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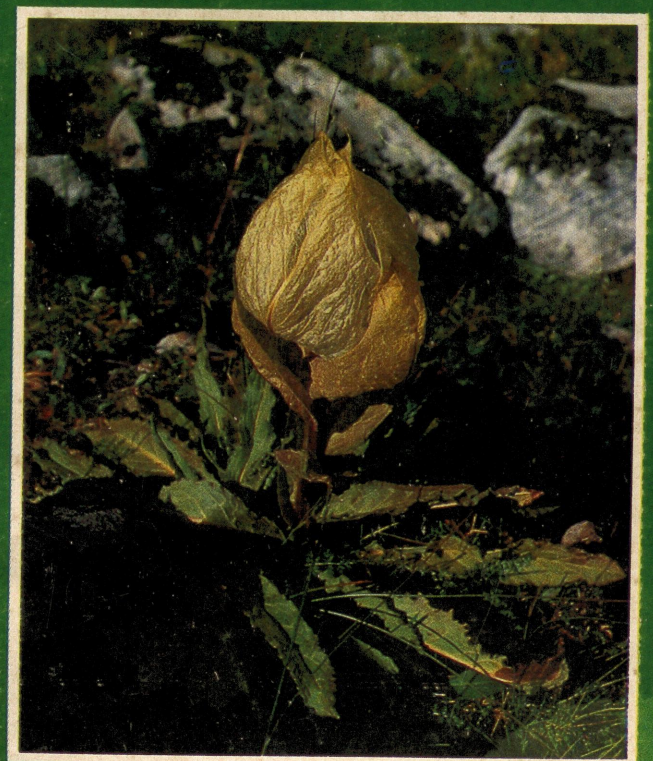
SCIENCE REPORTER

VANISHING PLANTS



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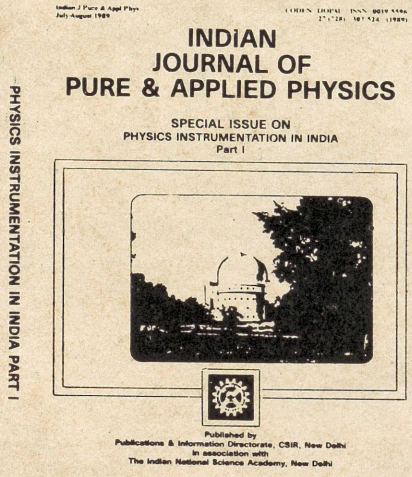

Physics Instrumentation in India : Parts I & II

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

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High Pressure Physics
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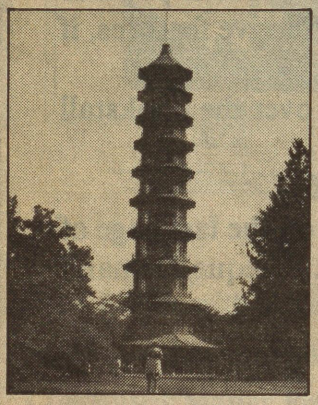

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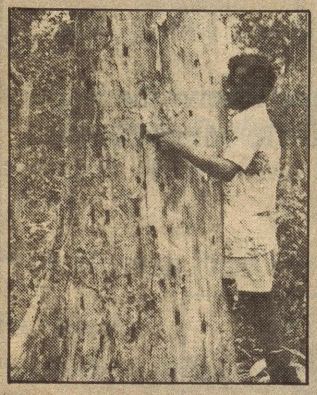

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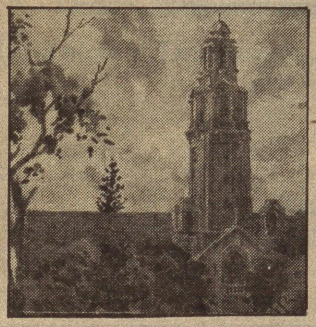

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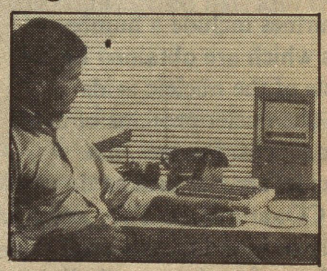

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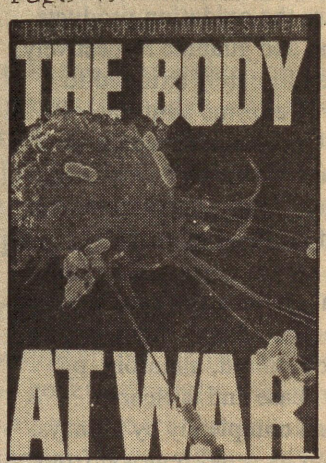

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REACTIONS

Gout vs. Uric acid

Sir, I must thank K.G. Prasanna for his informative and educative article *What is Gout* (**S.R.** July-August 1989). The article is written in a lucid and easy language. In the article author has presented the matter from different point of views but he has not paid much attention to the formation of uric acid from nucleoprotein , conversion of uric acid to allantoin by enzyme uricase and the possible advantage of high level of uric acid in blood.

The purines include a number of products which are obtained by the hydrolysis of the nucleic acids found in the nucleoproteins of plant and animal cells. Purines, like amino acids, are not broken down to NH_3, CO_2 and H_2O. They are ultimately oxidised to uric acid, the end product of purines catabolism. The important purines are adenine (6-Aminopurine) and Guanine (2-Amino-6-hydroxy purine). Adanine, widely distributed in both plant and animal kingdoms, is usually obtained from the pancreas of cattle. Guanine is present in the scales and skin of fish.

Hypoxanthine (6-Hydroxy purine) and Xanthine (2-6 Dihydroxy purine) are the oxidation products of adenine and guanine respectively, which are ultimately oxidised to uric acid by enzyme xanthine oxidase. Under normal conditions the amount of uric acid in human body is very small, only traces of it are found in blood and small amounts are excreted in the urine. In normal and healthy people, uric acid is converted into slightly more soluble compound, allantoin, by enzyme uricase and is cleared rapidly and completely by kidneys, resulting in its rapid removal from the blood. People that have lost this enzyme over the years cannot convert uric acid to allantoin and thus uric acid must be carried to the kidneys by the blood. After attaining the saturation level in blood, the pointed, needle-shaped crystals of uric acid are deposited in the joints of fingers and big toes. This deposition causes considerable pain when joints move, a painful condition called gout. This painful and sometimes debilitating disease is probably due to an "inborn error of metabolism".

Recent research on a group of young adult males suggests that those with high levels of uric acid in their blood have greater drive and ambition than their friends with normal level.

P.C. Sinha
Reader
Chemistry Department
Bihar National College
Patna University, Patna

More on Astronomy

Sir, I must thank R.M. Sathe for his informative and educative article **Entropy, Disorders and unhappiness** (*S.R.*, September, 1989). Articles of this type are highly useful to the college students. They inspire students and other readers to know more with interest. Sathe has explained the term 'entropy' in a simple and lucid manner.

I request you to publish more such articles and also on astronomy.

Ranajit Kabiraj
Vill + PO Japamali
Dt. Bankura
W. Bengal-722143-

Full Articles on Immunology

Sir, Thanks to Arun Kumar Tewari for his valuable and informative **Quiz on Immunology** (*S.R.*, November, 1989). Indeed this branch of life sciences is much neglected in the graduate syllabus. More information is expected from the author on immunology in the form of articles for the benefit of students.

Adinpunya Mitra
M.Sc. 1st Year
Department of Botany
The University of Burdwan
Burdwan-713104

Kudos

Sir, The article entitled **Entropy, Disorder and Unhappiness** by R.M. Sathe (*S.R.*, November, 1989) was simply excellent. It was a great pleasure to go through the article with its very elegant and apt analogies. The whole treatment is just superb to make the concept crystal clear.

Both the author and the editors have thus been placed in a position where they can but accept the heartfelt and sincere congratulations, I am sure, not only from me but from most other readers as well.

S.V. Datar
A-40, Observatory quarters
Shivaji Nagar
Pune

Freezing of Water

Sir, Refer to the interesting article by Bal Phondke on **Hydrogen** (*S.R.*, October, 1989). Unfortunately, it contains a slight mis-statement on page 437, middle column, last lines. At 4^0C water reaches its anomalous state of highest density (not expansion). Below 0^0C, when water is frozen, it acquires a larger volume and this is the reason for pipes bursting in colder climates.

Dagmar Sarkar
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Cover: *Balanophora* (top); **Lady's slipper** *(Paphiopedilum villosum)* (middle); **Brahmakamal** *(Saussurea)* (bottom). **Transparencies courtesy: Dr. Virendra Kumar** *(top)*, **Dr. S.K. Jain** *(middle and bottom)*

Design **by K. B. Dhingra**

Diversity holds the key

ONE of the greatest evils of modern civilization is its profligate use of natural resources without concern for environment. Trees and shrubs have provided for man food, fuel and material for clothing and shelter for ages. Forests have also been the source of many life-saving drugs in the form of herbs and medicinal plants. But their usefulness has also led to their overexploitation, to such an extant that many a valuable species is now found only in botanical gardens.

Besides overexploitation, clearing of natural forests for agriculture and other development projects have also led to destruction of habitat and extinction of several valuable plant species. Many others are now on the endangered list, and the list grows by the day.

Surprising it is not that wild fauna has received far greater attention of conservationists than wild flora has. The mute plants have no voice, they cannot scream; nor can they shed tears. And it's the crying child that gets the milk. World bodies like the World Wildlife Fund have been concerned only with conservation of wild birds and animals. Only recently has wild flora been brought under the ambit of WWF, which has now been renamed as World Wide Fund for Nature.

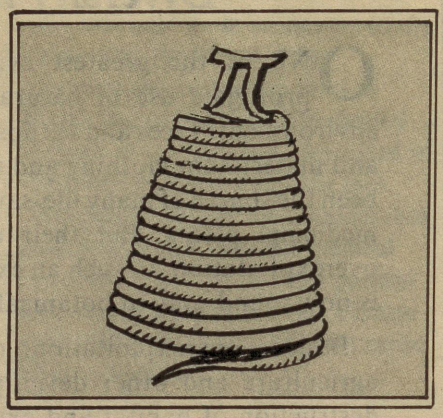
Nearer home, there is now greater public awareness about conserving the wild flora than ever before; thanks to strong movements like the 'Chipko' and 'Save Silent Valley'. The Greens that are acquiring an ever increasing political clout, especially in the West from which direction winds of new thought has been blowing in the recent history of mankind have also lent their might. Experts have been crying hoarse that establishment of National Parks, Biosphere Reserves and Sanctuaries are steps in the right direction.

Lest, however, that one should take too shortsighted or narrow a view, there are more significant points to ponder. For instance, mere replantation of cleared natural forest areas with a single species can never bring back the lost glory. It cannot regenerate the original diverse biota that a natural forest harbours. Evidence is already on hand in the overemphasis on hybrid crop varieties by our farmers that has led to the disappearence of several indigenous and valuable crop varieties.

What is at stake is not just disappearance of forest trees or useful plants but the biological and genetic diversity that is being lost almost irretrievably. Conservation in the true sense should be conservation of the splendorous spectrum of our flora and fauna that makes this earth worth living.

Yet Another Pi Record

WHAT is the exact value of π (Pi)? To simplify calculations, it is often taken as 22/7 or 3.14159. But this is an approximate value. Pi is an irrational number. Recently, David and Gregory Chudnovsky of the Columbia University have calculated the value of π upto 480 million digits. They have broken the earlier record of Yasumasa Kanada of the University of Tokya who had computed the value upto 201 million digits.



The Chudnovskys carried out their calculations on a CRAY-2 at the Minnesota Supercomputer Center in Minneapolis and on an IBM 3090-VF at the IBM Yorktown Heights Research Center in New York. Their calculation is based on a new formula inspired by one discovered earlier by Srinivasa Ramanujan. The formula relates pi to an infinite sum of rational numbers.

Continents in a Hydrocarbon Sea?

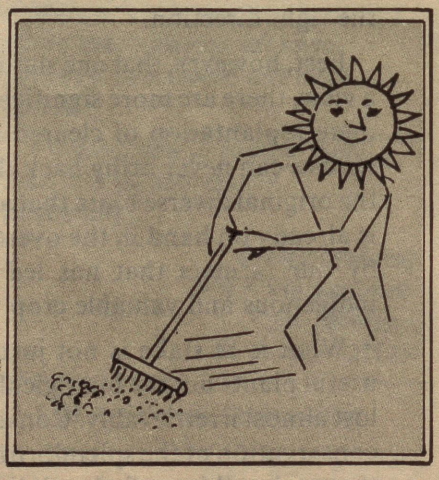
Continents of ice, rock and solid carbon dioxide amidst hydrocarbon sea have been found on Titan, Saturn's giant satellite. This observation has emerged from the study of the radio "echoes" received from that satellite, about 1.25 billion kilometers away from earth.

About 50 per cent larger than the Moon, Titan had remained under a shroud of mystery till now in so far as its surface features are concerned. Even the Voyager spacecraft which visited Saturn in 1980-81 showed this satellite to be nothing more than a smooth orange haze of hydrocarbon. The latest picture of the continents emerged when radio energy, seven times the power allowed to commercial radio stations, was beamed at the satellite using a 3.5 centimeter wavelength antenna. As the satellite rotates about 23 degrees each day, it become possible to "observe" its different faces. Plans are afoot to conduct further studies of the satellite using more powerful radio beams. On the basis of these studies, an appropriate radar system will be installed aboard the forthcoming Cassini mission to Saturn in the late 90s.

Cleaning Pollution Using Sun

Yes, instead of using solar energy to generate electricity for driving a pollution-cleaning plant, a new plant has been invented to clean up pollution directly using solar energy. It is invented by Graig Tyner and his team at Sandia National Laboratories, U.S.A. It is called sun-powered detoxification system.

The sun-powered detoxification system destroys most organic materials such as industrial solvents, pesticides, dioxins, PCBs, etc., by breaking them down into smaller, safer molecules. Grains of titanium dioxide are mixed with waste water and allowed to run through a long glass tube which is at the focus of a long parabolic trough. Ultraviolet rays coming from the sun initiate some chemical reactions which attack organic wastes and break them down into water, carbon dioxide and some very dilute acids which can easily be neutralised.

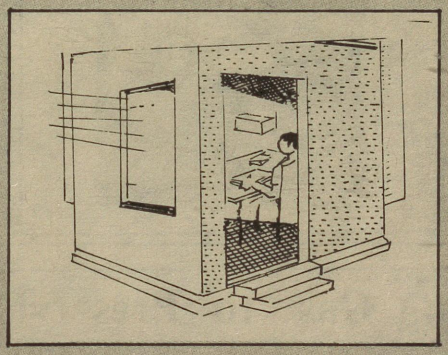


At present, the system cleans about 30 gallons of water per minute and is soon likely to be scaled up by a factor of two or three. It is expected to be able to reduce the concentration of organic pollutants to such an extent that water will be clean enough for drinking or discharge into lakes or rivers.

Hasan Jawaid Khan

Sunlight Enters Rooms

SOLAR-BEAM lighting developed at the University of New South Wales in Australia now brings sunlight into rooms. The new product is a linear prismatic lens which refracts and internally reflects sunlight 12 metres into a room. The device resolves the long-standing problem of developing a product that

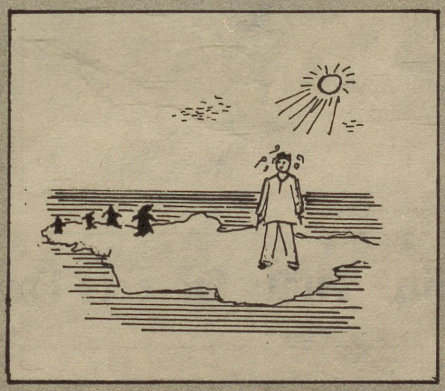


lets light in, keeps glare out, relates to the movement of the sun, and can be integrated with a controlled electric light system.

The product will result in substantial savings and because of the sunlight's superior luminosity—five times as much as a fluorescent light—the system will markedly enhance visibility in a room.

When Antarctica Was Warm

COVERED with ice sheets all over and with sunlight being a rare commodity, Antarctica is a penguin's delight. But it was not so long ago, perhaps a few million years ago. Scientists from Australia and New Zealand have unearthed rich deposits of fossils in Antarctica which indicate that it was once warmer. The fossils include the remains of dolphins that scientists would not normally expect to find so far south unless

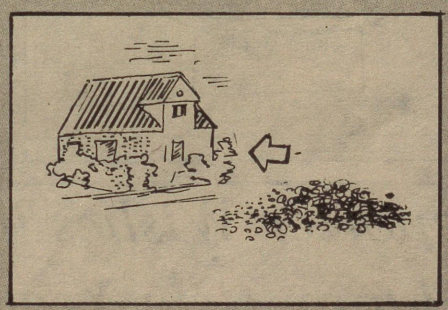


the waters were significantly warmer than what they are today.

Further, an analysis of isotopes of oxygen from marine molluscs found in sediments at the site indicates that water in the area was about 10 C warmer about four million years ago. The ice sheet was probably 50 km further inland and sea level was about 75 metres higher than what it is at present.

Build a House From Garbage

A Queensland company has developed a process which turns household garbage into light-weight aggregate suitable for use as a building material. It involves a four-stage firing process which converts fuel pellets of solid waste and clay into a vitrified, light-weight aggregate. This aggregate, which becomes a

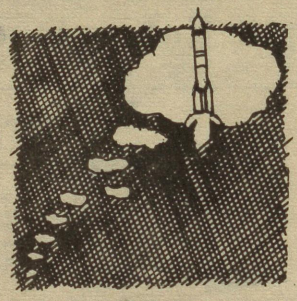


ceramic rock, is then graded for use by the building industry.

The fuel pellets provide a more homogeneous energy source to the kiln. The products of gasification are therefore burnt under more effectively controlled conditions. Gas emissions are also more efficiently treated before their discharge into the environment.

Four Months in a Cave

WHEN Stephania Follini finally emerged from isolation after spending four months in a cave in New Mexico, she believed she had spent two months—not four months—underground. But why at all did Follini an Italian interior designer, spend so much time in a cave? Redesigning the cave was not a part of her job certainly! In fact, she was part of a scientific study to find out how she responded to isolation, which is prevalent during space travel. Her waking days lasted 35 hours and were punctuated by sleeping periods of about 10 hours. She lost 17 pounds and her menstrual cycle stopped.



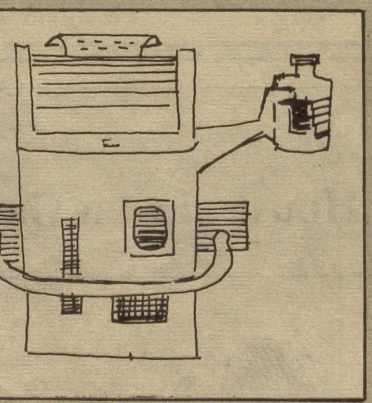
Laughing Gas to Preserve Seeds

WHETHER laughing gas (nitrous oxide) makes you laugh or not, but Sharon Sowa, an Agricultural Research Service chemist in Washington, USA, has found it to show promise in preserving seeds. The gas can be used to keep seeds viable to breed agricultural plants for drought-tolerance, disease-resistance and other traits.

Using nitrous oxide Sowa slowed respiration in the cells of snap beans by 35 per cent which was enough to enaesthetize the seeds. Air containing 80 percent nitrous oxide was blown over them and thirty minutes later the seeds were revived. Once brought into fresh air, the seeds recovered quickly and germinated normally.

Machine That Detects Drugs

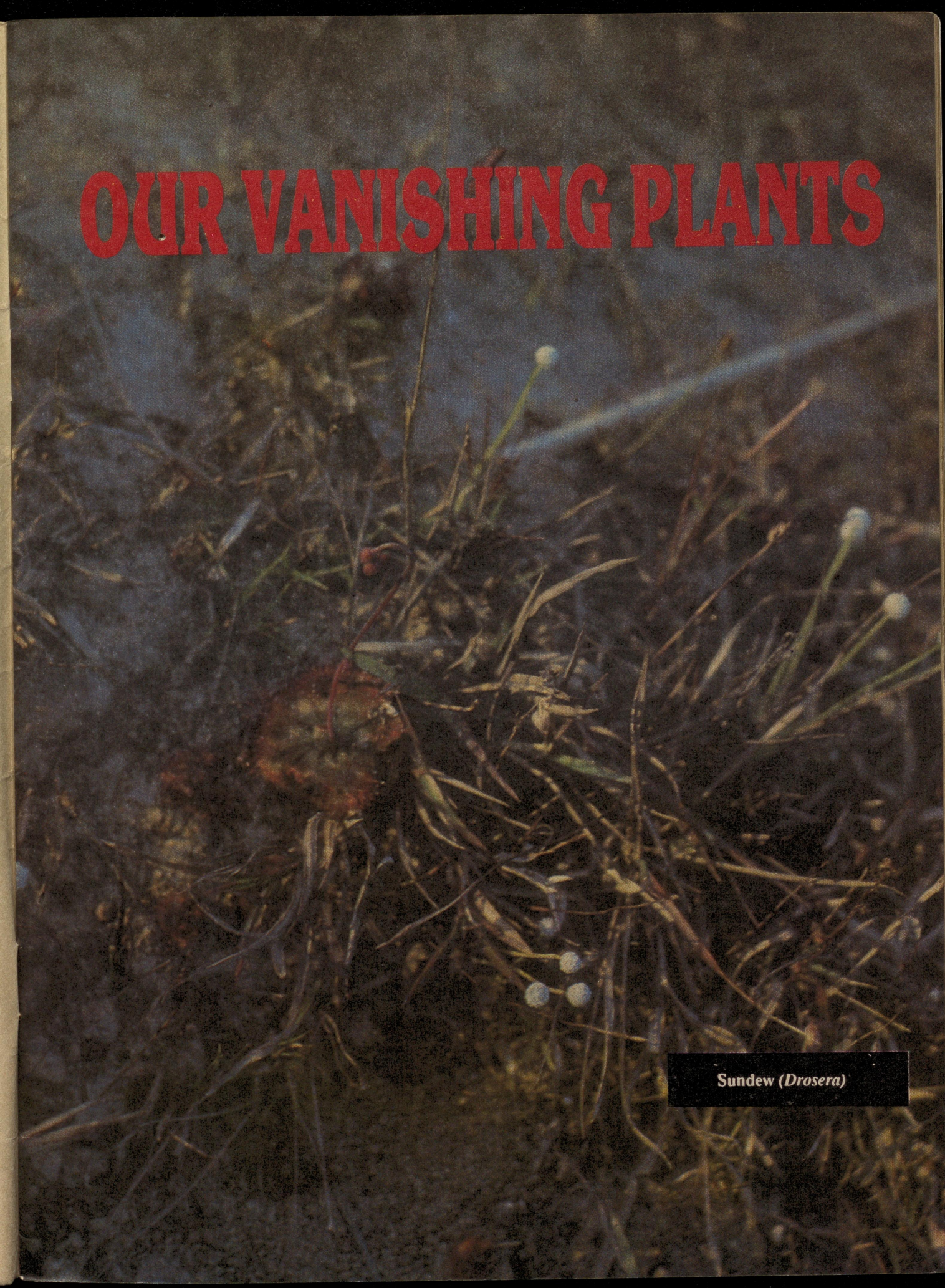
A drop of urine, fifteen minutes to half an hour's wait, and you get the result: hashish, cocaine, barbiturates, alcohol, amphetaminie. Negative or positive verdict. ADX, the automatic, simple, reliable and fast drug- and toxin-detection apparatus has entered the arena to fight drug-addiction. Marketed by a French pharmaceutical concern, it is not only a necessary weapon in the anti-drug crusade but also useful in emergency cases for clearing up certain accidental or suicidal comas, or for therapeutic observation.



For safety reasons, the practice of drug-testing has already been introduced in certain professional fields (for pilots and drivers). The ADX apparatus is effective. But for the present its range does not include anabolic steroids and so its application cannot be stretched to doping tests in sports.

Science Reporter Wishes its Readers a Happy New Year

OUR VANISHING PLANTS



Sundew (*Drosera*)

S.K. JAIN

Sarpagandha *(Rauwolfia serpentina)*

Nepenthes Khasiana, a very rare and endangered pitcher plant, is just near the main state highway in Meghalaya, whereas *Coptis teeta* occurs in rather remote hilly regions of northeast India. *Peucedanum dehradunensis* has so far been found growing only inside the compound of a bungalow in Dehra Dun.

Over-exploitation is one of the main causes of disappearance of not only economic species but also biological curiosities like the insectivorous and primitive species and other taxa needed for teaching or laboratory work (like *Gnetum, Psilotum,* etc.)

In the over-exploited category, usually, are the plants of medicinal reputation like species of *Podophyllum, Coptis, Aconitum,* etc., and horticultural plants like orchids and rhododendrons. With regard to over-exploitation of medicinal plants, species which are used as root drugs are particularly threatened. Over-exploitation of roots of even some very widely growing species can result in rarity (e.g., *Coptis, Rauwolfia*).

Absence of collections at regular intervals in herbaria and museums, long gaps in collections, or sometimes decline in populations and failure to locate any particular species under research are a few signals of rarity. A composite analysis of literature records, as in the Floras, and of herbarium or museum materials, together with a study of the species in gardens and in the wild, also gives useful clues to the status of the species.

A species is called extinct if all of its members and generations are dead and vanished for ever. Caution is necessary before using the term 'vanished'. One must be sure that all the possible habitats in the world have been explored and all the botanical gardens been reasonably checked for their occurrence before a species is declared as extinct. *Dichanthium planipedicellatum* was discovered in Manipur. It was therefore searched for in that type of locality but could not be found, and it is probably extinct. However, other localities also need to be searched.

S.K. JAIN

Lady's slipper *(Paphiopedilum hirsutissumum)*

S.K. JAIN

Lady's slipper *(Paphiopedilum insigne)*

Several such instances can be quoted from India.

While some governmental and semi-governmental institutions are trying to take steps for conservation of threatened species of flora and fauna by establishing new National Parks, Sanctuaries, and Biosphere Reserves, some strong public movements like 'Chipko' and the 'Save Silent Valley Society' organised by some committed individuals and institutions have created general awareness for conservation activities in India. Conservation of wildlife had been a part of Indian culture and tradition and classical literature is replete with references to 'Ashrams' and forest reserves where all kinds of life was protected. This tradition has survived in some measure in form of 'Sacred Forests' or 'Sacred Groves' in India, mainly due to religious faith and belief that any damage to the ecosystem may bring wrath of supernatural powers.

The methods of conservation of endangered species and genetic resources include: (a) Control on over-exploitation; (b) establishment of National Parks and biosphere or nature reserves in areas of special national importance; (c) establishment of gene sanctuaries for selected species in their natural habitat; (d) cultivation of rare species in more areas in forests and botanical gardens; (e) collection and preservation of germplasm material in the form of seed, pollen, tissue, etc; and (f) legislation for conservation.

