SCIENCE REPORTER

JUNE 1986
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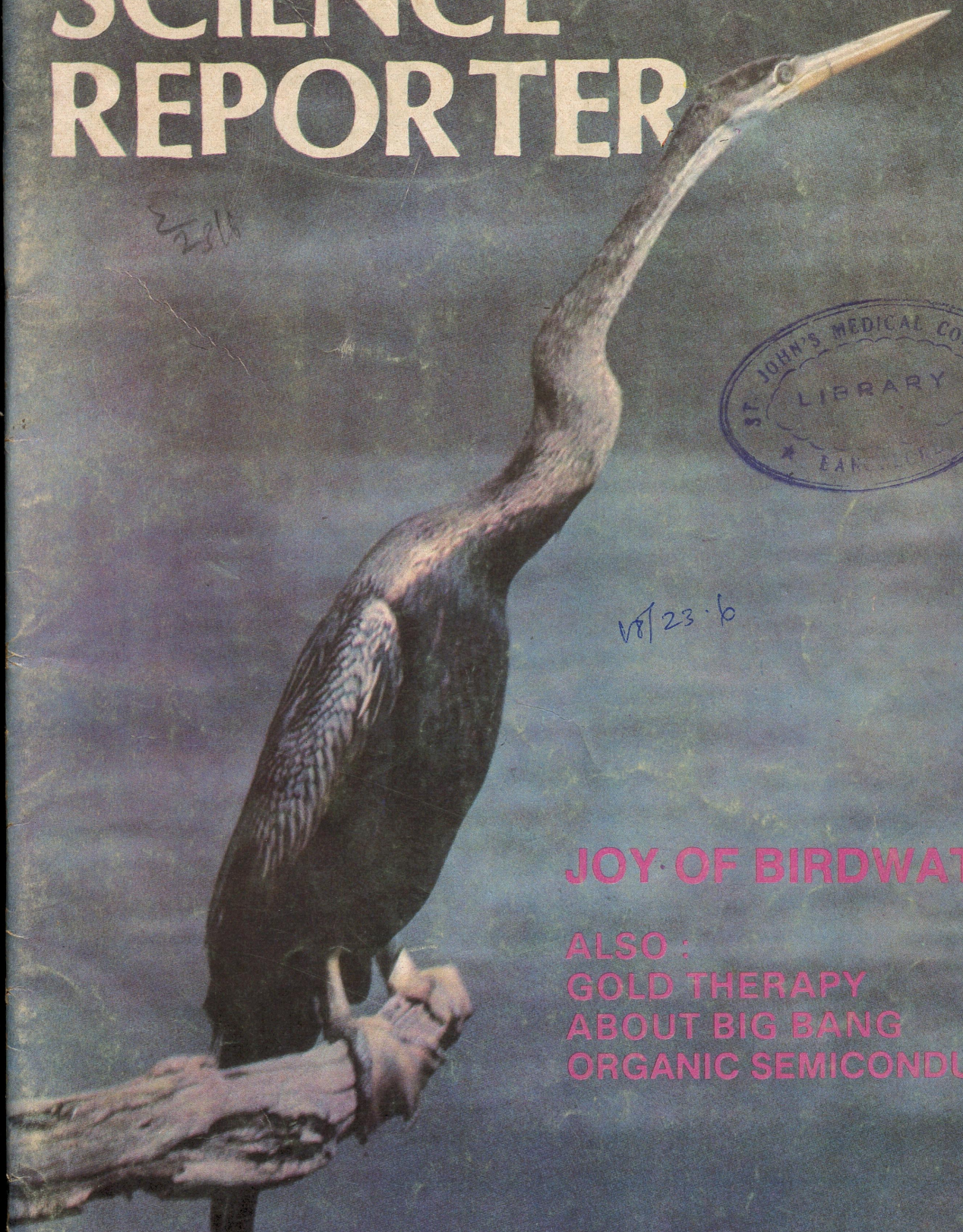

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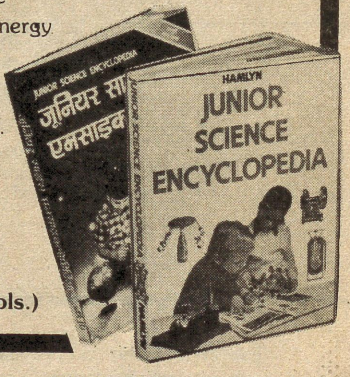

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SCIENCE REPORTER

JUNE 1986
Vol. 23 No. 6

LETTERS	356	Cephalopods ● Edible and poisonous mushrooms ● Biotechnology and plants ● Plant and air pollution ● Metal chelates in nuclear medicine ● Pollen storage ● Fish hatcheries
STARS AND PLANETS	358	July 1986
ON THE FRONTIERS	359	Fountains on Comet Halley ● "Shepherds" of Uranus rings discovered

MAIN ARTICLES

361	Gold therapy for arthritis	*Kailash C. Dash*
365	Testing materials with radiation	*S. Bhattacherjee*
369	All about organic semiconductors	*Debasis Mukherjee*
374	About the Big Bang	*P. Thiruvenganna Rao*

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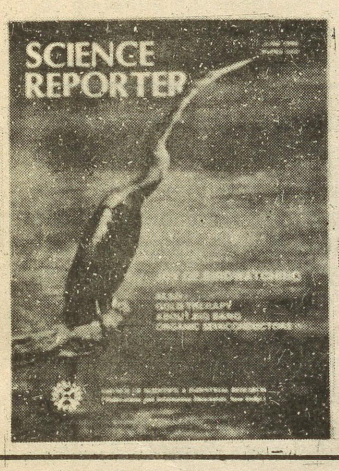

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SCIENCE SPECTRUM	378	Raman spectroscopy has many uses ● Remote sensing technology in fisheries ● The first higher vertebrate that detects electric fields ● Incestuous pollen fertilises virgin flowers ● Orchids ● Why don't rice plants drown? ● *Cuphea* ● Plants can date archaeological sites ● Tobacco ● Gametocides in plant breeding programmes ● Calmodulin ● Allelopathins
MEDICAL NOTES	388	Are O blood group people more biologicaly fit? ● Card to detect malnutrition
SCIENCE FOR THE YOUNG	390	Tips for birdwatching for the beginners ● Numbers as the sum of two squares in one or more ways ● Science quiz ● Cartoons
COMPUTERS	398	Computers of the fifth generation
OF LEAVES AND FEATHERS	399	Magic in May
FOR HER	400	Why bottle feeding is bad ● Food poisoning
SCIENCE IN INDUSTRY	402	Noise pollution analyser ● Polyphenylene oxide coatings ● Friction and wear monitoring system ● Reverse osmosis desalination plant
ENVIRONMENT	403	Lead and human health
TECHNOLOGY FOR VILLAGES	404	Slurry coating enhances phosphorus availability to soil
BOOK-REVIEWS	406	Pirates of the Cell ● From Quark to Quasar ● Problems of Biology ● Limits of Science ● Organometalic Compounds of Boron ● Fishery Economics and Management in India ● Aspects of Human Ecology ● Plant Cell Structure and Metabolism ● Octagon

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LETTERS

Cephalopods

Sir, With reference to the article **Embryonic development of Cephalopods** (*S.R.*, April 1986), would like to add the following on the basis of my recent findings.

(1) Microinjection of radio-active amino acids like proline and arginine in the yolk of *Loligo* embryos shows that the pressure caused by large amounts of amino acids (in sea water) can transfer these molecules into the embryo within 15 minutes. But even after 1 hour these are hardly incorporated into embryonic protein. The natural physiological process can probably transfer labelled amino acids from yolk into embryo within 6-24 hours and a part of these is incorporated into protein. The free amino acid pools in the embryo do not reflect the status of protein biosynthesis.

(2) The explanatory sentence for using glycerol (first applied on the mitosis of *Limnaea* — pond snail) is missing in the final print. The transparent yolk bubble attached to the smaller embryo is in front and not at the posterior end as I inadvertently stated in the article (p. 249, col.2). However, further experiments show that in most cases, glycerol inhibits mitosis *reversibly* and the stop signal acts in a different way.

R.L. Brahmachary
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Edible and poisonous mushrooms

Sir, The article **Mushroom poisoning** by Y.P. Gupta (*S.R.*,March 1986) was indeed informative and useful for mushroom lovers.

Edible mushrooms serve to add to world food to keep pace with growth of population. Their utilization as an article of diet and medicine is found in classical literature like the Vedas and the Bible. Due to their flavour they are relished by many. Still, people lost interest in them due to their bad effects on health. Even edible forms cause allergy in some people.

How can one tell edible forms from poisonous ones? In fact,there is no sure test by which one can identify edible mushrooms from poisonous ones. Even with the help of a good manual illustrated with excellent photographs, only a competent person can separate edible mushrooms from poisonous forms. For a beginner, their identification should be confirmed by a professional mycologist, preferably a specialist in Agaricales taxonomy.

A common poisonous mushroom is *Amanita muscaria,* commonly called fly mushroom because of its former use as an insecticide. *Amanita verna* is the deadliest of all known mushrooms. *A. brunnescens* is also poisonous. Atropin is administered as an antidote against. *A. muscaria* toxin but no antidotes against the last two species are known. In addition *Cantherellus floccosus, Lepiota molybditres, L. morgoni, Marasmius pernote, M. urens, Volvariella speciosa* are reported to be poisonous. Mushroom poisoning is not solely attributed to mushroom toxin but may also be due to infected mushrooms which are vulnerable to attacks by microorganisms. Individuals differ in their reactions to mushrooms. Therefore, when eating mushrooms for the first time, it would be wise to eat a relatively small quantity of those varieties that have been declared edible by a specialist.

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Biotechnology and plants

Sir, Re : **What can biotechnology do for us?** by V.A.Amalraj (*S.R.*, March 1986), I would like to mention some points. Biotechnology is in its adolescence and as far as plant genetic improvement is concerned, it still has to do a lot. The main obstacles faced by it in respect of plants are as follows:

(i) The regulation and expression of plant genes during ontogeny are complex. Synthesis of metabolic products of different biochemical pathways varies from organ to organ and plant to plant.

(ii) Due to polyploidy in a number of crop plants (e.g., wheat), it is extremely difficult to say whether the transplanted genes will be expressed or not.

(iii) In plants,many different pathways for synthesis and breakdown of metabolites are present but adequate genetic markers are not available.

(iv) Regeneration of cereals and other monocots from protoplasts has been found to be difficult.

(v) As the cell walls found in plant cells are more or less impenetrable by normal plasmid vectors, suitable plasmid vectors are still to be found out.

Production of an osmotic tolerance plasmid and manipulation and cloning of genes against environmental stresses are some of the areas in which biotechnology has still to direct its potentialities.

Alok Kumar Choudhary
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Plants and air pollution

Sir, In the article **Impact of air pollution on plants** by J.P. Gupta, Veena Gupta and L.C. Lamba (*S.R.*, March 1986), while discussing effects of air pollutants on plants and their control, the authors have not given detailed mode of action of air pollutants in inducing injuries to plants. So I would like to add a few points. The authors also did not mention that hydrogen fluoride turns leaf margins of dicots and leaf tips of monocots light to dark brown. Actively growing wet leaves are more sensitive to HF.

Like biotic pathogens (fungi, bacteria, etc.), abiotic pathogens such as air pollutants (gas, liquid and particulate) enter and induce injury and disease in plants in basically three ways.

1. Stomata. There are many examples of gaseous pollutant effects on stomata but the stomatal pores are not affected in the same way by all gases. O_3 injures the guard cells and alters their behaviour directly or indirectly by changing abscisic acid levels. In the case of SO_2, it is absorbed by subsidiary cells which results in decrease of turgor pressure of guard cells. Subsequently, guard cells collapse in open position thereby permitting greater SO_2 uptake.

2. Cell surface. SO_2 and O_3 injure the epidermal and mesophyll cells while PAN does not cause any injury to them. Mesophyll cells are joined at cell wall interfaces by gas spaces. The walls of these interfaces contain no lignin or "encrusting" substance. These unlignified surfaces provide avenues for the penetration of air-pollutants into the cell, while the lignified surfaces cannot be penetrated by SO_2, O_3, etc.

3. Subcellular compartments. After penetration of cell walls, the air pollutants affect cell membranes and subcellular compartments within the cell. O_3 reacts directly with plasma membrane and other internal cell membranes thereby altering all membrane functions. Conventional transmitting electron microscopic investigations show changes in structure of chloroplast in response to O_3, PAN, SO_2, HF and HCl. Changes in size and shape of the organelles and altered density of stroma have also been observed. Several workers have noticed the presence of large crystals in the chloroplast stroma of plants exposed to O_3, PAN, NO_2, and HCl.

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Metal chelates in nuclear medicine

Sir, With reference to **Metal chelates in medicine** by Krishna De (*S.R.*, March 1986), I would like to add a few words about the role of metal chelates in nuclear medicine. Complexes of radioisotope technetium-99m (Tc^{99m}) and to some extent indium-113m (In^{113m}) are widely used in nuclear medicine for diagnostic purpose. These include dynamic functional study of vital human organs like heart, lungs, kidney, liver and for early detection of cancer metastasis in brain, bone and in other parts. For this purpose, most radiopharmaceuticals used are tagged with Tc^{99m}. The organ to which Tc^{99m} goes is determined by the chelating agent. Due to ease of availability, low cost and near ideal characterstics of Tc^{99m}. Its chelates have replaced conventional radiopharmaceuticals tagged with Hg^{203} and I^{131} radioisotopes. Efforts are on in India and in western countries to prepare Tc^{99m} complexes which can functionally replace the cyclotron-produced isotopes like Tl^{201} (heart studies) and Ga^{67} (tumor studies), whose use is limited by high cost and non-availability of production facilities.

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Pollen storage

Sir, In the article **Gene banks for preservation of plants** (*S.R.*, December 1985) by B.K. Mishra and D. Nirupama mention has been made (p. 493) that pollen storage seems to be a far less promising method than seed storage for longterm conservation of genetic resources. I do not agree with the authors because as many as 13 interesting publications have appeared since 1972 to 1984 on pollen storage in organic solvents. Some of them have very convincingly demonstrated the unique feasibility and efficacy of organic solvents for long-term storage of pollen grains. More recently, Prof. Yozo Iwanami of the Biological Institute at Yokohama City University, Yokohama, Japan has reported (*Experientia*, **40** : 568-569: 1984) the retention of pollen viability of lily (*Lilium auratum*) soaked in organic solvents for 10 years at—10°C. Thus, the longest period of pollen storage recorded till today is 10 years in lily and not 9 years as mentioned by the authors for pollen grains of Mallus (apple).

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Fish hatcheries

Sir, Re : **Fish hatcheries for more fish seed** by M. Gouder, M.A. Hooli and G. Gaitonde (*S.R.*, August 1985) we would like to point out some errors and confusing statements.

On page 212, column 2, the scientific name of silver carp, *Hypophthalmichthys molitrix* is wrongly written as *Hypophthalmiehthryes molitrix.*

In the operation of low cost modified Chinese hatcheries, breeding and hatching are not conducted in the same cistern. The hatching cistern is supplied with many small inlets, fixed obliquely at the bottom, at an angle of 40° to the tangent of cistern wall. Flowing speed of water is lower in hatching cistern than in breeding cistern and generally anti-clockwise. The inner egg vessel of LDPE jar hatchery is filled with fertilized eggs. Fertilization does not take place inside it as stated on page 216, col. 2. The time of hatching is not less in this particular type of hatchery. It is mostly dependent on water temperature and is generally 15-20 hours at 26° C to 28° C.

Sukhbeer Kaur
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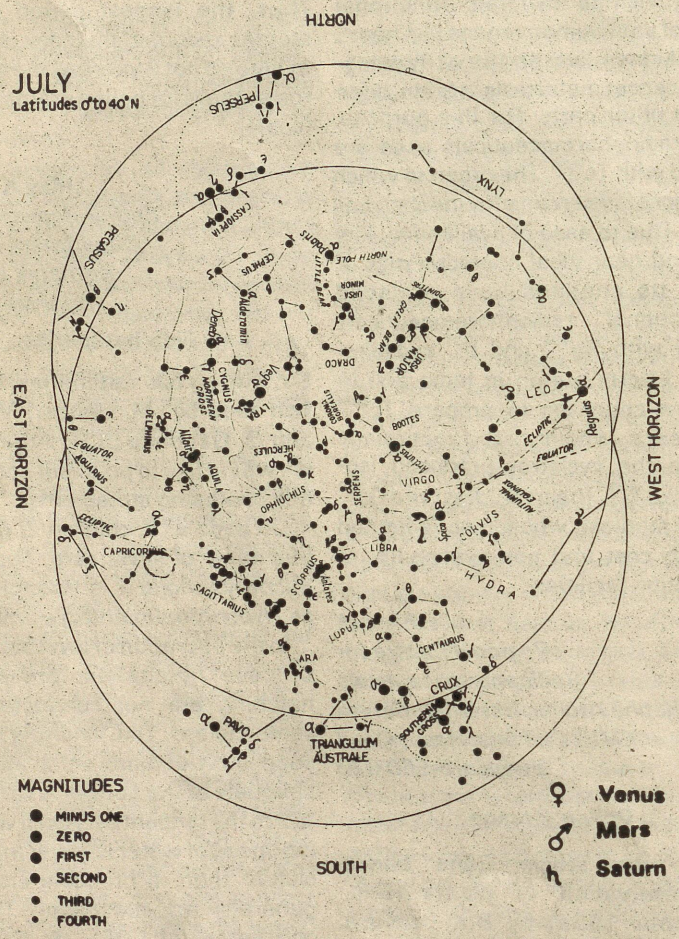
STARS AND PLANETS



Planetary positions for July 1986

Date	*1st*		*10th*		*20th*	
Planets	*R.A.*	*Decln.*	*R.A.*	*Decln.*	*R.A.*	*Decln.*
Mercury	8h 22m	18.8N	8h 32m	15.9N	8h 15m	14.9N
Venus	9h 23m	17.2N	10h 03m	13.6N	10h 46m	9.1N
Mars	19h 31m	26.9S	19h 20m	27.7S	19h 08m	28.4S
Jupiter	23h 35m	4.1S	23h 36m	4.0S	23h 36m	4.1S
Saturn	16h 10m	19.0S	16h 08m	19.0S	16h 07m	19.0S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The moon

NEW moon occurs on 7th at 10-25 A.M. and full moon on 21st at 4-10 P.M. I.S.A.

The moon passes about eight degrees north of Mercury on 9th, three degrees north of Venus on 10th, about five degrees south of Saturn on 18th, about a degree north of Mars on 20th and one and a half degree south of Jupiter on 25th. The lunar crescent becomes first visible after the new moon day in the evening of 8th. The moon is at apogee or farthest from the earth on 4th and at perigee or nearest to it on 20th. The earth is at aphelion or farthest from the sun on 5th.

The planets

Mercury *(Budha)*, visible in the evening sky, sets about an hour after sunset during the first half of the month. Thereafter it is too close to the sun to be visible. It becomes retrograde on 10th and is in inferior conjunction with the sun on 23rd. It is in Cancer *(Karkata)*. Its visual magnitude varies from +0.9 to +1.8.

Venus *(Sukra)*, visible in the evening sky, sets about two and a half hours after sunset during the month. It passes about one degree north of the star Regulus *(Magha)* on 11th. It moves from Cancer (Karkata) to Leo *(Simha)*. Its visual magnitude is about —4.1.

Mars *(Mangala)* rises at about sunset during the first half of the month and sets about one and a half hour before sunrise during second half. It is in opposition with the sun on 10th. It is in Sagittarius *(Dhanus)*. Its visual magnitude it about —2.4.

Jupiter *(Brihaspati)*, visible in the morning sky, rises about four hours after sunset during the first half of the month and about three hours after it during the second half. It becomes retrograde on 12th. It is in Aquarius *(Kumbha)*. Its visual magnitude is about —2.6.

Saturn *(Sani)*, visible in the evening sky, sets about two hours after local midnight during the first half of the month and about an hour after it during the second half. It is in Scorpio *(Vrischika)*. Its visual magnitude is about +0.3.

(*Source*: Director, Positional Astronomy Centre, New Alipore, Calcutta-700053)

ON THE FRONTIERS

Fountains on Comet Halley

COMETS are dirty snowballs spinning about their axes as they travel about the sun. When close to the sun they spew out their icy material due to heat in the form of tails which blow in accord with the breeze coming from the sun called "solar wind". So far, so good. But if one examines in detail the dirty snowball — the cometary nucleus —the picture gets blurred. Such is the impression one gathers about cometary nucleus after the recent visit of two spacecraft *Vega-2* and *Giotto* to Comet Halley. In fact, one can easily say that these visits to the comet are the first stepping stones to a fuller understanding of these heavenly bodies. The nucleus of Comet Halley is not only larger and darker than was anticipated but also responsible for some as yet undreamt of phenomena. Model of cometary nucleus is therefore in for a drastic revision (*Science,* March 28, 1986).

When the Soviet *Vega-2* approached Comet Halley within 9,000 kilometers on March 9 this year, it showed two bright spots on its dark nucleus. Not in accord with the current accepted model of a dirty — but not so dirty — snowball, scientists were left guessing what they were. But a revision of the way of looking at them produced some clarity. The bright spots were fountains on the dark debris that surrounded the nucleus of the comet. Icy material from the nucleus evaporated and sprayed into the surrounding space! The European *Giotto* produced further evidence supporting the new model. In fact, in the process of viewing the nucleus more closely, its camera was damaged and the spacecraft was sent wobbling out of control.

The entire drama which led to the destruction of *Giotto's* camera and other instruments took place like this: approaching the cometary nucleus at a relative speed of a quarter million kilometers per hour, *Giotto* encountered ionised gas at a distance of 8 million kilometers from it; at a distance of 1.1 million kilometers the gas became dense and slowed the incoming solar wind producing a "bow shock wave" as seen ahead of the bow of a boat; at a distance of 287,000 kilometers, dust particles moving 50 times the speed of a bullet were harmlessly hitting the spacecraft; at 8,000 kilometers, dust particles were energetic enough to erode the polished aluminium mirror of the spacecraft's camera; and at 1350 kilometers the spacecraft camera went blank.

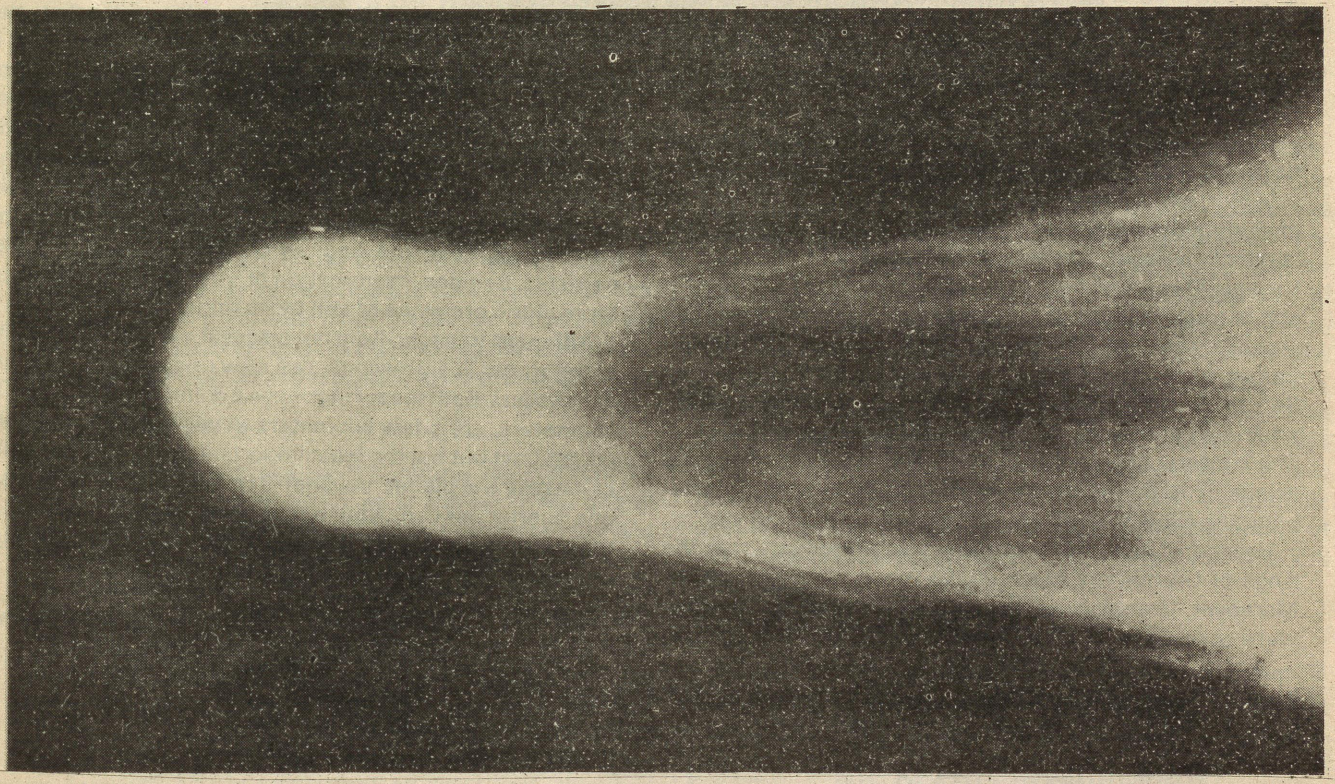


Photo of Comet Halley taken during its last visit in 1910. Can one see fountains on its nucleus? An enhanced computer image did show the fountains. ***(Photo : U.S.I.S.)***

Although the fate of the spacecraft was expected, the chronology of events did not happen the way it was thought for the simple reason that the comet's nucleus was different from what it was imagined. Earlier, when a 1910 photo of Comet Halley was enhanced by computer techniques, it showed the presence of small fountains in the comet. It was then thought that the contribution of those fountains to the material ejected in the tail due to heat was very small and could be ignored. But the recent *Giotto* encounter has clearly shown that the fountains on the nucleus of the comet have a far greater role to play in the creation of its tail than was imagined till now. It was the sudden explosive spray of the fountains which damaged the camera of the spacecraft. In other words, considerable re-thinking on the present model of cometary nucleus would only account for the fountains. Comet Halley, though a disappointment otherwise for viewers on earth due to dearth of tail, has left behind a mystery in its head.

"Shepherds" of Uranus' rings discovered

RINGS around planets are nothing but swarms of particles, big and small — literally satellites — circling them. But, what causes formation of rings and why some planets have rings and others do not is still unclear. Peter Goldreich and his coworkers at California Institute of Technology, U.S.A., have now put forward a hypothesis that a ring is produced by the presence of two moonlets on either side of it, which, like shepherds, herd the flock of particles to confine themselves to the ring. How this shepherding is conducted needs further investigation but the visit of Voyager-II in January this year to the planet has shown some truth in it by discovering two massive moonlets straddling its huge Epsilon ring (see also *S.R.*, March 1986). Earlier, such "shepherds" have been found near a ring of Saturn. But the Saturn ring has kinks and is not uniform, whereas Epsilon ring of Uranus is regular and disciplined. The contrast between these two rings will certainly help scientists to throw more light on the phenomenon of shepherding (*Science*, February 21, 1986).

Voyager-II also made one intriguing discovery that the rings of Uranus are black unlike those of other planets. Moreover, Uranus rings do not contain small particles as were observed in Saturn rings earlier. In fact, it is claimed that the blackness of the rings is due to the absence of small-sized particles! When Voyager-II went below the orbit of Miranda, the innermost satellite of the planet, it observed intense radiations and a large quantity of hydrogen leaking into space. Scientists claim that methane present in icy crystals on Uranus is turned into black organic polymer mass under the influence of radiations. Leaking hydrogen sweeps away the organic mass to the rings making them not only dark but also sticky. Stickiness forces the small particles in the rings to coalesce and form bigger particles. Besides, examination of Voyager data also gives hints of the presence of still more rings, faint and small.

Although Voyager-II did not discover a predicted satellite of the planet, it did discover two new rings of extraordinary dimensions. Both these rings have a diameter upto 100,000 kilometers, are a few kilometers in width and have sharp edges. Last but not the least important is the new estimate of mass of the planet. Voyager-II has shown that there is a one quarter per cent adjustment to be made in the mass of the planet, which is likely to have far greater implications in understanding the rings of the planet.

Dilip M. Salwi

GOLD Therapy for Arthritis

KAILASH C. DASH

Gold, in some chemical forms, has been regarded as a panacea for many diseases since the dawn of civilization. The medicinal uses of the metal have served as an important focus for medical debate, research and industry

GOLD is an extremely dense, valuable, bright yellow metal with a resplendent lustre. Because of its brilliant appearance, unalterability and occurrence in the native condition, gold was one of the first metals to attract the attention of man. It has been regarded as the very epitome of material value since the earliest civilizations. The making of gold from base metals by means of the "philosopher's stone" and the discovery of the 'elixir of life' were the chief pursuit of the alchemists of the Middle Ages.

Early developments

Although living things have a natural requirement for some metal ions, gold, as far as is known, is not one of them. The idea that gold compounds administered to living things could produce a therapeutic effect first occurred to the Chinese in 2500 BC. During those days gold was regarded as a universal remedy which would favourably affect the course of all diseases. In the 8th century, the alchemists attempted to prepare from metallic gold the 'elixir of life'—a magical substance that they believed would cure all diseases and confer eternal youth. In the 13th century, gold in the form of *aurum potabile* (gold dissolved in aqua regia and diluted with oil of rosemary or other essential oils) was recommended for the treatment of leprosy and many other diseases. Writing around A.D. 1250 the famous encyclopaedist Bartholomaeus Anglicus extolled the virtues of gold for treating 'cardiacal passion', 'evils of the spleen and other evils' and even suggested the use of gold in treating rheumatoid diseases. As recently as the late 18th century, gold was used for the treatment of nearly every illness, but with no biochemical basis.

