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THIS WAS THE MAN

He loved India and the Indian people with all his mind and heart, and they, in turn, gave him of their love most abundantly and extravagantly.



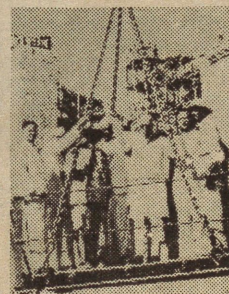
To the down-trodden, to the underprivileged, to the oppressed, he became the very personification of freedom.



"How can a nation rise, if half the nation, if our womenkind lag behind?" He posed this question and worked incessantly for the uplift of Indian women.



"I want work and work and work. I want achievement. I want men who work as crusaders"



Building India was His Passion

davp 89/738



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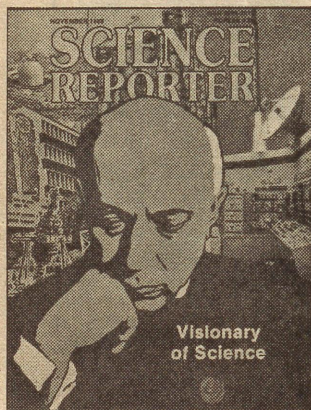
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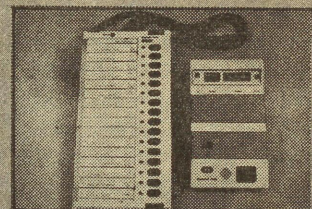
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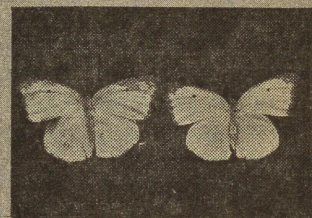
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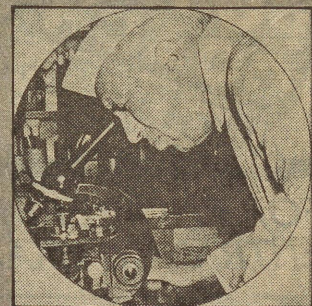
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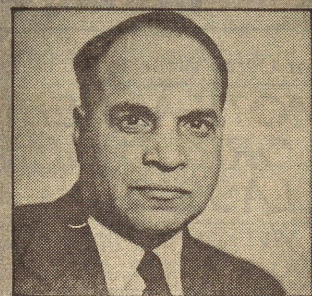
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The Government of Orissa has established the Institute to carry out basic and applied research in frontier areas of Life Sciences, especially in Molecular Biology, Genetic Engineering, Biotechnology, Tissue Culture and Environmental Biology. Sophisticated equipments and basic facilities to carry out research in these areas shall be available. Some amount of funds shall be available for chemicals, supplies and materials. Researchers are expected to obtain funds from various agencies by sending innovative research proposals in these areas.

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LETTERS

Human genetic disorders

Sir, With reference to the article **Human genetic disorders** by B.N. Singh (*S.R.*, April-May 1989), there is no doubt that the article is informative, lucid and interesting. The author has referred to many diseases in connection with genetic defects. However, I would like to bring to the notice of readers some other important diseases not mentioned in the article.

Testicular pemimization syndrome: Usually individuals with XY-chromosome including autosome are male. Sometimes, when certain male individuals have "T-fm gene" on the X-chromosome it reverses male into female individuals. The feminine characters are: (a) The development of breast and vagina; and (b) Degeneration of testis.

Procupine men syndrome: The disease was first reported in the Lambert family of England. This is a sex-linked disease found only in men because it is a Y-linked trait. In this disease the skin of an individual initially begins to turn yellow and gradually becomes black. It thickens until the whole body, with the exception of head, face, palm and sole, is covered with rough and brittle scale and outgrowth.

Hypertrichosis ear disease: This is also a sex-linked disease which is determined by the Y-linked genes.

Besides, the author has mentioned under the head "Haemophilia" that "Two types of Haemophilia" A and B have been reported. However, three types of Haemophilia have been reported till now, i.e., A, B and C. The Haemophilia C has been found in one per cent of individuals in very mild form.

Sushil Kumar Sharma
M.Sc. (Botany)
S.M.Q.-305, A.F. Stn.,
Hindan, Ghaziabad

Ozone depletion disturbing

Sir, I went through the article **Ozone depletion means danger**

(*S.R.*, July-Aug. 1989). The authors have neatly displayed facts and deserve full appreciation for the lucid presentation. I was disturbed to read the warnings mentioned in the article. I agree with the authors that an International Cooperation Programme should be launched to curb the production of chemicals that are more reactive to ozone. Sometime ago, in London, an international conference was held in this connection. The speakers urged governments to take necessary steps to ensure a pollution-free atmosphere for our future generations.

Prince Rafiqi
Moh. Bakshi-Abad
Islamabad, Kashmir

Saffron

Sir, The article **Saffron—a valuable crop** (*S.R.*, June 1989) was well written and interesting. I would like to add some more information on its history and toxicity. The flower "saffron", an english equivalent of Indian "kesar" was recorded as early as 1552 B.C. in a Theban medical papyrus, and its earliest name was probably the Hebrew "Karkom". In ancient times a golden-coloured, water-soluble fabric dye was distilled from saffron stigmas in India. Shortly after the death of Buddha (483 B.C.) his disciples made saffron the official colour of their robes. Sprinkling of saffron was also recorded in the streets of Rome when Emperor Nero (54-68 A.D.) entered the city. It is also referred to among the sweet-smelling herbs in the song of Solomon 4:14. Records suggest that saffron was even exported to China from India during the reign of Yuen dynasty (1280-1368 A.D.). Severe punishments and penalties were imposed on those who adulterated saffron: Ham Kolbele, for example, was buried alive in Nuremberg (West Germany) in 1456 with his impure product. Saffron from Valencia in Spain is considered to be of the highest

quality today. It was first introduced in to Spain by the Muslims in 8th century. However, in early times, the chief seat of its cultivation was in Cicilia, in Asia Minor.

As for its toxic effects, ingestion of only a few (5-10) grams of saffron is sufficient to induce abortion. Extensive bleeding from the skin and nephro-toxicity have also been recorded with excessive ingestion of the material. Bulbs of this plant are toxic to animals.

Shahidul Khair
C.C.R.U.M.
5, Panchsheel Shopping Centre
New Delhi-110017

Further reading helps

Sir, I am a mathematics student of 12th class (10+2 level). I have been reading *Science Reporter* for the last three years. I mostly relish recreation with numbers, fun with numbers, and cartoons. It would be fun if you publish a quiz page in every alternate issue. I appreciate one vital point in your magazine. You give the name of books at the end of every article for further study. It is of great help as one does not need to spend much time in searching for books on the subject.

Deepa Bandhu
3024 V/FJ Estate
Jabalpur-482009

Science for the young is attractive

Sir, I have been a regular reader of *Science Reporter* for more than a year. I found the articles 'Invisible Aircraft' (*S.R.*, June 1989) and 'On Scientific Method' (*S.R.*, July-August 1989) particularly interesting. I always find 'Science For the Young' the most attractive feature. I feel that, besides being a informative, lucid and interesting magazine, it also successfully updates its readers on the latest science news.

Anita Srinivasan
Old Rajinder Nagar
New Delhi-110060

Fibre can be used to transport light signals
from one place to another just as
metallic wire conducts electrical signals.
GORACHAND GHOSH discusses the various
aspects of this novel means of communication

LIGHT COMMUNICATION

LIGHT COMMUNICATION

OPTICAL fibres are flexible fibre-like glassy material through which light can be guided and propagated with very low loss. That is, the fibre can be used to transport light signals from one place to other just as metallic wire conducts electrical signals. The glass used in optical fibre is not the ordinary type of glass used for making window panes and drinking glasses. Technically speaking glass is not a particular material, but a state of matter. It is a solid state of matter in which the atoms are not in a regular array (as in a crystal), but where the interatomic spacings and bond angles are irregular. The crystalline and glassy states of silica (SiO_2) is shown in Fig. 1. If a liquid is cooled slowly, it changes into a crystalline solid at a temperature called the freezing temperature (T_f). However, if a liquid is cooled very rapidly, the liquid may gradually solidify in the glassy state and the temperature is called the glass forming temperature (T_g). The phase diagram of liquid and solid states of a material with the freezing and glass forming temperatures are shown in Fig. 2. One very good example is water: it normally freezes at 273K, but will form a glass if rapidly cooled to 140K from the liquid state. Similarly, natural rubber can be in the glassy state at 200 K.

Optical fibres can be of various kinds depending upon the transmis-

sion range of the fibre materials. Silica-based optical fibres are used in the near infrared (0.85, 1.33 and 1.55 μm wavelength) region, particularly for telecommunication purpose. Zirconium-based fluoride glass infrared fibres have the potentiality for ultra-low-loss transmission in the 2.55 μm region. These fibres are used in image transmission, sophisticated sensor development to control nuclear reactor, etc. On the other hand chalcogenide glass fibres (made from glass containing As, Ge, P, S, Se and Te) and polycrystalline optical fibres (made from KRS-5, KRS-6 and TlBr) are used to transmit CO_2 laser, particularly for medical applications.

An optical fibre consists of a core region and cladding region. The core region is made of silica glass doped with GeO_2 , B_2O P_2O_5 , etc., and typically has a diameter of between 3 μm and 100 μm . A fibre with a small core (called a single-mode fibre) propagates light in somewhat different fashion than a fibre with a large core (called a multimode fibre). The wavelength of light used in a typical optical fibre systems is between 0.8 μm and 1.6 μm . The single-mode fibre has a core diameter which is only a few times as large as the light wavelength. On the other hand, multimode fibre has a core diameter which is ten or even a hundred times as large as the light wavelength. The core of

the fibre is surrounded by a silica glass cladding having a slightly lower refractive index (by 0.2%-0.8%). The diameter of the cladding is 125 μm , although it can be larger for some applications. In this simple model, a light source (light emitting diode, laser diode) emits light from different points on its surface which travel at various angles relative to the reference axis as shown in Fig. 3. In the figure, after incidence on the fibre core, ray 1 is refracted or bent towards the fibre axis and after propagating some distance in the core region, it strikes the core-cladding interface. As the cladding has a slightly lower refractive index than the core, the ray is rapidly lost as it propagates further. Ray 2 is reflected by the core-cladding interface at a relatively small angle with respect to the fibre axis. With a small angle of incidence, the ray does not enter the cladding but is totally reflected by the core-cladding interface. The rays 2 and 4 propagate along a multimode fibre in a zig-zag path as shown. Other rays 3 and 5 are not captured and guided by the optical fibre since they are either incident on the cladding region or miss the fibre entirely.

The detail and precise understanding of the way in which light signals propagate through optical fibres can be realised by using Maxwell's equations to calculate the optical fields within the fibre and by treating the

optical fibre as dielectric waveguide. Some useful definitions relating to optical fibre are worthwhile to mention here. The total number of modes that can be carried by an optical fibre depends on the parameter V , which is defined as

$$V = n_1 k a \sqrt{2\Delta} \dots \dots (1)$$

where n_1 is the maximum value of the core refractive index, k is the propagation constant of a plane wave in free space and it may be expressed as $k = 2/\lambda$, a is the core radius. The parameter Δ is the relative refractive index difference between core and cladding (refractive index n_2) and is given by

which it radiates into space when escaping from the end of the fibre. The relationship between NA and the maximum angle θ inside the core, or the maximum radiation angle θ_a in air is given by

$$NA = n_1 \sin \theta = \sin \theta_a \dots \dots (5)$$

Optical fibre loss is another important parameter. Optical fibre is a glassy medium and all glasses absorb strongly in the infrared and ultraviolet region of the spectrum. Infrared absorption is caused by molecular vibrations whereas ultraviolet absorption is due to electronic transitions in the glass molecules. However, there are also absorption losses due to impurities such as transition

tiny particles of very pure SiO_2 . These particles are deposited on a rotating target mandrel in the form of soot. As the mandrel rotates and the burner moves back and forth over the mandrel, a soot "preform" is made which is typically about 1 meter long and 10 cm in diameter. The composition of the deposited soot particles can be varied by adding germanium tetrachloride (GeCl_4) and boron tetrachloride (BCl_3) with oxygen gas to increase or reduce the refractive index of the deposited material.

After making a sufficiently large soot preform, the preform is placed in furnace for melting the soot particles into a clear solid preform. This process is called sintering. Finally,

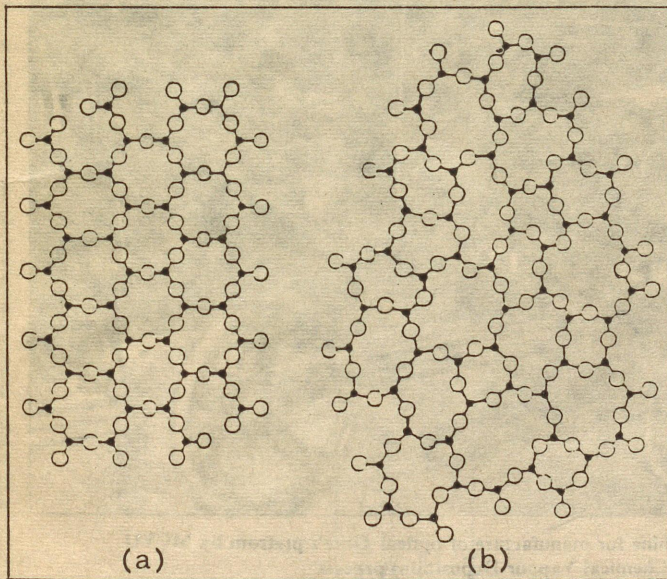


Fig. 1. Crystalline (a) and Glassy (b) Silica structures

$$\Delta = (n_1^2 - n_2^2) / 2n_1^2 \cong \frac{(n_1 - n_2)}{n_1} \text{ for } \Delta \ll 1 \dots (2)$$

λ is the wavelength of the light being carried by the fibre core. The total number of guided modes in a step-index multimode fibre is

$$N = \frac{1}{2} V^2 \dots \dots (3)$$

Another important parameter is the numerical aperture (NA) of the fibre which is defined as

$$NA = n_1 \sqrt{2\Delta} = \sqrt{n_1^2 - n_2^2} \dots \dots (4)$$

The importance of NA becomes clear when we realize that it is related to the maximum angle at which rays can be trapped in the fibre core and at

metals, OH ions, etc. The propagated light is also scattered by the phenomenon of Rayleigh scattering, similar to the occurrence of the blue colour of the sky.

Fabrication

Optical fibre fabrication is a two-step process. First, glass preforms are made from highly purified raw materials and then fibres are drawn from the preform. In one process of making preforms, silicon tetrachloride (SiCl_4) a volatile liquid is the starting material. The schematic diagram is shown in Fig. 4. Pure oxygen is bubbled through SiCl_4 and the mixture is burned in hydrogen to form

the target mandrel is removed and the preform is again heated to collapse into a solid rod. Optical fibre can be drawn from this preformed "solid rod". This process is sometimes referred to as the outside chemical vapour deposition (OCVD or OVD).

In another method, which is called the modified chemical vapour deposition process as shown in Fig. 5, pure oxygen is bubbled through optical grade silicon tetrachloride (SiCl_4), germanium tetrachloride (GeCl_4), and other doping materials through a high-quality silica tube (fabricated by some other process) about 1 meter long with 25 mm outer diameter and

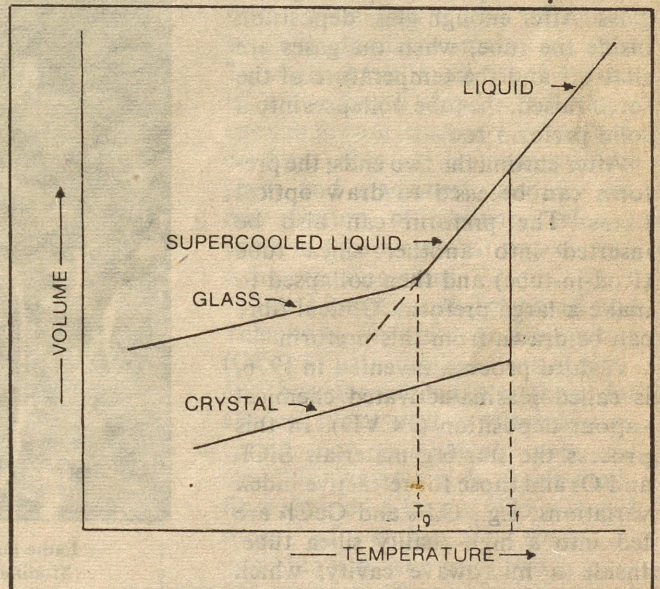


Fig. 2. Phase Diagram of Liquid and Solid States of a material

2 mm thickness. The tube is held in a glass-working lathe containing two synchronous chucks. The synchronous chucks rotate the tube and an oxyhydrogen burner torch is used to ignite the flowing gases to form pure glass which deposit on the walls of the tube downstream from the flame. The torch moves back and forth across the rotating tube. As the flame passes over the soot particles, it consolidates them into solid clear glass. In this way layer upon layer of new glass can be deposited inside the tube. The inner cladding layers are deposited first followed by the fibre core. Since the refractive index of the core glass is higher than the cladding, more GeCl_4 is passed in making core glass. After enough glass deposition inside the tube, when the gases are shut off and the temperature of the torch raised, the tube collapses into a solid preform rod.

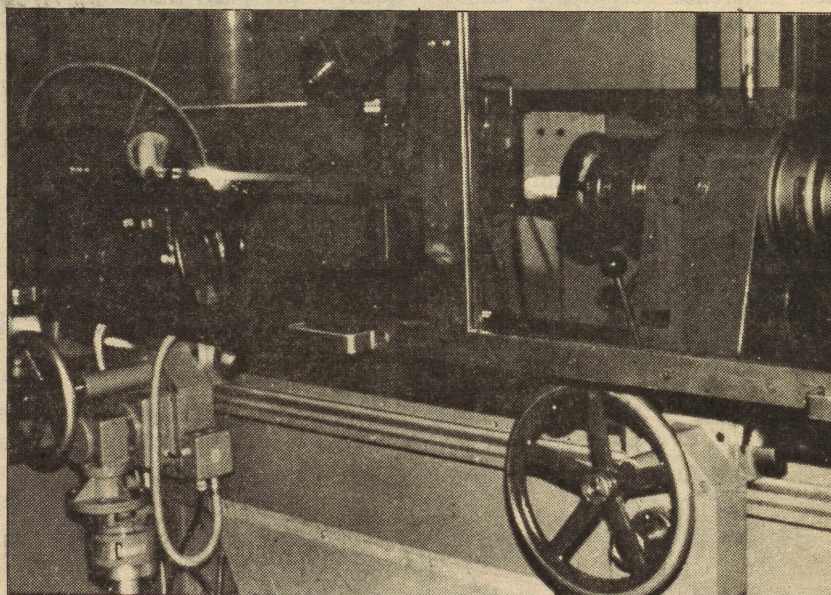
After cutting the two ends, the preform can be used to draw optical fibres. The preform can also be inserted into another silica tube (Rod-in-tube) and then collapsed to make a large preform. Optical fibre can be drawn from this preform.

A third process, invented in 1976, is called plasma-activated chemical vapour deposition (PCVD). In this process the starting materials SiCl_4 and O_2 and those for refractive index variations, e.g., C_2F_6 and GeCl_4 are fed into a high-quality silica tube. Inside a microwave cavity, which

moves to and fro along the tube, the reactions are initiated and deposition of the desired doped or undoped SiO_2 material occurs on the inner wall of the tube. In each pass of the microwave cavity a compact glass layer can be deposited. A pumping system downstream maintains a pressure of 10-20 mbar inside the tube and removes the reaction products such as chlorine or excess oxygen.

In 1977, a fourth process was developed in Japan which is called the vapour-phase axial deposition (VAD) process. Both multimode and single-mode optical fibres can be

manufactured by this method. When GeCl_4 and SiCl_4 are used in the VAD process, the refractive index distribution is determined by the surface temperature of the porous-soot preform where soot is deposited and the flow rates of GeCl_4 and SiCl_4 . The on-line control system measures the surface temperature distribution, determines the corresponding GeO_2 concentration and calculates the refractive index distribution. In this method, the surface temperature is kept between 500°C to 800°C . In the consolidation process, the porous-soot preform shrinks in both the



Lathe machine for manufacture of optical fibre's preform by MCVD (Modified Chemical Vapour Deposition) process.

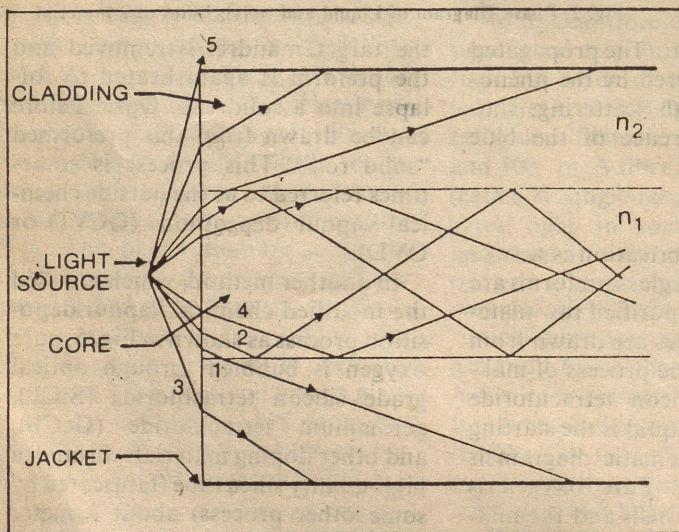


Fig. 3. Geometrical optics model of light Propagation in a Fibre

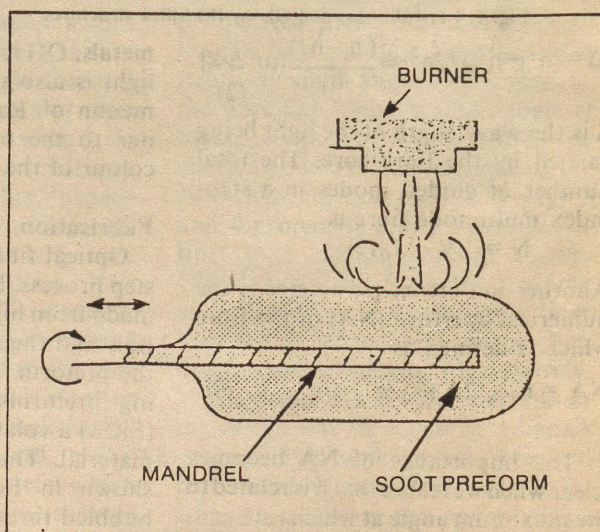
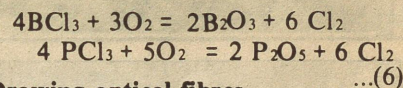


Fig. 4. CVD Glass Preform Fabrication



Drawing optical fibres

Having fabricated a clear silica-glass preform by any of the above described methods, one can now proceed to draw a fibre. Fig. 6 shows a simple schematic diagram of the fibre drawing tower. At the top of the drawing tower, there is a cylindrical oven, it is heated by electrical resistance (zirconia heater). The preform rod is fed into the oven at a controlled rate, where it reaches a sufficiently high temperature to soften. Fibre diameter can be measured by a suitable He-Ne laser-sensor method. Before winding the fibre on the collecting drum each piece of the drawn fibre passes over a pair of pulleys which apply a fixed amount of strain. This "proof test" is used to verify that the entire length of the fibre is strong enough for use in actual cables. Optical fibre cable can be made with the plant and machinery used for the manufacture of ordinary telecom cable in a conventional way or with minor modifications.

The International Telegraph and Telephone Consultative Committee (CCITT) with headquarters at Geneva has formulated standards for Optical fibres used in telecommunication. For example, the core and cladding diameters of single-mode fibre should be $10\ \mu\text{m}/125\ \mu\text{m}$ and those of multimode fibre $50\ \mu\text{m}/125\ \mu\text{m}$. At present two firms in India are manufacturing silica-based optical fibres and cables in collaboration with two foreign companies.

