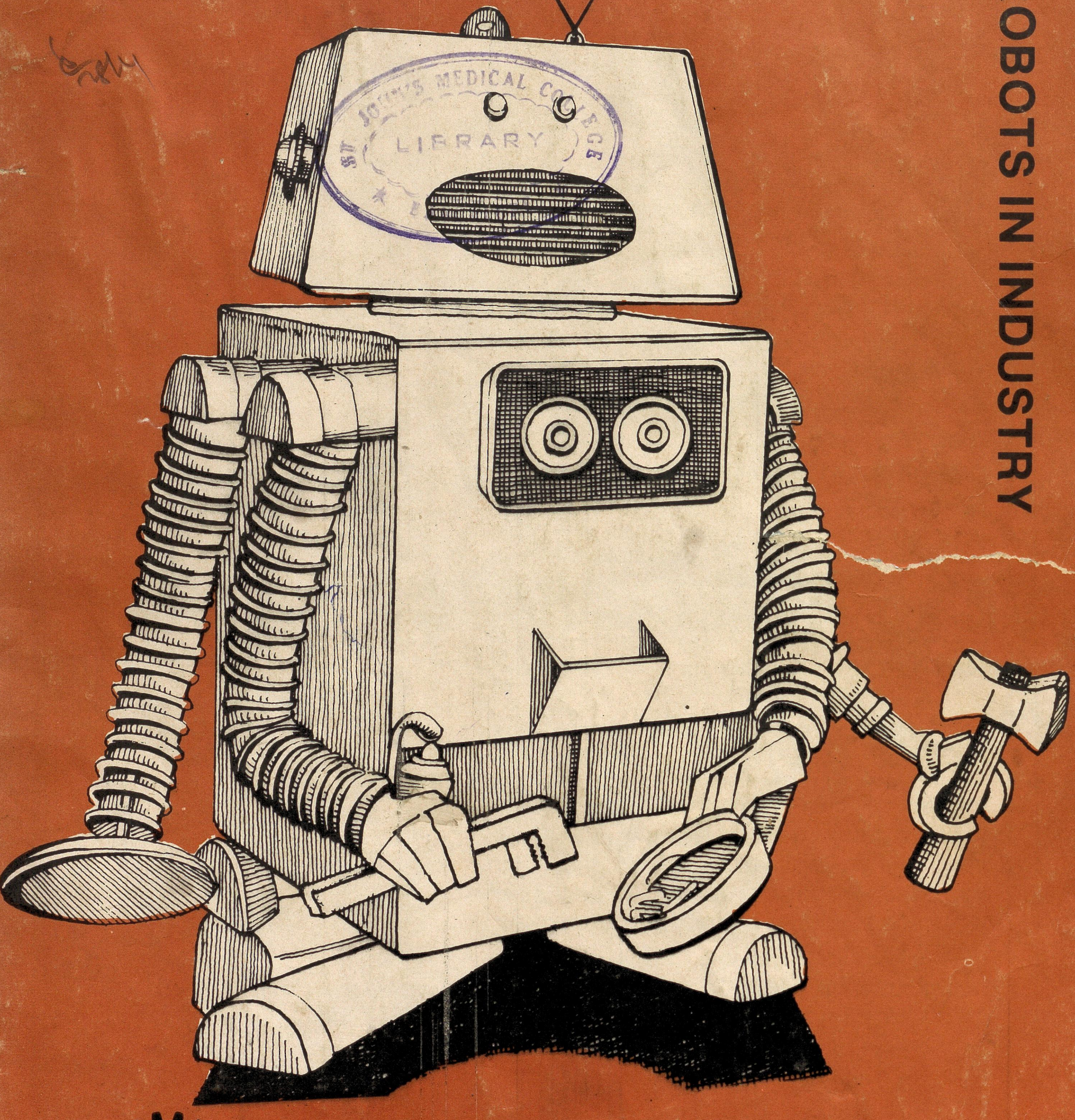
SCIENCE REPORTER

APRIL 1986
RUPEE ONE

ROBOTS IN INDUSTRY



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

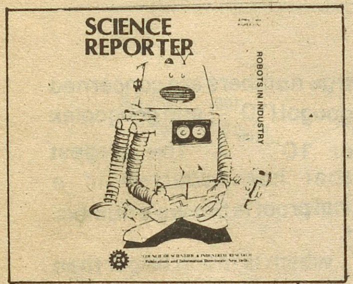

डॉयमन्ड
इंगलिश
स्पीकिंग कोर्स


Diamond
A SURE WAY TO BRIGHT SUCCESS
Letter Drafting Course
डॉयमन्ड लैटर ड्राफ्टिंग कोर्स

PUBLICATIONS AND INFORMATION DIRECTORATE (CSIR)

SCIENCE REPORTER

APRIL 1986
Vol. 23 No. 4



Cover: Dalbir Verma

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

Annual Subscription

Inland	**Rs. 10.00**
Foreign (By surface mail)	**$ 5.00**

LETTERS

Age of the universe

Sir, S. Ramadurai has contributed a very interesting and informative article on the **Age of the universe** *(SR,* Feb. 1986). However, what he has described and worked out is the age of the present epoch of the Universe since the Big Bang. The Big Bang, at the best, is the beginning point of the present epoch of the Universe and certainly it could not have come out of nothing and energy must have existed even before the Big Bang in some form or the other, though we do not know in what form and shape for certain. If that be so, it is not correct to say that we know the age of the Universe unless we delimit our Universe to the post-Big Bang Universe alone as is being done by the present-day scientists.

The age and history of the Universe including its pre-Big Bang period is still not known and the Rig Vedic **hymn of creaction**—

"Who knows, who ever told, from
whence
this vast creation rose?
No gods had then been born—who then
can e'er the truth disclose?
Whence sprang this world and whether
framed by hand divine or no—
Its Lord in heaven alone can tell,
if even he can show."

is more in tune with our present state of knowledge about the big question as it was thousands of years back when the hymn was composed by our forefathers.

The scientific answer, though good so far as it goes, is too simplistic to satisfy the human curiosity. For that, science has still to go a long way before it reaches, if at all it can, the definitive conclusions to the big questions like the above.

S.B. Singh
L.I.C. of India.
Bajaj Road.
SIKAR (Raj.)-332 001.

Author's reply

The article makes it very clear that the age reckoned is the age since the expansion started in the case of the Big Bang and characteristic time scale of expansion in the case of steady state universe. The reader is quite right in his assertion that universe could not have come out of nothing. But the question of scientific interest springs from the point of time to which one can meaningfully extend our present scientific knowledge. The time before 10^{-43} (after the Big-Bang) is not very meaningful, according to current ideas, as before this time called Planck time, quantum theory of gravity is necessary. As of now, we do not have a good theory of quantum gravity and hence our investigation stops at that point.

Regarding the Rig Vedic hymn the reader has referred to, it is possible that by thought processes the ancient rishis of our homeland might have come to those conclusions. But the scientific endeavour has always been to tread into the unknown and hence the great interest in Cosmology. It is a pity that the great thoughts of the ancient rishis of our land have not led to a logical scientific tradition as it has happened in the West.

S. Ramadurai
Department of Physics
Indian Institute of Science
Bangalore-560012

Prime numbers

Sir, In the article **The fascinating world of prime numbers** by P.K. Mukherjee (*S.R.*, Feb., 1986) reference has been made to Fermat's formula $Fn=2^{2^n}+1$, which generates primes for successive values on n but which fails for $n=5$. The person who pointed this fallacy was none other than the German mathematical prodigy L. Euler. The search for a general formula yielding only primes still continues.

The largest prime $M_{132048}=2^{132048}-1$ boasts of an impressive 39751 digits.

As far as large numbers are concerned we have a **googol** (10^{100}) and googoplex ($10^{gooogol}$ or $10^{10^{100}}$). The largest number that has occurred in a **mathematical proof is Skewe's number** ($10^{10^{10^{10^{34}}}}$ which is much larger than a googoplex

S.K. Gurtu
ISSA, Metcalfe House
Delhi-110 054

SOFAR channel

Sir, In connection with the article **Ocean acoustic tomography** by S. Prasanna Kumar (*S.R.*, Jan. 1986) I would like to furnish the following information on SOFAR (sound fixing and ranging) channel.

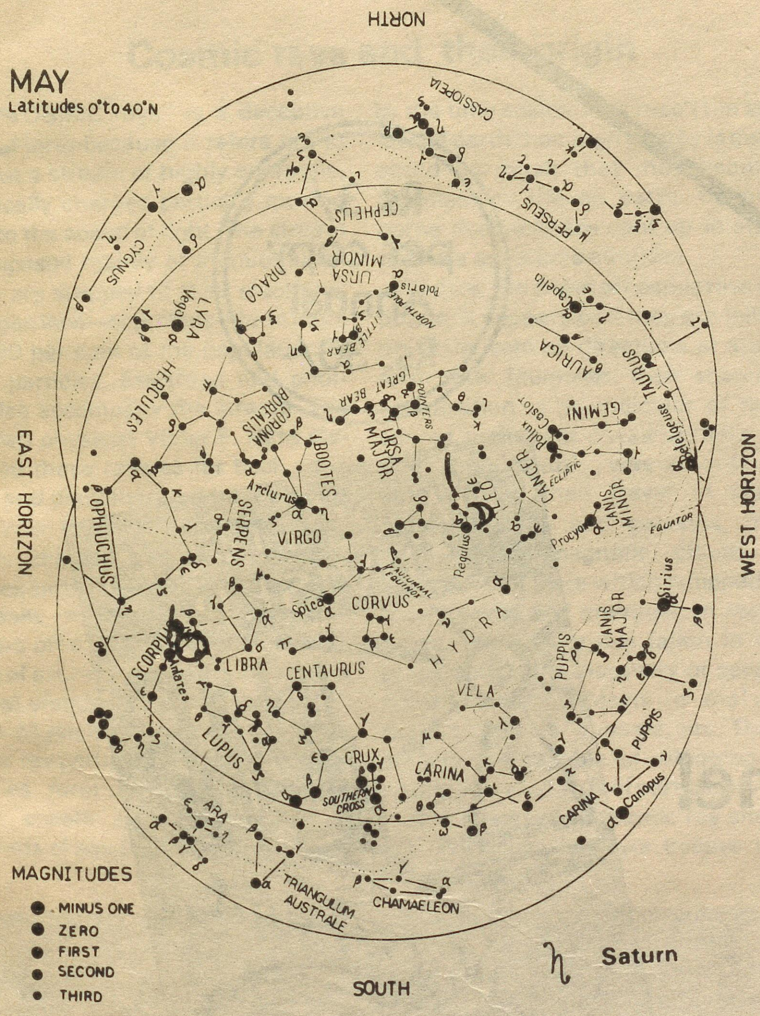
Of all the forms of radiation known, sound travels through the sea the best. The sound speed is found to vary with ocean depth and in mid-latitudes has a minimum at 1219 m. Sound emitted at this depth oscillates back and forth across the source depth, i.e., it is always refracted back towards the horizonatal line known as SOFAR axis. The sea thus acts as a lens and a good deal of acoustic energy is confined and guided in a narrow region thereby losses due to reflection from the surface and bottom are eliminated.

The property of sound to propagate great distances has been used for the rescue of downed pilots at sea. An explosive charge, set to detonate at the sound channel depth, is dropped by the pilot. By knowing the time of arrival at several receiving stations his position can be fixed. Using advanced signal processing techniques underwater sound can be detected almost half way around the globe. The measurement of arrival time of explosive signals has been used for geodetic distance determination and for missile-impact location.

In the TV serial *Cosmos,* Carl Sagan says that whales give plaintive calls meaningful to their species upto

(Continued on page 271)

STARS AND PLANETS



Planetary positions for May 1986

Date	*1st*		*10th*		*20th*	
Planets	*R.A.*	*Decln.*	*R.A.*	*Decln.*	*R.A.*	*Decln*
Mercury	1h 13m	5.0N	2h 12m	11.4N	3h 31m	18.9N
Venus	4h 12m	21.8N	4h 59m	23.8N	5h 52m	24.9N
Mars	19h 06m	23.7S	19h 19m	23.8S	19h 31m	23.9S
Jupiter	23h 08m	6.7S	23h 14m	6.1S	23h 20m	5.5S
Saturn	16h 28m	19.7S	16h 25m	19.6S	16h 22m	19.5S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The moon

NEW moon occurs on 9th at 3.40 A.M. and full moon on 24th at 2-15 A.M. I.S.T. The moon passes about three degrees south of Jupiter on 3rd, two and a half degrees north of Mercury on 7th, about three degrees north of Venus on 11th, five and a half degrees south of Saturn on 24th, two and a half degrees south of Mars on 27th and about two and a half degrees south of Jupiter on 31st.

The lunar crescent becomes first visible after the new moon day in the evening of 10th.

The moon is at apogee or farthest from the earth on 11th and at perigee of nearest to it on 24th.

The planets

Mercury *(Budha)*, visible in the morning sky, rises about an hour before sunrise during the first quarter of the month. Thereafter it becomes too close to the Sun to be seen being in superior conjunction with the sun on 23rd. It passes from Pisces *(Mīna)* to Taurus *(Vrisha)* through Aries *(Mesha)*. Its visual magnitude varies from 0.3 to —0.6

Venus *(Sukra)*, visible in the evening sky, sets about two hours after sunset during the month. It passes about 6° north of the star Aldebaran *(Rohini)* on 5th. It passes from Taurus *(Vrisha)* to Gemini *(Mithuna)*. Its visual magnitude is about—3.9

Mars *(Mangala)*, visible in the morning sky, rises about one hour and a half before local midnight during the first half of the month and about two hours before it during the second half. It is in Sagittarius *(Dhanus)*. Its visual magnitude varies from —0.6 to —1.5

Jupiter *(Brihaspati)*, visible in the morning sky, rises about two hours after local midnight during the first half of the month and about an hour after it during the second half. It is in Aquarius *(Kumbha)*. Its visual magnitude is about —2.2.

Saturn *(Sani)*, visible in the morning sky, rises about one and a half hours after sunset during the first half of the month and at about it during the second half being in opposition to the sun on 28th. It is in Scorpio *(Vrischika)*. Its visual magnitude varies from +0.2 to 0.0.

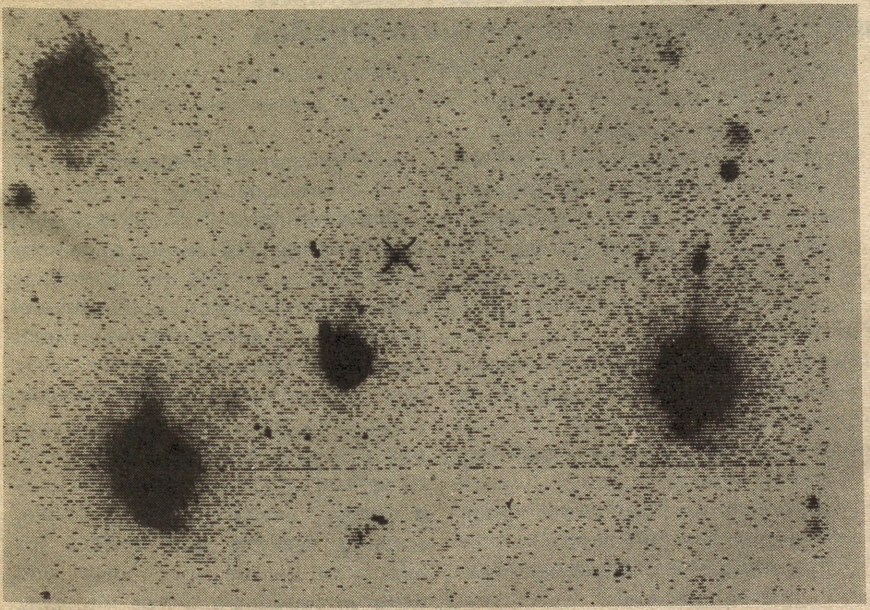
(*Source* : Director, Positional Astronomy Centre, New Alipore, Calcutta-700053)


COMPETITION ADVISER
Environmental
Pollution

Cosmic rays and their origin

"COSMIC rays" is a deceptive term because it refers not to rays but a stream of highly energetic, electrically charged particles moving close to the speed of light. The stream is composed mainly of atomic nuclei which are stripped of their electrons. Hydrogen ions—or protons—form more than 90 per cent of the population of these particles. Electrons and photons also accompany the stream. The Austrian physicist Victor F. Hess discovered these rays as far back as in 1912 and demonstrated their properties. When this highly energetic, electrically charged stream of particles reaches earth, it collides with the nuclei of gases in the atmosphere and triggers off a chain of events. Such a chain of events leads to the creation of several elementary particles of interest to physicists. Together with the cosmic ray particles these elementary particles form a "Cosmic shower" which covers an area more than hundreds of square meters. However, by the time cosmic rays reach the surface of earth their high energy is dissipated so much that they become harmless to life on earth. Balloon-borne detectors are sent up to study the rays at various altitudes.

To date, the origin of cosmic rays is a puzzle. It appears as if they are falling on earth from all directions at a uniform rate. Moreover, their chemical composition is no indicator of their source. In the past, physicists believed that their source was an ordinary star. During their travel in space between stars and galaxies, they encountered magnetic clouds or explosions of stars which whipped up their speeds and energies. In recent times, this theory has fallen in disgrace due to the discovery of several types of exotic objects in the sky, namely, pulsars, quasars, etc. These objects are capable of whipping up energies and speeds of particles to the extent observed in cosmic ray showers. Physicists however believe that after their emission by an exotic object the chaotic magnetic fields in space turn and twist the paths of cosmic rays so much so that it becomes difficult to determine their source. Nevertheless, recently, a group of U.S. physicists has claimed *Cygnus X-3* to be a source of cosmic rays (*Scientific American*, Nov. 85). Using ingenious techniques to eliminate all the factors that influence their paths, the group has arrived at this conclusion. *Cygnus X-3* is the third X-ray source in the constellation of Cygnus, about 37,000 lightyears away, almost at the edge of our galaxy, the Milky Way. However, what kind of process might be creating cosmic rays at *Cygnus X-3* is still unclear. There are two points of view which take into consideration the fact that *Cygnus X-3* is composed of two stars. One point of view is that the source of cosmic rays is a pulsar, whose radiations after interacting with the atmosphere of its companion star, generates highly energetic cosmic rays. The other viewpoint attributes cosmic rays to a spinning neutron star which is accreting material from its massive companion star. In the years to come, solution to this and other puzzles would give insights into various fundamental questions regarding exotic objects and structure of matter.

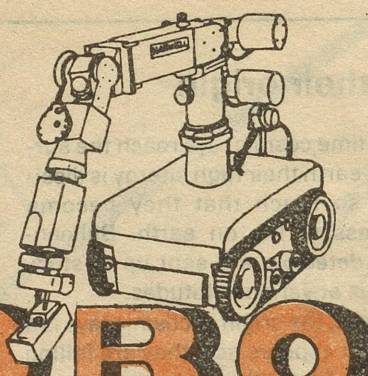


***Cygnus X-3* in near infrared light. The intervening dust clouds in the galaxy absorb visible light from *Cygnus X-3*, but this infrared emission suggests that the source is intrinsically bright in the visible range**

New theory of cancer

THE root cause of cancer in human body is an errant cell. The undesirable cell further perpetuates itself and proliferates to form the malingant growth known as cancer. What provokes a human body to produce that errant cell? This question has been probed since the turn of the present century, but it is only in the last few decades that some specific answers have come forth. There are at present two highly accepted theories: one attributes the errant cell to the interference of certain types of viruses in human cell machinery and the other to chemical changes "mutations"

(Continued on page 222)



ROBOTS FOR PRODUCTIVITY

G. MANOJ P. JAIKRISHNA

S. SESHAN

Use of robots in industry can not only increase productivity but also significantly improve quality down the production line

THE word 'Robot' was added to the world's vocabulary by the Czech playwright Karel Capek in one of his plays in the year 1920. Small, anthropomorphic creatures strictly obeyed their master's orders in that play and were called 'Robots', meaning forced labour in Czech.

A robot may be regarded as a general purpose form of automation. It is a unit with capabilities included in its basic design that permit it to perform many different tasks. In the industrial sense, a robot may be defined as a single apparatus made up of no less than three basic elements that enable it to operate automatically. The three basic elements are:

(i) The mechanical structure whose flexibility enables it to be programmed to operate in a variety of directions to perform its primary functions of positioning and orienting an end of arm attachment.

(ii) The power driving centre which functions to supply energy to the mechanical structure.

(iii) An on-board control regulating unit capable of
- (a) communicating with other devices and functions,
- (b) storing the changeable work instructions, and
- (d) directing the power drive and mechanical structure when executing stored work instructions.

The International Standards Organisation defines the robot as a position-controlled, re-programmable, multipurpose manipulator with several degrees of freedom of movement, capable of handling materials, parts, tools, etc., and of carrying out a variety of tasks. A robot is often equipped with one or more arms which end in a wrist. Its control unit characteristically uses a memory device and, if applicable, sensing systems and devices for adaptation to the environment and external conditions. These multipurpose machines are generally designed to perform a single function cyclically

Sh. Manoj is with the Bangalore Institute of Tech, Bangalore; Sh. Jaikrishna is with B.M.S College of Engineering,Bangalore, Prof Seshan is with the Indian Institute of Science,Bangalore.