VIRENDRA KUMAR

Lady's slipper *(Paphiopedilum fairieanum)*

For controlling over-exploitation, one approach is to impose controls on trade in threatened species. India is a signatory to the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES). Some restrictions on collection of plants and their products from wild populations and their export have been in force in India even before the ratification of the Convention.

VIRENDRA KUMAR

Pitcher Plant *(Nepenthes khasiana)* **from Jaintia Hills**

National Parks and Gene Sanctuaries

Sanctuaries are protected places, and genes are the unique segments of chromosomes which constitute the specific genetic make-up of an organism. Gene sanctuary, therefore, is a protected place where plants of specific genetic material and characters grow.

Sanctuaries for an individual species or groups of threatened species, whenever it is possible to establish them, are the best means of conservation. It has been possible to establish gene sanctuaries for *Nepenthes* (pitcher plant or insectivorous plants) in the Khasi Hills in Meghalaya and for rhododendrons and primulas in Sikkim. A sanctuary for *Citrus* is also being established in Meghalaya.

India now has 44 National Parks and 207 sanctuaries together covering some 88,000 sq. km. These constitute about 11.7 percent of the total forest area of India.

The Government has also taken up plans to set up 13 biosphere reserves (natural areas totally free from any damage) at following places: (1) Nilgiri (Tamilnadu, Kerala, Karnataka),

What Are The Threats or Causes of Threats to Species?

Natural Threats

(a) Floods, droughts, earthquakes;

(b) Critically low populations, like less than 100 individual plants;

(c) Diseases;

(d) Inadequacy of existing regulative mechanisms;

(e) Lack of pollinators;

(f) Invasion by exotics or other aggressive species;

(g) Air and water pollution (can also be manmade).

Manmade Threats

(a) Destruction or modification of habitats;

(b) Over-exploitation for commercial, scientific and educational purposes; (material for research, museums);

(c) Overgrazing by domesticated animals;

(d) Regeneration of scrub (and lack of grazing);

(e) Change in arable farming;

(f) Ploughing of old grasslands;

(g) Forestry;

(h) Traditional rural practices;

(i) Industrialization, urbanization, building townships, roads, dams;

(j) Tourism and tourist development—coastal and inland;

(k) Mining and quarrying;

(l) Pressure from introduced plants.

(2) Namdapha (Arunachal Pradesh), (3) Nanda Devi (Uttar Pradesh), (4) Valley of flowers (Uttar Pradesh), (5) Great Nicobar, (6) Gulf of Mannar (Tamilnadu), (7) Kaziranga (Assam), (8) Manas (Assam), (9) Sunderbans (West Bengal), (10) Thar Desert (Rajasthan), (11) Kanha (Madhya Pradesh), (12) Nokrek, Tura (Meghalaya), and (13) Rann of Kutch (Gujrat). Five of these Nilgiri, Nanda Devi, Great Nicobar, Sunderbans, and Nokrek biosphere reserves. — Rave already been set up.

Several international agencies are concerned with the work of conservation of endangered species. The Food and Agricultural Organisation (FAO) is promoting long, medium and short range preservation of germplasm of crop plants, but out of an estimated 25,000 species of plants believed to be rare or endangered, the FAO concerns itself with less than a hundred. The World Health Organisation has shown concern for conservation of medicinal plants used in traditional medicines, several of which are rare. The World Bank (WB) is realizing that compared with heavy industry, the study and sustained utilization of natural resources like plants and animals is a better long range investment, particularly in the developing world. The WB supports multiplication and sale of horticultural or ornamental plants in the vicinity of national parks to reduce pressure on wild populations.

The International Union for Conservation of Nature and Natural Resources (IUCN) is the main body concerned with endangered species; it prepared a World Conservation Strategy in 1980. IUCN's Survival Service Commission (SSC) set up the Threatened Plant Committee (TPC)

Plants Of Ornamental Value

THE main plants under this category are the orchids, of which a large number are on the verge of extinction. Orchids are among the world's most showy flowers and hence their cultivation has been taken up now. Culture from seeds has immense potentiality.

Paphiopedilum fairieyanum (Lindl.) Pfitz. (orchidaceae) or 'Lady's Slipper Orchid' is a ground orchid which occurs in Bhutan and Arunachal Pradesh. It is so rare that it was once labelled as 'the long lost orchid'.

Cymbidium aloiflium Sw. (Orchidaceae): The plant not only has attractive flowers but is reported to be medicinally useful and hence in great demand.

Aerides crispum Lindl. (Orchidaceae) is an orchid with showy flowers; grows in certain regions of peninsular India.

Rhododendron edgeworythii Hk. f. (Ericaceae) is a showy epiphyte, reported to have been collected only on three occasions during the last one hundred years.

Symplocos chengapae Raiz. & Sahni (Symplocaceae) is an ornamental tree with fragrant flowers, confined to Nicobar Islands.

Plants of Medicinal Value

RAUWOLFIA serpentina Benth. ex Kurz (Apocynaceae) or 'Sarpagandha' root is highly valuable in medicine. Although 'reserpine' has been synthesized, the drug from naturally growing plants is still in great demand. The first strong wave of reputation for this plant about 20 years back resulted in ruthless destruction of its natural population, and many areas recorded to be its favourable spots are today devoid of them.

Drosera sp. (Droseraceae): This small insectivorous plant is a botanical curiosity. Of late its use in medicine has also gained reputation. The natural populations are not enough to supply large quantities, and the plant has become rare.

Podophyllum hexandrum Royle (Podophyllaceae), 'Papri', 'banbaigan' occurs in north-western Himalaya. It has been subjected to drastic exploitation.

Saussurea lappa Clarke (AsteraceaeCompositae) or 'Brahmkamal' roots are valuable in medicine. The plant grows in higher altitudes of the Himalaya.

Atropa acuminata Royle ex Lindl. (Solanaceae) or 'Sagangur', 'angurshafa'. This plant is a source of some active principles. It occurs in western Himalaya and is rare. Several species of this genus are also rare.

in 1974 to provide a focus for information on threatned plants and to ensure that appropriate botanical data reached the decision-makers. The Worldwide Fund for Nature (WWF) is also doing commendable work, but mainly for animals.

Future Plants

Those interested in contributing to study of endangered species and their conservation may find the following guidelines useful:

1. To find out which taxa endemic to India occur in their region, state or district, and map their distributions.
2. To find out what is the distribution of those species in the country.
3. To determine whether any of these species are endemic only to their area of work.
4. To decide whether any of these species are of commercial importance and are in trade (large scale or small scale).
5. To collect detailed data on their distribution in the area of work and type of rarity, i.e. (i) few individuals at few spots; (ii) few individuals at many distant places, or (iii) many plants but only in one or a few spots.
6. To accumulate data on their past distribution and trends of shrinkage or depletion of populations or extinction; monitoring the populations.
7. To determine causes of threat, if possible quantification of threat.
8. To collect detailed data on the biology of those species, i.e., reproduction, pollination, fruit-set, diseases (pests and pathogens, etc.). This will lead to a study of biological causes of rarity, i.e., genetic erosion and non-adaptability to habitat, species competition, etc.
9. To suggest measures for conservation.
10. To inform on the species concerning its sustained utilization.
11. To collect detailed data for its inclusion in national or international Red Data Book, and Appendices of CITES.
12. To carry out conservation of its germ-plasm in some 'Rescue Centres'. Some species may not be able to expand in a particular locality due to competition with hardier

(Continued on page 24)

Plants of Scientific Value

THESE plants exhibit morphological curiosities, or are otherwise botanically interesting.

Balanophora involucrata Hk. f. (Balanophoraceae) is a fleshy tuberous parasite on roots of trees, occurring in the Himalaya. It has been collected only on a few occasions so far.

Sapria himalayana Griff. (Rafflesiaceae) occurs in Mishmi Hills of Arunachal Pradesh. Its flowers resemble the well known Rafflesia flower and are up to about 35 cm in diameter. It grows as a root parasite.

Nepenthes khasiana Hk. f. (Nepenthaceae) is an insectivorous pitcher plant. The leaf tips of the plant develop into curious pitcher-like structures arched over by lids. The pitchers are up to about 25 cm long. This plant is a special botanical curiosity and the present population of this species, restricted to the Khasi hills in Meghalaya, is not enough even to supply educational institutions of our country. The native habitat of this plant is now a gene sanctuary.

Dischidia benghalensis Colèb. (Asclepiadaceae) is a climber found in eastern Nepal and Sikkim. Leaves develop into pitchers which collect humus and debris and into these, special branched roots develop from the petiole for absorption.

R.D. KAK

R.D. KAK

Pilgrimage to KEW

RAJ D. KAK

VIRENDRA KUMAR

Starting from a small area of 4 hectares in 1759, the Royal Botanical Gardens at Kew in England, aptly called the Mecca of international botany, is presently spread over an area of 120 hectares. Throughout the year Kew Gardens offer to visitors a breathtaking view of vast lawns with multi-coloured flowers

WITH the earth's rich flora fast disappearing in the wild due to over-exploitation by man and habitat destruction, botanical gardens offer a safe refuge for many endangered species. The Royal Botanic Gardens, Kew, aptly called the Mecca of international botany, are among the finest botanical gardens in the world. These gardens function essentially as a botanical and not as horticultural institution. Nevertheless, the gardens proper, as open to general public, are very beautiful and give pleasure to thousands of visitors who may not be botanists.

Kew is renowned as the great authority on plant identification.

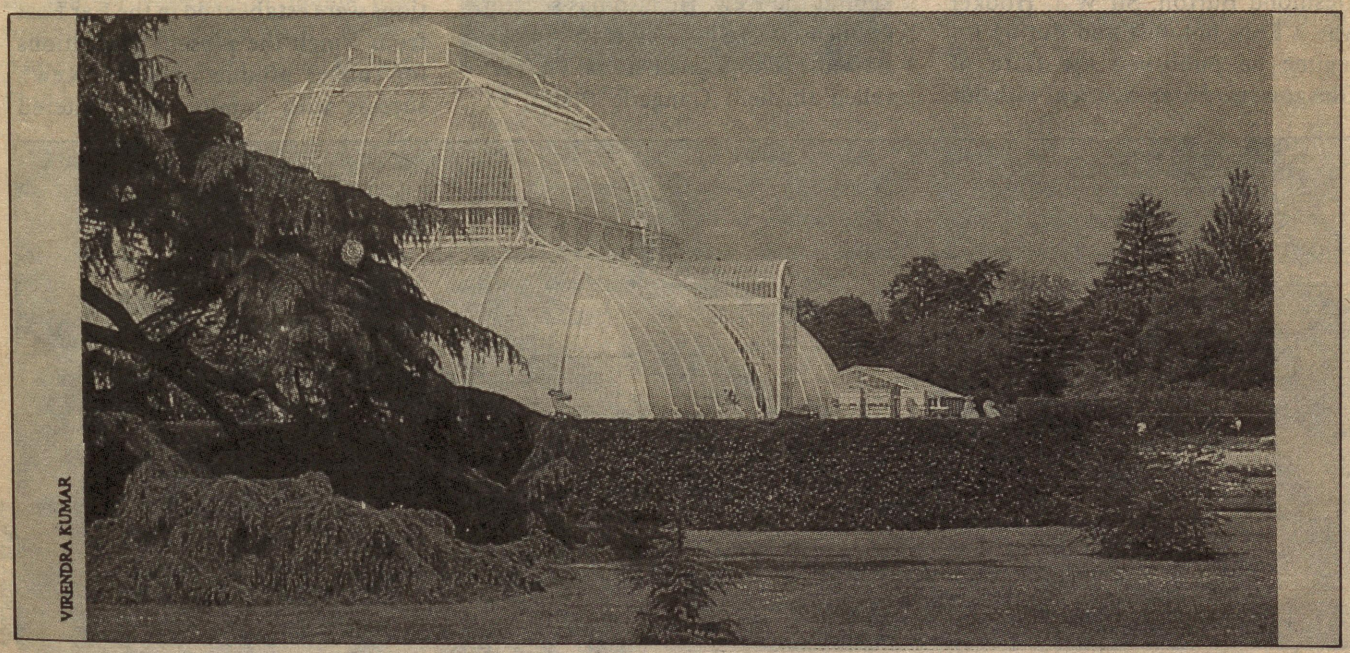
Opposite page *(Clockwise from bottom left)*: Rhododendron hybrid 'Bagshot Ruby'; Inside view of Prince of Wales Conservatory; the Kew Palace

Enquiries from all over the world are answered about drugs, fibres, food, oil-producing plants, gums, resins, etc., regarding their authenticity, source, and identification of adulterants. The Jodrell Laboratory, The Herbarium and the Department of Economic botany are the main divisions which answer these queries.

Kew, which is about 120 ha in area at present, can justifiably claim to be the finest gardens in the world. Its history can be traced back to 1759, when Princess Augusta, the then Dowager Princess of Wales and mother of George III, started a garden on a 4 ha plot. The Princess was a keen gardener; she lived with her husband Fredrick in 'White House' whose gardens have been described as one of the finest gardens in Britain in those days. Fredrick himself was an ambitious gardener and after his death in 1751 his widow carried on the work with enthusiasm, with the help of Lord Bute, who became prime minister in 1762. Bute encouraged Augusta's garden improvements and was instrumental in employing the architect Sir William Chambers to re-landscape the grounds and to erect a number of eye-catching buildings, the most noticeable being a 49 m high Pagoda. Princess Augusta died in 1772, but in the preceding 20 years she gave Kew Gardens the definite scientific character which they have retained.

IN 1772, after the death of Princess Augusta when George III succeeded the throne, he united the grounds of Richmond Lodge, his home which was adjacent to the White House grounds, and the formation of Kew as we know today began.

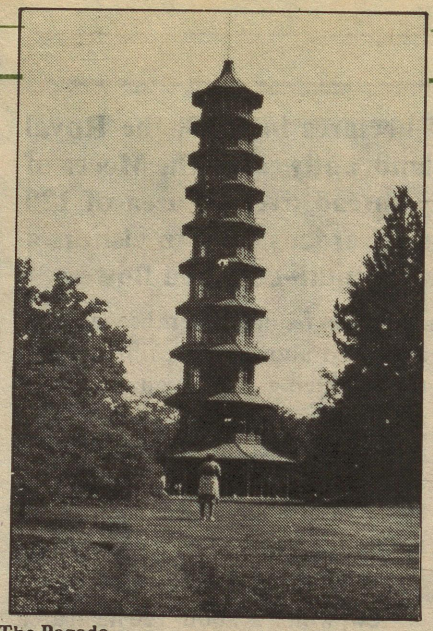
Sir Joseph Banks was appointed as the first Director of Kew. He has been mainly responsible for the Garden's scientific reputation. Banks



The Palm House

planned to grow plants from all over the world in Kew Gardens. For this he arranged to send trained collectors to various parts of the world. After his death and that of George III in 1820, Kew passed into decline. George IV and William IV made very few additions to the Gardens.

The present layout of the Garden was largely determined shortly after Sir William J. Hooker's appointment as the Director in 1841. He is described as a "vigorous pedestrian covering 60 miles a day with ease". When he took charge the combined area of Royal Gardens of White House and Richmond Lodge was only 6 ha. Soon he took charge of additional pleasure grounds and employed landscape designer W.A. Nesfield to re-landscape the garden into a unified whole. It is remarkable that within less than five years Kew increased in area from 8 ha to 100 ha. The new additions were mainly as arboretum. The first development which profoundly influenced the plan of the gardens was the construction of a Palm House, designed by Desmond Burton. Sir W.J. Hooker was a keen botanist and during his regime he published the flora of Glasgow in *Flora Scotica* with his own illustrations and plates. He also published new edition of *Curtis Flora londinensis*, 4 editions of *British Flora.*, etc.

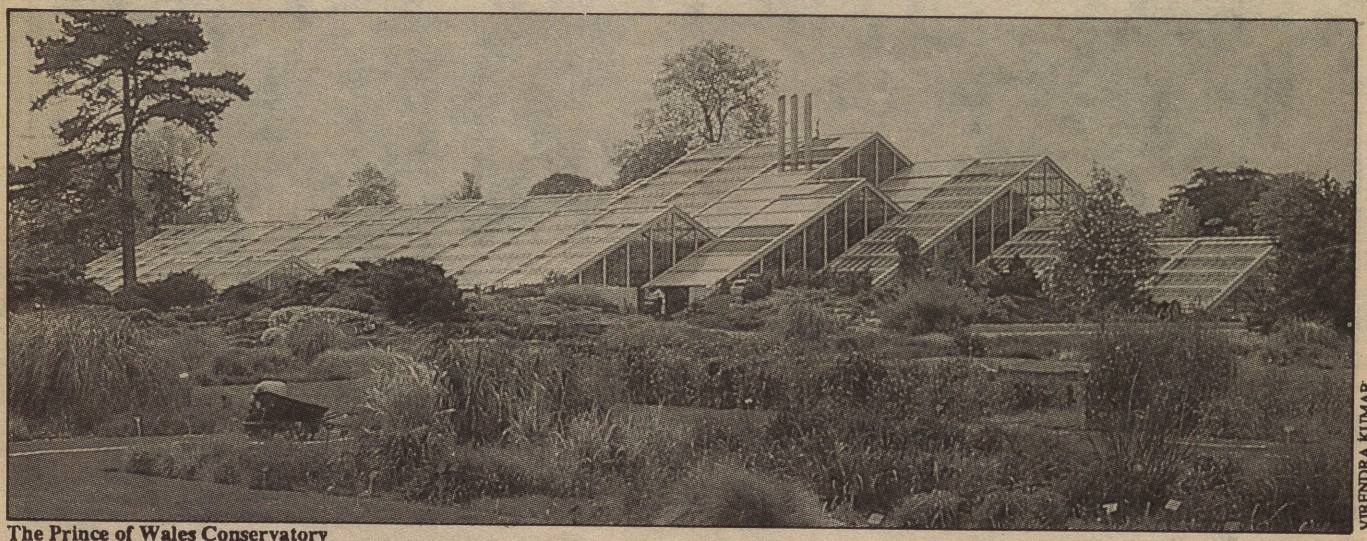


R.D. KAK

The Pagoda

By the time of Hooker's death in 1865 the garden was well stocked and established. The temperate house was well underway. His son Joseph Dalton Hooker was appointed as the Director of Kew after him. Joseph Hooker was a great traveller and collector. His collections are mostly kept at the Kew. He also has several publications to his credit. In 1847 he started his voyage to India. He travelled through Gangetic Plains, to Himalayas and went to Sikkim, Tibet and Nepal. He also visited Sunderbans in West Bengal, Chittagong and Khasia hills. His full account of Indian travels is documented in *Himalayan Journals*, London (1854). It was he who introduced Himalayan rhododendrons to Kew and other British gardens. He wrote a number of books including the *Handbook of New Zealand Flora. Flora Indica* (1 Volume). With George Benthem he wrote *Genera Plantarum.* But his *Flora British India,* which appeared in seven volumes, still remains his most important book. He made several improvements in the Gardens. It was he who created the Rock Garden, Holly Walk, Thorn avenue, Chestnut avenue and many other new features.

Kew's past success with economic plants included rubber and quinine. John D. Hooker got the seeds of the rubber plant, *Hevea brasiliensis* (Willd. ex A. Juss.) Muell. Arg. from S. America in 1876 and raised seedlings which were sent to Ceylon (present Sri Lanka) and Malaya. Aided by advice from Kew, plantations were established in the Far East from which the present plantations for rubber production grew. Kew's success with quinine really altered



VIRENDRA KUMAR

The Prince of Wales Conservatory

the history of the world. The drug is obtained from several species of South American tree Cinchona. By the close of nineteenth century *Cinchona* trees were destroyed in persuit of bark and never were replaced. Seeds raised at Kew in 1860's helped to establish the tree in India and alleviate the scarcity of the drug.

THE scenic beauty of Kew Gardens as they exist today is not easy to describe. It is so vast that it can be fully appreciated only after many visits. The rhododendrons that flood Rhododendron Dell with brilliant colours in spring are of breath-taking beauty. The blue-bells *Endymion nonscriptus* (Linn.) Gurcke in Queen's Garden are spectacular, while The Rock Garden can keep one enchanted for hours. The camellias along the Kew Road are sharp and brilliant.

The Queen's Garden, created by Sir George Tailor (one of the ex-directors of Kew), is essentially a 17th century garden with emphasis on small individual areas and change of levels. The garden is full of fascinating varieties of plants like rosemary, sage, curry plant, worm-wood, hellebores, etc., which feature in old herbals.

The features which dominate the Kew are glass-houses which are the epitomes of Victorian engineering skill. The Palm House, built in 1944-48 by the side of the pond, houses many exotics. Viewed from a distance, the palm house appears to float on the adjacent pond. It houses *Encephalartos longifolius* (Jacq.) Lehm., the oldest living green-house plant at Kew which was collected in 1775. The Palm House was recently almost dismantled and reconstructed. Many striking plants like *Gunnera chilensis* Lam. grow near the east shore of the Palm House pond.

The Temperata House is the largest in the world. It took more than 30 years, from 1860-1898, to build. It resembles a glittering wedding cake with its external stucoo piers topped by ornate urns. In its southern wing grows the most exotic genus *Strelitzia* named after the wife of George III. The largest plant displayed here is *S. nicolai* Regel & Korn crowned with beak-like blooms. In the main block grows the Childean wine palm *Jubaea chilensis* (Mol.) Baill. grown from seeds collected in 1846. Tree ferns, *Dicksonia antartica* Labill. and *Cyathea australes* (R. Br.) Domin, etc., are also grown in the temperate house. The Garden has other glass-houses also like, aroid-, filmy fern-, Australian-, Tropical water lily-, Tropical-, and Alpine palm houses.

R.D. KAK

Inside Palm House

The Alpine House, opened in 1981, is a marvel of new technology. It is a pyramidal moated structure where water and ventilation are used to control the temperature. Arctic plants are grown experimentally using lights to fool the plants in believing that nights last only an hour.

THE most recent development at the Kew is the carefully landscaped Princess of Wales conservatory situated near the rock garden. It was inaugurated by the present Dowager Princess of Wales, Princess Diana in July, 1987. Although it is built very differently from the huge conservatory at Edinburgh, it follows the same internal arrangement of providing different environments—from mangrove swamp to desert terrain. It also includes under-water viewing aquarium.

The Herbaceous Grounds is a fascinating area for plant lovers and botanists. Here plants are arranged according to their natural families to demonstrate their relationship. Millions of plants are in the beds while overhead on the long pergola, which covers the whole length of the Central path, roses and clematis are hung.

The wild life at Kew is also worth watching. Over one hundred species of wild birds are recorded from Kew. Of the water birds the mallards, coot, moorhen are exceedingly common on the lake and ponds. Ducks, herons and cormorants are also in abundance.

Kew is fascinating throughout the year. Daffodils (*Narcissus* spp.) and swelling buds herald spring followed by Crocuses (*Crocus* spp.) and anemones (*Anemone nemorosa* Linn.). *Acer opalus* Mill. is the earliest of the maple to flower. The flowering trees and shrubs are undoubtedly amongst the glories of Kew.

In summer (from June) many species of *Iris* and roses (*Rosa* spp) flower. True lilies *lilium* spp. are some of the flowers which adorn the garden in summer. The rock garden and chalk garden, the aquatic gardens and herbaceous grounds are at its best during summer.

Autumn at Kew is no less fascinat-

(Continued on p23)

RAIDERS OF OUR FORESTS

T.N. KHAN

IF you happen to pass through a rich forest slowly with a watchful mind, you may come across leafless trees on your way. You may also discover some dead or dying trees bearing several boreholes on the bark or wood surface (Fig. 1), or masses of bore-dust and wood-fibres nearby. You will certainly be eager to know the cause behind. Well, let us make a round up of the leafless trees or remove the bark of a dead or dying tree and examine carefully. What we discover is a layer of blackish faecal pellets on the ground below the defoliated trees, or whitish wormlike creatures of variable shapes and sizes inside excavated tunnels on the wood surface or inner bark surface of the dead trees. We may even detect some caterpillars and colourful insects feeding on the foliage of neighbouring trees. By now, I am sure, you are well introduced to some of the enemies of our forest wealth which cause severe devastation of our economy.

You may be wondering how these small creatures can possibly be so dangerous to forest. Well, let me cite one example. In 1921, forest pests caused a loss of Rs 125 million—an amount equivalent atleast to Rs 2,500 million in the present decade. Moreover, insect infestation is extensive and the depredation caused by them is on the increase not only because of their abundant occurrence and varied feeding habits, but also due to lack of proper knowledge of their ecobiology which is essential for the determination and adoption of any control measure. Such problems, of course, are inevitable in a developing country with rich forest growth like India.

A tropical country like India supports a vast pest insect fauna in its luxuriant forests, which range from defoliators, consumers of buds, fruits and seeds, sap-suckers, borers, etc.

Classification

All parts of a tree—from roots to twigs, buds and leaves, flowers and fruits and the bark, sapwood and heartwood—are susceptible to insect attack. Some insects prefer saplings and young trees, some attack older ones, others infest unhealthy and dying trees, still others prefer dead material, while some attack only rotten wood. Yet another category of insects select seasoned or converted wood for feeding and breeding. Besides taxonomic classification, they can, therefore, be categorized into different groups either on the basis of the plant part they attack or the physiological condition of the plant affected (e.g., healthy, diseased, dead, etc.). However, a categorization based on a combination of these two is better as it gives a more general view not only of the feeding habit of the insects, but also of the nature and extent of damage they cause. In this article forest insect pests are classified as defoliators, consumers of buds, flowers, fruits and seeds, sap-suckers, borers and so on of trees of different physiological conditions (Fig. 2). However, it should be noted that a tropical country like India supports a vast pest insect fauna in its luxuriant forest, which makes it impossible to consider all of them in an article like this. We shall, therefore, confine ourselves to the most important ones.