Further reading

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Sh. Gorachand Ghosh is with Research and Development Centre, Fibre Optics Project Hindustan Cables Limited 16/5, Hastings Road, Allahabad-211001

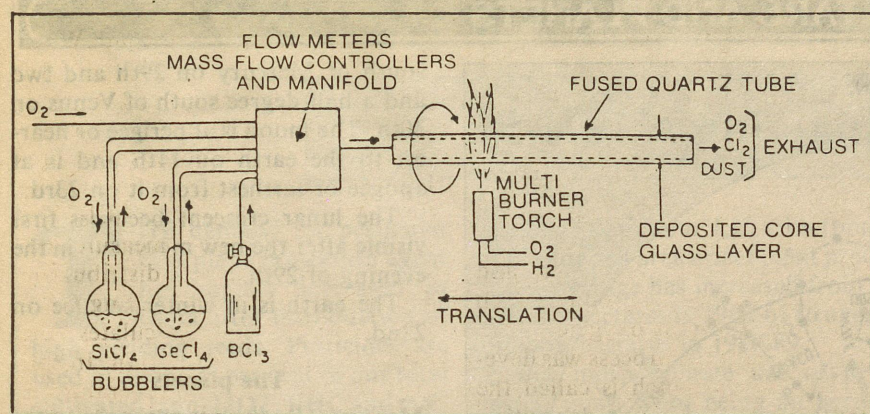


Fig. 5. MCVD Glass Preform Fabrication

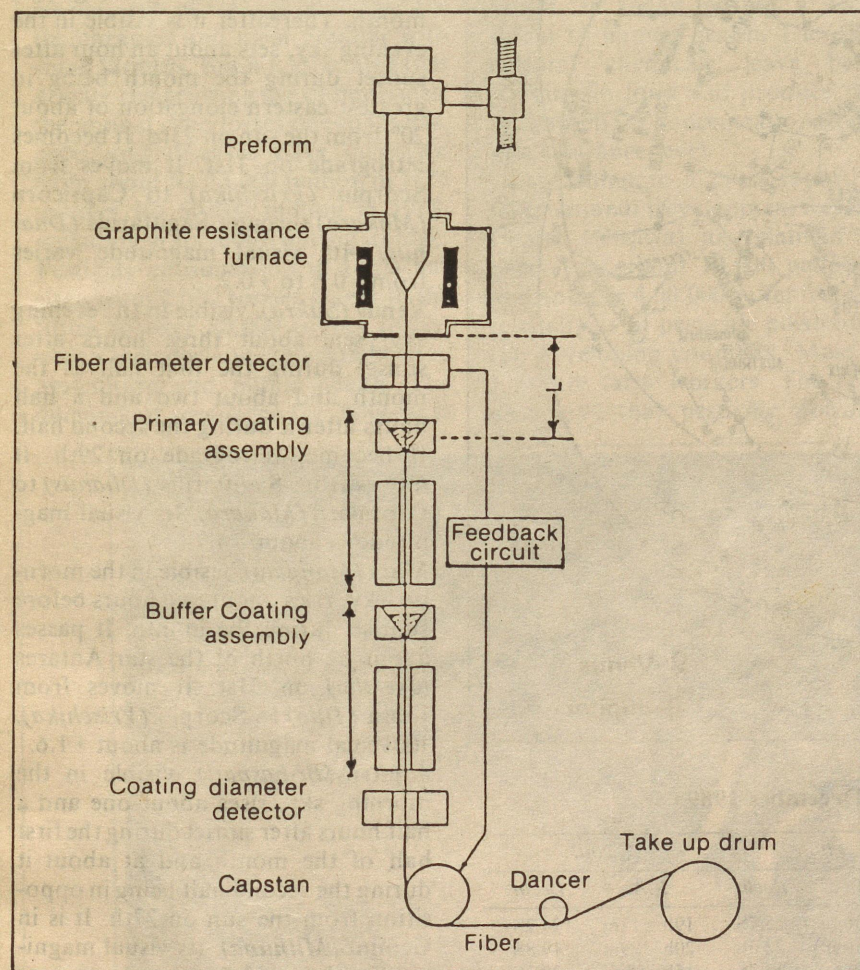
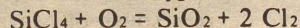


Fig. 6. Fibre Drawing Apparatus

axial and radial directions. This preform is generally elongated, overlaid with a silica tube, and drawn into a fibre. A feature of the VAD process is that it permits continuous long-length preform and fibre production. A 1500 mm long preform rod weighing 1.3 kg was made at deposition rate of 0.5 g/min over 48h. This pre-

form was made into a continuous 300 km long $50/125\ \mu\text{m}$ graded index fibre.

In all these processes, the following chemical reactions take place in the gas phase and the soot particles are smaller than $1000\ \text{\AA}$.



Pesticide Poisoning

THE demand for pesticides as a plant protection agent has rapidly increased in India after introduction of high yielding seeds. Pesticides are used in about 25 per cent of our total cultivated land. DDT, BHC and malathion, which account for more than 50 per cent of total production, are the cheapest and most popular with small farmers. But it is estimated that despite the growing use of pesticides, the annual crop losses due to insects, pests and diseases have increased from about Rs 33,000 million in 1976 to over Rs 60,000 million in 1988, including grain losses during storage. Pesticide consumption in India has risen from 2,000 tonnes a year in the fifties to over 80,000 tonnes today, which includes consumption both in agriculture and public health. The demand of pesticides for 1989-90 is

estimated at about 1.20 lakh tonnes. The cropped area under plant protection coverage has increased from 6.4 million hectares in 1960-61 to over 80 million hectares in 1988-89.

But indiscriminate use of pesticides, apart from being an occupational hazard in the developing world is today posing a serious threat to human health. These agricultural chemicals leave behind residues in food and produce ill effects when the concentration exceeds safe tolerance level.

According to a press report, the International Development Research Centre (Ottawa) has claimed that every year about 10,000 people die and another 4,00,000 suffer from various effects of pesticide poisoning in the developing countries. Most victims are farm workers. The report also says that pesticide poisoning

has overtaken endemic diseases in the third world countries. The alarming rise in the number of deaths from pesticide poisoning is attributed to increasing number of toxic chemicals and their large-scale use without proper testing of their toxic properties. A number of such chemicals banned in western countries are dumped on the third world.

Despite restrictions and regulations on pesticide use, India accounts for one-third of pesticide poisoning cases in the third world. Farm labourers employed for spraying operations are the worst affected, a majority of them get exposed for long periods. Cases of blindness, cancer, deformities, diseases of liver and nervous system from pesticide poisoning have been identified in the cotton growing districts of Maharashtra and Andhra Pradesh.



Pesticide spraying

ENVIRONMENT

Aluminium phosphide is the most effective fumigant for protecting foodgrains during storage. This chemical is a biocide and causes human poisoning on ingestion. A study by doctors of the All India Institute of Medical Sciences in 1988 shows that there is widespread aluminium phosphide poisoning in north India. There were as many as 114 cases in Rohtak (Haryana), 55 in U.P. and 30 in M.P. It was suspected that there may be more cases which remained unreported. Earlier, 28 deaths were reported from Udaipur (Rajasthan). The symptoms of aluminium phosphide poisoning are restlessness, vomiting, circulatory collapse and unconsciousness. Death occurs within four to six hours of intake.

106 deaths were reported from Kerala in late seventies due to consumption of wheat flour and sugar contaminated with the pesticide Folidol from leakage during shipment from Bombay to Cochin. Poor harijans in Chickmanglur district of Karnataka were afflicted with severe paralysis after eating crabs from paddy fields treated with pesticides.

Use of a number of such agrochemicals identified by the World Health Organisation (WHO) as highly toxic or hazardous has been banned or restricted in many countries. These include DDT (banned in USA, Australia, USSR, Poland, Switzerland and under voluntary restriction in the UK), BHC (banned in USA, Japan, USSR, Denmark, Sweden, France, West Germany), Aldrin (banned in USA, UK, West Germany, Sweden, Canada, Italy, USSR, New Zealand), Chlordane (banned in USA, UK, Argentina, Turkey, Sweden, Denmark, Bulgaria, Italy), Endrin (banned in USA, UK, Argentina, Japan, Mexico, West Germany, Finland), Methyl parathion (banned in Italy, Japan, Spain), Toxaphene (banned in Argentina, Finland, West Germany, Italy), Heptachlor and Lindane (banned in western countries). DDT, BHC and ethylene dibromide have been characterised as carcinogens. BHC is two-and-a-half times more

toxic than DDT, and a dose of 100 mg is enough to kill a rat of one kg body weight. Methyl parathion is 20 times more toxic than DDT. Ethylene dibromide causes cancer, infertility and deformity in newly-borns. Canada and UK have banned its use.

Use of other chemicals such as the herbicide, 2,4-D and paraquat is under review in the USA as 'suspected chemicals'. Aldicarb, carbofuran, chlorfenvinfos, dichlorvos, endosulfan, monocrotophos, oxydemelon, phorate, and phosphomidon are some other chemicals listed as hazardous which have been restricted for use in some countries. Indonesia banned all the 57 pesticides used for rice crop as they saved less crop and damaged more humans.

Even though the coverage of crops by pesticides in India is hardly 25 per cent of total cultivated land, the residue problem has become quite alarming. According to a report of WHO and UN, the level of chlorinated pesticides intake is higher among Indians than among people of other countries. A good amount of pesticide residue has been reported in various food commodities like wheat, rice, pulses, groundnut, fish, meat, butter, ghee and cheese. An average Indian's daily diet contains about 0.27 mg of DDT and the level of accumulated DDT in the body tissue of an average Indian is the highest in the world, varying between 12.8 ppm and 31.0 ppm. Delhi's citizens have the highest level of pesticides in their body fat in the world. This was displayed in a "Better Environment Exhibition" in Delhi in 1988. Varying levels of DDT residue in different foodstuffs have been reported, for example, 1.6 ppm-17.4 ppm in wheat; 0.8 ppm-16.4 ppm in rice; 2.9 ppm-16.9 ppm in pulses; 3.0 ppm-19.1 ppm in groundnut; upto 5.0 ppm in vegetables; and 68.5 ppm in potatoes. Analysis of cereals, pulses, milk, eggs, meat and vegetables showed that more than 50 per cent of the samples tested contained pesticide residues, and in more than 30 per cent, residue exceeded tolerance limits prescribed by WHO. DDT and BHC are the most common residues,

but substantial quantities of malathion and lindane residue have been found in foodstuffs collected from Calcutta markets.

In 70 per cent of the tested samples of bottled milk in Maharashtra, amount of DDT and dieldrin was 4.8 ppm-6.3 ppm and 1.9 ppm-6.3 ppm, respectively when the permissible limit in milk for both is 0.66 ppm. The average level of dieldrin residue in the milk sold by vendors in Bombay was found to be as high as 96 ppm. The levels of DDT and BHC residues in butter were on average 3.6 and 2.6 ppm, respectively; tolerance limit being 1.25 ppm. Babyfoods from Punjab, Gujarat and Bombay contained from 1.52 ppm to 2.12 ppm of DDT. Oilseeds, oils and desi ghee were quite high in pesticide residues, as were meat, fish and poultry.

The continuous use of these poisonous chemicals have also affected ground water sources through seepage into the soil. As a result, rivers, streams and ponds have become highly polluted with these harmful chemicals. Drinking water from ponds in Hassan district of Karnataka was found to contain 0.02 ppm to 0.2 ppm of pesticide. The level of BHC in water taken from Cauvery river (Karnataka) was over 1,000 ppb (parts per billion) and of methyl parathion 1,300 ppb. The Yamuna water in Delhi contained high DDT residues. Many forms of aquatic life like fish, birds and other animals have been greatly affected by such pollution.

There is need for adequate training on safe use of pesticides for which a scientific approach has been lacking. To minimise hazardous effects, attempts are being made these days to develop plant-based pesticides. The neem tree grows wild in Asia and Africa, and holds great promise of becoming a major source of natural insecticide. An insecticide from neem is being manufactured both as a dust and spray in the USA.

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You don't need a ballot paper or a ballot box
to cast your vote. Just press a button

MAN OR MACHINE: WHO COUNTS THE VOTES ?

BAL PHONDKE

IS it a gift horse which can be ridden to drive away all the ills that afflict the present system? Or is it a trojan horse harbouring inside hitherto unseen evils capable of wreaking havoc with the entire set up? These questions have suddenly become relevant in regard to what was till the other day an innocuous device. The electronic voting machine considered so far to be capable of helping the harassed personnel engaged in the conducting of the world's biggest battle of the ballot is, all of a sudden, being looked upon with suspicion.

It is not as if the voting machine is totally new and is being introduced for the first time. It was first tried on an experimental basis in 50 polling stations in the 70-Parur Assembly constituency in the general election to the Kerala legislative assembly in 1982. Enthused with the trouble-free use it was pressed into service again later that year in Nagaland. Subsequently, it has been tried out, albeit on a limited scale, in different parts of the country ranging from Karnataka and Andhra Pradesh in the south to Tripura and Arunachal Pradesh in the north-east. It has been used in the totally urban constituencies of the Delhi Metropolitan Council as also

among the predominantly rural electorate in some districts of Bihar. In all these areas the electronic voting machine had proved simple to use and bereft of any complications. With its help it was possible to curb many of the malpractices and to count the votes at a significantly faster rate.

THE machine is made up of two independent units connected together with a cable which is normally 5 meters long but can be extended as per the requirement. One of the units is the ballot machine. This is placed inside the polling enclosure. It carries the panel of names and symbols of the contesting candidates. A maximum of eight candidates can be accommodated in an unit. But by addition of more such units and connecting them in parallel arrangements can be made to serve constituencies fielding upto a maximum of 64 candidates.

In front of the row listing the name and symbol of a candidate is placed a push button. To cast his vote, a voter has to simply push the button against the candidate of his choice. This switches on immediately a pilot lamp indicating that his vote has been duly registered. It also prevents recording

of another vote until the machine is readied for the next voter.

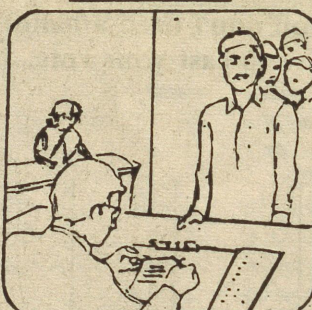
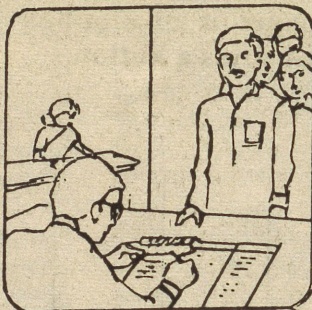
This resetting of the ballot unit is carried out by the polling officer who mans the control unit placed outside the polling enclosure. This unit can control all the ballot units connected to it. It consists of a microprocessor. When a button on its panel is pressed to reset the ballot unit, a visual indicator is switched on. When the indicator pilot lamp on the ballot unit gets lit as a result of a voter casting his vote an audio signal, an alarm, on the control unit is sounded. The polling officer then knows that the vote has been cast though he cannot know in whose favour that vote has gone. The moment that particular voter comes out of the enclosure he resets the ballot unit getting it ready for the next voter.

THIS arrangement thus ensures that each voter can cast only one vote. Even if the voter presses another switch after the pilot lamp is switched on the machine refuses to record it. Only after the polling officer resets the unit can it accept another vote. Likewise, if a voter presses two buttons simultaneously the machine does not accept it and no vote is recorded. The built-in soft-

Old System

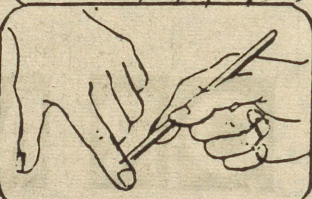
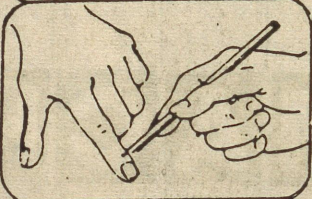
New System

Voter is identified as per the voters' list



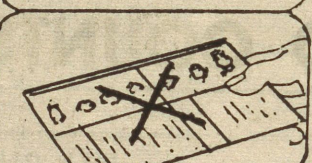
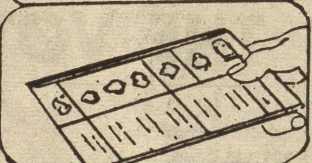
The same procedure is applicable

To prevent double voting, voter's finger is marked with indelible ink



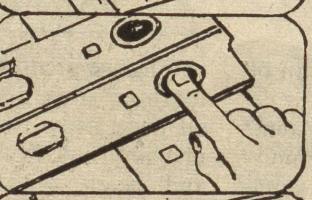
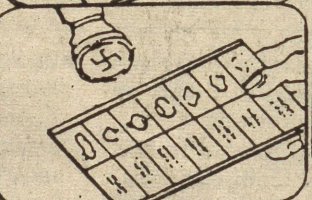
The same process is applicable

Ballot paper is given to the voter



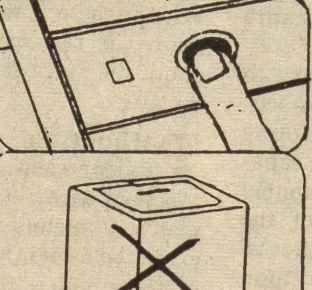
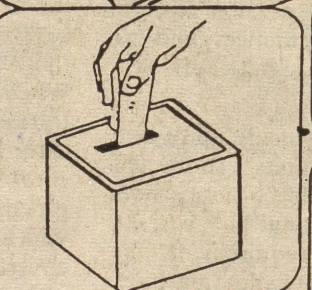
There will be no ballot paper

The voter casts his vote by printing a cross-mark against the name of the candidate of his choice



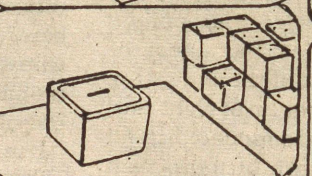
The voter presses a button to cast his vote

The ballot paper is placed in the ballot box



The casting of the vote switches on the indicator lamp

Ballot boxes are sealed and transported



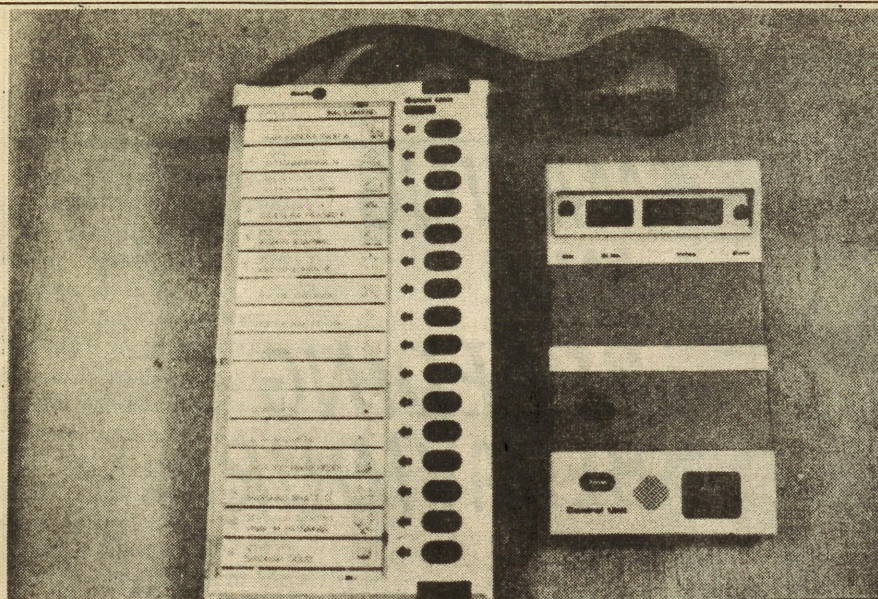
Ballot box is not required

ware ensures that only one vote is recorded at a time.

It is thus clear that incorporated in the machine are safeguards against several problems that arise in the present system. Firstly, it eliminates

the need of printing ballot papers in large numbers and keeping them in safe custody. Quite often, illiterate voters print the cross mark in an ambiguous manner or simultaneously against more than one candi-

dates. This is prevented by the machine. Since there is no paper and no pen the graffiti that has become common of late would also not find any place. Fake or spurious ballot papers interfering in the rightful pro-



The electronic voting machine. The ballot unit (left) bears the names of candidates with their respective party symbols and a push button against each name. The control unit (right) registers the ballots cast and also reads the ballot unit for the next voter to cast his ballot

cess of the polls also cannot play any role.

NOT only is the polling process made simpler and safer but the subsequent counting procedure is also made quicker by the control unit. This has a display much like that in a calculator or a cash register. Each unit has a four digit display implying that it can record a total of 9999 votes. The built-in memory of this unit has upto 64 different pockets to accommodate that many candidates. At the end of the day the machine can be sealed and transported to the counting centre. The seal can be opened there and merely by pressing different buttons, the total number of votes polled as well as the number cast in favour of different candidates can be found out.

The need for physical and manual verification of the number of ballot papers inside a sealed box is thus eliminated. So also the necessity of ensuring that the vote cast is valid. Even when a recount is required—with the machine such instances would be significantly fewer—it would take very little time since all that would be needed would be to recall from the memory the different numbers.

The problems that arise from hijacking of ballot boxes, stuffing

them with counterfeit ballot papers cannot now arise. Even if a control unit is snatched away during transport it would not help the person indulging in the nefarious activity. He might succeed in breaking the seal but cannot make any additions or changes in the electronic memory.

If the voting machine appears to offer all these advantages, why is it that the election commission is being urged by some political parties as well as social workers not to use it in the forthcoming elections? It is mainly because of two developments that have occurred in the recent weeks.

FIRST, during the crucial vote in the Rajya Sabha on the Panchayat Raj Bill the electronic vote registering machine failed not once but twice. And second, at a public meeting a computer expert demonstrated how certain computer programmes can be devised which would force the electronic memory record data in a pre-ordered manner. As a result of these two events the credibility of the voting machine is being doubted.

That, however, seems to be an overreaction prompted no doubt by the emotionally surcharged atmosphere which usually engulfs an election campaign.

There is no denying that the machine failed at a very critical juncture in the Rajya Sabha. Even so, it would be most unfair to brandish it on the strength of that one instance. To assess its reliability in an objective manner, a statistical evaluation would have to be undertaken. Indeed one such assessment is available.

In 1983, the machines were used in all the 150 polling stations of the Shadnagar assembly constituency of Andhra Pradesh. To meet the eventuality of machine failure, the electoral authorities had kept ready printed ballot papers as well. Not one had to be used. Close to a lakh voters had exercised their franchise. Yet, the poll recorded not one invalid vote. Nor did any candidate voice any complaint about even malfunctioning of the machine let alone its failure.

LIKEWISE the public demonstration by the computer expert mostly shows that a programme can be devised to record votes in a pre-determined fashion. This is known. Today computer programming has reached such advanced sophisticated level that a programme can be written to play a difficult game of chess.

That, however, does not provide an unequivocal evidence that the machine can be made to do a particular candidate's bidding. The machine employs ROM (Read Only Memory) type of memory. The chip for the same with the incorporated programme is imported. It is not easy to erase or alter that programme and replace it with the desired one unless the manufacturer, members of the election commission, and the chip maker, all are in collusion with the candidate. Moreover, since the list of candidates does not follow a single pattern in relation with party affiliation each single machine would have to be programmed differently if the elections are to be rigged.

Nonetheless, in the heat of a ballot battle such rational thoughts may not find favour with those who matter. And the forthcoming election may not go down in history as the first ever electronic election. If that happens, however, the blame cannot be apportioned to the poor machine.

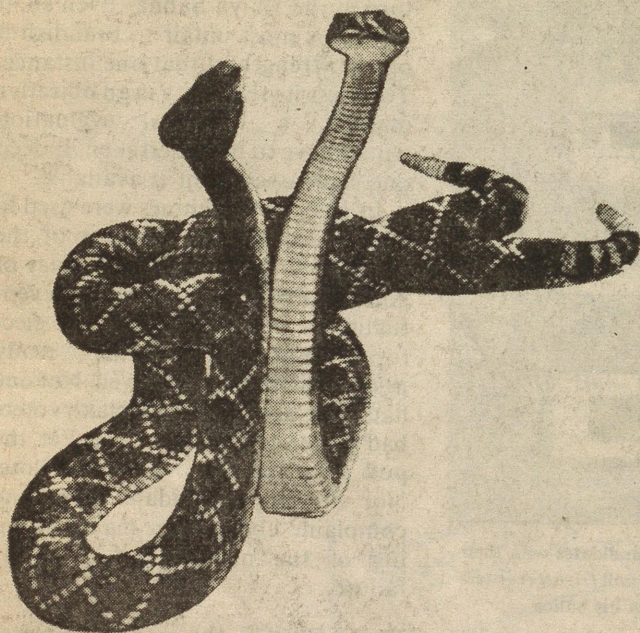


Fig. 1. Male and female rattle snake curl their hind ends together before copulation

MATING AND BREEDING BEHAVIOUR OF SNAKES

THE reptiles surviving today belong to four major groups. The testudines (turtles, tortoise and terrapins), the *Crocodylia* (crocodilis and aligators), the rhynchocephalia (the unique New Zealand tuartra) and the squamata (lizards and snakes). Of these, the snake branch of the squamata is the most recently evolved; it did not appear until well after the start of Cretaceous period (130 million years ago). Snakes are found all over the world except Arctic, New Zealand and Ireland. There are about 2,500 species of snakes all over the world. Although a considerable amount of evidence has been collected, little is known about the social relationship between snakes of the same species. Captive snakes rarely breed and field observations are also scarce. Little experimental work has been carried out and anecdotes are generally relied upon. As a result, certain aspects of the reproductive behaviour of snakes are under a cloud of mystery. Snakes do show sexual dimorphism, courtship and mating behaviour. They also show parental care and live as normally as any other living creature.