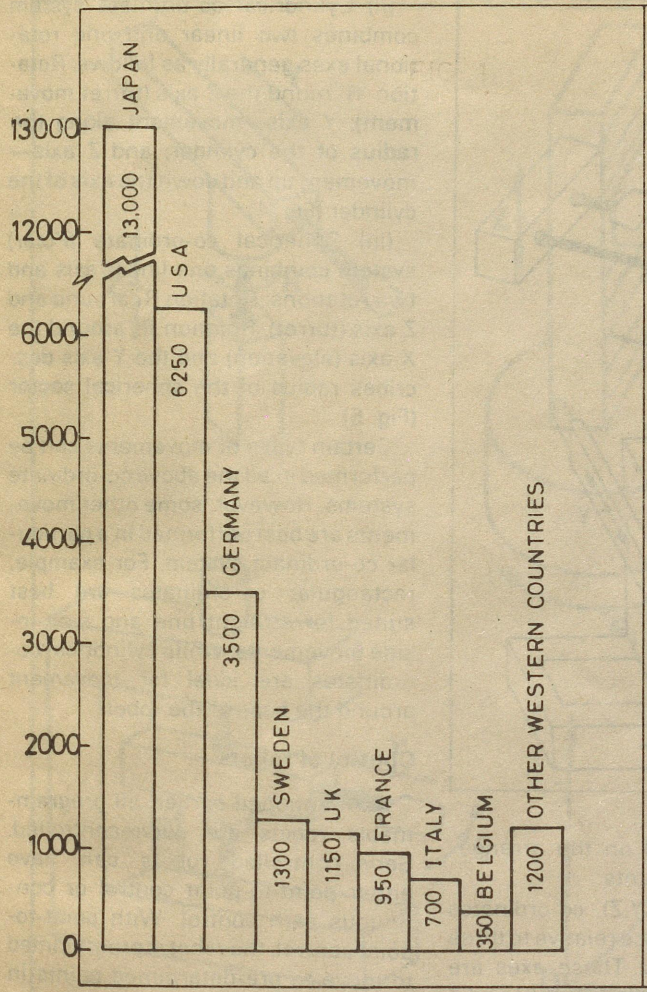


Fig. 1

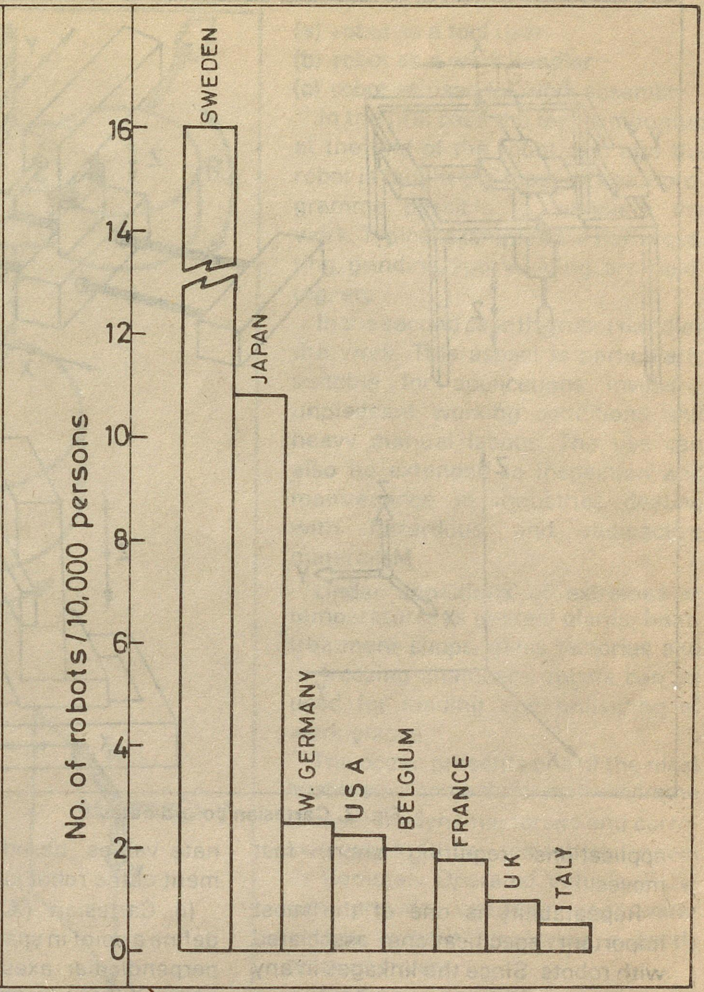


Fig. 2

and can be made to perform other functions without permanent modifications of equipment.

A robot is not a robot unless it has a control system. Unlike pick-and-place machines, all programmable robots have servo-control. This means they have feedback systems capable of controlling a portion of the arm or gripper or its speed.

Robot drives

An industrial robot is generally an arm fixed to the floor or ceiling, a vertical column or a gantry having a set of joints operated usually by electric, hydraulic or pneumatic power. Hydraulic machines tend to be used where accuracy, flexibility and repeatability are less important. Where these requirements are critical, electric powered machines are preferred. Pneumatic power is specifically intended for materials handling.

Whether powered by hydraulic, electric or pneumatic drive systems, industrial robot drives may be categorised as either direct or indirect drives. Each type has source advantages and limitations; the requirement of the intended applications determines which drive is appropriate. For instance, in applications in which the robot must carry heavy payloads and withstand heavy impacts, a direct drive system using hydraulically powered actuators is most effective. For lighter payloads or where greater stiffness is required, an indirect electrically powered drive system is preferable.

Direct drives are characterised by absence of mechanical linkage between the input power side and the output shaft. Hydraulic or pneumatic cylinders are typical examples of direct drives. When these devices are combined with a power source such as a high pressure hydraulic fluid, they become relatively small packages capable of exerting large forces and moving robot arms at high speeds.

Indirect drives have some sort of mechanical linkages between the input and output shafts. These linkages may take the form of ball screws, gear trains, chains, belts, etc. In almost all cases their purpose is to multiply the force or torque of the driving device to a level capable of moving the robot arm and the payload.

Since most indirect drives have a high gear ratio (about 100:1), they normally exhibit high stiffness. This characteristic is useful in processes such as drilling and routing and in

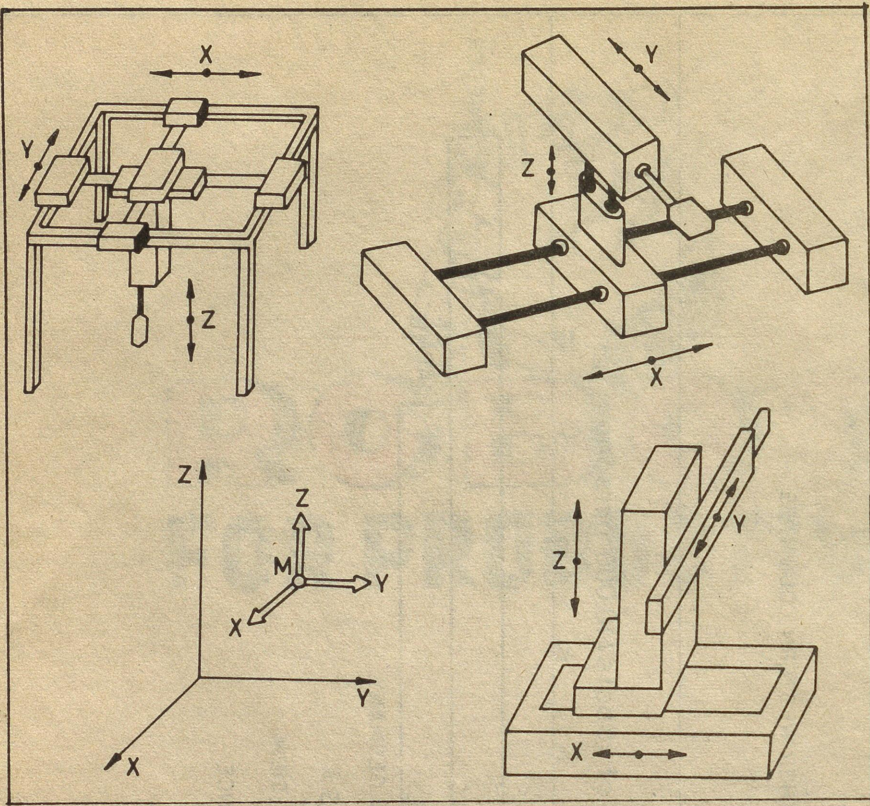


Fig. 3. Cartesian co-ordinates

applications requiring short, fast moves.

Repeatability is one of the most important specifications associated with robots. Since the linkages in any drive are subject to wear, provision must be made to compensate for this wear and the resultant backlash in order to maintain specified repeatability. This is accomplished by incorporating precision ball bearings in all joints and by making use of sensors to locate the working surfaces.

Robot axes

A robot may have various axes which together allow any point to be reached in some defined volume of space around it. The co-ordinates that describe the motion of the robotic arm vary depending on the type of robotic arm being employed. Every robot, regardles of its design, has three axes of articulation which are necessary for the wrist to reach any place within the working area. The control system then moves the arm around within the area.

There are atleast three different methods used to describe the co-ordinate values, based on the arrangement of the robot joints:

(i) Cartesian (X,Y,Z) co-ordinates define a point in space relative to three perpendicular axes. These axes are called X (base travel), Y (reach) and Z (elevation) axes. The X and Y axes define the horizontal plane while Z axis defines vertical dimension (Fig. 3).

Robot applications

(i) CURRENT APPLICATIONS

die casting	machine loading
spot welding	pelletizing
arc welding	stamping
glass handling	inspecting
heat treatment	plastic moulding
forging	spray painting

(ii) SOME NEAR TERM APPLICATIONS

batch assembly
order picking
packaging
medical lab handling
wire harness manufacture

(ii) Cylindrical co-ordinate system combines two linear and one rotational axes generally as follows: Rotation 'R' round the Z axis (turret movement); Y axis—movement along the radius of the cylinder; and Z axis—movement up and down the axis of the cylinder (Fig. 4).

(iii) Spherical co-ordinate (Polar) system combines one linear axis and two rotations: Rotation R_1 around and Z axis (turret); Rotation R_2 around the X axis (elevation) and the Y axis describes radius of the spherical sector (Fig. 5).

Certain types of movements can be performed in all the above co-ordinate systems. However, some other movements are best performed in a particular co-ordinate system. For example, rectangular co-ordinates are best suited for straight line and side-to-side movements, while cylindrical co-ordinates are ideal for movement around the base of the robot.

Control of robots

As mentioned earlier, all programmable robots are servo-controlled. Servo-controlled robots can have either point-to-point control or continuous path control. With point-to-point control, the robot is programmed to move to pre-determined points in space, moving from one point to another in a straight line. These robots are well suited for handling of parts and for certain loading operations.

Robots with continuous path control, on the other hand, have their data monitored on a time basis with the result that much more information can be stored to allow the arm to make smooth, continuous motions over a controlled path.

The brain of the robot is the microcomputer, situated in a separate console as far away as safety demands. The function of the control unit is to perform two essential tasks: one is actuator control and the other concerns recording, memory storage and playback. In each joint of the robot arm and wrist there are sensors. A typical example is a resolver and a tachometer that inform the computer of the actual position of the joint and how it is moving. They provide bulk of the inputs to the computer.

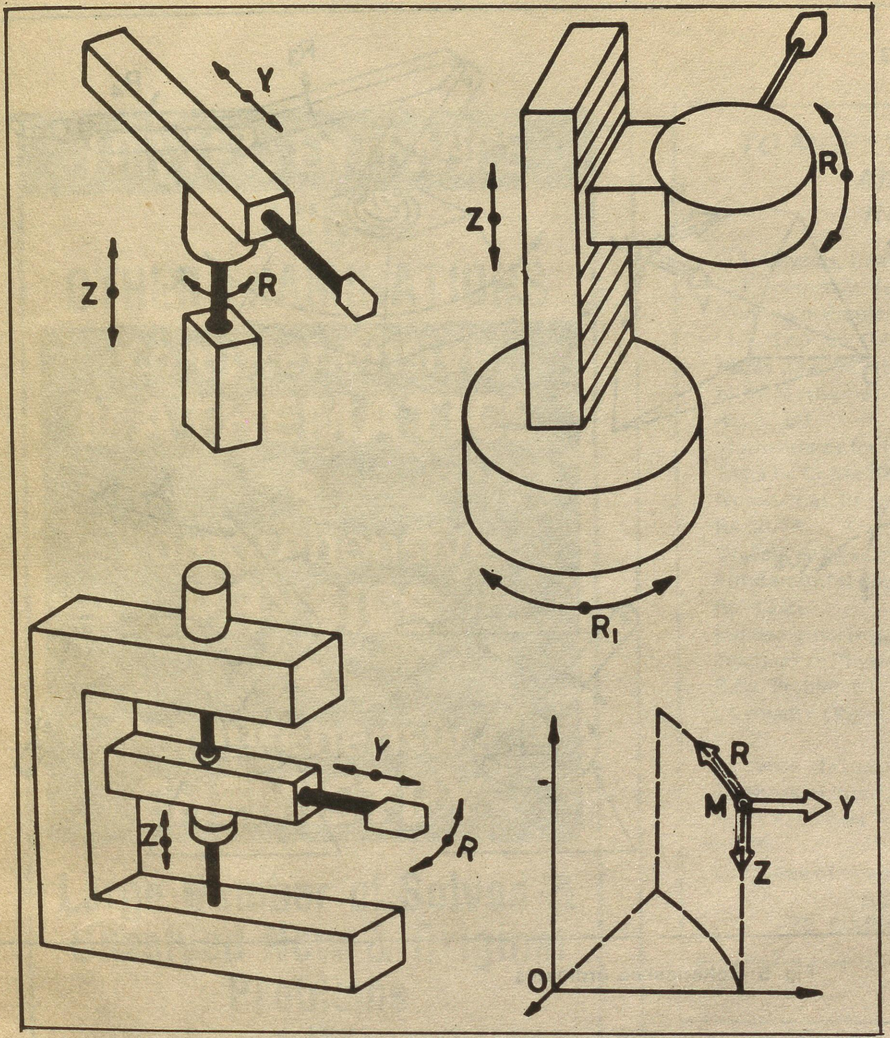


Fig. 4. Cylindrical co-ordinates

Robot programming

The robot is programmed to do a certain function; the computer compares the input at one point with the next desired position and generates an error signal. The appropriate motors are then activated to reduce this error and hence motion is obtained. The computer automatically accelerates the motion to working speed and then slows it down again as it approaches a set position in order to avoid overshooting.

Programming is usually achieved by one of four methods: the first three methods rely on the sensors in the joints to feedback information to the computer. In the fourth, lead through method, a handle is fitted to the front of the robot and the robot is actually led through the required sequence. The most common method used today employs 'teaching consoles that allow operators to edge the arm into place and then instruct the computer to remember the precise position.

Once the desired point in space has been reached,it is necessary to orient the tool in a certain way. For example, when a welding gun is positioned, the electrode must be absolutely perpendicular to the plane of the sheet metal to be welded. The orientation of the tool therefore requires three additional degrees of freedom, and these are provided at the robot's wrist. Simultaneous movements of the robot and the work-piece can lead to a complex system possessing seven, eight or even nine degrees of freedom.

Applications

Robot applications may be classified into the following broad categories:

(a) robot as a tool user
(b) robot as a work handler
(c) robot as used for work assembly.

In the first case the tool is mounted at the end of the robot arm and the robot is taught the most efficient programme possible to complete the work. Typical examples are flame cutting, grinding, spot welding, arc welding, etc.

In the second case the robot handles the work. This aspect is particularly suitable for applications involving unpleasant working conditions and heavy manual labour. The use can also be extended to inspection and maintenance in industries dealing with hazardous and radioactive materials.

Under conditions of extremes of temperature, as in steel plants, heat-treatment shops, glass factories and in freezing chambers, robots can be used for loading and unloading of work-pieces.

The ocean presents one of the most hostile environments for man—extreme pressures, dynamic forces and corrosive attack. Under-sea robots (known as Remotely Operated Vehicle, ROV) can provide valuable underwater details without employing a costly team of drivers.

Welding is an ideal application for robots. Welding done by robots is of high quality and is carried out at greater speeds than by skilled operators. In a recent study, robots have helped increase the welding speed from 70 cm/min to 250 cm/min.

Robots require no protective clothing, do not react to unpleasant fumes and will work a twentyfour hour day. Welding usually involves large and tedious runs, and is monotonous; robots provide the right answer in such cases.

Future robots

An ordinary robot is a non-human worker who can neither see nor feel what is done. It will operate successfully if everything is exactly in the right place at the right time. One of the most significant breakthroughs to be expected in the near future is the successful development of robot vision for commercial applications. This vital facility will not only enable a robot to

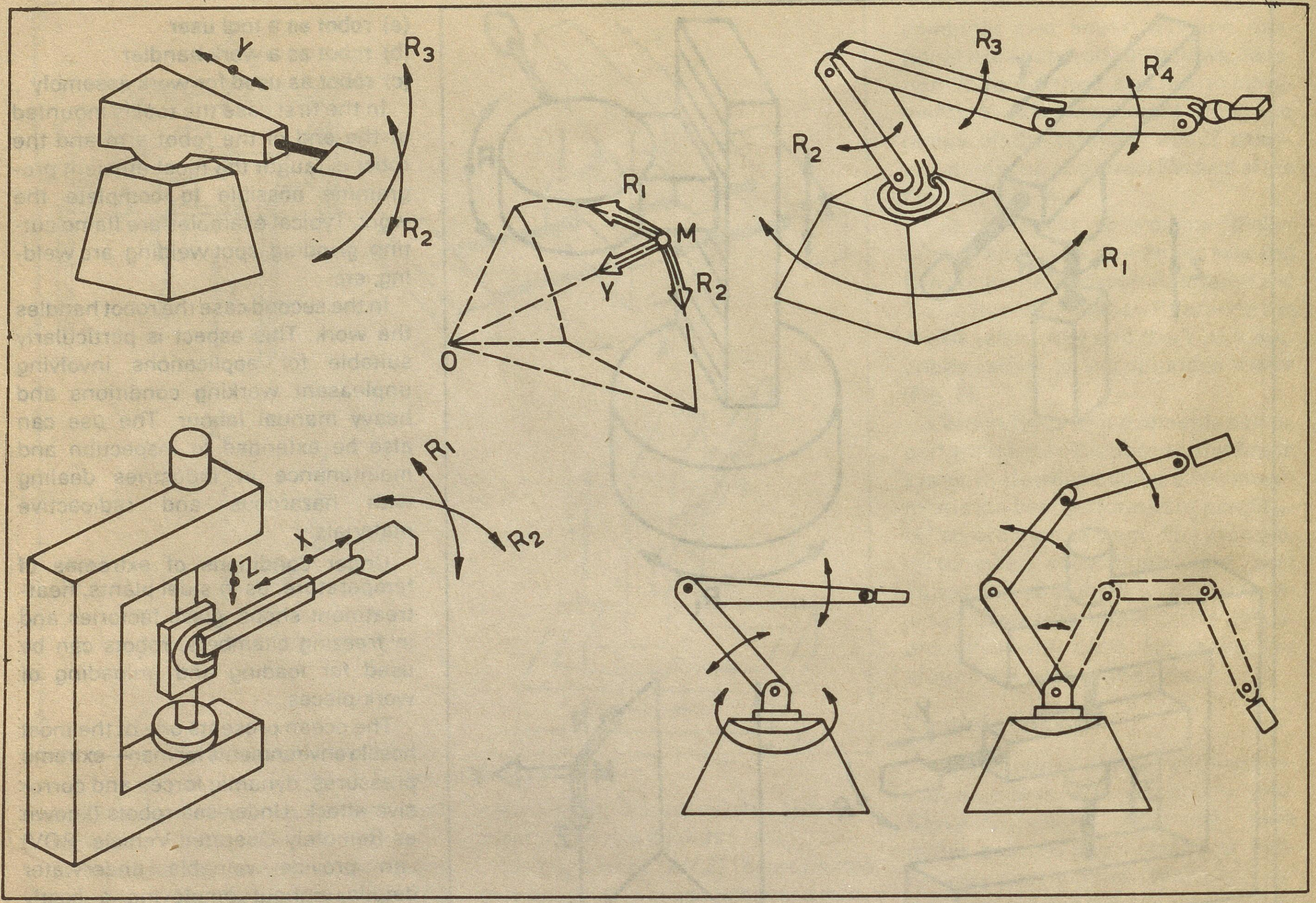


Fig. 5. Spherical co-ordinates

recognise objects but also to determine where they are actually located. In a factory environment this is particularly vital. While it is simple to tell a robot what it is looking at, problem occurs when in an industrial environment components get mixed up for one reason or the other. Present experimental systems are quite efficient at defining the position of individual black components on a white background. But the actual situations are not that simple and colours tend to be far more diverse.

Robots must be able to operate at stations that may well be widely separated. In achieving this goal robot vision undoubtedly can play an important role. The date, robot mobility has been accomplished by mounting the unit on linear tracks or on rails between work stations. Ultimately what may be needed is a robot that can literally see all.

Conclusions

So far, the impact of using robots in the production line has been two fold: (i) Improvement in productivity, enhancement in quality level and consistency of mundane tasks, and (ii) a proportional increase in quality down the production line.

It is obvious that robots have come to stay. Many people tend to think that introduction of robots may cause further unemployment. But this apprehension may not be true, because robots are normally employed for carrying out jobs in hostile environments where it is difficult to employ human labour. Secondly, increased productivity through automation should enable the redundant labour to be employed in other areas some of which are likely to be created by the enhanced production. Lastly, robots are not economically feasible where batches of production are small. They are best suited to mass production or large batch production and hence several sectors in industries do not get affected.

Further reading

1. Worsley, Roger, *Metal Working Production*, page-61, Vol. 127, No. 2 Feb., 1983.
2. Capes, Philip, *Metal Working Production*, page-84, Vol. 126, No. 6 June., 1982.
3. Worsley, Roger, *Metal Working Production, page-122*, Vol. 126, No. 9 Sept. 1982,
4. Morris, Henry M., *Control Engineering*, page-90, Vol. 31, No. 1 Jan., 1984.
5. Cake, Roger, *Chartered Mechanical Engineer*, page-29, Vol. 31, No. 5 May., 1983.

ELECTRONIC GLASSES AND THEIR SWITCHING APPLICATIONS

K.K. SRIVASTAVA

Dr Srivastava is Prof. of Physics at Punjab University, Chandigarh 160 014

Special glasses, containing metal sulphides, selenides and tellurides, conduct electricity like semi-conductors and can be used in a variety of switching and memory devices

GLASS is one of the earliest creations of man. Perhaps no other material possesses so unique a combination of physical and chemical properties as glass. For example, the oridinary electric light would not have existed if glass were not available. It provides a peculiar combination of properties such as transparency, ability to withstand high temperatures, mechanical strength, low cost, etc. Likewise, precision instruments such as microscopes, telescopes, cameras, range finders, etc., would have been unknown to us without glass.

Classification of glasses

Glasses can be broadly classified into two categories, ionic glasses and electronic glasses.

Ionic glasses Prior to 1955, almost all kinds of known glasses namely, window glass, soda-silica glass, fused silica, etc., were considered to be insulators because their electrical conductivity was very low. Furthermore, conductance in these glasses is ionic in nature, i.e., electrical conduction takes place through ions (not electrons). Therefore, such glasses are usually called ionic glasses. The values of conductivity of some typical ionic glasses are listed in Table 1. Ionic glasses cannot be used for a variety of electronic devices because they are basically ionic conductors.

Electronic glasses. In 1950s, a new category of glasses was discovered. It consisted of alloys of metal sulphides, selenides and tellurides (e.g., arsenic sulphide, arsenic selenide, etc). Electrical conductivity of such glasses is purely electronic in nature. Therefore, these glasses are often called electronic glasses. Some typical electronic glasses are listed in Table 1. As conductivity of such glasses lies within the range of semiconducting materials, and as they display all the basic properties of semiconductors, they are classified as semiconducting glasses or amorphous semiconductors or vitreous semiconductors. The most important thing is that these materials are amorphous and not crystalline, which implies the absence of a long range order. In crystalline materials, the atoms/ions/molecules are arranged in a definite order and this order/arrangement is found everywhere in the material. Therefore, crystalline materials are said to have long range order. This, however, is not true in case of amorphous (non-crystalline) materials. The high conductivity of electronic glasses and the absence of ionic conduction in them led scientists to study their electrical and physico-chemical properties. In recent years numerous applications of semiconducting glasses have been reported, e.g. switching and memory devices,

Table 1. Room temperature conductivity of some ionic and electronic glasses

Ionic glass	*Estimated conductivity ($Ohm^{-1} m^{-1}$)*	*Electronic glass*	*Estimated conductivity* ($Ohm^{-1} m^{-1}$)
Calcium boroaluminate glasses	10^{-25}		
Fused silica	10^{-19}	Arsenic sulphide (As_2S_3)	10^{-15}
Corning glass	10^{-15}		
Pyrex glass	10^{-13}	Arsenic selenide (As_2Se_3)	10^{-10}
Window glass	10^{-10}		
Soda-silica glasses	10^{-9}	As_2Te_3	10^{-4}
		As-Ge-Te glasses	10^{-10}

solar-cell applications, xerography infrared telescopes, ultrasonic delay lines, high energy particle detectors, computer memories, optical memories, etc. In this article only switching applications of electronic glasses have been dealt with. To understand mechanism of switching, it is necessary to know the meaning of "glass".