Enemies of Living Trees

Defoliators constitute one of the most destructive groups of insect pests of living plants. As their name signifies, they destroy leaves, which results in retardation of growth, weakening of vitality and even death in severe attacks. Butterflies and moths (Lepidoptera) constitute the largest group of defoliating insects. In India, the notorious defoliators include those of teak (*Tectona grandis*), shisham (*Dalbergia sissoo*) and deodar (*Cerdus deodara*). The

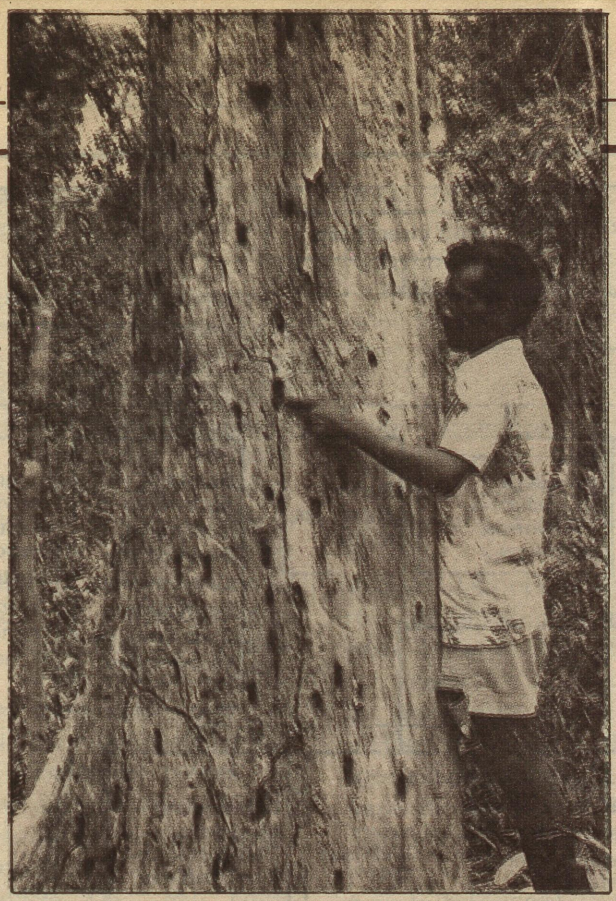


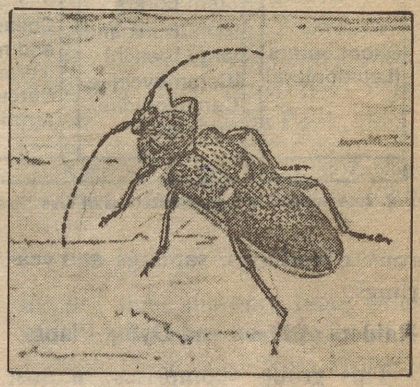
Fig. 1. One of several 'Bara Bhilwa' (*Tetrameles nudiflora*) trees in Peel Island, South Andaman, died of severe defoliation followed by borer attack. Bore-holes are visible on the surface

famous 'Teak-defoliator' *(Hyblea puera)* may cause a loss of several thousands of rupees per hectare of teak plantations. Similarly, 'Deodar-defoliator' *(Ectropis deodara)* causes severe damage to deodar forests. Sawflies (Hymenoptera: Tenthredinidae) are equally important in temperate climate. Some adult insects like locusts (Orthoptera: Gryllidae) and cock-chafers (Coleoptera: Scarabaedae) also cause appreciable damage to forests.

Two other important groups of insects that attack healthy forest plants include bud-worms and shoot-borers. Among the most destructive bud-worms found in India is the 'Spruce-bud-worm'. The pest destroys the buds of spruce *(Picea morinda)* of all ages, which prevents normal annual formation of new shoots. As a result the growth is retarded and the tree grows so weak that it easily falls prey to bark and timber beetles (Scolytidae and Platypodidae) and other borers (Cerambycidae and Buprestidae). The dying-off of spruce in the Himalayas is mainly due to this bud-worm. The shootborer's attack, on the other hand, leads to a heavy pruning of the crowns which not only retards the tree growth but also reduces the out turn of better class logs as the damage results in the formation of forked, crooked and branched boles. The most injurious shoot-borers of our forests include the 'Cedar, toon and mahogany shoot-borer' *(Hypsipyla robusta),* 'Bee-hole borer' *(Xyleutes ceramica),* and 'Red-borer' *(Zeuzera coffeae).*

Sap-suckers or plant-bugs (Hemiptera) constitute another group of enemies of living plants. They feed on the sap of trees of all ages and injure them by draining away their vital food and water supply. They may also infect the plant with disease. The 'Sal-bug' *(Drosicha stebbingii)* causes enormous damage to sal *(Shorea robusta)* by clogging-up the stomata and pores of leaves and twigs and by draining off sap from twigs and branches, causing them to dry up and die. It also kills the leading shoot of young saplings. The 'Champ-bug *(Urostylis punctigera)* causes serious damage to 1-14 year old champ *(Michaelia champaka)* trees and may doom cultivated stands to total destruction.

Some of the termites (e.g., *Cryptotermes, Neotermes)* cause severe harm to living plants by directly injuring them. They also damage the roots of saplings of a number of important species including sal, teak and badam in nurseries by hollowing out or severing or partly removing



the bark. In many cases, they penetrate a living plant by way of a dead branch or stub, or through the bark at an wound and establish themselves in a cavity in the heartwood, which is gradually enlarged. Continued excavation not only leads to the death of some of the roots or even whole trees, it also completely ruins the timber.

Other insect pests of living plants are not so important, although some of them may pose danger during epidemics. They include cut-worms (Lepidoptera), gall-forming insects (Diptera, Thysonoptera, etc.), flower and fruit eaters (Lepidoptera, Hemiptera, Coleoptera, etc.), and a few beetle-borers (mostly Cerambycidae), which become most dange-

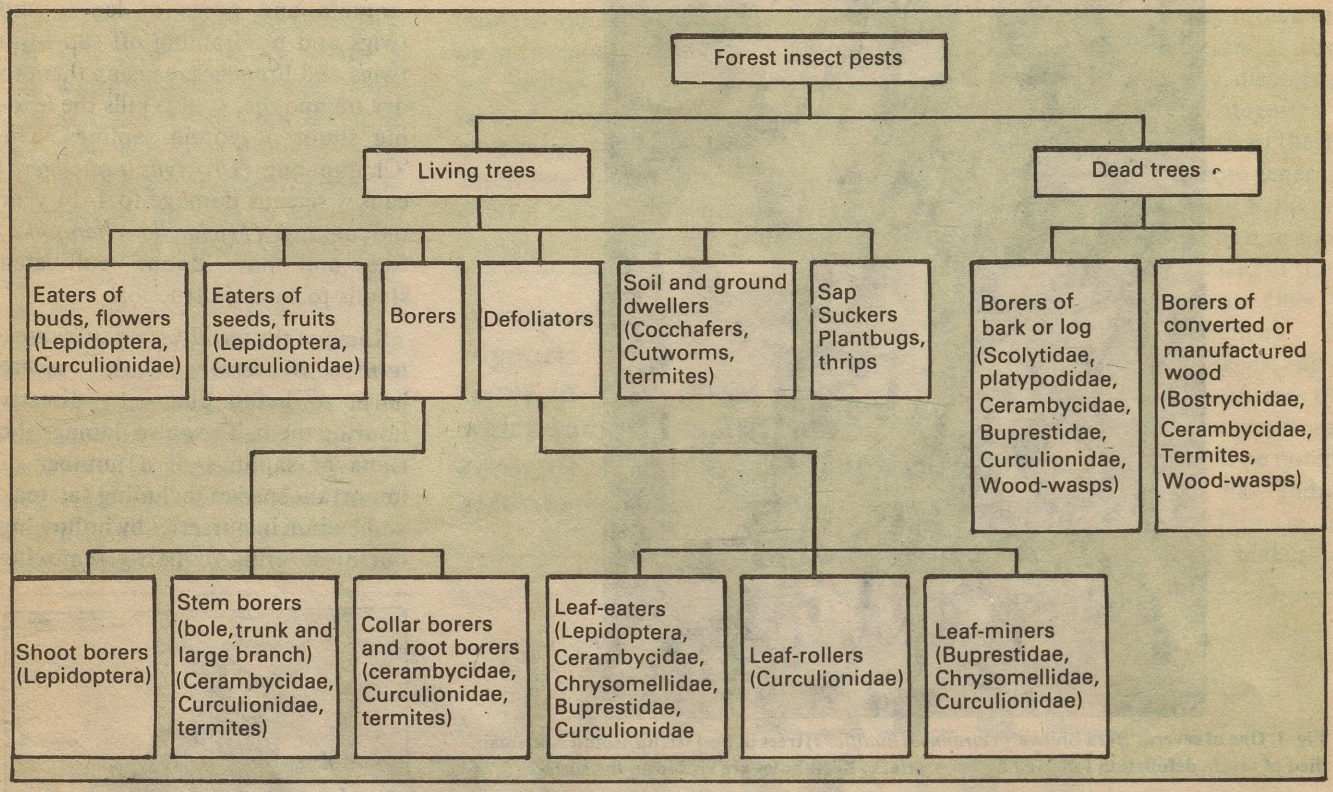


Fig. 2. A schematic representation of classification of forest insect pests with important groups in parentheses

rous to seedlings, saplings and yearlings.

Raiders of Dead and Dying Plants

This group comprises almost exclusively borers of different kinds. A borer may feed on the bark, sapwood or heartwood and consequently designated a bark-borer, sapwood-borer or a heartwood- borer. A borer can also be designated on the basis of the nature of its damage, such as a pin-hole borer which makes pinholes in the wood, or a powderpost borer that reduces the wood mass into powder.

Bark and timber beetles (Scolytidae and Platypodidae) constitute the first group that invades dying and dead plants and cause damage. As their name signifies, bark-beetles bore into the bark and do not cause any significant damage to the wood. Timber beetles, constituted by the shothole and pin-hole borers, in contrast, spoil the wood for constructional work and reduces its durability. Among several important bark and timber beetles, *Sphaerotrypes, Dendroctonus, Platypus*, etc., are very common in India.

The round-head borers (Cerambycidae) constitute the common and most destructive group of insect pests of dying and dead trees, logs and branches. A round-head borer may be a bark-boring, sapwood-boring or a heartwood-boring insect. The degree of damage caused by a wood-borer is directly determined by the depth of its penetration, and most round-head borers bore deep into the heartwood. The 'Singhbhum sal borer' *(Hoplocerambyx spinicornis)* is the most notorious borer in India and causes loss of several million rupees a year. The borer attacks dying trees and freshly felled logs and damages them by excavating enormous tunnels running deep into the heartwood. *Rhaphipodus (Remphan hopei)* is equally dangerous to dead and dying trees and logs of 'Garjan' *(Dipterocarpus* spp.). The species of the genera *Acanthophorus, Prionus, Xystrocera, Aeolesthes, Plocaederus, Monochamus, Acalolepta, Batocera,* etc., are only a few of several destructive enemies of our forest wealth.

Other important enemies include the flat-head borers (Buprestidae), some curculionid-borers (Curculionidae), wood-wasps, and carpenter-bees (Hymenoptera). Some termites *(Coptotermes, Cryptotermes, Neotermes)* and a few powderpost beetles (Bostrychidae) may also be included in this category.

Some of the above mentioned insects, particularly the round-head (e.g., *Acanthophorus)* and curculionid-borers (e.g., Tanymecus) feed on the roots and rootlets of unhealthy or even healthy plants and may kill them.

Enemies of Seasoned Wood and Wood Products

Powderpost beetles, perhaps, constitute the most important enemies of dry seasoned wood. They are commonly found in bamboo and wooden materials in old houses, particularly in villages, and in timber used in the construction of buildings, bridges and articles of furniture. Several pin-holes on the surface of the infected material, with very fine or powdery frass and wood-dust coming out of them constitute the most important features of their identity. *Lyctus* and *Bostrychus* may be regarded as the most common and important powderpost beetles of India. Some round-head borers (e.g., *Stromatium, Ceresium, Clytus)* also attack dry seasoned wood and wood products. The 'old house borer', *Hylotrupes bajulus,* is a destructive round-head borer of dry and seasoned timbers and wood products in Europe. Fortunately, this borer is not found in India. Some termites (e.g., *Kalotermes, Heterotermes)* also severely damage and ruin wood and wood products.

As mentioned earlier, Indian forests harbour a vast insect fauna. For example, more than 2,000 species of round-head borers are found in India. A single plant species, for example, teak or sandal, may serve as the host of more than 300 insect pests. Unfortunately, there is as yet no comprehensive inventory of all the insect pests found in India, so important for their effective management and control. We do not even know the size of each of the component pest groups, except for termites (Isoptera). These yawning gaps will have to be bridged before any comprehensive action plan can be taken up to save our dwindling forests from these insect invaders.

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ing. There are always flowers at Kew. It is worth visiting in autumn to see the plants in fruit and seed. In the main part of the garden and especially in the arboretum there is blaze of autumn colours of the foliage. In winter too Kew offers breathtaking scenery of snow covered lawns and trees. In short Kew is always at its best.

ABOUT the functions of the Kew, the most important is the training of student gardeners. The young gardeners all over the world try to do a stint at Kew. These young gardeners are given training in all aspects of the gardening. The principal scientific department at Kew is the Herbarium and associated library. The herbarium consists of over six million collections of dried specimens of plants, filed in cabinets in systematic order. There are three wings with total 10 floors. It was started by Sir William Hooker (1891) whose own collections formed the nucleus of Kew Herbarium and Library. Carpological collections are also part of these collections. Here research is mainly done (by members of the staff), though not entirely, for preparation of floras and monographs. *Flora of Tropical East Africa, Flora of West Tropical Africa, Flora Zambesiaca, Flora Cypress, Flora of Iraq* etc., are some of the on going projects. The Library is an indispensable adjunct to herbarium and is specialized in systematic botany. The herbarium scientific staff work in close collaboration with other departments such as economic botany museums and Jodrell Laboratory. Jodrell laboratory, built by Mr J.J. Jodrell in 1876, is an integral part of the Garden for study of plant anatomy and plant physiology. Besides plant anatomy, many other and varied matters are dealt with at Jodrell. These range from assitance to the solutions of problems of crime to growth harmones and atmospheric pollution. Many investigations are linked with economic botany. A number of publications are brought out from Kew. These are *Index kewensis, Hooker's Icones Plantarum, Kew Bulletin* and *The Kew Magazine.*

In October, 1987 Kew suffered devastation due to hurricane. Thousands of trees were uprooted and destroyed. Some of the trees were very old and of great historical value. It is very difficult to replace those trees. Great efforts are being made to fill in the gaps, but to bring back Kew to its old glory is an uphill task which needs hard labour and plenty of funds.

Dr. Kak is a scientist with the wealth of India, P.I.D.

Continued from p15

species there, but may colonise better elsewhere.

It will be useful if workers on regional flora could concentrate on 20 or 30 species and make detailed observations on them. Similarly, monographers can very usefully contribute: (a) by discussing about endemism in their accounts on family (ies), genera and species; (b) by emphasizing the taxonomic validity of endemic or threatened (and rare) taxa; (c) by focussing attention on any special biological characteristics of the taxa which would influence their regeneration and survival.

It would also help (1) to find out what rare endemics are being grown in botanic gardens; (2) to study the status of Linnean taxa in India; (3) to study the effect of introduced exotics such as *Eucalyptus, Casuarina* on populations of rare taxa; and (4) to study the effect of exotic weeds like *Eupatorium, Mikania, Parthenium* and *Eichchornia* on rare species.

It is evident that several thousand species of plants and animals of our country are under various degrees of threat. Though the preservation of species and conservations of their habitats are closely interlinked, the former is easier and less controversial. Closure of habitats influences near and even far populations. With more and more alternative methods becoming available for *in situ* preservation of individuals, populations or their germplasm, it is not too optimistic to hope that we should be able to stop or considerably slow down the current rate of extinction or depletion and lists of threatened plants of India will not expand in future.

Lastly, but significantly, public awareness about the richness and significance of biological diversity of our country and about the problem of endangered species is important. Our people—men, women and children—need to be told about the pride of our state flowers, trees and animals. It is heartening to see that some universities have included the subject in their syllabi.

Dr. Jain is Emeritus Scientist, National Botanical Research Institute, Lucknow-226001.

Plants of Phytogeographic Significance

INDIA has many endemic genera and species. Most of them show restricted distribution and are rare in every sense needing protection.

Helicanthes Danser (Loranthaceae) is a genus of parasitic plants, confined to the mountains of peninsular India.

Frerea indica Dalz. (Asclepiadaceae) grows in hilly regions of Maharashtra and has showy flowers.

Willisia Warm. (Podostemaceae) is a genus of small herbs which grows on rocks in swift-flowing systems of Western Ghats.

Ceropegia jainii Ansari & Kulkarni (Asclepiadaceae) is an erect tuberous herb endemic to Ratnagiri in Maharashtra.

Glyphochloa mysorensis (Jain & Hem.) Clayton (Poaceae/Graminae) is a grass endemic to Karnataka.

Jainia nicobarica Balak. (Rubiaceae) is a plant endemic to Andaman & Nicobar Islands.

Manisuris divergens (Hack.) Ktze (Poaceae/Gramineae): This grass was first collected in peninsular India in 1832 (?). Its second collection was in 1963, after 13 decades. It is confined to Western Ghats.

Other Economic Plants

PHYLLOSTACHYS bambusoides Sieb. & Zucc. (Poaceae/Gramineae) : It is common in China and Japan, but reported in India only recently. It is economically important.

Decussocarpus wallichianus (Presl) de Lauben. (Podocarpaceae) is the only conifer occurring wild in peninsular India.

Dioscorea spp. (Dioscoreaceae): This genus has gained much importance as a source of steroidal hormones.

Pinus gerardiana Wall. (Pinaceae) or 'Chilgoza'. The fruits of this tree are used as a delicious dry fruit. Its distribution is restricted to a small region in Western Himalaya.

Santalum album Linn. (Santalaceae) or 'Chandan' occures commonly but its uncontrolled illicit exploitation and attack by spike disease warrant care and protection to the species.

Trees of Forestry Importance

Though most trees of sylvicultural importance are carefully looked after by the Forest Departments, some rare species do need protection.

Pterocarpus santalinus Linn. f. (Fabaceae/Papilionaceae) : 'Rakta chandan' commonly called Red Sanders, the tree yields the valuable wavy-grained timber. It occurs in certain localised regions in Andhra Pradesh and its protection and expansion is very necessary.

Dysoxylum malabaricum Bedd. (Meliaceae) : This large tree grows in Western Ghats; its timber is ornamental.

The First Scientist Minister

PROF. Mambillikalathil Govind Kumar Menon, FRS was inducted by the Prime Minister Mr. V.P. Singh on 18th December 1989 in his Council of Ministers as Minister of State for Science and Technology. Prior to taking over the ministry, Prof. Menon was Member of the Planning Commission and Scientific Adviser to the then Prime Minister Mr. Rajiv Gandhi. Prof. Menon is the first scientist to become a minister.

Born on August 28, 1928, Prof. Menon had throughout a highly distinguished academic career. He obtained his B.Sc. from Agra, M.Sc. from Bombay and Ph.D. from Bristol. From 1949-55 he worked in the laboratory of Prof. C.F. Powell, NL, FRS. He was awarded D.Sc. (*honoris causa*) by Allahabad, Delhi and Jodhpur Universities.

An internationally recognised authority on cosmic ray physics, Prof. Menon has made notable contribution to nuclear emulsion technique, physics of elementary particles, particularly strange particles, and cosmic ray investigations in India at high altitudes and great depths underground.

Prof. Menon has won several coveted scientific awards and recognitions. He is the winner of Shanti Swarup Bhatnagar award and a recipient of the Khaitan Medal of Royal Asiatic Society. He is the Fellow of the Royal Society, Indian Academy of Sciences and the Indian National Science Academy.

Member of several scientific organisations, both national and foreign, Prof. Menon had at various times occupied the chairs of Chairman, Electronics Commission and Secretary to the Govt. of India, Department of Electronics; Director of the Tata Institute of Fundamental Research and Scientific Adviser to the Minister of Defence. He is a former Director General of C.S.I.R.

He was Chairman of the Cosmic Ray Commission of International Union of Pure and Applied Physics and of the Indian Space Research Organisation.

Innovation Award

A scientist of the Applied Mechanics Deptt. of the Indian Institute of Technology, Delhi has won the 'Innovation award' of the Institute for designing and developing an extensometer which can measure actual linear strain during the pull of Tor steel rods steel wire ropes. The actual computation of strain, eliminating all possible errors as this extensometer does, in Tor steel when it is used in the construction of multistorey buildings, bridges, roads, flyovers, etc. is very essential for the safety of these structures.

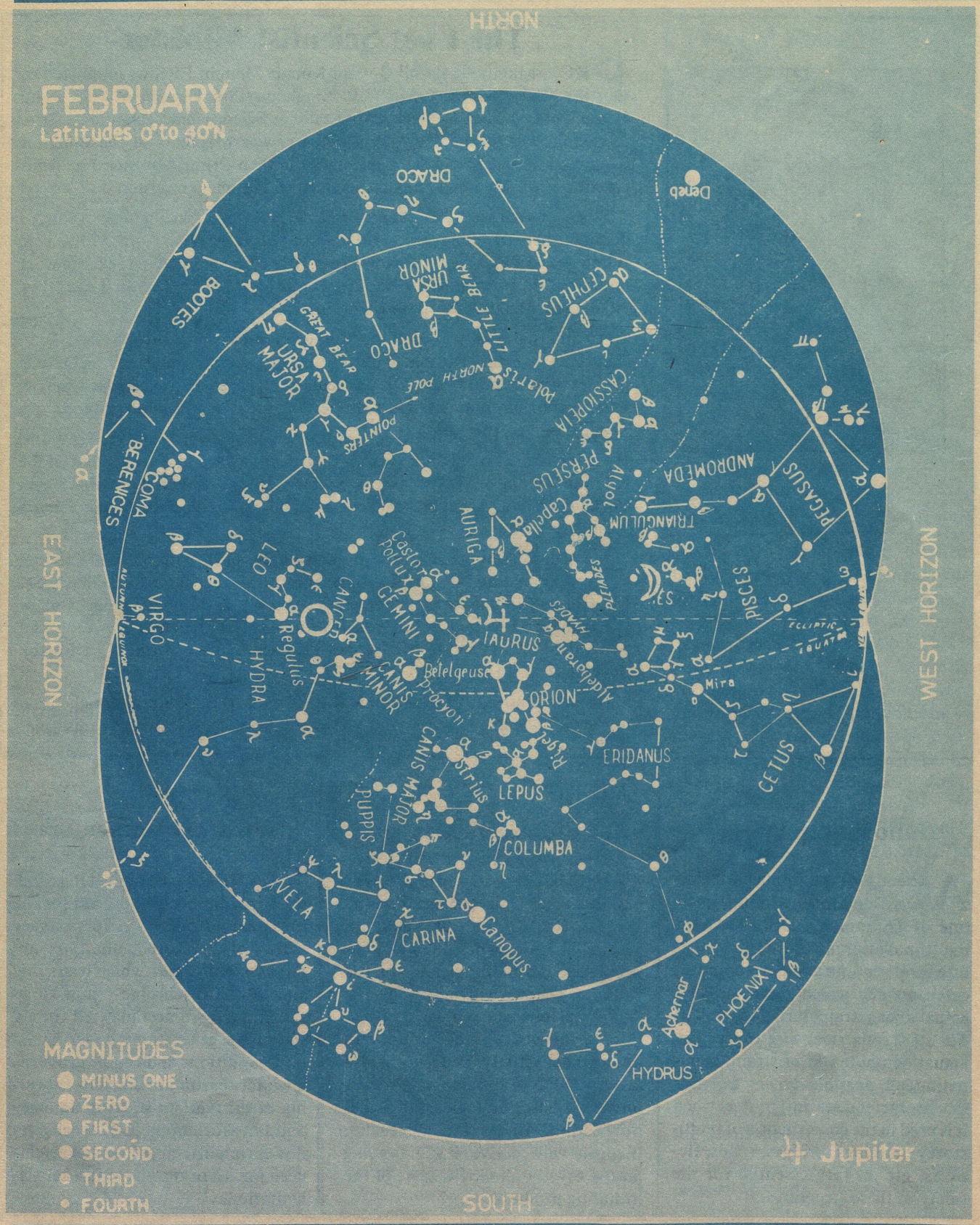
Bioinsecticides

TUCOGEN (Langhorne, Passedena) and Gujarat State Fertilizers Co, (CSFC) Ltd. at Vadodara will collaborate on developing bioinsecticides and biofungicides for use in India. The two will jointly develop biological insecticides based on *Bacillus thuringiensis* — a bacterium with insecticidal activity. Ecogen will also assist GSFC in developing *Pseudomonas* — based biological fungicides for cotton. Under the agreement, Ecogen will receive R&D funding and a royalty on GSFC sales of the resulting products.

New Chrysanthemum

NATIONAL Botanical Research Institute, Lucknow has for the first time introduced in India a new variety of chrysanthemum, *Chrysanthemum multicaule* which bears tiny and attractive chrome-yellow flowers. It has been acclimatized for six successive generations under Lucknow conditions and can be grown as a winter season annual. The flowering of this variety starts in January and lasts for about 10-12 weeks. Its flowers retain their colour and brightness for more than a year after dehydration.

SKY CORNER


NORTH
FEBRUARY
Latitudes 0° to 40°N
DRACO
Deneb
BOOTES
CEPHEUS
URSA MINOR
LITTLE BEAR
GREAT BEAR
URSA MAJOR
DRACO
Polaris
NORTH POLE
POINTERS
CASSIOPEIA
PERSEUS
ANDROMEDA
PEGASUS
BERENICES
COMA
AURIGA
Capella
Algol
TRIANGULUM
PLEIADES
HYADES
Aldebaran
TAURUS
Castor
Pollux
GEMINI
LEO
CANCER
Regulus
VIRGO
HYDRA
Betelgeuse
Procyon
CANIS MINOR
ORION
Rigel
ERIDANUS
Mira
CETUS
PISCES
ECLIPTIC
EQUATOR
CANIS MAJOR
Sirius
LEPUS
PUPPIS
COLUMBA
VELA
CARINA
Canopus
Achernar
PHOENIX
HYDRUS
EAST HORIZON
WEST HORIZON
MAGNITUDES
MINUS ONE
ZERO
FIRST
SECOND
THIRD
FOURTH
SOUTH
Jupiter

Night Sky During February 1990

THE diagram shows the evening sky as seen from latitudes 0° to 40°N. The inner circle represents the horizon as seen from latitude 22° 30'N. The chart has been extended on the northern and southern sides for use all over India. Beginners wanting to use the chart should hold it overhead and turn it in such a way that the North, South, East and West marked on the chart point to the correct directions. With some experience it would be possible to use it in a more convenient position. With the help of a few known star groups in the sky the remaining stars can be easily indentified using the above chart. From a particular place these stars will be seen at about 2130 hrs., 2030 hrs. and 1930 hrs. of local mean time on the 1st, 16th, and 30th of the month.

The star chart meant for a particular day for a given hour can be used for the next day 4 minutes earlier and for the previous day 4 minutes later. For example, if a chart is meant for 8-30 pm for the 17th Feb. It can be used on the 17th at 8-26 pm and on the 15th at 8-34 pm. In the same way it can be used for other months. For the 16th January, it is for 10-30 pm, and for the 16th March it is for 6-30 pm and so on.

The stars move from east to west in the sky in their daily motion (due to rotation of the Earth) at a rate of 15° per hour. The chart can also be used at other hours in the evening after taking into account the above shift in position of the stars.