It was Robert Koch of Germany, who in 1890, showed that gold compound $KAu(CN)_2$ was lethal to micro-organisms responsible for tuberculosis (*Myobacterium tuberculosis*) in the test tube. This discovery paved the way for a sounder basis of gold therapy. In the late 1920's, the mistaken belief that the *Tubercle bacillus* caused rheumatoid arthritis led Jaques Forestier of France (in 1929) and others to try gold in the treatment of that ailment. After thirty years of medical debate, the 1960 report of the British Empire Rheumatism Council finally confirmed that gold is of value in the treatment of rheumatoid arthritis. The results were confirmed by J.W. Sigler of the USA who in 1972 also reported positive radiological evidence for regression of the disease in the joints of patients with rheumatoid arthritis who were undergoing chrysotherapy (treatment of disease with gold compounds). Since then, medical enthusiasm has waxed and waned; the fact that gold compounds could cause remission of the disease was a source of optimism while the high percentage of toxic side-effects caused concern. Medical experts now concede that there is as yet no specific drug for the treatment of rheumatoid arthritis although gold compounds are still used for treating the disease.

Chemistry of gold

In the Periodic Table, gold finds a place in Group IB (copper family) and the common valencies are 1+ and 3+,

History of chrysotherapy

2500 BC	Chinese	Universal cure
900 AD	Abu Moussa, the wise	Cure-all
1500	Paracelsus	Tuberculosis
1810	Chrestien	Tuberculosis
1890	Robert Koch	Tubercle bacilii
1913	Bruck and Gluck	Lupus vulgaris
1927	Lande	Bacterial-endocarditis
1929	Forestier	Rheumatoid arthritis
1961	Empire Rheumatism Council	Rheumatoid arthritis

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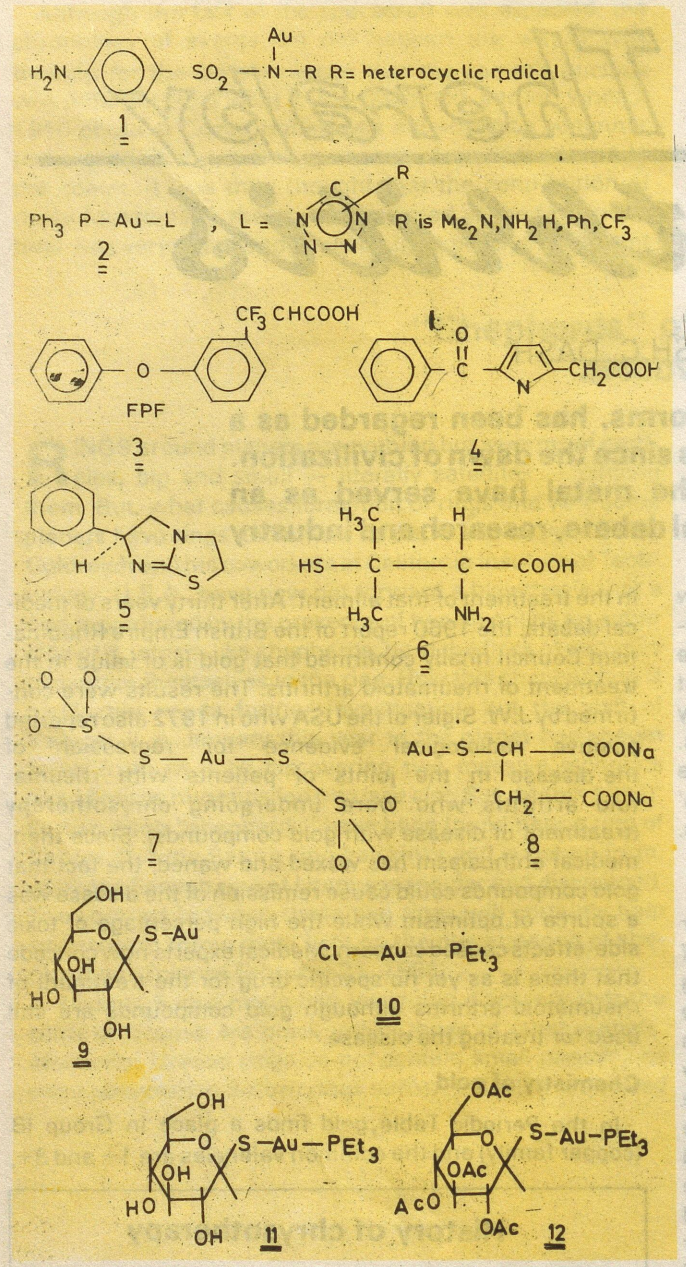

Fig. 1

in addition to the less common 1—2+and 5+ oxidation states. Only gold in oxidation states 0, 1+ and 3+ has been studied with respect to its effects on biological systems. Gold compounds in other oxidation states (e.g., 1—, 2+ and 5+) are rather unimportant in mammalian biologican systems. Colloidal gold (0) is used as a radioisotope for diagnostic scans and has been used for arthritis treatment on a limited basis. The reactions of gold (I) because of its therapeutic usefulness and gold (III) because of its oxidising ability and toxicity have been extensively studied from a biological perspective.

Gold (I) is a d^{10}-metal ion which like the isoelectronic mercury (II) can form two-, three- and four-coordinated complexes of which the *sp*-hybridised linear, two-coordinated structure is the most stable and most common. Ligands such as the thiolates, thioethers,and phosphines containing sulphur or phosphorus as donor atoms form strong linear complexes with gold (I) that are biologically very important.

Gold (III) mostly forms square-planar, four-coordinated complexes with dsp^2 hybridisation, that are typical of d^8 metal ions of the heavier transition series. Five- and six-coordinated complexes of gold (III) are also known, though less commonly. All gold (III) compounds are highly toxic and are seldom used as drugs. One limitation in the development of possible gold drugs as anti-rheumatic agents has been the lack of suitable animal model for test purposes.

Gold compounds as medicine

Gold salts are of value in the treatment of a wide range of diseases, e.g., asthma of tubercular origin. Gold-sulphur compounds have found use against bronchial-asthma. Sodium aurosulphite ($Na_5Au(SO_3)_4 5H_2O$), gold-thioglucose and gold calcium keratinate are believed to be active against tubercle bacillus. Gold compounds have been used for the treatment of the skin disease *pemphigus vulgaris*, which could be fatal if neglected. *In vitro* studies using gold complexes with some sulphur drugs against a wide variety of bacteria show a higher antimicrobial activity as compared to the parent sulphur compounds. Gold sulphamides are bactericidal. Gold sulphadiazine prevents the growth of *Bacillus subtilis, E. coli, Salmonella typhii, Shigella dysenteriae, P. vulgaris, Protous morganii* and *Klebisielle pneumonia*, etc. Gold compounds of some common sulphur containing drugs are useful in the treatment of ringworms and fungal infections.

Some gold compounds have been reported to be active against cancer. The T/C (survival time of treated animals/-survival time of controls) of the gold complexes $[AuCl_4][HL]$ (HL = antipyrine derivatives, where antipyrine is 2,3-dimethyl-1-phenyl-5-pyrazolone) indicate anti-tumour activity. In therapeutic concentrations, gold thiopolypeptides decrease cell proliferation and glycosaminglycan formation. The 5-substituted tetrazole triphenylphosphine gold (I) complexes have anti-arthritic and anti-tumour activities. The complex $[Au(5\text{-diazouracil})_2Cl_2]Cl.HCl$ also has anti-tumour activity (in mice) and Auranofin [2,3,4,6-tetra-o-acetyl-1 thioβ-D-glucopyranoside-S) (triethylphosphine) gold] which exerts a significant inhibitory effect on biological processes and functions essential to cell proliferation, suggestis its anti-tumour capabilities.

Epidemiology of rheumatoid arthritis

Women account for >75% of patients
Chronic course in >75% of patients
Rapid progression for >15% of patients
Most common age at presentation: 20-45 years

In rheumatoid arthritis

Rheumatoid arthritis is a chronic inflammatory disease of the joints causing painful swelling and shortening of fibrous tissues, frequently resulting in deformities. The exact mechanism by which clinically used agents alter or palliatively treat the course of the disease is not clearly understood, although many hypotheses exist.

Even though chrysotherapy is asociated with several side-effect potentials, the most severe being exfoliative dermatitis, bone marrow suppression and kidney damage, a careful study has established it as the best and most effective form of remittive rheumatoid arthritis therapy. Many gold compounds, e.g., gold (I) thiolates, are shown to be effective against rheumatoid arthritis when administered parenterally, i.e., through intramuscular injection.

Gold sodium thiosulphate, $Na_3[Au(S_2O_3)_2]$, known clinically as Sanocrysin, when administered in aqueous solution has been effective in the treatment of rheumatoid arthritis, tuberculosis and leprosy. Gold disodium thiomalate (GST) (Na_2Autm, clinical name Myocrisin), usually administered as an oil suspension, is useful against chronic rheumatism. Administered parenterally, it suppresses both primary and secondary lesions and is effective against adjuvant induced arthritis. Gold thioglucose, clinically known as Solganol, is widely used against arthritis. It is also administered as an oil suspension parenterally and because of its high molecular weight (appx. 1000) seems to be less toxic than GST. Solganol induces hyperphagia (increased macrophage level), an insatiable appetite and obesity in certain strains of mice, primarily due to a metabolic disorder.

Oral gold drugs

Most important among the properties of chrysotherapeutic agents worthy of medicinal chemical manipulation is the route of administration. All early gold compounds required parenteral administration to be effective which entailed frequent visits by patients to the clinic for a painful injection of the drug. Periodic injections resulted in fluctuating high and low serum gold levels with associated kidney problems. It was hypothesised that an orally effective form of gold therapy would improve patient compliance by reducing the need for numerous visits to the clinic as well as eliminating the pain associated with injectable medication. Daily oral administration of the drug as opposed to weekly (or monthly) administration might allow a low daily dosage resulting in clinical efficacy at lower total blood levels, which, in turn, might be expected to be associated with a lower incidence of side effects, particularly kidney toxicity. All injectable gold drugs were water-soluble and little attention had been directed to nonionic, fat soluble gold compounds. Fat solubility and lack of ionic character were properties that would enhance oral absorption.

Gold (I) forms strong bonds with phosphorus. To develop non-ionic stabilised form of gold (I), phosphine compounds were considered and trialkylphosphine gold

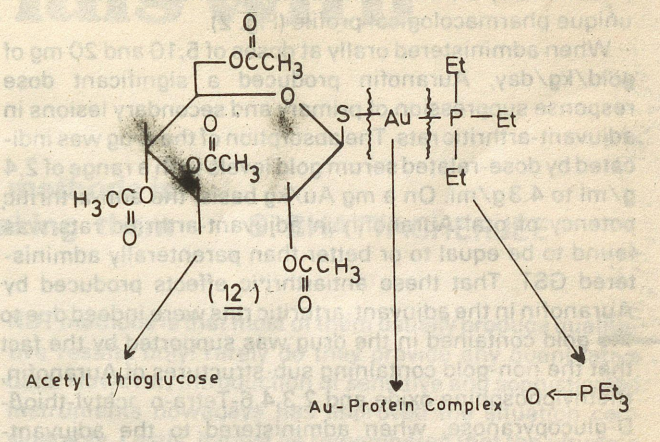

Fig. 2. Fate of auranofin molecule following oral administration

(I) compounds ($9R_3PAuCl$) were prepared. They are highly soluble in fats and their therapeutic responses seem to be structure-dependent. Although the non-gold phosphine compounds gave no protection, comparative studies indicated that the nature of the phosphine ligand in the gold complexes played a greater role in bringing about the changes in biological activity than did the other group (e.g., Cl) bonded directly to the gold. The serum gold levels as well as therapeutic effect were highest with the Et_3PAuCl complex, and with increase in the bulkiness of the alkyl substituent, both serum gold levels as well as therapeutic protection decreased. Surprisingly, Me_3PAuCl was also less effective. Oral Et_3PAuCl proved as effective as intramuscular GST. Analysis of the tissue gold levels in guinea pigs after oral administration of Et_3PAuCl or parenteral administration of GST showed that in the gastrointestinal tissues the gold concentration was higher with Et_3PAuCl. This compound has undergone preliminary (phase I) clinical trial. However, at the high doses used in the study, it produced diarrhoea, sufficiently severe to discourage continuation of the study.

Auranofin

As the development of oral gold drugs continued, studies were made to replace the chloride ligand in Et_3PAuCl with sulphur containing ligands. Since thioglucose had been proved to be a favourable ligand for gold (I) in aurothioglucose, it was chosen to replace the chloride ligand in Et_3PAuCl yielding the compound (1-thio-β-D-glucopyranosato-S) (triethyl-phosphine) gold (I) which also proved to be an orally effective anti-arthritic agent in experimental animals. However, its physical properties were unsuitable for pharmaceutical compounding as it was a non-crystalline and hygroscopic solid. Acetylation of the hydroxyl groups afforded a non-hygroscopic, crystalline solid which retained favourable anti-arthritic properties in experimental models. The new compound, [(2,3,4,6-Tetra-o-acetyl-1-thio-β-D-glucopyranosato-S) (triethylphosphine) gold (I)] clinically known as Auranofin is a stable crystalline fat soluble solid. It is not ionised in water or organic solvents. It is orally effective, both in animal (adjuvant rat) and human

(rheumatoid) arthritic conditions, and has an even more unique pharmacological profile (Fig. 2).

When administered orally at doses of 5,10 and 20 mg of gold/kg/day, Auranofin produced a significant dose response suppression of primary and secondary lesions in adjuvant-arthritic rats. The absorption of the drug was indicated by dose-related serum gold levels with a range of 2,4 g/ml to 4.3g/ml. On a mg Au/kg basis, the anti-arthritic potency of oral Auranofin in adjuvant-arthritic rats was found to be equal to or better than parenterally administered GST. That these antiarthritic effects produced by Auranofin in the adjuvant-arthritic rats were indeed due to the gold contained in the drug was supported by the fact that the non-gold containing sub-structures of Auranofin, triethylphosphine oxide and 2,3,4,6-Tetra-o acetyl-thioβ-D-glucopyranose, when administered to the adjuvant-arthritic rats at equimolar concentrations as that given with Auranofin administration, were without an effect. Auranofin produced lower gold levels in both blood and kidney and less toxicity than parenteral GST.

Auranofin is a unique chrysotherapeutic agent which differs from GST in a number of physicochemical, pharmacokinetic and pharmacological properties. It is antiinflammatory, antiarthritic, and immunoregulatory which offers a high predictive value for therapeutic effectiveness in rheumatoid arthritis. At present, there is no clinically used antiarthritic drug that shares this profile.

Further reading

1. Empire Rheumatism Council, *Ann. Rheum. Dis.*, **20**, 315 (1961).
2. Finkelstein, A.E., Walz, D.I., Batista, V., Misradi, M., Roisman, F., and Misher, A., *Ann. Rheum. Dis.*, **35**, 351 (1976).
3. Dash, K.C. and Schmidbaur, H. in *Metal Ions in Biological Systems* (ed. H. Sigel), Marcel Dekker, N.Y. Vol. **14**, 179 (1982).

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Testing Materials with Radiation

The most distinctive feature of these testing methods is their ability to test components without taking them apart which saves machine down time

S. BHATTACHERJEE

THE ever increasing demands for better quality control of various manufactured products have made non-destructive testing a key element in modern industrial management system. In fact, it has become an indispensable tool in any modern industry for ensuring quality products. The term nondestructive testing (NDT) includes a variety of techniques of detection and measurement of properties or performance capabilities of engineering components or materials without in any way breaking them apart or destroying them. In most cases, NDT is used to reveal defects or discontinuities in materials or components by indirect means. This fact necessitates development of a proper interpretation system for the data. Besides, a particular NDT method can be used to detect only a specific type of defects or conditions. Therefore for best results, a judicious selection and integration of appropriate NDT methods followed by proper interpretation of the data is essential.

Characteristic features

The most distinctive feature of all NDT methods is their ability to test materials or parts of any plant or machinery without impairing their serviceability or disrupting continuity of production. This helps not only in improving the quality of products but also in reducing cost by saving machine down time. Another notable characteristic of NDT methods is that they are all indirect methods of testing. They usually produce variation of some physical properties which serves as an indicator of defects or inhomogeneities in the test object. For example, presence of cracks or impurities change the electrical conductivity and elastic properties of materials. In some cases, some kind of visible changes in the physical feature or appearance of the test object are produced when the object is treated with a testing medium. In the liquid dye penetrant method, for instance, a liquid dye is spread over the surface of the test material with cracks, the liquid penetrates into the cracks which show up clearly. However, the nature of these variations and indications differ from method to method.

All NDT methods are specific, that is they detect only some specific kind or kinds of defects or conditions for which they are designed. This imposes a limitation on the applicability of the tests. Hence for a foolproof and complete inspection of a test object, a proper selection of diffeent methods becomes necessary. Another limitation of the NDT methods is that most of them usually produce qualitative results only, rarely do they provide any quantitative data. However, introduction of sensitive and sophisticated instruments nowadays has improved the situation considerably. Lastly, it must be remembered that the ultimate success of the whole exercise depends entirely upon the skill and ability of the observer or the person responsible for the testing. Wrong interpretation of the observations may lead to a wrong decision about the suitability or otherwise of the test sample for a specific use.

General principles

The essential elements of NDT methods can be classified into five broad divisions.

(i) The probing media. Various forms of energy (mainly radiating type like-X-rays, gamma rays, etc.) and matter (usually liquids and gases) are employed as probing media which are either directed to or applied on the relevant regions of the test objects. The main criterion for selecting a material for probing purpose is its ability to interact with the test material resulting in detectable modification of its characteristics by the flaws in the test object.

(ii) Modification of the probing media. The physical properties and distribution pattern of the probing medium undergo change due to interaction with the defects or discontinuities in the test item. These changes give an indication of the nature and extent of the flaws in the test material.

(iii) Detection. Every NDT method must have an appropriate device to detect the specific changes in the distribution and properties of the probing medium due to interaction with flaws in the test material.

(iv) Recording. There is also the need of a device for indicating or recording the changes as mentioned above in an intelligible form for proper interpretation.

(v) Interpretation. There has to be a suitable device or an experienced worker to interpret the data from the detector in terms of test material properties or flaws.

NDT methods: applications and limitations

Detailed discussion of the various NDT methods is not only beyond the scope of the present article but is also impossible within the permissible space of the article.

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Hence an attempt has been made to focus attention only on those NDT methods which employ high energy radiations as probing media. Penetrating power and resolving power which arise from short wavelength are the two most valuable qualities of the radiations which have made these methods more efficient and popular than other methods. However, for the sake of completeness and to enable the readers to get an overview of the various techniques, a list of most of the widely used methods is also presented.

Depending upon the nature of the probing media and the principle involved in the evaluation of flaws, NDT methods can broadly be classified as follows:

1. Penetrating radiations. Use of penetrating radiations for non-destructive testing of materials has proved to be the most successful. For this purpose X-rays and gamma rays in the energy range of a few kilovolts to a million volts are generally used. Both these forms of electromagnetic radiation have very short wavelengths (~ 1 Å) and are highly penetrating. Some of the important techniques belonging to this category are:

(a) Radiography (both X-ray and γ-ray), (b) X-ray diffraction, (c) X-ray fluorescence, (d) X-ray and γ-ray xeroradiography.

Apart from X-ray and γ-ray, high energy particles like neutrons, electrons and β-particles are also used in several NDT methods.

2. Acoustics. Here sound waves are used as probing media. In one method, changes in reflection and absorption characteristics of ultrasonic waves by defects in a sample are used as an indication of hidden flaws. Another technique called acoustic emission is based on the fact that when a material undergoes plastic deformation it releases quanta of energy which can be converted into elastic (sound) waves.

3. Magnetic properties. There are two methods, viz. (a) Magnetic particle test technique, and (b) Magnetic field test. These methods are especially meant for testing ferromagnetic materials and depend on the variation or discontinuity of the induced magnetic field at the cracks or discontinuities in the test object.

4. Motion of matter. Liquid or dye penetrant method is the oldest and simplest of all NDT methods and, as mentioned earlier, produces variation in the distribution of uniformly applied dye film at the cracks or holes in the test object.

In the eddy current method use is made of changes in eddy current, induced in a sample by a test coil, due to discontinuities such as cracks or voids.

5. Optical methods. In birefringent coating technique, the detection principle is based on the variation of birefringence formed due to double refraction of light on a photoelastic plastic layer applied on the test object. Any kind of strain will cause change in the pattern indicating the presence of a fault.

In laser holography, a complete three-dimensional photographic record of the object is made by using highly coherent laser source. Inspection of the holograms reveals the flaws.

Each of the methods listed above can reveal only some particular type or aspect of the flaws. For a thorough evaluation of the nature and extent of different types of defects which may coexist simultaneously, a suitable combination of the relevant techniques is necessary. As the prime aim of the present article is to deal with NDT methods based on penetrating radiations, we shall try to describe briefly these methods and their application and limitations.

Radiography

X-radiography is one of the oldest and most powerful techniques widely used even today for nondestructive testing of materials. High-energy gamma ray radiography is preferred to X-ray in several cases—especially for thick materials.

The principle can best be illustrated by a simple diagram as shown in Figs. 1(a) and (b). Since X-ray and gamma rays obey the same geometric principles of image formation as that of visible light, these radiations will also project a two-dimensional (invisible) shadow image of a three dimensional object on to a plane as shown in Fig. 1. The shadow image, usually received on a sensitive film, becomes visible on development and is known as a radiograph. The radiograph shows the X-ray transparency of the object. Radiograph obtained on a stationery film gives a permanent record and the technique is called film radiography. On the other hand, to economise cost and time, the film is some-

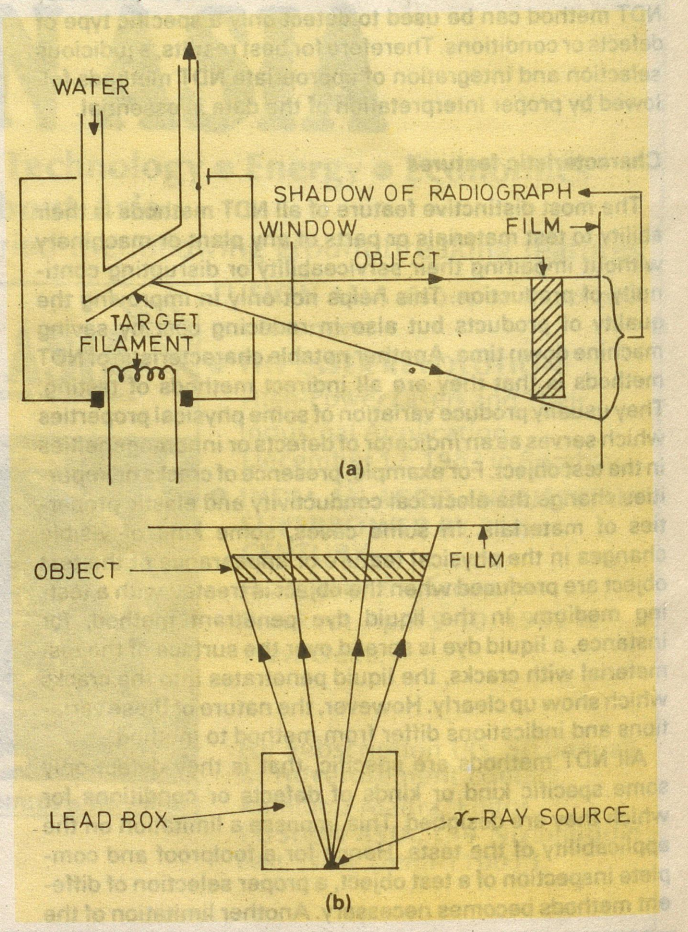

Fig. 1. (a) X-ray radiographic arrangement; (b) Gamma-ray radiographic set up.

times replaced by a fluorescent screen to permit direct viewing of the image. This technique is known as fluoroscopy.

The whole idea of radiography is based on two fundamental properties of X-rays and gamma rays, namely, their penetrating power and absorption by matter, especially the latter which varies with the atomic number of the element constituting the material and its thickness. The sharpness and definition of a radiograph depend largely on the geometry of the system and rectilinear propagation of radiation. If the test object is uniform in density, composition and thickness, the transmitted beam is of uniform intensity and consequently blackening on the film or screen will also be similar. On the other hand, if there is any variation of composition, thickness or density due to inhomogeneities or imperfections, the beam will suffer absorption by different amounts at different regions and consequently the intensities of parts of the beam emerging from different portions of the object will also vary. The variational pattern of intensities of emerging beam falling on the film or fluorescent screen will form an image showing the distribution of inhomogeneities and defects in the object. The density of blackening at any point on the radiograph will be proportional to the intensity of the beam falling at that point. Regions of high absorption will correspond to less blackened region.

Availability of compact sources of gamma rays has made gamma-ray radiography increasingly popular for routine use. The sources are radioisotopes which produce γ-rays by continuous disintegration of their nuclei. Selection of a particular isotope depends on the nature and thickness of the material to be tested. For this purpose, an important parameter, known as half value layer (HVL) of a material, is used in industrial radiography. The half value layer is defined as the thickness of the material that will reduce the intensity of a given radiation to half of its initial value. Compared to X-ray, a γ-ray radiographic unit is much simpler and less costly. Shorter wavelength and higher energy also make it more suitable for testing thicker material. However, there is need for proper precautions against exposure to radiation.

The most common γ-ray sources that are available and commonly used in India are cobalt-60 (half-life 5.24 years) and iridium-192 (half-life 74.4 days). Thulium-170 and europium-152 and 154 are also suitable for radiography of light alloys of small thickness, but these isotopes are yet to be developed on a commercial scale in India.

Microradiography is a new application of radiography which utilizes the same principle of radiography for evaluation of minute details (of the order of 1 μ region) in small or thin specimens (~0.1 mm thick). Main requirements of this technique are microfocus (ideally point focus) X-ray tube capable of giving highly divergent beam and fine-grained emultion X-ray film for achieving required high magnification and resolution in the micrograph.

Both film radiography and fluoroscopy find wide ranging applications in modern industries and medical science. Some of the important applications are:

(i) detection of internal discontinuities such as cavities, gas holes, porosity, cracks, inclusions, segregations, shrinkage in cast ingots, weldments, alloy castings, etc.

(ii) in maintenance of quality control of electrical and electronic components such as vacuum tubes, resistors, printed circuits, etc.

(iii) determination of the amount and localization of mineral constituents in biological samples like bones, tissues, etc.

Xeroradiography

In this method, X-ray or gamma ray beams after traversing through the test object are received on a plate made of an insulating material pre-charged to a certain level as in usual xerography. Under the influence of the incident X-ray or gamma-ray portions of the plate lose charge giving rise to an electrical "image" of the object. The image may be fixed on paper with the aid of a toner and used for flaw detection. Xeroradiographic inspection can be carried out with the same type of equipment employed for radiography.

One of the major disadvantages of all radiographic methods using high energy radiations is that they are highly directional. If detects like light cracks, folds, laminations, etc., are not properly oriented with respect to the incident beam, they may escape detection.

X-ray diffraction and X-ray fluorescence

X-ray diffraction is a powerful tool for identification and defect characterization of solid material. On the other hand, X-ray fluorescence spectroscopy is a very useful technique for qualitative and quantitative elemental analysis of crystalline and amorphous solids and liquids. The fluorescence

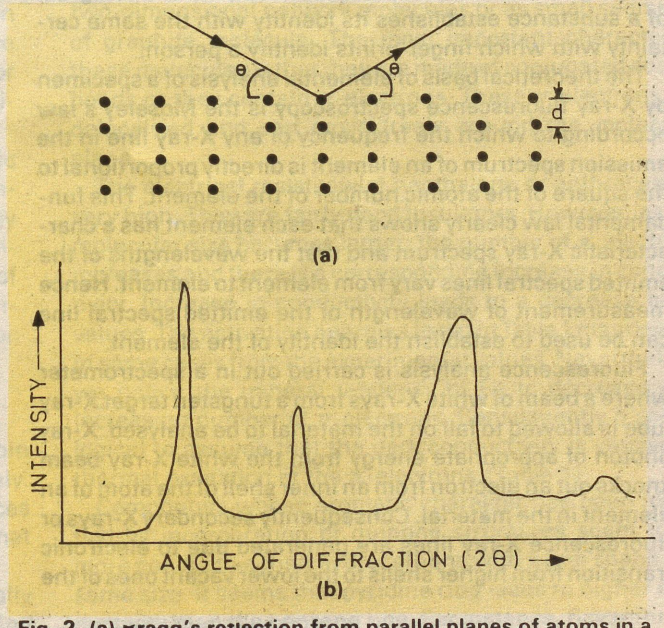

Fig. 2. (a) Bragg's reflection from parallel planes of atoms in a crystal; (b) Diffractogram of a powder sample showing the angular distribution of intensities of different reflections. Different peaks correspond to reflections from different sets of atomic planes

method, unlike diffraction, is independent of the physical and chemical state and depends only on the elemental composition of the specimen. For instance, the fluorescent spectrum of copper will be the same irrespective of whether it is present in the sample as free metal, ions, or combined with other elements to form a compound. X-ray diffraction pattern, on the other hand, depends on the crystal structure of the sample. Hence, the two methods provide information which are supplementary and are useful for complete analysis of a specimen.

Identification of a substance by X-ray diffraction is based on the well known Bragg's law:

$$2d \sin \theta = n\lambda.$$

Here n is the order of reflection similar to that of ruled gratings in optics; λ is the wavelength of the radiation, d is the distance between the set of planes of atoms in the crystal from which reflection takes place, and θ is the angle between the incident beam and the atomic planes called the glancing or Bragg's angle of reflection. X-ray diffraction from a crystal is visualized as equivalent to reflections from sets of parallel planes of atoms following usual geometry and principle of optical reflection as shown in Fig. 2(a). Modern X-ray counter diffractometers have provisions for quick and automatic recording of the positions (θs) and distribution of reflected intensities from different planes on a chart recorder. This record is known as a diffractogram (Fig. 2b). From the positions (θs) of different peaks, the interplanar spacings (d) of the corresponding planes can be determined and the sample identified. Thus X-ray diffraction provides a very powerful tool for identification of a specimen from the observed d-values which are in general different for different substances. IN fact, the diffractogram of a substance establishes its identity with the same certainty with which finger-prints identify a person.

The theoretical basis of elemental analysis of a specimen by X-ray fluorescence spectroscopy is the Moseley's law according to which the frequency of any X-ray line in the emission spectrum of an element is directly proportional to the square of the atomic number of the element. This fundamental law clearly shows that each element has a characteristic X-ray spectrum and that the wavelengths of the emitted spectral lines vary from element to element. Hence measurement of wavelength of the emitted spectral line can be used to establish the identity of the element.