Sexual dimorphism

Owing to the lack of proper vision, snakes show secondary sexual dimorphism. In some species like *Viper berus*, the adder, male and female differ from each other in colouration while in *Madagascar* tree snake of genus *Larguna*, the head of male and female is different. Sexual dimorphism is also exhibited by sea snake of genus *Lepemis*. Males of this species have short thorny scales. However, there are certain differences in weight and size of male and female. Females are generally heavier and longer than males. The males, on the other hand, have usually a long and curved tail. The base of the tail is thicker in male than in female because male copulatory organs when not in use retract like finger stall turned inside out within the root of the tail. Like lizards, snakes also possess two penis-like organs called hemipenis. In contrast to a true penis, the hemipenis does not possess a seminal duct but simply a groove along which sperm is passed during copulation.

In snakes, gonads are assymetrical which is an adaptation to their elon-

gated body form. The paired testis and ovaries lie in the posterior part of the abdominal cavity but still in front of kidney. The spermatozoa produced in the testis travel through the gradually tapering seminal duct. The duct becomes filled with spermatozoa during the reproductive season. The ova, which are the female generative cells, ripen and pass freely into the body cavity where the follicle surrounding them bursts. The ova are then transferred to oviduct.

Courtship and mating behaviour

Little information is available on the genetically controlled rhythms which control the sexual activity of snakes. Probably, external factors such as climate, temperature, effect of light and availability of food, influence their reproductive behaviour and stimulate the mating urge in both the sexes.

Snakes are most likely to be in breeding condition immediately after hibernation. However, time and duration of this period vary depending upon geographical circumstances and species. In moderate and sub-

tropical regions, snakes spend a definite period in hibernation. They go for mating in spring immediately after waking up from the winter sleep. As they stay together, search for a mate is spared. They join in clusters in characteristic 'snake-ball' pattern and copulate simultaneously.

In northern parts, short summer often does not allow sufficient time for the development of offsprings. For example, the Adder (*Viper berus*) or rattle-snake of Canada mate in autumn so that their embryos are able to remain in the body of the female over the winter. In tropical region, the situation is different. Here snakes spend a definite part in aestivation so as to survive in arid region. As the mating period also occurs during this time, the mate is easier find.

On the other hand, there are some species which are almost unaffected by season. For example, the Indian cobra (*Naja naja*) mates almost throughout the year, i.e., between December and August.

The male plays an active role in courtship and mating while the female remains almost entirely passive except that she oozes out a special scent through her skin or anal organ. The male follows the coiling

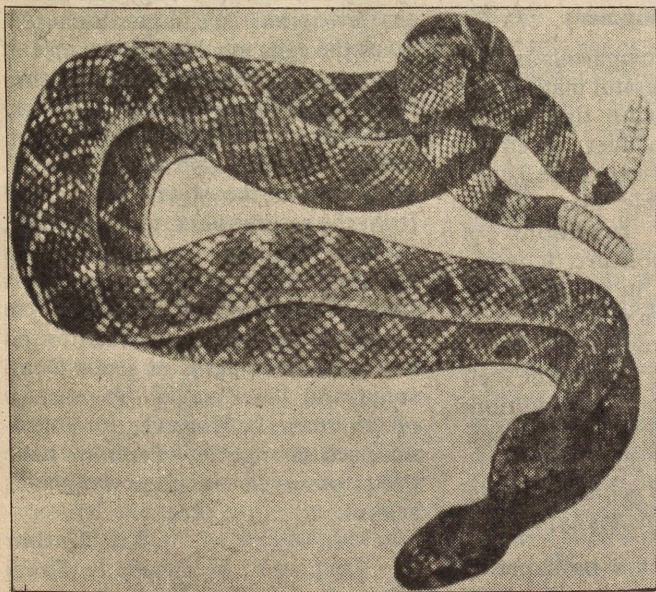


Fig. 2. Mating is accomplished by male snake throwing its body loop across the female



Fig. 3. Female of madagascar tree boa (*Sanzinia madagascariensis*) giving birth to a young snake (viviparity)

movement of the female and adapts his body to her. Male viper and pit viper perform courtship by characteristic nudging and jerking. In boas and pythons, the male scratches the back of the female. In King cobra (*Ophiophagus nannah*), the male flicks its tongue actively over the neck and head of the female (Figs 1 and 2).

An unexplained phenomenon that occurs in many species of snake during mating season is 'Combat-dance'. Two male snakes meet, rear up, intertwine and use the weight of their bodies to put the other off balance. There is no biting or angry hissing but one snake eventually flees. The strange thing about the combat-dance is that at present it appears to have no obvious function. The snakes do not seem to drive other males off nor do they establish a dominance hierarchy. However,

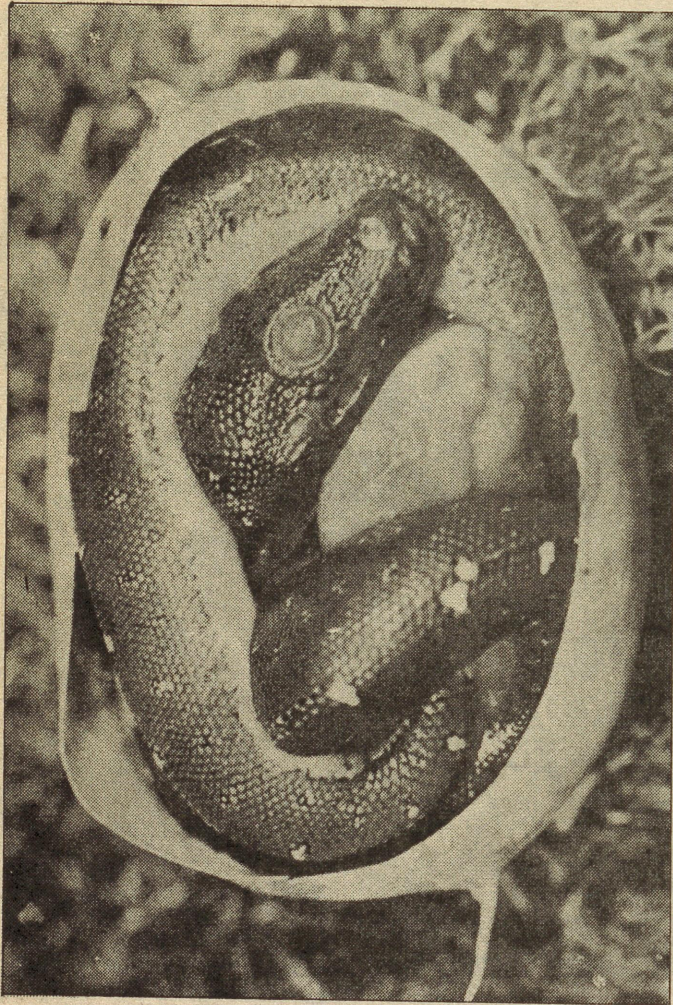


Fig. 4. Egg of green python (*Chondropython viridis*) which was opened shortly before hatching

some scientists believe that it is due to female rivalry or misidentification by a male. All that can be said at present is that any ceremony as obtrusive and conspicuous as the combat-dance must play an important role in the social life of snakes. Sometimes, male snakes have also been observed to mate with a dead female as females are particularly passive.

Once the copulation has been achieved, the mating pair lie together for at least one to two hours. Generally, they remain in this condition for six to twelve hours. During mating the male inserts one of the hemipenis into the female cloaca and fixes it inside the female's body. As a result the female cannot escape. Copulation may be repeated several times and may be continued for a few days or weeks.

Breeding and development

Most snakes are oviparous as they lay eggs. After successful mating, the fertilized eggs develop first in the lower part of the oviduct. When the time comes to lay eggs, the snake seeks out a suitable place which offers favourable conditions of temperature and moisture. It might be beneath a stone, in a hollow tree stump, among rotten vegetation or in a loose soil. Some snakes have a tendency to retain their eggs inside their body if the environmental conditions are not favourable! The embryonic development takes place inside the body. Snakes of the genus *Caronella* are good example of this type.

The eggs of snakes have perchmant-like shells and there is a large amount of yolk inside to provide

food for the young. Most of the snakes coil round the eggs after they are laid. If the eggs are laid soon after mating, hatching time is more since the embryonic development is completed outside the body. On the other hand, when the eggs are retained inside the body for a considerable period, like in snakes of *Caronella* genus, the hatching time is reduced. The embryonic development is completed inside the body. The speed at which the eggs reach hatching time also depends on temperature. They develop faster in warmer conditions. By the time the baby snake has grown large enough to hatch, it has developed an egg tooth at the tip of the upper jaw that plays a vital part in hatching. It enables the young snake to get out of the shell.

But independent of the climatic conditions, there exists several families of snakes which show viviparity (Fig. 3). The vipers and pit vipers are predominantly viviparous. Most sea snakes of family Hydrophiidae are viviparous. They give birth to young ones. These snakes retain their eggs inside their oviduct upto a very late stage of development so that they are hatched inside and then laid. The viviparity has an advantage for snakes that live in hostile climates because it gives the eggs much better chance of an even environment than they would get, if laid. The mother's body acts as an incubator. Snakes living in coldest climates also adopt viviparity. However, the eggs take their food from the reserve yolk; in some cases, the placenta-like structure develops for the food of the embryo. This interesting analogy with mammalian reproductive system has been found in Australian elapids of genus *Denisonia* and black snake (*Psendechis porphyriacus*). However, no pronounced change in behaviour have been observed in the viviparous snakes.

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Migration of Mottled Emigrant Butterfly



PEOPL**E** are familiar with the migration of birds of various kinds, viz., Siberian cranes, babblers, doves, ducks. But the migration of insects in swarms is feared not only for the associated superstitious beliefs like ill-luck, carriers of human souls, but also for the destruction of crops that it causes. The earliest record of insect migration could be traced back to the Biblical scriptures. In the past more than 100 years, there has been scientific documentation of migration by various insect species viz., locusts in Africa, mosquitoes in the Arctic and the tropics, butterflies, moths, beetles, bugs and dragonflies in many parts of Europe and North America. In October 1958, for instance, the swarm of desert locusts covering 1000 square km of Ethiopia completely devoured vegetation in the area. A similar thick swarm in Nigeria blotted out the sun and created a deafening roar like a mighty waterfall. India also witnessed locust swarm in the early 1960s which were fortunately contained on their arrival in the north-western states. Besides affecting vegetation, insect swarms carry diseases and affect public health. In August and September last year, the mottled emigrant butterfly (*Catopsilia pyranthe* Linn.) migrated in millions from north to south over Rajasthan, Gujarat and other parts of western India and as a result has aroused the interest of many people. The phenomenon of migration of the mottled emigrant butterfly could be compared with the well-known cases of insect migration in the past.

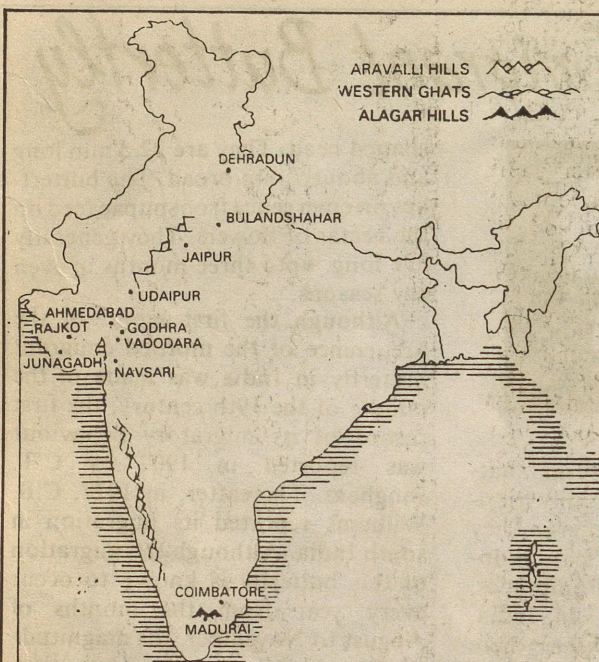
Catopsilia spp., to which the mottled emigrant butterfly belongs,

are the cosmopolitan, diurnal butterflies belonging to the family Pieridae of the order Lepidoptera. They are distributed in Africa, Indo-Australia, South-China Philippines, Burma and Sri Lanka. In India, besides *Catopsilia pyranthe*, there are four other species, viz., *Catopsilia crocale* (Cramer), *Catopsilia florella* (Fabr.) *Catopsilia pomona* (Fabr.) and *Catopsilia scylla* (Linn.). Although *C. crocale* is restricted to the hills of Himalayas in the east and some other regions of North India, it has also been found in south India. These are strong fliers but are not migratory in behaviour. The mottled emigrant butterfly is however the most commonly found butterfly of this group in the country.

Butterflies of the mottled emigrant are chalky-white or greenish-yellow in colour with a wing-expanse of 60-70 mm. They are found in congregation with wings folded vertically over the abdomen while resting on leaves. The adult female butterfly can lay about 500 eggs. The eggs are laid singly on the upper or lower side of leaves. Eggs are spindle-shaped which hatch in 3-4 days. Young larvae feed on the new, succulent leaves of *Cassia* spp. which is the most preferred host-plant. The bright green colour of larvae acts as a camouflage against enemy attack. Full grown larvae are about 41 mm long and 5 mm broad with distinct black and white stripes and tubercles on the ventral side. After 7-9 days of larval life, they moult into a short pyramidal shaped pupae which hang on to the twigs of plants. These chrysalis are dark green with yellow dorsal line on the thorax and short perfectly straight snout-

shaped head. They are 22.5 mm long and about 7 mm broad. The butterflies on emergence from pupae feed on the nectar of flowers. They generally live long, upto three months in even dry seasons.

Although the first report of the occurrence of the mottled emigrant butterfly in India was made in the middle of the 19th century, the first record of its migratory behaviour was reported in 1902 by C.T. Bingham. Thereafter, in 1927, C.B. Williams reported its migration in south India. Although the migration of this butterfly is known to occur every year from the months of August to November, the magnitude of its number last year was astonishingly high. The favourable environmental conditions along with the adequate availability of food plants, especially *Cassia* spp., must have contributed to the high level of multiplication of butterflies. Of importance is also the fact that Gujarat and Rajasthan recorded very high rainfall during monsoons as compared to the drought years of 1985-1987. Such environmental conditions must have favoured high rate of breeding often in quick succession before forming a large population of butterflies. However, once a large population is formed, what initiates these butterflies to take up migratory flights instead of dispersing and what sustains such long distance unidirectional flights is difficult to guess. Unfortunately, detailed information on the migratory behaviour of the mottled emigrant butterfly is not available. Studies carried out in 1971 by D.F. Owen on the African counterpart *C. florella* showed that oviposition behaviour of the butterfly is closely associated with the migration behaviour. The female butterfly always lays eggs only on the new succulent leaves of *Cassia* spp. so that the young larvae feed well on such leaves. The new leaves on plants are produced seasonally; with each species of *Cassia* producing new leaves only at the restricted time of the year. As a result, female butterflies migrate



Locations of migratory swarms of the mottled butterfly

from species to species as season changes thereby helping in the migration process. Like its African counterpart, the mottled emigrant butterfly must have been migrating towards south mainly in search of green succulent leaves of *Cassia* spp. It is also seen that during August and September, there is a lot of variation in day/night temperatures and the rains cease by early September in north India. Comparatively, more favourable weather conditions still prevailing in south help these butterflies in the course of migration. This contention is based upon the findings of G. Talbot who observed in 1939 in *Fauna of British India* that *Catopsilia* is highly partial to wet conditions for its multiplication. Studies carried out on a related species *C. crocale* at M.K. University by M.S.M. Christopher in Madurai showed that butterflies oviposited in number and time which synchronised with the rainfall and availability of larval food resource. The young plants of *Cassia alata* are preferred for egg laying. Even amongst *Cassia* spp. butterflies showed high level of preference for certain species of plants thereby specializing in monophagy. The fragile nature of savanna and peculiarity of host selection by these butterflies have created conditions forcing them to adapt to migratory behaviour in their life cycle.

Another reason of migration could be the onset of unfavourable winter conditions in north India. Thus, migratory flights of insects are the adaptive escape mechanism in place of diapause like (quiscent) resting conditions that these creatures have evolved. How do they predict the onset of unfavourable weather conditions and whether migration is actually a result of these conditions is yet to be resolved. And, also, it is not clear as to how they or their offsprings immigrate once the weather conditions are back to normal. Although studies on the emigration and immigration patterns are more or less complete in birds and to some extent in well-known insects like the Monarch butterfly, little is known about the immigration flights of the mottled emigrant butterfly. Studies carried out by G.F. Cockbill at Salisbury, Rhodesia, however, showed the immigration of *C. florella* on much smaller scale about six weeks after large-scale emigration in December and early January. It is also possible that, like *Pieris* spp., the idea of emigration and immigration is not compatible with the mottled emigrant butterfly as its name suggests.

Studies carried out at Anti-Locust Research Centre, London, in the early 1960s have shown that most of insect migrations are carried by

winds. The strength and direction of winds determine the rate of migration while insects simply beat wings till descent. Besides, other weather conditions like convection currents may also contribute towards the rate and height of migration. The role of winds in migration has, therefore, eliminated the need of postulating the basis for orientation and navigation during migration. However, in 1968, R.R. Baker of University of Bristol, U.K., suggested that butterflies maintain their flight direction keeping themselves at a constant angle to the sun, which explained their straight path of migration over a large area.

While environmental conditions help insects in migration, what appears to be common to all migratory insects, as J.D. Kennedy of Agricultural Research Council, Cambridge, attributes, is an intense "locomotory drive" that sets them off on migratory flights. This drive, according to C.G. Johnson of Rothamsted Experimental Station, Harpenden, U.K., is closely associated with the internal physiology and, at least in female insects, closely associated with their sexual immaturity. This association does not appear to be true in butterfly migration and for that matter in case of the mottled emigrant butterfly which was found to oviposit in twilight conditions during migration. The role of neuro-endocrine system in relation to internal and external physiology of migratory insects remains largely unclear. Like birds, it is likely that the hormonal changes as a result of perception of environmental conditions could possibly be responsible factors for undertaking migration. Besides, the behaviour modifying chemicals, especially aggregation pheromones, produced by insects themselves at the initiation of hormonal changes must be helping insects to remain in swarms. Unfortunately, many such facets of insect migration are shrouded in mystery and this, therefore, remains highly absorbing subject of intense research.

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Nehru's

Vision of Science

Subodh Mahanti
Ashok Jain

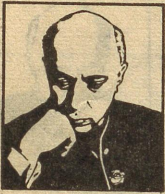
PANDIT Jawaharlal Nehru was greatly responsible for creating a sound infrastructure in the form of scientific and technical institutions and trained personnel for effective pursuance of science in post-independence India. He was also instrumental in instilling the spirit of science in the planning of Indian economy. To Nehru, as he said while delivering the presidential address at the third meeting of the general body of the Indian Institute of Public Administration, New Delhi on April 6, 1957, "Planning is science in action. Planning has to be flexible; it has to be wide awake and alert." Again it was Nehru who was responsible for establishing the heavy industries or the so called basic infrastructural industries.

Nehru developed personal rapport based on mutual respect with the leading Indian scientists of his time. His first real contact with scientist was with Professor Meghnad Saha, who was instrumental in persuading Subhash Chandra Bose to set up the National Planning Committee in 1938 under the chairmanship of Jawaharlal Nehru. Another scientist who came into Nehru's early contact was Professor P.C. Mahalanobis, the eminent statistician. Professor Mahalanobis also offered his co-operation to the National Planning Committee.

Perhaps, being the Prime Minister or executive head of the State it was but natural for Nehru to be involved in all the major developments including the developments in science and technology in the country. But Nehru's involvement with science was certainly something more than mere official involvement. Indeed, his unflinching faith in science and deep association with science and scientists in India could only become possible as a result of a strong commitment to science and all that it represented. It can be said without any hesitation that he said some of the finest things ever said in praise of science. Nehru considered himself a worshipper at the altar of science. While addressing the National Academy of Science at Allahabad on March 5, 1938 he said, "Yet inspite of the tumult and movement that have surrounded me, I do not come to you wholly as a stranger. For I too have worshipped at the shrine of science and counted myself as one of its votaries."

NEHRU'S association with science started in his childhood, when his tutor Ferdinand T. Brooks introduced him to science. As Nehru later recalled, "Brooks also initiated me into the mysteries of science. We rigged up a little laboratory and there I used to spend long and interesting hours carrying out experiments in elementary physics and chemistry." At Harrow, which he entered for schooling in July 1905, he studied arithmetic, algebra and geometry along with other subjects. After spending two years at

His unflinching faith in science and deep association with science and scientists in India could only become possible as a result of a strong commitment to science and all that it represented



Nehru believed that with the advancement of scientific knowledge, the traditional beliefs, superstitions based on religious dogmas would be removed from the society

Harrow, Nehru went to Cambridge (August 1907) where he studied at Trinity College and chose the Natural Sciences Tripos, his subjects being chemistry, geology and botany. Though Nehru abandoned active scientific studies when he left Cambridge in 1910, he continued to study the writings of the thinkers and philosophers of science which gave him a wide perspective and interpretation of science as a rational approach for solving many social problems.

While addressing the Cultural Conference of Students at Calcutta on January 3, 1939 he said, "There cannot be any doubt that we cannot progress nationally or individually unless we profit by the lessons of science.... We have to think presumably not of science as applied in industry or politics, but science in its wide connotation. What is science? It is a certain way of seeking the truth. It is a certain empirical way whereby we get prepared to reject anything if we cannot establish or prove it."

THROUGHOUT his career as a statesman, he urged his countrymen to adopt scientific method, scientific approach or scientific attitude to tackle problems that they faced either as an individual or as a social group. Nehru believed that adoption of the scientific method in Indian economy and social life would eventually pave the way for socialism. He said, "What I wish to emphasize is that science means an approach to all life's problems. It is to be applied to the problems relating to our family, religion and everything else. You cannot apply science in your industries keeping other departments of your life free from it. The whole scheme is unscientific. Therefore, if we want to consider various problems that face us as an individual and as a social group, the right way to consider these problems is to adopt the method of science. If we examine our social and economic systems, we will find that these have developed in a most irrational manner. If on one side there is an abundance of production, we find that on the other side is terrible misery and want."

Nehru clearly distinguished the method of science from the metaphysical method. He wrote to his daughter, "I have mentioned these few instances to you to give you some idea of the methods of scientific work. The old metaphysical way was to talk vaguely about big things which it was not easy, or even possible, to analyse or understand fully. People argued and argued about them and got very heated, but as there was no final test of the truth or otherwise of their arguments, the matter always remained in the air. They were so busy in arguing about the other world that they did not deign to observe the common things of this world. The method of science is the exact opposite. Careful observations are made of what appear to be trivial and insignificant facts, and these lead to important results and these theories are again checked by further observations and experiments".

Nehru admitted rather reluctantly that "there is no real conflict between true religion and science" but then "religion must put on the garb of science." Otherwise, Nehru thought, there cannot be any compromise between the two. He wrote, "In the early days of science there was much talk of a conflict between religion and science, and science was called materialistic and religion spiritual. The conflict hardly seems real today, when science has spread out its wings and ventured to make the whole universe its field of action, and converted solid matter itself into airy nothing. Yet the conflict was real, for it was a conflict between the intellectual tyranny imposed by what was deemed to be religion and the free spirit of man nurtured by scientific method. Between the two there can be no compromise. For science cannot accept the closing of the windows of the mind, by whatever pleasant name this might be called; it cannot encourage blind faith in someone else's faith. Science therefore must be prepared not only to look up to heavens and seek to bring them under its control, but also to look down, unafraid into the pit of hell. To seek to avoid either is not the way of science."