Planetary Positions for February 1990

Date	*1st*		*10th*		*20th*	
Planets	*R.A.*	*Decln.*	*R.A.*	*Decln.*	*R.A.*	*Decln.*
Mercury	19h 12m	21.5S	19h 58m	21.2S	20h 57m	18.9S
Venus	19h 30m	14.3S	19h 26m	14.8S	19h 37m	15.3S
Mars	18h 08m	23.8S	18h 36m	23.7S	19h 08m	23.2S
Jupiter	6h 08m	23.4N	6h 05m	23.4N	6h 04m	23.4N
Saturn	19h 23m	21.8S	19h 27m	21.7S	19h 32m	21.5S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The Moon

THE full moon occurs on 10th at 00.46 a.m. and the new moon occurs on 25th at 2-24 p.m. I.S.T. The moon passes about four degrees north of Jupiter on 6th, two degrees south of Mars on 21st, two and a half degrees south of Saturn and eight degrees south of Venus on the 22nd and about two degrees north of Mercury on 24th. The moon is at perigee or nearest to the earth on 2nd and again on 28th and is at apogee or farthest from it on 16th. The lunar crescent becomes first visible after the new moon day in the evening of 26th.

A total lunar eclipse occurs on 9th. It is visible in India. The moon enters the umbra at 10-59 p.m. on the 9th and comes out of it on 10th at 02-24 a.m. I.S.T.

The Planets

MERCURY (*Budha*), visible in the morning sky, rises about an hour before sunrise during the month. It is in greatest western elongation of about 25° from the sun on 1st. At the end of the month it comes too close to the sun to be visible. It moves from Sagittarius (*Dhanus*) to Aquarius (*Kumbha*) through Capricorn (*Makara*). Its visual magnitude varies from 0.0 to -0.3.

VENUS (*Sukra*), visible in the morning sky, rises about two hours before sunrise during the month. It becomes direct on 8th. It moves from Sagittarius (*Dhanus*) to Capricorn (*Makara*). Its visual magnitude is about -4.6.

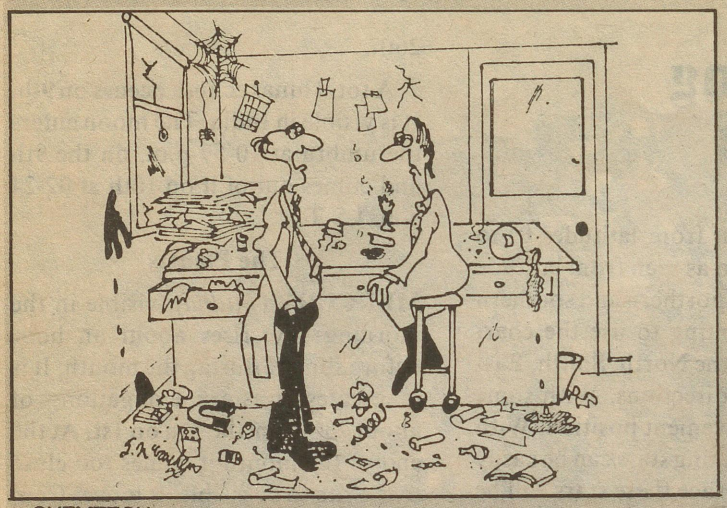
MARS (*Mangala*), visible in the morning sky, rises about two and a half hours before sunrise during the month. It is in Sagittarius (*Dhanus*). Its visual magnitude is about + 1.3.

JUPITER (*Brihaspati*), visible in the evening sky, sets about three hours before sunrise during the first half of the month and about four hours before it during the second half. It becomes direct on 25th. It is in Gemini (*Mithuna*). Its visual magnitude is about — 2.5.

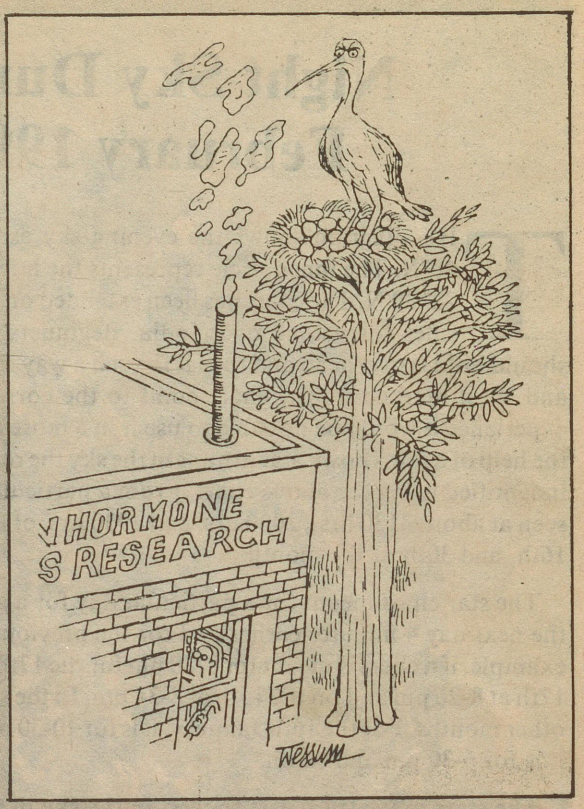
SATURN (*Sani*), visible in the morning sky, rises about one and a half hours before sunrise during the first half of the month and about two and a half hours before it during the second half. It is in Sagittarius (*Dhanus*). Its visual magnitude is about + 0.6.

(*Source*: Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta-700053)

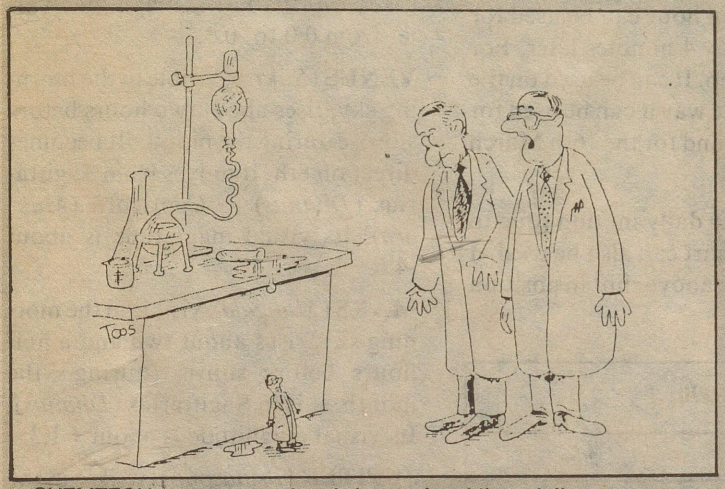
CARTOONS



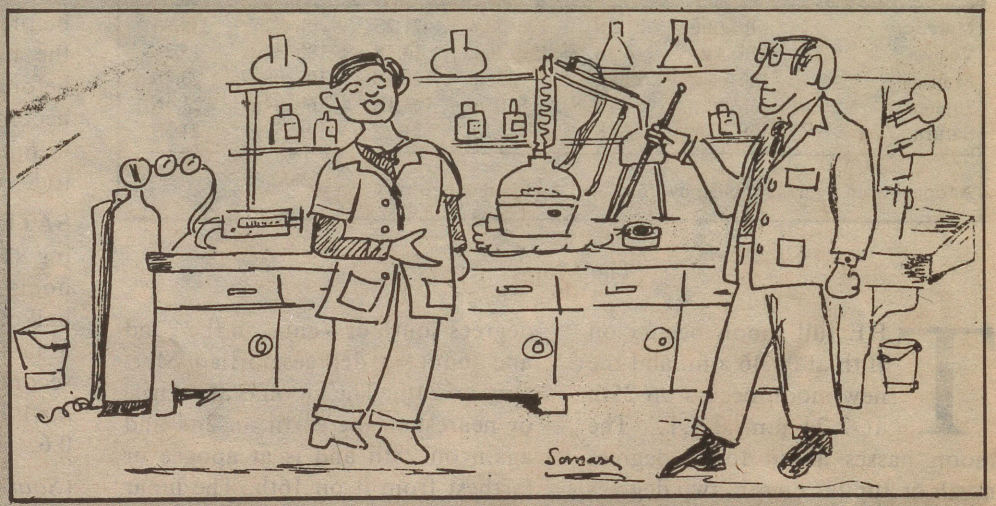
CHEMTECH *"Cleaning goes against the natural order. Haven't you heard of entropy?"*



CHEMTECH



CHEMTECH *"I suspect there's been a breakthrough."*



"I thought that the temperature was throughout constant, sir. I did not suspect that the thermometer bulb had broken inside the thermowell.."

Happy Journey Without Motion Sickness

"Hello Bela! What brings you here?"

"Doctor, I am going out for holidays———"

"Splendid! Why should that bring you to your doctor?"

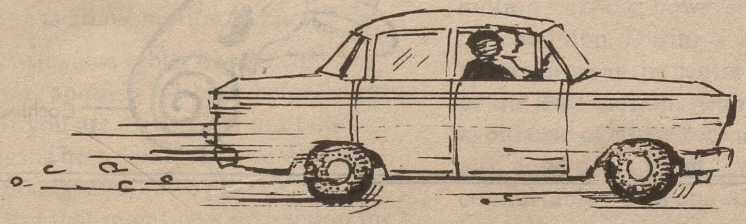
"It's my sister, Doctor. She feels nauseated and starts vomiting as soon as she sits in the bus."

"Oh! That means, your sister has got a tendency for motion sickness."

"What does that mean, Doctor? Could you kindly explain?"

"Yes! Motion illness implies that — one experiences nausea and vomiting when travelling by road, rail, sea or air."

"How does that happen, Doctor?



"The motion of ships, cars, aircraft, swings, etc., disturbs the balance organ of the inner ear and sets up a chain of reflex actions that may radiate to the vomiting centre in the part of the brain known as *medulla oblongata.* It is the lowest part of the brain. To put this in other words, the movement of the vehicle upsets the relation between what the eyes see and what the balance mechanism of the inner ear feels. The eye adjusts to the movement, whereas the inner ear does not and the resulting signals from the eye and ear do not tally."

"My friend felt the same, when she had gone to Srinagar."

"Yes! that is also a similar sickness. It is called altitude sickness. This results from the difference between the pressure inside the middle ear and that of the surrounding atmosphere."

"Yes Doc! But I had a similar giddiness when an E.N.T. specialist washed my ear from inside, that is, by inserting a syringe-like instrument in my throat."

"You are right Bela! The same reflex of motion sickness was set off by artificial stimulation of the balance organ due to the squirting of cold water into the ear."

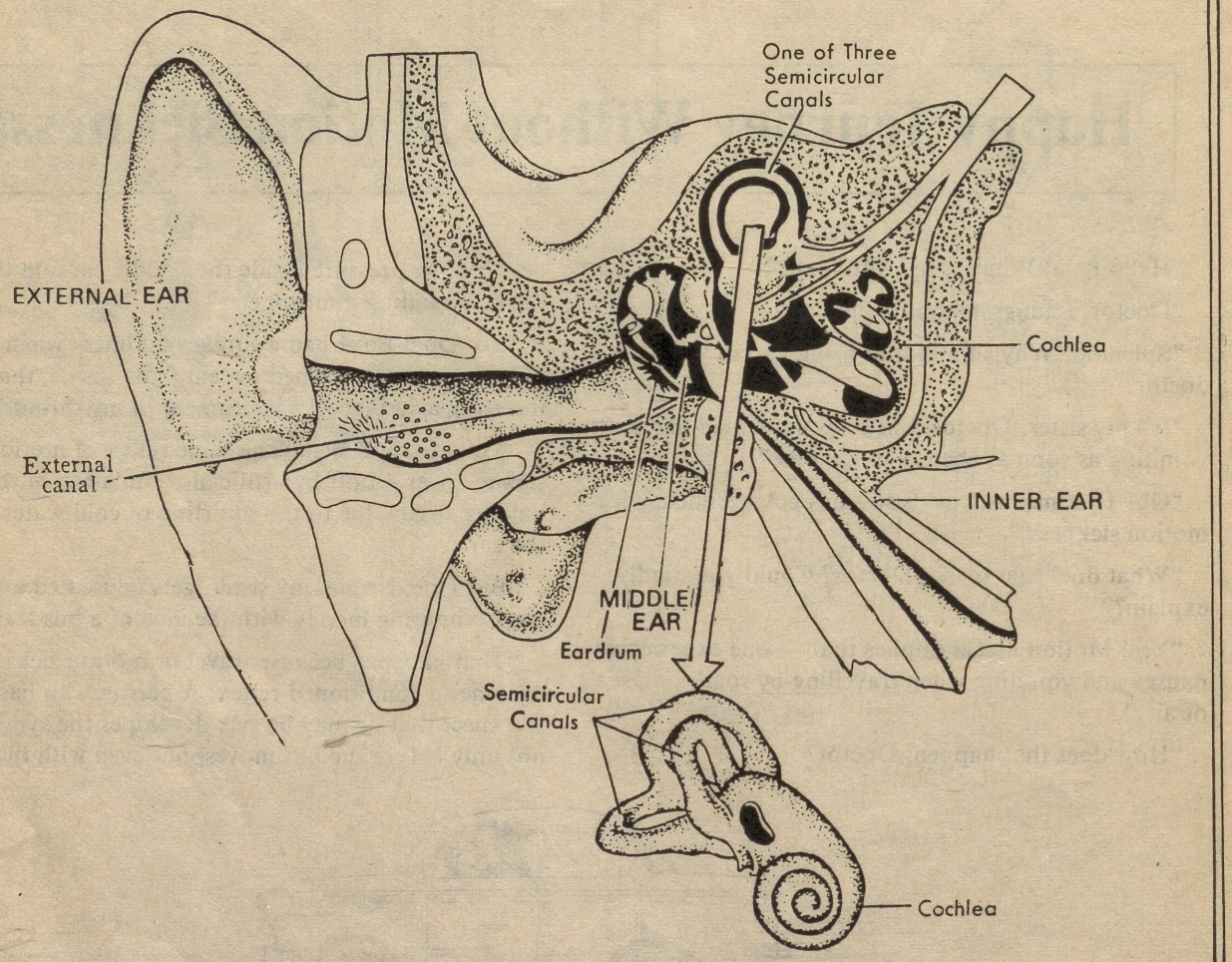
"But Doc, Neena, my sister, gets nauseated and starts vomiting merely with the idea of a bus travel."

"That happens because travel or motion sickness becomes a conditioned reflex. A person who has learnt to expect that he may be sick developes the symptoms not only before the bus moves, but even with the idea of the travel. It's a kind of hypersensitivity of mind."

"Does it mean than that motion sickness is purely psychological?"

"No! you can't label it like that straight-away. It would be injudicious. If it was of purely psychological origin, how could it affect small babies or animals? However psychological or emotional element is not to be lightly dismissed. An attack can often be averted by keeping patient's mind occupied. In small boats a spell at the tiller can work wonders, or in larger boats a walk on the deck! But .... if the attack has already begun the patient can seldom think of anything else."

"What are the other symptoms of this motion sickness, Doc?



"Nausea and vomiting, as you yourself described.

Appetite may be lost. A person may start sweating profusely. Also he may feel giddy."

"How can we make out if someone is getting such an attack?"

"The person's face may look pale. You may see 'cold perspiration' on his face. He might appear with a sick face. He might complain of abdominal discomfort sometimes even diarrhoea."

"But Doctor, after the journey begins, Neena starts feeling better."

"She is fortunate, Bela! Most cases of motion sickness vanish quickly once the journey is over, leaving no ill-effects. Why so? That is because most individuals quickly adapt to travel in an airplane, or a ship or an automobile. Few are wholly immune to motion sickness. But Bela, Neena is in good company. Even astronauts become ill if the inner ear organs are continuously stimulated by unusual motion."

"If I am not too inquisitive, could you explain the mechanism of motion sickness in greater detail?"

"Oh! That's good. You are getting deeply interested in the subject, isn't it? I will explain that to you. The inner ear possesses three semicircular canals, located at right angles in three different planes. Man is accustomed to movement in the horizontal plane, which stimulates certain semicircular canals; but he is not accustomed to vertical movement such as the motion of the elevator or 'lift' or a ship pitching at sea. These vertical movements stimulate the semicircular canals in an unusual way, producing the sensation of nausea, or motion sickness. Anxiety, grief or other emotions can also cause motion sickness, as it happens

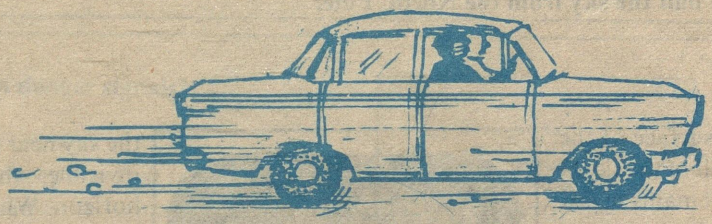
in the case of your sister with just the thought of travel."

"In air travel also do we get this illness, Doctor?"

"Yes! It is called air-sickness. It occurs during a bumpy flight caused by stormy weather or turbulent air. However it may also be triggered by poorly ventilated cabins, hunger, digestive upset, over-indulgence in food and drink and unpleasant odors, particularly tobacco smoke."

"Any First-aid-measures for the attack of motion sickness, Doctor?"

"For sea-sickness, rest lying down, with head held low, in a comfortable, well-aired place. For air-sickness, slide down in the seat as far as possible and keep the eyes closed. For car-sickness, stop the car and get out for a short walk. Keep a window open in the car and refrain from reading."



"Any do's and don'ts about motion sickness?"

"Do take a travel-sickness tablet like Ancoloxin, Avomine or Marzine, about 1/2-1 hour before starting out on a journey. If you are driving, do not take antihistaminic drugs. These will make you drowsy while driving. Do take games, toys, puzzles, audio tapes or anything else that might be a distraction for a child sufferer. Don't talk about the illness in front of a 'risk' person. Don't have a large meal or alcohol before setting out. Don't allow smoking in a car, if there is a potential sufferer."

"How do we treat an attack of motion-sickness, if one gets it?"

"Certain antihistaminics have proved highly effective in treating symptoms of sea-sickness. Mild sedatives may also be added. Patient should take small quantities of fluid regularly to avoid dehydration and try to eat small amounts of food regularly, *even if he is vomiting.*"

"When should one consult the doctor?"

"If there is severe pain in the abdomen together with sickness---"

"What will the doctor do?"

"He will ensure that the nausea and vomiting are caused by travel sickness and not by any other disease. In severe cases he might give an injection to stop vomiting."

"Any way to prevent this illness, Doc?"

"Do not expect the illness. Be calm and sensible. Do not stimulate the imagination of a possible sufferer. Allow time for a stop every hour on a car journey with children or susceptible adults. Keep warm with plenty of clothing in winter. In summer put on minimum of clothing. Keep a car window slightly open. Do not read during the journey. Being rested and in good health prior to a journey helps to prevent motion sickness. A cup of strong coffee taken just before departure may also be helpful. Alcoholic beverages in moderation make some people less nervous and thus help ward off motion sickness; however, in excess they can aggravate the condition. During a voyage by boat, it is advisable to remain near the centre of the ship, where there will be the least motion. Ample fresh air and exercise and avoidance of stuffy rooms and disagreeable smells are also good precautions. The traveller should keep comfortably warm and avoid over eating and rich foods. In car-sickness, children will frequently find it helpful to glance downwards. One more tip, avoid moving your eyes from side to side as you ride in a car. Keeping them fixed instead on the road ahead."

"Does this motion sickness, permanently dog a person throughout his life?"

"Most children grow out of car-sickness, but some adults are always vulnerable to travel sickness and in most severe circumstances, e.g., a ship in a rough sea, even the hardiest may succumb."

Suresh Nadkarni
Flat 38-39, 5th Floor
Municipal Building
Jobanputra Compound
Nana Chowk, Bombay-400007

Q. Which was the metal first discovered by man?

Neeraj Kumar Jain
A.O.A. Company, P.O. Kumhari,
Distt. Durg (M.P.)

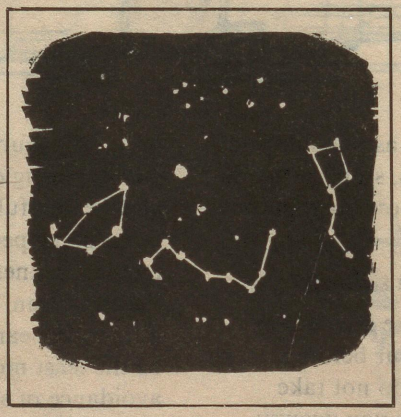
A. Gold, copper, silver, lead, tin, iron and mercury were among the few metals known to man since antiquity. It is generally agreed that gold in the form nuggets occurring in the sand of river beds was the first metal discovered by mankind in the latter part of the stone age. Since antiquity it has been used for making ornamental objects.

S.S. Saksena

Q. Why does one see only half the sky from the North Pole?

Shravan Kumar Vaishya
PHC, Surat Gunj
Barabanki (U.P.)

A. From any point on the surface of the earth one can see only half of the sky at a time as the other half remains below the horizon. At night, as the earth rotates and some stars set and others rise, the sky appears different from different places because the surface of the earth is curved. From the equator all the stars of the sky can be seen to rise and set. The Pole Star, of course, appears stationery on the northern horizon. But as one moves towards the poles, stars in the part of



the sky near the opposite pole become invisible—they never rise above the horizon. When one observes the night sky from the pole—it does not matter whether north or south—one can see only half the stars in the sky. They neither rise nor set, but go round in circles in the sky parallel to the horizon. The stars in the other half of the sky, between the equator and the opposite pole, never rise over the horizon and always remain invisible.

Biman Basu

Q. When a piece of sodium metal is put in water why does it catch fire?

Santosh Kumar Singh
Sultanpur (U.P.)

A. Sodium metal has a great affinity for water and reacts with it to liberate hydrogen gas and considerable amount of heat (exothermic reaction)

$$1\ Na + 2\ H2O = H2 + 2\ NaOH$$

The heat liberated is sufficient to ignite hydrogen gas which is inflammable. This accounts for the seemingly violent reaction between sodium metal and water. Because of the tremendous affinity for water, sodium metal is always kept immersed in solvents like kerosene, benzene, etc., in which the solubility of water is negligible.

S.S. Saksena

Q. What is a pacemaker ?

Sandip Kumar Yadav
548 A/5 Unchbagri
Rajapur, Allahabad (U.P.)

A. The regularity of heartbeat in a healthy individual is maintained by a bundle of special muscles in the heart known as the natural pacemaker. It sends out nerve singles to make the heart contract with a regular rhythm, at about 72 beats per minute in adults. This mechanism breaks down in some types of heart disease. As a result the heartbeat becomes irregular, sometimes, causing death. In such cases an artificial pacemaker can restore regular heartbeat. The artificial pacemaker is a battery-powered electronic device which delivers electric shocks to the heart muscles making it beat with a regular rhythm. The pacemaker is usually implanted in the body below the skin. The electric shocks are delivered with the help of a pair of wires inserted into the heart.

Biman Basu

Q. Why is red colour used in danger signals?

Anand Tiwari
11/3, Taldarwaja
Tikamgarh (M.P.)

A. There is a common misconception that red colour is used in danger signals because the human eye is most sensitive to red. Actually the human eye is most sensitive to the yellow part of the spectrum. However, since ordinary tungsten lamps also give out yellowish light which may be indistinguishable from yellow from a distance, red is better. Moreover, from traffic signals red and green from an ideal combination which can be easily distinguished (except by colour blind persons). Besides, being of longer wavelength, red light can be better seen through mist or fog and hence serves as an ideal danger signal.

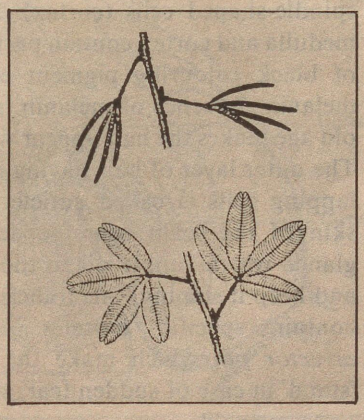
Biman Basu

Q. Why does the 'Touch-me-not' plant wilt down touched?

Abid Ali Khan
Lucknow (U.P.)

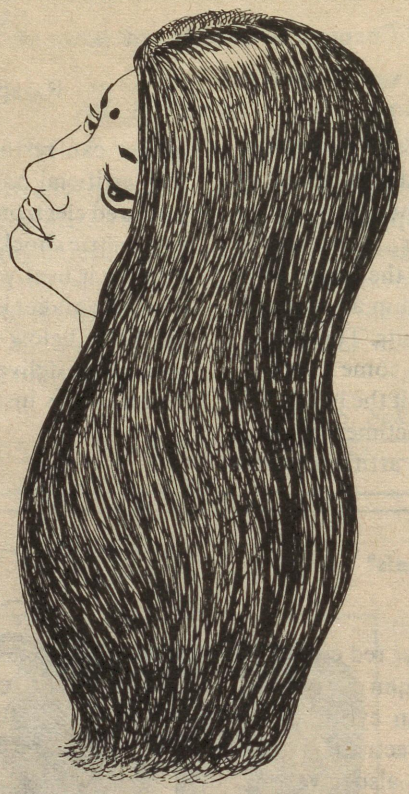
A. A leaf is made up of different types of cell. Each cell is filled with some fluid. This fluid pressure keeps the walls of the cells rigid and helps to keep the leaf-stalk upright. If the fluid is removed the pressure drops. Now with nothing to hold the stalk rigid the leaves droop.

In the leaves of *Mimosa pudica*, the lowering of pressure in the cells at the base of leaf and leaf lets occurs whenever the leaf is touched. Touching of leaves generates a stimulus which is conveyed to the base of each leaf and leaflet which ultimately leads to a drop in fluid pressure in the lower half of a group of cells there. However, the pressure of fluid in the upper half of that group of base cells remains unchanged. As the pressure in the lower half drops and that in the upper half remains unchanged, the leaf bends downward, aided to some extent by the weight of the leaf.



M.K. Singnai

Care — for long, lustrous hair



SANSKRIT poets, while narrating the beauty of their heroine, have compared her dense tresses with "dark rain clouds" and the hip-long, hanging *veni* with a "wavering snake". Silky, lustrous hair is the cherished desire of every woman. From adolescence till the age when hair start turning gray, ladies devote much of their time in shampooing, massaging, combing and styling. However, sometimes, lack of information in regard to products and processes they use inflicts much harm to hair than the desired good. For example, many shampoos with tall claims damage the scalp. Likewise, dyeing or bleaching may change the molecular structure of the hair, or drying wet hair with a dryer may damage the hair cuticle leading to dullness. It is therefore necessary to know the various characteristics of hair and its proper handling.

Structure

A normal human scalp bears approximately 1.5 to 2 lakh hair fibres. Each hair on human head has growing period of from 2-6 years at a time. Hair growth is not continuous, it goes into a resting phase every six months. The hair growth rate has been determined at about 1 cm to 1.5 cm per month. The roots of resting hair become club-shapped. It is the club hair that seem to come out on washing. Up to 10% of our scalp hair are in the resting phase at any one time. The scalp loses approximately 100 hair per day.

Hair grows out of small cavities in the skin called follicle. A small projection called a papilla, containing nerves and blood vessels, lies at the bottom of the follicle and nourishes the hair cells. Each hair consists of root within the follicle and the shaft above the surface of the skin. The shaft is primarily made of the protein, keratine. The core (medulla) of the hair consists of large, cube-shaped cells which is surrounded by spindle-shaped cells (cortex). Both medulla and cortex contain particles of black colouring pigment called melanin. Absence of melanin in the old age makes the hair appear white. The outer layer of hair having overlapping cells is called cuticle. The skin of the scalp bears sebaceous glands which supply oil to the hair and keep it shining. The follicle also contains specific muscles called *arrector pili* which make the hair 'stand' in case of sudden fear, shock or severe cold.