Fluorescence analysis is carried out in a spectrometer where a beam of white X-rays from a tungsten target X-ray tube is allowed to fall on the material to be analysed. X-ray photon of appropriate energy from the white X-ray beam knocks out an electron from an inner shell of the atom of an element in the material. Consequently secondary X-rays or fluorescence X-ray lines are generated due to electronic transition from higher shells to the lower vacant ones of the atom, following the usual principle of formation of optical spectra. The fluorescent X-rays have the same characteristic line spectrum wavelengths and relative intensities as X-rays produced by direct electron excitation in an X-ray tube. It may be mentioned here that quantitative analysis of elements in concentration of the order of 0.1 per cent has been reported by X-ray fluorescence spectroscopy. However, optical spectroscopy is superior to X-ray fluorescence for trace element analysis.

Considerable advances have been made in radiographic and diffraction techniques by the introduction of well designed fine focus X-ray tube and highly sensitive fine grained emulsion film and counters as detectors. Finer focussing of the electron beam is achieved by electrostatic method which can produce a focal spot of the order of a micron diameter. Television camera has been introduced for continuous viewing in fluoroscopy. Flash radiography is another step forward which is employed for studying rapidly moving objects. The advent of microprocessors has made great impact in all branches of engineering including nondestructive testing technology. Several microprocessor-based nondestructive testing instruments have already come out in the market.

In conclusion, we must repeat that the ultimate success of this highly application-oriented technology depends largely on the ability of the technician to interpret properly the indirect indications recorded by the detectors. This aspect of the technology calls for a collective effort by workers from various disciplines. To solve this problem, American Society for Testing of Materials (ASTM) was the first to prepare a comprehensive plan of training personnel in various disciplines. This pioneering approach has been followed by many other countries. In India too, some concerted action has been initiated through research and development programmes for improving NDT by several organizations like Nondestructive Testing Society, Indian Standards Institution, Hindustan Aeronautics, National Aeronautical Laboratory, Instrument Society of India, National Test House, National Physical Laboratory and several equipment manufacturing concerns.

Further reading

1. Clark, G.L., *Applied X-rays*, McGraw Hill, New York (1953)
2. Klug, H.P., and Alexander, L.E., Wiley Interscience, New York (1973).
3. Rumyantsev, S., *Industrial Radiology*, Foreign Language Pub., Moscow.
4. *Nondestructive Testing Hand Book*, Vol. I & II; Ed. Robert C. McMaster, Ronald Press, New York (1959).
5. Parrish, W. (Ed.), *X-ray Analysis Papers*, Centrex Eindhoven (1965).
6. Prasad, J., NDT and Design—An appraisal, *Journ. Accoustical Soc. Ind.*, Vol. IX, pp **83-93** (1981).

Organic polymers can be made conducting by structural modification during polymerisation or doping which makes them highly suitable for use in semiconductor devices

DEBASIS MUKHERJEE

All About ORGANIC SEMICONDUCTORS

ORGANIC compounds are generally electrical insulators. The typical organic material has strong bonding in the molecule itself. Coupling between molecules is generally very weak and the energy bands, if any, for electron motion are very narrow and separated by wide gaps. The gaps are so wide that usually electrons cannot be transferred between them at temperatures at which crystals will not decompose. This is true in general. Nevertheless, in recent years, attention has been paid to organic compounds which have electronic conductivity in the solid state.

Of late, the topic 'Organic Semiconductors' has created a lot of interest among scientists, especially solid state physicists. An organic semiconductor may be defined as a structure containing an appreciable number of carbon-carbon bonds and delocalized electrons (electrons that can move along the entire molecular chain) which are responsible for transport processes in the same way as classical semiconductors.

It was postulated many years ago that intrinsic electronic conduction takes place in some proteins and that this conduction is responsible for the principal mode of energy transfer in these biosubstances. It has not yet been definitely established whether or not a significant amount of energy is in fact transported this way, but many experiments on dry proteins indicate that electronic conduction does take place and it has the familiar form

$$\sigma = \sigma_0 e^{-Eg/2kT}$$

where Eg is the energy gap. The energy gaps for myoglobin and hemoglobin are 2.97 eV and 2.75 eV respectively. These values indicate that electrons in these substances are not appreciably excited at room temperature and that these materials are consequently good insulators.

In inorganic semiconductors, the structure is generally characterized by their strong covalent or ionic binding between atoms in the lattice. The charge transport can easily take place through a strong exchange interaction of overlapping atomic orbitals in a close pack structure. But in an organic semiconductor, rather weak van der Waals or London forces exist between molecules. Therefore, the overlap of molecular orbitals and intermolecular electron exchange are small so that the structure is not favourable for charge transport. In a semiconductor, the conductivity σ depends on the concentration of free charge carriers n, their charge e and mobility μ according to the equation (1). The concentration of carrier and hence the conductivity increases with temperature according to a Boltzmann type distribution with activation energy Ea as shown in equation (2). Thus semiconductivity with a positive activation energy is distinguished from metallic conductivity which falls as the temperature rises.

$$\sigma = n e \mu \quad \text{.....(1)}$$

$$\sigma = \sigma_0 e^{-Ea/kT} \quad \text{.....(2)}$$

Semiconducting organic solids fall into two major classes: (a) molecular crystals and (b) polymers. The molecules of condensed aromatic hydrocarbons can be regarded as two-dimensional network molecules or as small segments of graphite molecule. The most important character of these molecules is that they are made of conjugated double bonds or they contain π-electrons. These π-electrons are delocalized and can move freely around the molecular plane.

The electrical resistivity of napthalene or anthracene is very high. They are fairly good insulators. However, as the molecular size becomes larger, the number of π-electrons increases and there is a corresponding increase in conductivity. Increase in conductivity leads to a decrease in Ea values. The activation energies listed in Table 1 may deviate in some cases from the experimental values. Nevertheless, we notice the general tendency of Ea to decrease with increasing number of π-electrons. Consequently it seems logical to assume that the dark conductivity is caused by thermal excitation of the π-electrons (Table 1).

Compounds whose aromatic character has been modified by incorporation of quinone structures seem to be more conductive than hydrocarbons with same shape and same size. It seems that pyridine ring leads to higher conductivity than the benzene ring. For instance, flavanthrone (Fig. 1a) is a better conductor than pyranthrone (Fig. 1b), due to the presence of pyridine rings. Indanthrone black

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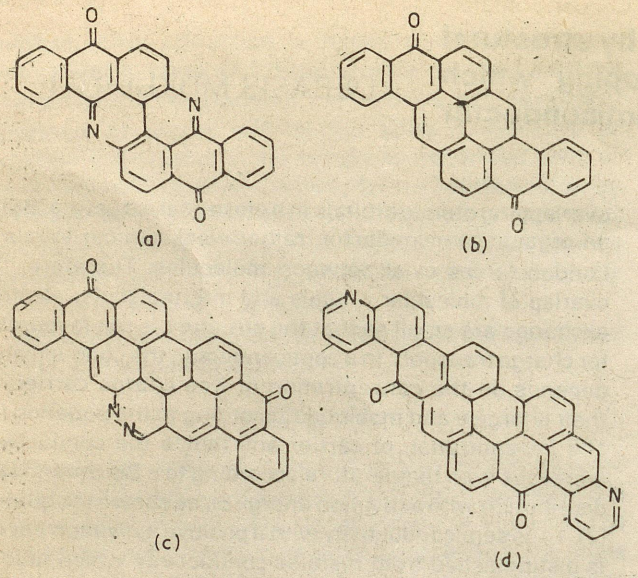


Fig. 1

(Fig. 1c), made up of ten rings, (part of them involving nitrogen) has resistivity of the order of 10^8 ohm-cm and that of cyananthrone (Fig. 1d), made of nine benzene rings and two pyridine rings, is 10^7 ohm-cm. The conductivity of cyananthrone can be compared with that of selenium—a typical inorganic semiconductor.

Donor-acceptor (D-A) complexes

There are two classes of compounds with high dark conductivity that have received most attention. Both of them, depend upon the presence of electron donors (D) and electron acceptors (A). Solids formed from D-A interaction can be divided into (a) charge-transfer complexes CTC and (b) radical-ion salts.

Charge transfer complexes are formed closed-shell molecules. They are neutral in their ground state and are characterized by weak van der Waals interactions. In crystalline CTC, the donor and acceptor molecules stack in the crystal in the order DA DA DA DA. These stacks are called mixed or intercalated stacks. The intermolecular spacing between the D and A molecules in the same stack is less than 3.4 Å to 3.6 Å spacing that is characteristic of van der Waals solids.

Charge transfer complexes can be generally defined as those compounds which are formed by the interaction of two molecules to form complexes without covalent bond participation. R.S. Mulliken of Dept. of Physics, University of Chicago, Illinois, proposed in 1952 that these complexes were formed as a result of an acid-base reaction between the aromatic molecule which acts as an electron donor or Lewis base, and the electron acceptor which acts as a Lewis acid.

Charge transfer complexes such as hydrocarbon-halogen complexes are generally characterized by a new electronic transition which lies at a lower energy than those associated with the respective donor or acceptor molecules comprising the complex. Such transitions are called charge

Table 1

Compound	*No. of π-electrons*	*Activation energy Ea (eV)*
Benzene	6	3.4
Napthalene	10	1.4
Anthracene	14	1.5
Tetracene	18	1.64
Pentacene	22	1.16
Hexacene	26	1.14

transfer bands and are responsible for the colour which often characterizes these materials. The energy level diagram of charge transfer complexes depends strongly on the ionization potential of the donor and the electron affinity of the acceptor.

Charge transfer complexes are good conductors. Their resistivity ranges from several ohm-cm to a hundred ohm-cm at room temperature. The bromine-hydrocarbon complexes are generally unstable and the resistivity increases gradually over a period of days. If bromine is gradually removed by substitution reaction with the liberation of an equivalent amount of hydrogen bromide, conductivity decreases. When the specimen which has lost bromine molecules is exposed to bromine vapour, it absorbs bromine again and regains the conductivity. In case of iodine-complexes, the substitution reaction of iodine does not take place, consequently iodine complexes are stable and so also is their electrical conductivity. These facts indicate that the origin of conduction in these complexes is the interaction between molecules of hydrocarbons and halogens which form additional molecular compounds with each other.

Many polymeric charge transfer complexes have been made, usually with donor species carried on a vinyl polymer. However, this often results in conductivity lower than that of the equivalent monomeric complex. If 2, 4, 5, 7-tetranitrofluorenone is used as acceptor, the conductivity of the polymer system is greater than that of the monomer by 10^3. Although the conductivities are low, this is an important observation because it shows that the polymer can be tailored to give the correct geometry to facilitate sandwitch stacking. The polymers are soluble and more tractable than the conjugated systems as the stiff rod-like stacks are plasticized by the flexible σ-bonded polymer matrix.

Generally the polymeric charge transfer complexes are brittle materials. They are of value where mechanical properties are not important, as in the case of poly (2-vinyl pyridine)-iodine complex which is used as a cathode in miniature Li-I_2 primary cells for implantable cardiac pacemakers. The complex serves a dual function as a source of iodine for the cell reaction

$$2Li\text{-}I_2 \rightarrow 2Li\,I$$

and as an electronic conductor carrying current to the collector. The conductivity of the complex is constant at $10^{-3}ohm^{-1}cm^{-1}$ as the iodine concentration falls from 90% to 75% on discharging the cell. This solid-state cell with the

Li I electrolyte formed *in situ* has a very high energy density (120 wh kg^{-1}) compared to the best lead-acid battery (30 wh kg^{-1}) and a service life of ten years.

Radical-ion salts such as poly(2-vinylpyridine) -iodine complex are essentially ionic in character. The ground state consists of positively and negatively charged ions, e.g. Tetrathiofulvalene (TTF-TCNQ salts, the molecules in each stack are tilted with respect to the axis of the stack. A common feature of all radical-ion salts and complexes is the planarity of the individual molecules. TTF-TCNQ has a room temperature conductivity parallel to the stacks of $10^3 ohm^{-1}cm^{-1}$. Most remarkable, however, is the recent discovery of superconductivity (complete loss of electrical resistance exhibited by certain materials when they are chilled to temperatures very nearly equal to absolute zero) in organic radical-ion salt tetramethyl tetraselenofulvalene hexa fluoro-phosphate $(TMTSF)_2PF_2$.However, little is known about this compound. Organic radical-ion salts are of practical interest because they have already demonstrated superconductivity and they are interesting theoretically because they exhibit a quasi-one-dimensional behaviour.

W.A. Little of Stanford University, California, in 1964, proposed a theoretical model to show that organic materials may exhibit superconductivity in some cases. He proposed that an attractive potential between conducting electrons could be mediated by an intramolecular polarizability. This would produce an effect similar to that of lattice phonons in the creation of Cooper pairs. Little envisaged the construction of a polymer-like molecule, consisting of a conducting spine and polarizable side groups. An electron travelling along the spine would polarize the side groups and this polarization could act as an attractive potential to the next electron coming along the spine. Although the polymer suggested by Little has not yet been made, several analogue of this polymer have been synthesized but none of them displays superconductivity. Recently, a second family of organic superconductors has been reported; they are compounds of bis(ethylenedithiolo)tetrathiofulvanene (BEDT-TTF). In 1983, workers of a research laboratory in California, reported that they have found superconductivity in rhenium oxide salt, $(BEDT\text{-}TTF)_4\ (ReO_4)_2$ at temperature around 2K under pressure of about 4000 atmosphere. The requirement of high pressure to produce superconductivity is characteristic of organic superconductors.

The conductivity of conjugated polymers investigated upto now ranges from 10^{-14} to $10^{+3}\ ohm^{-1}cm^{-1}$, depending on the number of delocalized π-electrons and the degree of delocalization. Various relationships between the structure and conductivity of these polymers have been observed:

(a) There is a decrease in activation energy Ea with increasing degree of polymerization or increasing number of π-electrons. For example, a copper-phthalocyanine polymer consisting of five phthalocyanine units has an activation energy, Ea of 0.12 eV-0.26 eV whereas for the monomer Ea is 1.7 eV.

(b) There is an increase in conductivity with decreasing activation energy, Ea, within a series of similar polymers. Copper-phthalocyanine can be mentioned again as an example. Its conductivity can be improved by polymerization from $10^{-12}\ ohm^{-1}cm^{-1}$ to $10^{-1}\ ohm^{-1}cm^{-1}$.

(c) The increase in conductivity which can be achieved by polymerization depends on the strength of the mutual coupling of subsequent π-electron orbitals of the monomeric units. This means that conductivity can be increased by various structural effects which favour π-orbital overlapping.

Ekaconjugated and rubiconjugated polymers

The above relationships provide a connection between conductivity and structure of conjugated polymers. Besides the number of π-electrons, it is mainly structure dependent delocalization of π-electrons which determines the conductivity of a polymer. In 1967, Herbert A. Pohl from Deptt. of Physics, Oklahoma State University, first used this fact to classify polymers into ekaconjugated and rubiconjugated semiconductors.

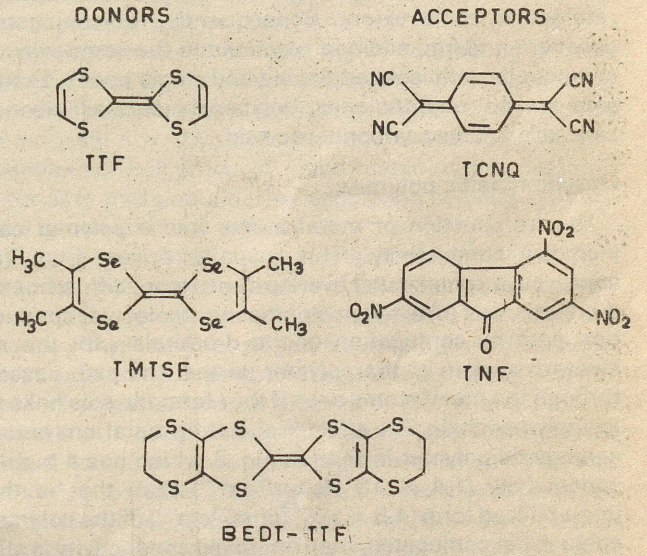


Fig. 2

Ekaconjugated polymers are compounds containing completely conjugated and often large planar structures of predominantly aromatic nature. The conductivity of this class of polymers exceeds $10^{-7}\ ohm^{-1}cm^{-1}$ and the carrier concentration exceeds $10^{-18}cm^{-3}$. The conductivity is hardly influenced by impurities and the activation energy tends to zero as the degree of polymerization is increased. These substances are relatively inert against addition reactions. Examples are polyacenes, poly-phthalocyanines, polyphenylenes, polyacrylonitrile and polyxanthenes.

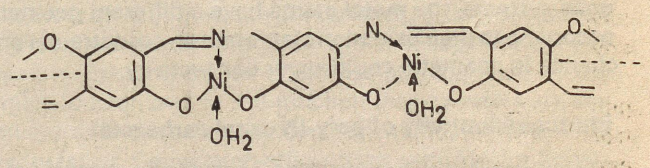


Fig. 3

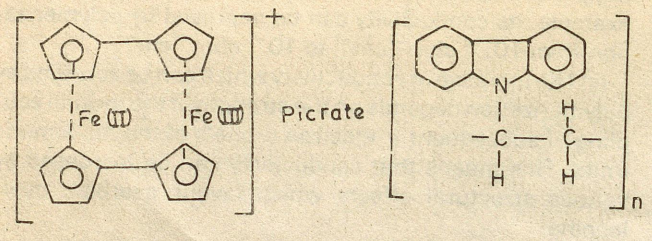


Fig. 4a Fig. 4b

Rubiconjugated polymers consist of structures which are not completely conjugated and often contain heteroatoms. In these polymers, delocalization of π-electrons is confined to smaller regions of the polymer molecules. The conductivity of these polymers is comparatively small, often less than 10^{-7} ohm $^{-1}$cm, $^{-1}$ carrier concentration less than 10^{18} cm^{-3} and the activation energy tends to a limit $Ea>0$ as the degree of polymerization is increased. The ESR spectra of the diamagnetic polymers do not indicate electron delocalization and the nature of single and double bonds is retained to some extent. Consequently, rubiconjugated polymers undergo addition reactions in the same way as compounds with isolated double and single bonds. Examples are polynaphthalenes, polybenzimidazoles, ribonucleic acid and deoxyribonucleic acid.

Organometallic polymers

The introduction of metal atoms into a polymer can increase conductivity. This usually arises from (a) improved intermolecular overlap due to more diffuse metal d-orbitals, and (b) extension of the intermolecular conduction path by conjugation of the d-orbitals with the π-electron system of the polymer so that the path passes through the metal atoms even if they form the sole links in the polymer chain. The effect of chelating metal ions onto a conjugated polymer is seen in Fig. 3 which has a higher conductivity (1.4×10^{-10}ohm^{-1}cm^{-1}) than that of the unmetallized form (4.5×10^{-13}ohm^{-1}cm^{-1}). If the polymer chain is not conjugated, then improved conductivity is still possible because with a transition metal a mixed valence state system can transport electrons by redox behaviour. This is illustrated by the ferrocene-ferricenium polymers (Fig. 4a), which conduct by metal-to-metal hopping without participation by the organic framework. The transport process is relatively insensitive to delocalization or to the corresponding anion. But it is strongly dependent upon the fraction of ferrocene unit oxidized. The electron hopping model for the transport process is consistent with these observations. Although the unoxidized ferrocene polymer is practically as insulator, the early oxidized form has a conductivity of 10^{-6}ohm^{-1}cm^{-1}. In the hopping mixed valence systems, the metal atoms have a different geometry according to their oxidation states and any constraints on a change in geometry could lower conductivity.

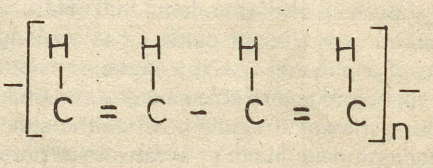
Photoconductivity of poly-(N-vinyl carbazole)

In xerography, a photoconductor coated on a metal drum is negatively charged in the dark by a corona discharge. The image to be copied is projected onto the photoconductor, thereby discharging the light areas. Black positively charged toner powder coated with resin is sprayed on to the latent image where it is held and subsequently transferred to negatively charged paper. The image is finally fixed by heating to sinter the resin.

The photoconductor formerly used was arsenic triselenide AS_2Se_3, but it is difficult to manipulate as it has to be applied by vacuum sublimation and is brittle. It is now being replaced by materials based on poly-(N-vinylcarbazole) (PVK) (Fig. 4b) which is a good dark insulator whose photoconductive properties were discovered in 1957. It absorbs UV light forming an exciton state which ionizes in an electric field and the electron is stabilized in trapping levels of low potential carbazole dimer units leaving only the radical cations, PVK^+, to act as charge carriers. In visible light, PVK remains an insulator but can be sensitized with an electron acceptor, 2,4,7-trinitrofluorenone (TNF), which by forming charge-transfer state shifts the absorption edge into the visible region and renders it photoconductive.

Polyacetylene and polypyrrole

Due to their unique properties, these polymers have been so widely studied that they deserve special mention. Polyacetylene is the simplest linear conjugated polymer. Its formula is



The electrical conductivity of this polymer can be varied over twelve orders of magnitude, ranging from 10^{-9} ohm^{-1}cm^{-1} to about 10^{3}ohm^{-1}cm^{-1}. Physically the polymer consists of a network of randomly oriented fibrils, whose diameter is a few hundred Å. The polymer can be stretched in one direction, as a result of which a considerable anisotropy in electrical and optical properties is produced. The conductivity of doped polyacetylenes is comparable to that of TTF-TCNQ and they also exhibit metallic properties. The polymer can be simultaneously doped with donors like AsF, and acceptors like I_2 to demonstrate compensation. In addition, the n- and p-type materials are capable of forming p-n junctions. A team at the University of Pennsylvania has shown that when electrochemically treated with anions like I_3^-, ClO_4^-, ASF_4^- using tetrabutyl ammonium salt dissolved in dichloromethane, polyacetylene can be changed from an insulator to a p-type semiconductor.

Films of polypyrrole with p-type conductivity upto 100 ohm^{-1}cm^{-1} are prepared by electrolytic oxidation of pyrrole in acetonitrile solution using either tetraethylammonia tetrafluoroborate or silver perchlorate. The films are flexible, nonfibrous, shiny and blue-black. They are stable in air and can be heated upto 250°C with little effect on transport process. They behave as degenerate semiconductors like amorphous silicon.

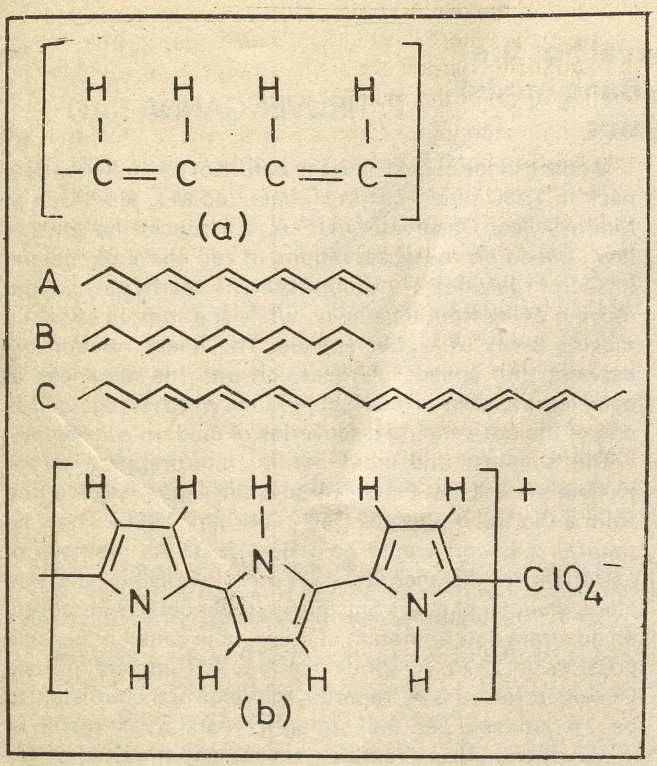


Fig. 5

A useful conducting polymer must have good mechanical properties. It must be stable, cheap, processable and light. Polypyrrole (Fig. 5b) satisfies most of these requirements but its characterization is difficult. It is expensive too. Another major disadvantage of polypyrrole is that it cannot easily be n-doped (reduced). Consequently its use in diodes may be a long way off.

Studies on polyacetylene have led to the introduction of the new concept, soliton, in the transport process of organic materials. A wave which propagates without dispersing is called a solitary wave, or soliton. In trans-polyacetylene, which is a linear conjugated polymer, a defect consisting of a kink or two single-bonds adjacent to each other, is mobile and can move along the polymer like a solitary wave. Reflection at the ends of the molecule can take place easily. Because of the alternating single and double bonds of $(CH)_x$, there are two degenerate ground states, A and B (Fig. 5). The existence of at least two degenerate ground states is a necessary condition for the existence of solitons, an example of which is C in Fig. 5. Here one can view the soliton as a domain wall that separates phase A from phase B, the spatial extent of neutral soliton is about 14 lattice spacings and its mass is about six times the electron mass. The injection of a hole or an electron into polyacetylene can create a charged soliton and this is the entity that carries the current.

Applications

The existence of two extreme grades of conducting polymers might be anticipated in discussion of the applications potential of such materials. In the first grade (economy grade), where cost is a main consideration, the materials synthesis and processing methods might be analogous to those used in today's polymer technologies. In the second extreme (device grade), where optimal electronic and/or mechanical properties are required, advanced synthetic methods will have to be developed which result in high structural perfection (low trap density, high mobility) materials. Here we could be in the high cost regime of semiconductor crystals.

An inexpensive method of forming highly conducting polymers might be the coaddition of monomer and doping agent during a step involving both polymerization and product fabrication. There are processes where conducting polymers are directly fabricated into shaped articles by combining monomer and dopant in a mold. These processes are analogous to today's Reaction Injection Molding (RIM) technology. In this regard it is noteworthy that monomers like terphenyl, acetylene and thiophene can be directly polymerized to form highly conducting polymer compositions (complexes of poly(p-phenylene), polyacetylene and polythiophene respectively) merely by the addition of a dopant like AsF_5. Unfortunately, the conductivity and mechanical properties of these materials are presently inferior to those obtained by doping the polymer synthesized by conventional techniques.

Possible applications of highly conducting polymers include battery electrodes which are being aggressively pursued by companies in USA, Japan, Germany and France. Polyacetylene and poly p-phenylene can be used as a cathode-active material in a secondary battery. In the case of polyacetylene, a solution of $LiClO_4$ in propylene carbonate is used to dope the polymer and the undoping allows its use as a cathode active material with a lithium anode. In the case of poly p-phenylene, the cathode is a partial hexafluorophosphate salt of the polymer, the anode is lithium or its alloy. Interest in these specific polymers for this application relate to their low density, insolubility, high obtainable surface area, reversible dopability with both n-type and p-type dopants and high electrical conductivity. Extremely high power densities are obtainable in such batteries, while maintaining high energy densities, and the polymeric nature of the active battery materials permits development of novel battery designs.

Highly conducting organic polymers have been of considerable interest in semiconductor device applications. Specific examples are their use as either the metal or the semiconductor part of Schottky diodes or as the n-type or the p-type material in n-p junctions. The performance of solid state devices in which the conducting polymer is used as a semiconductor has been rather disappointing. For example, Schottky diodes which use polyacetylene as the semiconductor part of the junction display relatively low forward-to-back resistance and high values for the diode quality factor. Conversion efficiencies were low for Schottky barrier solar cells using poly(p-phenylene sulphide) or poly acetylene as the semiconductor. These results are not very surprising considering the gross structural inhomo-

(Continued on page 377)

About The BIG BANG

The evolution of the universe from the primeval hot fireball upto the present as predicted by the Big Bang model can be explained in terms of the laws of physics

P. TIRUVENGANNA RAO

FROM the dawn of recorded history, man has been trying to understand the nature of the universe and his place in it. Every civilization or religion that emerged on earth has had a cosmology of its own at the core of its teachings. As these cosmologies were frequently expressed in mythical terms involving the names of gods and demons and of battles between them, they revealed far more the psychology of the people who devised them than the true nature of physical reality. The science of cosmology deals with the study of the beginning, evolution and ultimate fate of the universe. In this article, some recent developments, both in observational and theoretical cosmology, which have led to the Big Bang model of universe, currently the most acceptable model, are discussed.

The beginnings

Modern astronomy has had its beginnings some four hundred years ago, when Galileo Galilei turned his telescope heavenwards to examine the visible objects in the night sky. By 1785, William Hershel had proved that the sun was but an ordinary star in a huge disc-shaped collection of stars known as the Milky Way galaxy. The next major advance was made by Edwin Hubble who succeeded in measuring the distances to nebulae; he showed that the Milky Way galaxy was just one of the millions of galaxies scattered in space and time. Since then major advances in man's understanding of remote celestial sources have become possible with the coming of large ground-based, high resolution optical and radio telescopes and infrared, ultraviolet and x-ray telescopes carried above earth's atmosphere in rockets or orbiting space satellites. By 1970, astronomers could study celestial sources at virtually all wavelengths ranging from long radiowaves to short x-rays.

The development of quantum theory in the 1930s helped in explaining how atoms give rise to spectral lines in the light from stars and galaxies in different regions of the electromagnetic spectrum. This gave astronomers a tool to identify atoms from the spectrum of a star or a galaxy by comparing the lines with those in spectra of known elements or chemicals. It was also discovered that the spectral lines shifted from their usual wavelength positions either towards the red or blue end of the spectrum depending on the direction of motion of the source of light due to "Doppler effect". This provided a means of determining the velocity of stars and galaxies.

Modern ideas concerning the nature of the universe date back to 1930 when Edwin Hubble and M.L. Humason at Mount Wilson Observatory, U.S.A., announced the "Hubble law', based on the observations of red shifts of spectral lines from galaxies. They found that the nearby galaxies are moving away from us slowly, while the remote ones are moving away at higher speeds. The linear relationship between the speeds of recession and the distances of galaxies is known as the Hubble's law, which is regarded as one of the outstanding discoveries of modern astronomy.