Nehru believed that with the advancement of scientific knowledge, the traditional beliefs, superstitions based on religious dogmas would be removed from the society. He wrote in *The Discovery of India*: "As knowledge advances, the domain of religion, in the narrow sense of the word, shrinks. The more we understand life and nature, the less we look for supernatural causes. Whatever we can understand and control ceases to be a mystery. The process of agriculture, the food we eat, the clothes we wear, our social relations were all at one time under the domain of religion and its high priests. Gradually they have passed out of its control and become subjects for scientific study. Yet much of this is still powerfully affected by religious beliefs and the superstitions that accompany them."

WHILE admitting the superiority of science over religion, Nehru was not a blind supporter of science and its achievements. He reminded us of its limitations as well. He wrote in *The Discovery of India*, "There is no visible limit to the advance of science, if it is given the chance to advance. Yet it may be that the scientific method of observation is not always applicable to all the varieties of human experience and cannot cross the uncharted ocean that surrounds us." He elaborated this further, "Science deals with the domain of positive knowledge but the temper which it should produce goes beyond that domain. The ultimate purpose of man may be said to be to gain knowledge, to realize truth, to appreciate goodness and beauty. The scientific method of objective inquiry is not applicable to all these and much that is vital in life seems to lie beyond its scope—the sensitiveness to art and poetry, the emotion that beauty produces, the inner recognition of goodness."

Nehru warned us that if we accept science without grasping its true implications then the very spirit of science will be lost and science itself will face to the same fate as religion did. While opening the National Physical Laboratory, New Delhi on January 21, 1950 he said, "We all now-a-days talk of science in terms of praise, in a sense, we all worship at the altar of science at least verbally, and yet I often wonder if science is not going to meet the same fate as religion did in olden times, that is to say, people who are very religious, but seldom behaved as such. Religion became a set of ceremonials and forms and, may be, some kind of a ritual. Religion and the spirit of it somehow fade away, not from the minds of the elect and the select—that of course, always remains, but I am rather talking about the large number of people who talk glibly about science today, and yet in their life do not exhibit a trace of science in their talk or their actions or anything else."

It should be emphasised that while urging people to adopt modern scientific method and accept the superiority over ancient way of thinking, Nehru did not mean to ignore the good points of our ancient culture or the eternal human values. He was of the opinion that no nation can survive by totally forgetting its old culture. He wanted people to come out of the spell of the traditional beliefs and accept the great significance of the scientific age, but at the same time retaining those aspects of our ancient culture which do not come into conflict with the progressive ideas of science, because then, he thought, a unity of old and new would be established. Inaugurating the 'Vigyan Bhawan' of Gurukul Kangri Viswavidyalaya, Hardwar on August 8, 1958 he said, "I am proud of our ancient culture. It is both good and great. It is inspiring. We cannot afford to ignore that culture for that is the basis of our life and way of our living. I must, however, say without any kind of hesitation that while there is every reason for me and for each one of you to be proud of our ancient culture, if we decide to cling to it alone, forgetting the great significance of the scientific age wherein theories proved by science hold good, we will not be able to march with the pace of time.... In this progressing world, science stands as an established fact and it is based not merely on theories but on incontrovertible truths. Any nation that fails to grasp this fact will fail to go

While urging people to adopt modern scientific method and accept superiority over ancient way of thinking, Nehru did not mean to ignore the good points of our ancient culture or the eternal human values



Nehru accepted the inevitable consequence of scientific progress, that it cannot be stopped forever in its course of searching for truth, but, then, a science which confined itself to searching for truth alone irrespective of its social consequences was not acceptable to him

ahead and find its proper place among the progressive countries of the world.... If we want to build up economically and also politically, what is required is the pursuit of science and our resolve to do things on scientific basis.... both the present day scientific culture and our old culture must go hand in hand."

ON many occasions Nehru emphasised the role of science as a means to search for truth irrespective of its social consequences because he believed that neither is it desirable nor possible to suppress the desire of man to discover. He said, "Now we have these mysteries which these high priests of science flourish before us, not only flourish but threaten us with; and at any rate make us either full of wonder or full of fear. Whatever it is, we have got these new mysteries of science, and of the higher mathematics, which are unveiling various aspects of the physical world to us. No one knows where this will go to. Some people may be frightened of this but in the ultimate analysis one should never be frightened of the truth whatever it may be, you cannot suppress the desire of man to discover, to progress, to find out, to unravel even though it may sometimes land him in very dangerous situation. You cannot stop the progress of human mind or humanity."

We should remember that Nehru accepted the inevitable consequence of scientific progress, that it cannot be stopped for ever in its course of searching for truth, but, then, a science which confined itself to searching for truth alone irrespective of its social consequences was not acceptable to him. He was more impressed by the applications of science or byproducts of scientific advancement which brought a progressive social transformation. At the inaugural address on the occasion of the J.C. Bose Birth Centenary Celebration at the Bose Institute, Calcutta on November 30, 1958, he said, "The science which developed in the western world brought that capacity for search for truth in a somewhat different way, just as in philosophy and metaphysics the search for truth is in a somewhat different way, and brought heavy rewards in its train. It had not only the search for truth there but life and energy—not mere numbing of something that had been done before but experimentation and progress by succession of failures and successes. So science was a good thing and it showed tremendous results and, as everybody knows, it changed the whole concept of our own manner of living in the world. After all, much, if not everything almost, if I may say, that Europe or America is, is due to science—application of science."

IF Nehru took excessive interest in the development of science in India, it was mainly because he thought that science alone could provide the means to tackle the social problems. He strongly believed that it was impossible to think of any meaningful social change without science. "There is no other way except the way of science, ultimately, for the development of human life and institutions," he said. For the same reason, though Nehru admitted the need of fundamental research, at the same time he emphasised the greater need for applied research. At the inauguration of the Electrical Communication Department, Indian Institute of Science, Bangalore he said, "I have the greatest admiration for pure research which is essential and out of which may come many practical applications ultimately. Inevitably, a person like me who is concerned with day-to-day problems of greater importance, has always to think a little less of pure research and more of the application of research to the problems of human society, more particularly today..."

We find similar concern in his inaugural address at the thirty-fourth Indian Science Congress in New Delhi on January 3, 1947, where he said, Surely science is not merely an individual's search for Truth.... For a hungry man or hungry woman, truth has little meaning. He wants food. And India is a hungry, starving country, and to talk of Truth and God and even many of the fine things of life to the millions who are starving is a mockery. We have to find food for them, clothing, housing, education, health and so on—all the



absolute necessities of life that every man should possess. When we have done that we can philosophise and talk of God. So, science must think in terms of the 400 million people in India. Obviously, you can only think in those terms and work along those lines on the wider scale of co-ordinated planning.”

Nehru liked the scientific institutions of research growing up in the country because he believed and hoped “they will gradually make the Indian people more and more scientific in outlook—scientific not merely in the sense of dabbling in test tubes and beakers and the like but get that type of mind and that type of thinking which scientists ought to have, that is, the poise, the dispassionate type of mind, which is not swept away by passion and prejudice, and which can consider problems of life reasonably, logically and with as great a spirit of detachment as possible and thus come to conclusions.”

On many occasions, Nehru expressed his pleasure and pride in that in some way he was helping in the building of these scientific institutions which he thought were destined to play a greater role in shaping the ‘New India’. Of course, though he loved to imagine and dream, he was not carried away with these developments and so while inaugurating the National Metallurgical Laboratory, Jamshedpur on September 26, 1950 he said, “These laboratories are not progress in themselves but they are the foundation of progress.” Again at the Central Leather Research Institute, Madras on January 6, 1958 he said, “We talk a great deal of our national laboratories and institutes. Well, they have to justify themselves from day to day, not one justification for ever. The moment they lose grip or fall into routine, their thinking and action dries up and they are lost. Therefore, such an institution or any other scientific laboratory can only be kept by active men, all the time thinking and acting, trying to do something better today than yesterday and evolving new techniques.”

Nehru wanted a science to grow up in India which could meet the challenges that a developing country like India faced. He was convinced, though he himself was educated in England, that such science could not grow simply by imitating others. On the occasion of the laying the foundation stone of the Central Electronics Engineering Research Institute, at Pilani on September 21, 1953 he said, “If we want that science should progress in India, you must know that science does not develop through text books; it develops through research; it develops when new things are discovered. We do not want that our country should confine itself to learning from books what has been achieved in America, Germany, Japan or England. Unless we engage ourselves in research and industry science will not take root in our land.”

Nehru liked the scientific institutions of research growing up in the country because he believed and hoped they will gradually make the Indian people more and more scientific in outlook

Further reading

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4. *Jawaharlal Nehru on Science & Society*, Baldev Singh (ed), Nehru Memorial Museum and Library, New Delhi, 1988.
5. *Nehru: The Architect of Indian Science*, Ashok Jain, J.K. Ahuja and Subodh Mahanti (prepared by), NISTADS (CSIR), New Delhi 1989.
6. Scientists fail to live up Nehru's ideals, Subodh Mahanti, *LINK* (New Delhi), p-21, December 11, 1988.
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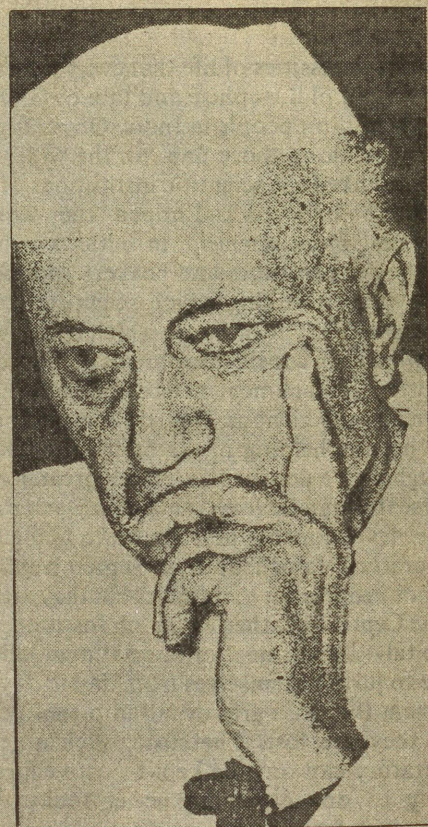
Sh. Mahanti is Scientist and Dr. Jain is Director, National Institute of Science, Technology and Development Studies, New Delhi-110012

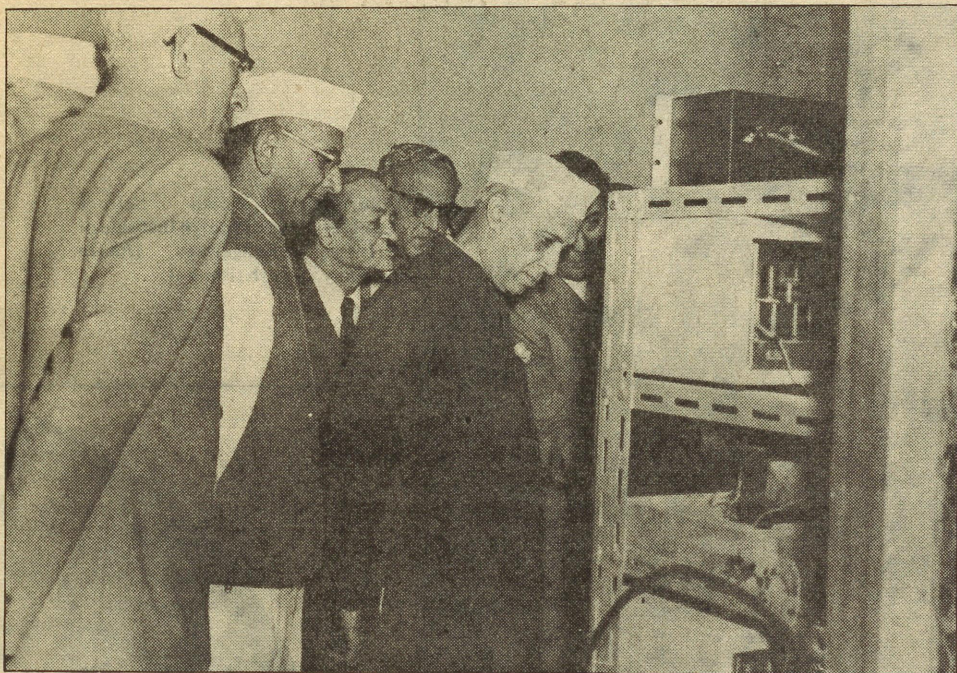
On Science...

"I am convinced that of all the big problems that face India today, nothing is more important than the development of scientific research, both pure and applied, and scientific method. This is indeed the basis and foundation of all other work."

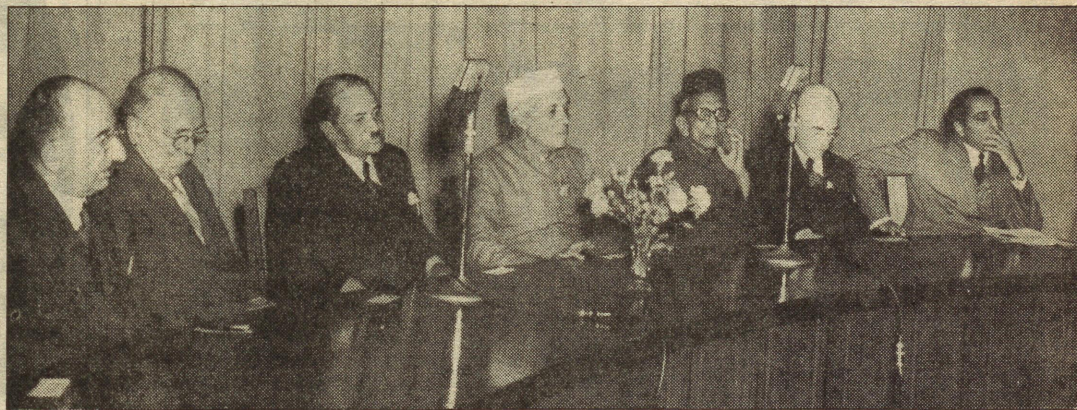
"...The scientific method is the only right method of approach to life's problems; and in India today it is even more important than elsewhere, because we are backward with science... In India today we should pursue science in the right way and try our utmost to foster it. There is no other way except the way of science ultimately for the development of human life and institutions. This is the scientific approach to life's problems.... The fundamental thing is a scientific approach. You cannot change man legally. You can create an atmosphere where his actions are governed by a scientific approach, science remains the only right method of approach... I am glad that the scope of the Institute of Sciences is comprehensive. I hope at the same time it will not presume too much and become too exclusive and disdain anybody who does not belong to it..."

"...Every advancement made in science should be utilised to the profit of human race. But, in a large measure unfortunately it is not so and there are all kinds of secret processes... I am very much interested in establishment of such new laboratories. In fact the Government of India in the course of the last two years has put up a chain of national laboratories in various parts of the country... It is not merely a question of improving certain techniques but rather to be always prepared to adopt new ones completely or new uses of certain products. We should always be wide awake and the only way to be such is to have more laboratories and research institutes in the country without waiting for other peoples experiments to give us the benefit..."

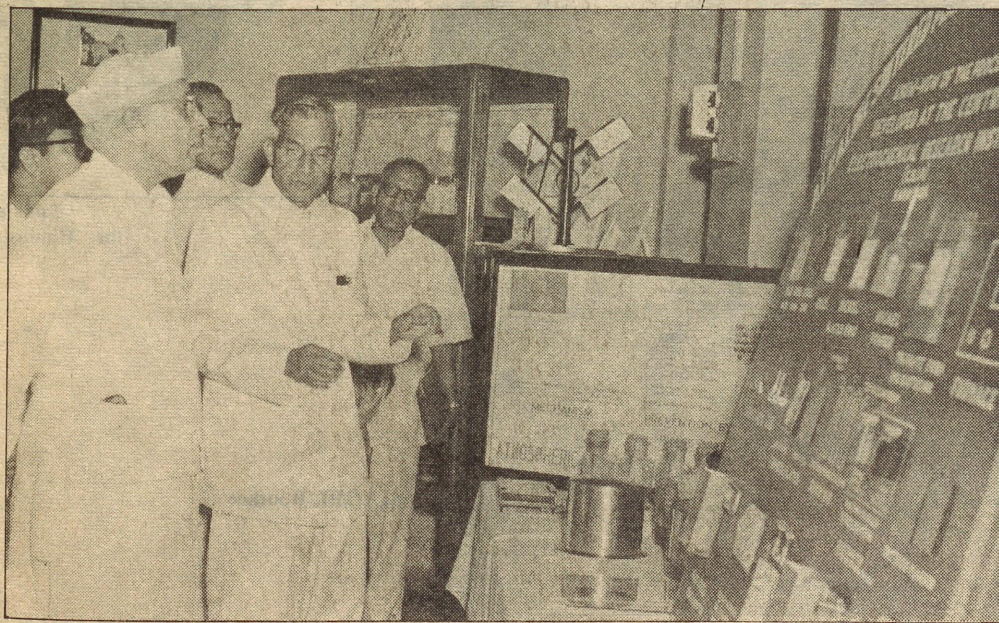




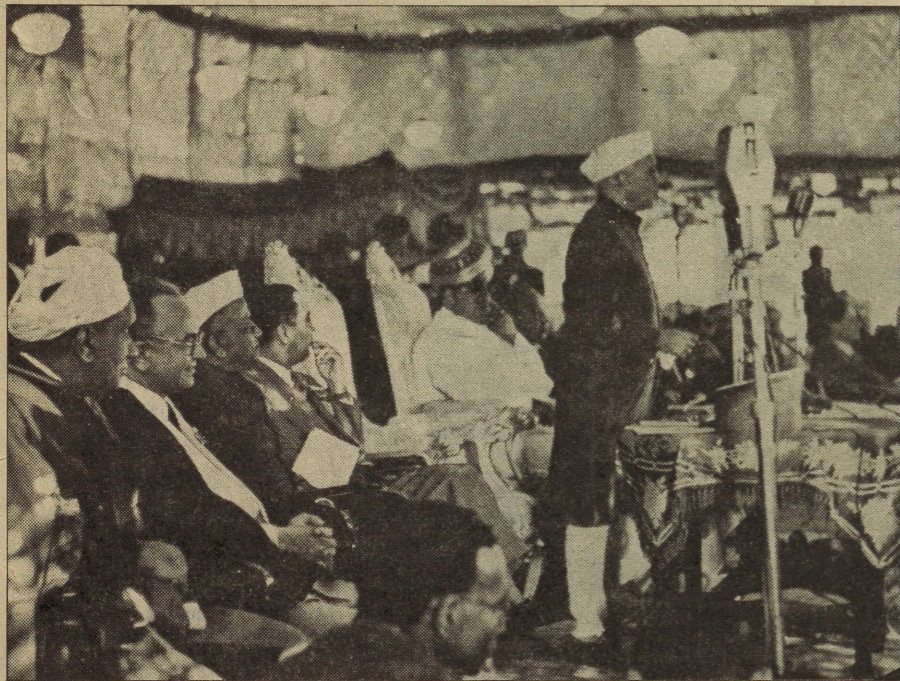
At TIFR, Bombay, with M.C. Chagla, S.S. Bhatnagar and Morarji Desai



With Dr. M.S. Thacker, Lala Shriram, Dr. H. Bhabha and others at NPL



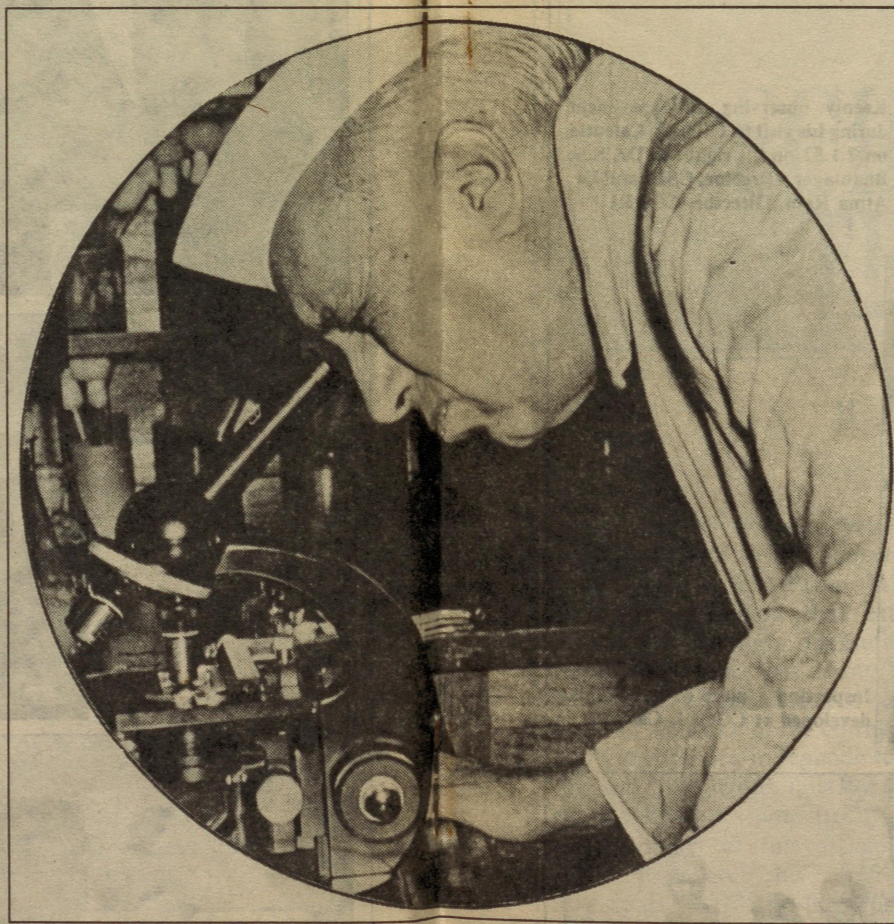
With Prof. K.S.G. Doss, Director, at CECRI, Karaikudi



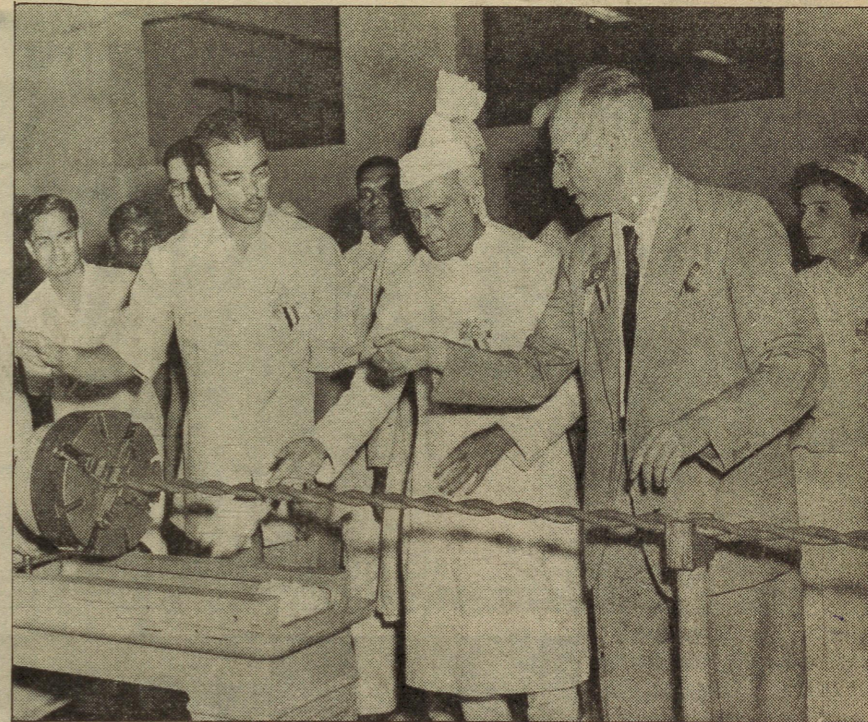
Addressing Indian Science Congress 1950 at Indian Institute of Science, Bangalore (Photo courtesy: R.S. Krishnan)