The term "healthy hair" is however a misnomer because the main body of the hair is composed of dead cells and is similar in composition to nails, claws, horns and hoof. It is why it does not hurt when hair is cut. Only the root of the hair is living which initiates new hair after its resting phase is over.

Types of Hair

Normally we find three types of hair — straight, curly and Negroid. A cylindrical hair shaft produces straight hair, oval shaft will form curly or wavy hair, and a flattened shaft will lead to Negroid hair. Diameter of the hair exerts an important influence on mechanical properties of hair assemblies. Thicker fibres hold a set better. Combing, to some extent, increases the diameter and consequently the manageability of the hair.

Factors that Affect the Hair

Both internal and external factors affect the quality of hair. Stress (which sometimes leads to excessive falling of hair), ill health and poor diet, inadequate blood circulation and hormonal imbalance have a deleterious effect on hair. The external factors which have damaging influence on hair include : long term exposure of hair to the sun and the atmosphere, use of chemical dyes, bleaching, drying or heating hair for making it curly. Long term exposure results in breakdown of cuticle cells on the surface of the hair. The hairs become irregular, sharp and jagged towards the tip end. When the damage is severe, all of the cuticle is removed and hair ends split.

We have all observed the 'fly away'

phenomenon. On combing or brushing the dry hair, a static charge is developed in the hairs and they flung apart from each other due to repulsion. This static charge has a strong influence on hair manageability. This can, however, be done away with certain conditioners having antistatic cationic agents.

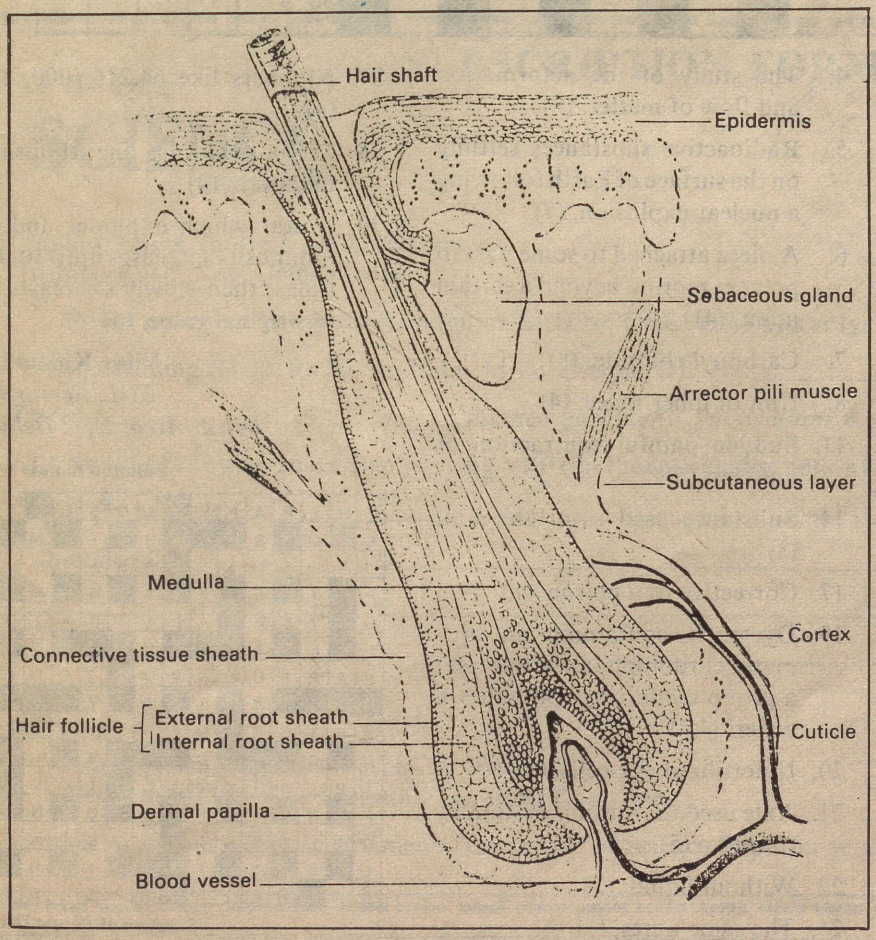
Bleaching and waving (curling) of hair both disturb the chemical and possibly the histological structure of the hair, as they affect the smoothness of the cuticular layer and change flatness of the hair surface. This will result in more light scattering and dullness in hair.

Hair Lustre : How to Improve It

Two properties determine the quality of hair—colour and lusture. Lustre depends on the property of light, scattering and reflectance. When a beam of light strikes a surface, part of it is reflected, part of it absorbed and part of it is scattered. Any deposits on the surface of the hair will diminish lustre as they will increase scattering of light at the cost of reflectance. Soil particles thus reduce reflectivity of the hair and impart dullness. Shampooing, by removing particulate matter, improves lustre. Soaps, which leave deposits of calcium and magnesium salts after washing, decrease light reflection. As such, to avoid deposits of these salts, soap should be applied at least two times. Good shampoos do not leave any deposits. Other products are also available which improve hair lustre. They provide a smooth coating to the hair.

The normal course to increase lustre is to apply oil to the hair. Small amounts of oil make hair dull as it did not form a continuous film on hair surface. However, oil applied in sufficient quantity levels out scaly surface of the hair thus improving hair shine. Researchers have found silicone oil coating very effective.

A number of hair conditioners are availabe in the market, but you will have to see for yourself which is good and harmless. Conditioners are products that, in addition to affecting combability, also improve hair styleability and manageability.

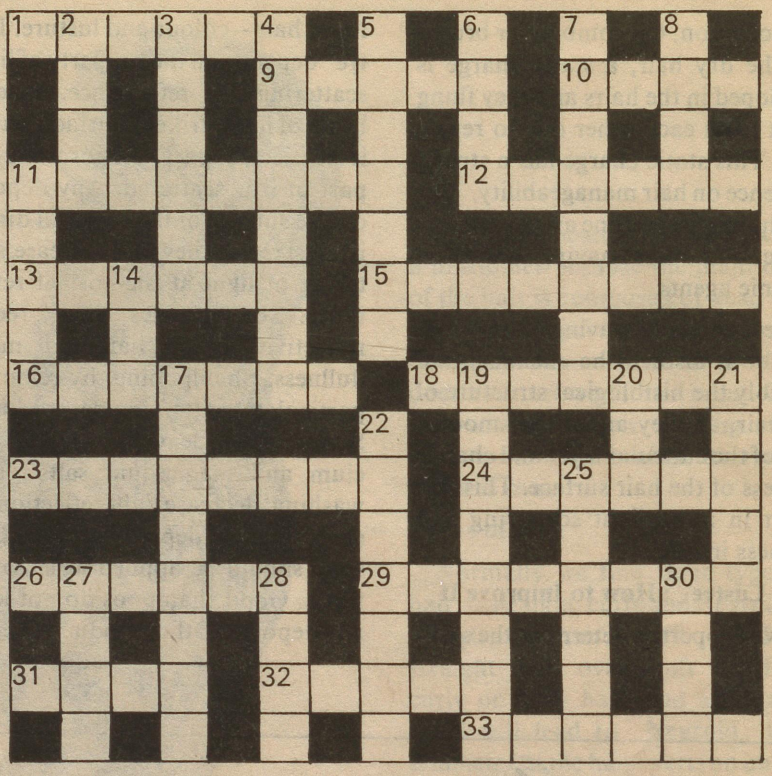


Dos and Donts

1. Wash your hair as often as required. Greasy hair need washing everyday, as grease picks up dirt easily. Do not be afraid to wash dry hair regularly either. If you leave it for more than a week, hair will become drier due to clogging of sebaceous glands in the scalp.
2. See that no traces of shampoo are left over.
3. Dry hair with a towel to remove excess water in case you want to use a drier.
4. Give massage to the scalp with fingers with your head down. This will improve blood circulation making hair roots stronger and healthier.
5. Add pomade, oil or a conditioner to give lusture to your hair.
6. Comb them starting from tips working back to roots with a comb or brush.
7. Make a hairdo of your choice.

C.B. Sharma

Crossword Puzzle



Across

1. Line connecting points having equal atmospheric pressure. (6)
9. A muscular pump with valves.(5)
10. Prefix pertaining to blood. (4)
11. A form of carbon produced by slow combustion of wood in an atmosphere deficient of oxygen. (8)
12. Fish. (6)
13. The US space programme for landing astronauts on the Moon and bringing them back safely. (6)
15. It contains about 10^{41} kilograms of matter. (8)
16. German-born Canadian John Charles ———, who shared the Nobel Prize with Dudley Herschbach and Yuan Tesh Lee for contributing to the dynamics of elementary chemical processes. (7)
18. Pertaining to gas. (7)
23. Nucleus of the deuterium atom. (8)
24. Large tree-climbing lizard of tropical America. (6)
26. A cord of fibrous tissue by which a muscle is attached to a bone. (6)
29. A type of star which after consuming its hydrogen contracts and becomes white dwarf. (3,5)
31. Plant with a sweet root. (4)
32. Spurious unwanted energy in an electronic or communication system. (5)
33. Browning of skin due to exposure to sunlight. (6)

Down

2. A frame in which window glass is set. (4)
3. Metal tube of a rifle. (6)
4. The study of the deformation and flow of matter. (8)
5. Radioactive substances settling on the surface of Earth following a nuclear explosion. (7)
6. A piece attached to some part to prevent motion beyond a certain point. (4)
7. Carbonyl chloride. (8)
8. Unit of inheritance. (4)
11. Sudden painful contraction of muscles. (5)
14. Substance used as a lubricant. (3)
17. Corrective to a poison. (8)
19. Dyestuffs containing an aromatic chromophoric group and a group conferring solubility in water. (4,4)
20. Unfertilized egg-cells. (3)
21. Axle used to transmit motion by rotation. (5)
22. Without liquid. (7)
25. The same notes. (6)
27. Numbers like 64,216,1000, etc. (4)
28. Prefix denoting one thousand millionth. (4)
30. A star which explodes and its luminosity increases upto 10,000 times, then slowly decreases to its original value. (4)

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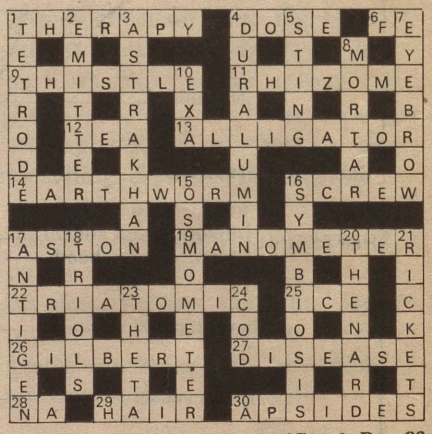
Solution in next issue



Solution of Puzzle Dec. 89.

PREVIEW

FEBRUARY 1990

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The Brave New World

BAL PHONDKE

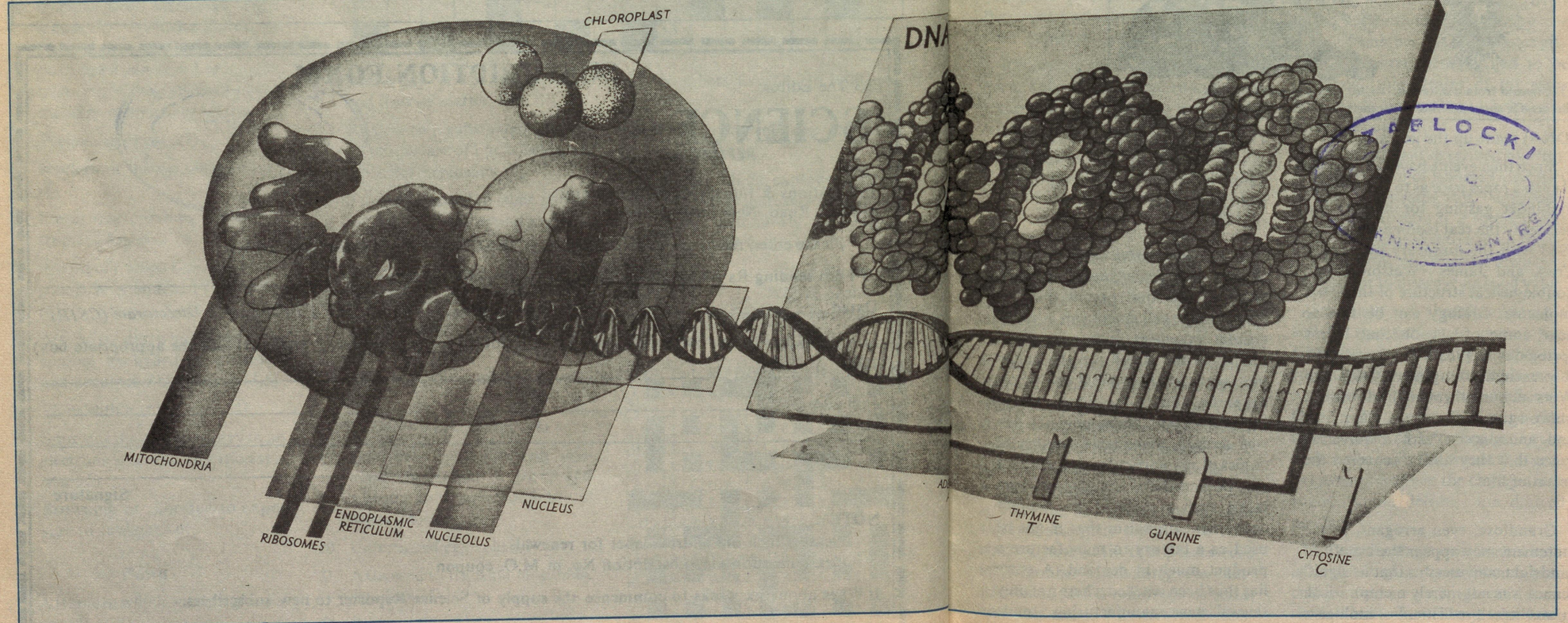
SHRI and Smt. Rajeev Sharma had been married for a decade now but the patter of small feet in the house had not caressed their ears. Both were healthy, their brothers and sisters had children of their own but Rajeev and Rita have so far had not experienced the joy and agony of having a child and bringing it up.

Pratap and Padmini Guha had a different problem. They too were healthy and without any discernible defuiting. They were blessed with a child too. Unfortunately, that child was at the same time a source of their unhappiness and concern. For the child was born a mongol, Down's Syndrome the doctors called it. Mentaly retarded as the boy was, they were concerned about his future as also afraid to have another lest it should also turn out to be so affected.

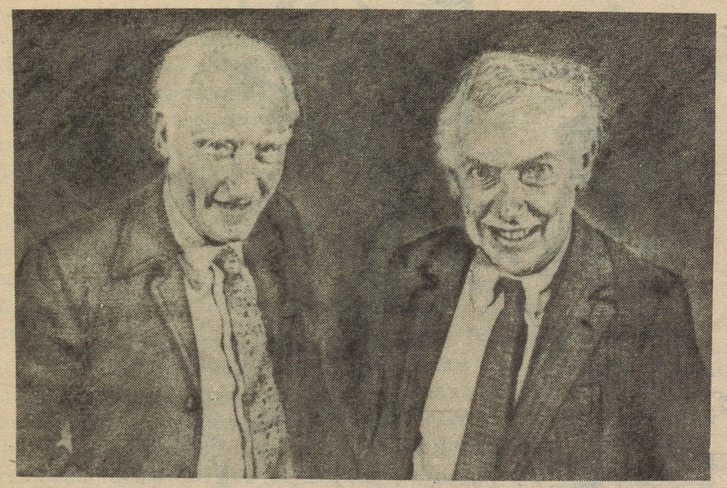
Dhondiba Muthunwar's problem was of a different nature. A poor farmer, he had an orange orchard. He and all his family would toil hard for days to envision the possibility of a bountiful crop only to see his hopes given a cold-shoulder by the early frost of winter.

None of these hapless individuals could have been helped more than a couple of decades ago, no matter which part of the globe they resided in. No longer need despair hold the sway. All of them and many more can not only be actively aided to overcome their predicaments but even assisted in preventing such dreaded predicaments. Thanks to the advent of that new scientific discipline, biotechnology.

In fact, not long ago even this name which derives from a confluence of two separate streams biology



ATGC: a simple code of four part which spells life



(Left) *Crick*, (Right) Watson

and technology would have been unthinkable. For, biology, a study of life form, was essentially an observational science. Scientists would patiently observe a living entity without disturbing it let alone tinkering with its constituents. Detailed information about the internal structure of that form came only from obscuring dead forms which then would be carefully dissected.

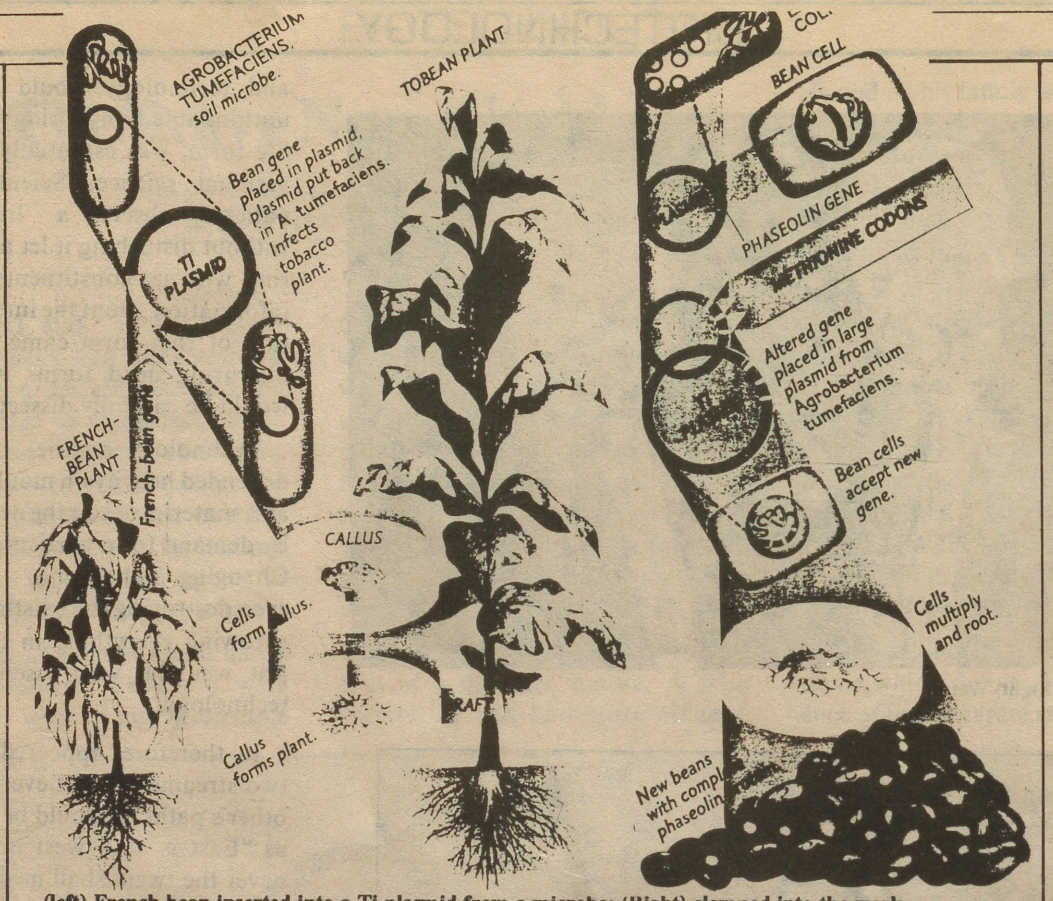
Technology on the other hand depended heavily on moulding available material to suit the need dictated by demand for a particular product. Changing, chopping, modifying, even destroying the existing order by throwing everything in the melting pot was the very essence of any technology.

It, therefore, appeared that these two streams will not ever cross each other's paths. It would be same story as "East is east, west is west. And never the twain shall meet".

But over the last couple of decades, the inevitable has happened. Not only have the twain met but have so associated with each other as to spawn the refreshingly new field of biotechnology which is so full of excitement.

IT is difficult to decide the precise birth data of this new baby of biotechnology. One could trace the origin back more a hundred years when that little known Austrian monk in the obscure little monastry in Czechoslovakia, Gregor Mendel, carried out some elegant experiments with the pea plant. He was perceptive enough to deduce from the results of these experiments the mechanism of heredity. He even went further and enunciated rules by which certain traits are inherited from generation to generation.

Mendel was unfortunately ahead of his time. He, therefore, was des-



(left) French bean inserted into a Ti plasmid from a microbe; (Right) clamped into the work-bench of E.coli plasmid, a phaseolin gene is supplemented with methionine codons

tined to suffer the fate of living in obscurity. Had the significance of his work and the import of his enunciations been recognised at that time the era of biotechnology might have been ushered in much earlier.

As events turned out, however, Mendel's reports remained buried in literature for more than three decades. It was only towards the end of the last century that his laws of heredity were discovered and the face of biology came to be changed for ever.

Still it took another half a century for the next important step. Although, the basic constituent of heredity at the cellular level was called the gene, its structure or composition was unknown until 1944 when O.T. Avery and his colleagues at the Rockefeller University, USA, discovered that the long-chained nucleic acid, the deoxyribonucleic acid (DNA) made up the genes.

Since then events have taken place at such a rapid pace as to leave even a bystander gasping for breath. But decidedly the real landmark came in 1953 with the discovery by Francis Crick and James Watson of the double-helical structure of the DNA molecule. Biology can be said to have come of age on that balmy spring day in 1953 when the two visibly excited young men, Crick and Watson, burst through the doors of a pub on the banks of the Cam river and announced with a quivering voice that they have discovered the secret of life.

Grandiose, even arrogant, as the statement may appear the benefit of hindsight convinces us that its significance was not merely metaphorical. It was indeed realistic. For biologists have not looked back since then. They gained the confidence that they can, if needed, do one better than nature by successfully attempting to rectify the latter's mistakes.

IN the last thirtyfive years biologists have learnt and developed several tricks that permit them to take a single cell even from a multicellular organism, isolate its DNA hidden inside which are the coded messages that help build the whole organism, chop the long-chained molecule at will, reassemble it in any way desired, make large number of copies of any particular segment that may be considered valuable and even insert such a segment in another convenient organism that might be used as a factory to manufacture a product much in demand. A stage has thus been reached where not only several new manufacturing units based on biological process would

get established but even some of these present-day plants employing chemical process might get replaced. With the chemical process showing their Mr. Hydelike ugly face of pollution the new biological plants would certainly be welcomed. The powerful tools already made available by this new technology which, everyone admits, is yet to reach its full stature, promise to help provide structures to three major problems afflicting mankind, hunger, sickness and energy shortages.

Even a country like India, which by no stretch of imagination can be considered to be at the cutting edge of this new technology, has already reaped bountiful harvests as a result of employing biological processes metaphorically as well as literally. The green revolution that has made the country self-sufficient in food has been a child of this new technology.

Impressive as the achievement has been, only the primitive concepts of biotechnology were used in improving crop yields. One finds in nature a large variety of strains of a particular species of plant. Each has certain advantages as well as some drawbacks. If a strain gives much better yield per hectare it might be susceptible to a disease which negates the advantage. Another might be resistant to the attack of the disease-bearing germs, but then might need a lot of fertiliser making its cultivation economically unviable. Yet another strain may have some of the bad or undesirable characteristics but would be extremely fastidious about the soil and climatic conditions needed for its growth rendering it unsuitable for mass cultivation.

What the new generation of agricultural scientists did was to construct a new strain that possessed a large number of advantageous characteristics with a minimum of unfavourable traits. This involved transferring the gene for a beneficial character to another strain lacking in it. This, however, was done by employing conventional biological techniques like crossing or mating the two plants and then carefully selecting those among hybrid progeny which now possessed the best of both the parents for further propagation. Not only is this procedure tedious but also time-consuming. With the pace at which mankind is increasing its size on this planet, the slow pace would have been self-defeating. If the agriculturists have been able to keep pace with the rate of growth of population the credit goes entirely to their perseverance and hard work.

NEW biotechnological processes not only help find short cuts that can accelerate the development of useful new varieties but also overcome restrictions imposed by the older techniques. So far the gene giving the desired benefits had to be obtained from strains of the same species. Biotechnology helps one cross that barrier.

An experiment described by Prof. Robert Weaver of Kansas University vividly illustrates this approach. According to him if a foreign gene can be introduced into a plant then it can be engineered to resist disease or drought or to improve its food value.

Scientists are, therefore, using a soil micro-organism to carry a foreign gene into a crown gall, a type of tumour that grows on some plants as a parasite, at the base of a sunflower. One might say at this stage that introduction of a foreign gene may perhaps be easy. But would that gene behave normally in the changed surroudings and deliver the derived product?

To answer these questions scientists took a gene from French-bean and inserted into a Ti-plasmid from the soil bacterium. The plasmid was then returned to its parent micro-organism. The latter was used to inject a tobacco plant.

After cells from the plant's crown gall were cultivated in the laboratory by supplying all the nutrients the cells developed into a fledgling plant. This tiny "baby" was then grafted onto the stem of a developing tobacco plant. The plant that matured expressed its own characteristics as well as that corresponding to the gene transferred from the french-bean. The new plant has, therefore, been named as Tobean. One can now think of a single plant that might provide all the nutritional requirements of man while giving adequate yields to feed all the population. Genetic engineers, as biotechnologists are being called, are trying to develop crops that can resist diseases and other stresses and even provide some of their own fertilisers. Others are employing the new tools to manufacture vaccines against diseases that attack farm animals or animals that are used as food. They may even engineer fitter and finer animals.

Food production, though important, is not the only field where the impact of biotechnology is going to be manifest. In the field of medicine, a large number of unfortunate individuals who fall prey to diabetes or those who suffer from dwarfism can be provided solace through the vehicles made available by the technology. Even more deadly ailments like heart disease and cancer can be tamed.

Scientists are even trying to employ bacteria to convert common wastes and garbages into alcohol, or natural gas so that the demands of the energy-hungry world can be adequately met.

Today there is mere promise than actual fulfilment. But that day too is not far off. For we are all set to enter what Aldous Huxley had so presciently called the "brave new world". □

In the World of BASIC-V

SO far it is not indicated how data is printed on a printer. There are two ways to do this. The first is to press simultaneously the SHIFT knob and PRINT SCREEN knob, which will transfer the contents of the screen on to the printer. However, when only output is required, LPRINT is typed in instead of PRINT in the line which is to be printed.

Now that the logic of writing a simple program is understood, one should understand what are the different commands that are part of Basic language. However, before that is discussed, the capability of a computer to perform calculations will be shown. While a calculator can certainly perform these computations, there is elegance when a computer is used. By combining a Print command and the actual operation, output becomes pleasing to the eye.