What is glass?

Glass can be defined in various ways. One may call it a supercooled, highly viscous liquid, or an amorphous, vitreous solid, or a disordered material. These definitions are equally applicable to both kinds of glasses, ionic and electronic. If a normal liquid is cooled beyond its freezing point into a solid without any discontinuous change in the first order thermodynamic parameters, e.g., volume, heat content, entropy, etc., the material so formed is a glass. Obviously, the process of cooling introduces a progressive increase in the viscosity of the material. Consequently, a glassy state can be said to be structurally continuous with the liquid state. As a liquid has no long-range order, glasses are often called disordered materials or amorphous solids.

Fig. 1 shows a typical volume-temperature relationship for selenium which conveniently goes into glassy state when the melt is cooled below its freezing point ($T_{f.p.}$). It is evident from the figure that the first order thermodynamic parameter, i.e., volume, does not undergo a discontinuous change with respect to temperature. However, nature of the curve, and hence the nature of the glassy state, does depend upon the rate of cooling (Fig. 1). Thermal history of a glass is, therefore, an important factor to be kept in view while studying properties of various glasses.

Some materials, for example, germanium, cannot go into the glassy state when the melt is cooled. Such materials crystallize at the freezing point irrespective of the rate of cooling. The formation of glass requires prevention of crystallization and growth process responsible for crystallization. In case of some materials, crystallization process is so fast that it is almost impossible to prevent it even with the fastest rate of cooling.

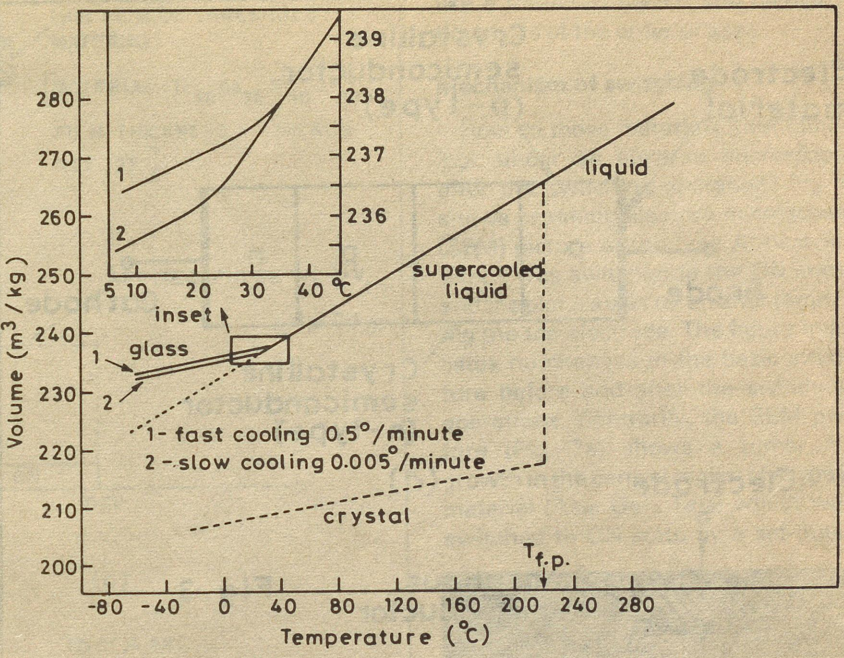


Fig. 1. Volume-temperature relationship of selenium of the liquid-crystal and liquid-glass transition

However, there are a variety of single elements, binary and even multi-element systems which form glasses. $As_{10}Ge_{15}Te_{75}$ is a typical example of an electronic glass which has switching applications. The subscripts 10, 15 and 75 are the atomic percentages of arsenic, germanium and tellurium. If these elements are taken in the desired compositional ratio and the molten mixture is rapidly cooled, the alloy so formed is a semiconducting glass. Scientists have investigated a variety of such combinations of different elements which form semiconducting glasses. Results of their investigations are usually represented in the form of a phase-diagram which tells the glass-forming regions for a given system. As an example, one such phase-diagram for As-Ge-Se and As-Ge-S systems is shown in Fig. 2.

Switching

One of the most common applications of solid-state electronic devices is in switching which requires the device to change "switch" from an 'OFF' or blocking state to an 'ON' or conducting state. There are a number of switching operations which require that a device remains in the blocking state until switched to the conducting state by an external signal. As the switching signal can be varied externally, such devices can be used to block or pass currents at predetermined levels. Several devices fulfilling this requirement are well-known, e.g., p-n-p-n diode, and semiconductor controlled rectifier (SCR). Their details can be found in any text book dealing with solid-state devices. They are usually four-layer devices (Fig. 3) that use crystalline semiconductors.

In the present article, the recently developed switching devices that use amorphous semiconductors (semiconducting glasses), much more superior to their crystalline counter-

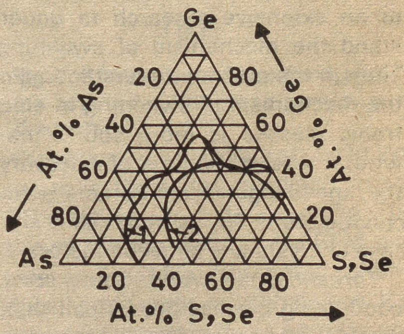


Fig. 2

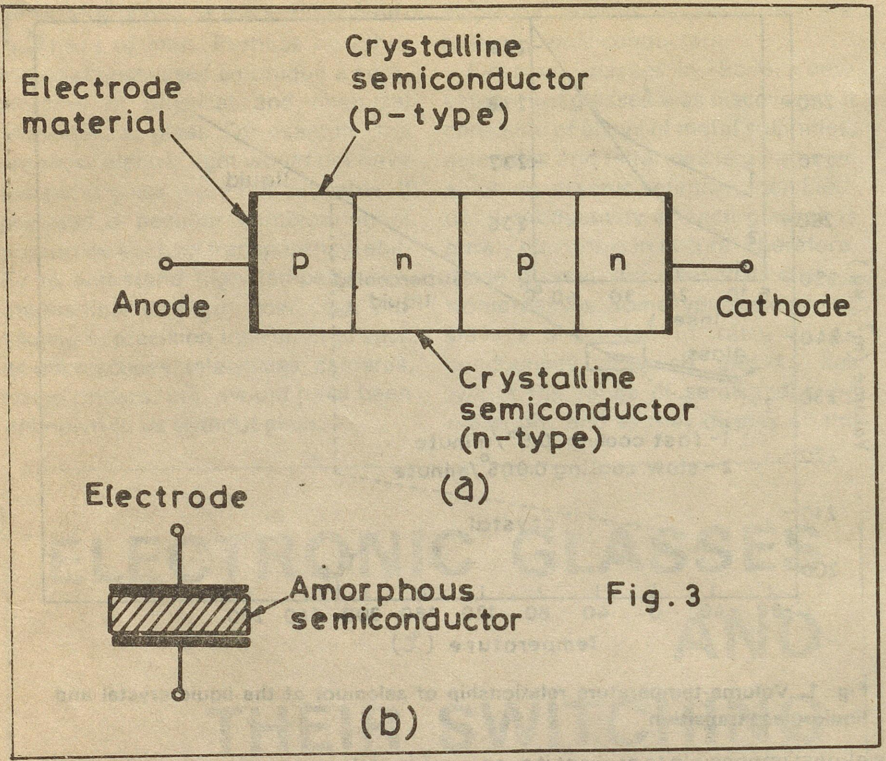


Fig. 3

parts, are discussed. They are much simpler in structure (Fig. 3b), easy to fabricate, more versatile in performance and cheaper to produce. The greatest attribute of these devices is their capability to display memory switching (in addition to threshold switching) which cannot be achieved by any of the existing devices using crystalline semiconductors.

Threshold and memory switching in electronic glasses

In 1968, S.R. Ovshinsky, President, Energy Conversion Devices, Inc., Michigan, U.S.A., discovered threshold and memory switching in semiconducting glasses. The discovery led to an extensive research to understand the mechanism of switching. Though the present understanding of the mechanism of switching in electronic glasses is more sound than what it was at the time of discovery, the knowledge of amorphous semiconductors is not as much as it is in case of crystalline semiconductors.

Threshold switching. Some semiconducting glasses (let us call them type A) only display threshold switching, in contrast to some other (say, type B) which display memory switching.

Fig. 4 shows the current-voltage characteristics and the time response of the device-voltage when a voltage pulse V_p is applied to a threshold switching device. The operating conditions quoted here are for a typical type A material ($Te_{50}As_{30}Si_{10}Ge_{10}$). A thin film (thickness ~ 1 micron) of the material is placed between the electrodes and the device is ready for use. If a voltage-pulse V_p ($> V_t$, the threshold voltage) is applied, after a delay time t_D (~ 10^{-6} sec.) the device switches from the OFF state to the ON state with a very fast speed (switching time $T_s < 10^{-10}$ sec.) and the voltage across the device drops to a value V_h (holding voltage). For the material under consideration $V_t \simeq 1$ volt. The principal characteristic of a threshold switch is that it will go back to the OFF state if the voltage across the device falls below V_h. Therefore, as shown in Fig. 4(c), the switch recovers its OFF state soon after (recovery time $t_R \sim 10^{-6}$ sec.) the applied pulse is terminated. The structure of semiconducting glass devices obviously is simple. The threshold voltage (switching voltage) can

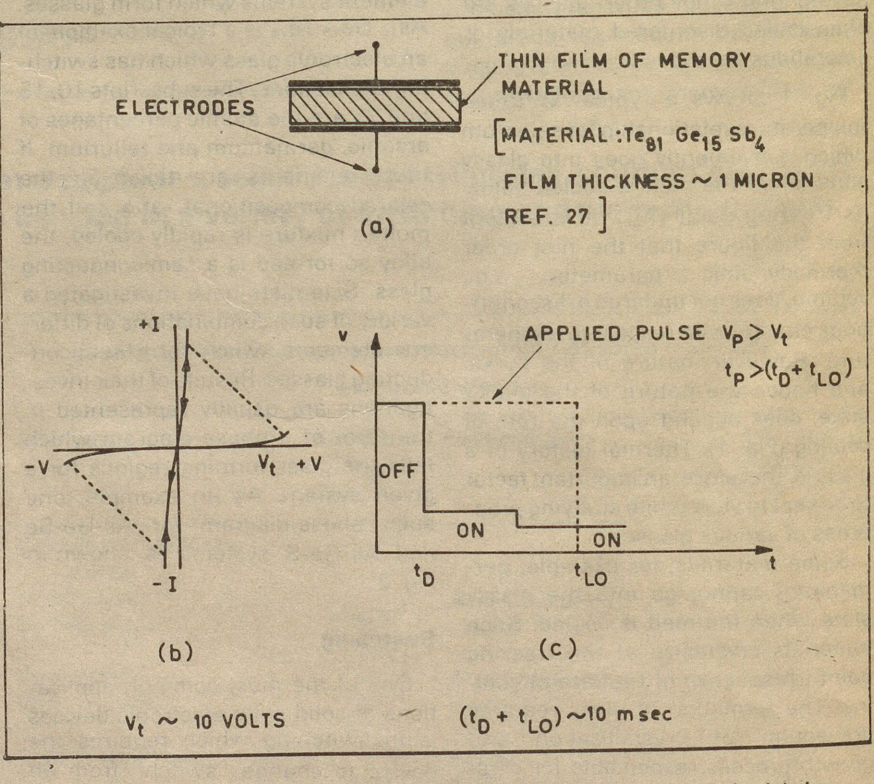


Fig. 4 Threshold switching; (a) device structure, (b) I-V characteristic, (c) time response of the device-voltage on the application of pulse V_p

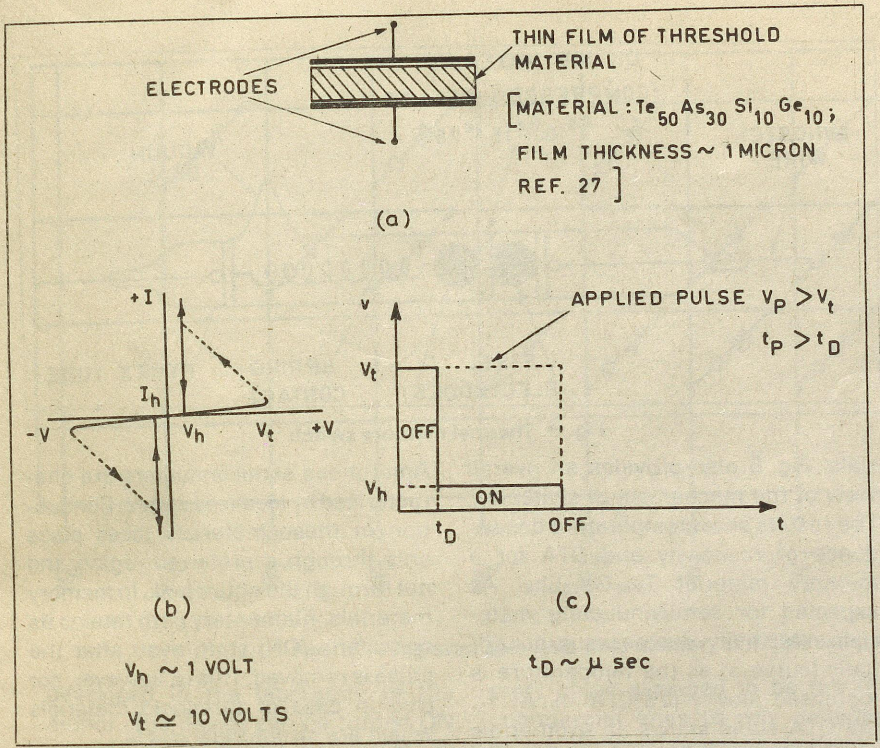


Fig. 5. Memory switching; (a) device structure, (b) I-V characteristic, (c) time response of the device-voltage on the application of pulse V_P

also be controlled conveniently by simply varying the thickness of the film or by varying the compositional ratio or by selecting another glass with different constituents. Also, the symmetry of the I-V characteristics, including the magnitude of V_t with respect to the polarity of the applied voltage, has always been a distinct feature of devices that use semiconducting glasses. Furthermore, a small value of V_h and the large resistance ratio between the OFF and ON states make such devices suitable for many applications.

Memory switching. Some electronic glasses of Type B display memory switching. Fig. 5 shows the device structure, I-V characteristics, and the time response of the device-voltage for a memory switch. The operating conditions quoted here are for a typical type B material ($Te_{81}Ge_{15}Sb_4$). Like a threshold switch, this device also switches very fast ($t_s < 10^{-10}$ sec.) from OFF State to ON state if $V_p > V_t$, where $V_t \sim 10$ volts in this case also. However, memory switches are distinctly different from the threshold switches in the following manner: (i) A memory switch retains its ON state even when the applied voltage is turned off or even reversed. In other words, no holding voltage is required after the device is switched ON. It will remain in its ON state till another reset pulse (of any polarity) is applied to change its state from ON to OFF. Precisely, this is what a memory operation is; (ii) A memory device goes to ON state after a delay time t_D but will retain the ON state only if the duration (t_P) of the applied pulse (V_P) is greater than t_D by an amount t_{LO} (called lock-on time). Generally ($t_D + t_{LO}$) is of the order of few m-sec; (iii) A fast reset pulse (~ 2-5 μsec) causes the memory switch to return to its OFF state and,

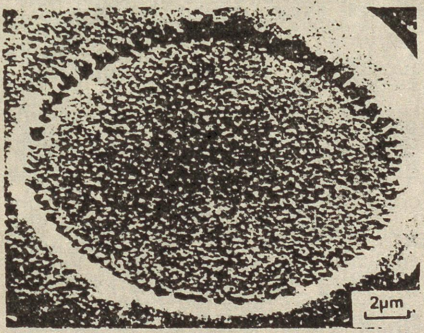


Fig. 6. SEM picture of type A material

like a threshold switch, the recovery time t_R is of the order of μsec.

Mechanism of switching

How do these materials (thin films) look under an electron microscope after the switching operation? Fig 6 shows scanning electron microscope (SEM) picture of the type A material which was switched to the ON state and the picture was taken after removing the top electrode. The figure indicates no changes in the basic structure before and after the switching operations. Contrarily, the SEM picture (Fig. 7a) shows a tumor-like growth in the central region of a type B material ($As_{40}Ge_{10}Te_{50}$) which was switched to ON state by a set-pulse

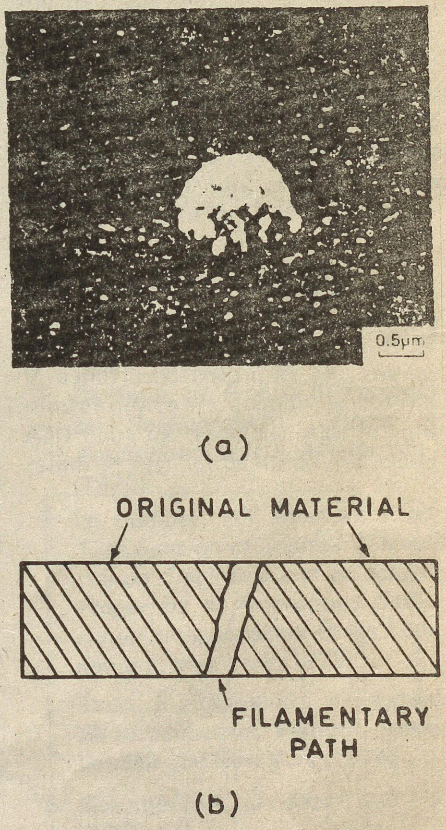


Fig. 7. SEM picture of type B material (a) top view (b) cross-sectional diagram

whose duration was long enough (~ m sec) to set the material to a permanent ON state, i.e., $t_P > (t_D + t_{LO})$. Fig. 7(a) shows the top-view of the SEM picture, whereas Fig. 7(b) shows, schematically, the cross-sectional view. It is therefore apparent that a narrow path, like a filament, grows into the material from top to bottom. The chemical analysis of this filament indicated a composition As_{25} Ge_5 Te_{70} which, according to the phase diagram available for As-Ge-Te system, turns out to be crystalline in nature. Composition of the remaining material, shown shaded in Fig. 7b, was found to be As_{40} Ge_{10} Te_{50} which is amorphous according to the phase diagram. As conductivity of a crystalline material is greater than the amorphous material, one can logically conclude that conduction essentially takes place through the filament after the memory device is switched ON.

There is another important indication obtained from Figs. 6 and 7, i.e., all threshold materials (type A) are structurally stable, whereas the memory materials (type B) are not so. The memory materials are also structurally reversible, i.e., the crystalline filament can be made amorphous by the application of a re-set pulse which brings the device back to the OFF state.

Fig. 8 provides a concrete evidence of the structural changes in type B material. The existence of peaks in Differential Thermal Analysis (DTA) curves (Fig. 8) proves occurrence of structural changes and confirms findings of SEM pictures. No such DTA peaks are obtained for type A materials. Fig. 8 also provides an overall view of the mechanism of switching. The results show temperature dependence of resistivity and DTA for a memory material $Te_{81}Ge_{15}Sb_4$. As expected for semiconducting materials, resistivity decreases exponentially (curve a) as the temperature is increased slowly (25°C/min). At T_1, the DTA curve shows an exothermic peak (curve a) which is caused by the heat of transformation as the material goes from amorphous to crystalline state. Eventually, at this temperature, there is a sudden drop in resistivity or increase in conductivity by many orders of magnitude and thereafter it is maintained at this value till a temperature T_M is reached. At T_M, the material melts and, obviously, goes to disordered (amorphous) state giving rise to an endothermic peak. Resistivity also increases at T_M and thereafter shows a normal exponential decrease.

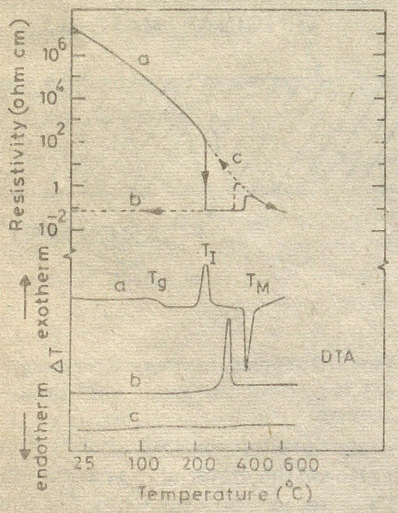


Fig. 8. Resistivity and DTA curves for a type B material showing a reversible structural transformation curve (a): heating rate = 25°C/min, curve (b): cooling rate less than 25°C/min, curve (C): cooling rate faster than 25°C/min.

Examine Fig. 8 when the material is cooled from a temperature a little above T_1, i.e., the temperature at which the material goes to ON state. At first, the situation is studied when the cooling rate is low (less than 25°C/min), i.e., curve (b). As the material is cooled slowly from temperature $T > T_1$, it retains its crystalline state as evidenced by the DTA curve (b). The resistivity of the material is also maintained at a low value for slow cooling. Before proceeding ahead, these observations to explain the memory switching have to be discussed. The application of a voltage-pulse V_P (the so called set-pulse) generates heat and duration of this pulse must be long enough ($t_D + t_{LO}$) to allow crystallization to take place along a tiny region (filamentary path) of the material.

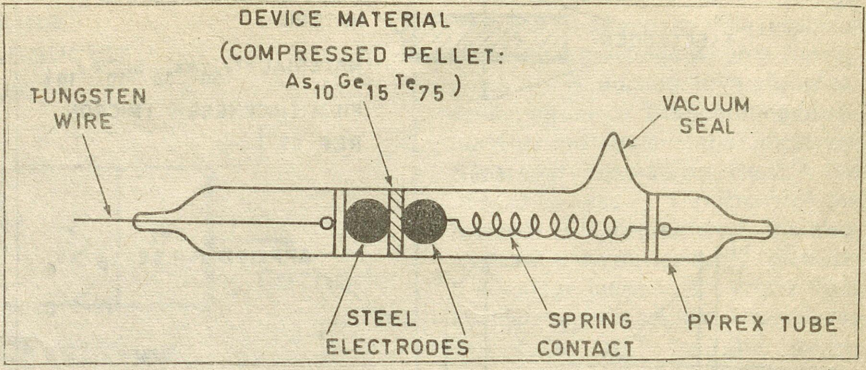


Fig. 9. Thermal memory switch

Amorphous semiconductors are characterised by localized states. Conduction in these materials takes place only through a preferred region and not through the entire bulk. In memory materials, filamentary path retains its crystalline (ON) state even after the pulse is removed. This is, however, not true in case of threshold materials which are structurally stable.