At CBRI, Roorkee



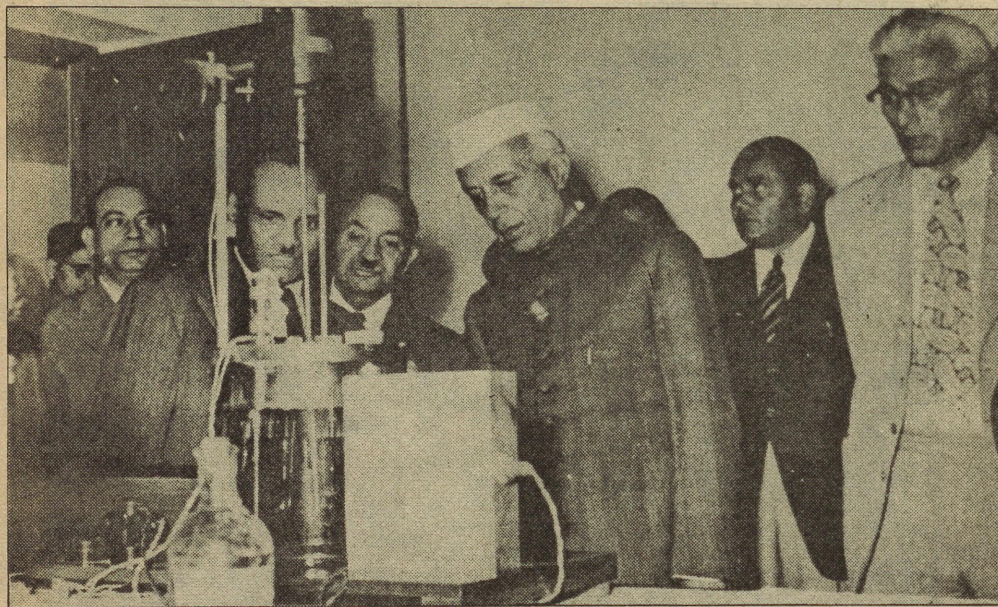
Looking through a microscope at the Hindustan Antibiotics Ltd., Pimpri 1965



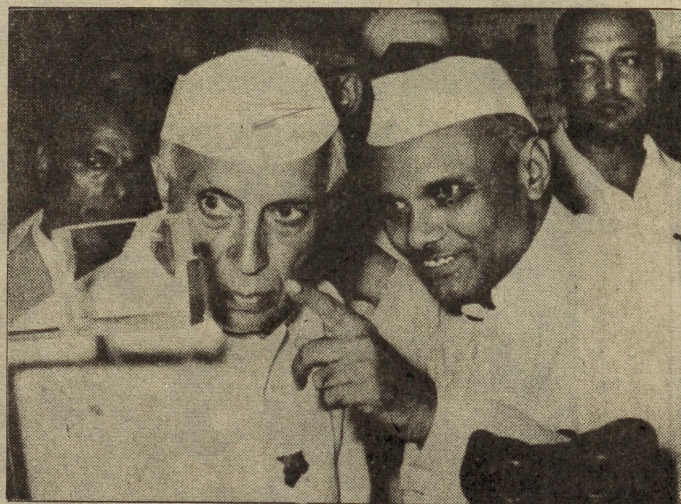
At CBRI, Roorkee



With Albert Einstein



Keenly observing an experiment during his visit to CGCRI, Calcutta on 2.1.52 on his right are Dr. S.S. Bhatnagar, Director, CSIR and Dr. Atma Ram, Director, CGCRI



Inspecting a piece of optical glass developed at CGCRI, Calcutta



Bidding goodbye to NML after concluding his visit on 2 March, 1958

"The spirit of science..... means not only accepting fresh truth that science may bring, not only improving the old, but being prepared to upset the old if it is against the spirit"

—Jawaharlal Nehru



NEHRU AND SCIENTIFIC TEMPER

H. NARASIMHAIAH

JAWAHARLAL Nehru was our first Prime Minister and also the best Prime Minister. He occupied that esteemed position with high distinction for seventeen years. But many people seem to have vague ideas of his sacrifices for the sake of the country, specially during pre-independence days. He was in various jails for a total period of more than fifteen years.

The object of this article is not either to sketch his biographical milestones or to high-light his administrative achievements. They are generally well known. For example, who does not know that he laid the firm foundation for a modern India based on science and technology? He was a man of vision. He established many science institutions of higher learning in different fields, especially in the field of atomic energy, space science and so on. He was also the father of planning, non-alignment and the policy of peaceful co-existence. But many people do not know the supreme importance he gave to scientific attitude. Even those

who know this aspect, either deliberately avoid any reference to it, or innocently skip it when they speak or write on Nehru.

I had the privilege of being in touch with his thoughts ever since my college days, from 1939 to his passing away in 1964. He never missed an opportunity to stress the importance of developing an analytical and questioning mind. Even before he became the Prime Minister he used to inaugurate the annual sessions of the All India Science Congress.

I vividly remember the vehemence with which he was opposing astrology in general and in particular the forecasts of our astrologers on the occasion of the *Astagraha Koota* (conjunction of eight planets) which occurred on 5th February 1962. At that time astrologers were shouting from the house-tops that heavens would come down to earth and there would be total catastrophe on that day. Naturally, there was a lot of panic and commotion among considerable sections of the public. Pandit Jawaharlal Nehru was assuring and

reassuring people that nothing untoward would happen on that day and the alignment of the eight planets would not have any supernatural effect on men. Needless to say that he was right and the astrologers had to eat humble pie. But a few clever astrologers tried to wriggle out of their predicament after the event, by giving some dubious and meaningless explanation.

I have taken many of his sayings regarding scientific temper from his published writings. If I remember correctly, he was the first person to speak so frequently on scientific temper. It is believed that the expression 'scientific temper' was first used by Pandit Nehru. But there is no doubt that he was greatly responsible for popularising that expression.

Spirit of Science

On one occasion he asks 'What exactly does the spirit of science mean?' and answers the question himself. "It means many things. It means not only accepting fresh truth that science may bring, not only improving the old but being prepared to upset the old, if it is against that spirit. It also means not being tied down to something that is old because it is old." This statement by Jawaharlal Nehru underlines the important aspect of scientific temper, that is, openmindedness. A person imbued with scientific outlook or scientific attitude should have an open mind. Of course, open mind does not mean a vacant mind or blank mind. Mind is like a parachute which works only when it is open. It also means that we should not be dogmatic. All our opinions including all the laws of science are tentative. There is no finality about them. In the light of fresh data and new experience we should be prepared to modify all our opinions, scientific laws and theories. For example, Newton's second law was modified by Einstein with the help of his special theory of relativity so that the law might be



made applicable to sub-microscopic particles. Thus the progress of science is evolutionary. There is no stagnation. It is like a running brook. Knowledge goes on accumulating.

Nehru says in another place, "Science is not a closed system. It is an open method of discussing the truth wherever it may be found." Thus the entire approach of Nehru is totally opposed to the monster of dogmatism and obscurantism which have been threatening the unity and integrity of our country.

Irrational Scientists

Nehru was keenly aware of the basic contradiction that was glaringly evident among the scientists between their highly scientific attitude inside their laboratories and the totally unscientific attitude in their activities outside the laboratories. To put it in his own words, "I find a curious hiatus in people's thinking. I find it even in the thinking of scientists who praise science and practice it in the laboratory but discard the ways of science, its methods of approach and the spirit of science in everything else they do in life. They become totally unscientific." This is the tragedy of our scientists and also of our country.

Even though man has gone to the moon and returned successfully, still we have two theories for eclipses—one to teach inside the class and the other for practising at home. The sun and the moon are not yet free from the clutches of 'Rahu' and 'Kethu'. Quite a number of scientists still believe that some days are auspicious and some inauspicious. 'Rahukala' continues to haunt many scientists. Scientists and science teachers proclaim in their classes that matter can neither be created nor destroyed. It is amazing that some of these people firmly believe that it is possible to create a watch or a gold ring from nowhere. They being endowed with an analytical mind in their scientific investigations become totally dumb and sheepishly follow godmen who claim supernatural powers. Scientists

teach Darwin's theory in the class but believe in the creation theory in life. They are naturalists in the class. But as soon as they step out of the class they suddenly become supernaturalists. We explain the theory of gravity in the class but believe in the possibility of levitation. Astronomy is for teaching but many of these teachers are guided by astrology in their activities. Thus a dichotomy exists among many of our scientists. This is deplorable.

It may not be out of place if I mention the views of David Hilbert, the greatest Mathematician of the century. He says, "when you collect the ten wisest men of the world and ask them to find out the most stupid thing in existence they will not be able to find anything stupider than astrology." According to a statement issued in U.S.A. by 186 internationally known scientists including 18 Nobel Prize winners, astrology is totally unscientific. The educated people are mostly responsible for the perpetuation of unscientific beliefs.

"Science is not a closed system. It is an open method of discussing the truth wherever it may be found"

—Jawaharlal Nehru

The present system of education is converting an uneducated superstitious person into an educated superstitious person. Besides, superstition, like parthenium, flourishes without any care. Needless to say that the educated superstitious person is more dangerous to society than his uneducated counterpart.

Nehru firmly believed that the welfare of our country lay in adopting science, technology and scientific temper. He says, "so far as we are concerned, we are definitely committed to encouraging not only in its various technical fields but build up scientific temper, a scientific approach to life's problems. Unless we gradually start to function more and more according to scientific temper, the advances we may make may not be wholly good. Science is not merely training to do a job but training to think in a particular way." It is the wide and yawning gap

between science in the laboratory and non-science in life that has been responsible for a number of problems. Science and technology are rapidly progressing, but scientific temper is lagging behind. We wish to have twentyfirst century technology. But at the same time our thinking in social and religious fields is not very much different from that of medieval beliefs.

Nehru emphasises the importance of the spirit of inquiry when he says "Science does not simply sit down and pray for things to happen but seeks to find out why things happen." He emphasises the questioning spirit and the spirit of inquiry. Questioning forms the basis of scientific temper. If there is no questioning there is no progress at all. Unfortunately, in our country the spirit of questioning is not encouraged either in the class or at home. Consequently, there is blind acceptance of many practices which are totally meaningless and unscientific.

This spirit of inquiry is absent among many of our educated people and scientists. Many so-called enlightened people literally believe that prayers can give material benefits. Even in these days of science and technology, many believe that it is possible to get rains by prayers. Many governments and government agencies organise prayers for rains in temples and other places of worship at the time of acute drought. It may not be out of place to mention that a Government of Karnataka Board took the help of a 'Yogi' in Bangalore for getting rains by prayers four years ago. He began praying in a tank. Needless to say that the Yogi's prayers for rain in the tank were in vain. Thus he met his Waterloo in that waterless tank.

Nehru said, "My preferences are all for science and the methods of science, for science has opened up new vistas which wait to be explained. Science and scientific method are the basis of life today. There lies in science the search for truth on the one hand and the betterment of humanity on the other. The scientific method is the most powerful method to be used to understand all problems of life and society. This

scientific method should be used in all fields including the field of religion.

Science, Humility and Religion

WHILE addressing a session of Science Congress, Nehru pleaded for humility on the part of scientists and others. He earnestly appealed to scientists "I plead with the scientists here and elsewhere to remember that the scientific spirit is essentially one of tolerance, one of humility, one of realisation that somebody else may have also a bit of truth, scientists should note that they do not have a monopoly over truth, that nobody had a monopoly, no country, no people and no book. Truth is too vast to be contained in the minds of human beings or in books however sacred." He decried a dogmatic approach in the field of religion when he said "The spirit of dogma, I say with respect, has affected badly the religious quest and made both minds and practices conform to rigidity. Rigid and intolerant ideas, ideas which assert in effect that 'I am in possession of truth, the whole truth, every bit of truth and nobody outside pale has it' narrow men's minds shutting the door against a tolerant and objective approach." I do not think it is necessary to stress the need for such liberal thinking in all fields in general and specially in the field of religion.

Every religion swears that it is the only repository of truth and the contents of its book are divine and infallible. Each claims that its god is superior to the god of other religions. There appears to be nothing so hostile to a religion as another religion. This dogmatic stand has given rise to irreconcilable and never ending conflicts and problems. And we have been witnessing furious religious and communal clashes, at the slightest pretext, all over the country. They have become almost a daily phenomena. And these social and religious problems have divided people on illogical considerations and have been a serious threat to the unity and integrity of our country.

Nehru was a socialist. He was interested in the welfare of the poor and the downtrodden. He realised

that economic reforms alone were not sufficient and there should be a radical change in the attitudes of the people. He was aware that many superstitions and religious beliefs such as fate and destiny were responsible to a considerable extent for the existing lethargic tendencies on the part of the people and the consequent backwardness of the country. Many a time Nehru used to become furious and attacked religions and organised religions in no uncertain terms. Once he said, "I want nothing to do with any religion, for all are concerned with keeping the masses satisfied to live in hunger, filth and ignorance. I want nothing to do with any order, religious or otherwise, which does not teach people that they are capable of becoming happier and more civilised on this earth, capable of becoming true man, master of his fate and captain of his soul."

Even though in theory all religions were founded with laudable intentions, in practice organised religions have been doing more harm than good. They have all become mostly commercial. In spite of their claims that they are spiritual in nature, they are all highly materialistic.

"When you collect the ten wisest men of the world and ask them to find out the most stupid thing in existence they will not be able to find anything stupider than astrology"

—Jawaharlal Nehru

Modern Temples

NEHRU used to become excited whenever he saw modern projects, higher institutes of science, and technological institutions. I vividly remember a picture of Prime Minister Nehru which appeared in newspapers, standing on the Bhakra dam in a pensive mood. On that occasion of dedicating the newly completed Bhakra dam in 1954, Nehru exhorted, "As I walked round the site I thought that these days the biggest temple and mosque and gurudwara is the place where man works for the good of mankind. Which place can be greater than this, this Bhakra-



Nangal where thousands and lakhs of men have worked, have shed their blood and sweat and laid their lives as well? Where can a greater and holier place than this be, which can be regarded as higher?" On another occasion he continued with the same theme and said "... I would put priests to work, also I would turn the temples into schools." What profound, meaningful and sublime sentiments! Such statements are really revolutionary. For Nehru work was worship. But in our country it is unfortunate that worship has become work.

Aim of a University

NEHRU had delivered innumerable addresses at Convocations. While speaking to the graduates of the Allahabad University he emphasised the objectives of a University thus 'A University stands for humanism, for tolerance, for reason, for the adventure of ideas and for the search of truth. It stands for the onward march of the human race towards even higher objectives.' On another similar occasion he said, "the noblest occupation of a University is pursuit of truth. There is nothing too sacred for investigation or too holy to be examined."

Yet, 13 years ago when the Bangalore University, for the first time in the history of any University, tried to investigate miracles and other verifiable superstitions scientifically under controlled conditions and accosted and challenged a few godmen to establish their claimed miraculous powers, most of the educated people raised their eyebrows and felt that such investigations should not be the concern of a University! Pursuit of truth is being carried on in science laboratories. Obviously 'God' will be more comfortable in such institutions than in temples where coconuts are broken and incense is burnt.

Science Education

WHILE speaking on 'Education and Science' Nehru once said, "more and more students are taking



to the study of technical and scientific subjects. Yet, I do not suppose it will be true to say that the background of general thinking in India is governed by scientific approach." Even today, 25 years after he made the statement, conditions have not changed. In fact, the situation is much worse.

An overwhelmingly large number of students have been opting for the study of physics, chemistry, mathematics and biology subjects after the secondary education. Our country may have even the largest number of students in the world pursuing science. The primary idea on the part of these students in taking up these science subjects is to get into engineering colleges, medical colleges, and other technical institutions for the sake of monetary considerations and not for the love of science for its own sake. Thus, science has become mostly a means of seeking better livelihood. Needless to say that they are far from adopting science as a way of life.

Indira Gandhi on Nehru's Scientific Temper

ONE of the best persons, if not the best person, to evaluate and assess Nehru's personality and his basic thoughts is undoubtedly his daughter Smt. Indira Gandhi. In her opening speech on the occasion when the Nobel Laureate S. Chandrasekhar gave the Nehru Memorial Lecture in 1968, she observed, "Science had a great fascination for Jawaharlal Nehru. To him science meant the spirit of enquiry as well as a tool for modernising India and Indian thought, and liberating people from prejudice and superstition. I think Jawaharlal Nehru's place in history will be that of a great moderniser of our country. Greater than all his other contributions to India was his work to make India cultivate a rational and scientific outlook. He knew that without science India could not solve her problems. In himself he combined the rational, scientific outlook with a basic faith—

the teachings of the Buddha, the Gita and Mahatma Gandhi and the humanism of the great authors of the East and West. Also, he thought of the philosophers of the enlightenment and of social revolution as well as the investigations of the scientists into the great mysteries of the Universe. He once described himself as heir to the entire thought of mankind, which is what perhaps every civilised person should be. He was happiest when he was amongst scientists."

Secularism

I have been greatly influenced by Pandit Nehru's thoughts and ideas on scientific temper. Even scientists will not speak about scientific temper since science has become only a profession for them. In my opinion it should become a mission and not a profession. Scientific outlook should be an integral part of our lives. It should be a way of life. My admiration for Nehru is all the more great since as Prime Minister he was emphasising the need for cultivation of scientific temper and adoption of the scientific method. No politician refers to scientific attitude. Much less a Minister lest he should lose the little popularity he has. Only Nehru, a

"Science does not simply sit down and pray for things to happen but seeks to find out why things happen"

—Jawaharlal Nehru

man of indomitable courage and conviction, could make such bold statements without caring for personal popularity.

Our Indian Constitution is founded on socialism, secularism and democracy. Jawaharlal Nehru was a firm believer in secularism. There is a lot of confusion in the understanding of this important word 'secularism.' The correct meaning of the word secularism is that the State or Government should have nothing to do with any religion. The Government should neither support any religion nor oppose any religion. It should be totally indifferent to religion. Religion should be considered as purely personal. But unfortunately

secularism is interpreted as equal respect for all religions. This erroneous definition has created a number of problems which we have been facing.

Social Commitment of Scientists

ALL of us should have a firm social commitment. It is not suggested that scientists should take an active interest in all social problems. But they should be true to their conscience and as a matter of duty should express their full and frank opinion on subjects which involve science. For example, when astrologers, godmen, yogis and others make claims such as astrology is scientific, objects can be materialised, gravitation can be defied, prayers can bring rains etc., silence on the part of scientists does great damage to society and scientific attitude. Moreover, such a silence or indifference may amount to supporting such claims indirectly. One important point to note is that persons who make paranormal claims which apparently violate known laws of nature, stray from their religious activities and trespass into the domain of science. And society rightly expects that such trespassers be questioned and dealt with in an appropriate manner by scientists. Hence, there is a strong justification for scientists not to ignore such paranormal claims but to investigate them scientifically and announce the findings for the information and the benefit of the public. Otherwise, the public will be cheated by charlatans in different fields in the name of God and religion.

Besides, according to the Indian Constitution "It should be the fundamental duty of every citizen to develop scientific temper, spirit of inquiry, humanism and reform." If the Government, scientists, educationists and the other educated people try in a sincere way to implement this all important Constitutional requirement, then we would have paid the highest tribute to Pandit Jawaharlal Nehru whose birth centenary we are all celebrating.

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SCIENCE IN THE SERVICE OF THE COMMUNITY

JAWAHARLAL NEHRU

I think it is right and proper and very necessary for the world of science to be in intimate contact with the new India. It is also essential that new India should also come in intimate contact with the world of science. Because if science—whatever progress it may make—is isolated from the living currents it will not go very far.

If the new currents of renaissance India go along lines that are not lines of science, then they too will go into a blind alley. Therefore it becomes essential that the two must march together.

Surely, science is not merely an individual's search for truth. It is something infinitely more than that if it worked for the community. Its objective must be to remove the ills of the community. It must have a social objective before it. For a hungry man or a hungry woman, truth has little meaning. He wants food. For a hungry man, God has no meaning. He wants food. And India is a hungry, starving country and to talk of truth and God and even of many of the fine things of life to the millions who are starving is a mockery. We have to find food for them, clothing, housing, education, health and so on—all the absolute necessities of life that every man should possess. When we have done that we can philosophise and think of God. So, science must think in terms of the 400 million persons in India. Obviously, you can only think in those terms and work along those lines on the wider

scale of coordinated planning.

I hope that the Science Congress will devote itself to this task and not wait merely for the Government to take action. Governments may be good and may be bad, but Governments normally are very slow and the only thing that moves them is some immediate public outcry which affects their future indirectly. Therefore I should discourage among the scientists a reliance always on what Government may or may not do.

"Surely, science is not merely an individual's search for truth. It is something infinitely more than that if it worked for the community."

Naturally, they have a right to expect things from the Government, and speaking just as one Member of the present Government of India—speaking, may be, partly for my colleagues but largely for myself—I may say that we are intensely interested in scientific development in India and we shall do everything in our power to encourage scientific research. We should like to tap all the latent scientific talent in the country and to give it opportunities for growth and service to the community.

IT is a tragedy that, when these enormous forces are available in the world for beneficent purposes and for raising human standards to undreamt of heights, people should

still think of war and conflict and should still maintain economic and social structures which promote monopoly and create differences in standards of wealth between various groups and peoples. It is a tragedy, whatever other people might say about it, and no man of science should accept it as a right ordering of events. So in India today, while we are busy with our own political and economic problems, we have inevitably begun to think more and more of the vaster problems that face us and in the decision of which science must inevitably play a big part.

I do believe firmly that the only right approach to the world problems and to our national problems is the approach of science, that is to say, of the spirit of science and method of science. Somehow eminent men of science when they come out of their study or laboratory forget the approach and method of science in other fields of life. While in our particular field, we may be meticulously careful, when we come out into the social and economic fields, we forget the scientific approach. I firmly believe that it is through the method and spirit of science that we can ultimately solve our problems. All over the world it is because we forget the scientific approach that many of our troubles arise.

WHILE you must discuss your particular problems I want that you should not ignore the picture as a whole. There has been a



tendency in the last few generations towards greater and greater specialization. It has yielded rich results but it has led to the narrowing of vision of the average person. Perhaps some of our troubles are due to this fact, and also because you can never understand a picture fully unless you have a conception of the whole.

You cannot divorce science from social and political happenings and from the economic structure of the world. Therefore, perhaps it is time that science developed a certain philosophy and unity, if I may put it so. It had this quality in the olden days when science presented a smaller picture than it does now. That gave a certain organic unity to it. Now with each department going its own way, it has become difficult. I do think that in the present circumstances of the world we should develop something of that unity of outlook and appreciation of the world problems. Nearly two years ago a bomb burst in Hiroshima. It created inevitably a great deal of excitement. It seemed to me to herald all kinds of enormous changes, constructive as well as destructive. It produced a conflict in people's minds as to where we were going, rather where civilization was going, what things could happen. Whether it was necessary or not I do not know, but obviously it led to one question which troubled a large number of people. The question was whether to gain a certain end any means and every means possible should be adopted because the means adopted at Hiroshima were horrible beyond words. May be the end desired was achieved, but it is a question which every scientist has to consider.

SCIENCE has two faces like Janus: science has its destructive side and a constructive, creative side. Both have gone on side by side and both still go on. No one knows which will ultimately triumph. Hiroshima became a symbol of this conflict and, in spite of all the decisions of the Atomic Energy Commission of the

"I do believe firmly that the only right approach to the world problems and to our national problems is the approach of science, that is to say, of the spirit of science and method of science."

United Nations—and we welcome those decisions, of course, in so far as they go—the doubt remains in one's mind as to where we are speeding.

On the other hand, apart from the atomic bomb aspect of it, we are obviously on the threshold of a new age in the sense of enormous power resources being put at the disposal of humanity and the community. Will this new age change—and I think it will change—enormously the whole structure of society? My mind goes back to the time when gunpowder burst upon the world. Gunpowder at any rate pushed the Middle Ages away completely and fairly rapidly, in course of time, brought or helped to bring about a new political and economic structure.

OF course, there were many forces at work. Nevertheless, gunpowder did produce that powerful effect on society and ultimately out of the feudal order a new capitalist order gradually developed. Now I wonder whether this so-called atomic bomb is not also the herald of a new

"You cannot divorce science from social and political happenings and from the economic structure of the world."

age, of a new structure of society, which has to be established in order to fit in with present conditions. All these thoughts come to my mind because I want to understand this picture in this broad way and not to be lost in the argument. I myself am convinced that there is going to be no very great progress either in science or in other ways unless certain fundamental changes take place in the social structure. Here in India we have a peculiar structure. You can see in different places different types of social structures. You can see social structures approximating to those in the early Middle Ages as well as to those of the 20th century. This picture which is rapidly changing even the 20th century structure does not

seem to answer the present needs.