The simplest and most natural interpretation of the Hubble's law is that the universe is still expanding, starting from a Big Bang (*see* also *S.R.*, February 1986). The next natural question would be : How fast? As methods of astronomical distance measurement involving pulsating stars, globular clusters and quasi-stellar objects improved, an accurate determination of the Hubble constant became possible. In 1974, A. Sandage and G.A. Tammann of Hale Observatories, U.S.A., reported the value of this constant to be 16 km/sec per million light years as a result of observations of very remote galaxies and their red shifts. An accurate determination of the Hubble constant is important because it enables astrophysicists to determine the age of the universe. Using the above value, the age of the universe is estimated at 15 billion years.

As all galaxies and matter in universe exert gravitational pull on each other, the rate of expansion must be slowing down. If astronomers are able to measure accurately the deceleration rate, they could tell us what would be the ultimate fate of the universe. At present, the universe is expanding at a certain rate given by the Hubble constant. When astronomers observe distant galaxies using telescope, they are looking at them as they had appeared some millions of years ago in the past. By measuring the red shifts and distances of the most remote galaxies, it may be possible to figure out how fast the expansion is slowing down. Although the relation between speed and distance for nearby galaxies is linear, it is not so for the most remote galaxies.

Depending upon the kind of universe in which we live in, the data could fit into one of three different curves (Fig. 1), all of them corresponding to the Big Bang model of the universe. The three curves, A, B and C, relate the distances of galaxies to their speeds of recession. If the data correspond to curve A, it would mean the universe was expanding much faster in the past than it is today. This means that the rate of expansion is slowing down rapidly so that the universe will reach a maximum size and will then start contracting. Curve B corresponds to the case where the galaxies will come to rest after a time when they are infinitely apart. Curve C corresponds to the case in which the galaxies will be rushing away from each other no matter how long we wait. The universe will then be

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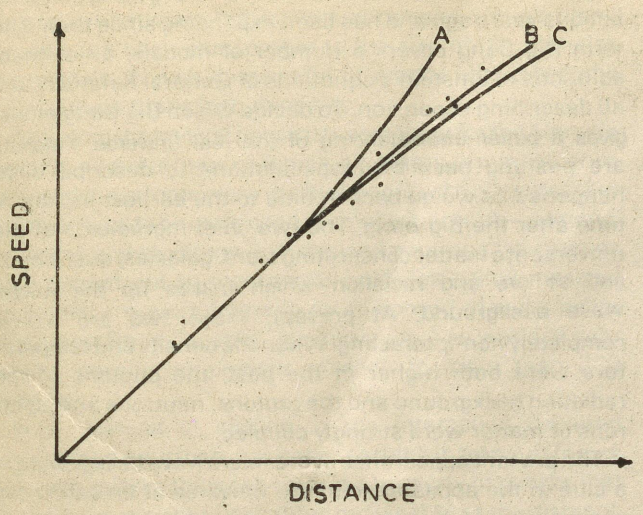

Fig. 1. Shows the curves A, B and C relating the speed of galaxies with distance. It is seen that the dots representing astronomical data do not lie on any single curve

expanding for ever. The question as to whether we live in an open or closed universe depends upon the measured average density of matter in the universe.

In 1965, two physicists Arno Penzias and R. Wilson working at the Bell Telephone Laboratories in U.S.A. built a highly sensitive horn-shaped radio receiver for use in conjunction with a space program. When they were testing this receiver, they discovered a faint whisper of radio noise coming from all directions in outer space and found it to be microwave radiation at a wavelength of about 1.285 cm. This important discovery of the cosmic microwave radiation lent further support to the Big Bang cosmology. It is noteworthy that in 1946, George Gamow had theoretically predicted that if the universe began with a Big Bang, it must have been very hot in the beginning. It must have been filled with radiation corresponding to a temperature of at least ten billion degrees shortly after the Big Bang. As the universe expanded, it must have cooled. Finally, after about fifteen billion years, the universe has expanded so much that the background temperature should be only a few degrees above absolute zero. Using a similar line of reasoning but with new data, R.H. Dicke at Princeton in the mid 1960's calculated that the temperature of the universe today should be three degrees above absolute zero. In the years following the work of Penzias and Wilson, additional observations were made over a wide range of wavelengths. These indicated that the cosmic background radiation corresponds to the theoretical curve predicted by Max Planck for a black body at a temperature of 2.7 K. Hence the cosmic microwave background radiation can be considered as an echo of the Big Bang of the early universe.

It has also been observed that 3 K black body radiation is isotropic and homogeneously distributed throughout the universe while all matter is spread out uniformly in the form of stars, clusters of stars, galaxies and clusters of galaxies and also in the form of invisible matter. So, on a large scale, matter and radiation in the universe appear to be uniformly distributed in all directions.

The space-time curve

Theoretical cosmology in its modern form began in 1917 with Albert Einstein's publication of a paper describing how the equations of general relativity can be applied to describe the behaviour of large aggregations of matter. The General Theory of Relativity, which is also the theory of gravitation, follows the earlier development of the Special Theory of Relativity. While the Special Theory unifies the concept of space and time into a single concept of space-time, the General Theory unifies the concepts of space-time and matter. The gravitational field of an object, whether it be earth, the sun or a galaxy, manifests itself as the curvature of space-time. Objects such as planets, stars or galaxies move along paths in that curved space-time. In other words, matter tells space-time how to curve and curved space-time tells matter how to move. Gravitation is expressed in terms of the geometry of curved space-time rather than the geometry of flat space-time. If there is matter somewhere in the universe, space-time is curved in its neighbourhood. As the universe as a whole consists of matter and radiation uniformly distributed in all directions, there must be an overall curvature of the universe.

Assuming that the universe is isotropic and static, Einstein first tried to solve the equations of general relativity and found that they could not be solved unless he introduced an arbitrary factor called the cosmological constant. Since at that time the universe was known to be static, he had to introduce this arbitrary constant and come out with the first theoretical model of the universe, a closed spherical universe with a positive curvature. This constant represents a force of cosmic repulsion to counteract the force of attraction between galaxies. Einstein is reported to have commented later that the introduction of this constant was the biggest scientific mistake he ever made in his life!

In 1922, the Russian mathematician Alexander Friedmann discovered that he could solve the equations of

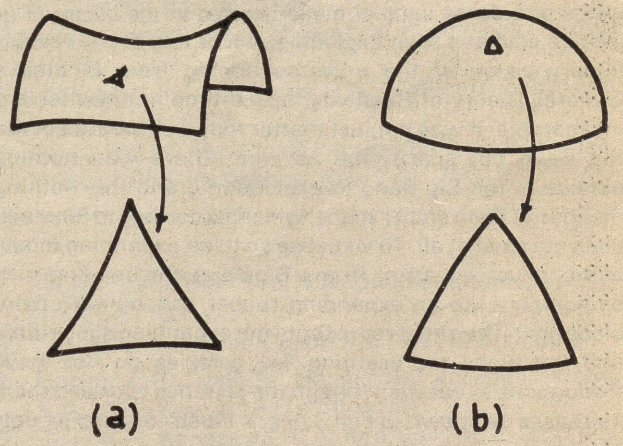

Fig. 2. Illustrates curved space-time geometry of the Universe with (a) negative curvature (b) positive curvature. Since the curvature of four dimensional space-time cannot be visualized, only the analogous two-dimensional surfaces are shown. The sum of the angles or a triangle is less than 180° in (a) and greater in (b)

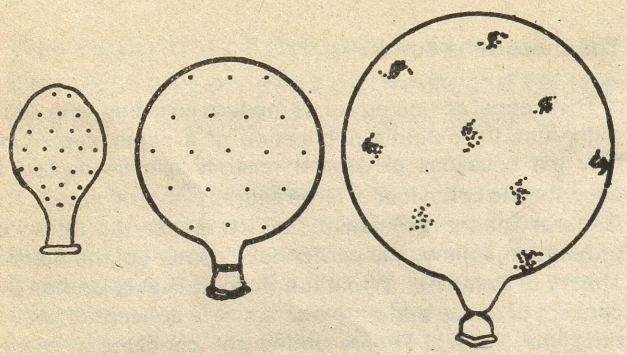

Fig. 3. Illustrates the expanding model of the Universe as an expanding rubber sheet being blown up. The sheet represents the expanding space-time and the blobs representing the galaxies do not move through the sheet even though the distance between them increases

General Relativity without the cosmological constant. Friedmann's solutions, which from the basis of cosmology today, predict that the universe is expanding starting from a singularity—a point of zero volume in space-time and infinite density of matter. These solutions imply a number of Big Bang models depending upon the amount of matter in the universe. If the measured average density of matter in the universe is below a certain critical limit, then the space-time of the universe has a negative curvature as in Fig. 2 (a) and is infinite in extent and expands forever. If it is above the critical limit, then the universe has a positive curvature and is finite but unbounded like the surface of a sphere as in Fig 2 (b). In such a universe, a light ray travelling in any direction will eventually come back to where it started from . According to Friedmann's solutions, the critical density is related to the rate of expansion of universe, i.e., Hubble constant. According to present estimates, the average density of the universe is not sufficient to halt the expansion and the universe will expand forever.

At this stage, it is better to make a few remarks about the Big Bang model of the universe. The most common misconception about the nature of the Big Bang is the image of a dense lump of matter located in the centre of an infinite void and then exploding. According to the revolutionary vision of the universe arising from Einstein's General Theory of Relativity, space-time and matter are inseparable. It was not just matter that was created in the Big Bang but space-time as well. There was nothing outside of the Big Bang to explode into and this nothing means not even empty space, which, according to Einstein, does not exist at all. To visualise such an expanding model of the universe starting from a Big Bang, the universe may be compared to an expanding rubber balloon with paint blobs on it. The sheet represents the expanding space-time and the blobs representing the galaxies do not move through the sheet even though the distance between them increases as shown in Fig. 3. Fig. 4 illustrates two models of universe, open and closed.

To the last second

The expansion of the universe indicated by the Hubble law and the discovery of cosmic microwave radiation suggest that the universe started from a Big Bang about 15 billions years ago and has been expanding since then. The term Big Bang covers a number of models, all of them solutions to Einstein's equations of General Relativity and all describing expansion. To decide which Big Bang model gives a better understanding of the real universe, theorists are pushing back their speculations to describe what happened as we go back in time to the earliest instant of time after the Big Bang. The two chief ingredients of the universe are matter constituting stars, galaxies, dust clouds and so on, and radiation which makes up the microwave background. At present, these two are almost completely non-interacting. When the density and temperature were both higher in the past, the photons of the radiation background and the protons, neutrons and electrons of matter were strongly coupled.

The present appearance of the microwave background is a clue to the appearance of the universe at an estimated cosmic age of 10^5 years when matter and radiation parted company. Going further back, the next important phase was when the cosmic age was a few minutes and the temperature was a few billion degrees. Before this time, it was too hot for protons and neutrons to bind together in atomic nuclei. The photons were so energetic that they could break the nuclei apart. As the universe cooled from this phase, nuclear reactions began to take place producing about 75 per cent of hydrogen and 25 per cent of helium in the universe with traces of a few other light elements. The abundances of these two elements which are detectable today lend further support to the Big Bang model. The expansion of the universe was so rapid at this stage that only these elements could form and not the heavier elements.

As we go still further back, to the time before the first minute, the universe goes on getting hotter and hotter and the density becomes higher and higher, finally leading to what can be called a 'standard Big Bang'. It is estimated that at the cosmic age of 0.0001 s, when the temperature of

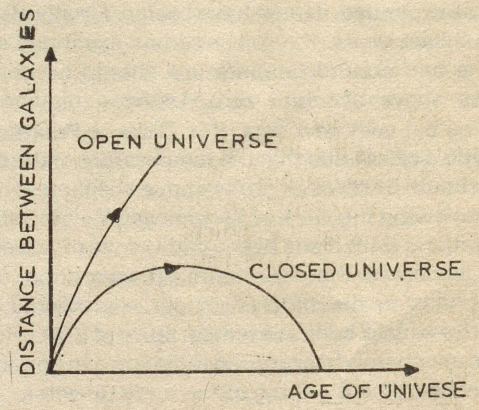

Fig. 4. Shows how the separation between two galaxies varies with the age of the Universe. An open universe expands forever, but a closed universe eventually folds back on itself and collapses into a singularity. The universe is open or closed according as the average density of both luminous and invisible matter is below a certain critical limit or above it

the universe was 10^{12} K, the density was so high that the separation between the individual protons and neutrons would have been comparable to the size of the particles themselves. A new description of matter would become necessary at these high densities.

Quantum theoretical physicists searching for the ultimate particle of matter out of which all others are made once believed that atoms were the building blocks of matter. But atoms proved to be composed of smaller particles—protons, neutrons and electrons. Protons and neutrons themselves later turned out to incorporate particles called mesons, which in turn were found to be composed of still smaller particles named "quarks" by physicists. The world of sub-atomic physics at present extends to more than 200 particles.

Now, instead of looking at the interaction between protons and neutrons, it is better to think in terms of forces between quarks themselves. It is a property of quarks that the forces acting between them get weaker as the distance between them decreases. This implies that at higher densities the 'quark soup' becomes a mixture of separate non-interacting particles. If this type of quark behaviour is correct as predicted by quantum theories, it then implies that the standard Big Bang model is correct and that the temperature goes on increasing towards the beginning of the universe. However, there are other elementary particle theories not involving quarks in which the number of elementary particles increases without limit, as more massive particles are included. If this type of model is applied to the early universe, then instead of the temperature rising as we go back in time, energy goes into the creation of an ever increasing number of particles. This sort of Big Bang has a cold, rather than a hot beginning. But the quark model is the more widely accepted one at present and so is the standard Big Bang model.

The question, then, is : How far back in time can the standard Big Bang model be projected? The General Theory of Relativity, the solutions of which suggest an expanding universe, predicts a singularity in the solution of cosmological equations—a point where the density and temperature are infinite and the volume of the universe is zero. But General Relativity is purely a classical theory and does not take into account the quantum mechanical behaviour of matter. The quantum effects do not allow the existence of a point-like singularity. Werner Heisenberg's Uncertainty Principle, which lies at the heart of quantum mechanics, does not allow the simultaneous determination of the exact position and velocity (energy) of particle. The classical concept of a perfect point-like particle is therefore untenable. Instead, we must imagine that any particle such as a quark occupies in the quark soup a very small volume of quantum fuzziness.

When we go still further back in the early evolutionary universe, the density becomes so high that the small quantum mechanical size of the quark becomes important. At this crucial age of the universe which occurs at a time of 10^{-43} sec, there will be a fundamental breakdown in our ability to describe space-time and matter in classical terms. At this time, the temperature of the universe is estimated at 10^{32}K, and the universe is described as a primeval hot fire-ball. How this fire-ball came into being is not known. Theorists speculate that our universe is but one of several other parallel universes. It is at present impossible to say anything about the early universe as there is no satisfactory quantum theory of gravity. Theoretical physicists are now working hard to unify the two great pillars of modern physics, namely, the theory of quantum mechanics and the General Theory of Relativity.

So, the evolution of the universe from about 10^{-43} sec upto the present age on the basis of Big Bang model can be explained in terms of the known laws of physics. This is a remarkable achievement of modern physics and justifies the well known statement of Albert Einstein that the most incomprehensible thing about the universe is that it is comprehensible!

Further reading

1. Kaufmann, III, William J., *Astronomy: The Structure of the Universe* : Macmillan Publishing Company Inc., New York (1977).
2. Narlikar, J.V., *Introduction to Cosmology,* S and AE, (1983).
3. *Griffin, John (Ed.), Cosmology Today, A New Scientist* guide, IPC Magazines Ltd., Kings Reach Tower, Stamford St., London, SE19LS (1982).
4. Roychaudhuri, A.K., *Theoretical Cosmology,* Oxford (1979).
5. Landsberg, P.T. and Evans, D.A., *Mathematical Cosmology,* Oxford (1979).
6. Capra Fritjof, *The Tao of Physics,* Bantum Books Inc., (1980), 666 Fifth Avenue, New York, 10019.

SEMICONDUCTORS *(Continued from page 373)*

genities and the high impurity levels of presently available materials.

Further reading

1. Mullikan, R.S., *J. Amer. Chem. Soc.*, **74** (1952), 811.
2. Feraris, J.P., Cowan, D.O., Walatka, V.V. and Perlstein *J. Amer. Chem. Soc.*, **95** (1973), 948.
3. Little, W.A., *Phys. Rev.*, **A134** (1964), 1416.
4. Cawan, D.O., Park, J., Pitman, C.U., Sasaki, Y., Mukherjee, T. and Diamond, N.A., *J. Amer Chem. Soc.*, **94** (1972), 5110.
5. Weiser, G., *J. Amer. Chem. Soc.*, **94** (1972), 5028.
6. Fincher, C.R., Ozaki, M., Heeger, A.J. and MacDiarmid, A.G., *Phys Rev.*, **B19** (1979), 4140.
7. Diaz, A.F., Kanazawa, K.K. and Gardini, G.P., *J.C.S. Chem. Commun.*, 1979, 635.
8. Kanazawa, K.K., Diaz, A.F., Geiss, R.H., Gill, W.D., Kwak, J.F., Logan, J.A., Robolt, J.F. and Street, G., *J.C.S. Chem. Commun.*, 1979, 854.

Applications of Raman spectroscopy to medical diagnosis, electrochemical interfacial analysis, turbulent flow, time resolved spectroscopy, optical fibres and microbes are some of the recent developments. It has been one of the major sources of scientific information about the geometry of molecular structure, including much of the data on the way electrons are distributed in molecules and how they bring about chemical binding of atoms. In fact, it can be said that there is hardly any branch of physics, chemistry, biology and astronomy in which Raman Effect has not become a tool for analytical and fundamental research. As scientists try to probe deeper into the problems of interaction of radiation with matter using advanced laser technologies, we can be sure of many more novel and significant developments in Raman Effect and light scattering in the future.

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Remote sensing technology in fisheries

MODERN developments in space photography and satellite techniques have opened up newer avenues in environmental studies particularly resource assessment. Space photographs, in contrast to conventional aerial photographs, are far superior and advantageous in some respects like wide coverage, etc. LANDSAT-I was one among the first successful satellites used in remote sensing of environment using a multispectral scanner.

A classical example of the successful use of remote sensing in the assessment of pelagic fishery resources was that of Peruvian commercial fisheries in 1963. This attempt was successful in not only obtaining the imagery of pelagic fish schools but also in identifying the species as each species of fish has its own characteristic reflectance spectrum. Today's improved multispectral scanning systems, with a proper choice of sensing, can provide a rapid synoptic coverage of important fishing areas and with data on location, quantity and even species. This is possible because of the intimate relationship between the distribution and abundance of fish with certain sea water characteristics like water temperature which can be easily recorded by suitable remote sensing techniques.

Satellite remote sensing data may also provide information on the routes and time of migration of long distance migrants, such as marine fishes and mammals. It is well known that processes like offshore transport and turbulent mixing of water have important effects on the survival of fish larvae. Offshore transport carries away eggs and larvae from productive coastal grounds, while turbulent mixing reduces stratification of nearshore water column disrupting aggregation of organisms required for feeding by the newly hatched larvae.

Satellite images showing sea surface temperature and the concentration of phytoplankton pigments can provide data on environmental limits of the ranges of spawning in fishes. The distribution of spawning adults would reflect the aggregation of food organisms for larval feeding. Measurements of fish eggs and larvae, plankton concentration, chlorophyll concentration, nutrients, temperature and salinity made at specific locations at regular intervals with remote sensing techniques may give valuable information on favourable sites for aggregation of fishes.

Remote sensing and Indian fisheries

During the last two decades remote sensing has found wide application in oceanography and fishery. Although the declaration of a 320 km exclusive economic zone (EEZ) has changed the water spread area to be managed by a nation, concept of conservation and utilization of marine resources has not changed. India has an extensive coastline of about 6,100 km and a vast oceanic area covering about 2.02 million sq. km EEZ. Remote sensing data through satellites would be immensely useful for estimating wealth of the vast marine environment off the Indian sub-continent.

Realising the need, the Indian Space Research Organisation (ISRO) in collaboration with Ministry of Agriculture has undertaken a joint experimental programme under Fisheries Project. The sea surface information from LANDSAT has been correlated with the registered fish catches off Dwaraka coast in Gujarat and a positive relationship observed. The spectral signature studies off Karwar coast have indicated a colour ratio between green (550 nm) and red (660 nm) bands showing chlorophyll *a* concentration.

Whereas the presence of chlorophyll in phytoplankton denotes productivity of the ocean, the index of productivity calculated from above data and its subsequent transfer to other levels of productivity in the marine food chain give an estimate of fish potential. However, a correlation between fish catches off Karwar and chlorophyll concentration could not be established.

Plans are now underway to utilise data from various satellites include the Indian Remote Sensing Satellite (IRS-IA) slated for launch by the U.S.S.R. in 1987.

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The first higher vertebrate that detects electric fields

WHEN in 1798 a complete skin of duck-billed platypus was brought to the British Museum, London, most of the naturalists considered it to be a hoax. It was only four years later, when a complete carcass of the strange animal was delivered to the museum, that naturalists began to believe in its existence. However, nobody could have then believed that it would turn out to be the first higher verte-

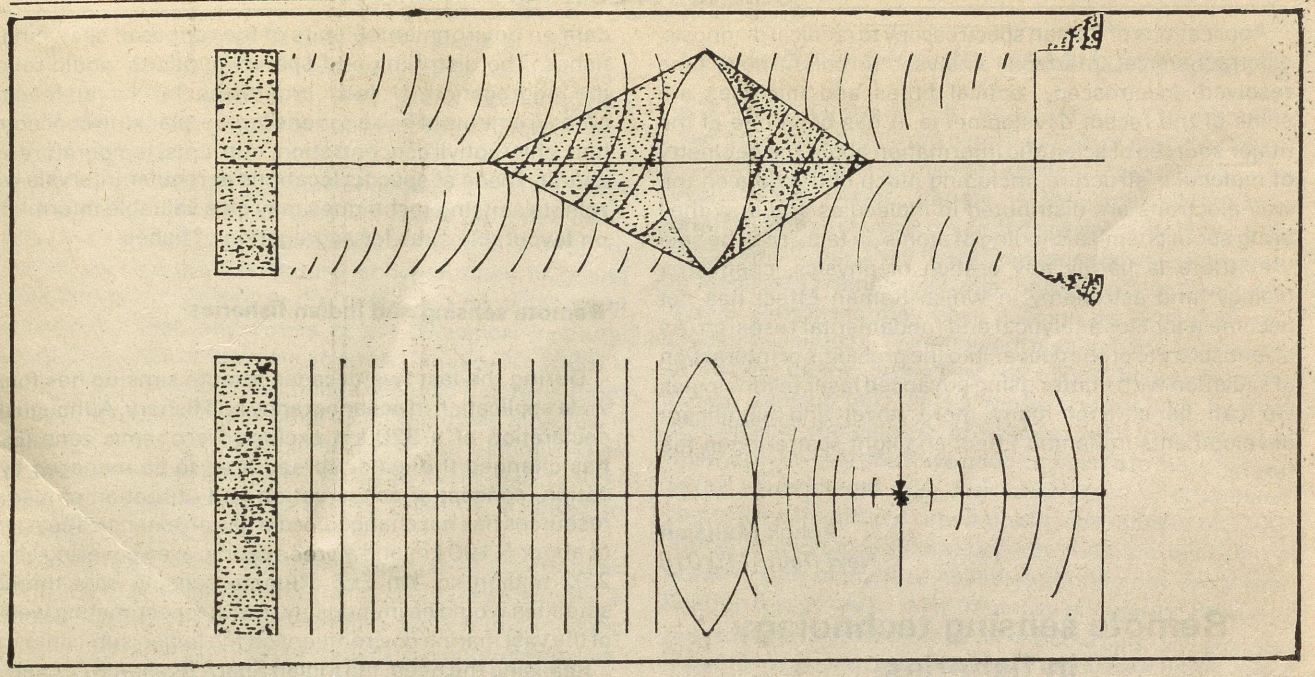

Fig. 2. In an ordinary source like a mercury lamp, light is emitted in all directions resulting in a low intensity in a given direction *(Top)*. The laser beam is highly directional and the intensitv decreases negligibly with distance *(Bottom)*

energy by an amount proportional to the magnetic field applied to the crystal. By varying the magnetic field the energy of the scattered photon and hence its frequency can be continuously altered. By using polished crystals forming a laser cavity the scattered beam comes out as a laser beam and we get a tunable laser. At present this process is limited to the infra-red range. Patel and his collaborators have used this device in a variety of investigations involving the detection of pollutants in atmospheric and stratospheric regions at concentrations of a few parts per billion.

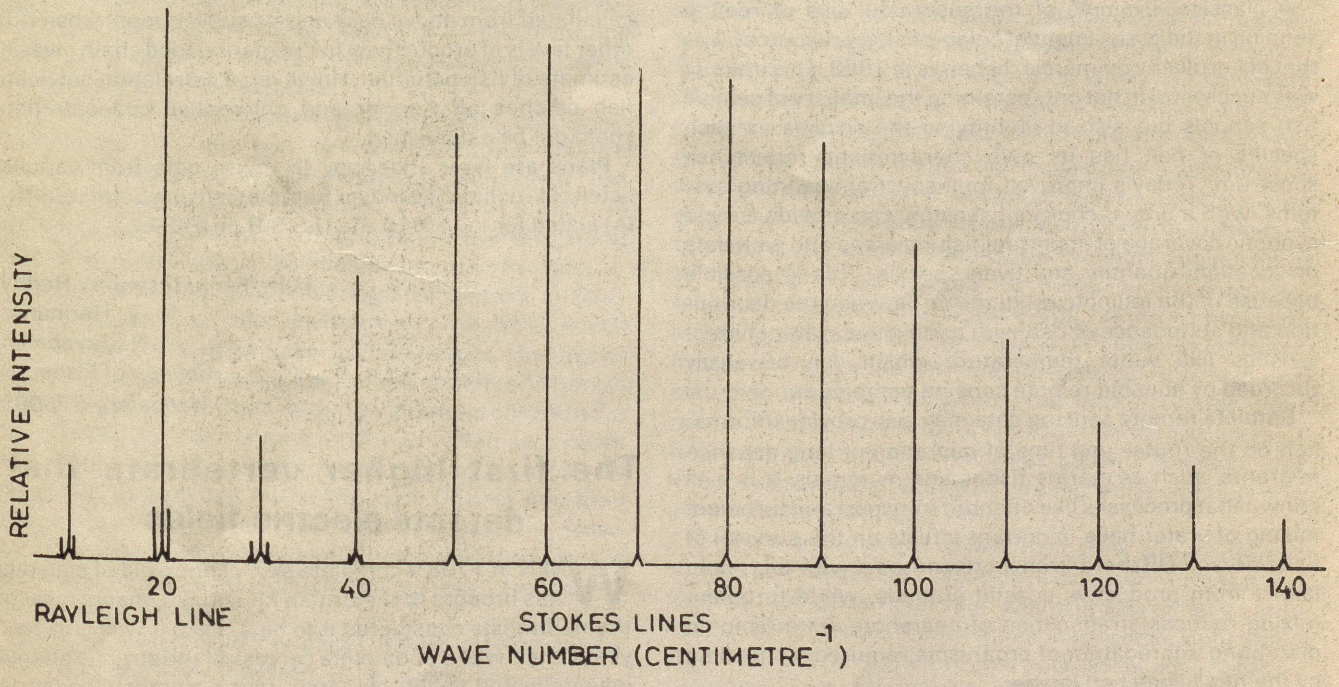

Fig. 3



Fig. 3. *Cuphea wrightil*

average lauric acid percentage in *Cuphea* is 65% compared to coconut oil which may contain 45%-50% lauric acid. Similarly, high capric acid content (87%) in some species suggests it to be a potential substitute for coconut, palm kernel oil and petrochemicals.

Genus *Cuphea* is not found in India. Recently, however, we have introduced some species of the genus at our research centre and the crop is being cultivated on an experimental basis at Jammu. Some species of *Cuphea* hold a great promise as a future industrial crop. There are however some basic problems to be tackled before it can be commercialised. They are domestication of the crop, dormancy due to hard seed coat, sticky hairs, indeterminate flowering and early seed shattering. For geneticists, the investigation of the mechanism by which *Cuphea* produces such predominant medium chain fatty acids is a challenging task before they may be able to transfer such genes to other oil seed plants to produce medium chain fatty acids.

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Plants can date archaeological sites

PLANT material of one kind or the other is usually found in excavations of prehistoric sites. In the past few years, considerable attention has been paid to retrieval and identification of plant remains from archaeological excavations. As a result, a new line of study known as Palaeoethnobotany or Archaeobotany has come into existence to study remains of plants used by prehistoric man.

If archaeologists pay any attention to plant remains, they do so in the hope of obtaining a date from them. Though plant remains make an important contribution towards determining the age of archaeological sites, they are by no means the only source of dating material. New dating techniques have been developed which do not require plant remains as a source of archaeological material. However, contribution which plants can make are interesting because of the diverse ways in which they can be made to tell a chronological story.

Radiocarbon dating

This technique of determining the chronology of ancient civilizations by measuring radiocarbon content of organic remains was developed by W.F. Libby and his collaborators. The technique depends upon the basic physiological process of the life of the green plants—the conversion of carbon dioxide from the atmosphere into plant tissue and food through photosynthesis. When the plant tissue dies, it contains in effect a sample of the carbon dioxide of the contemporary atmosphere. At any time the atmospheric carbon dioxide contains a very small proportion of radioactive carbon ^{14}C. ^{14}C is continuously produced in the atmosphere as a result of capture of slow neutrons by atmospheric nitrogen nuclei. Chemical properties of the ^{14}C-containing carbon dioxide are identical with those of normal carbon dioxide.

When living plant tissue dies it ceases to receive any further supply of ^{14}C. On the other hand the radioactive carbon atoms present in the sample decrease with time by radioactive decay. This decay occurs in a well defined manner which can be characterised by the parameter, $T_{1/2}$ the half life period of radio carbon. $T_{1/2}$ is defined as a period in which a given number of radioactive atoms in a sample is reduced by a factor of two. One important thing to note here is that the radioactive decay does not depend on environmental factors.

