phase I, New Delhi-110028, pp. 164, Rs. 100/-.
4. **NUTRITION AND HEALTH** *by* T. Geoffrey Taylor, *Edward Arnold Publishers Limited*, 41 Bedford Square, London WC1, 3DQ, Pp. 59, £ 2.50.
5. **CHILDREN'S KNOWLEDGE BANK** *by* Sunita Gupta and Neena Agrawal, *Pustak Mahal*, Khari Baoli, Delhi-110006, Pp. 232, Rs. 20.00.
6. **PRACTICAL PHYSICS** *by* P.C. Bose, *Tata McGraw-Hill Publishing Co. Ltd.*, 12/4, Asaf Ali Road, 3rd Floor, NewDelhi-110002, Pp. 140, Rs. 12.00.

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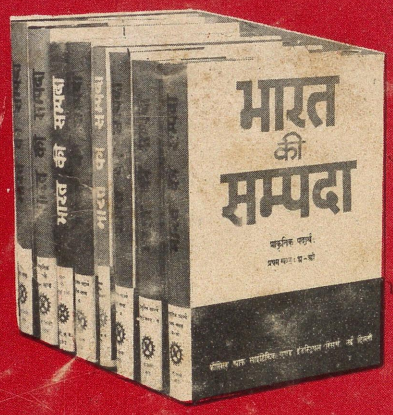

हिन्दी में वैज्ञानिक विश्वकोश

भारत की संपदा

प्राकृतिक पदार्थ

भारत के प्राकृतिक पदार्थों—वनस्पतियों, खनिजों, प्राणियों के बारे में वैज्ञानिक तथ्यों से परिपूर्ण 'वेल्थ ऑफ इण्डिया-रॉ-मैटीरियल्स' का लगभग 5,000 पृष्ठों में परिष्कृत एवं परिवर्धित हिन्दी संस्करण प्रामाणिक जानकारी के लिए हिन्दी आकारादि क्रम में, 10 खण्डों में **'भारत की सम्पदा'** नाम से सचित्र वैज्ञानिक विश्वकोश के रूप में प्रकाशित हो रहा है. लगभग 3,000 पृष्ठों में इसके छः खण्ड और दोनों पूरक खण्ड प्रकाशित हो चुके हैं.

लेख किस बारे में हैं

भारत की सम्पदा में विशेषज्ञों द्वारा लिखे गये विनिबंधी (मोनोग्राफिक) लेख ऐसे खनिजों, जीवों और पेड़-पौधों के बारे में हैं जिनसे औषधियां, खाद्य-पदार्थ, फसलें, पेय-पदार्थ, फल, नट और मसाले अथवा वसा, तेल, शाक, सगंध तेल, स्वापक, धूमक तथा चर्वणीय पदार्थ या रंगरोगन, रेशे और लुग्दी, प्रकाष्ठ तथा वन उत्पादों आदि में से कोई पदार्थ प्राप्त होता है.

लेखों में क्या मिलेगा

वनस्पतियों की सही पहचान और उनके वैज्ञानिक नामों के साथ भारतीय भाषाओं के प्रचलित नाम मिलेंगे. अतिरिक्त जानकारी प्राप्त करने के लिये संदर्भ ग्रंथों की सूची मिलेगी. संदर्भों के उचित उल्लेख के साथ अद्यतन आंकड़े मिलेंगे. प्रत्येक खण्ड के अंत में उसमें आये भारतीय भाषाओं के नामों की अनुक्रमणिका (इण्डेक्स) मिलेगी. फसल पौधों के बारे में उनकी खेती, कटाई, भण्डारण, रोग तथा नाशक जीव और उनका नियन्त्रण मिलेगा. प्राकृतिक पदार्थों के उत्पादों के रासायनिक संगठन तथा उपयोग मिलेंगे और महत्वपूर्ण आर्थिक उत्पादों के भारत में प्राप्ति-स्थान, उत्पादन, आयात, तथा निर्यात के आंकड़े मिलेंगे.

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यह ग्रंथमाला वैज्ञानिकों, उद्योगपतियों, विद्यार्थियों, शिक्षण और अनुसंधान संस्थानों, पुस्तकालयों, विकास अधिकारियों तथा जन साधारण के लिये समान रूप से उपयोगी है.

व्यवस्थापक (बिक्री एवं विज्ञापन)

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