So personally I feel convinced that a radical change must come, a radical change in the direction of allowing the whole community to develop and not only a small group on top. I do not think that the enormous big projects that we have in view in India can really succeed without the cooperation of the people at large. I think we shall be able to turn these vital currents in the right direction and mould them on scientific lines.

IF this country is going to develop as it is going to, that development is not going to take place in an isolated way; it must be coordinated, it must be planned and it must be related. Unless this is done, you cannot go far.

The first objective, it seems to me, from any point of view and more especially from the point of view of science, is to help in the building of a free and self-reliant India. India today has made its mark in the world of science, more especially in theoretical physics and some other departments also. We have done well when we have hardly tapped the talent in India. We have only scratched the barest surface of the Indian people and yet we have done tolerably well, and now, when I think of what we can do, and will no doubt do, when we open the doors of opportunity to a large number of people in India, then the kind of picture I see rather overwhelms me. If we could tap, say, even five per cent of the latent talent in India for scientific purposes, we could have a host of scientists in India.

Today, of course, we have tapped only less than one per cent of our talent. To open the doors of opportunity and to build a political and social system which allows people to have the capacity to develop and function for the good of the community should be our main aim.

* This is an abridged version of the Presidential address at the 34th Indian Science Congress, Delhi on 3 January 1947.

Planktonic Molluscs that Indicate Ocean Currents

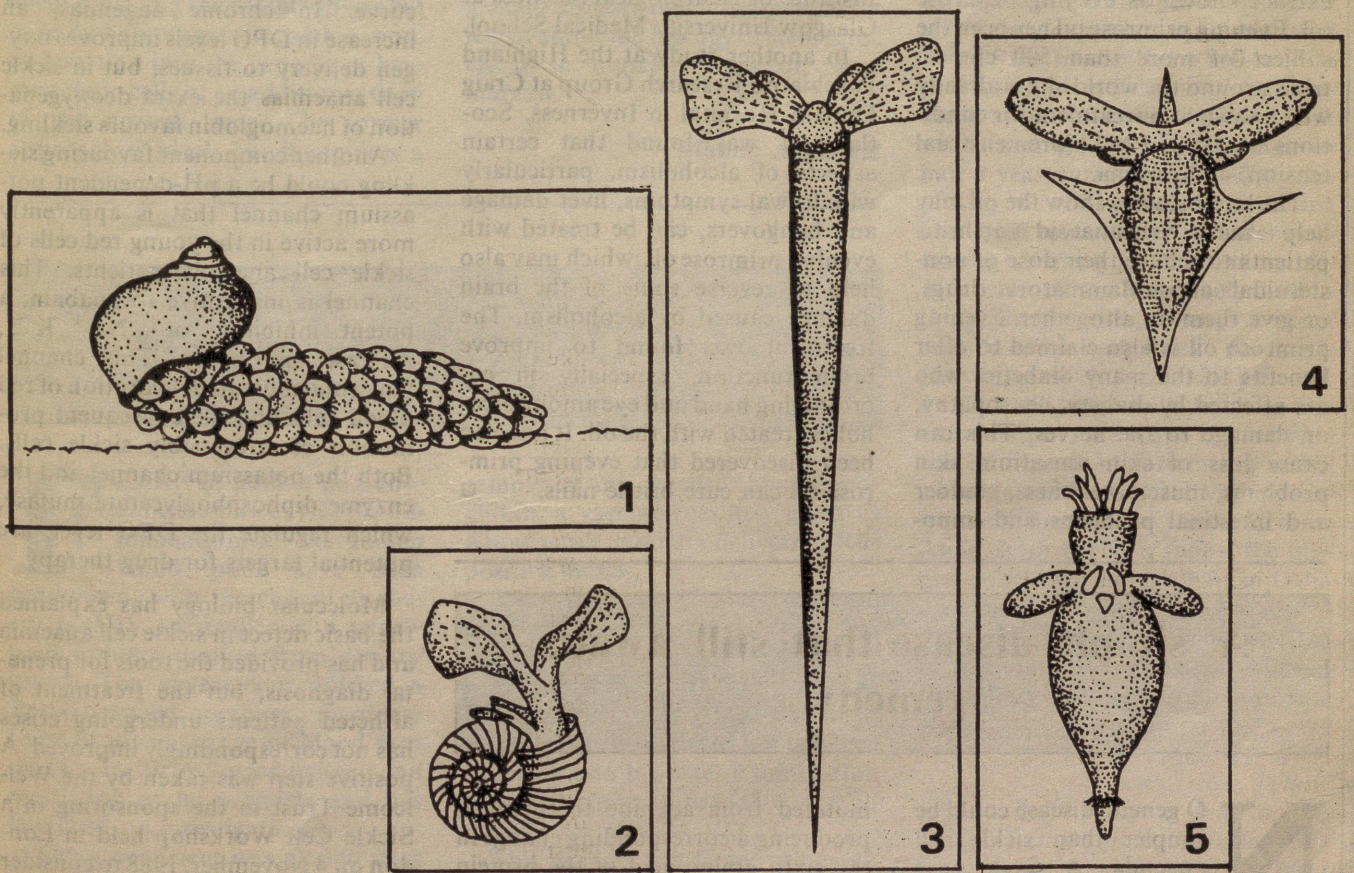
MOLLUSCS, the class of creatures with shells, are generally benthic animals, that is, they live on the sea bottom. But a few are specially modified to lead a holoplanktonic life floating on water. Such animals are generally abundant in the warmer parts of the ocean. It is interesting to know that some planktonic molluscs such as the species of *Janthina*, *Limacina* and *Clione* periodically drift in vast swarms into the North Sea from the Atlantic Ocean due to water currents and winds. As a result, they serve as useful indicators of movements of water-masses and associated fishery resources in these areas. Further, many of these mol-

lusc living in the open sea like foraminiferans and radiolarians form extensive deposits (oozes) on the sea bottom. Although considerable information is available on the benthic molluscs, knowledge about the planktonic molluscs is scanty.

Janthina (Fig. 1) (Gastropoda: Mesogastropoda), an eyeless, violet snail, has an exceedingly thin and transparent lavender blue shell. It has a very strong bubble float (raft) formed by the secretion of viscous mucus. The animal clings to this raft and hangs upside down on the surface of the sea. A long row of egg capsules may also be seen beneath the bubble raft occasionally. *Janthina* feeds on the polyps of coelenterates

by immobilising their stinging cells through the secretion of violet dye. Interestingly, its raft may also harbour small crabs.

The pteropods (those possessing wing-like structures) belonging to the opisthobranch molluscs are fast swimmers and are of two types: those with a shell and those without a shell. The front part of the body of these animals is drawn out on either side into two symmetrical wing-like lobes and hence they are popularly known as 'sea butterflies'. These lobes or parapodia are the modified foot, and form an important part of the feeding mechanism. *Limacina* (Fig. 2), a primitive pteropod possesses a spiral shell, the diameter of which is only 30mm. *Creseis* (Fig. 3), an advanced mollusc, has a straight and tapering shell. *Cavolinia* (Fig. 4) has a transparent uncoiled shell which is in the form of quiver or vase. The maximum length of these shells may be a



Figs. 1. *Janthina*; 2. *Limacina*; 3. *Creseis*; 4. *Cavolinia*; 5. *Clione*

few centimeters. The lobes of these shelled and herbivorous pteropods are ciliated and, by the action of the cilia, food particles such as diatoms and other small organisms are sent to the mouth in a steady stream. Further, by the slow flapping movement of these lobes, the animals progress through water.

The naked sea butterflies do not possess shells, mantle cavities or gills. Their lobes, which are attached ventrally behind the head, produce effective strokes in the dorsal ventral

plane. *Clione* (Fig. 5), a naked carnivorous animal, measures only one centimeter and feeds on its shelled cousins. For the capture of prey, there are complex tentacles possessing suckers with hooks. These tentacles can contract into the mouth cavity when the animal is resting.

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Multiple Benefits of Plant Oil

MEDICAL studies in Britain suggest that rheumatoid arthritis, diabetes, alcoholism, skin and nail problems can be alleviated by taking a natural plant extract known as evening primrose oil. Evening primrose oil has been the subject of more than 500 clinical trials around the world and is already well known as a treatment for conditions such as PMT (premenstrual tension) and eczema.

The latest studies show the oil may help many rheumatoid arthritis patients to reduce their dose of non-steroidal anti-inflammatory drugs, or give them up altogether. Evening primrose oil is also claimed to offer benefits to the many diabetics who are affected by diabetic neuropathy, or damage to the nerves. This can cause loss of skin sensation, skin problems, muscle weakness, bladder and intestinal problems and impo-

tence in males, and there has so far been no effective treatment for it. New evening primrose oil has been found to actually reverse the nerve damage in diabetics. This was the conclusion of a study done by the Institute of Neurological Sciences at Glasgow University Medical School.

In another study at the Highland Psychiatric Research Group at Craig Dunain Hospital in Inverness, Scotland it was found that certain aspects of alcoholism, particularly withdrawal symptoms, liver damage and hangovers, can be treated with evening primrose oil, which may also help to reverse some of the brain damage caused by alcoholism. The treatment was found to improve brain function, especially in coordinating hand and eye among alcoholics treated with the oil. It has also been discovered that evening primrose oil can cure brittle nails. □

A simple disease that still awaits remedy

NO genetic disease could be simpler than sickle cell anaemia. A single base pair in the β -globin gene is

mutated from adenine to thymine, producing a corresponding change in the sixth amino acid of the protein from glutamic acid to valine. Under

conditions of low oxygen tension, the abnormal deoxyhaemoglobin polymerizes and eventually leads to a change in shape of red blood cell called sickling. When distorted, red blood cells obstruct small blood vessels resulting in 'crises', a term that dramatically describes a wide spectrum of events. They include from relatively brief painful episodes to massive thrombosis leading to infarction in bone, lung or brain. The organ damage is potentially crippling and the crisis may be life-threatening.

Although all patients with sickle cell anaemia have exactly the same genetic defect, there is wide variation in clinical expression of the disease. One of these variations α -thalassaemia results from the coexistence of a deletion in another globin gene. Other mutations may affect the intra-erythrocytic level of diphosphoglycerate (DPG), the main physiological regulator of the oxygen-haemoglobin dissociation curve. In chronic anaemias, an increase in DPG levels improves oxygen delivery to tissues, but in sickle cell anaemias the extra deoxygenation of haemoglobin favours sickling.

Another component favouring sickling could be a pH-dependent potassium channel that is apparently more active in the young red cells of sickle cell anaemia patients. This channel is insensitive to ouabain, a potent inhibitor of Na^+ , K^+ , ATPase and pump. This channel may contribute to dehydration of red blood cells and the consequent promotion of irreversibly sickle cells. Both the potassium channel and the enzyme diphosphoglycerate mutase, which regulate the DPG level, are potential targets for drug therapy.

Molecular biology has explained the basic defect in sickle cell anaemia and has provided the tools for prenatal diagnosis, but the treatment of afflicted patients undergoing crises has not correspondingly improved. A positive step was taken by the Wellcome Trust in the sponsoring of a Sickle Cell Workshop held in London on 4 November, 1988 to consider new approaches to the treatment of

sickle cell anaemia.

Treatment strategies can be broadly divided into five categories; anti-sickling agents; vasoactive drugs; promotion of persistence of fetal haemoglobin; bone marrow transplantation; and gene therapy. The first three approaches have failed so far, but there is increasing interest in the last two. Transplantation is available only to patients who have a suitable sib donor and the risks associated with the procedure and with graft-versus-host disease are still too high for this approach to become generally applicable in the treatment of sickle cell anaemia. But it is worth noting that bone marrow transplantation has been used successfully to treat about 200 children suffering from the more severe anaemia, thalassaemia major.

Gene therapy would avoid the problem associated with transplant rejection and graft-versus-host disease. Two approaches must be envisaged; replacing the mutated β -globin gene by homologous recombination, or insertion into the genome of haemopoietic cells of an additional copy of the normal gene. The former approach is ideal, but it requires a

substantial improvement in the isolation and culture of pluripotent stem cells (the stem cells that have more than a single mode of action) as well as in the efficiency of homologous recombination. The second approach also requires technical advances in stem cell culture and the development of suitable gene-transfer methods.

The development of novel treatment strategies could be greatly facilitated by animal models, and it would seem to be a high priority to adopt the new techniques of embryonic cell manipulation to create a mouse model of sickle cell anaemia. In some cases, mutations in the mouse models have failed to mimic directly the human disease. But this serves only to emphasize the importance of physiological studies and provides an opportunity for discovering key steps in the disease process. Finally, if somatic gene therapy is going to be a viable approach for treatment of genetic disease, much more must be learnt about the biology of stem cells, be it in muscle, brain or bone marrow.

Madhu Aggarwal

lic. But the AIIMS authorities say that women who might have received the contaminated vaccine are unlikely to develop AIDS because the vaccine has only antibodies to HIV, not the antigen itself.

Madhu Aggarwal

Hair-raising scheme

HUMAN hair is one of the India's resources that has heretofore gone to waste. But an Indian and a Japanese company have now formed a partnership to turn what was discarded into profit.

Hair is a potentially profitable source of amino acids. Under the new arrangement, Union Bros of Japan will supply expertise, equipment and part of the finance for a \$10-million processing plant being set up at Pondicherry in South India. The plant will consume 1,200 tonnes of human hair a year, turning it into 80 tonnes of L-cysteine, 24 tonnes of L-tyrosine and 1,400 tonnes of dry powder containing as many as 19 amino acids. The products are extensively used in the pharmaceutical, food-processing and cosmetic industries. The company expects to make 25 per cent profit and Japan will purchase the entire output for 8 years. Human hair has become an important raw material for amino acids after whaling restrictions made that source scarce. Apart from barber's shops, the biggest sources of human hair in India are temples, where Hindus shave their heads as a religious custom. One temple alone in Tirupati in Andhra Pradesh collects 4,000 tonnes of hair a year.

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(Continued on p. 533)

Further fears of HIV in India

FEARS of human immunodeficiency virus (HIV) contamination in the Indian blood pool have been heightened with the chance discovery of HIV antibodies in a widely used product derived from donors' blood. The government ordered a Bombay-based company, manufacturer of a wide range of blood products, to stop production and marketing of its products and has launched an investigation.

The government was alerted after the detection of HIV antibodies in

samples of anti-rhesus (Rh) immunoglobulin, a vaccine routinely given to Rh-negative mothers delivering Rh-positive babies.

The contamination would have gone unnoticed had it not been that one purchaser of the vaccine was a physician at the All India Institute of Medical Sciences (AIIMS) who casually asked a colleague to test it before injecting into his wife. Examination of more samples showed they were all positive for HIV.

This incident has sacred the medical community as well as the lay pub-

The Little-known Pioneering Biochemist *

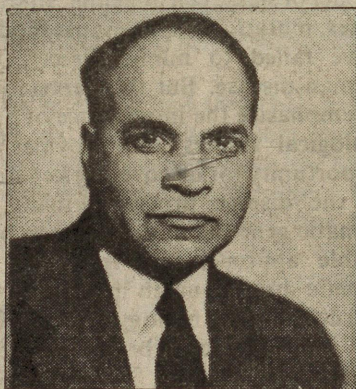
“...because he lived you may be alive today. Because he lived you may live longer.” Such was the tribute an American paid to an Indian biochemist who died at Pearl River, New York State, on 9 August 1948. Yet this man has remained obscure outside the ken of biochemists. Who is he? What were his aspirations? What were his achievements and what were his frustrations? Was he a religious mystic, or a down-to-earth practical scientist?

Yellapragada Subbarow is that little-known biochemical prodigy, born on 12 January 1895 in Bhimavaram, in West Godavari district. Like many a great scientist, he did not exactly distinguish himself either in his school days or graduate studies. He twice failed to pass the matriculation examination. Yet he made a spectacular start at the Harvard Medical School in 1924. One of his first researches led to a rapid colorimetric method for the estimation of phosphorus in body fluids and tissues. The American Society of Biological Chemists was not slow to recognise this biochemical tool. The method entered the standard biochemistry textbooks in 1925 as the “Fiske-Subba Row Method”.

The next landmark discoveries that Subba Row made with his senior collaborator Cyrus Fiske were phosphocreatine and adenosine triphosphate (ATP).

Had Lady Luck been as benevolent to him as to Otto Meyerhof and Archibald Hill, Subba Row and Fiske should have won the Nobel Prize for their work on phosphorus metabolism. John Edsall, of the Department of Biochemistry and Molecular Biology, Harvard University, feels that the credit for the discovery of ATP has gone only, but unfairly, to Karl Lohmann of Germany.

Hill and Meyerhof were awarded, in 1922, Nobel Prize in medicine (or physiology) for explaining muscular contraction in terms of the conversion of glycogen to lactic acid. Phosphocreatine and adenosine triphosphate, however, proved to be sources of muscular energy which makes possible all physical activities of living beings.



Dr. Subba Row

Subba Row's interest shifted to the so-called pernicious anemia factor, a cure for the deficiency disease, then thought to be related to tropical spruce. This was the disease which had afflicted many members of his family and even consumed his elder brother. Harvard, however, was not the place for Subba Row to get the wherewithal for his later researches. It gave him an initial start but did not nourish him further.

From a purely academic setup he moved over to the industrial environment of Lederle Laboratories at Pearl River, New York State, in May 1940.

It was at Lederle that the brahmin from Bhimavaram, directing a team of young scientists, presented to the medical world “a vitamin that avenged the death of Subba Row's brother from tropical spruce, and anti-filarial that fought an old scourge of India and other tropical countries, anti-vitamins which

opened a new line of attack on cancer, and an antibiotic that seemed like a panacea for many bacterial and some viral infections”.

Subba Row will for ever be remembered for his direction of research leading to the broad spectrum antibiotic Aureomycin, the trademark for chlortetracycline hydrochloride.

With William Bell as president, Dr Wilbur Malcolm as director, and Subba Row as associate director of research, Lederle became a pharmaceutical leader in a brief period of time.

Subba Row's perseverance in getting Lederle a secure place in the field of vitamins is well documented in the record books of the company. Suffice it to say here that the patents game he abhorred earlier in the academe he could no longer afford to ignore at Lederle. In this game, Subba Row and his associates were able to produce for Lederle, in the mid-1944, 400 kg a month of pantothenic acid (as calcium salt), considered then as a ‘universal’ vitamin.

He had his share of frustrations in his research career, as in his personal life. His better endowed rivals won glory as discoverers of the vitamin properties of nicotinic acid and pantothenic acid, and the final step in the isolation of vitamin B₁₂ eluded him. The sulpha drug phenosulphazole, held out then as a cure for polio victims, proved to be a failure. His attempts to conquer cancer through chemotherapy became more of an obsession.

Subba Row's self-effacing stance denied him perhaps the position that Cyrus Fiske held at Harvard. He thirsted for fame and name, which were denied to him in his lifetime for the simple reason he projected his students and collaborators and never presented himself as a candidate for any honour. He even went to the extent of writing to the president of the Harvard University, when Fiske's promotion to full professorship hung in a balance, that he was just an extra pair of hands to Fiske and the brains behind their joint work were Fiske's.

His marital life was one of ever-

lasting misery to his young wife Seshagiri, whom he left behind when he set sail to America a couple of years after their wedding. How could the poor girl realise the her husband was created not for bringing up a family but for alleviating human misery through battles on the frontiers of medical science? Yet she felt greatly relieved to learn that SubbaRow had not annuled their marriage nor remarried in an alien land.

"One of most eminent medical

minds of the century" is how *The New York Herald Tribune* described Subba Row, in its obituary columns.

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* Based on *In Quest of Panacea: Successes and Failures of Yellapragada Subba Row*, By S. PK. Gupta in collaboration with Edgar L. Milford, published by Evelyn Publishers, Ella's Cottage, B-108 Gulmohar Park, New Delhi 110049.

Magic Tetrahedra

A tetrahedron is a geometric figure having four faces and four vertices. Some magic tetrahedra can be obtained by placing the non-repetitive digits 1 to 8 at the vertices and the faces of a tetrahedron. There are only three different ways in which the digits 1 to 8 can be paired so as to have a constant difference d between the partners in the pairs:

1 2 3 4	1 2 5 6	1 3 5 7
4 ←	2 ←	1 ←
5 6 7 8	3 4 7 8	2 4 6 8

In the first group, the difference between the corresponding digits in the top and bottom sets is 4. In the second group, the difference is 2, and in the last group the difference is 1.

Now, if four digits belonging to any of the above groups are randomly distributed on the vertices of a tetrahedron and their partners are placed on the corresponding faces opposite those vertices; then a magic tetrahedron is obtained—the sum (S) of the three vertex digits and face digit is the same for every face trian-

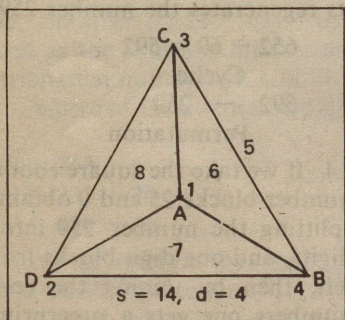


Fig. 1

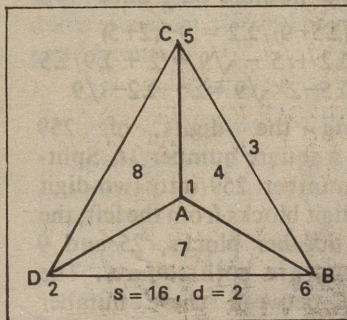


Fig. 2

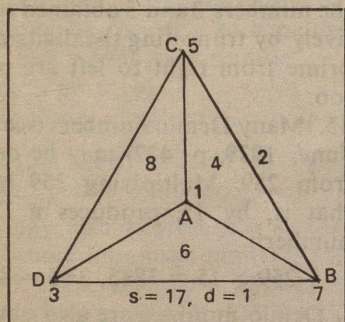


Fig. 3

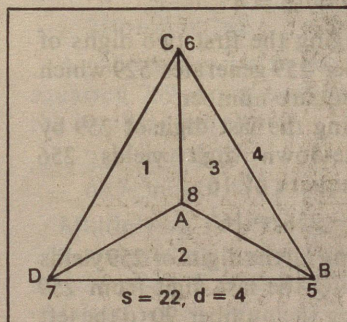


Fig. 4

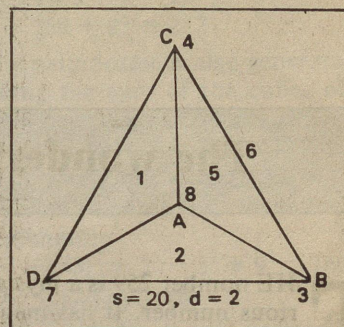


Fig. 5

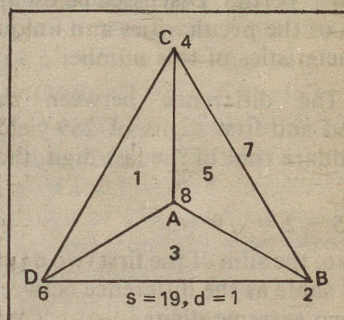


Fig. 6

gle of the tetrahedron. The magic tetrahedra formed for each of the three groups are shown in Figs. 1-3. The constant difference d for each group is also denoted. The digits 5, 3 and 2, which are respectively shown to lie outside the tetrahedra, belong to the face triangle CDB.

It is interesting to note that in each case the sum $S+d$ is 18. It is also possible to form conjugate magic tetrahedra by replacing each digit in the above tetrahedra by its conjugate digit. This can be done straightaway by subtracting each digit from 9 which is the sum to which two conjugate digits add to. The conjugate magic tetrahedra thus obtained are shown in Figs. 4-6. Note that in contrast with the first three tetrahedra the sums $S+d$ for these tetrahedra are not the same.

The six different magic tetrahedra obtained above can further have their mirror images. So, in all, twelve magic tetrahedra are possible. However, the number of distinct possible sums remains six only.

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The wonderful number 259

THE number 259 is a mysterious number. It has many amazing and curious properties. Discussed below are some of the peculiarities and unique characteristics of this number.