In Fig. 8 (curve c), study the DTA and resistivity curves for faster rate of cooling (>25°C/min). Rapid cooling (quenching) does not give any peak in the DTA curve. Also, the original high-resistivity state is resorted. In other words, the crystalline state is not allowed to stay if rate of cooling is fast. These observations indicate that memory materials are structurally reversible and reversibility can be brought in a controlled fashion through a rapid or slow cooling. One can now see the role of a reset pulse. The function of the fast reset pulse (~μsec.) is to pour sufficient heat energy into the crystalline area. This energy not only breaks bonds but also allows sufficient diffusion of atoms forming the crystalline material. The subsequent rapid cooling restores the original amorphous (glassy) state.

The above discussion does provide a satisfactory explanation of the mechanism of switching in semiconducting glasses. Theoretical models have also been proposed which provide a quantitative explanation. Their discussion however is beyond the scope of this article.

Some novel applications of amorphous switches

Thermal memory switch. This simple and cheap device (Fig. 9) has been

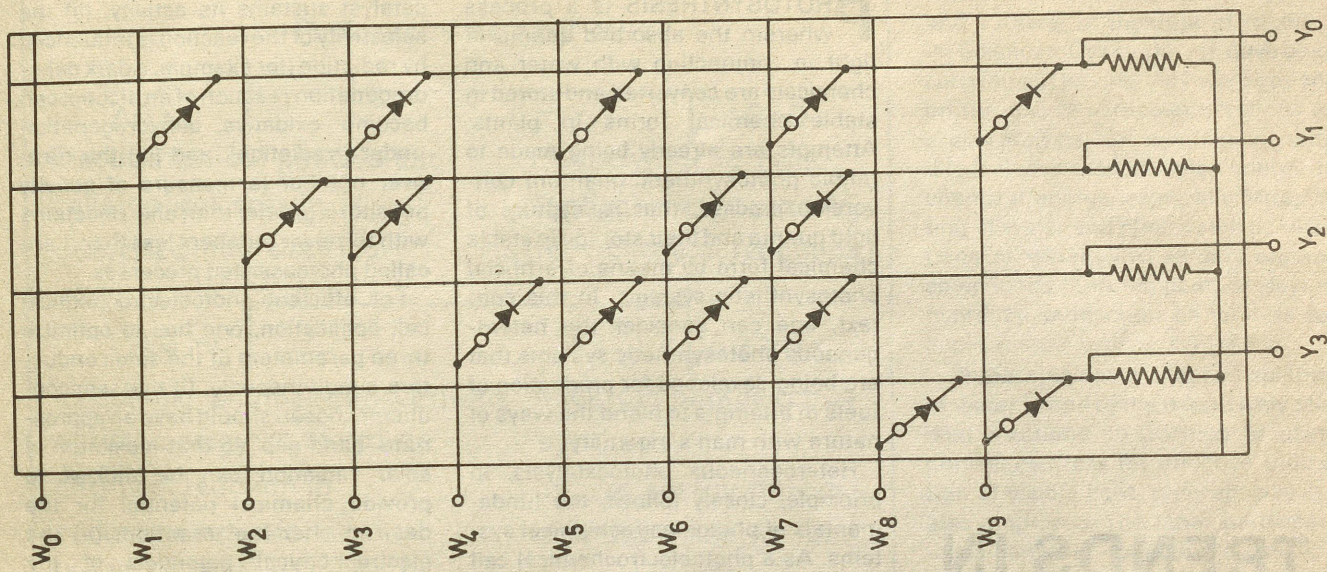


Fig. 10. Programmable read-only memory (PROM) using amorphous switches

developed in the laboratory of the author. The device can be turned ON at a predetermined temperature by adjusting the dc bias across its two terminals. If attached to the radiator of an automobile, it will sense the temperature of water and therefore can be used to energize a relay to turn the motor OFF automatically at the desired temperature. The 12-volt battery of the car is sufficient to provide the dc bias if a suitable thickness of the memory material is used for operation. After the motor is turned OFF, the device can be brought back to its original OFF state by simply turning the ignition-key OFF which, in effect, provides a high-frequency reset pulse.

Programmable read-only memory (PROM). Fig. 10 shows a basic diagram of a conventional ROM (Read Only Memory). As the name implies, the device can be used only to "read" a programme already written, i.e.,

$Y_0 = W_1 + W_3 + W_5 + W_7 + W_9$
$Y_1 = W_2 + W_3 + W_6 + W_7$
$Y_2 = W_4 + W_5 + W_6 + W_7$
$Y_3 = W_8 + W_9$

The device can be made programmable (Read and Write both) by adding an amorphous switch in series with all the diodes as shown by open circles in Fig. 10.

An American Company is planning to introduce a family of high-speed programmable read-only memory chips expected to be the first commercial ones to rely on amorphous—silicon switches instead of conventional devices. The new PROMs having only half the size of traditional PROMs will use an anti-fuse approach. The conventional devices are ROMs (read only memory) which can only be used to read a programme that is already written. To write another programme, the diode-connections (Fig. 10) are either broken (fused) or a fresh device is made.) With it, an amorphous-silicon switch in each cell (diode) will act as an insulator (OFF) until a programming voltage is applied, causing a non-reversible phase transition transforming the material into crystalline silicon that then acts as a conductor (ON). The programming voltage is around 10-20 volts.

Wafer hyper interconnection package (WHIP) technology. WHIP, the latest IC technology, owes its easy programmability to an "antifuse" technique employing amorphous-silicon switches. A WHIP wafer of amorphous silicon is sandwitched between two layers of metal lines. These lines and spaces of at least 11 micrometers wide are laid down in one layer at right angles to lines in the other layer. The WHIP is programmed when voltage between 10-20 volts is applied to the metal layers. Rather than break an existing connection, as a conventional fuse would, the programmable voltage turns the desired areas. (The locations where connections are required between two chips) conducting (ON) and connects the two layers of metal for linking up chips.

Further reading

1. Kolomiets, BT, *Phys. Status Solidi*, **7** (1964) 359.
2. Doremus, W, *Proc. of Symposium on Semiconductor Effects in Amorphous Solids*, Amsterdam (1970).
3. Le Comber, PG, Mort, J, *Proc. 13th Session of Scottish University on Electronic and Structural Properties of Amorphous Semiconductors*, Academic Press, London and New York (1973).
4. Tauc, J, *Amorphous and Liquid Semiconductors*, Plenum Press, London and New York (1974).
5. Savage, JA, *J. Mat. Sci.* **7** (1972) 64.
6. Maruno, S, Noda, M and Yamada, T, *Yogyo-Kyokai-Shi*, **81** (1973), 445.
7. Ovshinsky, SR, *J. Non. Cryst. Solids*, **2** (1970), 99.
8. Klinger, MI, *J. Non. Cryst. Solids*, **4** (1970), 463.
9. Ball, MA, *J. Phys. C. (GB)*, **4** (1971) 1107.
10. Davis, EA, *Phys. Bull. (GB)*, **22** (1971) 81.

TRENDS IN HETERO-GENEOUS PHOTO-CATALYSIS

A variety of chemical products may be obtained by photocatalytic reactions using metal-doped semiconductor materials

B. VISWANATHAN

PHOTOSYNTHESIS is a process wherein the absorbed quanta of light in conjunction with water and chemicals are converted and stored in stable chemical forms in plants. Attempts are already being made to mimic photosynthetic quantum conversion process, that is, capture of light quanta and their storage in stable chemical form by means of artificial photosynthetic systems. In this context, one can consider the heterogeneous photosynthetic systems that are being developed for production of fuels in attempts to blend the ways of nature with man's ingenuity.

Heterogeneous photocatalysis, in principle, closely follows the fundamentals of photoelectrochemical systems. As a photoelectrochemical cell electrode, a photocatalyst has to perform three requisite functions, namely, (i) efficient absorption of photons to generate electron-hole pairs, (ii) effective separation and stabilisation of these charge carriers with definite lifetimes before they recombine for their utilisation in redox process, and (iii) efficient subsequent redox chemistry to form the required chemicals.

A photoelectrochemical system is one in which a photoactive semiconductor, in contact with a liquid or solid electrolyte, gives rise to electron-hole pair separation when illuminated with light. The charge carriers so separated drive chemical redox reaction. A general scheme of the types of known photoelectrochemical cells is given in Fig. 1. In photoelectrosynthetic cells, which are of relevance for photocatalysis, two different redox couples are present and corresponding reactions occurring at the electrode upon illumination lead to net chemical change.

The same sequence of events holds good for heterogeneous photocatalytic processes. A reaction is considered photocatalytic only when (i) the catalyst sustains its activity, (ii) the selectivity of the reaction is influenced by radiation (for example, a dark dehydrogenation reaction of an alcohol can become oxidative dehydrogenation under irradiation), and (iii) the turnover number (a measure of activity per site) is greater than one. Reactions with turnover numbers less than 1 are called photoassisted processes.

For efficient photoelectrochemical cell application, one has to optimize three parameters of the semiconductors simultaneously: (i) the semiconductor chosen should have an appropriate 'band gap' so that maximum of solar radiation can be utilized to provide chemical potential for the desired chemical reaction, (ii) the electrochemical potentials of the charge carriers produced as a result of illumination should be matched to the redox chemistry desired so as to obtain maximum rates without any external EMF or bias, (iii) the electrode should be stable over long term. These conditions are equally applicable to photocatalytic processes.

The chemisorption of a molecule at the surface of a semiconductor results in the modification of electronic structure of the surface relative to that of the bulk. This results in transfer of electron from or to the chemisorbed species,thus creating a surface potential. As a result of this charge transfer, the potential at the surface (5nm—200nm) is distorted compared to that in the bulk. The electron-hole pairs produced by illumination in this region have definite lifetimes and can be accelerated.

The electrochemical potential of the electrons at the surface with respect to the redox species decides whether the illuminated surface acts as a sink for electrons or holes. When an illuminated electrode acts as a source of electrons, the corresponding positive holes move under the influence of the electric field inside the bulk of the solid and are made available at the second electrode (in PEC cells) or at the darkened surface to promote the counter redox reaction, namely oxidation reaction.

Sh. Viswanathan is with the Chemistry Deptt. at Indian Institute of Technology, Madras-600 036

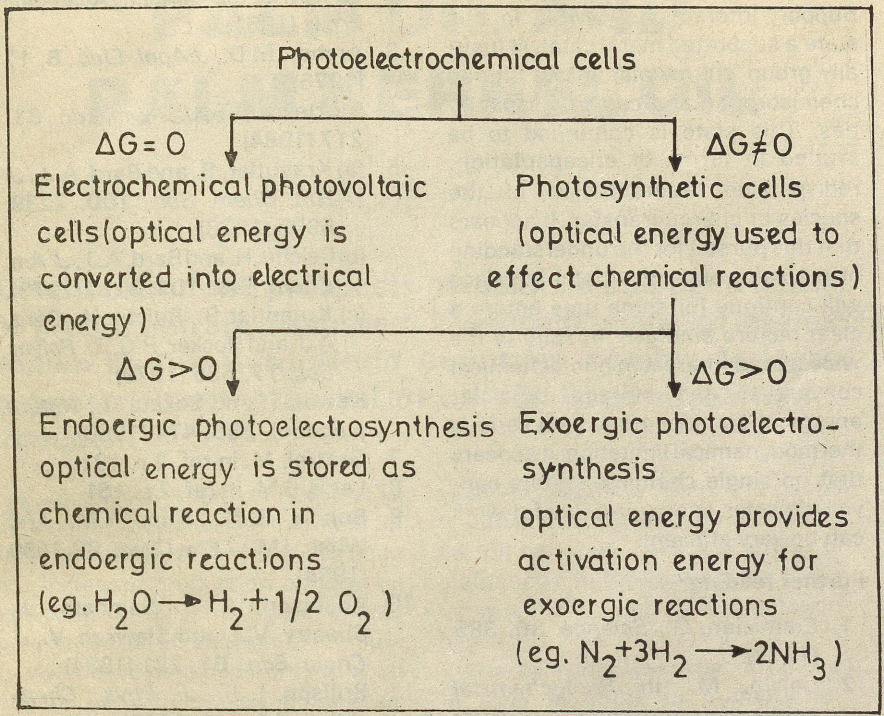


Fig. 1. Types of photoelectrochemical cells

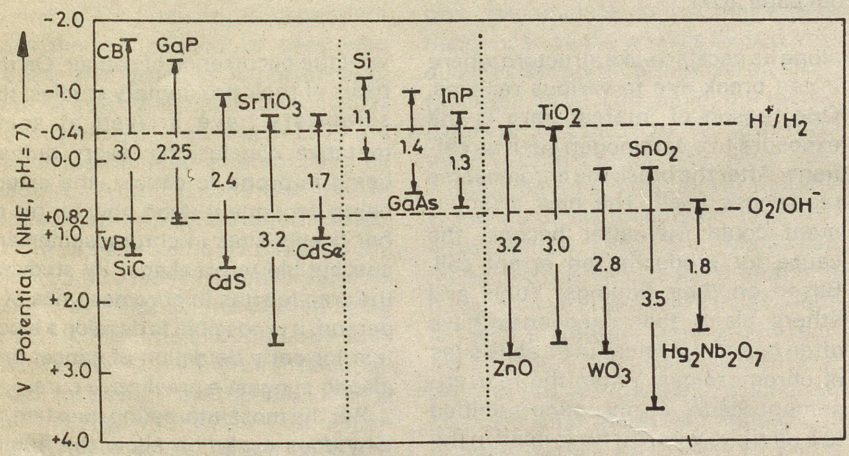


Fig. 2

The possibility of loading semiconductor materials with controlled amounts of metals like Pt, Pd, Cu by photodecomposition process has added another dimension to heterogeneous photocatalysis. Since photoreduction is normally carried out at low temperature, a high degree of dispersion of the metal can be achieved and the range of applicability of this method for preparation of supported metal systems can be extended to other elements by use of non-aqueous medium.

The scope of heterogeneous photocatalytic reactions at metal semiconductor interfaces has increased considerably in the last few years. For example, the oxidative decarboxylation of caboxylic acids to produce alkanes, photooxidation of hydrocarbons, photosynthesis of amino acids and initiation of radical polymerization with specific advantages with respect to control of polymerization rate, molecular weight distribution and sequence of distribution have all been studied by A.J. Bard and his coworkers at Texas, USA. T.Sakata and T.Kawai of Institute of Molecular Sciences, Osaka, Japan, have been carrying out pioneering investigations on the use of particulate systems as photocatalysts in connection with direct conversion of solar energy to chemical energy, especially for splitting of water and photocatalytic reactions of water with various organic compounds from the point of view of hydrogen production as well as for application in organic synthesis.

Photocatalytically induced splitting of water is one of the extensively studied reactions. In addition to using photosensitizers for effective utilization of visible light, relay species are also employed. The latter participate in oxidative or reductive quenching processes with the excited photosensitizers, limiting the electronic back reaction and promote oxidation or reduction of water. The reaction is facilitated by the presence of a catalyst like RuO_2 or Pt. Oxidative and reductive half reactions in water splitting process can be carried out in a single cell configuration as has been attempted by Sakata and Kawai, or by the use of membranes that are permeable either to electrons or to protons. In the single cell mode, important parameter to be considered is the position of the conduction and valence band edges in relation to the redox half reactions of water. For example, the H^+/H_2 redox level should be below the conduction band edge such that this reaction takes place at a considerable rate without experiencing appreciable overpotential or activation energy (Fig. 2).

The photocatalytic reactions at metal-semiconductor systems have received considerable attention because of the possibility of separating electron-hole pairs effectively in the semiconductor and carrying out the reduction process at the metallic component. As such, photosynthetic processes on semiconductors have many kinetic limitations, viz., the formation of stable products has to be faster than the recombination reaction. The choice of the semiconductor support at present seems to be $SrTiO_3$ because of (i) its stability under reaction conditions, (ii) its value of the band gap (~3.2 eV) which is larger than the energy required for water decomposition (>1.23 eV), and (iii) the electron-hole pair formed on excitation has the requisite redox properties (see Fig. 2). Various metal-loaded $SrTiO_3$ samples have been tried for water decomposition and their relative efficiencies are 10^2-10^4 times higher than the metal-free systems. The reasons for this increased efficiency or the mechanism of the process on metal-loaded systems are not clear at present. The study of semiconductor-metal interface is, therefore, being actively pursued nowadays using surface sensitive techniques especially with a view to estimate the extent of band bending and the height of the Schottky barrier as well as to probe the nature of metal deposit on the support.

Another independent development in heterogeneous catalysis which may have relevance to the understanding of the semiconductor-metal photocatalysts is the study of Strong Metal Support Interactions (SMSI). In this state a supported metal catalyst (usually group VIII metals) shows altered chemisorption and catalytic capabilities. This state is continued to be argued in terms of encapsulation, redispersion, interdiffusion of the species or charge transfer. It appears that this pursuit for the understanding of the semiconductor-metal interface will continue for some time before a clear picture emerges In spite of the widespread interest in photochemical conversion and storage of solar energy, there appears to be a serious thermodynamical limitation; it appears that no single chemical system converting solar energy into useful work can be very efficient.

Further reading

1. Ciamician, G., *Science*, **36**, 385 (1912).
2. Calvin, M., in *Photochemical conversion and storage of solar energy*, Ed. J.S. Connolly Academic Press (1981), p.l.
3. Archer, M.D., *J. Appl. Elec.*, **5**, 17 (1975).
4. Mc Devitt, J.T., *J. Chem. Edn.*, **61**, 217 (1984).
5. (a) Kraeutler, B. and Bard, A.J., *J. Am. Chem. Soc.*, **100**, 2239, 5985 (1978).
   (b) Reiche, H. and Bard, A.J., *J. Am. Chem. Soc.*, **101**, 3127 (1979).
   (c) Kraeutler B., Reiche H., Bard, A.J. and Hocker, R.G., *J. Polym. Sci.*, **17**, 535 (1979).
6. Kawai, T. and Sakata, T., *Nature* (London), **286**, 474 (1980).
7. Gratzel, M. in ref. 2 p. 131.
8. Lehn, J.M. in ref. 2 p. 161.
9. Bolton, D.N., Sun, Y.M. and White, J.M., *J. Phy. Chem.*, **88**, 1690 (1984).
10. Adamson, A.W., Namnath, J., Shastry, V.J. and Slawson, V., *J. Chem. Edn.*, **61**, 221 (1984).
11. Brillson, L.J., *J. Phys. Chem. Solids*, **44**, 703 (1983).

ON THE FRONTIERS *(Continued from page 207)*

induced in the cell machinery by "carcinogens", cancer-causing chemicals. Recently, Jorge J. Yunis and others of the University of Minnesota Medical School, U.S.A., have propounded a new theory of cancer based on their own findings, although retaining some of the previous ideas. Their theory attributes the creation of an errant cell to something intrinsic and fundamental in cell machinery, to what are known as "fragile sites" in chromosomes of the machinery.

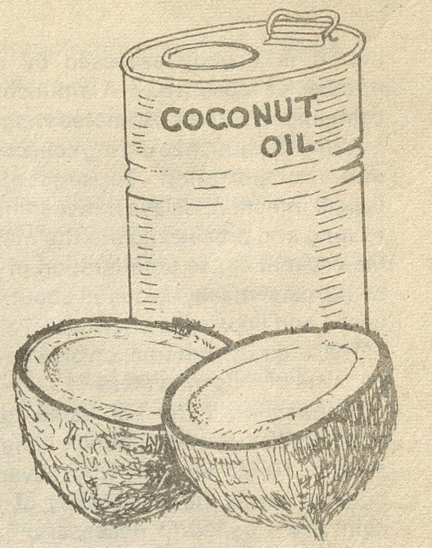
Chromosomes, necklace-like structures with genes as beads, govern the functioning of cell machinery in human beings or for that matter, any living being. Genes, the basic units of heredity, which are composed of DNA molecules, not only code for composition of cells but also control their creation and differentiation. In recent years, "Oncogenes", the dormant genes with the potential to produce an errant cell, have also been discovered. According to Yunis and others, every chromosome has some fragile sites along its necklace-like structure where it can break due to various reasons. One reason of interest here is the exposure to a carcinogen such as caffiene. After the break the chromosome rearranges itself. The new arrangement could thereafter become the cause for producing an errant cell. Based on their findings, Yunis and others claim that oncogenes have often been found near the fragile sites of chromosomes. When the rearrangement occurs, an oncogene is shifted to a new site where it finds itself in the company of a gene which activates it to produce an errant cell. The researchers have further found that a carcinogen such as caffiene accelerates the process of breaking of chromosomes at its fragile sites and so increases the possibility of an oncogene to activate itself and cause cancer. On the other hand, Vitamin B folic acid, which is rich in Thymine found in DNA, resists the process of breaking of a chromosome. In other words, Vitamin B folic acid can prevent the occurrence of cancer. On the basis of their preliminary studies, the scientists have arrived at some tentative conclusions: every human being is prone to cancer, the extent being dependent upon how far his or her fragile sites in chromosomes are susceptible to breakage. By studying the fragile sites in chromosomes of a person, it is possible to develop a blood test for early detection of cancer and also to suggest a preventive cure.

But the most interesting question is, why does evolution allow the fragile sites to be perpetuated? The fragile sites allow re-designing of chromosomes under various environmental pressures and so are responsible for the diversity of life that is seen. Moreover, cancer generally strikes at a late age, when reproductive power of human beings is over. Evolution perhaps wants the deadwood to be removed.

Dilip M. Salwi

PALM OIL AND PALM KERNEL OIL

JACOB JOHN



The problems and prospects of palm oil and palm kernel oil production are discussed. The recent revival of interest shown by the Third World countries notably Malaysia suggests that the arrival of an edible oil revolution is imminent

A notable achievement of the third world countries in the field of farming over the recent past has been the increased production of palm oil and palm kernel oil. The palm oil and palm kernel oil of domestic and industrial value are obtained from the West African oil palm *Elaeis guineensis* Jacq. It is presumed that the oil palm took its origin in the swamps of West Africa where even today a substantial portion of the industry is dependent upon the exploitation of semi-wild groves. The growing importance of palm oil as a dependable source of fat is indicated by the fact that in 1971 the total industrial production of palm oil reached 12,20,000 tons and that of palm kernel oil 4,22,000 tons. In 1981-82 the values rose to 55,37,000 tons and 7,93,000 tons respectively and for the period 1982-83 the figures stood at 57,48,000 tons and 8,33,000 tons respectively. Of all the oil producing crops, oil palm is the highest yielding one that even the poorer oil palm plantations of West Africa out yield the best coconut plantations elsewhere. Two tons of palm oil per acre are usually obtained in plantations in the Far East, three tons have been recorded in Sabah and it has been speculated that as high as four tons of oil per acre can be obtained.