On the assumption that the proportion of radioactive carbon in the atmosphere is constant (an assumption which is not absolutely true), that the amount of residual radioactive carbon can be measured and that its rate of decay is accurately known (another assumption which is giving some trouble), it is theoretically possible to estimate how long ago the tissue was formed. If the plant material could be associated with human culture, that culture could thereby be dated.

Selection of samples for radiocarbon dating is important because, in a long lived species, the date at which a plant died may be very different from that at which the oldest tissue was laid down. For example, in a giant redwood, the heartwood cells may have been laid down 2000-3000 years ago and may have long been dead though the tree as a whole may still be alive. In such a case, it is important to know where the sample used for radiocarbon dating had originated. However, this cannot always be established with accuracy. Another source of error is contamination by organic matter of a different period which is quite likely in archaeological excavations.

Plant material is not of course the only source of radiocarbon dates. Animals feed on vegetation and so receive radioactive carbon and can be used for dating Animal tissue may also contain carbon derived from calcium carbonate of water bodies, etc. This is concentrated in the hard skeleton like molluscan shells and may be a source of unexpected error.

Tree ring dating

Trees particularly those growing in the temperate latitudes,show more or less well marked growth rings in cross

brate that could detect its prey on the basis of electrical fields or potentials. To date, some old fishes, some groups of fishes of Africa and South America and some amphibians have only been reported to have such electric-field-sensing organs.

The duck-billed platypus belongs to a group of lower mammals called "Monotreme". It has a duck-like beak, lays eggs and has teats and hair like a mammal. It does not feed on dead things. It feeds only on live shrimps, frogs and small fishes. According to the controlled experiments of Henning Scheich and others of the Zoological Institute, Federal Republic of Germany (*Nature*, January 30, 1986), a platypus feeds only on live things because it detects them by electric potential generated by their moving muscles. It is therefore able to probe blindly in mud or among stones for its food. It has also been found to avoid objects with minute electric potentials across them. It is found in Australia and Tasmania.

Nothing is yet known about the organ present in the beak of the platypus which detects electric fields or potentials. A simpler form of this organ has also been found in spiny anteater, another mammal belonging to Monotreme group. So, if one views this discovery from evolutionary perspective, the Monotreme group of mammals has evolved this electrosensitive organ on its own.

Dilip M. Salwi

Incestuous pollen fertilises virgin flowers

STRANGE and an interesting phenomenon is observed in an aquatic plant called *Callitriche*. In this plant, the sexes are in separate flowers, yet they pollinate themselves without any pollen to be seen!

This puzzling phenomenon of 'virgin' births was discovered some 30 years ago, but only recently a botanist Thomas Philbrick of the University of Connecticut has found an astonishing answer *(Amer. J. Bot,* Vol. p. 882). He stained pollen grains with a fluorescent dye and followed their fate using a special epifluorescence microscope.

There are two types of flowering arrangement in *Callitriche* depending on their environment. The plants which rest on water's surface have well-developed sex organs which can cross-pollinate other *Callitriche* plants. Whereas the flowers which are submerged or stranded on land have only rudimentary sex organs, and their pollen sacs never shed pollen grains. Philbrick found that in these flowers the pollen germinated inside the male flowers and then began a fantastic journey, boring down through the pollen sac, along the stalk attaching the sac to the flower, out of the flower into vegetative tissue, and up into the ovary of a nearby female flower.

Phibrick suggests in his paper that this is a way for producing seed in the face of a highly unpredictable environment.

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Orchids—popular test-tube plants

ORCHID cultivation in many parts of the world has become a highly developed aspect of modern floriculture. They are one of the highest developed plants on the evolutionary ladder. Variety is the chief attraction of orchids. With their vast range of diversity of form and habit shape and colour, their floral grandeur and abundance that in most cases remain fresh for long periods and with their overall loveliness they have become an ideal subject of study by scientists. Their flowers simulate the appearance of swans, moths, butterflies, scorpions, tigers, monkeys doves, dancing lady, lady's slipper, pansy, etc., in every conceivable combination of colours. They freely cross on intergeneric level and have been subjected to more hybridization experiments than any other group of ornamental plants tried in horticulture. A prodigious number of 32000 hybrid orchids, mostly produced by man, are available at present with many rare novelties coming out every year bearing testimony to their immense popularity. People all over the world grow orchids on window sills, on basement of apartments or in green houses. Many new horticultural firms have come into being, for orchid culture is considered to be a multimillion dollar industry in S.E. Asia, Europe and America.

Slow vegetative growth and an extremely low rate of germination (perhaps the lowest in seed plants) are some of the drawbacks of orchids. Their popularity demanded their fast and large-scale propagation by natural or artificial means. All who have studied germination of orchid seeds agree that there is something very unusual with seeds of most orchids. They do ot germinate when merely supplied with water and nutrient salts. Seeds require an outside organic food supply for the growth of young embryos. Though unusual, it is not surprising when one considers the meagre food reserve of its seeds. The small oily food content of seeds is converted, chiefly into sugar at the very early stages of germination and is used up much before the prolonged period of germination is completed. It is at this early stage that, for maintenance of constructive metabolism of the young and minute seedlings, a symbiotic fungus plays an important role directly or indirectly by supplying necessary material. The fungus hydrolises macromolecules of the debris on which it grows and produces sugar which means energy for the germinating seed. Other substances may also be provided by fungi but information on their nature and quality is scarce. Whether orchids provide their fungi any substance is even less known. Research has however proved that they perhaps exchange vitamins and growth factors with each other.

That the orchid seeds unlike most other plants, are not endowed by nature with sufficient food reserve to see them through their germination period and unless either by artificial or natural resources a further supply of food or stimulant is forthcoming, the tiny and poor seeds are unable to carry on and die of starvation, and that in nature the association of a symbiotic fungus possibly meeting all their demand was probably not known to people prior to 1899 when Prof. M. Noel Bernard, a French Scientist, discovered

MEDICAL NOTES

Are O blood group people more biologically fit?

K. Landsteiner, a German Nobel Laureate discovered in 1900 that individuals can be assigned different groups according to whether their red blood cells clump or remain separate when mixed with the blood of different persons. This major breakthrough claimed the importance and usefulness of ABO blood groups in man. E. Von Dungern and L. Hirszfeld, both of Germany, in 1971, proved that these blood types are inherited. This happens to be one outstanding example of Mendelian inheritance applied to a human character.

Around 1919, L. Hirszfeld and his German colleague H. Hirszfeld, raised a fundamental question on the differences between populations and the gene frequencies of the ABO blood groups. They questioned if the differences could be the result of natural selection, arising from differences in fitness between the various blood groups, which might depend upon locally determined features of the external environment. During 1920, the first phase of a trial in search of an association between a disease and blood-groups was made. The rationale was simple. If a certain environment disfavoured a particular blood group, it should either raise early mortality rate or lower fertility in persons of that group. This implies that one or more diseases caused by that environment should be more common or tend to be more severe in persons of one blood group than of another. So, one may expect some diseases to attack preferentially persons of one blood group and other diseases those of another group.

World-wide investigations on the search for probable association between ABO blood-groups and diseases have shown that most associations are with group A and the least with group O. Extensive studies on different types of cancer, diabetes, cardiac infarction, small pox, leprosy, pernicious anaemia and many more diseases have shown that persons of group A are affected more while those with group O have an immunological advantage. Only gastric and duodenal ulcers are associated with group O but these diseases are rarely fatal.

How is fitness estimated?

When we wish to establish any association between a disease and blood groups, we usually estimate the ratio of group A: group O in the following way :

$$\text{Relative Incidence (A:O)} = \frac{\text{Total of group A in patients}}{\text{Total of group O in non-patients (controls)}} \times \frac{\text{Total of group O in patients}}{\text{Total of group A in non-patients (controls)}}$$

In 1955, the famous British mathematician, B. Woolf used this statistical method and since then his formula for the estimation of relative incidence has proved to be extremely useful. This can be demonstrated with an example. The relative incidence of leukaemia is 1.12 (A:O) which means that persons with group A have approximately 12 per cent more probability to be afflicted with leukaemia than those with group O.

Fitness of group O in infectious diseases

A study of acute and chronic bacterial infections and their sequelae as well as some virus infections shows that group A persons have a disadvantage compared to group O (Table 1).

It therefore appears that people with blood group A tend to suffer more from severe illnesses than people with group O. The latter seem to make their bearers fit and healthy to a higher degree.

Non-infectious diseases

Evidence is now available from the study of seniles of 75 years of age and older, active soldiers, active athletes of 40 years and over as well as doctors/surgeons/scientists

Table 1

Disease	*Relative Incidence (A : O*
Leprosy	1.15
Tuberculosis	1.15
Syphilis	1.20
Hepatitis	1.27
Chicken pox	1.28
Small pox	1.68
Diarrhoea	1.68

Source : Chakravartti and Chakravartti, 1979

Table 2

Disease	*Relative Incidence (A : O)*
Leukaemia	1.12
Breast cancer	1.12
Uterus cancer	1.13
Cleft-lip and palate	1.14
Diabetes Mellitus	1.15
Oral cancer	1.25
Dental caries	1.27

Source : Chakravartti and Chakravartti, 1979

plants creates a tiny vacuum that pulls in air like lungs.

The rice leaves have a waxy sealant unlike other aquatic plants. The sealant prevents absorption of gases directly from water. According to Kende, flooded rice plants must draw gases from the atmosphere through pores in leaves above the water and through a sheet of air enclosing partially submerged leaves. He also points out that the air flow is regulated by the amount of carbon dioxide gas in these airways.

The rice plants take in CO_2, and also release this gas into airways; typically a cell gives off one carbon dioxide molecule for every oxygen molecule consumed. Such a one-for-one exchange of gases would normally keep the pressure in the airways steady. But since carbon dioxide is many times more soluble in water than oxygen, it escapes more quickly into the water. The pressure in airways is thus lowered and more air is pulled in.

It is interesting that during rainy season, deep water rice plants grow as much as 30 cm a day keeping their topmost leaves just above the rising flood-waters.

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Cuphea: a new source of medium chain fatty acids

GENUS *Cuphea* of family *Lythraceae* has evoked world wide interest for being unique in having medium chain fatty acids as a dominant constituent of their seed oil unlike most of the angiosperms in which dominant seed lipid constituent is linoleic acid. Coupled with this, there is an unparalleled diversity of fatty acid pattern which ranges from C_8 to C_{18}. According to researchers, wide range of fatty acid chain lengths in the oil from *Cuphea* seeds means that required fatty acid can be tailor selected.

Medium chain fatty acids like lauric, capric and carprylic acids find extensive use in preparation of various industrial products ranging from detergents, soaps, lubricants to cosmetic preparations. At present, commercial sources of these oils are palm kernel and coconut oil. Moreover, some species of *Cuphea* provide an alternative renewable source of capric acid which is presently available only from petrochemicals.

Genus *Cuphea* is a native of temperate and sub-tropical regions of Mexico and Brazil. In early 1960s, F.R. Earle, working at Northern Regional Research Laboratory, Peoria, Illinois University, USA, for the first time identified *Cuphea* as a potential source of medium chain fatty acids. So far, fatty acid patterns in 46 to 260 reported species of *Cuphea* have been recorded. The genus has been considered to be the most advanced of the herbaceous genera in evolutionary terms. The plants and flowers vary widely in morphology; plants being a few cms to several metres tall with an array of light pink to deep purple flowers and a significant diversity in seed sizes. According to Shirley Graham, Prof. and Laboratory Coordinator of Biological Sciences of Kent



Fig. 1. *Cuphea procumbons*

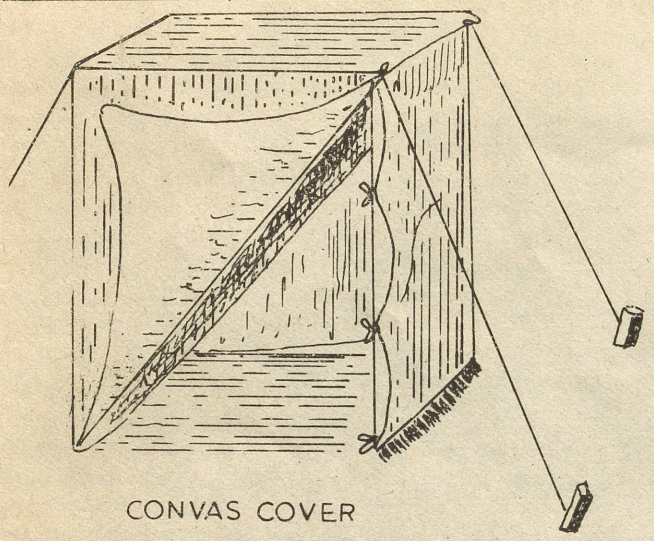
State University, United States, generally the larger flowered species tend to produce C_8 and C_{10} fatty acids whereas the smaller ones contain C_{18} fatty acids. She has been making frequent field trips to Mexico and Brazil since 1960 and collecting *Cuphea* germplasm for research projects in Europe and the U.S.A.

A few *Cuphea* species are self pollinating, although most of them are cross-pollinated by long-tongued bees. Annual herbaceous species of *Cuphea* bloom in the first year unlike coconut and palm trees which take many years to reach fruiting stage. The plants have a tendency to grow densely by continuous formation of side branches. Flowering starts approximately two months after planting; first on the main stem and then on all branches and continue to flower and set seed for the next two months. Flowers have six pink petals. The ripened seeds are yellow to dark brown and lens-shaped. The seed weight ranges between 1.6g to 4g per thousand. Single plant yield has the potential for 1000kg-2000kg of seeds per hectare and oil content is in the range of 42%. In feeding trials no toxicity has been found.

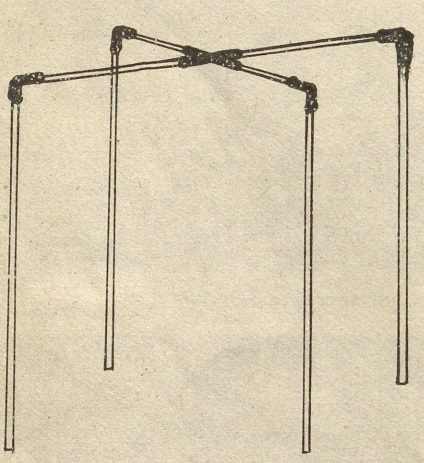
Lauric acid is the most common and plentiful fatty acid in 43% of the species studied so far and comprises upto 83% of the total fatty acid content in many of these species. The



Fig. 2. *Cuphea leptoda*



CONVAS COVER



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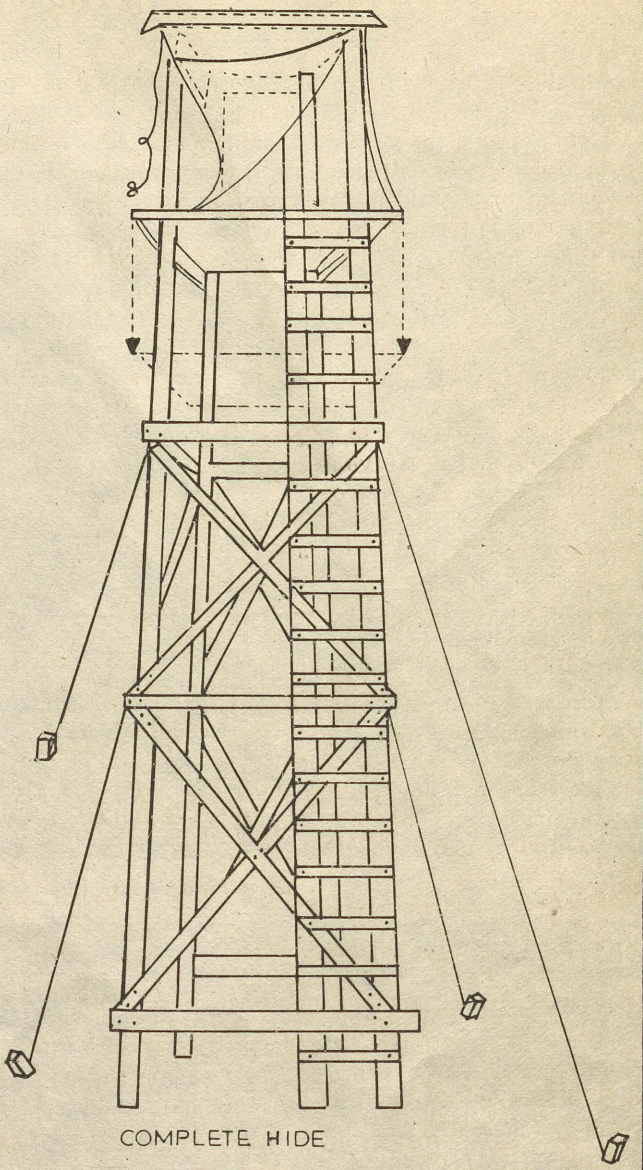

COMPLETE HIDE

How to build a hide

The best time for birdwatching is morning, say about dawn to 10 a.m. Birds. regardless of any season, are most active during this period. They once again become active in the afternoon. So, to undertake a successful outing for birdwatching, time must be taken into consideration.

Birds are selective in habitat, certain species prefer a particular habitat. Here also, it depends upon you where to look for what type of bird. Many birds are found in and around human habitations, others prefer forests and still others reside in open fields. For the beginners it is advisable to get acquainted with the birds found in the neighbourhood first, and then make trips to other places. If one is interested in migratory birds, a seashore or a lake in winter is the ideal place. If you are interested in fruit-eating birds, look for a Banyan or Pipal or Fig tree (*Ficus* spp.) with fruits, and Silk cotton tree (*Bombax* spp) or Indian Coral tree (*Erythrina* spp) with flowers, where as many as 50 to 60 species of birds in the locality may congregate during the day. It would be interesting and useful to follow a mixed hunting party of insectivores in a deciduous forest where quite a good number of species gather to hunt together.

Patience is a must for birdwatching. Sometimes you may not see a single brid for a long time. But suddenly you may come across a very uncommon, and thus rewarding, bird. This will more than compensate for your long wait.

Though it is not possible for everyone to have a camera for photographing birds, if one can obtain a camera (with a telephoto lens); it is very useful. Salim Ali writes, "Bird photography adds enormously to the zest of bird-watching.....There is no other pleasant way of prolonged and intensive watching than in persuit of bird photography, and there can be no success in bird photography without

section of their trunks. They are caused by rapid production of relatively thin-walled wood cells in the early part of the growing season, followed by slower growth later with the cells becoming smaller and more heavily thickened. After winter dormancy, new growth in the following spring presents a clear contrast with the old.

Some tree species in which growth rings occur live very long and provide a valuable record of changes in growth rate over a long period of time : 2000-3000 years for redwoods *(Sequoia sempervirens)* and big trees *(Sequoiadendron giganteum)* and over 4000 years for the bristlecone pine *(Pinus aristata)*. The important feature of these living records is that they contain distinct patterns of narrow and wide rings which are not accidental but are a direct reflection of changes in the environment. Broad rings are associated with wetter years and the narrow ones with years of exceptional drought. The same ring pattern is found in all the trees which have lived over the same period of time. Patterns of rings in living trees may be linked by overlap with patterns shown in the dead timber. Then, by linking up or cross-dating, a particular archaeological culture can be dated.

However, there are some limitations to tree ring dating. Growth rings are dependent on many external factors such as rainfall, difference in soil texture, drainage, severe late frosts, and defoliation of trees by insect parasites. Consequently, false rings may also appear, for example, birch *(Betula)* has a reputation of producing false rings.

Pollen analysis

Pollen grains possess a remarkable resistance to decay and so constitute a valuable record of past vegetation. Good work has been done on the post-glacial vegetation in several countries by using pollen analysis. "Pollen diagrams" or "Pollen spectra" have been prepared. In India, quite a lot of work has been done in this regard in Kashmir valley. On the basis of pollen analysis, post-glacial period is divided into pollen zones of different pollen types, the tree pollen being the most significant. There is no universally agreed system of zone numbering, or even of the number which has been recognized. If an archaeological level, or an artifact, could be reliably related to a certain tree pollen spectrum, it would be possible to match this spectrum with one of the recognised pollen zones. The archaeological level is thus dated. This dating method is feasible only, if the pollen zones themselves can be given a chronology by typing them with a method such as radiocarbon dating.

References

1. Dimbleby, G.W. (1967), *Plants and Archaeology,* John Baker Publishers, London.
2. Kusumgar, S. S., Lal, D. (1963), Radiocarbon dating: Techniques, *Proc. Ind. Acad. Sci.,* 125-140.
3. Lone, F.A; Khan, M. and Buth, G.M. (in press), Wood remains from archaeological sites, *Man and Environment,* Vol. IX.
4. Zeuner, F.E. (1958), *Dating the Past,* London.

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Tobacco—a rich source of protein

MAN has used tobacco for untold centuries, at first magicoreligiously as herbal medicine and then for the pleasure of smoking and chewing. It has in the past generated attractive wealth to practising farmers, traders and manufacturers and earned enormous revenue for the local governments and continues to do so even today. Tobacco is now the world's most maligned yet legally sold product, being tolerated mainly for its revenue yielding ability. World bodies like FAO and WHO have shown strong reservation against tobacco trade and culture, particularly in the third world countries. Ecologists and environmentalists also are raising their eyebrows against tobacco.

It is well known that direct use of tobacco in any form is highly injurious to health; therefore, researches are in progress on alternative uses of tobacco as a source of protein. Investigations at Central Tobacco Research Institute, Rajahmundry (Andhra Pradesh), and Bidi Tobacco Research Station, Anand (Gujarat), have shown that about 1500 kg/ha of leaf protein concentrate (LPC) can be obtained from a thickly planted tobacco crop. This LPC is free from anti-nutritional factors like nicotine, polyphenols and nitrate content. It is low in lipid content and contains starch and some mineral matters (ash) which are not nutritionally objectionable. Detailed biochemical analysis of protein hydrolysate has shown that its essential amino acid profile is better than the FAO provisional pattern with 7.4% lysine and 1.6% methionine content. The residual leaf material and leaf extract after protein recovery, when drawn into 0.05 mm thick sheets and subjected to smoke analysis, were found to contain 0.05% nicotine, 1.13% sugars and no chlorides.

Further work is in progress to examine the biological value of the extracted protein, the animal feed value of the fibrous residue and insecticidal (nicotine) value of the whey left after protein recovery.

Green leaf fraction technology can further be extended to recover many other chemicals like free amino acids and vitamins from the supernatant which may find profitable use in microbial cell culture as rich nutrient broth. While recovery of the latter group of chemicals still remains a scientific dream, protein recovery is certainly an achievable reality.

In tobacco cultivation the seedlings are generally left over in nursery beds after required number of pullings by the farmers. These left over nursery beds can be utilized to extract protein from a short duration tobacco crop without interfering with the main commercial crop. This will

Science quiz

Mark the correct answer :

1. The study of the relation of an organism to its environment:
(a) Bionomics, (b) Biometry, (c) Bionics, (d) Bionomy

2. The study of shells :
(a) Cryogenics, (b) Conchology, (c) Cosmology, (d) Cytology

3. The raising of silk-worms for the production of raw silk:
(a) Aquaculture, (b) Sericulture, (c) Horticulture, (d) Floriculture

4. Study of mental and physical differences of mankind:
(a) Ethnology, (b) Ecology, (c) Etymology, (d) Entomology

5. Study concerns with the production, control and application of very low temperature:
(a) Cryptography, (b) Cryogenics, (c) Cytogenetics, (d) Chronobiology

6. Study of old age:
(a) Geology, (b) Genetics, (c) Gerontology, (d) Genealogy

7. Technique used for quicker diagnosis of breast cancer among woman:
(a) Lexicography, (b) Iconography, (c) Hydrography, (d) Mammography

8. Study of nature, causes and remedies of diseases:
(a) Philology, (b) Phrenology, (c) Pathology, (d) Pomology

9. Study of bones :
(a) Odontology, (b) Ornithology, (c) Osteology, (d) Osteopathology

10. Communication of two minds at a distance with help of thought, feeling or emotions:
(a) Telepathy, (b) Hydropathy, (c) Homoeopathy, (d) None of the above

11. Study of fresh water ecosystem :
(a) Ecology, (b) Physiology, (c) Anthropology, (d) Limnology

12. Study of prehistoric remains :
(a) Archaeology, (b) Morphology, (c) Philology, (d) Psychology

13. Ecology of forests:
(a) Silvics, (b) Ethics, (c) Ceramics, (d) Optics

14. Study of art of measuring time :
(a) Biology, (b) Horology, (c) Etymology, (d) Neurology

15. Study of the theory and practice of classifying organisms :
(a) Taxonomy, (b) Anatomy, (c) Agronomy, (d) Astronomy

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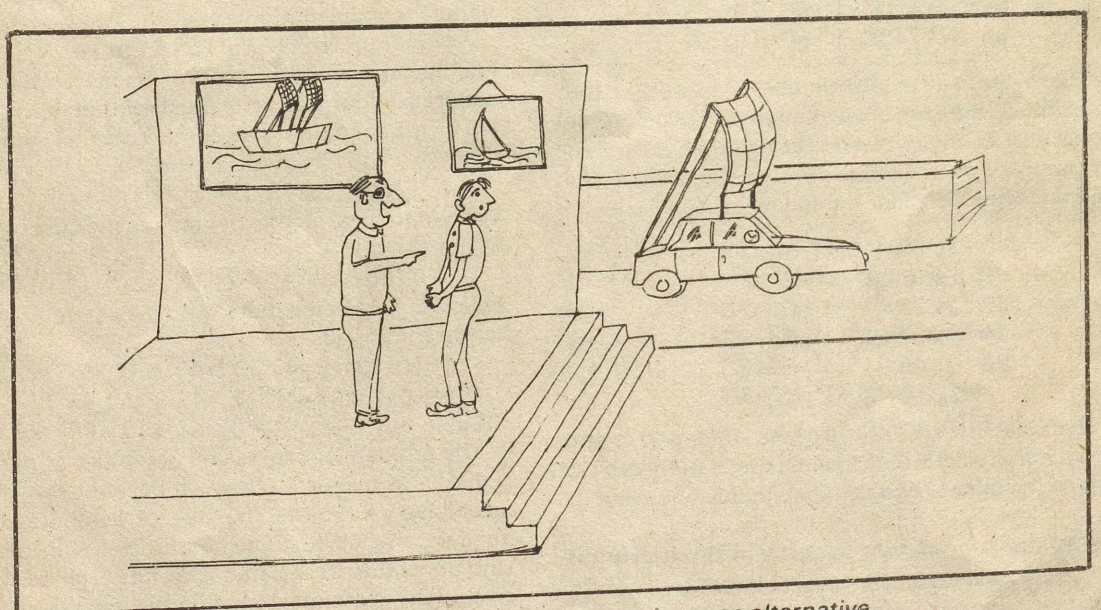
(Answers on p. 398)



"Of course it is a bit slower, but it works on an alternative source of energy, you see, and saves me a lot of petroleum".

Table 1 Calmodulin isolated from representative organisms of diverse species.

Animals	*Plants*
Amoeba	Chlamydomonas
Euglena	Mushroom
Sea anemone	Physarum
Earthworm	Barley
Crayfish	Cotton
Octopus	Peanut
Sea urchin	Spinach
Electric Eel	
Xenopus	
Chicken	
Cow	
Hamster	
Mouse	
Pig	
Rabbit	
Rat	
Human	

Source : Physiological Reviews, (1982) Vol. 62, No. 1, p. 3, published by the American Physiological Society.

Table 2 Physical properties of calmodulin

Property	*Specific Value*
Heat resistance	$t_{½}$= 7 min at 100°C
Molecular weight	16,700 (148 amino acids)
Isoelectric pH	3.9
Conformation	40%—55%—helix
Drug binding	Phenothiazines
Hydrophobicity	Increased by Ca^{2+}

Source : Physiological Reviews (1982), Vol. 62, No. 1, p. 4, published by the American Physiological Society.

Table 3. Calmodulin-regulated enzymes

Enzymes	*Tissue Source*
Adenyl cyclase	Pancreas, Sperm, Brain
Cyclic nucleotide phosphodiesterase	Brain, Thyroid, Lung, Parotid
Succinate dehydrogenase	Liver
NAD^+ kinase	Plant, Sea urchin
Glycogen synthetase kinase	Liver
Phosphorylase kinase	Skeletal muscle, cardiac muscle
Phosphoprotein phosphatase	Liver, Brain

Source : Physiological Reviews (1982), Vol. 62, No. 1, p. 8 published by the American Physiological Society.

biological activity. The half life of the protein is 7 minutes at 100°C (Table 2).

The calcium-binding properties of CaM are interesting. Calmodulin contains four metal-binding sites. It has been suggested that the four metal-binding sites are all calcium specific and equivalent. Calmodulin is a highly coiled molecule. In the absence of metal, 40% of the protein exists in an α-helical configuration. Calcium binding increases the helicity to greater than 50%.

Another useful property of CaM is its specific binding to a variety of pharmacological agents such as phenothiazines. It has been shown that the binding of phenothiazines to CaM is also calcium dependent. The interaction of calcium with CaM exposes a highly lipophilic region of calmodulin. Further, the binding of phenothiazine by the lipophilic region of CaM prevents the stimulation of several enzymes, phosphodiesterase, myosin light-chain kinase, and Ca^{2+} Mg^{2+}- ATPase (calcium-magnesium-dependent adenosine triphosphatase). Moreover, CaM activates ATP (adenosine triphosphate)-dependent calcium uptake by synaptosomes indicating its involvement in synaptic function. Several toxicants are also known to disrupt synaptic function by altering calcium and calmodulin regulated processes in the central nervous system.

CaM is known to influence the chromosomal movements during cell division, and flagellar motility of spermatozoa. It may also control a variety of hormonally regulated systems. It is now well established that CaM is involved in the capacitation of spermatozoa. It has also been implicated in the control of protein synthesis in tumour cells and also in the process of ageing.

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Allelopathins

PLANTS contain a wide spectrum of constituents whose function is not clearly understood. Many of these constituents, frequently referred to as 'secondary plant substances, have been shown to participate in interactions between species of plants, as well as between plants and other organisms. Such interactions are called allelochemic. The phenomenon of allelopathy is a type of allelochemic interaction where the chemicals released by some plants inhibit the growth of other plants. The chemicals involved in such a interaction are called allelopathins.