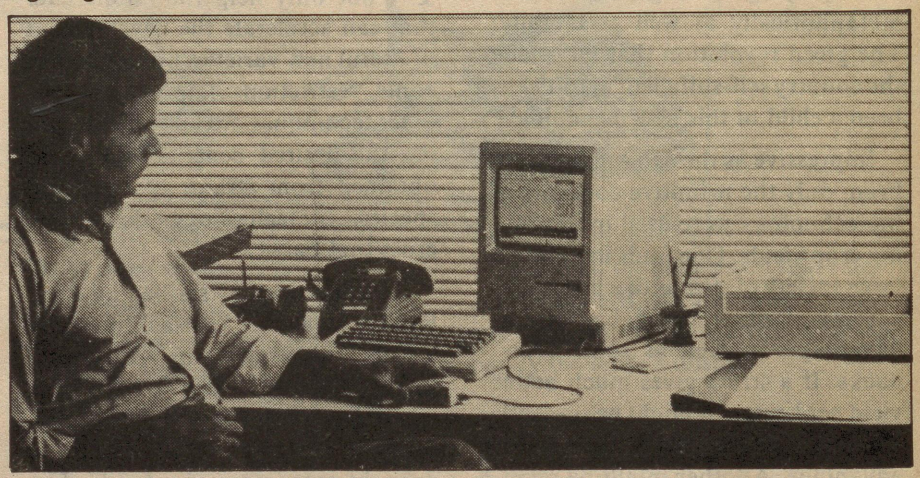
Mathematical Calculations

The following signs are used for the various mathematical calculations :

\+ Addition - Subtraction
* Multiplication / Division
** or > Raised to the power of

Now run Program 1 and see whether the output corresponds to what is given (see right side). Now the output of the same program can be made more attractive. This is easy to do as the Print command is interpreted in two ways. When PRINT is followed by a string (any matter enclosed between " ") it merely reproduces the string. But if the PRINT command is followed by an arithmetical operation, it computes and prints the result. Thus PRINT "2*3" will appear as 2*3 while PRINT 2*3 will appear as 6 in the output. By following the right syntax both the PRINT commands can be combined in a single PRINT statement. First type out PRINT followed by the string; follow this by a semicolon and then write the arithmetical operation. Thus writing PRINT "2*3="; 2*3 will give output as 2*3=6.

Accordingly, write each line in the Program 1 as given below viz., after giving the Print command, first enclose what is to be printed between strings followed by a semicolon and then the actual operation; the semicolon after the Print statement ensures printing on the same line viz., 20 PRINT "50+10="; 50+10. Note that one gap is left after = sign and as indicated a semicolon is used after the string; the gap after = sign gives some space and makes the printout attractive. Programm 2 shows all the steps written in this manner. When you run it, you will see the elegance which is absent in a calculator.



For writing very large of very small numbers the so called E NOTATION is used; E stands for exponentiation and thus one writes :

20000 as 2E+4
.00002 as 2E–4

INPUT	OUTPUT
10 REM CALCULATIONS	
20 PRINT 50+10	60
30 PRINT 50–10	40
40 PRINT 50*10	500
50 PRINT 50/10	5
60 PRINT 50 2	2500
70 END	

Program 1. Calculations

Hierarchy of Operations

The question arises : if a calculation involves more than one operation, how do they get executed? As the computer is structured to follow a logic, the following is the order in which it proceeds to perform :

Brackets are removed first, then exponentiation followed by Division and Multiplication and, finally, Addition and Subtraction are executed. In short, whatever is inside the brackets is evaluated first; if there are several brackets, they will be executed from the innermost to the outermost. In other words, when a detailed calculation is to be performed, the line/statement must be correctly written. If one wants to multiply 10 by the sum of 20 and 30, it should be

written as : Print 10* (20+30); writing the same as Print 10*20+30 will give the result as 230. In Program 3, these aspects have been shown. As can be seen, this Program has also been made more attractive by using printing command as before; in fact, whenever it is possible a Program should be written in this manner.

Library Functions

There are several functions which are often used in calculations and hence these are incorporated in Basic Language itself. These are called Library Functions; while the exact list of these varies from computer to computer, most computers provide the following ARITHMETIC FUNCTIONS :

SQR (X) The square root of X (X > 0)

ABS (X) The absolute value of X, i.e., the value of X if X is positive, and X without its minus sign if X is negative. For example, ABS (6) = 6, ABS (-5.5) =5.5 = ABS (0)=0.

INT (X) The inteoger part of X, i.e., the largest whole number that is less than or equal to X. Thus INT (6.7) = 6, INT (-8.4)=-9 and INT (.08)=0.

```
INPUT
10 REM LIBRARY FUNCTIONS
20 PRINT "NUMBER", "INTEGRAL", "ABSOLUTE", "SIGN"
30 N = 34.5
40 PRINT N, INT (N), ABS (N), SGN (N)
50 END
OUTPUT   NUMBER   INTEGRAL   ABSOLUTE   SIGN
           34.5         34       34.5     +1
```

Program 4. Library Functions

SGN (X) The sign of X. If X is positive, SGN (X)=+1. If X=0 SGN (X) = 0 and if X is negative, SGN (X) =-1.

LOG (X) The natural logarithm of X (X > 0), i.e. the power to which e (=2.71828) must be raised to equal X.

EXP (X) The exponential of X, that is, e to the power X.

RND (1) Chooses a number between 0 and 1 at random.

Some of these functions are very important in several Programs and will be illustrated later. For the time being a small Program (Program 4) shows calculation of Integer, Absolute and Sign of a number. At this stage you need not worry about the command in line 30.

INPUT	OUTPUT
PRINT "50+10 ="; 50+10	50+10 = 60
PRINT "50-10 ="; 50-10	50-10 = 40
PRINT "50*10 ="; 50*10	50*10 = 500
PRINT "50/10 ="; 50/10	50/10 = 5
PRINT "50 TO POWER 2 ="; 50 > 2	50 TO POWER 2 = 2500

Program 2. Calculations Made Attractive

INPUT	OUTPUT
PRINT "50+10*5= "; 50+10*5	50+10*5 = 100
PRINT "(50+10)*5 ="; (50+10)*5	(50+10)*5 = 300
PRINT "(50+10)* (50-10) ="; (50+10)* (50-10)	(50+10)* (50-10) = 2400
PRINT "(50+10*50-10) ="; 50+10*50-10	(50+10*50-10) = 540

Program 3. Hierarchy of Operations

In addition to these arithmetic functions, BASIC provides trigonometric functions for problems involving the measurement of sides and angles of triangles. These functions are also very important and are given below.

SIN (X) sine of X, where X is in radians.

COS (X) cosine of X, where X is in radians.

TAN (X) tangent of X, where X is in radians.

ATN (X) arctangent of X, i.e., the angle (in radians) whose tangent is X.

ASN (X) arcsine of X, i.e., the angle (in radians) whose sine is X.

ACOS (X) arccosine of X, i.e., the angle (in radians) whose cosine is X.

Here trigonometric functions have been defined in terms of radians because it is easier to work with it. A radian is approximately equal to 57 degrees or to be precise,

1 Radian = (180/Pi) where Pi = 3.14159.

In the next part the concept of variables will be introduced and then actual Programming.

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(To be continued)

Sun-Weather Connection

IT is common knowledge that the sun is the source of most of the earth's heat. This heat supply is maintained at a steady level which helps in creating an environment which is well suited to the development and sustenance of life on this planet. But, is the heat supply by the sun absolutely constant? If not, in what way does it affect the terrestrial weather and thereby life itself? Does the long term weather follow any pattern so that it can be predicted well in advance for the benefit of mankind? These are some of the questions under scientific investigation at present.

Attempts, quite distinct from superstitious beliefs, to connect happenings on the earth with the phenomena observed on the sun have a long history. In the modern times, William Herschel, the famous English astronomer of the eighteenth century, was perhaps the first to suggest that the price of wheat in the market may be related to the number of spots on the sun. Since then all kinds of phenomena, such as the incidence of heart strokes and epidemic diseases, the activity in the share market, have been related to the solar activity. It may be interesting to know that there sprung up organizations in the United States which prepared and sold to gullible investors charts of the behaviour of the stock market based on the dubious connection between stock market and natural cycles such as that of the solar activity and the appearance of planets. However, none of these relations have been scientifically proved. The connection between the terrestrial weather and the number of sunspots has been suspected for a long time but only in the last few years has evidence come to light which is suggestive of a link between the weather on earth and the level of activity on the sun.

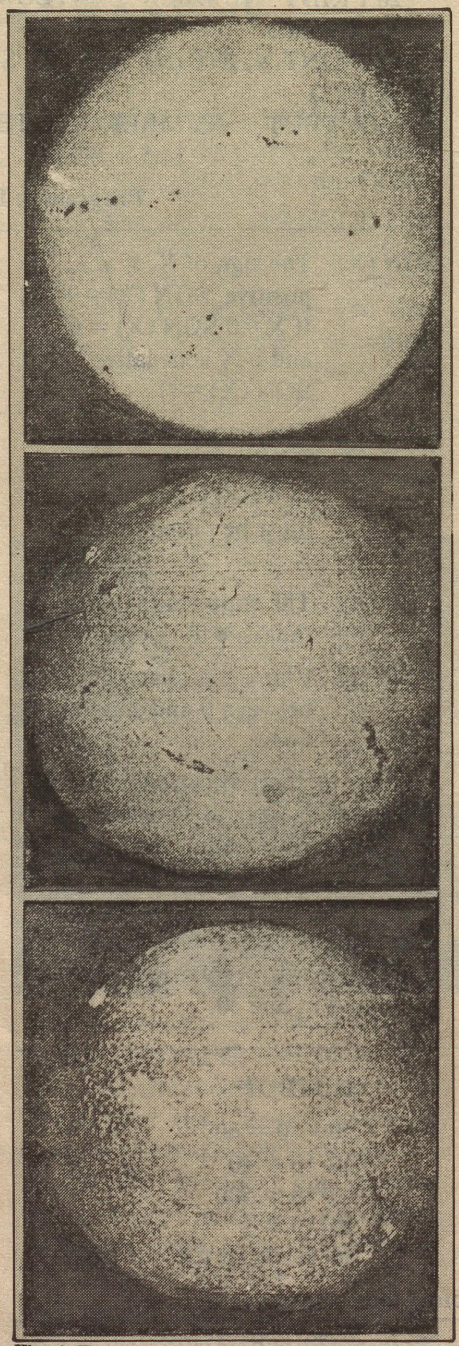

Fig. 1. The sun photographed through different coloured filters

THE solar surface seen through even a modest telescope shows the existence of dark spots (Fig 1). Most of these spots are quite small, only a few hundred kilometers across. The larger spots may be some twenty or thirty thousand kilometers across (in comparison the diameter of earth is 12,000 km). The very large spots are gigantic in size; the largest sunspot may approach a million kilometers across. The sunspots larger than about 40,000 km may be visible even with the naked eye on a clear day. The darkest region of a sunspot, called "Umbra", is about 1,500 degrees cooler than the normal solar surface whose temperature is about 6,000 degrees Kelvin. With a temperature of 4,500 degrees the sunspots are not really dark; they appear so only in contrast with their brighter surroundings. But, how does a cooler region survive for any length of time surrounded by hot regions? The secret lies in the strong magnetic field, of the order of a thousand gauss, that a sunspot possesses (by way of comparison, the strength of the magnetic field on the surface of earth is only a fraction of a gauss). The pressure exerted by the magnetic field plus the gas pressure at 4,500 degrees Kelvin is sufficient to balance the gas pressure outside the spot at 6,000 degrees Kelvin, so that the spot can live for weeks without being dissolved. Careful records of the sunspots have been kept from ancient times.

The sunspots do not stay at the same place where they first appear. Also, their number varies with a period of eleven years. At the beginning of a cycle, a few spots appear at a solar latitude of about 40 degrees north and south. Then they start drifting towards the equator and as they do so their number also increases. In about six years, their number reaches a maximum, while the migration towards the equator continues. In about 11 years, the sunspots have moved to a belt near the solar equator and their number has also decreased to the level at the start of the cycle. At the same time, the spots belonging to a new cycle begin to appear in the mid latitudes. The drift of the spots towards the equator and the variation in their number is shown in Fig 2, the so-called butterfly diagram because of its appearance. The other forms of solar activity, such as prominences and flares, also follow a periodicity of 11 years. This is, therefore, called the solar activity cycle. The underlying cause of the solar activity is the magnetic field present in layers just below the solar surface. The question is how the solar activity affects the solar luminosity (the total energy radiated by the sun per second) and what the implications of latter are for the terrestrial weather.

IT is known to all that the total energy received per unit time by a surface of area one square meter placed normal to the rays of the sun at the top of the earth's atmosphere is a constant quantity. This, the so-called solar constant, has a value of about 1368 watts per square meter. It is this constant that enables us to fix the temperature of the solar surface. Of all the energy that falls on the earth, about 15 per cent is retained by the atmosphere. The rest is absorbed by earth. Of this about half is re-emitted by earth. But this re-emitted radiation cannot escape to the outer space now because it is reflected by the atmosphere. The atmosphere in this way acts like the glass wall of a greenhouse, allowing the radiation to come in but not allowing it to go out. The trapped radiation determines the average global temperature, which in turn determines the long term weather on earth. The greenhouse effect of the atmosphere depends on its chemical composition. One of its important constituents in this respect is carbon dioxide (CO_2). The amount of CO_2 in the atmosphere has been steadily increasing because of large scale burning of coal, oil and other fossil fuels, required mostly by industrial activity. It is feared that the rising amount of CO_2 may push up the average global temperature which may bring in its wake changes in weather harmful to the mankind.

Very precise measurements in the last decade, carried out with the help of instruments placed aboard artificial satellites, have revealed that the solar constant is not really constant. Its value has been found to vary with time, though the magnitude of the change is extremely small. It has been observed that since 1980 the value of the solar 'constant' decreased steadily at the rate of 0.019 per cent per year (Fig 4). If this trend continues, there will be a change in the solar luminosity of a fraction of a per cent by the end of the present century. If the number of sunspots was decreasing since its maximum in 1979, it

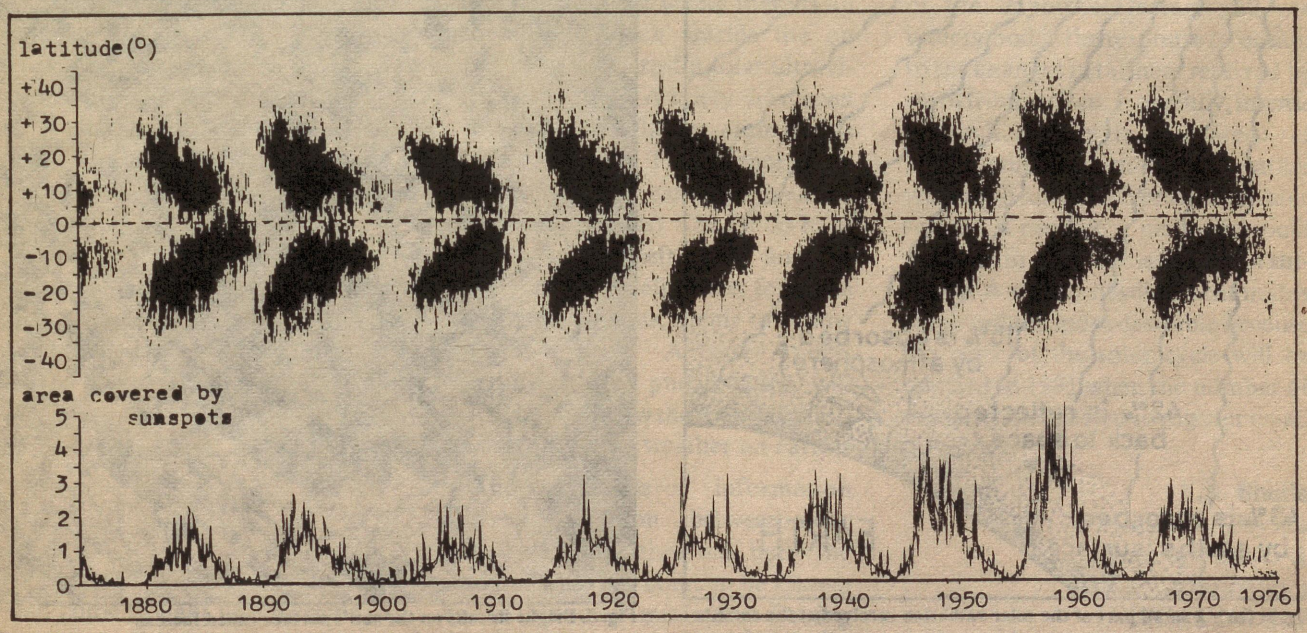

Fig. 2. The 'butterfly diagram' showing drift of sunspots with time

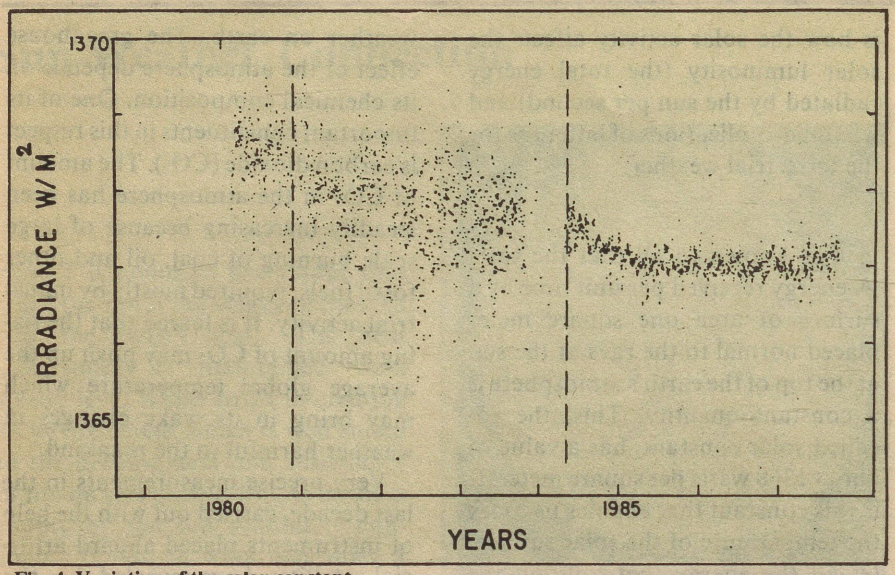

Fig. 4. Variation of the solar constant

would appear that the solar luminosity decreases in phase with the sunspot number. At first this might seem paradoxical as the solar luminosity is normally expected to decrease as the area blocked by the sunspots increases. The paradox is resolved if the large number of bright streaks of light, called faculae (Fig 5), which appear as the solar activity approaches its peak, are taken into account. The faculae make up for the decrease in luminosity caused by the light blocked by the sunspots. So, the solar luminosity decreases or increases as does the number of sunspots.

The extent to which the varying solar luminosity might affect the

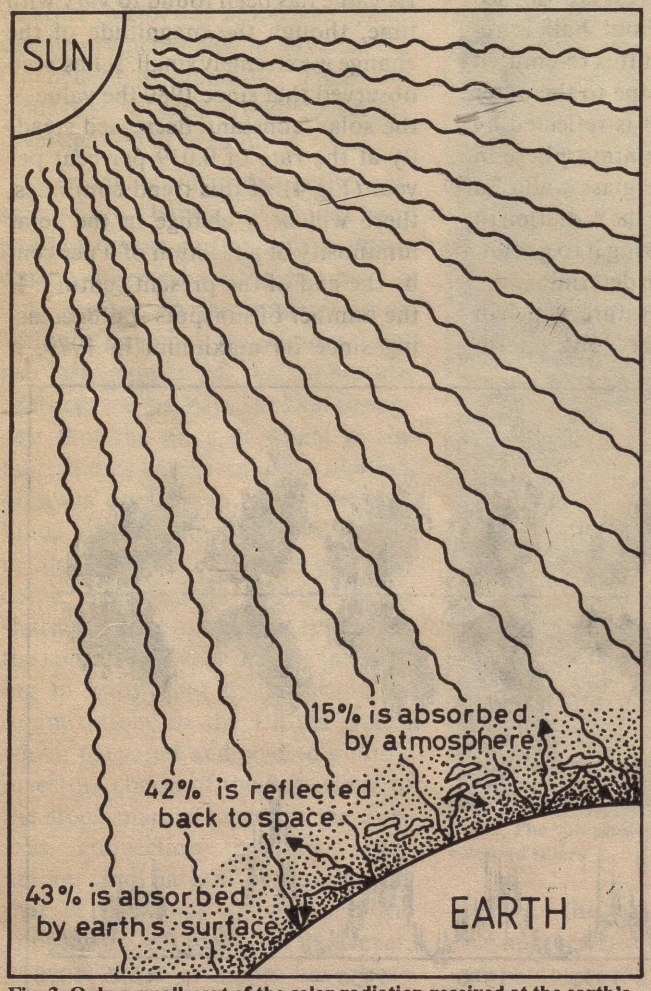

Fig. 3. Only a small part of the solar radiation received at the earth's surface is absorbed by theatmosphere and may cause the greenhouse effect

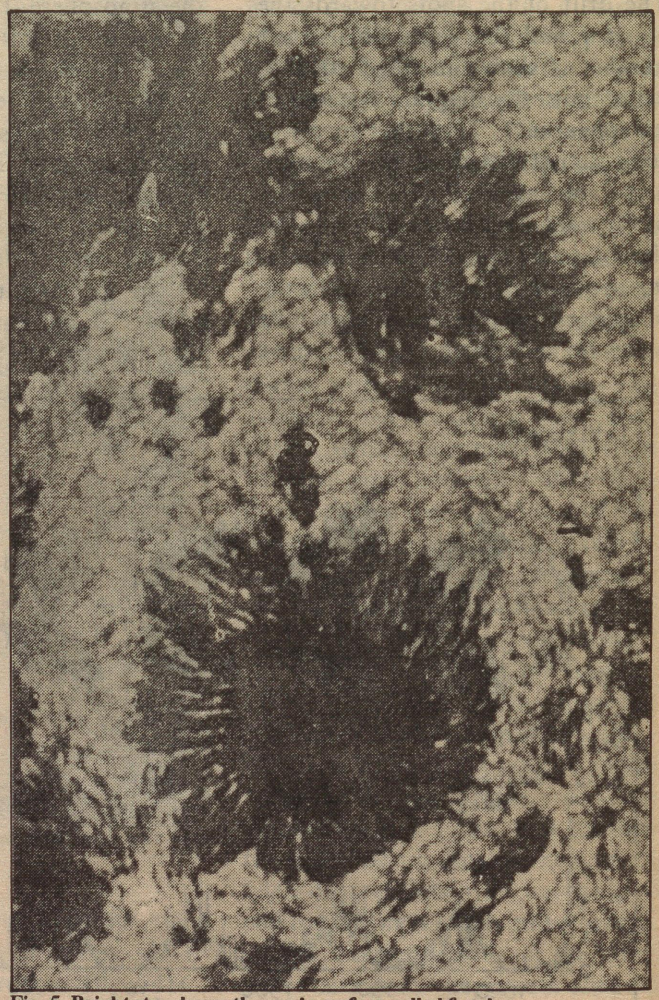

Fig. 5. Bright streaks on the sun's surface called faculae

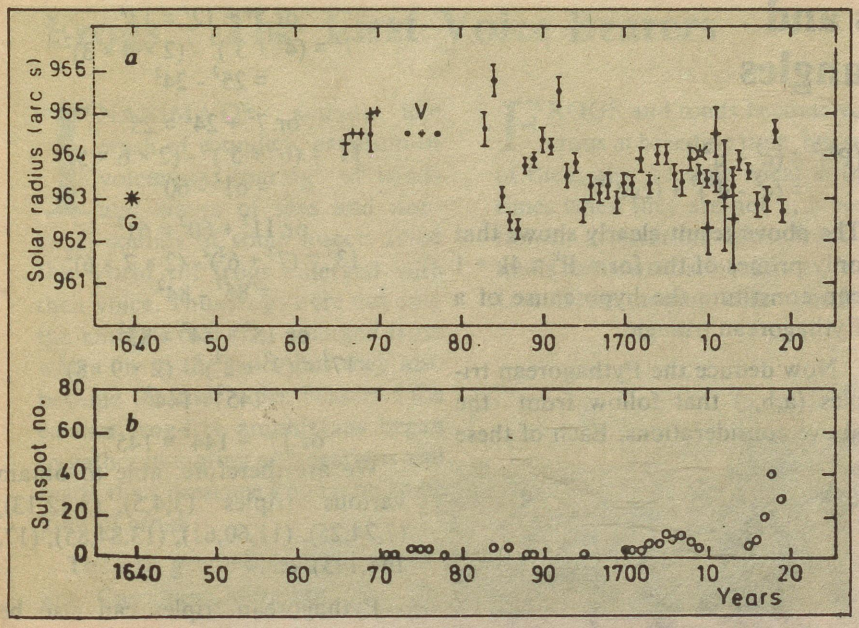

Fig. 6. The Maunder minimum. Between 1640 and 1670 hardly any sunspots were seen

weather is not known at present. The weather is a complex phenomenon, determined by a large number of factors, and it is difficult to isolate one single factor affecting it. And then there is CO_2 which is suspected to push up the average global temperature. It has been shown, however, that even the most alarming of the CO_2-generated global warming models do not explain the observed temperature changes and other phenomena that depend upon the temperature changes. The changes in solar luminosity are definitely required to explain these changes. In fact, to put the argument in reverse, there is a need to understand the effect of solar variability on the temperature changes on earth in order to assess the impact of man's reckless actions contributing to the increased CO_2 level in the atmosphere.

IN the last few years, another fact has come to light which seems to link the weather on earth directly with solar activity cycle. Every two years there is a sudden reversal in the direction of stratospheric winds in the tropical regions of the earth. (Stratosphere is the region of the atmosphere of earth above troposphere at a height of about 25 km. Incidentally, troposphere is that part of the atmosphere where there is an ozone layer which shields life on earth from the harmful solar ultraviolet radiation. Anxiety has been expressed about the depletion of this ozone layer too). This phenomenon has been called the quasi-biennial oscillations (QBOs). The QBOs have two phases, the left phase and the right phase. The left phase, for some mysterious reasons, seems to follow sunspot activity. A better understanding of this phenomenon will throw light on how the solar variability may influence weather on earth.

Another source of information about connection between solar activity and weather has been the study of what has come to be known as the Maunder minimum. During the 17th century there were abnormally few spots on the sun (Fig 6). The weather records show that at that time Europe went through an extremely cold weather, sometimes called the 'Little Ice Age'. Analysis of the observations seems to indicate that there was a slight increase in the solar radius and a slight decrease in the rate of solar rotation. Both these factors could bring about a decrease in the solar luminosity of a fraction of a per cent sufficient to cause the little ice age.