1. The difference between the second and first digits of 259 yields the square root of the last digit, that is,

$$5 - 2 = \sqrt{9}$$

Also, the sum of the first two digits is the same as the difference between the two extreme digits :

$$2 + 5 = 9 - 2$$

The following interesting relation also exists between the digits of 259 :

$$\Sigma 2 + \Sigma 5 + \Sigma 9 = (2+5) \times 9$$

2. Squaring and adding the first two digits of 259 yields 29, the number formed by deleting the middle digit of 259 :

$$2^2 + 5^2 = 29$$

Further, by adding to the second digit the square of the first digit yields the last digit of the number 259 :

$$2^2 + 5 = 9$$

3. The number 259 can be expressed as the difference of two squares in two different ways :

$$259 = 22^2 - 15^2 = 130^2 - 129^2$$

4. It is also expressible as the sum of three distinct squares in two different ways :

$$259 = 3^2 + 5^2 + 15^2 = 3^2 + 9^2 + 13^2$$

5. The number 259 can also be expressed as the sum of four cubes (three of them being discrete) in two different ways :

$$259 = 2^3 + 2^3 + 3^3 + 6^3 = 1^3 + 2^3 + 5^3 + 5^3$$

6. The number 259 is the sum of a fourth and a fifth power, that is,

$$259 = 2^4 + 3^5$$

The curious coincidence may be noted. The numbers 2, 3 and the powers 4, 5 form a perfect arithmetical sequence 2, 3, 4, 5.

7. The number 259, interestingly, may be expressed in the form of a geometric series, viz.,

$$259 = 1 + 2 \times 3 + (2 \times 3)^2 + (2 \times 3)^3$$

8. The following relations exhibited by second and fourth powers of 259 are also worth noting :

$$2 \times 259^2 = 64^2 + 221^2 + 285^2$$

$$2 \times 259^4 = 64^4 + 221^4 + 285^4$$

9. The factors of 259, viz., 7 and 37, can be expressed as the sum of two fractional cubes :

$$7 = (5/3)^3 + (4/3)^3$$

$$37 = (19/7)^3 + (18/7)^3$$

10. The individual digits of the number 259 can each be expressed in two different ways by using all the digits of the number only once :

$$2 = (\Sigma 5 - 9) / \Sigma 2 = 9 - (2 + 5)$$

$$5 = \Sigma 2 + 5 - \sqrt{9} = 2 + \Sigma 9 / \Sigma 5$$

$$9 = \Sigma 5 - 2 \times \sqrt{9} = \Sigma 5 - \Sigma 2 - \sqrt{9}$$

11. Adding the digits of 259 generates a square number 16. Splitting the number 259 into two-digit and one-digit blocks from the left, the resulting number blocks, 25 and 9 respectively, are both squares. The difference between these number blocks too is a square :

$$25 - 9 = 16 = 4^2$$

Interchanging the first two digits of the number 259 generates 529 which is also a square number.

Replacing the last digit of 259 by its upside-down digit yields 256 which is square of 16 :

$$259 \rightarrow 256 = 16^2$$

Multiplying all the digits of 259 yields 90. Deleting the last digit from 259 and joining the number 90 to the left of the remnant number yields 9025, a

square number :

$$9025 = 95^2$$

Taking the product of the sum of the first two digits with the last digit of 259 yields 63. When this number is subtracted from 259, a square number is obtained :

$$(2 + 5) \times 9 = 63$$

$$259 - 63 = 196 = 14^2$$

12. A cubic number may also be derived from 259 by inserting 37 (one of the factors of 259) between the last two digits and zero between the first two digits of 259 :

$$259 \rightarrow 20\ 5\ 37\ 9 = 59^3$$

13. Replacing the last digit 9 of 259 by its upside-down digit 6 yields 256. This number, interestingly, may also be derived from 259 by adding its digits and then taking the square of the resulting number :

$$259 \rightarrow 256$$

$$(2+5+9)^2 = 16^2 = 256$$

Interestingly, from 256 one can get back 259 by carrying out certain mathematical operations. Reverse the number 256 and subtracting from the reversal the product of the digits of the number 256. This yields 592, the cyclic permutation of whose digits regenerates the number 259 :

$$652 - 60 = 592$$

Cyclic

$$592 \rightarrow 259$$

Permutation

14. If we take the square root of the number blocks 25 and 9 obtained by splitting the number 259 into two-digits, and one-digit blocks from the left, then by joining the resulting numbers one gets a superprime 53. This number is not only a prime but the numbers 3 and 5 obtained respectively by truncating the digits of this prime from right to left are primes too.

15. Many Demlo numbers (see S.R.J., June, 1979, p. 422) may be derived from 259. Multiplying 259 by $\Sigma 5$, that is, by 15, produces a Demlo number :

$$259 \times 15 = 3885, 3+5 = 8$$

Demlo numbers are also obtained by multiplying 259 by 9, 99 or by 111,

SCIENCE FOR THE YOUNG

1111, 11111, etc.,

$$\begin{aligned} 259 \times 9 &= 2331 & ; 2+1 &= 3 \\ 259 \times 99 &= 25641 & ; 25+41 &= 66 \\ 259 \times 111 &= 28749 & ; 28+49 &= 77 \\ 259 \times 1111 &= 287749 & ; 28+49 &= 77 \\ 259 \times 11111 &= 2877749 & ; 28+49 &= 77 \end{aligned}$$

16. By taking the cyclic permutation of the digits of 259, the numbers thus formed are 592 and 925 respectively. These numbers, including the parent number 259, are all multiples of 37, that is,

$$\begin{aligned} 259 &= 7 \times 37 \\ 592 &= 16 \times 37 \\ 925 &= 25 \times 37 \end{aligned}$$

Calling these numbers a, b and c, respectively, the differences b-a, c-b and c-a are all monodigital palindromes :

$$\begin{aligned} 592 - 259 &= 333 \\ 925 - 592 &= 333 \\ 925 - 259 &= 666 \end{aligned}$$

Interestingly, the cyclic numbers a, b and c themselves may be expressed in terms of other cyclic numbers, e.g.,

$$\begin{aligned} 259 &= 74 + 185 \\ 592 &= 74 + 518 \\ 925 &= 74 + 851 \\ 259 &= 111 + 148 \\ 592 &= 111 + 481 \\ 925 &= 111 + 814 \end{aligned}$$

17. The number 259 may be expressed as the sum and difference of two triangular numbers [1, 3, 6, 10, 15, 21,.... where n^{th} term = $n(n+1)/2$], viz.,

$$\begin{aligned} 259 &= 253 + 6 \\ 259 &= 231 + 28 \\ 259 &= 325 - 66 \end{aligned}$$

It is also expressible as the sum of a triangular and a square number :

$$259 = 210 + 49$$

The number 259 may also be represented as the sum of a palindromic and a triangular number :

$$\begin{aligned} 259 &= 88 + 171 \\ 259 &= 181 + 78 \end{aligned}$$

Note that the number 171 is triangular and palindromic too.

We may also express 259 as the sum of three Fibonacci numbers [0, 1, 1, 2, 3, 5, 8,.... where $(n+2)^{\text{th}}$ term = sum of n^{th} term and $(n+1)^{\text{th}}$ term], viz.,

$$259 = 233 + 21 + 5$$

18. Many palindromes (i.e., numbers which read the same forward as well as backward) may be derived from the number 259. Adding the extreme digits of 259 generates the monodigital palindrome

11. Adding to and subtracting from this number, the middle digit of 259 generates the numbers 16 and 6 respectively. The sum of these numbers is a palindrome :

$$\begin{aligned} 2 + 9 + 5 &= 16 \\ 2 + 9 - 5 &= 6 \\ 16 + 6 &= 22 \end{aligned}$$

Replacing 6 by its upside-down digit 9, the numbers 16 and 6 are transformed to 19 and 9 respectively. The product of these numbers yields a palindrome :

$$19 \times 9 = 171$$

Subtracting the factors of 259 from the parent number also generates palindromes :

$$\begin{aligned} 259 - 7 &= 252 \\ 259 - 37 &= 222 \end{aligned}$$

Separating 259 into two-digit and one-digit blocks from the left and taking the sum and difference of the squares of these number blocks produces numbers which are double of palindromes :

$$\begin{aligned} 25^2 + 9^2 &= 706 = 2 \times 353 \\ 25^2 - 9^2 &= 544 = 2 \times 272 \end{aligned}$$

A palindrome is also generated by multiplying 259 by the square root of its last digit :

$$259 \times 3 = 777$$

Adding the square root of the last digit to 259 also results in a palindrome, that is,

$$259 + 3 = 262$$

A palindrome is also generated by squaring 259 and adding the digits of the resulting number :

$$\begin{aligned} 259^2 &= 67081 \\ 6+7+0+8+1 &= 22 \end{aligned}$$

Multiplying the extreme digits of 259 and adding to the product the middle digit 5, the number 23 is obtained which, when added to 259, generates a palindrome :

$$\begin{aligned} 2 \times 9 + 5 &= 23 \\ 259 + 23 &= 282 \end{aligned}$$

A palindrome is also generated by taking the sum of the cubes of the extreme digits of 259, that is,

$$2^3 + 9^3 = 8 + 729 = 737$$

A palindrome also results from the following operations which are self-explanatory :

$$\begin{aligned} (2 \times 5)^2 + 2^2 - 5^2 + 9^2 &= 160 \\ 259 - 160 &= 99 \end{aligned}$$

It is also possible to obtain a palindrome by multiplying the sum of the extreme digits with the middle digit of 259 :

$$(2+9) \times 5 = 55$$

If the above number is added to the number obtained by multiplying the sum of the first two digits with the last digit of 259 and then the sum is subtracted from 259, a palindrome is again produced :

$$\begin{aligned} (2+5) \times 9 &= 63 \\ 55 + 63 &= 118 \\ 259 - 118 &= 141 \end{aligned}$$

19. When the individual digits of 259 are added to the number itself, the resulting numbers are products of primes, e.g.,

$$\begin{aligned} 259 + 2 &= 261 = 3^2 \times 29 \\ 259 + 5 &= 264 = 2^3 \times 3 \times 11 \\ 259 + 9 &= 268 = 2^2 \times 67 \end{aligned}$$

The number 264 shows curious properties. It is a Harshad number as it is divisible by the sum of its digits. The square of this number yields a palindrome :

$$264^2 = 69696$$

When turned upside down the above number generates 96969 which is palindromic too. The palindrome 69696, moreover, may be expressed as the product of two palindromes, of which one is mono-digital :

$$69696 = 11 \times 6336$$

The palindrome 6336 may further be represented by a palindromic expression :

$$6336 = 8 \times (63+36) \times 8$$

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(Continued on p.528, 535)

Fragile-X Chromosome and Mental Retardation

IMPORTANCE of cytogenetics is increasing in the medical field for its diagnostic and prognostic values. An important landmark in the development of this science was finding of an extra chromosome in patients with Down's syndrome. Subsequently, changes in the number and structure of chromosomes were demonstrated in many other disease states, such as cancers, congenital malformations, mental disorders, etc.

Down's syndrome is one of the most common clinical syndromes associated with demonstrable chromosome abnormality. It is also referred to as 'trisomy 21' due to the presence of an extra copy of chromosome No. 21.

Next to the Down's syndrome, the second most common cause for mental retardation was recently found to be due to an interesting cytogenetic phenomena known as 'fragile-X chromosome' which are X-chromosome having a 'fragile' site.

The role of autosomal fragile sites is obscure, but a fragile site present on X-chromosome is associated with one form of mental retardation. This disorder is also referred to as 'fragile-X syndrome'. As both fragile-X syndrome and Down's syndrome are characterized by mental retardation, sometimes the disease state may be misinterpreted as Down's syndrome. This discrepancy can be avoided with the help of chromosomal analysis of the patients.

Clinical features of fragile-X syndrome include mental retardation which may vary from severe to mild. Speech delay is greater than motor development delay. The speech tends to be narrative and compulsive and is referred to as 'litany speech'. Some patients show behaviour problems which have been labelled as autistic and hyperactive. Macroorchidism (testicular enlargement) is generally present in adults and possibly in pre-puberty males. Birth weight of the affected child is more than that of

Though fragile-X chromosome is known to cause mental retardation, not much is known about its nature and effects. At the present state of rudimentary knowledge, the study of fragile-X chromosome is an essential part of clinical cytogenetics for its diagnosis, prevention and possible treatment for mental retardation.

Diagnosis of fragile-X syndrome

Patients with mental retardation and other symptoms can be checked up for the presence of Fragile-X chromosome by chromosomal analysis. Culturing lymphocytes of peripheral blood in a nutrient medium and preparing chromosomes is the usual method for finding fragile-X chromosome. For the expression of fragile site, the culturing medium should be deficient in folic acid. Parents of a patient can have information from doctors regarding the place where cytogenetic analysis is carried out.

Folic acid therapy for fragile-X syndrome is under intensive clinical trial. Oral administration of folic acid to patients leads to considerable improvement in disease condition.

Genetic counselling and prenatal diagnosis

Genetic counselling is an aspect of clinical medicine, advising about the recurrence risk of a particular abnormality. Fragile-X chromosome in female carrier may be used as an important marker for genetic counselling, since there would be 50% risk in these women giving birth to mentally retarded child with fragile-X chromosome.

Prenatal diagnosis enables one to prevent the birth of an abnormal child through abortion or management. Prenatal diagnosis of fragile-X syndrome can save many families from the burden of having a mentally retarded child.

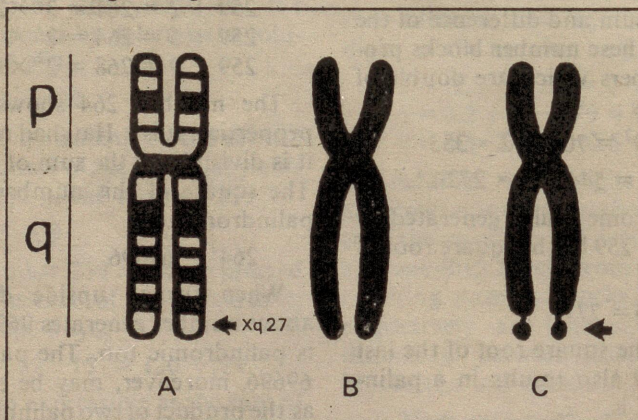


Fig. 1. Diagrammatic representation of X-chromosome. (A) G-banded pattern of X-chromosome to identify the location of fragile site Xq²⁷ (indicated by arrow). p & q are short arm and long arm of X-chromosome; (B) Normal X-chromosome without fragile site; (C) X-chromosome with a fragile site at Xq²⁷ (indicated by arrow)

Fragile site is a weak point on a human chromosome and can be seen as a non-staining gap on metaphase chromosomes (Fig 1). It occurs consistently at the same point in an individual positive for fragile site. The site is heritable and is said to be the manifestation of DNA-coded infor-

siblings. The affected child has larger than normal head circumference before puberty which returns to normal in adulthood. Patients with fragile-X syndrome has characteristic facial appearance due to (a) large forehead, (b) prominent chin, (c) large ears, and (d) pale irides.

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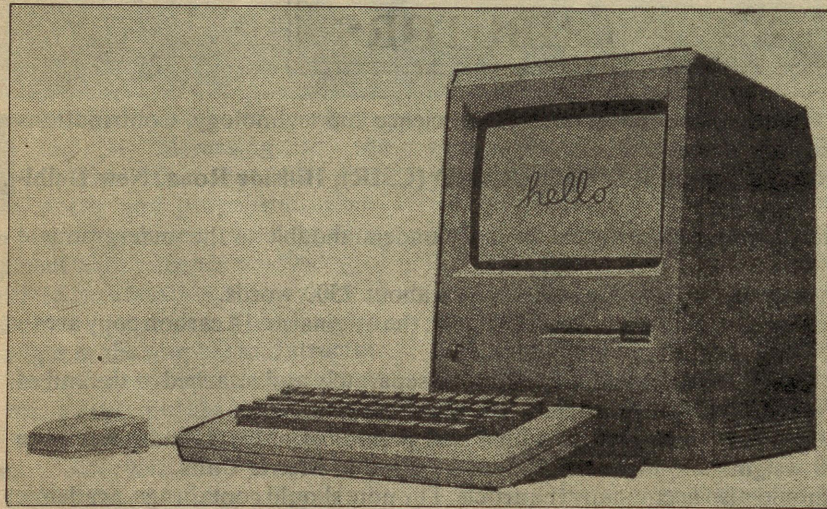
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In the World of BASIC-III

IN the previous part, you were asked to become familiar with keyboard and type anything at random. In short, every knob on the board, viz., alphabets, numbers, various signs, Shift Key, Caps Lock, etc., is to be used. Also try to manipulate the cursor. When a complete line is typed or even earlier, you may get the message "Syntax Error" on pressing the return key. For the time being you ignore it and continue the typing. As long as the word OK or Ready appears on the screen, it is all right.

Print Command

Now comes execution of commands. The most important command is PRINT command which tells the computer to print the information. Even though the computer understands both small and capital letters, it is preferable to use capital letters during programming. In fact, there are occasions when a computer would not differentiate the word 'yes' from 'YES'. Hence you can press the Caps Lock key and keep it in that position. If small letters are to be typed, this can be easily done by pressing the Shift key and by typing

(this cancels the earlier command).

As PRINT command is very important, there is a need to study it in detail. Bring the cursor to the left of the line and type:

```
PRINT 20
```

Note that one space is left after PRINT. Now press the Return key. The computer will come up with:

```
20
OK
```

You will notice that wherever the cursor is positioned, 20 will appear on the next line after one space. This space is deliberately left so that the sign before the number can be indicated. If the number is positive, the computer does not indicate it but one space is still left. Earlier, during random typing, the computer came up with a message: "SYNTAX ERROR". This is the computer's way of saying, "Look, I do not understand you—could you be more specific?"

Take a look at the left side of Program 1 and type out exactly as it is given. You would notice that when the computer is asked to print a number, it understood the command but when it is asked to type a word or

an alphabet, it prints 0. This is a feature of Basic language, viz., whenever it encounters a variable name without any physical quantity assigned to it it automatically assigns 0 to it. In computer parlance, this is called default and the computer takes its own decision as to what the result should be.

Print with Strings

Type the following:
PRINT "A"

As usual one space may be left after Print but right now do not leave any space before or after A. The alphabet A gets printed. Type what is given in the right side of Program 1 and see for yourself that whatever is enclosed in the inverted commas or quotes is printed. It may be a numeral, an alphabet, any other notation or even any combination of these. The computer does not bother about what it is asked to print. In computer parlance, the enclosed item between " ", is called a string. The first thumb rule is: when you want to print something other than a numeral, enclose it in strings.

PRINT 20	PRINT "20"
20	20
PRINT 50+30	PRINT "50+30"
80	50+30
PRINT A	PRINT "A"
0	A
PRINT GOOD	PRINT "GOOD"
0	GOOD
PRINT (** \$ &)	PRINT "(** \$ &)"
Syntax error	(** \$ &)

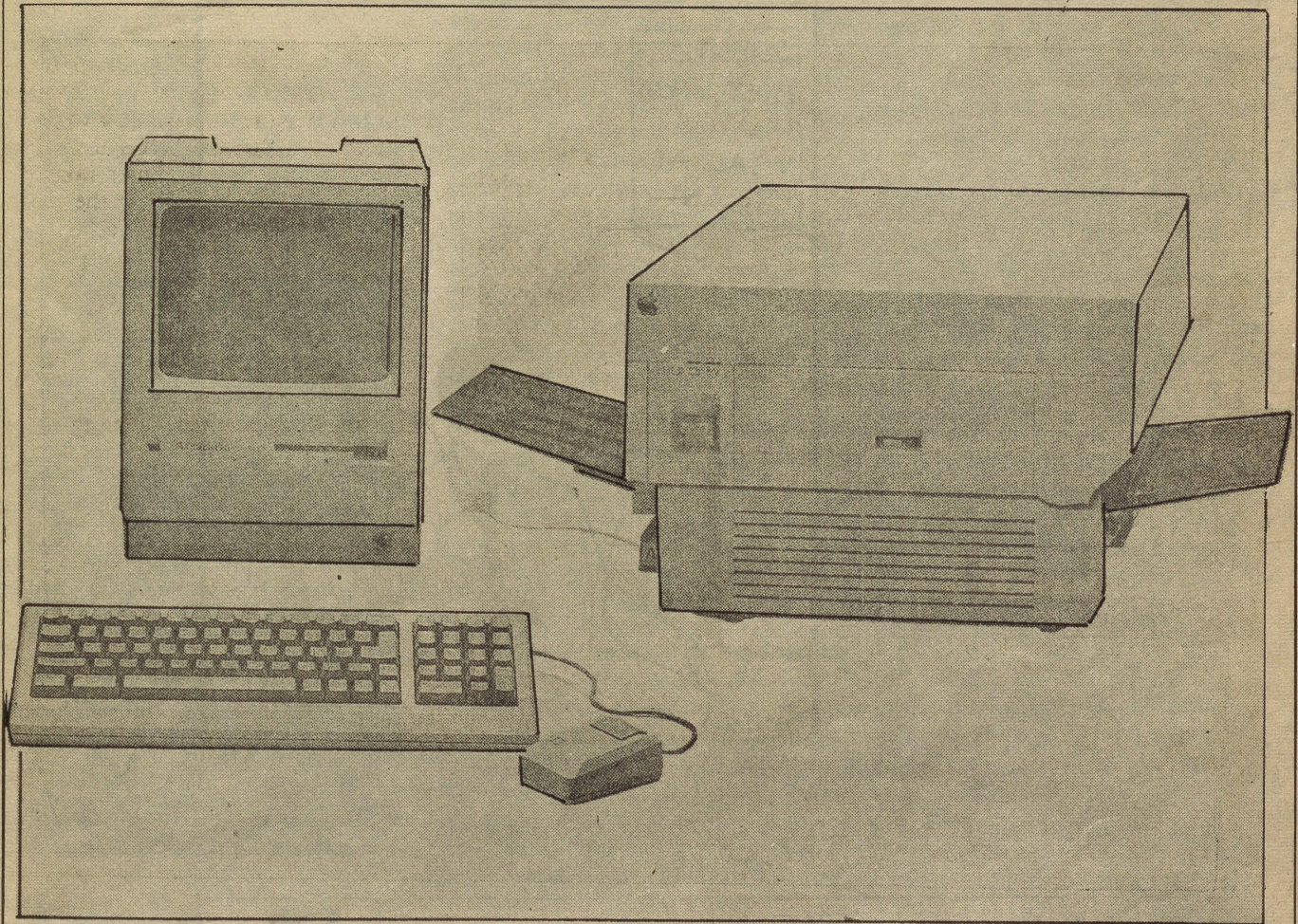
Program 1. Printing with and without Strings

In other words, the computer recognizes only numerals when a simple print command is issued and all other things are treated as zero.

How Punctuations Affect Print Command

Take a look at both left and right side of Program 2 and run it exactly as given. Take care to use comma, semicolon and colon as indicated. You will notice:

- (i) When there is a semi-colon



PRINT 5, 8	PRINT "5, 8"
5 8	5, 8
PRINT 5 ; 8	PRINT "5 ; 8"
5 8	5;8
PRINT 5 : 8	PRINT "5 : 8"
Syntax error	5:8
PRINT "A", "B"	PRINT "A, B"
A B	A, B
PRINT "A"; "B"	PRINT "A; B"
AB	A ; B
PRINT "A"; "B"	PRINT "A:B"
Syntax error	A:B

Program 2. How punctuation mark affects Print command

separating two numerals or strings in the same print command, there is no space in the case of strings in the output and just one space when

numerals are printed. The extra space is for the sign. This is true even if there were two Print commands and a semi-colon is at the end of the first Print command.

(ii) If there is a comma between two numerals or strings in the same print command, a gap exists between the two items in the output.

(iii) In case a colon is used, the computer does not accept the command and sends an error signal.

The next two rules are: when you want to print two items with no space between them use a semicolon and when you want a large space use a comma (an intelligent reader should see for himself how many items can be typed in a single line with a comma between them).

Tab Command

Before concluding this part, a small command called TAB command can be pointed out. Try to type: PRINT TAB (7); "one"

Ensure that a semicolon is present after TAB(7). The word ONE starts at the seventh column. Though this command may not appear to serve any purpose in ordinary programming, it is a clever device to make the printout attractive and is useful in compiling data, games, writing poetry and other such purposes.