Allelopathins are known to be present in stems, leaves, roots, flowers, fruits and seeds of several plants. They are released from plants either in soluble form or in volatile form.

Allelopathins have been categorised into several chemical groups which include water-soluble organic acids, straight-chain alcohols, aldehydes, ketones, unsaturated lactones, long-chain fatty acids, quinones, terpenoids, steroids, phenols and coumarins. Some also come under the chemical groups like flavonoids, tannins, alkaloids, cyanohydrins, sulphides, purines and nucleosides.

(Continued on page 399)

FOR HER

Why bottle feeding is bad

IN the developing countries, breast-fed babies grow better and are more likely to survive. But bottle-feeding is on the increase, putting millions of infants at risk. Breast-feeding is an unequalled way of providing ideal food for healthy growth and development of infants. It forms a unique biological and emotional basis for the health of both mother and child. The advantages of mother's milk over dangers of bottle are described in Table 1.

A code to protect infants

In 1981, the World Health Assembly adopted an "International Code of Marketing" to help stop irresponsible promotion of breast milk substitutes. As a result, the following picture has emerged:

(i) Thirtythree Governments have banned all advertising of breast milk substitutes.

(ii) Seventeen countries are running mass media campaigns to highlight advantages of breast milk.

(iii) Eighteen countries have brought in national 'codes' to regulate marketing of powdered milk.

Table 1

No.	*The advantages of mother's milk*	*No.*	*The dangers of bottle feeding*
1.	Better nutrition—Breast-milk has all the proteins, vitamins, and minerals a baby needs for the first few months of life. Even among malnourished mothers, studies show that breast-fed babies are twice as likely to achieve normal weight for age compared to non-breast feel babies.	1.	Lack of hygiene—Infants are exposed to infection via contaminated bottles, teats and baby food.
2.	Less infection—Mother's milk also immunizes the infant against common ailments—reducing by as much as 50% are risk of diarrhoea.	2.	Illiteracy—Many mothers in poor communities cannot read instructions on how much powder to use and how to make a safe food.
3.	Natural contraception—Although not a reliable mothod, breast feeding has a powerful contraceptive effect. In many countries, it is the most important factor in preventing mother's pregnancy in the first year after giving birth.	3.	Expense—Buying enough commercial baby milk can take up to half the income of a poor family.
		4.	Over-dilution—Using less than the recommended amount of milk-powder can lead directly to malnutrition.
		5.	Spoilage—Most poor mothers have nowhere to keep bottled milk cool and no convenient way of sterilising the equipment.

The encouragement of breast-feeding is an important part of the health care, nutrition and other social measures required to promote healthy growth and development of infants and young children and breast-feeding is an important aspect of primary health care. Recent survey indicates that information about the superiority of breast milk has led to a change back to breast-feeding in the rich world.

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Food poisoning

ONE frequently comes across reports of food poisoning due to consumption of foods containing pathogenic organisms or their toxic metabolic products. The symptoms generally are vomiting, diarrohea and severe gastroenteritis. The control and prevention of food poisoning are important aspects of food microbiology.

All food-borne diseases are classified as 'food infections' or 'food intoxications'. Food infections are those in which microorganisms present in the food at the time of eating enter the host and cause illness. Food intoxications are those diseases in which microorganisms grow in food and produce a substance therein which is toxic to man and animals. Food poisoning is the toxicity introduced in the food by microorganisms and their products.

who are above 65 years. All show a greater fitness with group O (Joergensen, 1975).

To conclude, it seems that, under present conditions persons with group O have a greater chance (more than 60 per cent) to live to be of 75 years or more compared to persons with group A. All evidence points to a better health for group O persons.

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Card to detect malnutrition

MORE than 200 different growth charts are currently in use in over 80 countries for monitoring the growth of under-five children. Regular monthly weighing and the use of a growth chart can reveal the slowing down of normal growth and so give an early warning to mothers and health workers. This early warning is of great significance as the growth of a child can be checked relatively easily at this crucial stage. A simple screening tool to detect malnutrition instantly has recently been devised by two Indian doctors, Umesh Kapil and Mahesh C. Gupta of the Institute of Health and Nutrition, New Delhi. It is in the form of a single card (Fig. 1.)

This new device, called "KGAT card", is simple, small, portable and easy to operate. It is excellent for the interpretation of anthropometric measurements, such as measurement of size, weight and proportions of human body in terms of malnutrition by any literate mother or health worker. One has simply to adjust the age of the child (up to 60 months) with the help of a movable card "M" on the window of the KGAT card, and one gets instantly the minimum expected weight (in kg), height (in cm) and mid upper arm circumference (MUAC in cm), etc. of the child. And if these observed values are less than the critical values (which are also shown simultaneously against each parameter) the child has severe malnutrition. Alternatively, by adjusting the height (in cm) of the child on the KGAT card, one gets the instant minimum expected weight for this height along with the critical value which indicates severe malnutrition. The reference values for various parameters used in the KGAT card have been taken from the W.H.O.

(Continued on page 399)

KAPIL AND GUPTA

Anthropometric Table (KGAT)*

CHILD'S AGE	49	Months
Minimum expected weight for this age	13.4	Kg.
Weight less than this indicates severe malnutrition	10.0	Kg.
Minimum expected height for this age	98.6	Cm.
Height less than this indicates severe malnutrition	88.2	Cm.
Minimum expected mid upper arm circumference (MUAC) for this age	13.5	Cm.
MUAC less than this indicates severe malnutrition	10.1	Cm.
CHILD'S HEIGHT	100	Cm.
Minimum expected weight for this height	14.0	Kg.
Weight less than this indicates severe malnutrition	10.9	Kg.

M

* Developed by Dr. Umesh Kapil and Dr. Mahesh C. Gupta for the Institute of Health and Nutrition, E-85, Ansari Nagar, New Delhi-110029, India

Fig. 1. KGAT card showing anthropometric measurements of a 49 months old child. Age of the child can be adjusted (up to 60 months) by the movable card "M"

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Slurry coating enhances phosphorus availability to soil

PHOSPHATE fertilizer is a costly input in agriculture. In India, the most common source of phosphorus is superphosphate. The P_2O_5 availability through superphosphate accounts for only 22 per cent of total P_2O_5 production in the country. There is, therefore, need to find out ways and means to increase efficiency of phosphorus supply to crops.

When a water soluble phosphatic fertilizer such as superphosphate is applied to soil, the granules of monocalcium phosphate, the active ingredient of superphosphate, absorb water from surrounding soil until a saturated salt solution is formed. This solution being acidic in nature reacts with the soil minerals dissolving large amounts of Ca, Al, Fe, Mn, etc. Some of these are subsequently precipitated as new compounds with low solubility. In this way the mobility of phosphate is reduced resulting in its decreased availability to plants. The conversion of water soluble phosphates, after reacting with the soil constituents and changing into insoluble phosphates, is known as fixation. This phenomenon does not allow more than 15%-20% absorption of phosphate by soil.

The dissolution of phosphate in soil is shown in Fig. 1.

If phosphate granules are coated with spent (residual) slurry, easily available from biogas plants, such granules would retard phosphate fixation by avoiding direct contact of granules with the fixing agents. The slurry coating acts as a physical barrier on superphosphate granules, or binds phosphorus on its anion exchange sites, or reacts with phosphorus to form organic phosphate compounds. Experiments have shown that use of slurry-coated superphosphate increases phosphate availability to crops.

Biogas slurry is a suitable, cheap and indigenously available material. It is produced after the cow dung undergoes anaerobic fermentation in biogas plants. During

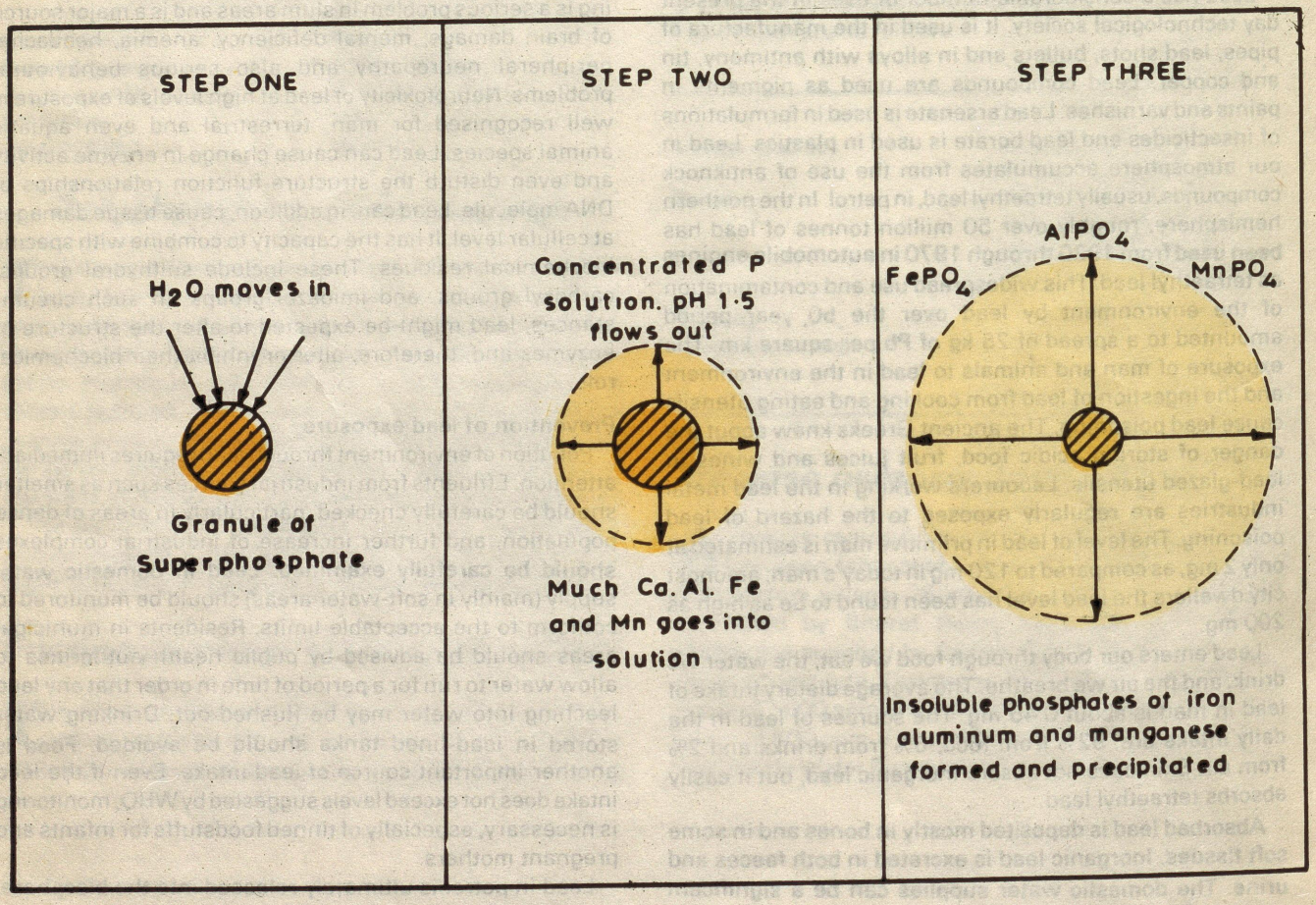
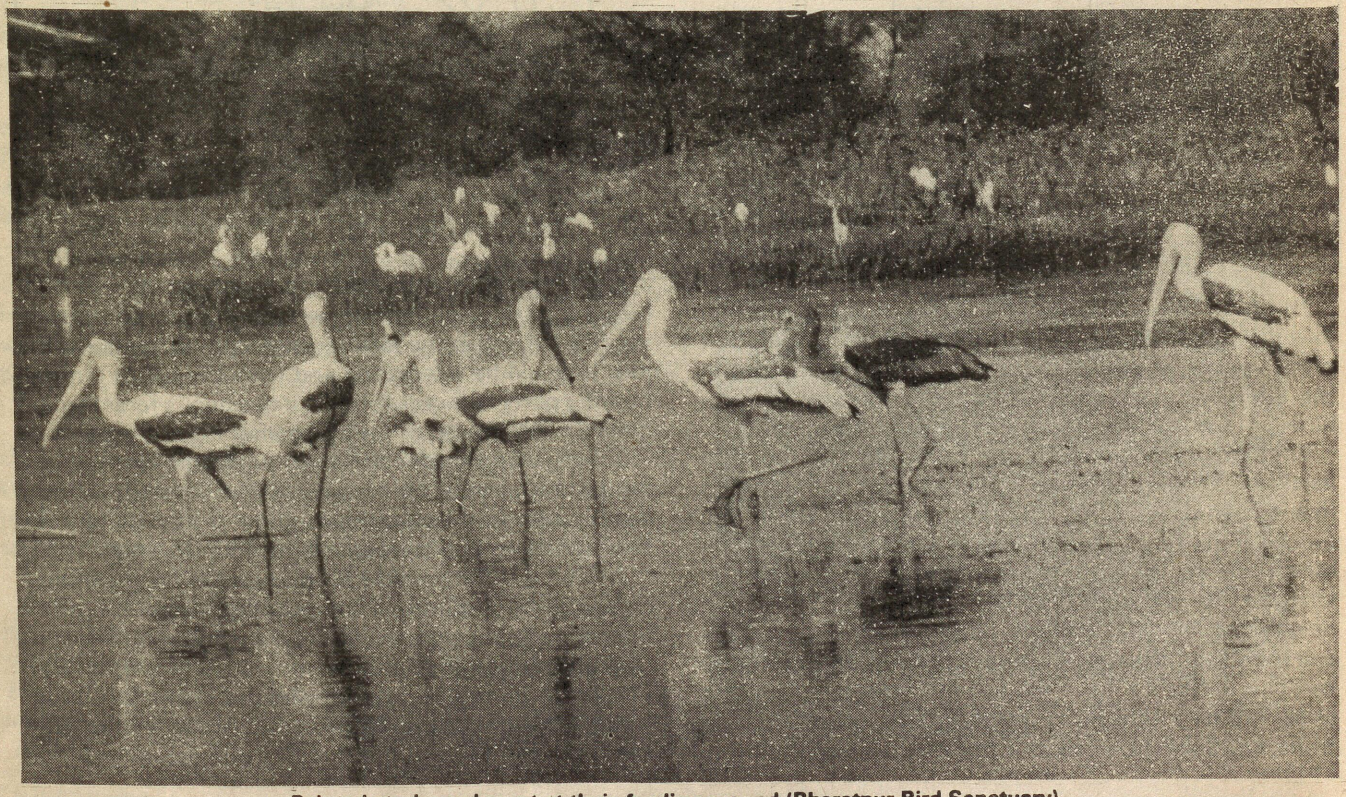


Fig. 1. Dissolution of phosphate in soil



Openbilled storks at their colonial nests (Bharatpur Bird Sanctuary)



Painted storks and egret at their feeding ground (Bharatpur Bird Sanctuary)

THE LIMITS OF SCIENCE *by* Peter Medawar, *Oxford University Press,* 2/11 Ansari Road, Daryaganj, New Delhi 110 002, Pp. 108, £ 3.95

IS science omnipotent? Until very recently, most people believed it to be so, and they had reasons to do so. If one looked at the monumental achievements of science during the nineteenth and twentieth centuries one was bound to get a feeling that science was capable of anything. Yet it could not do many things — it couldn't for example, answer questions such as "How did everything begin?" or "What is the point of living?" Did that in any way limit the power of science? Certainly not, as Nobel laureate Sir Peter Medawar succinctly explains in this little book. His central purpose is to exculpate science from the reproach that it is quite unable to answer those ultimate questions that he shows to be beyond its explanatory competence. This charge, he argues, is no more sensible than to reproach a railway locomotive for not flying! But inspite of this he believes science to be a 'great and glorious' enterprise — the most successful that human beings have ever engaged in.

The three essays which comprise the book, though written in three different styles, bear Medawar's inimitable hallmark — they are frank and full of wit. The first essay entitled "An essay on Scians" is written in the aphoristic style adopted by authors like Francis Bacon which, Medawar says, is the style of exposition most considerate of the reader's interests. It is a collection of twenty delightful pieces, each under a separate para heading, covering a wide spectrum and brings out almost every facet of science as it is practised. The subjects covered include unintelligibility in science, science and culture, science and politics, women in science, fraud in science, guesswork in science, and of course favorite 'The Art of Soluble'.

In the second essay Medawar explodes the myth that scientific discoveries can be premeditated. Citing three case histories, including that of Roentgen's discovery of the X-rays, he argues that they could never have been possible by the present system of research management and funding. Scientific discovery, he says, is as much a consequence of a conscious preparedness as the creative ability of the human mind.

The third and final essay, which bears the title of the book, is the longest and is written in the format of a short book. The tone is more philosophical than the other two essays. It is in this essay that Medawar attempts to explain why science cannot answer questions like "How did everything begin?" It is not to science, he argues, but to metaphysics, imaginative literature or religion that we must turn our attention for answers to such questions. At the same time, he provides ample reasons to support his view that there is no limit upon the power of science to answer questions of the kind science *can* answer. This, he says, is science's greatest glory, for it entails that everything which is possible in principle can be done if the intention to do it is sufficiently resolute and long sustained.

Like his previous best-seller *The Art of the Soluble* (1968) Medawar's latest book provides a deep insight into the way a scientific mind works. It should be read not only by every student of science but also by the non-scientist public who generally fail to grasp the real nature of scientific enterprise.

Biman Basu

ORGANOMETALLIC COMPOUNDS OF BORON edited *by* K. Smith, Chapman and Hall, London (1985),(Available with: *B.I. Publications,* 54 Janpath, New Delhi-110 001), Pp. 304, £ 22.50

DURING recent years, there has been tremendous development in the chemistry of organometallic compounds. Initially, chemists were attracted to this class of compounds due to their novel bonding pattern. Later, researches increased many fold when many of these compounds proved potentially useful in industrial applications. To cover literature on these compounds, several books, treatise, monograph series, etc., have been written on one or other aspect of their chemistry. However most of such publications usually deal with organometallics of metals in general. Recently, Chapman and Hall have initiated a programme to publish a series of source books on the chemistry of organometallic compounds of individual metal/metals. The book under review is one of such source books. In a dictionary format, the book provides a handy reference to over 1300 of most important and useful organoboron compounds synthesised upto mid -1983. The compounds have been arranged according to their molecular formulae following the Hill convention (i.e., in the increasing order of carbon atom followed by hydrogen and then other elements). Every entry has been assigned a number. For each compound molecular formula, structure diagram, preferred name along with other names, physicochemical characteristics, important uses, available toxicity data, and CAS registry number are given. In addition, each compound is provided with selected bibliographic references. The book is provided with four indices, namely, name, formula, CAS registry and structure index. All these indices refer to the entry number assigned to individual compounds.

The book is a welcome addition to the existing literature on organometallic compounds. The literature survey is exhaustive and uptodate. The selection of references pertaining to individual compounds has been made in such a way that it facilitates any one who requires detailed information about a particular compound. The structure index is another attractive feature of the book which would help the researchers working on organometallic compounds. By this index one can have a close look at the structure of all the compounds included in the book. It would have been better if this useful publication would have been hard bound instead of paper-back. In a true sense, the book can serve as a guide book for researchers working in the field of organometallics.

K.K. Kakkar

The snake bird

DARTER, also known as snake bird [*Anhinga rufa* (Daudin)], (Bengali—*Gayor;* Gujarati—*Sarpa greeva;* Hindi — *Pan dubbi*), is seen on large lakes, rivers and sea-side pools where it is found fishing or basking while perched on a tree or stone (*see cover*). It is a non-migrating bird and is found all over India. Its size is about that of a kite. It has a long, slender velvety, brownish, snake-like neck and a black body. Its bill is sharp and pointed like a spear. It swims with most of its body under water and only the long neck and head shows above the surface, resembling the hood of a snake. Hence the name! The male and female birds look alike.

Darters do not swim together; they are solitary, and do not allow other Darters to enter their fishing grounds. When suddenly disturbed while they are perched on a tree, they dive and disappear under water, to emerge later. But when frightened while swimming, they take off from water, flapping heavily.

Darters nest from June to August in North India and from November to February in South India. These birds nest either in colony or separately on trees near water. The nest is made of sticks built gregariously in trees among nests of herons. The female lays three to five bluish eggs. Fledglings have a rich brown colour. The Darters eat small fish which they capture by diving under water. The birds can dive upto a depth of 50 meters or so. They catch fish by thrusting their spear-like bill into its body. When a fish is caught, the bird rises to the surface and flicks the fish into the air with a jerk of the head, catching the fish again in its open bill. The bird then swallows it immediately. It catches fish all day till it is satisfied.

N.R. Mankad
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patient and intensive watching"

For constant watching and intensive study of a particular behaviour, such as nesting, mating nest feeding etc, 'hides' are very useful. Any material which can provide camouflage with the surrounding may be used to make hides. Straw, leafy branches, metallic frames with canvas covering, etc., may be used for such hides.

What to note while watching a bird

First of all you must put the date and time in your note book and then specify the following:

1. *Habitat.* A short description of the place where you see the bird is always desirable. You must mention whether the habitat is open, forest or plain, scrub jungle, marshy land, and so on. This will help in understanding the distribution of birds according to habitat.

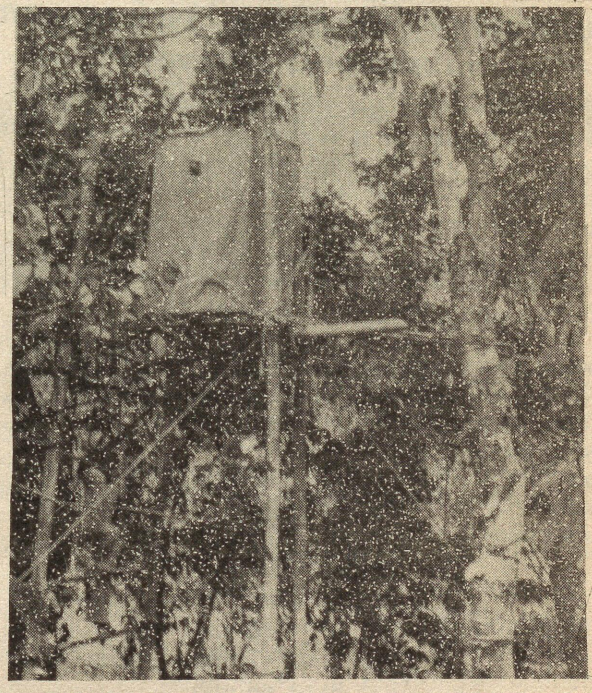
2. *Weather condition.* A very short account of the weather condition must be mentioned. This will help a birdwatcher in correlating the specific behaviour of a particular bird with weather and would help him in ascertaining the behaviour pattern.

3. *Colour and size of the bird.* An intelligent birdwatcher should note the colour and size of the bird at first glance. While noting the colour it will be helpful to note the colour, in detail, of all parts and general pattern. Sometimes a small point provides the needed clue to identify a bird.

4. *Try to draw rough sketch.* If you make a practice to draw rough sketches of the bird under your observation, it will help you in many ways. In fact, field drawn sketches are very helpful in analysing the behaviour of a bird. This is important for a serious student of field ornithology as well.

5. *Note the activity of the bird.* In addition to noting the shape, size, posture, type of beak, type and colour of legs, etc, one should note the behaviour of the bird to identify it easily. Flight pattern, method of feeding, food material, all provide identifying clues in one way or the other.

6. *Get acquainted with the vocalization.* It is always interesting and useful to know the bird by its call/songs. It requires little practice, but once you get the knack for it, this



A canvas hide mounted on a wooden machan to observe a barbet's nest (at Periyar Tiger Reserve, Kerala)

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- The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper of at least 10 cm × 15 cm size.
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Table 1

Possible values of (x, y)	*The resulting numbers N=(x, y)*
(3, 3), (3, 4), (3, 5), (3, 6), (3, 7), (3, 8), (3, 9)	18, 25, 34, 45, 58, 73, 90
(4, 4), (4, 5), (4, 6), (4, 7), (4, 8), (4, 9)	32, 41, 52, 65, 80, 97
(5, 5), (5, 6), (5, 7), (5, 8)	50, 61, 74, 89
(6, 6), (6, 7)	72, 85
(7, 7)	98

The number N can, therefore, be expressed as the sum of two squares in two different ways:

$$N=(ac-bd)^2+(ad+bc)^2$$
$$=(ac+bd)^2+(ad-bc)^2$$

If $a\neq b$ and $c\neq d$ then the number N can distinctly be expressed as the sum of two squares in two different ways. However, if a=b or c=d then N can be written as the sum of two squares in only one way,

$$N=(ac-ad)^2+(ac+ad)^2;\ a=b$$
$$N=(ac-bc)^2+(ac+bc)^2;\ c=d$$

In the light of the result obtained above,let us now see why only the numbers 50, 65 and 85 can be expressed as the sum of two squares whereas other numbers cannot be so expressed. We can represent the said numbers as

$$50=5\times10=(2^2+1^2)(3^2+1^2)$$
$$65=5\times13=(2^2+1^2)(3^2+2^2)$$
$$85=5\times17=(2^2+1^2)(4^2+1^2)$$

It is clear that since in all these numbers a=b and c=d, they are expressible as the sum of two squares in two different ways. Let us take examples of some other numbers and see why they cannot be expressed as the sum of two squares in more than one way. Consider the following numbers:

$$40=2\times20=(1^2+1^2)(4^2+2^2)$$
$$=5\times8=(2^2+1^2)(2^2+2^2)$$
$$58=2\times29=(1^2+1^2)(5^2+2^2)$$
$$74=2\times37=(1^2+1^2)(6^2+1^2)$$
$$90=2\times45=(1^2+1^2)(6^2+3^2)$$
$$=5\times18=(2^2+1^2)(3^2+3^2)$$

It will be seen that in all the above cases either a=b or c=d. Hence, from our previous conclusions these numbers can be written as the sum of two squares in only one way.

Numbers as the sum of two squares in three or more ways

It will be instructive to tackle the problem of expressing a number as the sum of two squares in three or more ways. This can be accomplished only with the help of a computer. However, the task is simplified if one considers the conjecture that a number having three factors,of which at least two are distinct primes of the form 4n+1, can be expressed as the sum of two squares in three different ways. Thus the following numbers,less than one thousand,satisfying the envisaged condition can be written as the sum of two squares in three ways, viz.

$$325=5^2\times13=(1, 18)=(6, 17)=(10, 15)$$
$$425=5^2\times17=(5, 20)=(8, 19)=(13, 16)$$
$$650=5\times10\times13=(5, 25)=(11, 23)=(17, 19)$$
$$725=5^2\times29=(7, 26)=(10, 25)=(14, 23)$$
$$845=5\times13^2=(2, 29)=(13, 26)=(19, 22)$$
$$850=5\times10\times17=(3, 29)=(11, 27)=(15, 25)$$
$$925=5^2\times37=(5, 30)=(14, 27)=(21, 22)$$

To be able to express a number as the sum of two squares in four ways one must be able to split the number into three factors each of which is the sum of two squares. Such a number can be written as

$$N=XYZ=(a^2+b^2)(c^2+d^2)(e^2+f^2)$$

For the number N to be expressible as the sum of two squares in four ways one must require that $a\neq b$, $c\neq d$ and $e\neq f$. This condition is evidently satisfied in the case of the number 1105 which can be written as

$$1105=5\times13\times17=(2^2+1^2)(3^2+2^2)(4^2+1^2)$$

We can then write this number as the sum of two squares in four ways, viz.,

$$1105=33^2+4^2=32^2+9^2=31^2+12^2=24^2+23^2$$

Following are some more examples of numbers belonging to the same class :

$$2210=10\times13\times17=47^2+1^2=43^2+19^2=41^2+23^2=37^2+29^2$$
$$2405=5\times13\times37=49^2+2^2=47^2+14^2=46^2+17^2=38^2+31^2$$
$$2665=5\times13\times41=51^2+8^2=48^2+19^2=44^2+27^2=39^2+12^2$$

The problem of expressing a number as the sum of two squares in five or more ways becomes unwieldy and so exclusively requires the use of computers. Interested readers are, however,invited to deal with the intricacies and adventure associated with this problem to search for excitingly new and interesting results.