Man appears to be the cardinal agency for the spread of oil palm in the African continent. Vast areas of oil palm groves are seen in Sierra Leone, Liberia, Ivory Coast, Ghana, Togoland, Dahomey, Nigeria and Cameroun. Isolated areas of oil palm cultivation are seen in East Africa where the rainfall is sufficient. A sizable proportion of the oil palms in Zaire are grown on plantations. In the Far East the industry is almost completely plantation-based.

The oil palm was first introduced in Java in 1849, in Sumatra in 1911 and in the peninsular Malaysia in 1917. In recent years in the Malaysian peninsula, the expansion has been taking place so fast that it now happens to be the world's largest producer and exporter of palm oil. In 1971 Malaysia produced palm oil to the extent of 5,42,000 tons, while in 1980 the production of palm oil went upto 2.8 million tons. This is over half the world palm oil production figure of 4.84 million tons. The Malaysian industry expects to reach a total of 4 million tons in 1985 and 6 million tons in 1990. The oil palm produces an edible oil which ranks second after soybean in the worldwide production of fats and oils. Malaysia's industry is oriented almost exclusively to export market and it now claims almost 88% of total world palm oil exports. A considerable portion of Malaysia's oil palm plantations prior to 1970 was rubber land. These rubber lands were transformed into oil palm estates during 1970's. About 52% of the total of 11,38,676 hectares is owned and operated by private large estates, 42% by government and the remaining 6% by independent small holders. Most of the oil palm of Malaysia belongs to the Tenera variety —the product of Dura and Pisifera crossing— and yields upto five tons of oil per hectare. In South America oil palms are grown in many countries including Brazil, Ecuador and Columbia. Other countries like Sri Lanka, Solomon Islands, Papua New-Guinea and India grow oil palm on a smaller scale. In India oil palm cultivation was started in the state of Kerala in 1960's.

On the basis of the internal characteristics of the fruit, oil palms are categorised into three main fruit varieties.

(a) *Dura*: The fruit posseses a thick shell between the mesocarp and the kernel.

(b) *Tenera*: : This variety has a thinner shell than dura. In its mesocarp there is a characteristic ring of fibres encircling the nut which one can see clearly on cross-section.

(c) *Pisifera*: This variety does not have a shell.

The fibrous mesocarp contains about 50% palm oil by weight. Most of fat synthesis in the mesocarp occurs during the last fifteen days of fruit ripening. Therefore, to achieve maximum oil yield under ripe fruits should not be harvested. Further, the mesocarp contains fat-splitting enzymes such as lipases and lipoxidases. For this reason there would be enhanced enzymatic activity in overripe fruits and the quality of oil would be considerably diminished. It is necessary to have trained harvesters to assess and gather fruits at the right stage of ripen-

Dr. Jacob John is Astt. Professor in Biochemistry at Regional Agricultural Res. Station, Pattambi 679306 (Kerala)

ing. It is usually assessed by the number of loose fruits in a bunch in comparison with its estimated weight. Injuring the bunches during collection and transportation, consequential fungal infection, delays between harvesting and processing are the major factors that cause deterioration of oil being catalytically brought about by lipase and lipoxidase enzymes.

The large scale extraction of palm oil consists of following steps.

Sterilisation The harvested furit bunches (usually each bunch weighs around 10-30 kg and has several hundred fruits held together) of oil palm are washed (if necessary) and placed into cages. The cages are then let into sterilisers where they are heated approximately to 130°C by high pressure steam. The steriliser condensate is composed of condensed steam with entrained debris and some oil from the debris fruits.

Stripping : Individual fruits are stripped from bunches. This is done in a thresher. The stripped bunches are either incinerated or returned to the plantation as a mulch

Digestion : The steamed fruits are macerated almost to a homogeneous mass by constant agitation and beating against baffles in a steam jacketted kettle. In this process special care has to be taken to prevent kernels from being cracked or crushed.

Oil extraction : The mass is either pressed in a hydraulic press or screw pressed to yield a mixture of crude oil and a mixture of nuts and fibres.

Clarification: The red orange palm oil leaving the press is in a partially emulsified form containing suspended materials such as sand, dirt and cellular debris. It is separated into its components and the oil is cleaned by the continuous addition of hot water through a series of screens. The rather clear oil is then allowed to pass through several settling tanks or through a centrifugal separator. At this stage, a relatively clear oil is obtained. Remaining impurities and water are eliminated through centrifugation and vacuum drying. During clarification stage a substantial amount of heavy dark sludge (oil palm sludge) separates out. As this sludge has some residual oil in an emulsified form, it is further submitted to centrifugation. The resulting sludge is discarded.

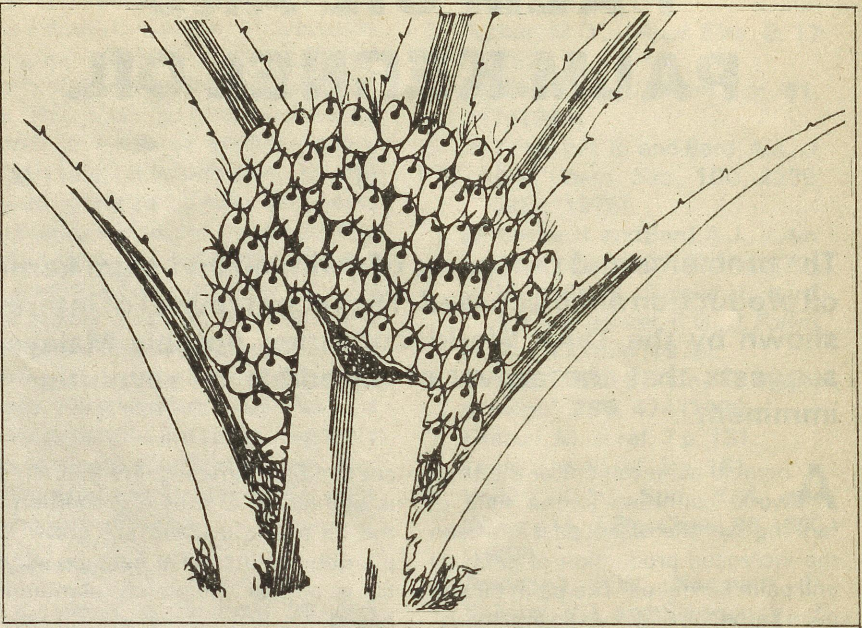


Fig. 1. Oil palm crown with ripe fruit bunch

The moisture content of the oil is normally brought to less than 0.1% in order to maintain a minimum point of hydrolysis. The crude palm oil possesses a deep orange colour and has a semi-solid character in the existing ambient temperature of its extraction centres. Nevertheless, the solid content depends upon the free fatty acid (FFA) concentration and on the exact conditions of cooking and heating. The odour of the crude oil to a certain extent is due to presence of β-ionone and its allied entities generated during the oxidative events of carotenoids that take place in the drastic sterilisation stage. Though these substances give colour to the oil, they do not have any nutritional value.

Preservation of the quality of palm oil depends upon its careful handling.

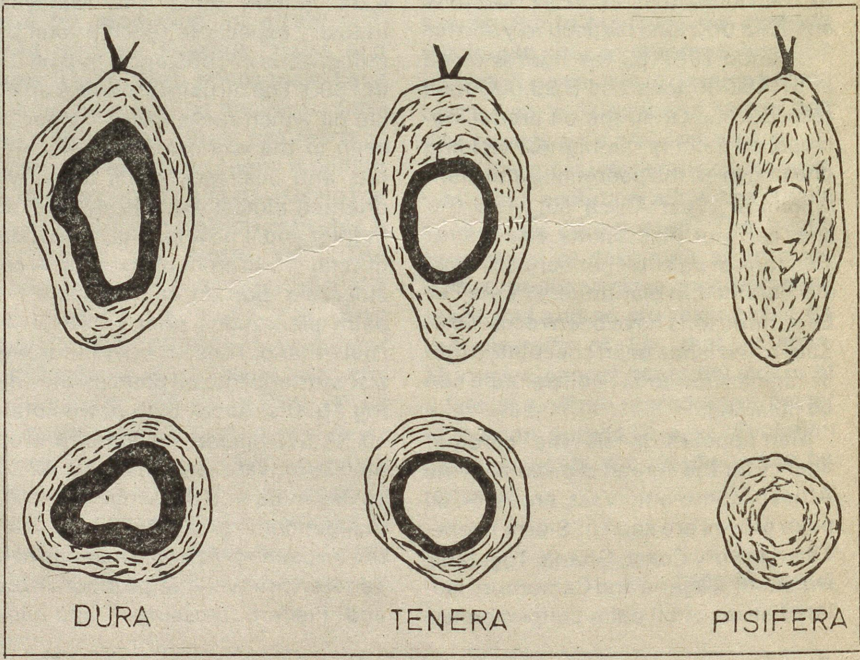


Fig. 2. Internal structure of the oil palm fruits

Deterioration of the oil leads to high refining costs. The desired bleached colour and taste of the finished product can be achieved if oxidation is kept as low as possible. Unacceptable processing techniques and handling procedures such as overheating the oil, contamination by prooxidant metals such as copper and iron and direct contact between overheated oil and atmosphere aid the destruction of the potent natural antioxidant viz; tocopherols. Increased FFA concentration helps dissolution of iron from processing machinery plants and storage vessels. Therefore it is necessary to keep the FFA concentration within the prescribed limits. A soluble iron content of 5 mg/kg or less is tolerated. Because of frequent use of iron drums for internal transportation, iron content of the order of 30-50 mg/kg has been detected in West African oil samples.

As in the case of other fats of plant origin, refining of palm oil is carried out through neutralisation, bleaching and deodourisation. Elimination of FFA in the neutralisation process results in direct oil loss to the refiner, therefore, it is advisable to refine the oils of low FFA for keeping refining losses low. FFA can also be removed through steam distillation but it is not possible to bring down the FFA content to the desired level of less than 0.1% by this method alone. Hence, if it has been steam distilled, it should be immediately followed by neutralisation, bleaching and deodourisation. The presence of the thermolabile carotene and its congeners impart a dark orange colour to the palm oil, consequently bleaching forms an important aspect of palm oil processing. In modern processing techniques, these chromogenic components are eliminated by heat-bleach method, that is, the pigments are disintegrated by heating the oil to over 180 °C under vacuum. This action is either followed or preceded by a mild treatment with a small amount of bleaching earth or other degumming agent. After bleaching, an acceptable good quality oil will have residual colours of between 1 and 3 red Lovibond units in a 13.34 cm cell. Chlorophyll, if present, gives a slight green tint and can be removed by treating with bleaching earth.

The main cause of acidity in the oil is the amount of moisture present in the kernels, as moisture is an invariable requirement for lipolysis to proceed. Therefore, rapid reduction of moisture in palm kernel should be achieved because fresh unsterilised kernels contain a moisture level of 22%. Fungal growth not only affects the quality of the oil but also of the meal. Release of fungal metabolites like aflatoxin B_1 in palm kernel even upto a concentration of 2 ppm is also not uncommon.

Though palm kernel oil differs much from palm oil, its characteristics and properties resemble those of coconut oil. Usually it is a colourless to brownish-yellow oil and solidifies in temperate climate to a white or yellowish fat. The FFA content calculated as lauric acid varies from 0.5% to 10%. Although the solid fat has a higher melting point than coconut oil it is more greasy and has a less brittle consistency. The unfinished oil has a strong, very characteristic and tenacious taste and smell. It has a tendency to become rancid rapidly and is refined before use. The refined oil keeps well.

The local population of West African countries consumes large quantities of unrefined oil in soups, for frying and in other multifarious preparations. However, in almost all other countries, only refined oil is used for edible purposes. For preparation of various chemical derivatives fully hydrogenated palm oil is used as a starting material. On account of the high content of lauric acid, palm kernel oil is mainly used for production of high quality soaps possessing excellent solubility consistency and lathering properties. In detergent manufacture too, palm kernel oil is widely used because of its high lauric acid content. However use of palm kernel oil for edible purposes has limitations, for the products of hydrolysis render a soapy taste which is readily detectable. In frying also, its use is limited because in combination with other oils it has a tendency to foam badly.

On account of its high melting point, palm oil is used in margarine preparations without hydrogenation. One negative aspect of hydrogenation of palm oil is the transformation of the highly nutritive carotenoid pigments into substances of no food value.

Palm oil can be readily fractionated into stearin and olein. The palm olein serves as a good vegetable oil for cooking purposes. There are four main conventional processes for fractionation of palm oil :—

1. Crystallisation of crude oil by cooling and separating the fractions;
2. Dry fractionation of the neutralised and bleached oil;
3. Solvent fractionation; and
4. Crystallisation followed by separation in aqueous detergent.

Table 1. India's total import of edible oil

Year	Million tons
1980-1981	1.07
1981-1982	1.20
1982-1983	1.50

Edible oil production in India

For years India has been deficient in edible oil. Though sporadic improvements in production do take place in certain years, the nation will still continue to import oil for years to come. In fact, during 1983 India imported about one million tons of vegetable oil to meet consumer demand (Table 1).

Oil seed production in India in 1981 was 12.38 million tons while in 1982, it stood at 14.02 million tons. For 1983 the total production appears to be approximately 14.5 million tons. The incredible success that has been achieved in the recently revived palm oil industry initiated by Malaysia amply shows the high potentiality of raising this oil crop in suitable areas of Indian peninsula.

Further reading

1. Hartley, C.W.S. *The Oil Palm* (Second Edition 1979), Longman Publications, London and New York
2. Corner, E.J.H. *The Natural History of Oil Palms* Weidenfeld and Nicolson, London (1966).
3. Cornelius, J.A. (1983), Private Communication.
4. Corley, R.H.V. (1973), Oil Palm Physiology, In *Advance in Oil Palm Cultivation*, 37, Incorp. Soc. of Planter, Kuala Lumpur

HOW GALLSTONES ARE FORMED

S.P. MOULIK
SWAPNA DAS (PAL)

Instability of bile causes precipitation of cholesterol in the gall bladder. The sterol particles agglomerate to form what is known as gallstone

THE formation of stone in gall bladder often causes acute pain in the region. Removal of the gall bladdei with the stone by surgery is the recommended medical remedy. Although this has been the common practice, oral administration of suitable chemical compounds to dissolve the stone has been attempted with success. In this article an attempt has been made to present the physicochemical basis of stone formation with concise description of bile, the stone, mechanism of stone formation and related studies.

Bile—its nature and composition

In mammals, fluid bile is synthesized in the liver. This hepatic bile is transported to the gall bladder where it becomes about seven fold concentrated. After each fat-containing meal, the gall bladder pumps out bile into the stomach. Bile is required to solubilize fat portion of the food through emulsification for proper absorption. Bile helps in the digestion of fatty food.

The compound that helps emulsification of fat is the natural detergent bile salt. Both conjugated and nonconjugated salts of cholic acid, deoxycholic acid, chenodeoxycholic acid and lithocholic acid mixed with phospholipid (lecithin) and cholesterol essentially constitute bile. The molecular structures of these compounds and their configurations at the air/water interface are shown in Fig. 1. In addition to these, the dye bilirubin (a breakdown product of haemoglobin), inorganic ions, viz., Na^+, Ca^{++}, Mg^{++}, Fe^{++}, etc., and proteins are also present as minor components in bile. Physiologically, cholesterol is a very important biochemical. The bile acids, steroidal hormones (like progesterone, testosterone, etc.), vitamin D_3, etc., are formed from cholesterol through enzymic reactions. Lecithin is required to emulsify cholesterol as well as to maintain the level of fat in liver. Inadequate amount of lecithin causes accumulation of fats in the organ and makes a "fatty liver"

In bile, the three major lipid components, bile salts, lecithin and cholesterol combine to form species called 'mixed micelles'. They play a key role in the stability of bile. Above a critical concentration, molecules of a lipid or a detergent assemble or aggregate to form entities of a particular shape called micelles. Micelles are polydisperse and of colloidal dimension. When more than one lipids or detergents combine to form such species in solution, they are called 'mixed micelles'. Pure and mixed micelles have the striking properties of adsorbing ionic and polar molecules on their surfaces and solubilizing nonpolar molecules in their apolar interior. The resulting species are also mixed micelles. Typical representations of pure and mixed micelles are shown in Fig. 2. In bile, normal water solubility of cholesterol (about 5 μM) is enhanced through mixed micelle formation with bile salts and lecithin (Fig. 3). Apparently, bile is a stable system containing a sufficient quantity of cholesterol. One ml of normal human bile contains, on an average, 98.13 mg bile salt, 43.4 mg lecithin and 7.28 mg cholesterol. The composition may however vary depending on the variation of the physiological conditions.

Gallstone: its nature and composition

Gallstone is essentially an agglomerated cholesterol. It may also contain bilirubin, inorganic ions and proteins. On rare occasions, a stone may have dye as its major component The stones are apparently hard and cannot be solubilized in acids and alkalies. Detergents (surfactants) and nonaqueous solvents like alkanols, acetone, chloroform, carbon tetrachloride, etc., can solubilize stone.

It is believed that under some abnormal physiological conditions, the cholesterol withholding capacity of bile is lost, and the sterol precipitates in the gall bladder. Periodic contractions of the organ help, in course of time, the assembled sterol particles to grow into a lump, called the stone During squeezing of the gall bladder, some cholesterol particles enter into the bile duct and block the passage. This abnormality causes pain in the region. Usually, more than one stone of various sizes occur in patients. Fine cholesterol particles in the form of sediments called the biliary mud also occur infrequently.

Mechanism of gallstone formation

Water is the major constituent of bile. The total amount of lipids, bile salts, lecithin and cholesterol is smaller than water and its concentration is considered constant or unaltered in all situations. Concentration of the minor components (bilirubin, inorganic ions and proteins) is very small, even in comparison to lipids, and is therefore physicochemically insignificant. Bile is a single phase pseudo three-component system and

Dr. Moulik and Ms. Das are with the Deptt. of Physical Chemistry, Faculty of Science at Jadavpur Univ. Calcutta-700 032

can be thermodynamically described by Gibbs phase rule. In 1966, D.M. Small, M. Bourges and D.G. Dervichian of Pasteur Institute, France introduced this concept and considered the stability of bile being governed by the phase rule. To remain in a single phase, the components in a system must bear certain fixed ratios. In a three-component system, fixation of the concentrations of two components automatically fixes the concentration of the third. If in excess, that amount of the component should be out of phase and precipitated. When applied to the pseudo three-component bile system, the critical solubility limit of cholesterol is guided by the concentration of bile salt and lecithin present in the bile (Fig. 4).

This remarkable thermodynamic mechanism has been put to test by taking natural bile from controls and patients as well as biles formulated artificially in the laboratory. The single phase and multiphase regions have been identified. In the multiphase region liquid crystals, microcrystals, etc., have been recognized. The important significance of this concept has been the diagnostic prospect of normal and abnormal biles. In accordance with the phase rule, biles falling above the phase boundary line are abnormal and those falling below are normal. But this simple procedure is not an absolute monitoring device. Biles of normal subjects have been observed, on many occasions, to be falling above the phase boundary line, while biles from patients fall below. Cholesterol supersaturation in the biles of such normal subjects has been rationalized considering them to be prone to stone formation. Cholesterol under-saturation in the cases of patients has been explained thus: their biles are cholesterol deficient on account of stone formation. The existence of a sharp, phase boundary line was later on disregarded and a phase boundary zone proposed. But this also could not fully account for the anomalies referred to above. There is another view of positive contribution of micro-components on the cholesterol solubility so far ignored in the pseudo three-component phase rule description of bile. Individuals may

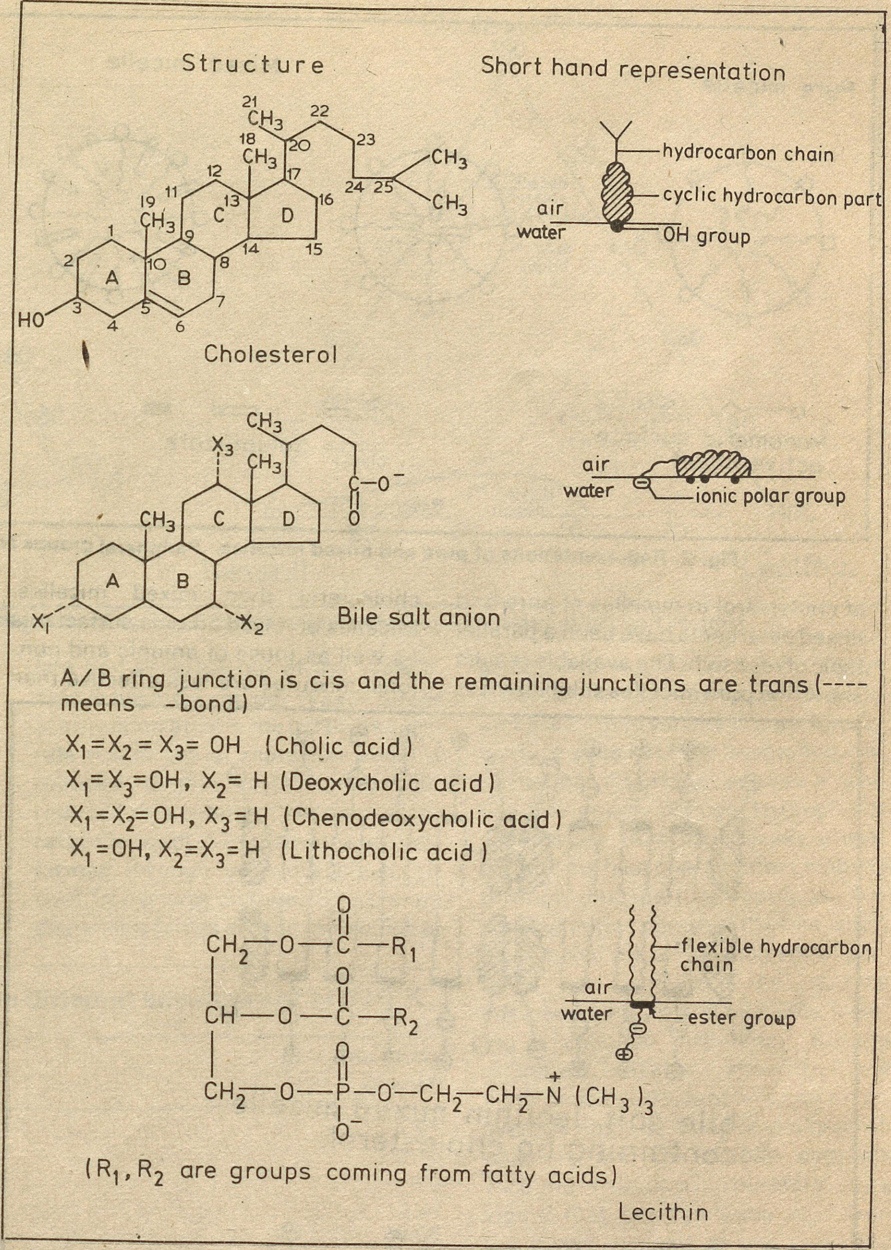


Fig. 1. Structures of cholesterol, bile salts and lecithin and orientation of their short hand representations at the air/water interface

have their own boundary lines depending on the overall composition of their biles. It is then not unlikely that an overall generalisation may very often contend with exceptions.