V. Ramshesh
10C Kamet
Anushakti Nagar
Bombay-400094

CARTOONS



By Pradeep K. Srivastava

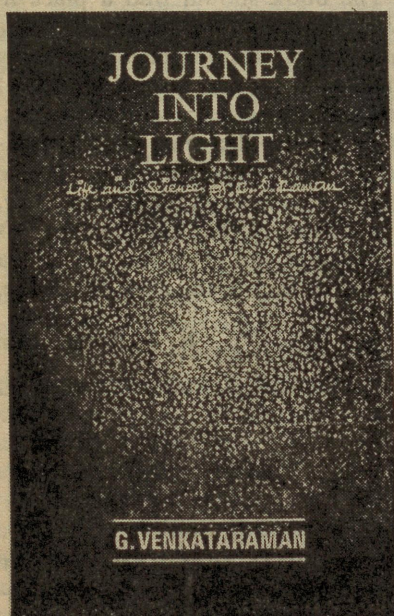
"Perhaps he knows!....."



"The secret of his good health and comfortable stay for 35 years in this research institute is due to the simple fact that he did everything except research".

BOOK REVIEWS

JOURNEY INTO LIGHT : LIFE AND SCIENCE OF C V RAMAN
by G Venkataraman *Indian Academy of Science*, Bangalore 560080, ISBN 81-85324-00-x, pp. XVIII+570, Rs. 325.00



RAMAN, the scientist, has remained for the millions of Indians a hallowed personality who stirs up visions of a keen analytical brain coupled with dynamic activity. Raman symbolises the person in whom the Eastern philosophy and Western science are harmoniously blended. The announcement of the Nobel Prize in Physics to Raman in 1930 brought in a sense of pride and achievement in the heart of every Indian of the era. Repeated stories about the discovery of 'Raman Effect' and about how Raman achieved a feat in science with an equipment costing two hundred rupees, what western scientists could not achieve with their sophisticated equipment, have transformed Raman into a legendary figure.

Though every Indian looks up with respect and awe at the mention of C.V. Raman's name, very few

know what exactly are his achievements in science. Many Indian scientists who have a good knowledge of 'Raman Effect' are not aware of his contributions in other branches and of his efforts to build up the structure of modern science in India. The younger generation idolising the name of Raman should emulate the ideals of the band of research workers who flocked to Raman in the 20s when scientific research was not a rewarding vocation but a labour of love. The international scientific community would desire to know more about the other achievements of the discoverer of 'Raman Effect' and about the Indian pioneers of Raman spectroscopy which continues to be a field of active research even today after six decades of its discovery. Dr. Venkataraman has not only commendably fulfilled all the above mentioned needs by taking us through the *Journey into Light* but has also provided enough interesting commentaries which many readers would like to savour, ponder over and even criticize. He has not failed to point out the human weaknesses in Raman. Thus the *Journey into Light* will not only inform readers but also educate and even stimulate and provoke them.

The social, political and scientific atmosphere in which Raman was born is narrated in the first chapter which is followed by a condensed account of Raman's early life up to his entering government service as an Assistant Accountant-General. Raman, the topper of all examinations, had carried out research and published a paper in a foreign journal even before he was eighteen! Raman fell in love with a young girl and married her refusing to take any dowry. The anecdote about the young girl singing the Thyagaraja's song '*Ramani sammanam evaro*' meaning 'Rama, there is no equal to you' at the first time Raman came to see her adds flavour to the story of Raman's early life. In the chapter enticingly captioned, 'Oh! Calcutta', the author traces Raman's transformation from a government servant to a full time scientific investigator. Calcutta was a

world centre for scientific research comparable to Cambridge and Göttingen of that epoch. Venkataraman gives an account of the activities of such stalwarts of science as J C Bose, P C Ray, M N Saha and S N Bose. The contributions of Sir Asutosh Mookerjee in the shaping of Raman are vividly brought out in this chapter.

Sir Asutosh Mookerjee as Vice Chancellor of Calcutta University realised the great potential in Raman and saw to it that he was appointed Palit Professor of Physics. When criticisms were made against the appointment by pointing out that Raman guiding students for a doctorate himself lacked a doctorate and that he had not been exposed to research atmosphere in the western world, he circumvented them by awarding an honorary doctorate to Raman and by sending Raman on a tour of western scientific laboratories.

In the largest chapter entitled, 'Glimpses from the Golden Era', the scientific activities of the Raman's



School of Physics in Calcutta earlier to investigations on light scattering are vividly portrayed. But it is the chapter entitled, 'Elementary, My dear Watson' which is thrilling as its

BOOK REVIEWS

title connotes. The quest towards 'Raman Effect' started with the question—Why is the sea blue? Rayleigh's explanation was disputed by Raman who gave his own explanation which had grains of the discovery that there is a change in the colour of light due to scattering. This phenomenon which was then envisaged as the optical equivalent of Compton Effect was theoretically propounded by a few western scientists. Yet, their attempts to discover the phenomenon were not successful. The reasons why they failed and Raman succeeded are lucidly brought out in this chapter. The sixth chapter is meant for the readers who have scientific background and to know the basic ideas of Raman Effect. The next chapter brings out the impact of laser on Raman Effect and the renaissance in the Raman Effect studies.

With his strong views on men and matters Raman got into trouble in Calcutta and had to shift to Bangalore where he started a new phase of life. The history of the Indian Institute of Science to which Raman shifted from Calcutta and his achievements there form the Chapter entitled 'On to Bangalore'. This chapter will be found interesting by those who want to know about the impact of science on society and the impact of men of vision on scientific institutions. In the next chapter entitled, "Son et Lumiere", which is meant only for those with scientific background, the significance of several studies carried out under the guidance of Raman is brought out. The author has not minced words in pointing out several wrong deductions of Raman.

Starting the next chapter with the quotation of Samuel Smiles, "He who have made no mistakes, never made a discovery", Venkataraman deals with the famous Born-Raman controversy. As scientific controversies are a class apart from political, economical and societal, even a general reader will find this chapter interesting. Again Raman had trouble with the authorities of The Indian Institute of Science and could not get on with other scientific luminaries. Hence he had to found his own insti-

tute and a scientific academy. The events that led to this phase of his life are brought out in the following two chapters.

Raman's considered views, opinions and comments on very many aspects of life are valuable at any epoch and these are compiled with a cogent commentary by Venkataraman in the Chapter 'Sharing the Pleasure'. In the Last chapter, Venkataraman has ably abstracted the essential features of Raman the scientist as well as Raman the man, and compared the features of a few other top scientists who shaped Indian science as seen today.

Going over the collection of photographs in the book will itself be a pleasant experience for those who admire Raman. The large collection of notes gives interesting information. The name and subject indexes at the end of the book help a lot for anyone who would like to make a different appraisal of Raman's life and work.

During the reading and re-reading of the book over a period of a few months, the reviewer felt a mixture of happiness and depression—happiness in being conducted through the *Journey into Light* by a master guide and depression to realise that behind the dedication of the book 'In fond memory of Suresh' lies a great private tragedy of the author.

A host of questions are asked today in the year following Raman's birth centenary celebrations. Has scientific research in India today failed to attract such devoted workers as were found in the 20s? Have scientific institutions been bureaucratised? Why is it despite considerable allocation of funds for research and India having a large bank of scientifically qualified personnel, Indian scientific contributions have not made such a powerful impact on international scientific community as in Raman's days? Why is it that Indian Raman spectroscopists failed to be leaders in this field after the 60s when renaissance for Raman spectroscopy was not included in the syllabus for postgraduate physics courses in a few universi-

ties in India? The book is the one which should be read by those who want an answer to these questions. Many may not agree with the commentaries and opinions of the author but there is no denying the fact that his method of expressing his views is far from rigid and he gives due respect to those who might differ from him.

The book should find a place in every library so that future Ramans may get inspiration, science administrators may ponder over problems of present day science and scientists, and science policy planners and politicians may gain some insight into the future of science in the 21st century. The statement that 'the past moulds the present and plans the future' is a verifiable fact in the area of science.

K. S. Rangarajan

ROMPING IN NUMBERLAND by P.K. Srinivasan, *Alarsri Publications* Alarsri, Plot 5, Street 25, T.G. Nagar, Madras-600061, Pp. 62, Rs. 20.00.

JOY and pleasure can be derived from mathematics by discovering beautiful number patterns and arrangements. Playing with numbers by invoking the fundamental skills of addition, subtraction, multiplication, and division, many new and fascinating number properties may be discovered. The book under review shows how this can be accomplished. Written in a simple style, the book is meant for students of age between ten and twelve. The book will motivate them to enter the fascinating world of numbers and discover for themselves many peculiar and enchanting number patterns. The book will be able to develop in young students self-confidence needed for taking further studies in mathematics.

P.K. Mukherjee

BOOK REVIEWS

NUMBER FUN WITH A CALENDAR by P.K. Srinivasan, *Alarsri Publications*, Alarsri, Plot 5, Street 25, T.G. Nagar, Madras-600061, Pp. 76, Rs. 20.00.

Recreation and fun with numbers relieves young students from the boredom of traditional mathematics and helps develop in them a taste for learning mathematics. Devising new innovative approaches and methods for teaching and learning mathematics has always been a challenging task. Number fun with a commonplace material like calendar can be both fascinating and exciting.

The author of the book under review has tried to find new patterns with numbers in a calendar. The author has shown how to discover magic rectangles, magic squares cross puzzles, star puzzles, etc., from the numbers that appear in the calendar. The entire material has been presented in the form of a dialogue between a father and his sons, which makes the book more appealing. The book meant for students of age between eleven and fourteen has been written in a simple and lucid style. It will be able to provide young students a new source of mathematical enjoyment and motivate them to take up mathematics seriously.

P.K. Mukherjee

ELEMENTS OF THERMAL SCIENCE FOR ENGINEERS by C.P. Gupta and Rajendra Prakash, *Nem chand & Brothers*, Roorkee (U.P.) Pp. 452, Price not mentioned.

AS the title suggests, the book deals with the basics of thermodynamics and heat transfer. Broadly speaking, thermodynamics deals with the transformation of energy of all kinds from one form to another.

The first law governs energy transformations quantitatively without any restriction on the direction. Whereas the second law states that free flow of heat is only possible from a body of higher temperature to that at a lower temperature, i.e., it dictates its direction. Thermodynamics is basically the science of these energy transformations at equilibrium. The science of heat transfer embraces the complexities of heat flow due to temperature non-equilibrium. Though these two sciences are put together in the same book, it is necessary to keep in mind that the principles of heat transfer are not obtainable from the basic laws of thermodynamics. It is certainly, firmly grounded on the sciences of thermodynamics and fluid mechanics, but heat transfer itself is a separate branch of science. This book is intended to serve as a text-book for the beginners' courses in thermal science as in recent years the syllabi of a majority of technical institutions have been revised to incorporate basic principles of thermodynamics and heat transfer as a core-course for all branches of engineering.

The book is well written and the subject matter has been presented in a simple, lucid and precise manner. The worked-out examples would help students understand the subject properly.

Bibek Banerjee

A BOOK OF PROBLEMS IN ORDINARY DIFFERENTIAL EQUATIONS by M.L. Krasnov, A.I. Kiselyov and G.I. Makeyenko, *Mir Publishers*, Moscow (Available at: *USSR Book Center*, Connaught Place, New Delhi 110001), Pp. 332; Price Rs. 24.00.

UNDoubtedly, this book by Krasnov and others is not just yet another book on ordinary differential equations containing a large collection of exercises for stu-

dents of higher technical schools and colleges. It covers many novel topics, including those normally covered in a book of differential equations, for instance, method of isoclines for equations of the first and second order, problems on finding orthogonal trajectories, integration of a system of differential equations which occur in applied problems in natural sciences and technology, Lyapunov stability concerning the existence of solutions to a set of simultaneous differential equations, and the operator method of solving differential equations.

What is appealing about the book to average readers, especially students, is the large collection of nearly 1000 problems of different types of equations, a good proportion of which are really 'tough' by IIT-JEE or GATE examination standards. Answers and hints for most of the harder problems are given at the end. In short, with these problems interspersed with text portions, a student need not hunt for standard treatises on the subject like those of Piaggio or Forsyth! Some of the problems such as the Laplace transform method of solving linear equations, Frobenius method of integration in series involving the definition of special functions, phase-trajectories and asymptotic solutions to differential equations are of immense importance to engineering students. One or two appendices included in the book concern with basic formulae of differential geometry, few Laplace transforms and bibliography.

As regards scope for further improvement of this otherwise well-written book, apart from a bit comprehensive listing of Laplace transforms, few sections on numerical method of solving intractable and non-linear equations might be of immense help. Finally, this reviewer wishes that the authors should write a companion volume on partial differential equations, which are of course important in many boundary value problems in natural sciences and technology.

R. Sambasivan

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Hasan Jawaid Khan

Vegetables round the year

A leading Japanese food company has developed a system that produces virtually bacteria-free vegetables with significantly shortened growth periods. The Hydroculture System, an adaptation of hydroponics principle, is designed to attain a regular supply of vegetables of consistent quality and size, regardless of location, season, insects or weather conditions. The system can produce a stable supply of vegetables anywhere in the world at a low cost.

In the triangular panel and spray system, also known as the 'T.S. Farm', nutrients are sprayed over vegetable roots, rather than immersing them in chemical solutions. In this manner, the roots can absorb the required oxygen more effectively from the atmosphere, thereby quickening vegetable growth. Plants suitable for cultivation using this method include such vegetables as lettuce,

parsley, celery, spinach, various spices and herbs. Experimental cultivation of strawberries and other fruits is also underway.

The T.S. Farm is composed of two insulated rooms—one a nursery for seedlings and the other for rearing vegetables to maturity. Modular triangular panels on the inside form three-sided pyramids. The inner surface provides twice the area for cultivation than conventional flat-type hydrocultivation systems. To enhance growth conditions, light, temperature, humidity, carbon dioxide and oxygen levels are controlled independently in each room. The carefully controlled internal conditions provide for a virtually bacteria-free environment which makes the use of pesticides unnecessary. The T.S. hydrocultivation system can also be shipped or transported over long distances.

Sugars keep away salmonella

ADDING certain sugars to the drinking water of chickens can keep them safe from salmonella and people who eat them safe from food poisoning. John DeLoach of the US Department of Agriculture in College Station, Texas, dramatically reduced the number of *Salmonella typhimurium* bacteria in infected chickens by adding lactose, a sugar found in milk and D-mannose, a natural sugar produced by a Mediterranean plant, to their water. At 10 days old only 53 per cent of the birds which drank water containing lactose and only 26 per cent of the birds which drank water containing D-mannose had any salmonella bacte-

ria. Initially, all the birds were infected with salmonella.

Chicken treated with mannose and lactose had 99.9 per cent fewer bacteria than a control group of birds which drank ordinary water. According to DeLoach, both sugars act by modifying the environment within the chicks' intestines probably because other species of bacteria, non-pathogens, ferment the sugars. This fermentation changes the pH in the gut making it less conducive to growth of salmonella.

Salmonella food poisoning occurs when improperly cooked food is eaten. Symptoms include nausea, diarrhoea and vomiting.

Fungus to kill mosquitoes

SCIENTISTS are worried by a resurgence of malaria in the world, partly due to drug resistance. Now, an entomologist at the University of Sydney's Army Malaria Research Unit is undertaking promising research into the biological control of mosquitoes. The entomologist, Dr Tom Sweeney, has focussed on two known mosquito killers, a fungus called *culicinomyces*, and a protozoan parasite, called microsporidia. The control method involves producing the fungus or parasite artificially and releasing it into the mosquito habitat. The fungus can easily be grown artificially but the parasite would be better because it spreads by itself, says Dr Sweeney.

The key to the success of the parasite as a control was the biological cycle of the parasite, and the cycle of the mosquito which, unfortunately, was very complicated. It is so complicated that Dr Sweeney is using a computer-simulated program in conjunction with researchers at Cornell University in the United States. He estimates that it will be another three to four years before all the answers are found and then there is no guarantee that the parasite will be able to control the most important disease-causing mosquitoes.

The fungus method of control is theoretically much simpler. The spores of the fungus float in water and are eaten by the mosquito larva. They germinate and multiply inside the body of the larva finally killing it. The fungus then grows through the dead body of the larvae appearing on the outside as a hairy growth. The spores float on water to be eaten by other mosquito larvae and the cycle begins again. The fungus can easily be grown in the laboratory.

More people, less food

WITH industries increasingly taking over agricultural land, and with returns from agricultural lands diminishing over the years, the world seems to be at the doorstep of an acute food scarcity problem in the near future. "Some one-third of the world's cropland is losing topsoil at a rate that undermines its future productivity", says Lester R. Brown of the World Watch Institute of Washington in *Feeding Six Billion*, published in *World Watch* monthly. He further goes on to say that, "An estimated 24 billion tons of topsoil washes or blows off the land annually—roughly the amount on Australia's wheatland. Each year, the world's farmers must try to feed 88 million more people with 24 billion fewer tons of topsoil."

Soil erosion and cropland loss in Third World nations is intimately linked with deforestation. As firewood becomes scarce, villagers burn crop residues and animal dung depriving the land of organic matter and nutrients. This decreases the ability of the soil to absorb moisture making it more vulnerable to drought. The loss of organic matter increases runoff, which in turn leads to flooding. This is strikingly evident in the Indian subcontinent, where deforestation is destroying tree cover in the Himalayan watersheds. The area subject to annual flooding in India expanded from 47 million acres in 1960 to 124 million acres in 1984.

Yields rise with magnetised water

OF late, magnetic phenomena have been gaining in prominence in various fields of science and technology. The phenomenon of 'life-giving water' is one such

instance. It has been experimentally proved that if water is passed through a magnetic field, it acquires some wonderful properties. Steam boilers fed with such water form less scales. People who have a habit of drinking it assure you that they feel much better. And plants that are watered with it grow and develop more rapidly. However, there is so far no precise explanation as to how this happens.

At the Institute of Plant Physiology at the Bulgarian Academy of Sciences, research has been carried out to clarify the mechanism of impact on the magnetically-treated seedlings and of irrigating crops with magnetically-treated water. Yields of tomatoes went up by 26 per cent and their early ripening by 23 per cent when irrigation was performed by magnetically-treated water. Similarly, yield add early ripening of cucumbers increased by 7 and 5 per cent, respectively, and that of peppers by 13 and 3 per cent, respectively. Carnations also showed an increase in yields, in addition to early blooming and better quality of flowers. Positive results were also obtained with cotton, wheat and alfalfa. At the same time, ferromagnetic treatment of maize, beans, fodder peas before sowing increased their yields by 10-20 per cent on an average.

Fossil records reveal little

ALTHOUGH fossil records for the ancestors of the modern flowering plants go back only 120 million years, research has indicated that flowering plants may have existed on earth some 200 million years earlier than can be confirmed by fossil evidence. William Martin, Alfons Fieri and Heinz Saedler of Max Planck Institute of Plant Breeding in Cologne, West Germany, used changes in nucleotide sequence of a slowly evolving enzyme called glyceraldehyde-3-phosphate dehydrogenase as a molecular clock. They calculated that the ancestors of modern flowering plants were already diversifying 300 million years ago. The accuracy of their clock was confirmed when they found a uniform pattern of change in nucleotide sequences of nine flowering plants, six animals and one yeast.

Caffeine dangerous during pregnancy

CAFFEINE can be added to the danger list (tobacco and alcohol are already present) during pregnancy according to reproduction biologist Dr Irene Pollard, of the Macquarie University, in New South Wales. Dr Pollard has warned that even moderate coffee could be a risk harm to pregnant mothers. New research indicates that intakes in excess of four cups a day are not as harmless as once thought. There are also risks associated with caffeine in tea, chocolate, some cola drinks, and certain analgesics, she says. Better quality coffee and chocolate are likely to have

higher caffeine levels.

The warning follows a study of the effects on rats of a caffeine intake equivalent to a pregnant woman's drinking 10 cups of coffee a day. The findings indicated that foetal growth was retarded and the mortality rate among newborn rats increased significantly. A high intake of caffeine in male rats also affected their offspring. Litters, included several runts, died after two or three weeks. While the effects of high doses lingered in the trial rats and could be traced to their offsprings, the effects of caffeine could be reversed gradually.

SCIENCE FOR THE YOUNG

Crossword Puzzle

Across

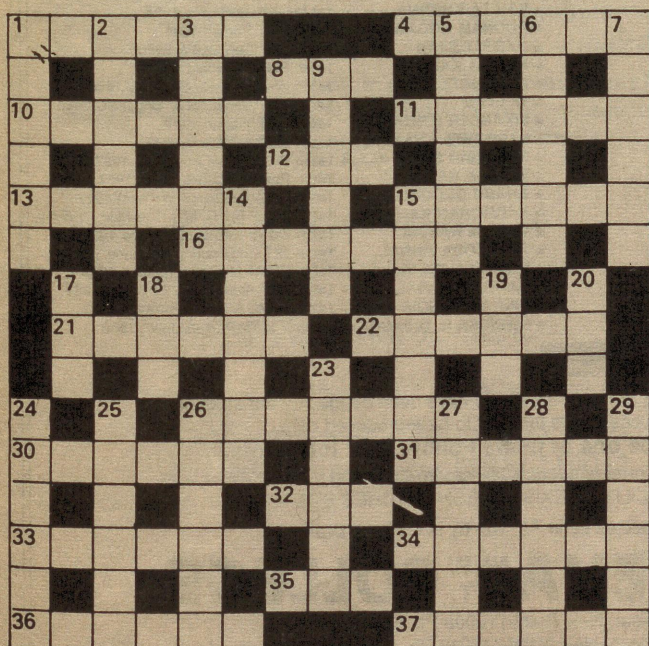
1. Surname of the British physician who discovered the circulation of the blood. (6)
4. Jellied petroleum used in making fire-bombs. (6)
8. The unit of electrical conductance, now known as Siemens. (3)
10. Gnawing mammals, e.g., rat, squirrel, etc. (6)
11. The universe. (6)
12. Two-winged insect. (3)
13. Class of the arthropoda, e.g., wasp. (6)
15. That part of a radio or T.V. system which receives or transmits signals. (6)
16. Surname of the famous British geneticist who became Indian citizen in 1961. (7)
21. It can only exist in the absence of matter. (6)
22. Surname of a French engineer best known for his invention of the first morkable I.C. engine. (6)
26. Hormone affecting the amount of glucose in the blood. (7)
30. A substance which causes bodies to adhere to one another. (6)

31. A tough, pink-white metal of the iron group. (6)
32. A measure of the degree of sensitivity to light for the roll films. (1, 1, 1)
33. Inability in understanding the printed word owing to a lesion of the brain. (6)
34. Unit of measurement of electric current. (6)
35. They belong to the order hymenoptera and live in highly organised societies. (3)
36. An interferometer used for studying fine spectrum lines. (6)
37. A pincer-like tool having broad, flat jaws, used for twisting or cutting wire, etc. (6)

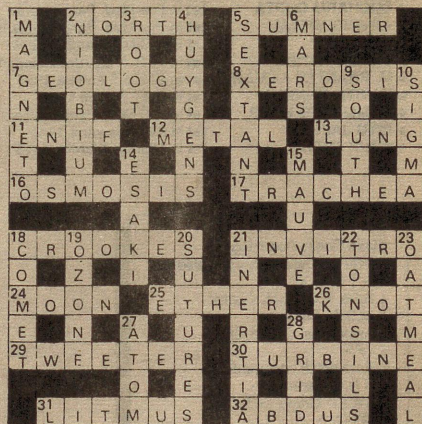
Down

1. Protrusion of an organ from its normal position, most common in the case of the bowel. (6)
2. Genus of annual or biennial cruciferous herbs eaten as salad. (6)
3. Castrated human male. (6)
5. Position of moon when it is at its greatest distance from earth. (6)
6. Hollow under the arm near the shoulder. (6)
7. Tissue consisting of cells which are highly contractile. (6)

9. Compound of one of the halogen elements. (6)
14. A straight line touching the curve at a point. (7)
15. Lack of enough blood in the body. (7)
17. Tiny drop of moisture condensed from water vapour in the air. (3)
18. Visible colour with the greatest wavelength. (3)
19. An electrically charged atom. (3)
20. A naturally occurring mineral from which a metal can be extracted. (3)
23. Surname of a German chemist who discovered caesium and rubidium. (6)
24. The interval between two frequencies of any type of oscillation, which are in the ratio two to one. (6)
25. Single-celled animal of irregular and constantly changing shape. (6)
26. A blue vat dye. (6)
27. A line perpendicular to a surface. (6)
28. Flower cluster with separate flowers on equal stalks springing from a main central stem. (6)
29. An internal force which resists change in the shape or size of a body. (6)



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(Solution Next issue)



Solution to Puzzle in SR October 1989

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