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Science quiz

Mark the correct answer :

1. The study of the relation of an organism to its environment:
(a) Bionomics, (b) Biometry, (c) Bionics, (d) Bionomy

2. The study of shells :
(a) Cryogenics, (b) Conchology, (c) Cosmology, (d) Cytology

3. The raising of silk-worms for the production of raw silk:
(a) Aquaculture, (b) Sericulture, (c) Horticulture, (d) Floriculture

4. Study of mental and physical differences of mankind:
(a) Ethnology, (b) Ecology, (c) Etymology, (d) Entomology

5. Study concerns with the production, control and application of very low temperature:
(a) Cryptography, (b) Cryogenics, (c) Cytogenetics, (d) Chronobiology

6. Study of old age:
(a) Geology, (b) Genetics, (c) Gerontology, (d) Genealogy

7. Technique used for quicker diagnosis of breast cancer among woman:
(a) Lexicography, (b) Iconography, (c) Hydrography, (d) Mammography

8. Study of nature, causes and remedies of diseases:
(a) Philology, (b) Phrenology, (c) Pathology, (d) Pomology

9. Study of bones :
(a) Odontology, (b) Ornithology, (c) Osteology, (d) Osteopathology

10. Communication of two minds at a distance with help of thought, feeling or emotions:
(a) Telepathy, (b) Hydropathy, (c) Homoeopathy, (d) None of the above

11. Study of fresh water ecosystem :
(a) Ecology, (b) Physiology, (c) Anthropology, (d) Limnology

12. Study of prehistoric remains :
(a) Archaeology, (b) Morphology, (c) Philology, (d) Psychology

13. Ecology of forests:
(a) Silvics, (b) Ethics, (c) Ceramics, (d) Optics

14. Study of art of measuring time :
(a) Biology, (b) Horology, (c) Etymology, (d) Neurology

15. Study of the theory and practice of classifying organisms :
(a) Taxonomy, (b) Anatomy, (c) Agronomy, (d) Astronomy

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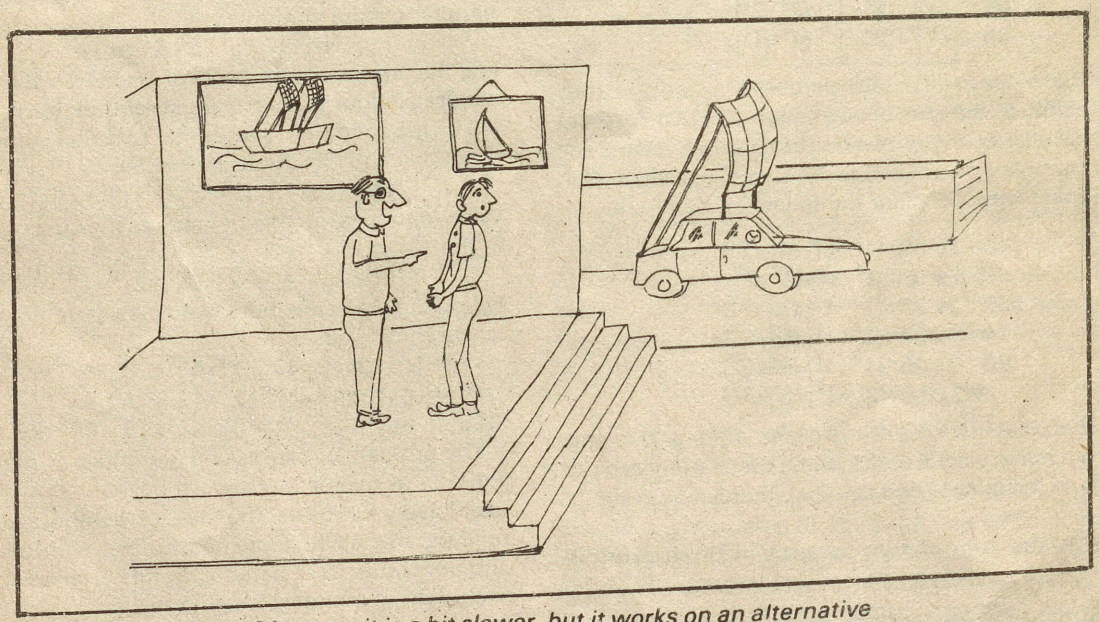
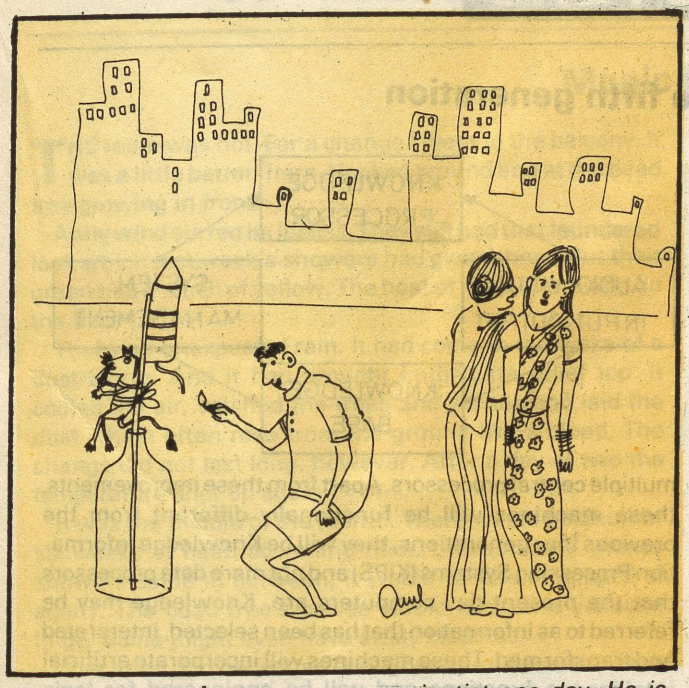
(Answers on p. 398)

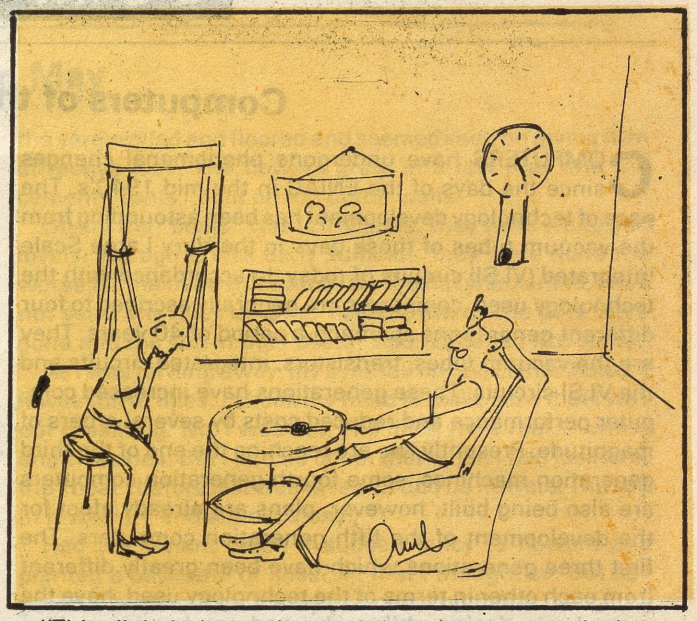


"Of course it is a bit slower, but it works on an alternative source of energy, you see, and saves me a lot of petroleum".

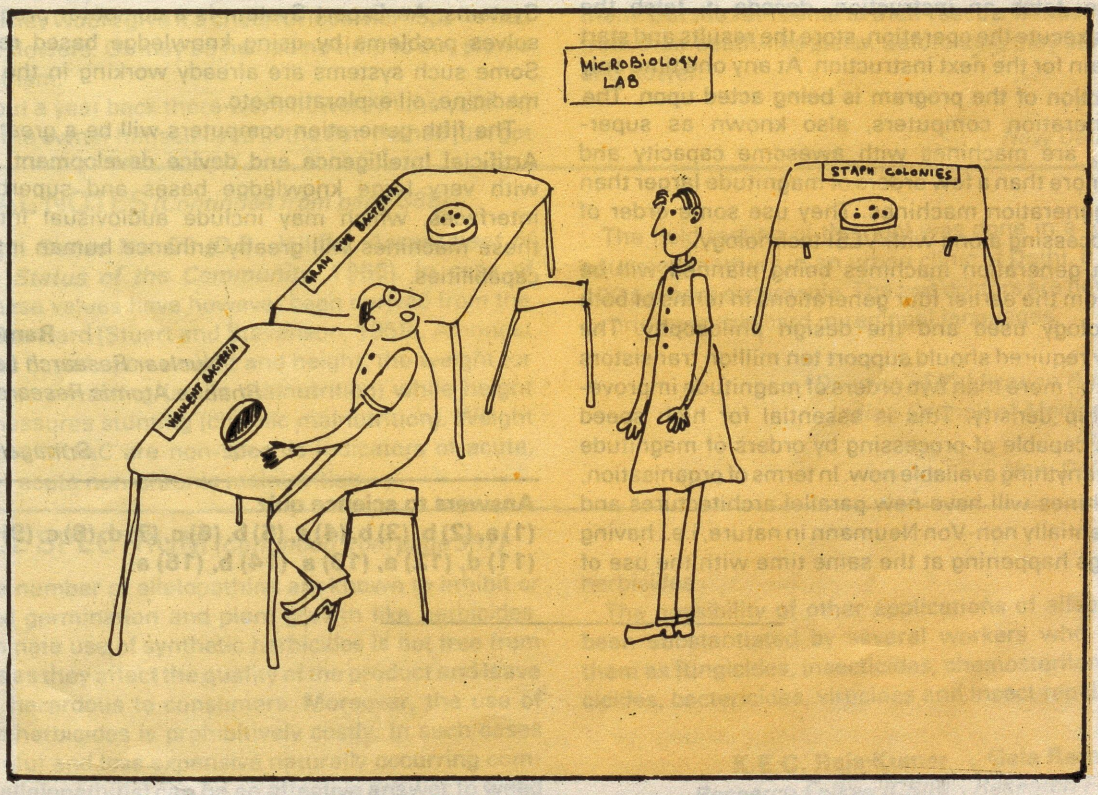
Cartoons by ANIL KUMAR AGGARWAL



"Yes! son may become a space scientist one day. He is always conducting one or the other ingenious experiment."



"This digital electronic watch has date, year, calculator, two video games, three alarms, ten telephone numbers, fifteen melodies..... but if you want to see time you have to use that one."

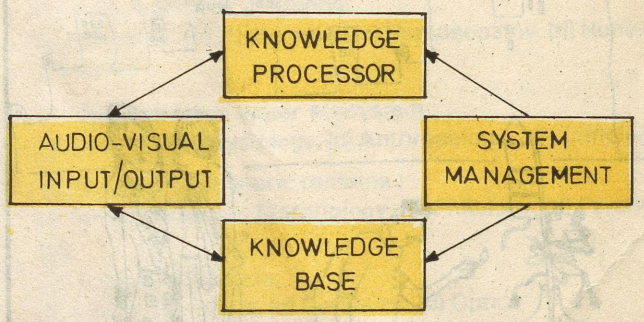


"So these are not the bacterial colonies but my fruit jelly. Then what did I eat after my luch?"

Computers of the fifth generation

COMPUTERS have undergone phenomenal changes since the days of the ENIAC in the mid 1940's. The pace of technology development has been astounding from the vacuum tubes of those days to the Very Large Scale Integrated (VLSI) circuits of today. In accordance with the technology used, computers are generally ascribed to four different generations spanning a period of 40 years. They are the vacuum tubes, transistors, integrated circuits and the VLSI circuits. These generations have increased computer performance and reduced costs by several orders of magnitude. Presently, we are reaching the end of the third generation machines, some fourth generation computers are also being built, however, plans are already afoot for the development of the fifth generation computers. The first three generations which have been greatly different from each other in terms of the technology used, have the **same basic design philosophy and are known as Von** Neumann machines after the computer pioneer and mathematician, John Von Neumann. They are made up of a central processor, a memory and arithmetic unit and input-output devices. These machines operate in a largely serial fashion, i.e. fetch an instruction, decode it, fetch the operands, execute the operation, store the results and start all over again for the next instruction. At any one time only **one instruction of the program is being acted upon. The** fourth generation computers, also known as super-computers, are machines with awesome capacity and speeds of more than a few orders of magnitude larger than the third generation machines. They use some order of parallel processing along with VLSI technology.

The fifth generation machines being planned will be different from the earlier four generations in terms of both the technology used and the design philosophy. The technology required should support ten million transistors on a chip, i.e., more than two orders of magnitude improvement in chip density. This is essential for high speed processors capable of processing by orders of magnitude faster than anything available now. In terms of organisation, these machines will have new parallel architectures and will be essentially non-Von Neumann in nature, i.e., having many things happening at the same time with the use of



multiple central processors. Apart from these improvements, these machines will be functionally different from the previous four generations, they will be Knowledge Information Processing Systems (KIPS) and not mere data processors that the present day computers are. Knowledge may be referred to as information that has been selected, interpreted and transformed. These machines will incorporate artificial **intelligence functions and will be engineered for logic** processing and inference capabilities. Such systems are available in a limited sense even now in the form of Expert Systems. An Expert System is a computer program that solves problems by using knowledge based reasoning. Some such systems are already working in the fields of medicine, oil exploration, etc.

The fifth generation computers will be a great effort in **Artificial Intelligence and device development. Coupled** with very large knowledge bases and superb human interfaces, which may include audiovisual interaction, these machines will greatly enhance human intellectual capabilities.

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Answers to science quiz
(1) a, (2) b, (3) b, (4) a, (5) b, (6) c, (7) d, (8) c, (9) c, (10) a, (11) d, (12) a, (13) a, (14) b, (15) a

OF LEAVES AND FEATHERS

Magic in May

THE room was hot. For a change I went to the balcony. It was a little better there. I looked around and at the bead tree growing in front.

A shy wind stirred its leaves. They still had that laundered look which last week's showers had given them. But their green had a touch of yellow. The heat of May was telling on the tree.

That was unexpected rain. It had come in the wake of a dust-storm. And it had brought immediate relief too. It cooled the air, washed the trees and shrubs and laid the dust which often rose from the ground like a cloud. The change did not last long, however. After a day or two the temperature shot up again.

It was the middle of the month. There would be another six weeks of heat, scorching heat. Unless some chance showers came in between, it would be one long spell of agony. The bead tree's leaves would take on a yellower tinge. Some might even have sickly blotches.

Just then I glanced at the front-yard below. It was covered with cement. Gray and bare, it seemed to be a patch of desert, a stiff, smooth desert.

I wondered why the tenant did not have a few flowers in the yard. They would give it a cheerful look. Perhaps he had no love of flowers. Or may be he had no time to buy plants and tend them.

But about a year back there were flowers in the yard. At that time the owner himself lived in the flat. He had just got the yard walled and floored and seemed keen on giving it an attractive look. The flowers grew in a few pots and the cement "boats" built on top of the walls.

One of the "boats" was full of lilies. They were white and lovely. Though it was early summer, they were none the worse for the heat. But ever since the flat was rented, I had not seen any lilies or other flowers there. The pots were gone and the soil in the "boats" had hardened like stone.

As I was turning away, my eyes fell on one of the "boats". It was full of lilies! I shook my head to make sure that I was not dreaming. No, I was not. The lilies were real — white and vivacious. But I had no doubt that when I had looked at the "boat" before last weeks rain, it had no flowers. The soil in it was dry and almost stony.

Had the tenant taken a sudden fancy to flowers and planted a basketful of lilies? At first I thought so. But as I gazed, I made out how they had come up there.

When the last year's lilies vanished, that was not the end of them. The flowers and leaves died away, but the bulbs stayed on in the soil. And they lay buried there all these months.

Then the days grew hotter. The sun might have parched them. But the rain came to their rescue. It roused the bulbs from their death-like sleep. Before long they burst into leaf and flower.

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MEDICAL NOTES *(Continued from page 389)*

Monograph Series No. 53 (D.B. Jelliffe, *Assessment of Nutrition Status of the Community,* 1966). In case of MUAC, these values have however been derived from the Harvard Standard (Stuart and Stevenson, 1959). Amongst the indices based upon weight and height, the weight for height detects wasting (acute malnutrition) while height for age measures stunting (chronic malnutrition). Weight for age and MUAC are non-specific indicators of acute, chronic or acute non-chronic malnutrition.

The field testing of this tool was done in a group of 20 educated mothers in an urban clinic of Delhi. It was found 100 per cent acceptable. The two doctors are now planning to bring out this card in regional languages.

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SCIENCE SPECTRUM *(Continued from page 387)*

A large number of allelopathins are known to inhibit or alter seed germination and plant growth like herbicides. Indiscriminate use of synthetic herbicides is not free from problems as they affect the quality of the product and leave residues hazardous to consumers. Moreover, the use of synthetic herbicides is prohibitively costly. In such cases less harmful and less expensive naturally occurring compounds (allelopathins) can be an effective answer to weed problem. These compounds are said to be easily degradable by microbes and are also pollution-free. One of the promising uses of allelopathins could be their use as 'natural herbicides'.

The possibility of other applications of allepathins has been substantiated by several workers who have used them as fungicides, insecticides, chemosterilants, molluscicides, bactericides, virucides and insect repellants.

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Why bottle feeding is bad

IN the developing countries, breast-fed babies grow better and are more likely to survive. But bottle-feeding is on the increase, putting millions of infants at risk. Breast-feeding is an unequalled way of providing ideal food for healthy growth and development of infants. It forms a unique biological and emotional basis for the health of both mother and child. The advantages of mother's milk over dangers of bottle are described in Table 1.

A code to protect infants

In 1981, the World Health Assembly adopted an "International Code of Marketing" to help stop irresponsible promotion of breast milk substitutes. As a result, the following picture has emerged:

(i) Thirtythree Governments have banned all advertising of breast milk substitutes.

(ii) Seventeen countries are running mass media campaigns to highlight advantages of breast milk.

(iii) Eighteen countries have brought in national 'codes' to regulate marketing of powdered milk.

Table 1

No.	*The advantages of mother's milk*	*No.*	*The dangers of bottle feeding*
1.	Better nutrition—Breast-milk has all the proteins, vitamins, and minerals a baby needs for the first few months of life. Even among malnourished mothers, studies show that breast-fed babies are twice as likely to achieve normal weight for age compared to non-breast feel babies.	1.	Lack of hygiene—Infants are exposed to infection via contaminated bottles, teats and baby food.
2.	Less infection—Mother's milk also immunizes the infant against common ailments—reducing by as much as 50% are risk of diarrhoea.	2.	Illiteracy—Many mothers in poor communities cannot read instructions on how much powder to use and how to make a safe food.
3.	Natural contraception—Although not a reliable mothod, breast feeding has a powerful contraceptive effect. In many countries, it is the most important factor in preventing mother's pregnancy in the first year after giving birth.	3.	Expense—Buying enough commercial baby milk can take up to half the income of a poor family.
		4.	Over-dilution—Using less than the recommended amount of milk-powder can lead directly to malnutrition.
		5.	Spoilage—Most poor mothers have nowhere to keep bottled milk cool and no convenient way of sterilising the equipment.

The encouragement of breast-feeding is an important part of the health care, nutrition and other social measures required to promote healthy growth and development of infants and young children and breast-feeding is an important aspect of primary health care. Recent survey indicates that information about the superiority of breast milk has led to a change back to breast-feeding in the rich world.

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Food poisoning

ONE frequently comes across reports of food poisoning due to consumption of foods containing pathogenic organisms or their toxic metabolic products. The symptoms generally are vomiting, diarrohea and severe gastroenteritis. The control and prevention of food poisoning are important aspects of food microbiology.

All food-borne diseases are classified as 'food infections' or 'food intoxications'. Food infections are those in which microorganisms present in the food at the time of eating enter the host and cause illness. Food intoxications are those diseases in which microorganisms grow in food and produce a substance therein which is toxic to man and animals. Food poisoning is the toxicity introduced in the food by microorganisms and their products.



A
CLOSTRIDIUM BOTULINUM

B
SALMONELLA ENTERIDIS BACTERIA

Fig. 1. Food poisoning bacteria causing illness

People generally do not eat foods that show visible spoilage, but sometime when the appearance, flavour and taste are normal, they do eat them. On the other hand, certain foods may show no signs of spoilage and yet be responsible for food poisoning.

Staphylococcal poisoning. **There has been a wide range** of foods involved in staphylococcal food poisoning outbreaks which include milk and milk products, meat and meat **products, poultry and egg products, chicken and bakery** products. Foods that require considerable handling during preparation and need to be kept at a slightly elevated temperature are frequently involved in staphylococcal poisoning. Some strains of *Staphylococcus aureus* produce a potent enterotoxin. Consumption of food containing this toxin causes a sudden onset of illness within 3 to 4 hours. Symptoms include nausea, vomiting and diarrhoea. Foods most commonly involved include those which are eaten cold, e.g., salads, bakery products, hams, processed meat and dairy products.

Staphylococcal poisoning can be controlled by preventing the entry of the bacteria into food, by destruction of the bacteria by heat and by restriction of their growth by refrigeration.

Botulism. **Botulism is caused by an exotoxin of *Clostridium botulinim,*** a heat-resistant rod-shaped bacteria and it is the most potent exotoxin known to man. Botulism is a neuroparalytic disease affecting humans and animals in which 30% to 70% of cases are fatal. Most cases are associated with home canned vegetables, infected sausages, ham, preserved meats, fowl or fish. Home canned food should be heated at the boiling point for several minutes before use.

Salmonellosis. Salmonellosis is caused by living bacteria of the Salmonella group. The disorder results from the growth of Salmonella in the intestine. Members of this genus produce endotoxins. When ingested with contaminated food, **symptoms appear in 6 to 12 hours and the infection is characterised by continued fever, acute gastroenteritis and involvement of the lymphoid tissue of the** intestine. Infection is usually accompanied by diarrhoea and frequently by headache, nausea and vomiting **Organisms may be present in the faeces, urine and blood.**

Salmonellas are disseminated in various ways. Rats and mice are generally believed to be involved in spreading the organism.

Perfringens poisoning. Another type of food poisoning is caused by strains of *Clostridium perfringens.* The development of food poisoning symptoms requires the growth of the organism in the human intestine. Growth is rapid and causes milk illness, with diarrhoea and abdominal pain, but vomiting is rare. The onset of symptoms occurs between 8 to 22 hrs after the food has been consumed. The organism is more important as a cause of 'gas gangrene' which **involves muscles.**

Symptoms of perfringens poisoning include gastrointestinal pain, headache, diarrohea or constipation and prostration. They may be followed by several types of paralyses of the central nervous system. Death occurs by cardiac or respiratory paralysis, usually in 3 to 7 days. Spoiled canned foods or those which are suspected of being spoiled should not be tasted. The suspected food should not be fed to animals or chickens.

Streptococcal poisoning. Food which appears to be the cause of gastroenteritis in humans contains large numbers of *Streptococcus faecalis.* These organisms are referred to as entercocci because they are frequently found in human intestinal tract. Poisoning is caused by inadequately refrigerated food contaminated with the organisms.

Afflatoxins. In recent years, attention has been drawn to the problem of afflatoxin food poisoning due to the growth of some fungi, i.e., Aspergillus species. Normally, these organisms do not grow in milk but they are known to grow in fermented milk products like *dahi* and yoghurt. They contain afflatoxin M if the milk used for their manufacture is contaminated with this toxin. Since oil-cakes and other animal feed often contain afflatoxins, there is a possibility of such toxin being transferred to milk and milk products.

Mycotoxines are chemical substances produced by a variety of molds in foods such as corn, wheat, rice and peanuts and these toxins produce illness or death in small animals. Besides afflatoxins, various other mycotoxins are also produced by certain molds. They grow on bread, rice, corn and other grains.

References

1. Hobb, C.B. and Chirstian, J.H.B. (1973), ***The Microbiology Safety of Food,*** Academic Press.
2. Moreau, C. and Moss, M. (1974), ***Molds, Toxins and Food,*** Wiley, New York.
3. Riemann, H. (Ed.) (1969), *Foodborne Infections and Intoxications,* Academic Press Inc., New York.

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SCIENCE IN INDUSTRY

Noise pollution analyser

THE National Aeronautical Laboratory (NAL), Bangalore, has developed a statistical analyzer for noise signals. The equipment is designed to assess noise pollution in a noisy environment. It measures and assesses noise levels which are within the range of 30 db (A) to 90 db (A). By the data acquired from the equipment, it is possible to determine histograms, cumulative distribution of noise levels, L values and noise pollution level. Noise assessment is a highly relative factor. It requires comparative study of objective measurement of noise with subjective measurement made in simulative experiments in laboratory. It has been demonstrated that distribution of A-weighted noise level correlates well with the subjective response of annoyance caused on human beings in a noisy climate. **Also, it has been demonstrated through statistical studies** that annoyance is felt not only by the frequency content but also because of noise within a tune. All these factors are **taken into consideration in designing the analyzer. The** analyzer has the following specifications:

Input impedance	: 5 MO
Frequency range	: 20 Hz to 20 kHz
Dynamic range	: 30 db (A)-90 db (A)
Resolution	: 1 db
Operating time	: 180 hr.

Polyphenylene oxide coatings

THE Central Electrochemical Research Institute, Karaikudi, has achieved the production of polyphenylene oxide coatings from phenolic monomers such as catechol, resorcinol and *o*-cresol through an *in situ* electropolymerization technique over different metallic surfaces. The salient features of this technique are: (i) Simultaneous polymer production and coating formation, (ii) Reproducibility of the process and repeatability over a number of electrode surfaces, and (iii) Lower energy consumption.

The polyphenylene oxide coatings may be used in automobile industry for surface protection, and in polymeric capacitors used in electrical and electronics industries.

Friction and wear monitoring system

THE study of wear and friction characteristics of composites involves the use of a pin and disc machine **where pin is made of composite material and the disc of** any standard material with known characteristics. The disc is rotated about its axis and the pin is brought to bear on it to effect wear on itself. The wearing out reduces its length and the interface of the composite and the disc develops **friction. This work is being carried out at the Indian** Institute of Science, Bangalore.

The National Aeronautical Laboratory (NAL), Bangalore, has developed a friction and wear monitoring system for this machine. Friction is monitored as a horizontal force acting on a pivoted bar in the machine with strain gauge based load sensors and the wear is monitored with LVDT type displacement sensors. Whereas the friction sensing is done in two ranges of 0-1 kg and 0-10 kg, wear sensor has a range of 0-0.5 mm. Output of the devices is a signal conditioned in instruments developed in the laboratory. The accuracy of the system is 0.25% of the range. Compatible recording terminals are provided in the instrument for recording the parameters.

The system has since been used for front line research in the field of composite investigations. The specifications of the system are as follows:

System accuracy	: **0.25% of the range (customers requirement)**
Sensors	: **wear—LVDT range: 0-0.5 mm;—friction—strain gauge based load cell; and range—0-1 kg, 0-10 kg**
Working temperature range	: **25°-55°C**

Reverse osmosis desalination plant

A reverse osmosis plant of 50,000 litres/day capacity has been fabricated, installed and commissioned at Puthagaram village, 28 km from Madras city. The plant **fabricated by Bharat Heavy Electricals Ltd, has the membrane supplied by Central Salt & Marine Chemicals** Research Institute, Bhavnagar. The plant treats the borewell water of 5000 ppm and supplies good quality safe drinking water of 500 ppm. The plant has been handed over to the Tamil Nadu Water Supply and Drainage Board.

Lead and human health

LEAD (Pb), a grey, ductile, malleable metal, has been known to mankind since 2500 B.C. Lead poisoning, in contrast to mercury and cadmium poisoning, has been known from biblical times; it is not a byproduct of modern technology. Lead is one of the earliest known metals extracted from ore by prehistoric man for various uses. It is found in nature as sulfide (galena) and also as carbonate (cerussite). Although lead is present at 15 ppm (parts per million) in the earth's crust, it is not uniformly distributed. It is found in high concentrations wherever it occurs; in rivers, 3 ppb (parts per billion), and in sea water, 5 ppb. Lead is present in all living organisms. The human body (70 kg) contains about 120 mg lead, 96% of which is located in bones; its concentration in man increases with age. Lead, like cadmium and mercury, has never been identified as an essential element nutritionally or physiologically in man or in other mammals.

Uses of lead

Lead has a considerable number of uses in the present day technological society. It is used in the manufacture of pipes, lead shots, bullets and in alloys with antimony, tin and copper. Lead compounds are used as pigments in paints and varnishes. Lead arsenate is used in formulations of insecticides and lead borate is used in plastics. Lead in our atmosphere accumulates from the use of antiknock compounds, usually tetraethyl lead, in petrol. In the northern hemisphere, roughly over 50 million tonnes of lead has been used from 1920 through 1970 in automobile engines as tetraethyl lead. This widespread use and contamination of the environment by lead over the 50 year period amounted to a spread of 25 kg of Pb per square km. The exposure of man and animals to lead in the environment and the ingestion of lead from cooking and eating utensils cause lead poisoning. The ancient Greeks knew about the danger of storing acidic food, fruit juices and wines in lead-glazed utensils. Labourers working in the lead metal industries are regularly exposed to the hazard of lead poisoning. The level of lead in primitive man is estimated at only 2 mg, as compared to 120 mg in today's man; amongst city dwellers the lead level has been found to be as high as 200 mg.

Lead enters our body through food we eat, the water we drink, and the air we breathe. The average dietary intake of lead in man is about 0.45 mg. The sources of lead in the daily intake are: 92% from food; 6% from drinks and 2% from air. Skin does not absorb inorganic lead, but it easily absorbs tetraethyl lead.

Absorbed lead is deposited mostly in bones and in some soft tissues. Inorganic lead is excreted in both faeces and urine. The domestic water supplies can be a significant source of lead contamination, particularly in soft-water areas where plumbing systems are made of lead. Lead plumbing may become a major source of lead intake by people living in the hill states of India where drinking water is 'soft' (low calcium concentration) and the water is distributed through lead pipes. Canning of food using lead solder to seal tins has been another source of lead contamination in canned foods. Recommended limits of lead intake according to WHO are: 3 mg/week with food, 100μg/ in drinking water and $\mu g/m^3$ with air ($1\mu g = 10^{-6} g$)

Lead poisoning

Plumbism, a disease caused by acute lead poisoning, has been known for centuries. Cicero (106-43 B.C.) certainly knew the toxicity of lead and pointed out that "the mouth claims more victims than the sword". In a classic paper, Gilfillan *(J. Occup. Med.*, 7:53-60, 1965) gave the thesis that lead poisoning was the major factor in the fall of Rome. Young children living in dilapidated buildings are generally exposed to acute lead poisoning because of the habit of eating non-food substances such as peeling paints and paints and plasters containing lead. Childhood lead poisoning is a serious problem in slum areas and is a major source of brain damage, mental deficiency, anemia, headache, peripheral neuropathy and also serious behavioural problems. Neurotoxicity of lead at high levels of exposure is well recognised for man, terrestrial and even aquatic animal species. Lead can cause change in enzyme activity and even disturb the structure-function relationships of DNA molecule. Lead can, in addition, cause tissue damages at cellular level. It has the capacity to combine with specific biochemical residues. These include sulfhydral groups, carboxyl groups, and imidazol groups. In such circumstances, lead might be expected to alter the structure of enzymes and, therefore, alter or inhibit their biochemical role.

Prevention of lead exposure

Pollution of environment through lead requires immediate attention. Effluents from industrial sources such as smelter should be carefully checked, particularly in areas of dense population, and further increase of industrial complexes should be carefully examined. Lead in domestic water supply (mainly in soft-water areas) should be monitored to conform to the acceptable limits. Residents in municipal areas should be advised by public health authorities to allow water to run for a period of time in order that any lead leaching into water may be flushed out. Drinking water stored in lead-lined tanks should be avoided. Food is another important source of lead intake. Even if the lead intake does not exceed levels suggested by WHO, monitoring is necessary, especially of tinned foodstuffs for infants and pregnant mothers.

Lead in petrol is ultimately released into the biosphere, therefore, its concentration in petrol should be reduced.