Recently, the overall solubility of cholesterol in bile has been shown to depend on the total lipid content, that is, the sum total concentration of bile salt, lecithin and cholesterol. As the total lipid concentrations of individuals may vary, the phase boundary lines are expected to be different. Striking exceptions to the general pseudo three-component phase rule concept are thus explained.

Cholesterol solubility in surfactant micelles

In the nonsurgical management of gallstone ailment, oral administration of chenodeoxycholic acid and ursodeoxycholic acid detergents has been shown to be effective. These bile salts are known to increase kinetics of gallstone dissolution. Micelles of the detergents help in efficient dissolution of cholesterol. Studies of the solubility

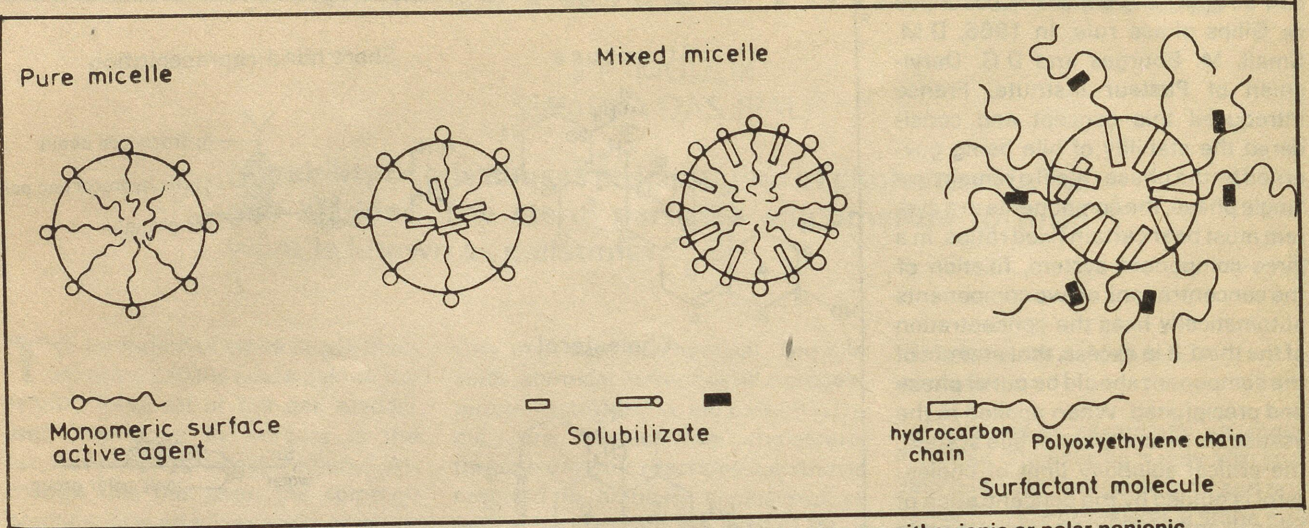


Fig. 2. Representations of pure and mixed micelles. Peripheral groups are either ionic or polar nonionic

of cholesterol in micelles of pure and mixed detergents have been a parallel topic of research. The available results show that pure micelles solubilize less cholesterol than mixed micelles. Micelles of mixed anionic surfactants as well as those of anionic and nonionic mixtures are less effective than nonionic and cationic mixtures. Inorganic ions like Na^{+} and Ca^{++} and bilirubin and other dyes affect solubility (mostly they decrease it). Phenyl-ring containing salts like phthalate, salicylate, etc., cause significant increase in the solubility, perhaps through the formation of expanded, mixed micelles to accommodate more cholesterol. The comparative cholesterol solubility in different environments is given in Table I. Results presented in the Table show that surfactant mixtures have striking cholesterol solubilizing capacities. Cholesterol saturation levels in them are higher than nonaqueous, tetradecane and n-decanol, whereas solubility in cyclohexane is a little over twice the amount reported for TX 100 + CTAB and TX 100 + SDS mixtures. This is an expected property of surfactant mixtures which form mixed micelles to accommodate more solute.

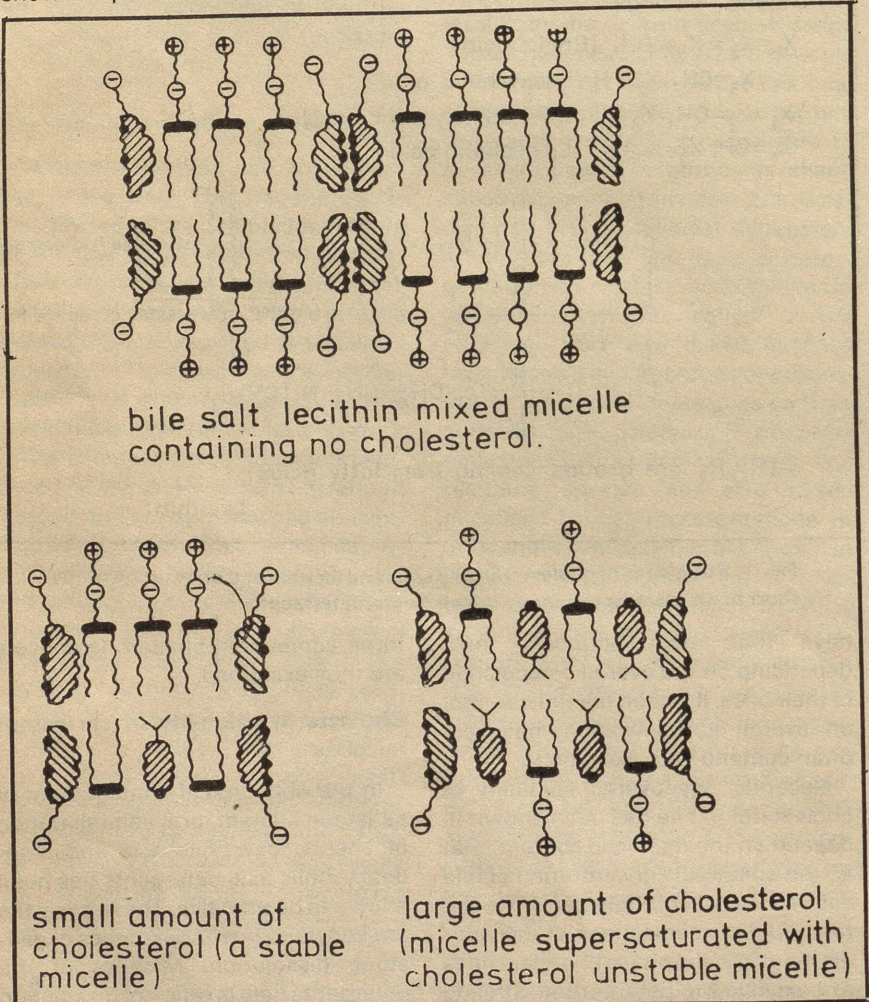


Fig. 3. Mixed micelles of bile salt and lecithin without and with cholesterol

An alternative stone formation mechanism

An important feature of bile is that, even in sterile condition, a portion of the total cholesterol continuously precipitates out of the system; a part of the phospholipid and bile salts also settles down with it. To be in line with the concept of micelles and mixed micelles, bile should be indefinitely stable in solution unless subjected to drastic treatment such as significant cooling and salt addition. (Lowering of temperature causes lowering of solubility of the lipid components, and salts may form sparingly soluble ion

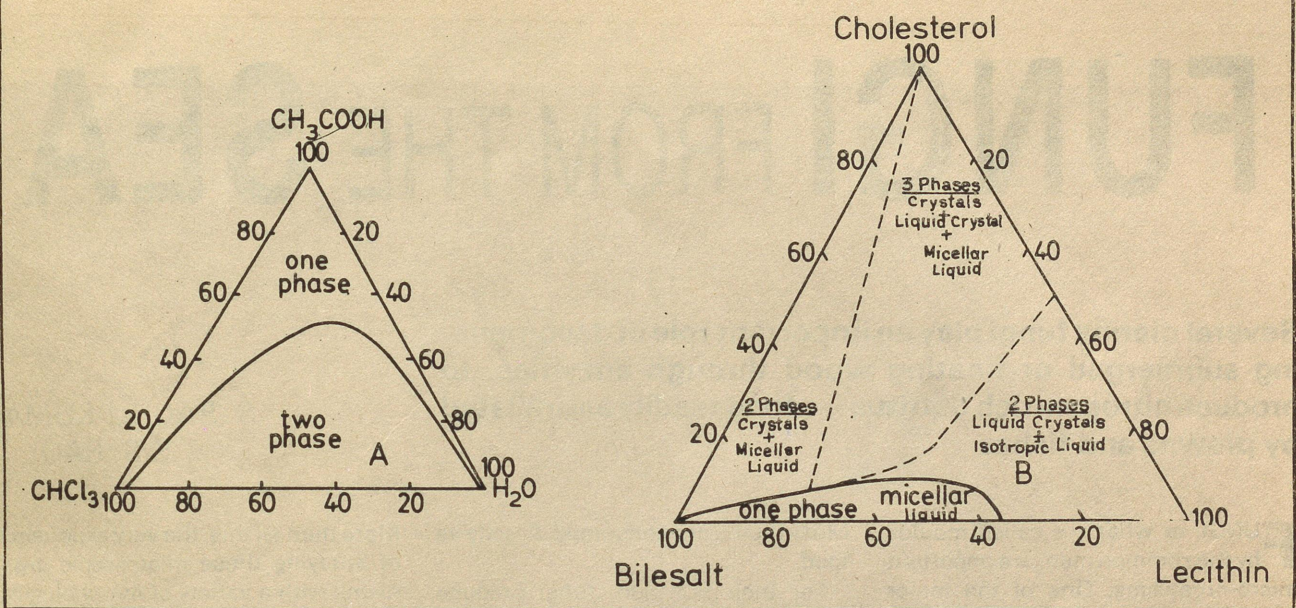


Fig. 4. Ternary phase diagrams of acetic acid-chloroform-water and cholesterol-bile salt-lecithin

pairs with the ionic detergents. Both destabilize micelles). The spontaneous cholesterol separation from bile offers an alternative view about the physicochemical nature and stability of bile. Due to its precipitation tendency, bile behaves like a hydrophobic colloid. Hydrophobic colloids, in general, under the conditions of minor charge imbalance, continue to coagulate and separate out of the system. This is because van der Waals' forces of attraction among the particles override the forces of repulsion under a reduced double layer charge (or reduced zeta potential) with the natural tendency of minimising the surface formed through unfavourable (positive), free energy change. (Short range dispersion forces among molecules of gases and liquids and long range attraction forces among colloid particles are termed van der Waals' forces). Surface does not form spontaneously, formation of surface requires a positive free energy change. Hydrophobic colloids are thus intrinsically unstable; the surface charge offers stability through inter-particle repulsion. According to this concept, the bile, apart from mixed micelles, cholesterol particles are stabilized by surface adsorbed lecithin and bile salts forming a colloidal dispersion. Results presented in Table 1 show that one ml of mixed surfactant solution on an average holds 0.08 mg of cholesterol, whereas one ml of bile contains 7.28 mg of sterol. It is, therefore, quite logical that, besides being soluble in the mixed micelles of bile salts and phospholipids, the remaining excess of cholesterol in bile is in the state of colloidal dispersion. In the laboratory such a colloidal dispersion of cholesterol can be readily prepared by using anionic surfactants like, sodium dodecyl sulphate (bile salts are also anionic detergents). A part of the bile is inherently unstable and cholesterol precipitation is its natural tendency.

Like coagulation of hydrophobic colloids, ionic imbalance in bile can assist precipitation through charge interaction. The precipitated cholesterol is

(Continued on p.234)

Table 1. Cholesterol solubility in different environment at 310 K

Environment	*Solubility (μ g/ml)*
Water	1.81
CTAB (100 μM)	3.12
CTAB (10 mM)	4.0
SDS (1 mM)	3.50
SDS (10 mM)	4.08
TX 100 (24 μM)	5.28
TX 100 (20 mM)	16.00
CTAB + TX 100 (0.96 mM + 5 mM)	97.73
SDS + TX 100 (9.2 mM + 20 mM)	93.67
SDS + SMS (0.9 mM + 0.3 mM)	50.18
Cyclohexane	211.00
Tetradecane	26.10
n-Decanol (303 K)	19.70
Blood Plasma	0.55
Bile	7280.00

CTAB = Cetyltrimethylammonium bromide
SDS = Sodiumdodecyl sulphate
SMS = Sodiummyristyl sulphate
TX 100 = p-(1,1,3,3-tetramethylbutyl) phenoxypolyoxyethylene glycol

FUNGI FROM THE SEA

Several marine fungi play an important role in decomposing submerged or floating wood through enzymes, to produce nitrogen-rich detritus—a food readily assimilated by prawns and fishes

S. RAGHU-KUMAR
T.S.S. RAO

FUNGI, or what are called moulds by the common man, are important micro-organisms. One of the major reasons for studying fungi is their importance in various industries. Yeasts, which are fungi, are used in alcoholic beverage industries for fermentation and production of alcohol and the baker's yeast is used to make bread. Several fungi produce antibiotics; penicillin being well known. Others are exploited for their metabolic products such as citric acid produced by *Aspergillus niger* and the enzyme cellulase by *Trichoderma viride.* Mushrooms are consumed directly as food.

For their nutrition, fungi produce extracellular enzymes and convert complex organic molecules into simpler substrates which are then absorbed through cell surface. This mode of nutrition is very important in recycling of nutrients, which otherwise would get locked up as dead organic matter. Fungi are the major causal agents of plant diseases and animal and human mycoses. For scientists they are valuable tools for the study of cell and molecular biology.

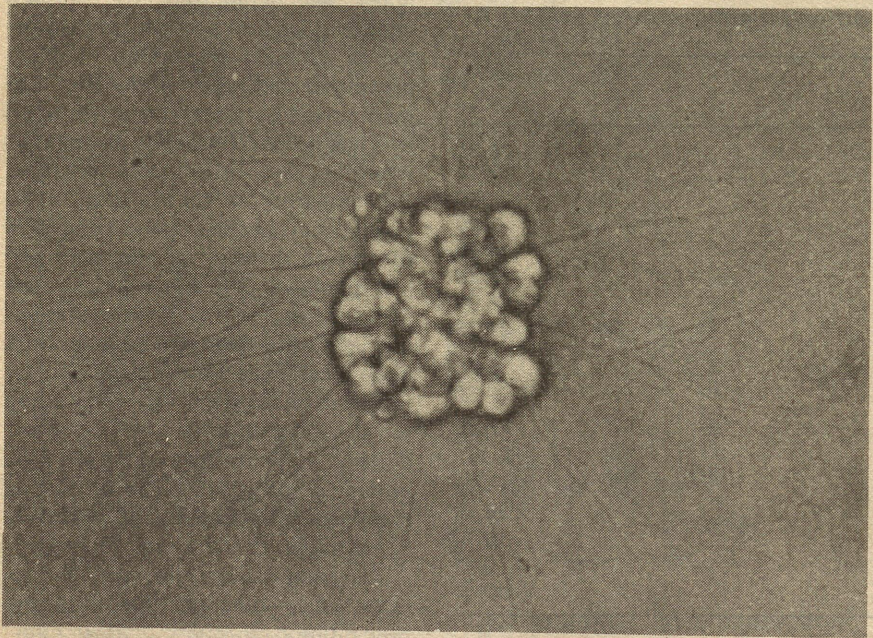


Fig. 1. Cells of the thraustochytrid *Schizochytrium* sp., showing the extensive ectoplasmic net system

More than all this, the very experience of studying these microscopic organisms with a variety of morphological structures and physiological functions is exciting. Most fungi studied so far grow only in freshwater and under terrestrial conditions. But fungi are also common in the sea. This knowledge about the role of fungi in marine environment has been gained only in recent years.

A few marine fungi were first described in the last century by various European authors, but only sporadically. Probably, the greatest impetus to their study arose out of the work of E.S. Barghoorn and D.H. Linder of U.S. in 1944. They isolated several fungi specific to the marine environment from wood submerged in the sea. These fungi were found to have remarkable adaptations for aquatic mode of life. This exciting discovery and the potential role of these fungi as wood degraders generated much interest in marine lignicolous (those growing on wood) fungi. Earlier, the American mycologist, F.K. Sparrow, had described saprophytes and also algal parasites in 1936 and pointed to their important role. Marine mycology progressed rapidly in the 1960s following the publication of the monumental book *Fungi in Oceans and Estuaries* by T.W. Johnson and F.K. Sparrow in 1961.

Marine fungi and what do they look like

Fungi which grow and sporulate exclusively in a marine or estuarine

Dr. Raghu-Kumar is C.S.I.R. Pool officer at National Institute of Oceanography, Goa; Dr. Rao is Dy. Director at the same institute

Fig. 2. The exotically shaped ascospores of the marine, wood-degrading fungus *Halosphaeria quadricornuta* are adapted to their environment

habitat are considered obligate marine fungi, whereas those from freshwater and terrestrial environment and capable of growing and sporulating under marine conditions are considered facultatively marine.

All groups of fungi, the Phycomycetes in the broad sense (lower fungi) and the Ascomycetes, Basidiomycetes and Deuteromycetes (higher fungi) are represented in the marine environment. However, the Basidiomycetes are rare and only 4 species are known. Jan and Erika Kohlmeyer in their treatise in 1979 listed a total of 209 higher marine fungi described till then, of which 91% were obligately marine. About 70 marine Phycomycetes, both obligate and facultative, have so far been described. There is yet another group of obligate marine microorganisms, the thraustochytrids, with about 35 species, which for all practical purposes are considered fungi but appear to be a distinct group of organisms. They have been placed in the Phylum Gymnomyxa, Class Labyrinthulea of the Kingdom Protista by Lindsay Olive (U.S.A.). There are only about 300 species of marine fungi known till today. However, this is a new field of research and a great number of marine fungi, specially those of tropical waters, remain to be discovered.

Marine fungi show adaptations to their environment. Physiologically they require Na^+ ions for growth unlike their freshwater and terrestrial counterparts. Their structure confers several advantages on them for this mode of life. The unicellular thraustochytrids produce a prolific system of fine 'ectoplasmic net' which helps in absorbing the dilute nutrients present in seawater (Fig. 1). They reproduce through flagellate, motile, asexual cells called zoospores, each of which possesses two flagella—a long anterior and a short posterior one. They swim in water in search of fresh substrates on which they settle down and produce new vegetative cells, the thalli.

The sac-like 'asci' of most marine Ascomycetes which contain the sexual spores (ascopores) are deliquescent, and so release them into water. Such ascospores possess a fantastic array of forms with variously arranged appendages, hairy in some species and mucilaginous in others. The nature of these appendages is important in identification. Appendages help the ascospores in attachment and in flotation, so that once released from the fruit-body (ascocarp) they float on water for a sufficient time before finding a fresh substrate. The ascospores also have oil globules which confer on them a positive buoyancy. The marine Deuteromycetes and Basidiomycetes often possess branched, tetraradiate (four-armed) spore formation which also possibly serves in flotation (Fig. 2).

Most species of marine higher fungi are lignicolous. One of the commonest

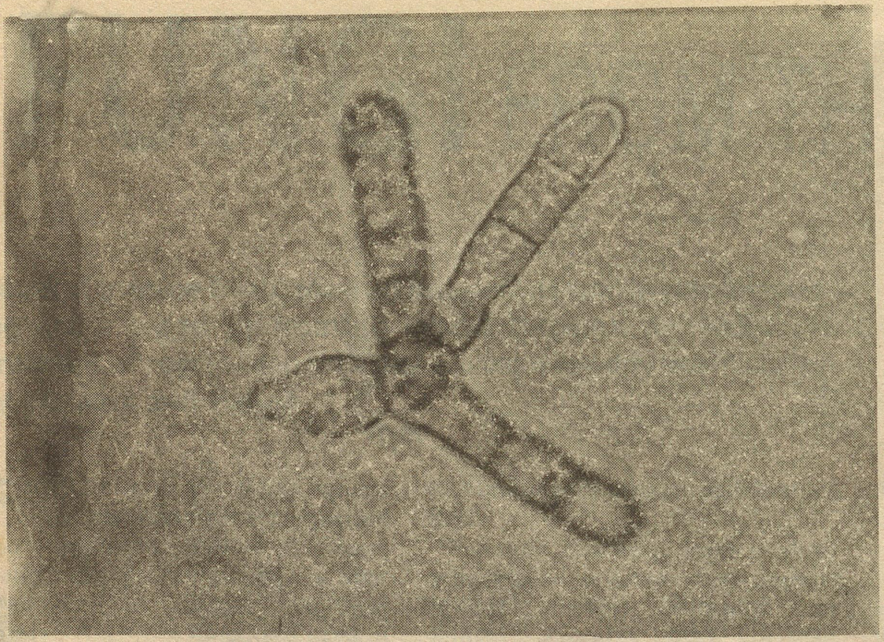


Fig. 2. The tetraradiate conidia of the marine wood-degrading fungus *Clavariopsis bulbosa*

marine Ascomycetes in Indian waters is *Halosphaeria quadricornuta*. This species has two-celled ascospores with two appendages at each end, giving it an exotic shape. Those of *Lulworthia* species are long, threadlike with a mucilaginous cap at each end.

What do the marine fungi do?

Fungi play an important role in mineralization of dead organic matter and recycling of nutrients. In coastal waters, all groups of fungi take part in this process. This function seems to be taken over by the thraustochytrids in oceanic waters and sediments. However, the precise role of fungi in this phenomenon has hardly been investigated.

Marine fungi are abundant on decaying organic matter such as decomposing algae and marine macrophytes (larger plants such as the macroscopic algae and angiosperms) and marine sediments and water harbouring detritus. Using the right techniques, thraustochytrids and obligate as well as facultative marine fungi playing an active role in decomposition can be isolated from them. There is a very important function they perform in detritus ecosystems. Most animals of this ecosystem, including many economically important ones such as prawns and detritus-feeding fish, cannot assimilate fresh macrophyte vegetation. They have to be decomposed and made assimilable by fungi and bacteria before they can be consumed. In a way, these microorganisms 'cook' the detritus for such animals. While doing so they take up the dissolved nitrogenous compounds from the surrounding water and incorporate them in their own cells. As a result, there is an enrichment of nitrogen in detritus, reflected in a low carbon-to-nitrogen ratio of the detritus in comparison to fresh, undecomposed detritus. This is highly suitable for the nutrition of detritus feeders. However, finer details of fungi/detritus complex is lacking in the marine environment.