ALTOGETHER, there is now little doubt that the solar variability could bring about profound changes in weather pattern on earth. There are reasons to believe that the abnormally cold weather experienced by Europe and America during the last year and the twnety-two year drought cycle in the United States is due to the variation in the solar luminosity.

A working model of the weather which might predict sufficiently in advance the weather on the earth on the basis of the observations of solar activity is still to be developed. One of the important factors still not understood is the response of oceans to the changes in the heat received by earth from the sun. Hopefully, intense research activity in this area of science will lead to models of weather which will have some predictive value so that, if necessary, measures could be taken in time to lessen human suffering. A speedy development in this area is all the more desirable because the peak of the solar cycle will be reached in 1991 when the number of sunspots is expected to register an all time high.

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Prime Numbers and Pythagorean Triangles

Pythagorean triangle is a rich source of mathematical entertainment. Working with this triangle many enthusiasts have derived many interesting and curious results. The present article is devoted to examining a very interesting proposition, whether any arbitrary prime can form the hypotenuse or one of the sides of a Pythagorean triangle? Also, outlined in the article is an alternative method for obtaining the Pythagorean triples.

It is well known that any prime P (except 2) can be expressed as the difference of two squares as

$$P = \frac{(P+1)^2}{2} - \frac{(P-1)^2}{2}$$

or $P = a^2 - b^2$

However, all primes cannot be expressed as the sum of two squares. Only those primes are expressible in this manner which are in the form $P^k = 4k + 1$

If the prime P is squared, the above relation can be written in the form

$$P^2 = (a^2 - b^2)^2$$
$$= (a^2 + b^2)^2 - (2ab)^2$$

This relation can be expressed as:

$$P^2 + (2ab)^2 = (a^2 + b^2)^2$$

This result at once reveals that any prime barring 2 can form one of the sides of a Pythagorean triangle. Now investigate the possibility of a prime forming the hypotenuse of a Pythagorean triangle. As already stated, primes of the form $P^k = 4k + 1$ can be expressed as the sum of two squares, viz.,

$$P^k = c^2 + d^2$$

Taking the square of the prime P^k leads to

$$(P^k)^2 = (c^2 + d^2)^2$$
$$= (c^2 - d^2)^2 + (2cd)^2$$

The above result clearly shows that only primes of the form $P^k = 4k + 1$ can constitute the hypotenuse of a Pythagorean triangle.

Now deduce the Pythagorean triples (a,b,c) that follow from the above considerations. Each of these

Pythagoras

triples will correspond to a Pythagorean triangle whose hypotenuse or one of the sides is a prime.

Using the formula for P given above, the various primes as the difference of two squares can be expressed as:

$3 = 2^2 - 1^2$ $\quad$ $11 = 6^2 - 5^2$
$5 = 3^2 - 2^2$ $\quad$ $13 = 7^2 - 6^2$
$7 = 4^2 - 3^2$ $\quad$ $17 = 8^2 - 8^2$

The square of a prime expressible as $P = d^2 - b^2$ can be obtained from the formula

$$P^2 = (a^2 + b^2)^2 - (2ab)^2$$

Thus,

$$3^2 = (2^2 + 1^2)^2 - (2 \times 2 \times 1)^2$$
$$= 5^2 - 4^2$$

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

$$5^2 = (3^2 + 2^2)^2 - (2 \times 3 \times 2)^2$$
$$= 13^2 - 12^2$$

or $5^2 + 12^2 = 13^2$

$$7^2 = (4^2 + 3^2)^2 - (2 \times 4 \times 3)^2$$
$$= 25^2 - 24^2$$

or $7^2 + 24^2 = 25^2$

$$11^2 = (6^2 + 5^2)^2 - (2 \times 6 \times 5)^2$$
$$= 61^2 - 60^2$$

or $11^2 + 60^2 = 61^2$

$$13^2 = (7^2 + 6^2)^2 - (2 \times 7 \times 6)^2$$
$$= 85^2 - 84^2$$

or $13^2 + 84^2 = 85^2$

$$17^2 = (9^2 + 8^2)^2 - (2 \times 9 \times 8)^2$$
$$= 145^2 - 144^2$$

or $17^2 + 144^2 = 145^2$

We are therefore, able to obtain various triples (3,4,5), (5,12,13), (7,24,25), (11,60,61), (13,84,85), (17, 144,145), etc.

Pythagorean triples can also be derived from the primes $p^k = 4k + 1$ that are expressible as the sum of two squares, viz.,

$5 = 1^2 + 2^2$ $\quad$ $37 = 1^2 + 6^2$
$13 = 2^2 + 3^2$ $\quad$ $41 = 4^2 + 5^2$
$17 = 1^2 + 4^2$ $\quad$ $53 = 2^2 + 7^2$,
$29 = 2^2 + 5^2$

The squares of such primes ($p^k = c^2 + d^2$) can be expressed as the sum of two squares as follows:

$$(p^k)^2 = (c^2 - d^2)^2 + (2cd)^2$$

Thus,

$$5^2 = (2^2 - 1^2)^2 + (2 \times 2 \times 1)^2 = 3^2 + 4^2$$
$$13^2 = (3^2 - 2^2)^2 + (2 \times 3 \times 2)^2 = 5^2 + 12^2$$
$$17^2 = (4^2 - 1^2)^2 + (2 \times 4 \times 1)^2 = 15^2 + 8^2$$
$$29^2 = (5^2 - 2^2)^2 + (2 \times 5 \times 2)^2$$
$$= 21^2 + 20^2$$
$$37^2 = (6^2 - 1^2)^2 + (2 \times 6 \times 1)^2$$
$$= 35^2 + 12^2$$
$$41^2 = (5^2 - 4^2)^2 + (2 \times 5 \times 4)^2$$
$$= 9^2 + 40^2$$
$$53^2 = (7^2 - 2^2)^2 + (2 \times 7 \times 2)^2$$
$$= 45^2 + 28^2$$

We are thus led to another set of triples (3, 4, 5), (5, 12, 13), (8, 15, 17), (20, 21, 29), (12, 35, 37), (9, 40, 41), (28, 45, 53), and so on.

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Frogs : The First Voice Bearers

INANIMATE sounds like crash of thunders, eruption of volcanoes, roaring of winds and waves of seas and non-vocal sounds of some insects filled the world till frogs emerged with their voice. Thus frogs were not only the animals that first emerged from water on to the land, but they also became the first voice bearers : the earliest frog-like amphibians began to gather in mating aggregations and made their presence known by some kind of croak.

The first group of living amphibians, Caecilians, were voiceless. But some salamanders, like Pacific giant salamander, *Dicamptodon ensatus,* produce a low pitched rattling sound with the help of lungs. The lungless arboreal salamander, *Ensatina oschscholtzii,* produces a mouse-like squeak by expelling air from closed jaws or through nasal passages. Newts emit a sound similar to that produced by rubbing a wet finger over a glass plate.

FROGS and toads become vociferous at breeding time, but some of them also become vocal at other times when they are not in hibernation or aestivation. Most frogs and toads have two distinct kinds of calls. One is the mating call, specific to each species in its pitch, duration and periodicity. This mating call is produced with closed mouth and by vibrating air over the vocal cords.

The second type of call is the cry of distress or pain. This is produced with the mouth opened.

The voice of male frog of each species is distinct. Female frogs rarely use their voice. If at all they use, they give much weaker calls than the males, and they are not mating calls. Both the sexes produce sounds by the vocal cords on which air is pumped backward and forward. These vocal cords lie on the larynx in the throat between the mouth and lungs. The inner aperture of the nostrils opens into the roof of the mouth. When completely immersed in water, nostrils are closed and the air in the lungs will last until the frog comes up again. As the sound is produced even when the mouth is closed, the male can 'call' even under water.

Frog's vocal sac

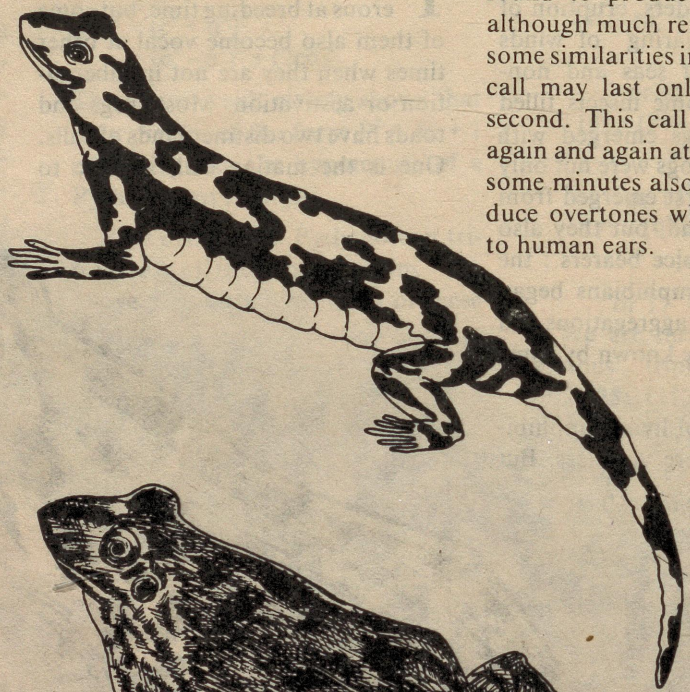
THE grunting sound made by frogs is quite different from the

mating call and is used to recognize sex. When a male frog siezes another male frog, the siezed one grunts as a signal for the first one to drop. A female frog, which has completed laying all eggs may also grunt when siezed, signalling the male that he is no more required to fertilize eggs.

The sound may be intensified in males of some species by a resonating sac. A small slit-like opening on the floor of the mouth allows air to move in and out of the sac. When making a call, the loose skin of the sac gets distended with air and at the cessation of sound the sac empties and becomes normal. Some species may have a pair of such sacs, one at each side of throat. Females lack the vocal pouches. The vocal sac is formed of an extension of the mouth cavity lined with layers of muscle and skin. When muscles are thick, the sac cannot balloon out, and this is called internal sac. Thin layers of muscles make it possible for the sac to expand.

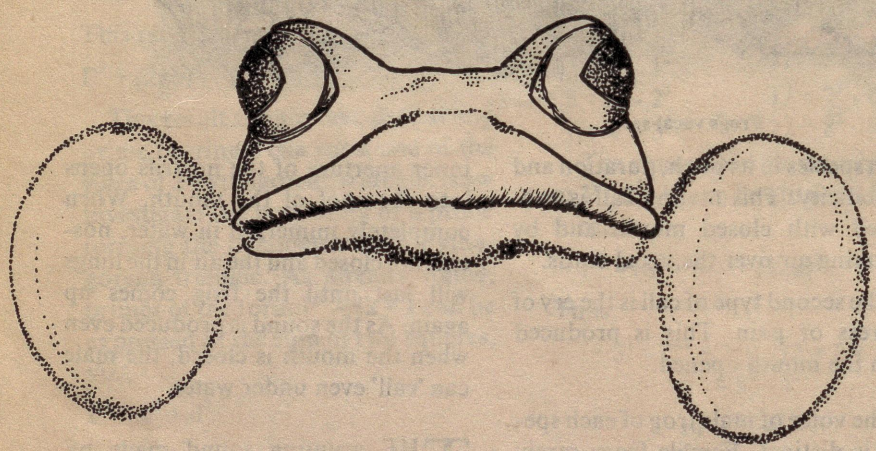
The voice of frogs is one of the signs of sexual maturity and ability to reproduce. *Rana esculenta,* the edible frog, is known to produce sound when it is eighteen months old, while *Rana temporaria*, the common European frog, produces at 14 months.

The duration of the mating calls is specific to the species producing them. When recorded on oscillograph, no two species have been found to produce identical calls, although much related species show some similarities in the calls. A single call may last only a fraction of a second. This call may be repeated again and again at short intervals for some minutes also. Frogs often produce overtones which are inaudible to human ears.



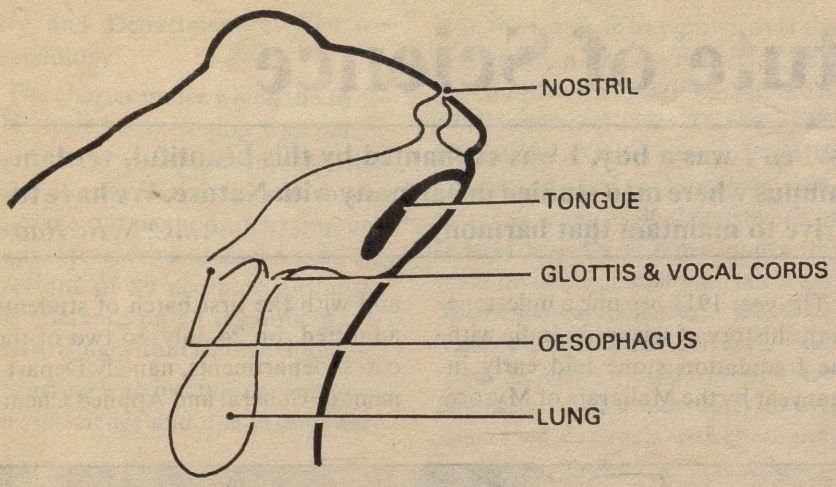
Salamander

Common frog



Lateral vocal sacs

Toad



Position of vocal cords

UNUSUAL calls of certain frogs gave rise to their popular names. Carpenter frog's (*Rana virgatipes*) calls sound like two carpenters striking nails at different times. The pig frog, *Rana grylio,* calls like a pig. Other interesting sounds are those of *Kassina senegalensis* (family Rhacophoridae), which makes a popping sound resembling that when a bottle is uncorked, and of *Phrynomerus bifasciatus* (family Phrynomeridae) whose call is like a shrill whistle which is audible for nearly one kilometer. Certain frog calls indicate the onset of storm. Tree frogs sing at the onset of a storm, probably stimulated by the rising humidity. The occasional croaking of frogs heard during summers is usually not for mating. These calls often respond to non-amphibian stimulus such as the whistle of a train.

The hearing mechanism in amphibians is correlated with the presence of voice. Salamanders and Caecilians have no visible external ears and can hear sounds which are below 244 cycles. Larval newts receive vibrations from the ground through lower jaw while resting and adult newts receive sound through fore-limbs. Frogs have a prominent ear (tympanum) located just behind eye, above the corner of the mouth.

Tree frog

DIFFERENT species have different degrees of hearing sensitivity. Experiments show that frogs are insensitive to sounds below 50 cycles per second or over 10,000 cycles per second (human hearing range is 16 c.p.s to 20,000 c.p.s).

Interestingly, in frogs, hearing is related to the homing instinct. The Southern toad, *Bufo terrestris,* is able to find its way with the help of the voices of its companions left in the pond, and could return from a spot more than a kilometer away from the pond.

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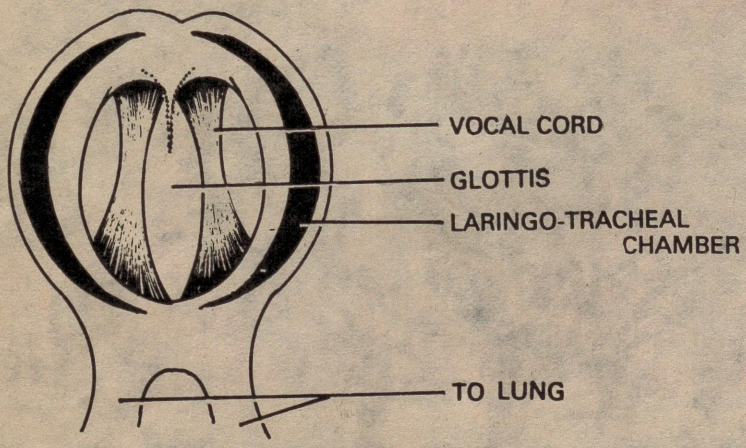


Laryngo-tracheal chamber cut open showing vocal cords

Indian Institute of Science

When I was a boy, I was enchanted by this beautiful, verdant campus where men studied in harmony with Nature. We have to trive to maintain that harmony." ....*C.N.R. Rao*

IT is neither a national laboratory which concentrates on research and applied work to the exclusion of teaching nor a conventional university which concerns itself mainly with teaching. Which is this unique institution? This could well be a quiz on national TV or radio. Or, it may not. For, more likely as not, every university student of science in India would come out with the correct answer.

Known popularly in Bangalore as the Tata Institute, the Indian Institute of Science (IISc) is veritably the Mecca of the students of science in the country.

The scion associated with the Institute's short name belonged to the nineteenth century but had the vision of the twenty-first century. He was Jamsetji Nusserwanji Tata (1839-1904) in whose mind the Institute took birth in 1898. He also provided the initial resources for its creation: an endowment to establish a University of Science for educating and developing the faculties of the best of our young men and women. What's more, Jamsetji did not want this institution to be just an ivory tower of learning or scholarship of the Victorian genre. He envisaged the application of the results of investigations for the benefit of the country. Three other men of enlightenment (apart from the Viceroys Lord Curzon and Lord Minto) were responsible for transforming Tata's dream into reality. Nobel Laureate Sir William Ramsay, of the noble gases fame, chose Bangalore as an ideal place for an institution of Jamsetji's vision. And, on the advice of his illustrious Dewan Sir K. Seshadri Iyer, the Maharaja of Mysore Krishnaraja Wodeyar IV offered land (372 acres) free of cost.

The year 1911 became a milestone in the history of science in India with the foundation stone laid early in that year by the Maharaja of Mysore and with the first batch of students admitted, on 24 July, to two of the oldest departments, namely Department of General and Applied Chemistry and Department of Electro-Technology.

The charter under which the Institute started functioning was that it "be devoted to experimental science and that it aim at training students in experimental methods, carrying out original research and discharging the functions of an accepted authority and reference on all scientific problems arising within its own domain".

Starting with just two departments (one in science and one in engineering), the Institute has grown over the years both in size and in stature, having completed its Platinum Jubilee in 1984 (reckoned from 27 May 1909 the date when the Viceroy signed the charter). Today the Institute comprises as many as 36 departments or centres broadly grouped under five main divisions, namely Physical and Mathematical Sciences, Chemical Sciences, Biological Sciences, Electrical Sciences, and Mechanical Sciences, besides four other centres concerned, one each, with continuing education, technical consultancy, rural development, and scientific information. And the hub of all its activities is the library, which has the pride of place among the specialised libraries in the country.

Many of the departments have been recognised by the University Grants Commission as centres of advanced study. These include the Department of Biochemistry, which is also an ICMR-recognised centre for research in reproductive biology; the Department of Inorganic and Physical Chemistry; and the Molecular Biophysics Unit. In addition, many departments/centres receive UGC's special assistance. These are the Department of Microbiology & Cell Biology, Department of Organic Chemistry, Department of Physics, Solid State and Structural Chemistry Unit, Department of Civil Engineering, Department of Electrical Engineering, and Department of Metallurgy.

Courses

Unlike the IITs which admit students for B.Tech. courses, IISc offers only postgraduate courses leading to Ph.D. in science or engineering, M.Sc.(Engg), M.E., M.Tech. and M.E. (Integrated). It is one of the institutions accorded the status of university by the UGC. In one respect, IISc has also the characteristic of a learned society or academy in that it confers honorary fellowships on eminent scholars and scientists and on those who have made noteworthy and lasting contributions to the cause of science and industry in India.

With the creation of the chain of Indian Institutes of Technology since 1950s many an alumnus or faculty member might have feared that the centre of gravity of science in the country would shift away from IISc. This has not happened mainly because the Institute is ever alive to the new challenges science and its offshoot technology pose to its practitioners. Its agenda of research and education is always in perpetual forward motion to reflect the changing paradigms in both research and teaching. One example should suffice to prove this point. Quick to realise the merit of Nayudamma Committee's reforms in postgraduate engineering education, IISc introduced a four-year integrated M.E. programme for science graduates.

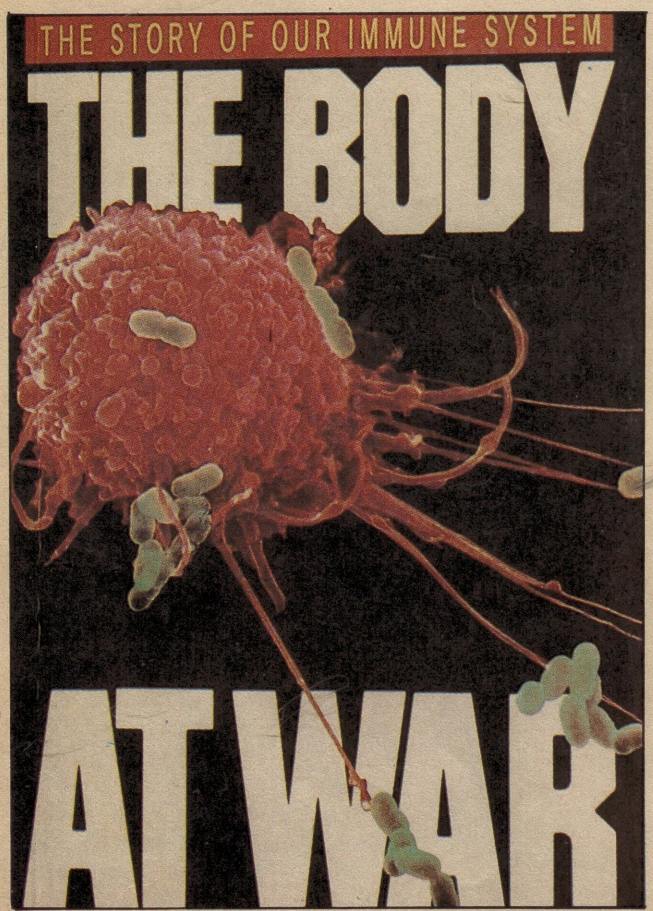
Impact on S&T Base

The Institute has been a reservoir of leadership and manpower to the country's scientific infrastructure as well as its industrial base. It would be superfluous to mention the names of those who have gone on from IISc to direct science and technology in the country. C.V. Raman, Homi Bhabha, Vikram Sarabhai, J.C. Ghosh, M.S. Thacker, S. Bhagavantham and Satish Dhawan, to mention a few, have all been associated with the institute in one capacity or another.

The Institute's departments and their faculty have played key roles in founding many a national laboratory, or a learned society, or a learned periodical. The Department of Biochemistry, for example, is not only the oldest department in this discipline in the country, it was also

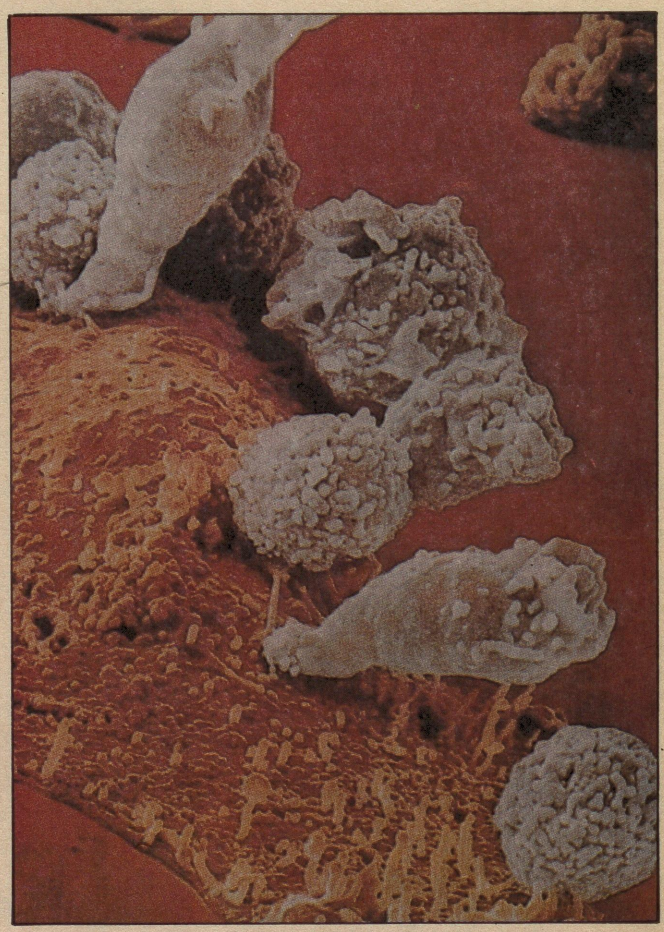
Story of Immune System

EVERY branch of science experiences at various times periods of sudden spurt in growth much like the period of adolescence in a person's life when physical as well mental growth takes a quantum jump. Later such a period is labelled as the golden age of that scientific discipline.



Physics, for example, enjoyed such a period of exceptional expansion around the turn of the last century. Though this branch of natural sciences has more or less dominated human creative and innovative endeavour throughout this century, the period of 1890's and the first decade or two of the present century is *sans pareil*. A large number of discoveries were made during that period of hectic activity. An equally larger number of new and imaginative apparatus were built, new grounds were broken, new theories proposed, bold new concepts aired. In the process, the entire discipline was given a new direction not to speak of the innumerable branches that developed and went along their somewhat independent ways. A period when the likes of Rutherford, Becquerel, Curies, Roentgen, J.J. Thomson, Einstein, Bohr were all making significant contributions all at the same time has to be unique.

Immunology or the study of the defence of the human body against inimical microbial or other agents has experienced just such a period of phenomenal growth in the last quarter of a century. The almost explosive addition to the fund of knowledge in this area during this period has not only helped the fledgeling discipline



A brown cancer cell being attacked by T cells

establish itself as a robust and vibrant branch that threatens to outgrow its parents, pathology and microbiology, but has also metamorphosed itself from the proverbial ugly duckling into a beautiful swan.

NOTWITHSTANDING this all round development the field had not attracted the attention of even students of other sciences let alone the common man. The excitment that has been almost infective had left the people cold.

The arrival of the scourge of AIDS changed all that. It suddenly made people sit up and take notice. This is quite in keeping with the general popular psyche. An useful institution really gets ignored until a tragedy or tracema let loose by the breaking down of that institution forces people to take note. It is the same human tendency that makes people display an ambivalent attitude towards a routine medical check-up in times of good health. However, at the slightest hint of sickness the very same people would panic and rush to the specialist urging him to undertake even some unnecessary tests.

The weakening of the immune systems in the face of an attack by the human immune deficiency virus (HIV) resulting in the manifestation of AIDS has forced people to crave for more knowledge about this crucial armour endowed by nature. It is not a mere coincidence, therefore, that a number of monographs explaining for the benefit of the uninitiated the fascinating network of the internal forces that keep at bay agents of infection have appeared on the scene over the last 5 or 6 years. Prof. John Dwyer's "The Body at War" is the latest addition to this genre.

For years Sir Gustav Nossal's *Antigens, Antibody and Immunity* published by Penguins was the only popular monograph on the subject. Excellent in its contents and bordering on the brilliant in its exposition this slim volume is now out of print and also out of date. Immunology has marched on relentlessly since then.

Recently, quite a few others have seen the light of day, notable among which are "Me or Not Me" by R.V. Petrov and "In Defence of the Body" by Gince Bari Kolata who used to appear regularly in "Science". Dwyer's book stands out because of the manner in which he has organised state of the art knowledge in the field.