(Continued on page 405)

Slurry coating enhances phosphorus availability to soil

PHOSPHATE fertilizer is a costly input in agriculture. In India, the most common source of phosphorus is superphosphate. The P_2O_5 availability through superphosphate accounts for only 22 per cent of total P_2O_5 production in the country. There is, therefore, need to find out ways and means to increase efficiency of phosphorus supply to crops.

When a water soluble phosphatic fertilizer such as superphosphate is applied to soil, the granules of monocalcium phosphate, the active ingredient of superphosphate, absorb water from surrounding soil until a saturated salt solution is formed. This solution being acidic in nature reacts with the soil minerals dissolving large amounts of Ca, Al, Fe, Mn, etc. Some of these are subsequently precipitated as new compounds with low solubility. In this way the mobility of phosphate is reduced resulting in its decreased availability to plants. The conversion of water soluble phosphates, after reacting with the soil constituents and changing into insoluble phosphates, is known as fixation. This phenomenon does not allow more than 15%-20% absorption of phosphate by soil.

The dissolution of phosphate in soil is shown in Fig. 1.

If phosphate granules are coated with spent (residual) slurry, easily available from biogas plants, such granules would retard phosphate fixation by avoiding direct contact of granules with the fixing agents. The slurry coating acts as a physical barrier on superphosphate granules, or binds phosphorus on its anion exchange sites, or reacts with phosphorus to form organic phosphate compounds. Experiments have shown that use of slurry-coated superphosphate increases phosphate availability to crops.

Biogas slurry is a suitable, cheap and indigenously available material. It is produced after the cow dung undergoes anaerobic fermentation in biogas plants. During

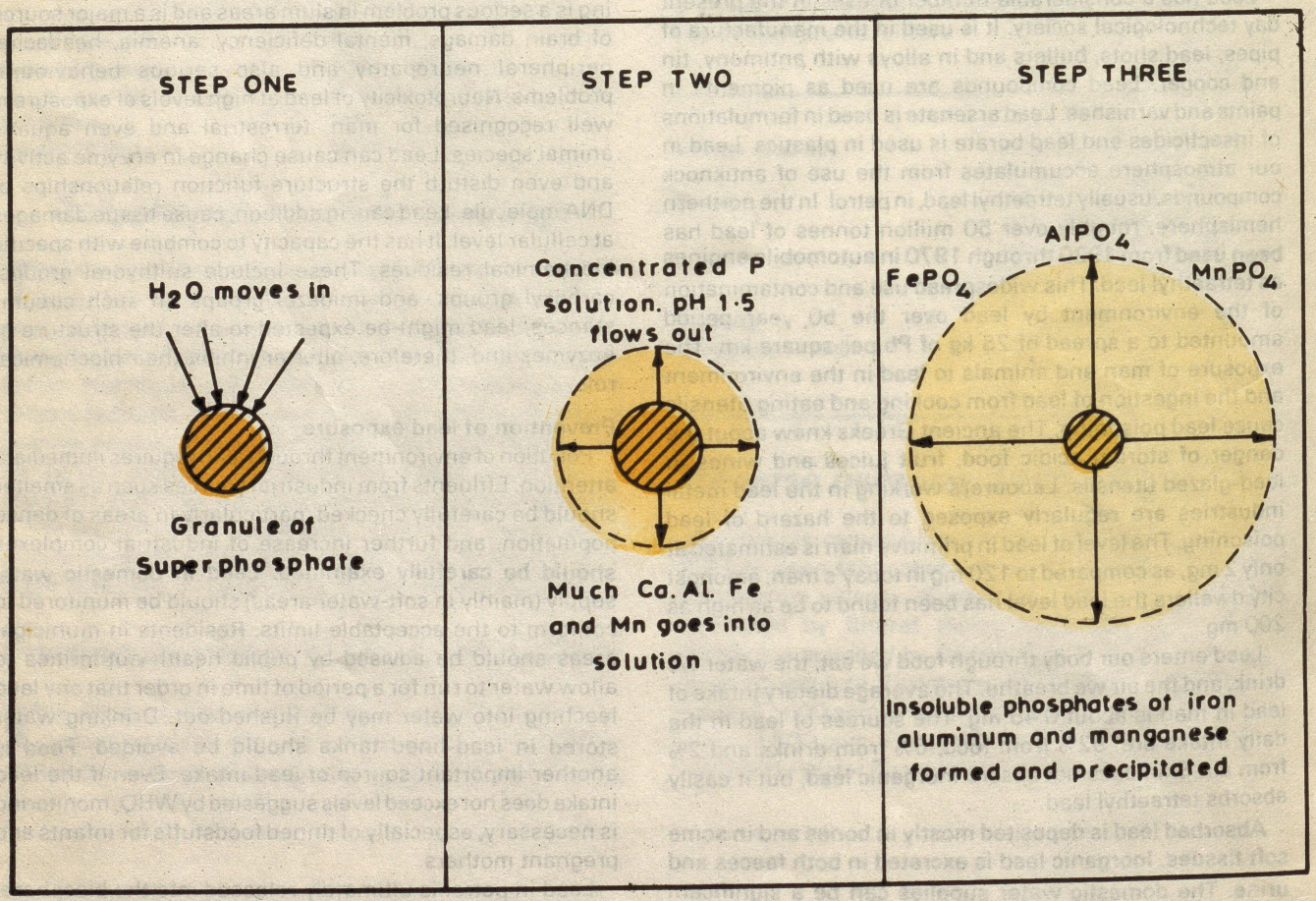

Fig. 1. Dissolution of phosphate in soil

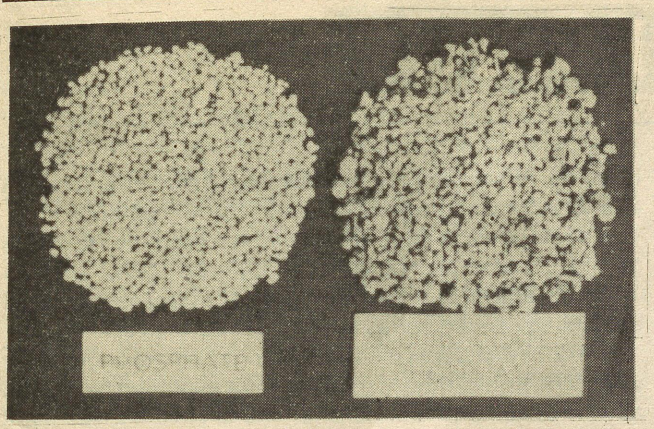

Fig. 2. Slurry-coated phosphate

fermentation, about 25%-30% of its total solids get digested. Thus the residue can be regarded as an almost semi-decomposed humus forming material.

Two parts by weight of superphosphate is mixed with one part by weight of wet slurry by hand on a cemented floor. It is necessary that all the granules have a uniform, thin coating of slurry. The smeared fertilizer granules are then spread out on floor and dried under the sun. On drying,the fertilizer is ready for application in the field.

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ENVIRONMENT *(Continued from page 403)*

Small reduction has been made in the amounts of lead added to petrols in some European countries. In the Soviet Union, petrol is always free from lead.

When lead poisoning develops, the first important step should be the removal of the patient from the source of lead contamination. A physician should be consulted. Lead is eliminated from the body by the use of chelating agents, e.g., D-penicillamine and British antilewisite (BAL).

References :

1. Chisolm, J.J. Jr. (1971), Lead Poisoning, *Scientific American,* **224,** 15.
2. *Survey of Lead in Food (1972),* Ministry of Agriculture, Fisheries and Food, London, HMSO.
3. Lenihan, J. and W.W. Fletcher (1977), *Environment and Man, Volume Six; The Chemical Environment,* Blackie, Glasgow and London.
4. Venugopal, B. and T.D. Luckey (1978), *Metal toxicity in mammals, Vol. 2. Chemical toxicity of metals and metalloids,* Plenum Press, New York and London.

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BOOK-REVIEWS

PIRATES OF THE CELL : THE STORY OF VIRUSES FROM MOLECULE TO MICROBE *by* Andrew Scott, *Basil Blackwell Ltd.*, Oxford, Pp. 247, Price not mentioned.

ARE viruses living bodies? If they are, then they clearly represent life at its simplest and most basic level. The diseases they cause range from trivial infections such as the common cold to scourges like smallpox (which, thanks to virology and WHO, has been banished from the surface of the Earth), rabies, yellow fever, cancer and AIDS—the 1980's most frightful disease. The region between the two extremes is vast. It includes influenza, chickenpox, measles, mumps, hepatitis, polio and many more capable of killing, or maiming for days, weeks or months on end.

If living things live to make more of themselves, then viruses are the best examples of 'life'. Yet, because of the nihilistic futility of viral life, they are denied the outwardly grand title of "a form of life".

A British science writer and broadcaster who has specialised in biochemistry, molecular biology and medicine, Andrew Scott outlines the marvellous and complex systems of the human body to fight off the threat of viral invasion. He also deals with what happens when these defence systems fail, and explains lucidly the simple but effective tool of vaccination.

Scott's book spans 14 chapters starting from the discovery, of what later came to be known as tobacco mosaic virus, towards the end of the last century by the Russian botanist Dimitri Ivanovski through the theories of the origin of viruses to the future hopes of converting this deadly foe to a helpful friend of humanity.

One of the landmarks in the history of virology is the unravelling of the viruses' structure. Viruses are now known to be certainly not small cells but indeed small pieces of genetic material (DNA or RNA) wrapped up inside a protein coat and sometimes further enclosed within an outer lipid membrane.

The processes of viral infection, says Scott, is a form of biological hijack, in which the viruses invade suitable host cells and commandeer the complex molecular machinery of the cells to manufacture many more viral particles.

The book's focus is on the breakthroughs in vaccine technology and development. This is because, as the author says, "In the entire history of medicine there could be few more significant achievements than the development of vaccination." With the cracking of the genetic code and unravelling of the 'secret of life', the possibilities in vaccine design opened up by genetic engineering are turly unlimited", adds Scott. The previously haphazard and fortuitous approach to the production of attenuated live virus vaccines is going to be steadily replaced by the methodological alteration of viruses towards precisely defined aims.

In a reference to interferon (s), which has failed to live up to the initial expectations as a 'cure-all', Scott sees its anti-viral activities of greater benefit. It, in fact, is suspected of causing cancer, it was expected to cure, in some cases.

The book discusses the three theories on the origin of the virus. The first of them considers their evolution before the advent of complex cellular life. The second derives them from ancient parasitic cells which invaded other cells and gradually became simpler and simpler, relying increasingly on host cells for survival and multiplication. The third, and today's dominant theory, traces their evolution from the genetic material of cellular life, little bits of which might have escaped to take up independent existence as viruses.

In the last chapter Scott is sanguine that scientists with the aid of genetic engineering tools will put them to the service of humanity– just analogous to the use of bacteriophages as antibiotics to combat dangerous bacterial infections.

Profusely illustrated with half-tones and line drawings of viral structure and their invasion into human body, and based on as recent references as 1984 in *Science* and *Nature*, the book is a little monograph Scott addresses to undergraduates in medicine and life sciences as well as laymen interested in biology. A 7-page index adds to the usefulness of the book.

P.S. Shankar

FROM QUARK TO QUASAR: Notes on The Scale of The Universe *by* Peter Cadogan, *Cambridge University Press*, 139 Munirka Enclave (Self Financing Flats), New Delhi 110067, Pp. 189, £ 12.95

ALMOST sixty years ago, while delivering the inaugural address at the Bose Institute in Calcutta, Sir J.C. Bose had made a profound observation. "When human sight fails," he had said, "we continue to explore the region of the invisible. The little that we can see is as nothing compared to the vastness of that which we cannot." Today we see how prophetic his words were. In 1917, man's concept of his universe was rather limited. On the atomic scale the neutron was yet to be discovered, DNA was unknown and radio astronomy, pulsars and quasars had not yet entered astronomers' vocabulary. But within a span of a few decades all that had changed. High-energy particle accelerators, electron microscopes and new astronomical observation techniques had opened up new vistas in our understanding of the universe. The atom now contained not just electrons and protons but a whole range of strange

subatomic particles, the genetic code was no longer a mystery and the cosmic horizon had expanded beyond the visible limits.

From the invisibly small world of subatomic particles to the inconceivable immensity of the remotest astronomical objects, the extremes of size and distance are almost impossible to comprehend. Impossible, that is, if you don't have a copy of *From Quark to Quasar* on your bookshelf.

Contrary to what the title might suggest, it is not a technical book on physics or astrophysics. It is a remarkable volume filled with facts and information that anyone would find useful. Profusely illustrated with high-quality photographs, most of them in colour, it takes the reader on a pictorial journey spanning some 62 orders or magnitude (10^{-35}m-10^{26}m) to provide a unique look at the scale of the Universe. Some of the photographs are truly breathtaking.

The basic scheme of the book is to take the reader from a familiar to the unfamiliar world through two well laid-out tours. The first tour begins with the "human range"—a scale of 1m—taking the reader through the terrestrial, planetary and stellar worlds to the "galactic range" of quasars at the edge of the Universe where distances are measured in terms of 10^{26}m! The second tour takes the reader into the very heart of matter. It begins at a scale of 10 cm (10^{-1}m) with the familiar "biological range" comprising birds and bees, going further down in the scale into the invisible world of molecules and atoms. The journey ends at the subatomic range 10^{-35}m, in the world of pre-quarks and quarks.

The text accompanying the photographs not only provides explanatory notes on the pictures but contains a wealth of useful information on a variety of topics, ranging from particle physics, molecular structure and living cells to architecture, civil engineering and astronomy. The introductory chapter describes the techniques scientists use to measure distances—both extremely small and extremely large.

Printed in a large format (26 cm x 25 cm) and sturdily bound, *From Quark to Quasar* is a book readers of all ages would enjoy browsing through. And it is highly informative too.

Biman Basu

□

THE PROBLEMS OF BIOLOGY *by* John Maynard-Smith, *Oxford University Press*, 2/11, Ansari Road, Daryaganj, New Delhi-110002, Pp. 134, £ 4.95

BY reading reputed scientific journals like *Nature* and *Science* of the last one or two years, one can know the trends in scientific research the worldover. It would however not give one the still unsolved problems in various subjects. After all, research trends are also fashions which change from time to time depending upon the interests of scientists. It is therefore difficult for a new comer to research to know problems that though important, are not being tackled. In this context, it is indeed a pleasure to see the series *The Problems of Science* exclusively devoted to the fundamental problems in all major branches of science brought out by a reputed publisher. Each title is written by an authority on the subject who is not only renowned for his research but also has a facile pen to present ideas in a clear and lucid manner.

The book under review is the first title in the above mentioned series. Its author is a Professor of Biology at the University of Sussex, U.K., and a Fellow of the Royal Society, London. As the book is essentially meant to present a picture of the status of biology today, it has some fine points and its own limitations. Taking the second things first, the book is necessarily a picture of the frontiers of biology by a person who has his own bias and research interests. The author has however tried to shed off his bias by giving his own views on subject in the Preface. He claims neutrality while discussing the problems and also the ways in which they should be tackled. About the finer points of the book; it is so simply written that lay reader can understand it, though the subject moves at a faster pace making things difficult to understand for those who are new to the subject. Though the book is not specifically meant for non-biologists, it would certainly benefit those who are interested to apply non-biological techniques or theories to biology because, after all, research is today interdisciplinary.

The book begins with the definition of life as we know it and takes up the subject of molecular biology which is the basis of most, if not all, the frontier subjects that follow, namely, heredity, evolution, development and origin of life. Although on occasions the author has discussed a brief history of a subject depending upon what he is trying to emphasise, most often he goes right into the subject and gives a clear-cut indication of the problems still unsolved. For instance, he has emphatically said that the origin of sex, development of an organism, heredity mechanism in the origin of life, biochemistry of brain and energy production, etc. are the major unsolved problems in biology. At places, the author has clearly shown how scientists become biased in their opinions due to their own researches. For instance, in brain research, there are three theories and —obviously —three groups of scientists are holding on to them. He has asked why there should be any controversy when all three of them could be used to understand different aspects of brain. Another fashion in research, he has claimed, is to attribute anything incomprehensible to the working of genes as if that solves the problem! He thinks scientists should be bold enough to say what they understand and what they do not. At the end he has admitted that ninety per cent of unsolved problems lay in the realm of behaviour and development, where scientists do not even know the kind of questions they have to ask!

Dilip M. Salwi

THE LIMITS OF SCIENCE *by* Peter Medawar, *Oxford University Press,* 2/11 Ansari Road, Daryaganj, New Delhi 110 002, Pp. 108, £ 3.95

IS science omnipotent? Until very recently, most people believed it to be so, and they had reasons to do so. If one looked at the monumental achievements of science during the nineteenth and twentieth centuries one was bound to get a feeling that science was capable of anything. Yet it could not do many things — it couldn't for example, answer questions such as "How did everything begin?" or "What is the point of living?" Did that in any way limit the power of science? Certainly not, as Nobel laureate Sir Peter Medawar succinctly explains in this little book. His central purpose is to exculpate science from the reproach that it is quite unable to answer those ultimate questions that he shows to be beyond its explanatory competence. This charge, he argues, is no more sensible than to reproach a railway locomotive for not flying! But inspite of this he believes science to be a 'great and glorious' enterprise — the most successful that human beings have ever engaged in.

The three essays which comprise the book, though written in three different styles, bear Medawar's inimitable hallmark — they are frank and full of wit. The first essay entitled "An essay on Scians" is written in the aphoristic style adopted by authors like Francis Bacon which, Medawar says, is the style of exposition most considerate of the reader's interests. It is a collection of twenty delightful pieces, each under a separate para heading, covering a wide spectrum and brings out almost every facet of science as it is practised. The subjects covered include unintelligibility in science, science and culture, science and politics, women in science, fraud in science, guesswork in science, and of course favorite 'The Art of Soluble'.

In the second essay Medawar explodes the myth that scientific discoveries can be premeditated. Citing three case histories, including that of Roentgen's discovery of the X-rays, he argues that they could never have been possible by the present system of research management and funding. Scientific discovery, he says, is as much a consequence of a conscious preparedness as the creative ability of the human mind.

The third and final essay, which bears the title of the book, is the longest and is written in the format of a short book. The tone is more philosophical than the other two essays. It is in this essay that Medawar attempts to explain why science cannot answer questions like "How did everything begin?" It is not to science, he argues, but to metaphysics, imaginative literature or religion that we must turn our attention for answers to such questions. At the same time, he provides ample reasons to support his view that there is no limit upon the power of science to answer questions of the kind science *can* answer. This, he says, is science's greatest glory, for it entails that everything which is possible in principle can be done if the intention to do it is sufficiently resolute and long sustained.

Like his previous best-seller *The Art of the Soluble* (1968) Medawar's latest book provides a deep insight into the way a scientific mind works. It should be read not only by every student of science but also by the non-scientist public who generally fail to grasp the real nature of scientific enterprise.

Biman Basu

ORGANOMETALLIC COMPOUNDS OF BORON edited *by* K. Smith, Chapman and Hall, London (1985), (Available with: *B.I. Publications,* 54 Janpath, New Delhi-110 001), Pp. 304, £ 22.50

DURING recent years, there has been tremendous development in the chemistry of organometallic compounds. Initially, chemists were attracted to this class of compounds due to their novel bonding pattern. Later, researches increased many fold when many of these compounds proved potentially useful in industrial applications. To cover literature on these compounds, several books, treatise, monograph series, etc., have been written on one or other aspect of their chemistry. However most of such publications usually deal with organometallics of metals in general. Recently, Chapman and Hall have initiated a programme to publish a series of source books on the chemistry of organometallic compounds of individual metal/metals. The book under review is one of such source books. In a dictionary format, the book provides a handy reference to over 1300 of most important and useful organoboron compounds synthesised upto mid -1983. The compounds have been arranged according to their molecular formulae following the Hill convention (i.e., in the increasing order of carbon atom followed by hydrogen and then other elements). Every entry has been assigned a number. For each compound molecular formula, structure diagram, preferred name along with other names, physicochemical characteristics, important uses, available toxicity data, and CAS registry number are given. In addition, each compound is provided with selected bibliographic references. The book is provided with four indices, namely, name, formula, CAS registry and structure index. All these indices refer to the entry number assigned to individual compounds.

The book is a welcome addition to the existing literature on organometallic compounds. The literature survey is exhaustive and uptodate. The selection of references pertaining to individual compounds has been made in such a way that it facilitates any one who requires detailed information about a particular compound. The structure index is another attractive feature of the book which would help the researchers working on organometallic compounds. By this index one can have a close look at the structure of all the compounds included in the book. It would have been better if this useful publication would have been hard bound instead of paper-back. In a true sense, the book can serve as a guide book for researchers working in the field of organometallics.

K.K. Kakkar

FISHERY ECONOMICS AND MANAGEMENT IN INDIA *by* P.S. Rao, *Pioneer Publishers and Distributors*, D/9, Vanishree, Opposite Diamond Talkies, L.T. Road, Borivili (West), Bombay 400 092), 1983, Pp. 356, Rs. 225.00

HARDLY 1/10th of the total terrestrial surface is under man's control and is being utilized for purposes such as agriculture, industry, housing etc. Increasing population has also compelled man to "grab" even agricultural land for urban development. This has resulted in food shortage. It is believed that in course of time land sources will not be sufficient to support the increasing population, and even if man succeeds in improving farm technology for maximum exploitation of land resources, it will not be possible to produce and provide nutritious and balanced diet for everyone. Countries like India, where malnutrition is alarming, fisheries can come to help, especially when prices of land-based food are increasing by leaps and bounds. Moreover, vast marine and inland resources in the country remain unexploited. Keeping above information in view, the author has done a commendable job in bringing for the first time at one place scattered information on various economic aspects of marine fishing industry. The information presented will not only help planners but also students who are preparing for examination. It would be of use to bankers, too, who have to assess various types of fishery projects.

The book has been divided in four (I-IV) parts and 14 chapters. The first four chapters of Part I (Introduction to Fisheries Economics) highlight superiority of fisheries over inland agricultural resources, primitive and modern methods of fishing, fishery resources, production, inland as well as marine, and important commercial fishes of India. Though all the four chapters are interesting, four of the six tables on various economic aspects, such as cost and return for composite fish culture, economics of induced breeding of carp spawn, mix culture, etc., (Chapter 3; appendix, pp. 105-115) are based on the prices of mid-seventies. However, appendix to Chapter 4, which deals with local names in various languages and general characteristics of commercially important fishes, is a valuable guide for readers. Chapters 5 and 6 on common properly resources versus profitability and costs and earnings of fishing boats in India provide a detailed information of profitability in fishing industry. Fish marketing and management is the central theme of the next four chapters of part III. The author has explained at length the term marketing, which according to him, denote not only simply buying and selling but also creating a demand in the market. Other chapters of this part deal with prices and price determination of fish, fishery inputs for production and marketing and trends in fish utilization and demand pattern for fish. Last part of the book is devoted to various social and legal aspects of fisheries, including socio-economic conditions of Indian fisherman. A list of training institutes/centres offering special courses in fisheries in India serves the purpose of a guide to interested students and researchers. Keeping in view the scanty information available, the book also discusses subjects such as the role of fishery cooperatives and law of sea.

Information presented in this book will be of immense use to those it is meant for. However, it is not within the reach of students due to its high price. Further, the author should update data in subsequent edition of the book. The book should find a place on the bookshelf of every library dealing with fishery courses.

Rajiv Mathur

ASPECTS OF HUMAN ECOLOGY — A dynamic inter-relationship between man and environment *by* S.L. Malik and D.K. Bhattacharya, Northern Book Centre, 4221/1 Ansari Road, New Delhi-110 002, 1986, Pp.112, Rs. 100

ECOLOGY is an inter-disciplinary or multidisciplinary field of science which systematically draws knowledge from many related or seemingly unrelated fields such as genetics, evolution, sociobiology and anthropology. The book under review covers human ecology, a science of dynamic relationship between man and environment. This branch of science has aroused interest among scientists, planners, administrators and above all among the public due to the effects of technology on human society. The book is divided into three sections. Section I deals with human variations from the viewpoint of enviromental adaptation, human evolution, methods used in studying the various problems of human ecology, density dependent and density independent factors affecting population growth, and alterations made in the biological make-up of man to cope with environmental stress. To avert the ill effects of industrial development the author stresses the need to pay more attention to the study of anthropology, human ecology, preventive medicine and their applications to economics and public policy.

Section II deals with the cultural aspects of human ecology. Man is the only animal who in most circumstances uses culture as means of coping with his environment. Cultural ecology tries to explain how technological systems are adapted to environmental conditions. Cultural ecology therefore helps to moderate harsh enviroment through the mechanism of culture. The author has also tried to explain how cultural ecology affected early agriculture, population size and growth, rise and fall of civilizations. Section III combines both biological and cultural adaptive strategies which are exceedingly important in solving problems of population explosion, spread of infectious diseases and depletion of non-renewable energy sources. The author has tried to identify the areas which need immediate attention and has proposed some solutions.

This thought-provoking book will be of interest to not only human ecologists, administrators and planners but the general public as well. Glossary at the end of the book enhances the value of the publication.

Raj D. Kak

PLANT CELL STRUCTURE AND METABOLISM *by* J.L. Hall, T.J. Flowers and R.M. Roberts, 2nd Edition, *Longman Group Ltd.*, (Available with: B.I. Publications, Promotion Department, 61-63, Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp. 543, £ 4.50

RECENT advances in molecular biology have clearly established the fact that the cell is no more simply a temporal or structural continuum but distingushes itself by exhibiting remarkable functional complexity. With growing sophistication in laboratory techniques, a great deal has been learnt on the relationship between structure and function in plant cells and of the biochemical properties of various organelles. The purpose of the book under review is to present in narrative form current ideas about how various cell organelles function vis-a-vis complex metabolic pathways rather than discussing the subject in the traditional format under broad headings of lipids, carbohydrates, proteins, etc.

The first two chapters are introductory in nature with basic information on plant cell types, microscopic techniques and cell molecules. The subsequent chapters deal with cellular organelles and soluble phase of the cell and are arranged in such a way that related topics are grouped together. As a result, ribosomes and protein synthesis; mitochondrion and respiratory chain; chloroplast and photophosphorylation, and so on go hand in hand. The last chapter on protoplasts, their isolation, culture and importance in physiological studies and somatic hybridization is a welcome addition, in view of their immense potential in modern genetic engineering. The sequence of topics in the book is based on the fundamental concepts of organization of biomolecules and their operation with special reference to interdependence. As a result, unavoidably, the text contains numerous cross references to other chapters.

The book is profusely illustrated with explicit line drawings and electron micrographs of excellent quality. Adequate citation of literature, a list of books and reviews for further reading and an exhaustive subject index make the book eminently readable.

P.K. Panda

OCTAGON *by* Saberhagen, *Penguin Books* (Available with: *Penguin Overseas Ltd.*, 706, Eros Apts., 56 Nehru Place, New Delhi-110 019), Pp. 272, £ 2.50

"To split the mighty atom,
All Mankind was intent.
Now anyday the atom
May return the compliment".

THESE words of Otto Hahn apply equally well to computers and are the essence of the science fiction under review. OCTAGON is the key character of a computer game. Starweb, run by Berserkers Inc. Albuquerque. The players have to pay fees and take part in the mail-order Starweb adventure which involves fighting imaginary battles on the "killing ground" of a computer's memory banks. Or so the players thought till suddenly they were killed one after another in mysterious circumstances.

Robert Gregory and Henry Bramhaguptra (sic) old friends and computer scientists, had evolved a secret code, each retaining one half of it. The code, when fed into the system, would probably collapse or overpower the entire interconnected central system of computers causing a sudden nationwide data-processing failure. The two scientists had parted ways some twenty years ago, each with his half of the code, holding in their hands the reins of an all-encompassing control. Now they are both in the same Starweb game. Could this have any bearing on the bloody way the game is progressing? All declared enemies of OCTAGON are being picked and killed by self-operating machines. The game is changing into a devastating race between the all powerful computer and Man.

The story highlights the mixed bag that mechanization/computer offers to humanity. On the one hand, it generates hopes for the handicapped. There is a character in the fiction with paralysed arms and legs, who, when suitably fitted with remote control equipment, is able to live a fairly active, independent life. On the other hand, it shows how vulnerable our progressive dependence on computers can make us.

It is a thrilling book which keeps the reader absorbed with spurts of good humour.

Santosh Mehtani

Books Received

1. INSTRUCTOR'S MANUAL TO ACCOMPANY FUNDAMENTALS OF PROGRAMMING IN BASIC: A STRUCTURED APPROACH *by* Robert C. Nickerson (Available with: B.I. Publications Pvt. Ltd, Promotion Department, 61-63 Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp. 241, Price not mentioned

2. FUNDAMENTALS OF PROGRAMMING IN BASIC: A STRUCTURED APPROACH *by* Robert C. Nickerson (Available with: B.I. Publications Pvt. Ltd, Promotion Department, 61-63 Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001) Pp. 452, $ 21.95.

3. WORKBOOK TO ACCOMPANY FUNDAMENTALS OF PROGRAMMING IN BASIC: A STRUCTURED APPROACH *by* Robert C. Nickerson (Available with : B.I. Publications Pvt. Ltd, Promotion Department, 61-63 Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp. 255 $ 9.95

4. INTRODUCTORY NUTRITION *by* A. Guthrie (Available with: B.I. Publications Pvt. Ltd, Promotion Department, 61-63 Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp. 653, $ 30.95

5. SOLUTIONS MANUAL TO ACCOMPANY GENETICS *by* Peter. J. Russell (Available with: B.I. Publications Pvt. Ltd., Promotion Department, 61-63 Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road Bombay-400 001) Pp. 135, $ 5.95.

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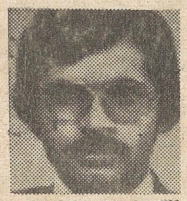

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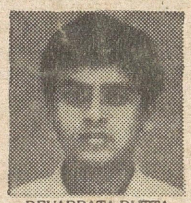

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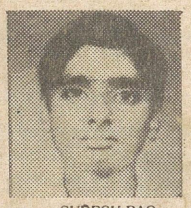

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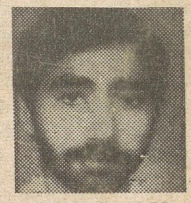

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