Wood-degrading fungi

Woody substrates often find their way into the sea. Besides, man deliberately introduces wood in the marine environment in the form of fishing craft and structures such as jetties. Several Ascomycetes and Deuteromycetes invariably attack such wood. They produce a vast array of wood-degrading enzymes such as cellulases, hemicellulases and pectinases. The fungal hyphae grow within the secondary wall of the wood cells causing soft rot. The annual costs of treating fishing craft against rotting runs to several crores of rupees in India. The main reason for wood rot are the wood-borers, in conjunction with fungi. Larvae of the bivalve teredinids (shipworms) find wood softened by fungi ideal for settlement and carry on with the destruction. The gribbles (crustaceans) which are also wood-boring organisms thrive on fungus-infested wood, using the fungi for providing important additional source of food. Different woods are colonised by different fungi in various successional patterns and degraded at different rates. Not much is known about their sensitivity to wood preservatives. Work on these aspects have not been carried out in India.

Many unusual substrates also harbour fungi. Several fungi grow attached to sand particles (arenicolous fungi) and on calcareous shells of animals, the mechanisms of which are not understood. Even synthetic materials like polyurethane are subjected to attack by marine fungi and such activities make biodegradation by marine fungi a very important subject.

Many marine fungi can degrade hydrocarbons. Species of *Candida, Cladosporium resinae* and *Cephalosporium* have been isolated from oil polluted waters and this area of research is receiving growing attention.

Marine fungi as parasites

Many marine fungi cause diseases of algae and aquatic animals (Fig. 3). Such diseases are bound to be more in aquaculture systems where a uniform genetic stock of organisms is cultivated in high densities. Hence it is important to study these aspects with the growing demand for commercial aquaculture of algae and seafood animals. An example of a serious disease of an aquaculture algae is the 'Red wasting disease, of *Porphyra* in Japan, where this alga is cultivated on a large scale, caused by *Pythium porphyrae*. Several important diseases of animals are known from western countries. Examples are the *Ostracoblabe* disease of the oysters 'burnt

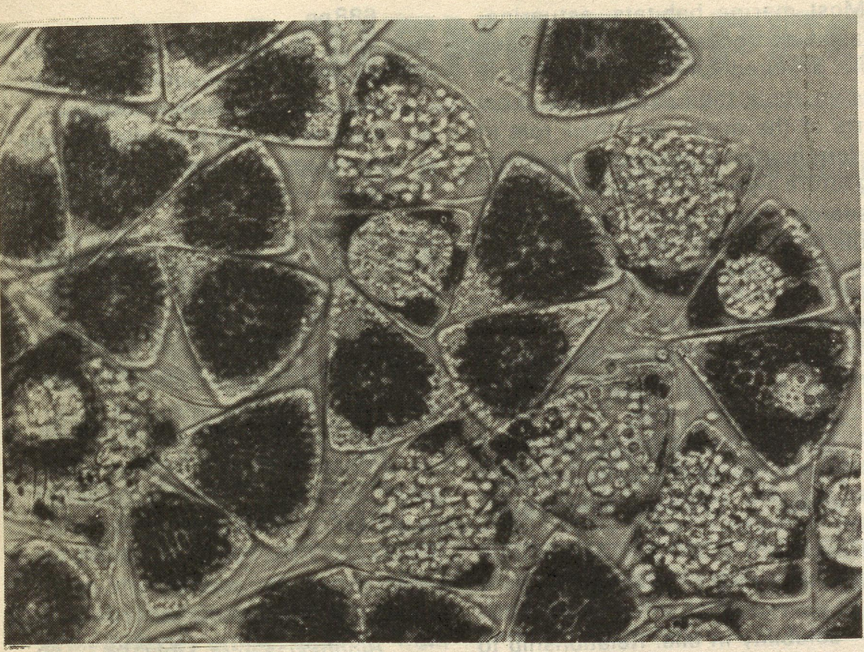


Fig. 3. Cells of the marine diatom *Licmophora*, infected by the fungus *Ectrogella perforrans*

spot' diseases of several important crustaceans and the *Lagenidium callinectes* disease of the eggs of the edible Atlantic blue crab.

In nature also, fungal diseases are not uncommon. Planktonic diatoms may be parasitised by Phycomycetes. Planktonic algae being the most important primary producers in the sea, such diseases could affect the entire food web. Ascomycetes and Deuteromycetes parasitise larger seaweeds. Animal diseases such as those caused by *Ichthyosporidium* are commonly encountered in fishes. Unfortunately, very little is known about the taxonomy, physiology and biochemistry of these fungi.

Fungi in oceanic waters and sediments

Among higher fungi, yeasts are common in oceanic waters and sediments. Yeast cell counts in oceanic waters average five to tens of cells/litre, but may be higher in polluted waters and phytoplankton blooms.

The thraustochytrids are abundant not only in estuarine waters and sediments but also in the ocean. One of the authors (SRK) and Alwin Gaertner of the Federal Republic of Germany studied these organisms for several years in the North Sea and demonstrated a very high number and distinct seasonal and spatial changes in their numbers and species. Thraustochytrids have been isolated even from depths of up to 3,000 m in the Atlantic. They are also common in the Antarctic waters and several interesting species, including psychrophiles growing only at or below 5°C have been reported. However, the role of these organisms in mineralization, the substrates they grow upon and their physiology and biochemistry still remain unexplored.

Work done in India

Marine microbiology in general and marine mycology in particular have still to find a firm foothold in marine research in India. There have been only a few records of fungi in marine habitats from India, mostly of terrestrial genera from estuaries, mangroves and intertidal beaches. Concerted efforts to study these organisms are even fewer. Little work has been done on obligate marine fungi in Indian waters.

The first report of obligate marine fungi from India was by G. Becker and J. Kohlmeyer, who reported them from catamarans in 1958. E.B. Gareth Jones reported a few more from wood in 1968. J. Kohlmeyer and others have described a new species, *Corollospora pulchella* from wood. One of the present authors (SRK) published a detailed account of marine lignicolous fungi from India in 1974. Of the 209 species of higher fungi described by Jan and Erika Kohlmeyer in their treatise, only 20 have been reported from India. U.K. Gopalan and others described fungal diseases of marine crustaceans in Cochin backwaters in 1980. T.N. Rai and his colleagues have reported a number of fungi from mangroves, which though not obligately marine, might play an important role in detritus formation.

Work on several aspects of marine bacteria and fungi is being carried out at the National Institute of Oceanography at Goa. Work is now progressing on the obligate and facultative marine fungi from marine detritus, using selective techniques. One promising field that is being studied is the ecology of the thraustochytrids. In cruises with the oceanographic research vessel *Sagar Kanya* and the research vessel *Gaveshani*, one of the authors (SRK) isolated several 'thraustos' from the Arabian Sea. Studies are also being carried out on fungal diseases in Alga.

Future prospects

The major concern of man with microorganisms is to utilize them for his benefit. Marine fungi have not yet been studied in detail with reference to applications such as production of drugs or fermentation products. These fungi, growing upon a wide variety of substrates and often quite different from those in the terrestrial milieu, could be expected to produce a great range of interesting metabolic products. Their physiology, biochemistry and ecology have not been investigated in sufficient detail for this purpose. This requires the presence of a large number of cultures from various marine sources. This could come from a study on the ecology and survey of marine fungi and hence such studies are very important.

One of the most interesting aspects of marine mycology is the study of thraustochytrids. The role of these organisms in the sea remains a mystery. Research on this aspect will also help in obtaining enough isolates in culture to study their physiology and biochemistry.

The importance of marine wood degrading and parasitic fungi has been mentioned earlier. These aspects should be studied intensively.

Marine fungi could be valuable as models in cellular and molecular biology studies. The ultrastructure researches carried out by F. Kazama, F.O. Perkins, D. Porter in the United States and E.B. Gareth Jones and his colleagues in the United Kingdom have revealed interesting details about their ultrastructure.

Most marine habitats, estuarine, coastal and oceanic, have still been little explored for fungi. Nothing is known about their existence in most parts of the ocean and their role in various biological processes. An exciting future awaits this research and, as research always goes, these studies could lead to most interesting, important and unforeseen results.

Further reading

1. Andrews, J.H. (1976), The pathology of marine algae, *Biological Review*, **51**: 211-53.
2. Johnson, T.W. and Sparrow, F.K., (1961), *Fungi in oceans and estuaries*, J. Cramer, Weinheim, 688 pp.
3. Jones, E.B.G. (ed.) (1976), *Recent advances in aquatic mycology*, Elek Science, London, 749 pp.
4. Kohlmeyer, J. & E. (1979), *Marine mycology. The Higher Fungi*, Academic Press, New York, London, 690 pp.
5. Olive, L.S. (1975), *Mycetozoans*, Academic Press, New York, London, San Francisco.
6. Raghu-Kumar, S. (1974), Marine lignicolous fungi from India, *Kavaka* **1**: 73-85.
7. Smith, J.E. & Berry, D.R. (1975), *The Filamentous Fungi*. Vol. 1. *Industrial Mycology*, edward Arnold, London.

GALLSTONES *(Continued from p 229)*

flushed out when the gall bladder shrinks. Materials which cannot be flushed out may accumulate and agglomerate to form a stone; glycoproteins providing the requisite surface for nucleation. A weak gall bladder is believed to be the probable cause of this phenomenon

Further reading

1. West, E.S., and Todd, W.R., *Text Book of Biochemistry*. The MacMillan Company, New York (1963).
2. Admirand, W.M., and Small, D.M., The physicochemical basis of cholesterol gallstone formation in man, *Journal of Clinical Investigation*, **47** (1968) 1043.
3. Carey, M.C., and Small, D.M., The physical chemistry of cholesterol solubility in bile: Relationship to gallstone formation and dissolution in man, *Journal of Clinical Investigation*, **61** (1928) 998. that supersaturated bile is frequent in healthy man, *Journal of Clinical Investigation*, **52** (1973) 1467
4. Holzbach, R.T., Marsh, M., Olszewski, M., and Holan, K., Cholesterol solubility in bile; Evidence that supersaturated bile frequent in healthy man, *Journal of Clinical Investigation*, **52**, (1973) 1467.
5. Bourges, M., Small, D.M., and Devichian, D.G.. Biophysics of lipid association III. The quaternary systems lecithin-bile salt-cholesterol water, *Biochimica Biophysica Acta* **144** (1967) 189.
6. Pal, S. and Moulik, S.P., Cholesterol solubility in mixed micelles solutions of ionic and nonionic surfactants, *Journal of Lipid Research*, **24**, (1983) 1281.
7. Pal, S. and Moulik, S.P., Solubility of cholesterol and cholesteryl benzoate in some polar and nonpolar organic solvents, *Indian Journal of Biochemistry and Biophysics*, **21** (1984) 12.
8. Pal, S. and Moulik, S.P., Solubility of cholesterol in bile salt-synthetic detergent mixed micelles and that of cholesteryl benzoate in synthetic detergent mixed micelles, *Indian Journal of Biochemistry and Biophysics*, **21** (1984) 17.

Salient features of a communication satellite

SATELLITES are classified in many ways based on their applications. In a broader sense, they can be classified into two types—communication satellites and remote sensing satellites. Communication satellites are used for communication purposes while remote sensing satellites are used for the survey of natural and renewable earth resources. Most communication satellit s are placed in geo-synchronous orbit (36000 km from the surface of earth) while remote sensing satellites are placed in low altitude orbits varying from 500km to 1000km. There are also some other classifications of satellites, namely, astronomical satellites, weather satellites, etc. Here some of the salient features of a communication satellite [Fig. 1] will be discussed.

Table 1 No. of transponders in various satellites

	Name of satellite	No. of transponders
(a)	INTELSAT-I (Early Bird)	2
(b)	INTELSAT-II	1
(c)	INTELSAT-III	2
(d)	INTELSAT-IV	12
(e)	INTELSAT-V	27
*(f)	INTELSAT-VI	50

*To be launched in 1986.

Types of communication satellites

Communication satellites can be classified into two types—passive satellites and active satellites. A passive satellite works just like a reflector in the sense that a signal transmitted from a ground station is reflected back to earth and is received by several ground stations. This type of satellite has no active component which needs power supply. Because of this inherent characteristic, passive satellites have a longer life. Another advantage of such a satellite is that it has no orientation problem because it is like a balloon whose surface reflects back the incoming signals from ground. The biggest disadvantage of a passive satellite is the requirement of extremely powerful transmitter on ground. ECHO-I was a passive satellite. Using this satellite, only one part in 10^{18} of the transmitted power from ground was returned to the receiving ground terminals. As the signal has to compete with the noise coming from various sources, special low-noise receivers were used. Passive satellites waste a lot of radiated power.

All communication satellites presently in use are active satellites. Active satellites have on-board electronic equipment which change the frequency of received signal from ground, amplify it and then send it back to earth. Active satellites do not need extremely high power ground transmitters as required in the case of passive satellites. The size of an active satellite is much smaller than a passive satellite. Passive satellites were used only in the beginning and that too in very few numbers.

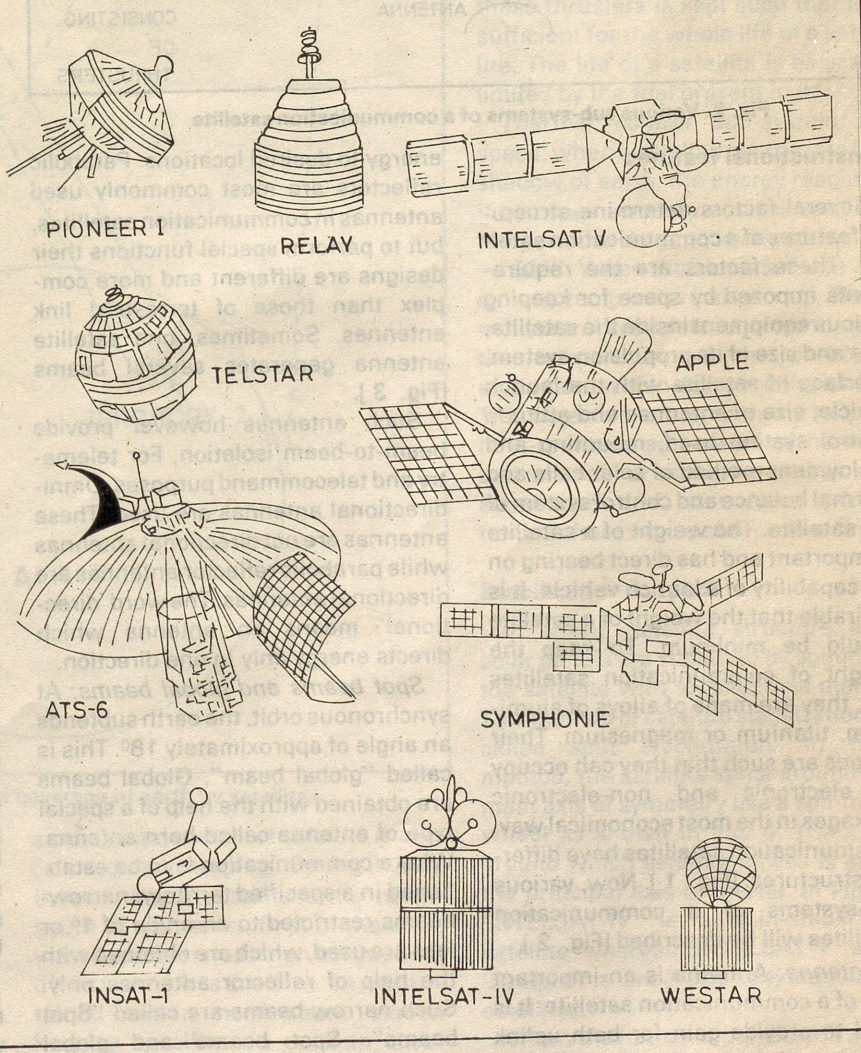


Fig. 1. Constructional features of various satellites

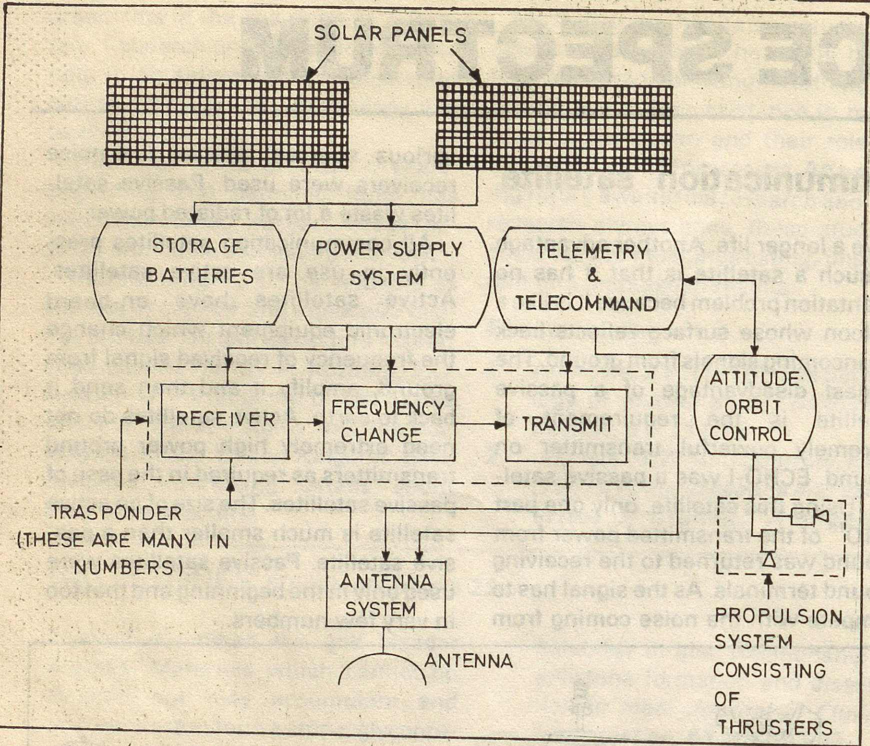


Fig. 2. Various sub-systems of a communication satellite

Constructional features

Several factors determine structural features of a communication satellite. These factors are the requirements imposed by space for keeping various equipment inside the satellite, type and size of its propulsion system, interface of satellite with the launch vehicle, size of antennas and attitude control system used, mounting and deployment method of solar cells and thermal balance and control system of the satellite. The weight of a satellite is important and has direct bearing on the capability of a launch vehicle. It is desirable that the weight of a satellite should be minimum. To keep the weight of communication satellites low, they are made of alloys of aluminium, titanium or magnesium. Their shapes are such that they can occupy all electronic and non-electronic packages in the most economical way. Communication satellites have different structures. [Fig. 1]. Now, various sub-systems of a communication satellites will be described [Fig. 2].

Antenna: Antenna is an important part of a communication satellite. It is used to provide gain for both uplink and downlink signals and to direct energy to desired locations. Parabolic reflectors are most commonly used antennas in communication satellites, but to perform special functions their designs are different and more complex than those of terrestrial link antennas. Sometimes, one satellite antenna generates several beams [Fig. 3].

Such antennas however provide beam-to-beam isolation. For telemetry and telecommand purposes, Omnidirectional antennas are used. These antennas are not directional antennas while parabolic reflector antennas are directional antennas. The word 'directional' means an antenna which directs energy only in one direction.

Spot beams and global beams: At synchronous orbit, the earth subtends an angle of approximately 18°. This is called "global beam". Global beams are obtained with the help of a special type of antenna called horn antenna. Where communication is to be established in a specified territory, narrow-beams restricted to an angle of 1° or less are used, which are obtained with the help of reflector antennas only. Such narrow beams are called "Spot beams". Spot beams and global beams have been shown in Fig. 3.

Telemetry and Telecommand sub-system: To operate a satellite, information about its health is continuously gathered. Several parameters of the satellite in orbit are monitored. On-board processors, multiple-beam antenna performance, solar array and battery capabilities and transmitter performance are monitored and controlled to keep the system working. The telemetry and telecommand requirements increase as satellites become complex. Nowadays, microprocessors are employed to perform various monitoring and control operations.

Transponder: Communication sub-system of a communication satellite is called transponder. It is also called the heart of a satellite. All communication operations aboard a satellite are performed by its transponder. Sometimes, a transponder is also called communication payload or satellite repeater. The function of a transponder or a satellite repeater is to receive weak signal from ground, amplify it, to change its frequency and finally to send it back to ground station on earth. Depending upon service requirements a satellite contains many transponders, some for telephone, some for television and others for meteorology or other experiments. The number of transponders in satellites has been increasing with time (Table 1).

Power generation and storage system: Solar energy converted into electricity through photovoltaic cells (solar cells) is the prime source of power in communication satellites. In spin-stabilized satellites, solar cells are placed about the body of the satellite. But in a 3-axis body stabilized satellite, solar cells are placed in solar panels, such as shown [Fig. 1] for INTELSAT V satellite. The solar arrays are deployable and provide much larger electric power than spin-stabilized satellites because the solar array area exposed to sun is larger in case of 3-axis body stabilized satellites than spin-stabilized satellites.

Storage batteries are used to take up the power load during the periods when a spacecraft is in the shadow of earth. The life of a battery is a signifi-

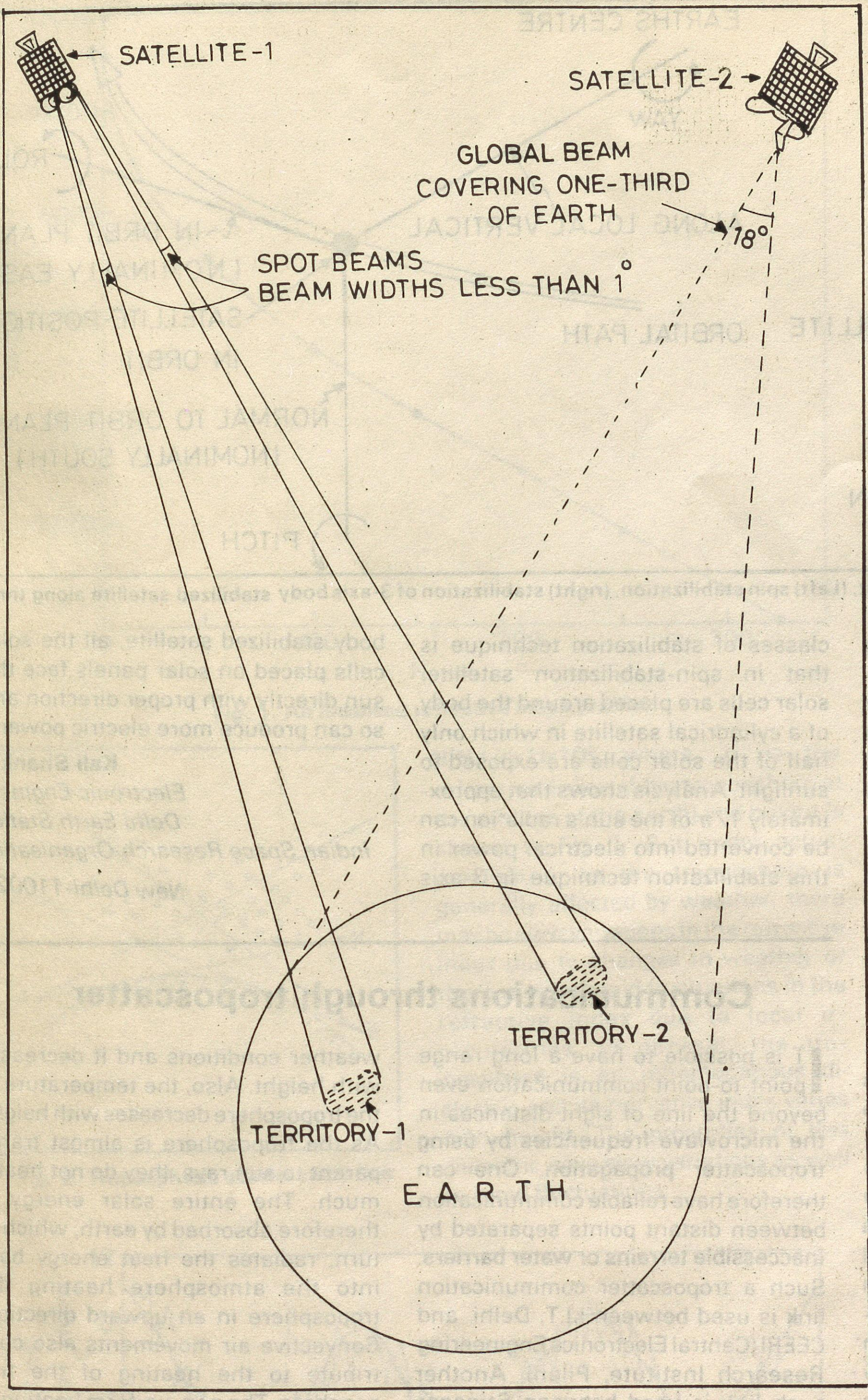


Fig. 3. Global and spotbeam coverage of earth by satellites

cant factor because it influences the life of a satellite.