THE monograph is divided in five parts encompassing different vignelles of the immune system including its absence. This helps the reader digest the excellent fare course by course and relish the individual item independantly.

Thus, having obtained a bird's eye view picture of the intricate set up of the defence organisation the reader can move on to understanding the mechanism by which these immune forces can be overcome whenever required or to realising what happens when the forces are defeated. This style of organising the information also helps the reader take in only as much as he needs to at a time.

But by far the most captivating facet of Dwyer's book is the literary or story-book style that he has adopted to put across a point and engage even the reluctant reader's attention. This is apparent throughout and the only way to express one's apreciation of this style is to quote the original.

To introduce the subject of immunology, right at the outset he begins with a "true-story".

"In the fall of 1972, I met an intelligent and worried mother. She told a distressing tale, as puzzling as it was intriguing. Now twenty-eight years of age, she had given birth to three children. The first, a boy, had been perfectly well and developed normally until he was thirteen months old. At that time the young family to which he belonged lived in rural Illinois. When the baby developed his first bout of high fever and irritability, his mother was not unduly concerned; she did not panic when their family doctor took a few hours to come to the house. However, the physician soon recognised that this baby's condition was worrisome: the child was toxic. Alarmed, he arranged for his admission to the nearest hospital which was a good fifty miles from his home.

Meningitis was suspected and then confirmed when streptococcal bacteria of a particular type known as pneumococcus were found in the child's spinal fluid he died twelve hours after admission. An autopsy revealed overwhelming sepsis but no clues as to why this previously helahty child should have become sick and died within twenty–four hours. A tragedy of course, lots of unanswered questions certainly, but, consoled the family doctor, 'These things happen occasionally, bacteria can be deadly. You are young and time and your future children will help ease this pain.'

The next baby born to this couple was a girl who arrived a year after the loss of their first child. Indeed, it was true that time and this beautiful infant did ease that earlier pain, for a while, at least. She was in perfect health and when she was fifteen months old, the family moved to Detroit. When, out of the blue, the child developed the onset of a high fever and listlessness, the now sensitised parents immediately rushed her to the emergency room of a university hospital.

She was admitted for observation and her condition rapidly deteriorated. Meningitis was diagnosed, together with pneumonia. The parents must have felt desperate as the all-too-easily-remembered scenario unfolded before them yet again. The same bacteria that had killed their son were found in their daughter's spinal fluid. Again, antibiotics were administered in large doses butwere useless against the rapidly multiplying bacteria. Once more, these parents lost their baby within twenty– four hours of the

onset of the illness. An autopsy was performed but showed no obvious abnormalities; the baby had simply been overwhelmed by the virulent organisms.

Another consulting physician in another hospital office did his best to answer the parents' anguished questions. How could this have happened to two babies, both appearing to be so healthy in their first year of life? 'It may be coincidence,' said the Detroit pediatrician, 'but it is also possible that there is a genetic defect in your children. Perhaps your babies do not have normal immune systems. They certainly seem to have been unable to present any defence with which to fight these invading bacteria.'

After much anguish, the parent decided on a third attempt at parenthood. A second beautiful and healthy baby girl entered their lives. When this most precious of children was nine months of age, the mother brought her to my clinic and told me the story.

'I know you are going to say the baby looks normal and has had no serious problem and therefore there is nothing to worry about at this stage, but this was true of my other children as well,' she said. 'Please take my baby and find out if she does have a weakness that will stop her from fighting bacteria. Don't let this baby be taken away from me.'

Needless to say, all of us in the clinic were moved by this story and the anguish that this women was clearly experiencing. She had read extensively and knew that she wanted all the defense mechanisms that act in concert to constitute our 'immune system' checked for hidden even subtle imperfections.

To the best of our ability we obliged. We contacted the hospitals where the first two children had died. No help was obtained from Illinois, but Detroit told us that they had in retrospect checked the second baby's serum to determine if normal amounts of antibodies (bacteria-fighting chemicals that we will discuss in detail a little later) had been present in normal amounts. No abnormalities were found.

We tested this third baby's blood and secretions for antibodies. We immunised the child with a new vaccine against pneumococcal bacteria. We challenged her white blood cells in our test tubes and in every test that we performed, the baby appeared to be perfectly normal.

Six weeks later the mother, holding her baby close to her, heard the words she wanted to hear from this immunologist: 'I don't know what was wrong with the babies that you lost, but this little one is in perfect condition and has responded well to the new vaccine that we gave her. I am confident that her immune system is working well. Please put the past behind you, relax and enjoy her.'

Four months later, the mother called to tell me that this baby was dead. The news from this anguished mother devastated me more than any other professional loss.

The story of the third loss had been identical to that of the other two, with an instantly panicking mother failing to save her child, despite immediate and competent medical attention.

I have begun my introduction of immunology at this low point for a number of reasons. Firstly, the cases we have discussed allow one to emphasise the lethal potential of the microbial enemies with which we are all constantly battling. Indeed, every day many people, for various reasons, are overwhelmed by infections and die within twenty-four hours. These cases which so baffled us in 1972 also illustrate how rapidly this youngest of clinical specialities is moving. For today, presented with such a story, a correct diagnosis would immediately be suspected, readily established and rapid therapy provided."

OR to tell us what fungi are, he narrates the story of Mary Beth.

"Mary Beth was sixteen when I first saw her. She was in our intensive care unit, her arms heavily bandaged and tied to the frame of the bed. The night before, she had tried to commit suicide by slashing her writs.

Unlike many a wrist slasher, Mary Beth had really meant to kill herself and had very nearly succeeded. She had lost a great deal of blood and was still receiving a blood transfusion. She was wide awake and as I approached she looked at me with eyes that seemed drained of all feeling. Mary Beth had tried to kill herself because she felt herself to be ugly. Hers was an ugliness that made people shiver as they turned away in embarrassment at their obvious inability to hide their shock. What place was there in this world which so venerates beauty for a sixteen-year-old girl with her disfigurements?

Mary Beth's nose was swollen to twice the normal size; a black crust covered most of it. Pus from deep ulcers covered most of her face, and her top lip was swollen and twisted. I had seen a number of people similarly afflicted, suffering from an illness associated with severe breakdown of the immune system.

After receiving indifferent permission to examine the rest of her body. I noticed that she had trouble opening her mouth, but it was clear that the inside of her cheeks and her tongue were covered in a milky white substance. The rest of her body bore isolated ulcers in no particular pattern. Between the upper part of her legs her skin was an angry red color, as was her markedly swollen vulva. A profuse creamy discharge came from her vagina. Mary Beth was the victim of a fungal infection known as candida albicans; her disease is called chronic mucocutaneous candidiasis (muco = mucous membranes; cutaneous = skin). While she could defend herself from bacteria, she had no defense against fungi. Each requires a separate system of defense."

Again to let us peep into the complex build up of the immunological arsenal Dwyer leads us into a make-believe world by saying.

"Imagine that you are undertaking a review of the security system for an ultra-important, indeed ultra-secret industrial complex, and find that the following system has been devised. All the authorised personnel in the plant and all the goods that have been legitimately brought into the plant display, in an appropriately prominent situation, a vivid identification tag. Anything or anybody that does not display this vivid ID will be regarded as a danger that must be rapidly removed. A system has been perfected in which certain security personnel do nothing but

patrol around the complex looking for something amiss. Screening are specialised, each one educated to spot some specifically suspect situation. For example, a subtle change in a specific programme for driving a computer or the rearrangement of a usual packing order for certain stores would be recognised as departures from normal from different teams. These inspectors are not trained to correct the problem they find, but rather have the authority and the appropriate signalling capacity to activate various security forces that can physically deal with the problem.

Because different situations may call for different kinds of force, many weapons systems are available to the security forces of the complex, and these can be activated individually. Frequently, however, if the complex is seriously endangered many weapons systems may be called upon simultaneously to ensure the maximum efficiency of the defense effort.

Should a would-be saboteur enter the establishment in the early hours of the morning, our spotters would recognise the likelihood that the saboteur is an intruder and move in closer for a better look using a closed-circuit TV camera that locks on to the suspect and freezes a close-up image of his face on one half of a monitor screen. A computer then runs through all the physical characteristics of the plant's legitimate employees on the other half of the screen, so that with incredible accuracy the physical features of the foreigner and members of the legitimate family are compared. This is the manner in which the intruder will be presented to these vital 'first line of defence' security men who can then be confident that the intruder is just that, and justify the severity of the response that they must initiate.

The moment that they are certain of the seriousness of the situation, these generals must alert the plant 'soldiers' to the danger and direct them to the target. These soldiers are an organisation unto themselves with a hierarchy based on intelligence and training. Certain of them carry receivers allowing them to receive the messages from the inspectors who spotted the infringement. As these men are also highly specialised, an inspector who is trained to recognise the specific problem encountered will activate that specific arm of the response force ideally prepared to handle this particular problem.

A response team will include commandos that will guide a force of variously armed personnel into the battle zone and then urge them to attack. Some of these tactical forces may be more involved in disarming and immobilising than they are in direct killing. So well organised is this team approach that some men have a specific job of cleaning up, removing corpses and other debris from the site of the battle, indeed out of the plant, so that peace can reign again.

Now, as you can imagine, the battle will be brief or protracted, violent or otherwise, depending on the speed with which the intruder is recognised (once established in a secure spot he may be much harder to dislodge) as well as the weaponry he has for resistance and the forces the plant can effectively marshal. One thing is certain; in this highly sophisticated plant bristling with valuable and sensitive equipment, unnecessary force is to be avoided. No use shooting the intruder in the computer room and at the same time permanently damaging the computer. Some innocent bystander damage may have to be tolerated, but one wishes at all times to keep this to a minimum.

As we all know, commandos can get carried away with the glory of the battle and launch a missile when a hand grenade would have been perfectly satisfactory. Therefore, when our inspectors alert the response force, they also pass the same information to the plant's management team, who ultimately have control over matters from that point forward. They must determine the nature and the intensity of the response to be launched for it is their responsibility to ensure appropriateness; enough force to do the job but not more than enough, for excesses may damage the plant unnecessarily.

These management types have also been specifically trained in this business of recognising who is family and who is not, and can thus check the decision making of the team that has sounded the alarm. Via radio communications, these super-managers can control with ultimate authority both the inspectors and the soldiers. In this way, security is maintained and the damage to the plant minimised.

An attack on such an establishment is always a learning process and good management demands that security be strengthened in an area where an attack or infringement was even partially successful. If on two occasions intruders have had some success entering a plant via its large air conditioning ducts, the team that looks after this area must be expanded and equipped for a faster, more powerful response should this previously vulnerable area ever be approached again.

The specialised nature of the work of each of these teams requires personnel who are highly trained. It is not surprising that establishments are available where these skills can be gained and perfected so that on graduation the successful candidates are ready for a particular role in the chain or network of security measures that protect the plant.

The above fanciful sketch, as you will no doubt have guessed, incorporates the major design features of our immune system."

One can go on and on but at that rate one will have to reproduce the entire book.

Unfortunately, in such an otherwise high quality book some errors, mercifully only a handful, have inevitably crept in. For example, while explaining the size of a virus Dwyer says as a nanometer is one millionth of a metre", which is incorrect. A nanometer is one millionth of a millionmetre or a thousand millionth of a metre. These errors in no way diminish the value of the book. But then from the writer of the calibre of John Dwyer one expected perfection much the same way one expects perfection from the immune system that he talks about.

Bal Phondke

THE BODY AT WAR *by* John Dwyer, *Union Hyman Ltd.* (Available from: *Rupa & Co.*, 3831, Pataudi House Road, Daryaganj, N. Delhi-110002) 1989, Pp. 253, £ 6.99 (ISBN. 0-04-820039-5).

(Continued from page 55)

nal springboard of 'Electro–Technology' of 1911 vintage.

To foster research and development activity in frontier areas of astronomy and astrophysics, identified by the Government of India as a thrust area, a joint programme has been under way, since 1982, in collaboration with the Indian Institute of Astrophysics, the ISRO, Raman Research Institute, Tata Institute of Fundamental Research, and the Physical Research Laboratory.

High–profile centres apart, the industrial research nature of IISc is reflected in the Centre for Scientific and Industrial Consultancy, set up in 1975, whose aim is to undertake research to promote the material and industrial welfare of India. This centre's activities cut across disciplinary boundaries. At a more specific level the Cell for Application of Science and Technology to Rural Areas, thoughtfully acronymed ASTRA, has contributed to the upliftment of rural areas in the state. Biogas plants, windmills, bullock–carts, low–cost building technologies, energy consumption patterns in villages, rural ecosystems, and solar energy for sericulture are some of the areas which ASTRA has addressed.

In contrast to ASTRA, whose focus is rooted in the rural base of the country, the Department of Management Studies functions as a teaching–cum–research centre, more or less on the pattern of Indian Institutes of Management. Its thrust, however, in recent years has been on resource management—physical, biological and human—with emphasis on the management of production operations, energy, R&D capability, and environment.

At an academic level, the Centre for Continuing Education, aims at quality improvement of teachers, especially of engineering colleges. The centre also runs a 'Proficience' programme for the benefit of personnel employed in scientific and industrial establishments, in collaboration with professional societies. But what is more attractive is the assistance the centre provides in the writing of standard books in science and mathematics at the high school level, a function which is analogous to that of NCERT.

Of special interest to the students of science communication is the work of the Foreign Languages Section, which began merely as a translation unit in 1949. The section's research focus is on formal linguistic analyses of scientific theory and literary texts, aimed at capturing significant generalisations about the interplay between human mind and the demands of communication in different realms of activity. The UGC Centre for Science Information, offers, free of cost, up–to–date computerised information service to faculty members and researchers in Indian universities in biological sciences, chemistry, earth science, mathematics and physics and related fields; and the Instrumentation and Services Unit, functions both as a service centre and as a research centre.

An autonomous Centre for Genetic Engineering, set up as recently as 1988, with financial support from the Department of Biotechnology, fosters basic research and undertakes goal-oriented research in health and agriculture–related fields, besides training pre–doctoral and post–doctoral students in this specialised field.

Academic Distinctions

More than 35 faculty members have been elected fellows of both the Indian National Science Academy and the Indian Academy of Sciences. More than 25 faculty members have won the Shanti Swarup Bhatnagar Prizes, and some of them have also received the Hari Om Trust Award of the UGC, VASVIK Research Awards and FICCI Awards.

Apart from the very large number of research papers they have published, the faculty have written nearly 200 books, most of them at an advanced level.

Unique Features

There are many features which make IISc stand apart from other research institutions or universities. The Institute may be described as one of the biggest enterprises of its kind in the country. Yet, it is a relatively small institution, as a consequence of which it is able to innovate and introduce newer systems of imparting knowledge, or to grapple with theoretical problems at the frontiers of science and technology, or to step down from glamorous research to solve the socio–economic problems of the country towards its sustained development.

What impresses even a casual visitor to the Institute is the camaraderie that exists between the faculty and the students. This has contributed not a little to the progress of both.

In a sense, the Institute, over the years, has come very near fulfilling, not by design though, the cherished goals of its creator Jamsetji, who had originally envisaged for his 'university' a plan which included "scientific and technological education, medical and sanitary education, including research in bacteriology, studies in philosophy and education (including methods of education), ethics and psychology, Indian history and archaeology, statistics and economics and comparative philology". Except for history, the Institute has in fact not only addressed all the fields envisaged in the Jamsetji plan, but has distinguished itself in many.

P.S. Shankar
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The Homi Bhabha Fellowships Council invites applications for the award of fellowships from outstanding young scientists who are at a stage in their careers when scope normally available for full development of their talents may be restricted by the relatively junior position in their profession or in the organisation to which they belong.

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Applications for the Fellowships should be directed to:

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C/o National Centre for the Performing Arts
Dorabji Tata Road
Nariman Point
Bombay-400 921

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- **The matter should be typewritten, double space on one side of the paper; the original and a carbon copy are to be sent.**
- **The article should preferably be illustrated; captions and legends typed separately and attached at the end of the article. Photographs should be on glossy paper of at least 10 cm×15 cm size.**
- **While quoting names of scientists, etc., their initials, nationalities and periods of research under reference should invariably be mentioned. All weights and measures should be given in Metric Units.**
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New Alloys and Composites for the Aerospace Industry

SOME men like it hot and some cold. So is it with materials. No material can perform equally well over a wide range of temperatures. For instance, bones which provide the structural framework of the human body will become brittle if exposed to very low temperatures such as liquid air.

One of the major tasks of technology is to make materials that can perform well at extremes of temperatures such as experienced in aero engines. Designing materials for the aerospace industry has often proved to be challenging to metallurgists and materials scientists.

It was man's inability to match the properties of naturally available materials such as timber and metals with the newer tasks he wanted to perform with these materials that led to the development to new materials such as alloys and composites.

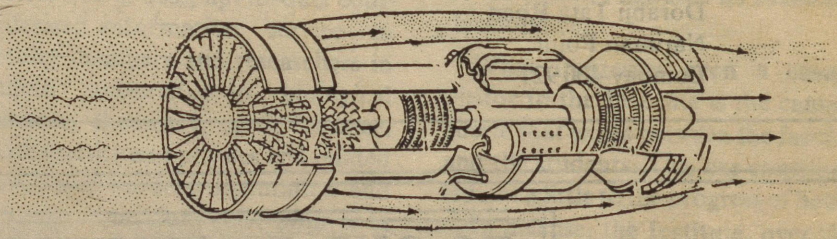
While alloys are made up of two or more metals and are essentially metallic, composites are made up of different kinds of materials, e.g.,glass fibre reinforced plastics, graphite particles in aluminium matrix, etc.

At least three ongoing aerospace projects are making imaginative use of new alloys and composites. Two of these projects are in the military sector and one in the civilian.

On the civilian front, Aerospatiale of France and Aeritalia of Italy are jointly building ATR 72, a 74-seat passenger aircraft. It is the first civilian aircraft in which the entire outer structure of the main wing is made of composite materials.

The 27-meter-long wing weighs about 25 per cent less than a comparable metal wing. Besides, the parts made of composite sandwich construction are five times as strong as steel and about 15 times as strong as aluminium. The reduced weight will reflect in savings in fuel costs.

ON the military front, two projects in Europe are noteworthy. The Eurofighter, a multinational effort, will use an EJ 200 engine being developed by a team led by Rolls-Royce of the UK; and the Rafale, the French combat aircraft expected to be test-flown in February 1990, will be equipped with an M 88 engine.



The M 88 engine, developed at a cost of about $ 5 billion, is truly a remarkable achievement. It is 40 per cent shorter and 45 per cent lighter than the Atar 90 engine used in the Mirage F1, for the same power. Its thrust/weight ratio is the best so far in the aircraft industry, viz. 8.5, which is twice that of the Atar 90 and 12 per cent higher than that of the General Electric's F404.

Low weight and high temperature performance are the prerequisites of the materials used in aeroengines. For instance, turbine blades should be able to withstand high temperatures as well as centrifugal forces that are as high as 50,000 times their weight. In the M 88, the temperature of the gas at the entry to the turbine will be around 1,600°C—higher than the melting point of the nickel alloy blades used in earlier models. The temperature of the rotating turbine discs in the M 88 will be around 600°C.

Engineers at Snecma, the French firm responsible for the production of M 88, have developed new materials that can meet these demands. A nickel-based alloy with a tantalum additive, called AM1, is used for making the turbine blades, and another nickle-based alloy called N 18, a truly hard and fault-resistant alloy, for the turbine disks. The Snecma process of making turbine disks involves special powder metallurgical techniques that will ensure a very high degree of homogeneity, and a carefully controlled isothermal

forging technique to ensure precision of the disk geometry.

COMPOSITE materials are also being used in place of titanium, thus saving on both costs and weight. For example, the set of "hot" and "cold" flaps in the M88 will weigh about 10 kg when they are made of composites, compared with 25 kg otherwise.

Although composites account for only 6-7 per cent of the total weight of the M88 engine as of today, by 1995 Snecma materials scientists expect the figure will go up to 14 per cent.

The Eurofighter will use advanced materials to a greater extent than any previous European military aircarft. Most of the fuselage as well as the wings will be made of carbon fibre composites. In an unusual and unprecedented step, the two 50 square metre — wings will be produced by two different agencies adopting two different techniques. The left wing will be made by Aeritalia of Italy using an automated carbon fibre tape laying machine. British Aerospace and Casa of Spain will make the right wing manually, at least to start with.

The carbon fibre fuselage will be made by Messerschmidtt Belkow–Biohm of the Federal Republic of Germany. These carbon fibre composites are made of long fibres of carbon, in the form of a tape, which is then impregnated with resin and cured at high temperatures in cylindrical autoclaves.

Despite growing use of speciality composites in the aerospace industry, there is still some weariness about mass production of carbon fibre and other composite components. But as Mr Brian Phillipson of the British Aerospace team working on the Eurofighter says "Having been forced into certain materials you then have to find new production techniques"

Subbiah Arunachalam

Proteins and Plastics from Potato Peels

POTATO is among the most highly consumed items of food all over the world. Not only is it cooked at homes, hotels and hospitals, but literally tons of it is consumed by fast food and packed food industries. Even in traditional societies like India companies manufacturing potato wafers and chips are mushrooming.

Till recently potato peels were considered waste material to be disposed of. An estimated ten billion pounds of potato waste are created each year from the peeling and cutting of potatoes for French fries in the USA alone, according to Dr Robert Coleman of the Argonne National Laboratory.

Now Coleman and colleagues have come up with an improved method of making biodegradable plastics from potato wastes. The low-cost plastic is suitable for making bags for shopping or garbage disposal, and degradable containers for time-released fertilizers and pesticides. Mulch covers for fields could be made to last all summer and then decay around harvest time. Also, by appropriate interventions in the manufacturing process, one can make the plastic either biodegradable under bacterial action or photodegradable to dissolve by exposure to sunlight or ultraviolet light. And, if desired, one can obtain a product incorporating both characteristics.

The Argonne process consists in converting the carbohydrates in the potato waste to glucose and then to lactic acid which can be directly polymerized into plastic sheets. These plastics have already been accepted by the US Food and Drug Administration as bio-compatible and non-allergic materials.

IN another equally interesting research project, researchers at the Idaho National Engineering Laboratory have come up with a technology that would convert potato peels into valuable food products. Applying a unique separation technology developed for producing fructose sweetener from beet-sugar molasses, the Idaho biotechnologists are able to make potato-protein powder from the peels. If the process can be made commercially viable, the Idaho research could lead to a method for turning potato wastes into food supplements of high nutritive value.

S.A.

California Quake Alert

CALIFORNIA at the best of times is truly paradise on earth, but it is also one of the world. Within two months of the devastating quake that rocked the San Jose area, scientists at Lawrence Berkeley Laboratory have proposed a $ 12. 5 million project for round-the-clock monitoring of the 60-mile Hayward fault running through Berkeley, Oakland and Richmond, which is considered to be the most likely source of the next big earthquake in Northern California. The project will employ seismic sensors, movable Global Positioning System satellite receivers, and a computerised data base to provide measurements of fault zone processes with enought precision for possible advance warning of a major disturbance. The project will take about three years to become fully operational, and will need about $ 3 million per year to operate.

S.A.

How Woollen Clothes Keep us Warm in Winter

WOOL provides warmth and comfort in winter which cotton and linen fabrics cannot provide. Wool is the protective covering of sheep and some other animals. Besides wool obtained from Marino sheep, the other important wool in vogue is Angora wool. Also called *Mohair*, this wool is obtained from Angora goat which are partcularly raised in Turkey, the United States of America and South Africa. Mohair is valued for its lustre and softness. Cashmere is the fabric from cashmere goat grown in Kashmir, Tibet, China and Iran.

The wool fibre is softer, thinner than ordinary hair and is more elastic, springy and wavy (the property commonly known as crimp). The crimp imparts resilience to the fibre which quickly recovers from wrinkling and crushing.

Wool is primarily a protein called keratin. Its molecular structure consists of long polypeptide chains in which 17 or more amino acids are linked together by the disulphide group of cystine. Reagants which alter the disulphide linkage change the physical properties of the fibre as a whole. They are oxidisers, reducers, alkalies and light. Action of chlorine and other hologens causes wool to become yellowish, harsh and lose its feltering property. Heat also makes the wool harsh and lose its strength. Wool normally is insoluble in water but, it boiled for more than two hours, loses 25% of its weight.

ANOTHER important quality of wool is the length of the fibre. This is because spinning machinery is built to deal with fibres of only a certain range of lengths. Individual fibres are not measured when wool is bought, but the length of the staple is estimated or measured in either the crimped or the straightened form.

Soundness is the capacity of a wool to withstand tension. This is the most important quality of wool and is tested qualitatively by extending the staple. A wool staple with tension below half the sound wool is "tender" and may not be preferred for quality spinning. Staples of the finer wools are closely crimped (from 5 to more than 20 crimps per inche). Closeness of crimps decides quality of wool.

Wool fibres are highly extensible, especially in the wet state and are capable of recovering fully from large deformation. However, it is wise to dry woolen knitted garments by spreading them flat on some base, rather than hanging.

Wool is frequently used as a fire fighting agent in the from of blanket as it easily cuts off oxygen supply needed for burning. Wool fibres can absorb about twice as much moisture as cotton. Wool also provides rain repellency due to its hairy characteristics. Shephards normally cover themselves with woollen blankets to ward off rain.

The wool fibres have the structure like that of hair. Each fibre has overlapping scales which interlock with scales of other fibres and hold them together. The interlocking results in the creation of a large number of airspaces between them. Crimps also help make air cavities.

Wool keeps us warm in winter because it has both resilience and high moisture absorbing capacity. If either of these is lacking, a fibre cannot protect the wearer from cold. The cotton fibre has no resilience and little moisture absorption capacity, so it is not warm like wool.

THE insulation value of a fabric depends on the air entrapped within it and on its surface. Inwoollen and worsted fabrics which are lofty and porous because wool fibres repel each other, roughly 80 per cent of the total fabric volume is made up of air. Air, of course, is poor conductor of heat and higher the percentage of air in the volume of a fabric, the greater the insulation value.

The concept that air is held in fabrics in separated compartments or cells is erroneous. Air is actually held closely and tenaciously against the fibre surfaces. In high velocity air movement this film is somewhat reduced but as long as the fibre is free for contact with the air, a perceptible film of air will surround the fibre.

Just as air is entrapped with in the fabric, air is also held close to the fabric surface. The hairy surface presents an enormous area of free fibre to hold air films. Even when wet, wool does not lose its resilience. The hair surface is maintained and with it the insulating film of still air.

Wool has the highest absorption capacity of all apparel fibres. It can hold as much as 30 per cent of its weight in moisture without feeling damp. Our body exudes moisture even when cold. This moisture must be removed or it will carry heat away from the body. By absorbing moisture wool creates heat. If you go from the dry atmosphere of a heated room to the moist atmosphere of a cold, dampy day, your woollen clothes slowly absorb water vapour at the same time generating heat. This phenomenon is known as "heat of absorption".

These unique properties of wool fibre keep us warm and cosy in the winter.

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