Attitude and orbit control: This subsystem performs two jobs. First, it controls the location of a satellite in orbit by controlling its orbital velocity and, secondly, it controls its attitude. It has the capability to maintain or adjust the orientation of a satellite in a precise way with respect to its one or more axes. Orbital control of satellite is also called 'station keeping'. During its stay in an orbit, a satellite drifts north-south or east-west. Drift in the east-west direction is less than north-south direction. A satellite is maintained within north-south station keeping specification upto an accuracy of $\pm 0.3^{\circ}$. For a satellite mission of seven years, the fuel required to execute full north-south station keeping is 15-20 per cent of the fuel needed for its maintenance.

Propulsion sub-system: After placing a satellite in orbit, it needs small pushes to maintain its orbit. It needs a small north-south push occasionally to compensate for the effects of sun and moon and a small east-west push to compensate for the elliptical shape of the earth's gravitational field. A spin-stabilized satellite needs a push to start spinning. For all these operations, hydrazine thrusters using mono-methyl hydrazine as fuel and nitrogen tetraoxide as oxidiser are used. These are small thruster-jets which are being fired in pulses for the above mentioned operations. The onboard propellant quantity of fuel for these thrusters is kept such that it is sufficient for the whole life of a satellite. The life of a satellite is basically limited by the fuel present in it.

Thermal control sub-system: In space, when a satellite passes into the shadow of earth, the energy reaching it becomes very low and the satellite temperature drops to levels as low as $-150^{\circ}C$. When the satellite faces sun, its temperature shoots up. Thermal control system is required to keep the temperature of the on-board equipment within the operating limits. This objective is met with the help of heat-radiators and electrical heaters activated either by thermostats or telecommand and heat pipes which transfer heat from a source to a sink.

Stabilization in space

In space, satellite structure and solar panels are stabilized by spinning the satellite with an electrical motor. This method of satellite stabilization is called spin stabilization. In this method, the satellite spins around its main axis of symmetry like a spinning wheel as shown in Fig. 4. The axis around which satellite moves is also the principal axis of inertia. In Fig. 1 'INTELSAT-IV' is a spin-stabilized satellite whereas 'INTELSAT-V' and 'Symphonie' are 3-axis body stabilized satellites.

When the flat-solar panels and several large antennas are used in satellites, the structure of a satellite

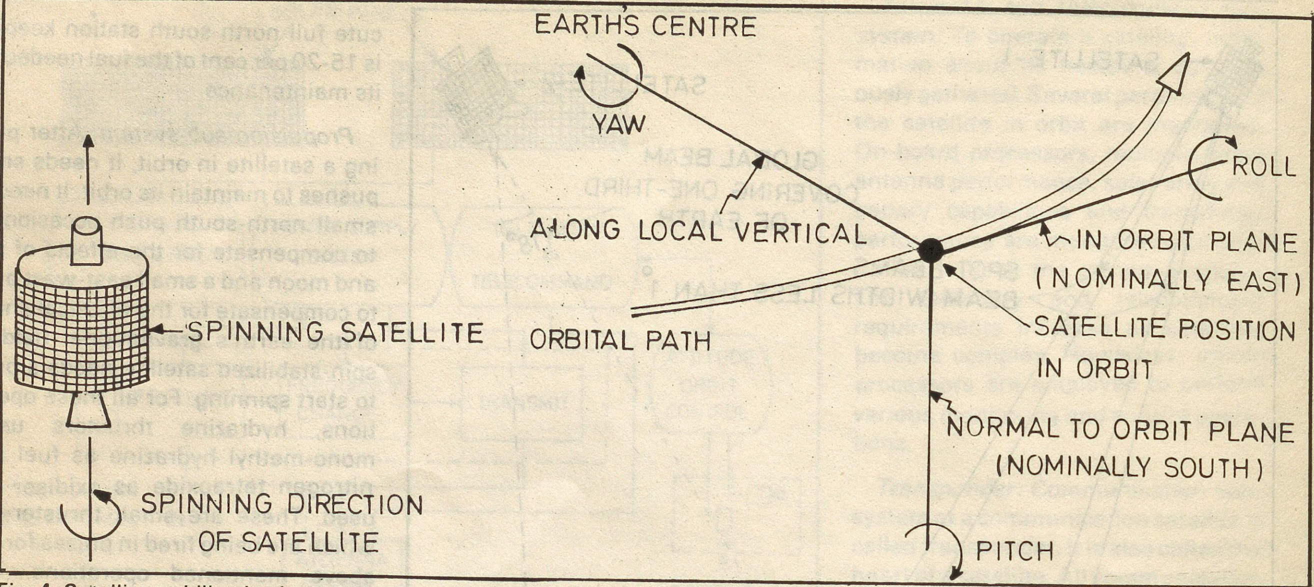


Fig. 4. Satellite stabilization in space orbit, (Left) spin stabilization, (right) stabilization of 3-axis body stabilized satellite along three axes—Roll, Yaw, and Pitch.

becomes large. It therefore needs more power. In this case, 3-axis body-stabilization method is favoured over spin-stabilization. In body stabilization method, the satellite is stabilized about three axes, called yaw axis, roll axis and pitch axis. For an observer on earth, these three axes appear to be stationary. This stabilization about three axes is done with the help of momentum wheels. Three-axes of stabilization are shown in Fig. 4.

Choice of stabilization technique

Probably, no aspect of communication satellite system design causes more controversy than the choice between different classes of stabilization systems. This controversy is given utmost attention as the question is a complex one. Such a decision has a direct influence on both the overall configuration of a satellite and its each sub-system design. Each type of satellite stabilization technique has its own merits and demerits. In 3-axis body stabilized satellites, flat solar panels are used which face the sun constantly and generate more electrical power but have problem of overheating. In spin stabilization satellite, the cylindrical solar panels are used where power generation is comparatively less but over-heating problem of panels is not present.

The difference in the electrical power generation between the two classes of stabilization technique is that in spin-stabilization satellite, solar cells are placed around the body of a cylindrical satellite in which only half of the solar cells are exposed to sunlight. Analysis shows that approximately $1/\pi$ of the sun's radiation can be converted into electrical power in this stabilization technique. In 3-axis body stabilized satellite, all the solar cells placed on solar panels face the sun directly with proper direction and so can produce more electric power.

Kali Shanker
Electronic Engineer
Delhi Earth Station
Indian Space Research Organisation
New Delhi-110021

Communications through troposcatter

It is possible to have a long range point-to-point communication even beyond the line of sight distances in the microwave frequencies by using troposcatter propagation. One can therefore have reliable communication between distant points separated by inaccessible terrains or water barriers. Such a troposcatter communication link is used between I.I.T, Delhi and CEERI (Central Electronics Engineering Research Institute, Pilani. Another such link is used between Srinagar and Dhushanabe (USSR) by the overseas communications services. The region of atmosphere extending from ground upto a height of approximately 16-kilometers is called "Troposphere". In the troposphere, the percentage of gas components almost remains the same as at the surface of earth. But the water vapour content is strongly dependent on weather conditions and it decreases with height. Also, the temperature of the troposphere decreases with height. As the troposphere is almost transparent to sun rays, they do not heat it much. The entire solar energy is therefore absorbed by earth, which in turn, radiates the heat energy back into the atmosphere heating the troposphere in an upward direction. Convective air movements also contribute to the heating of the troposphere. The non-uniform heating of areas near ground produces ascending and descending air currents which result in turbulences and mixing of air masses vertically. The refractive index of the troposphere, which is a function of the meteorological variables, such as temperature, water vapour content of air and air pressures also decreases with height. An idealised relation between excess refractive index

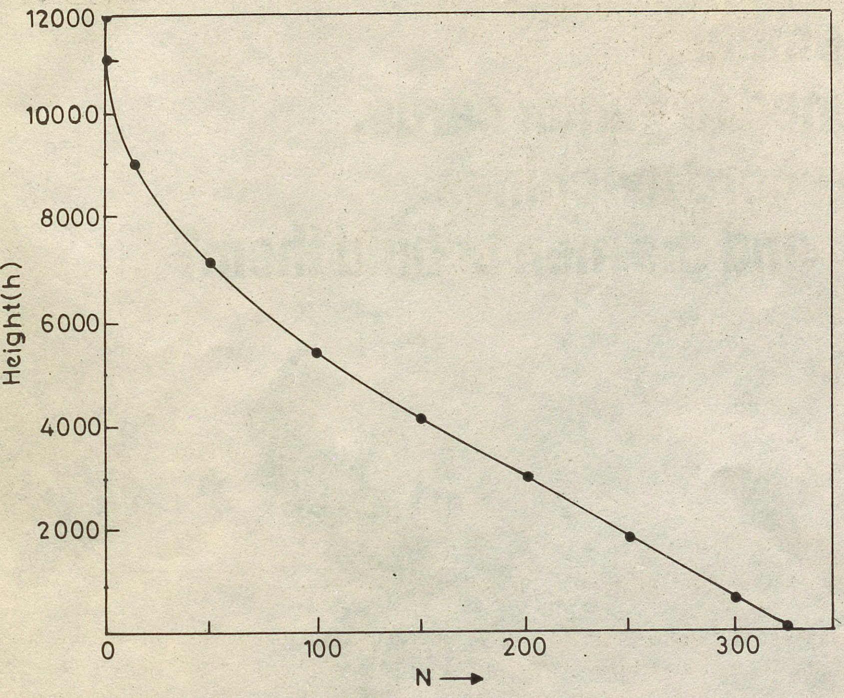


Fig. 1. An idealised refractive index profile

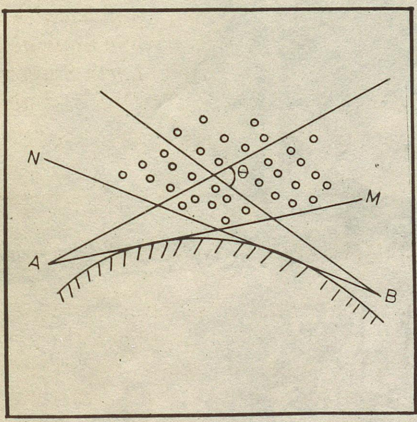


Fig. 2. Tropospheric scatter radio link

$N[N=(n-1)\times10^6$, where *'n'* is the refractive index of the troposphere at the surface of the earth) and height is shown in Fig. 1. But under actual conditions, as the troposphere is generally affected by weather, there may be slow variations in the refractive index due to changes in weather or there may be rapid fluctuations in the refractive index due to local irregularities. In general, the troposphere is an inhomogenous dielectric and its refractive index varies with height. The properties of this dielectric have slow variations as well as rapid fluctuations.

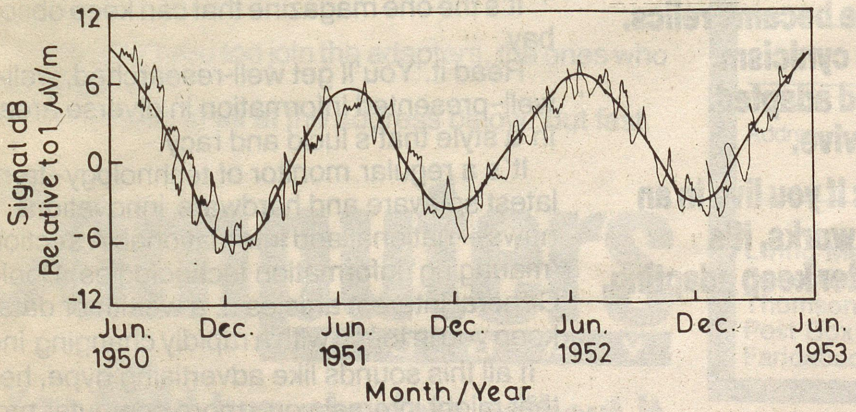


Fig. 3. Seasonal variation in field strength

The atmosphere does not exhibit smooth variations in its physical properties. Air in the troposphere is in a random, erratic flow. The local velocity of the air varies erratically with time both in magnitude and direction. This is known as turbulence. As a result the refractive index of the atmosphere also varies in an irregular way, consisting of 'blobs' of different dielectric constants randomly distributed (Fig. 2) when a radio wave is sent through the troposphere, some of the energy is scattered in the forward direction by these blobs. This energy is received by the receiving antenna. A tropospheric scatter radio link is shown in Fig. 2. A is the transmitting point B is receiving point, AM and BN are tangents to earth's surface. All the points above AM and BN are seen simultaneously from A and B. The collection of these points within the troposphere makes up the common volume. In other words, the volume intercepted by the transmitting and receiving antenna beams is called the "common scattering volume". The refractive index in this common volume has both temporal and spatial fluctuations which are random as mentioned above. All the blobs within this common volume which receive the electromagnetic waves transmitted by the transmitting antenna become sources of scattered radiation and a scattered wave is received by the receiving antenna. Different parts of the scatter volume contribute to the scattered wave. In Fig. 2θ is known as the scattering angle. The scattered intensity is more for smaller scattering angles. The scattered signal is strongest in the direction of the wave emitted by the transmitter. So, a radio signal can be transmitted from A to B, the distance which is beyond the line of sight, due to scattering phenomenon communication in this mode is known as "Troposcatter communication."

As different parts of the scatter volume contribute to the scattered wave in the troposcatter, the received signal is the sum of many components which had travelled different distances. The combination of these incoming waves gives rise to fading. Whenever the signals received are in phase, the amplitude of the signal will be more

and whenever the signals received are out of phase the amplitude will be less. The received signal level is therefore the vectorial addition of various signals received from the scattering volume. As the scattering volume itself is undergoing random fluctuations,the received singal level will also be fluctuating. This random fluctuation of the received singal is known as a 'Fading.'

There are two types of fading. Slow fading is the variation in the signal level that can take place over hours, days and even months. The slow fading is due to gross changes in the atmospheric conditions, the changes which take place on seasonal basis. The mean value of the signal over an hour is called "Hourly median". The hourly median signal exhibits large variations over the seasonal cycles. The ratio of received signal levels in winter and summer may be around ten and in morning and evening may be around four. Longer paths of radio signals exhibit less variations over the season than the shorter ones. Fast fading is the variation in the signal level which takes place over a few seconds or milliseconds. The received signal is the vector sum of many signals coming from different blobs in the atmosphere. As their phases vary at random, it gives rise to fast fading. Fig. 3 gives the seasonal variations of a received troposcatter signal. Fast variations are superimposed over slow variations. When two frequencies, which are very close to each other are transmitted, they fade in a similar way. However, when the spacing between them is increased, they do not fade in a similar way. The fading is different for each frequency. This is known as "Frequency selective fading". So, in general, signals at different frequencies do not fade simultaneously. This limits the bandwidth of radio waves that can be transmitted.

Due to fading, there will be variations in the received signal level which will affect the reliability of communication. One way to overcome this is to increase the transmitter power or the size of the antenna so that the level of the signal at the receiver, even during the worst fading condition, is above the required minimum level. But this is not economical. A technique known as "Diversity technique", which is more economical, is therefore used. It has been found that the fading of two radio signals, which are sufficiently separated in space, frequency or polarizaion, is not identical. When one signal fades the other signal does not fade in the same manner due to the characteristics of the medium. This fact is used in diversity reception.

If information is transmitted on two or more carriers of the same frequency in such a manner that the transmission paths are sufficiently separated physically in space, the received signals will have independent fading. This is known as "Space diversity". If the signal is received by two antennas, at one it may fade, while at the other it may not. These signals are combined so that the resultant signal is above the required minimum signal during most of the times.

In a similar manner, if the information is transmitted over the troposcatter system on two or more carrier frequencies which are sufficiently separated, then the fading in each will be more or less statistically independent. This is known as "Frequency diversity". If the information is transmitted simultaneously on the same frequency but with different polarizations, the fading at each signal will be more or less statistically independent. This is known as "Polarization diversity".

There are various methods of combining the received signals so that the resultant signal level is always high. One technique is selection combiner. This selects the highest received signal. This is done by a switch which connects the receiver to that antenna which catches the strongest singal (in the case of space diversity). Another technique is "Maximal ratio combiner" which gives different gains for different received signals depending upon their levels and adds them vectorially. The third technique is "Equal gain combiner" which gives equal gain for all the received signals and adds them vectorially. The most efficient technique of combining is the maximal ratio combiner. One or more of the above diversity techniques can be used to overcome the fading.

References

1. Leang, P. Yeh, Simple methods for designing troposcatter circuits, *IRE transaction on communication systems,* September 1960.
2. Panter, Phillip F., *Communication System Design. Line of Sight and Troposcatter System.*
3. Clustts, C.E., Kemedy, R.N. and Trechan, J.M., Results of B.W. Tests on the 185 mile Florida-Cuba Tropospheric Scatter Radiox System, *IRE Transaction on communication systems,* December 1961.
4. Lukhnov, M.D., *Progagation of Radio Waves,* MIR Publication, Moscow.

R, Gopalakrishnan
Space Applications Centre
Delhi Earth Station
New Delhi

Metre redefined

IF someone says that the distance between two places is 100 kilometres, anyone can have an idea of the distance between the places. Even when the distance is expressed in light-years, a student of physics will be able to have an idea of the distance. But if someone says that the distance between two stars is 31.54×10^6 second, one might wonder whether he is ignorant of the unit of distance, because second is well-known as the unit of time and not of distance or length. Length is measured in metre, foot, mile, etc., and, in case of astronomical distances, in light-year (1 light-year = the distance travelled by light in vacuum in one year). But, recently, metre has been redefined in terms of a fraction of a second and one who expresses distance or length in seconds is perfectly right.

In the third week of October 1983, the General Conference on Weights & Measures (CGPM— abbreviation of Conference Generale des Poids et. Measures) meeting held in Paris redefined metre, not as a simple length, but in terms of a fraction of a second. According to the definition, a metre is "the length of the path travelled by light in vacuum during a time interval of 1/299792458 of a second." The speed of light is therefore a universal constant in nature and by definition its value is 299792458 metre/sec. Now, if a scientist ever discovers that the speed of light in vacuum is greater than this defined value, the length of a metre will be increased in such a way that the defined value of the speed of light in vacuum remains unchanged.

Why the new definition?

The question that naturally arises is why it became necessary to redefine metre, and that too in terms of a fraction of a second. The reason is that a distance or length can be measured with more precision if it is measured in terms of time rather than in terms of the erstwhile metre. In fact, during the past few years, scientists have been measuring distance in terms of time. It may be said that such measurements have received recognition from the CGPM in 1983. For the sake of clarity, how distances are measured in terms of time has to be discussed. Suppose, for example, the distance of the moon from earth has to be determined. A laser beam is directed at the moon and the time taken by it to come back after reflection from the moon is observed. Then the distance between the moon and earth would be ct/2, where c is the speed of light in vacuum. Radio astronomers measure the distance between their telescopes in a similar way. So, the distance between two places as t seconds means the distance is ct metres (if c is expressed in metre/sec.).

As time is the most accurately measurable of all physical quantities, the accuracy of measurement of distance in terms of time depends on the accuracy of the value of c. For the last 10 years or so, scientists have been trying to measure c with more precision. But the accuracy with which a metre can be measured stood in their way. As speed is the distance traversed in unit time, the accuracy with which speed can be determined is limited by the accuracy with which distance and time can be measured. But the precision with which a metre could be measured earlier was 4 parts in 10^9. Whereas using the Caesium "clock", adopted as the international standard in 1967, time can be measured with an uncertainty of 1 part in 10^{13} (According to this standard, a unit second is duration of 9192631770 periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of Caesium-133 atom).

To increase the accuracy of measurement of c for the past decade or so, physicists have been calculating c by measuring the frequency of a laser radiation and multiplying it by its wavelength. One may now wonder that if wavelength is expressed in metre, how can the accuracy of c be increased in the above process? It is true that wavelength is expressed in metre but the wavelength is measured spectroscopically and the uncertainty in measurement is less than that in the measurement of metre. Besides, nowadays, the wavelength of laser is measured by counting the beat frequency of interference between it and a standard light beam. So, the measurement of both frequency and wavelength depends on time. As a consequence of the new definition of metre in terms of time, the accuracy in measurement of a distance or length has increased by about 160 times. This means that the uncertainty in the measurement of metre is now less than the diameter of an atom.

Brief history

Originally, a metre was intended to be one ten millionth(10^{-7}) of the distance from the equator to the North Pole along the meridian through Paris. The first standard metre was a platinum bar kept in the Archives of the French Republic in 1799. After being considered as a standard metre for 90 years, it was replaced in 1889 by the International Prototype metre, which was taken to be the distance between two fine lines engraved on a platinum-iridium bar kept at International Bureau of Weights & Measures in Paris maintained at 0°C. Again, after about 71 years, the International Prototype metre was abandoned when in 1960 the International Bureau of Weights & Measures (CGPM) decided to define the metre by an optical method. According to this definition, a metre is exactly 1650763.73 wavelengths of the orange-red light emitted by Krypton-86. This definition lasted for only 23 years as in October 1983 a metre was redefined as a fraction of a second. Justifiably, the CGPM wants the new standard to last longer than its predecessors and so it has built-in flexibility. Even if time can be measured with better precision than 1 part in 10^{-13}, which a Caesium clock permits today, the new definition of metre would remain unaffected.

From the point of view of the accuracy of measurement, the new definition of metre is certainly important to scientists. It is however not so in daily life. This is because for measurements, whose precision is less than about 4 parts in 10^9, the new standard of a metre is indistinguishable from the old one. But, in daily life, the accuracy of measurement of a length or distance is much less than 4 parts in 10^9. So if someone says, "you are 10^{-8} sec. taller than me" instead of saying, "You are 3 cm taller than me" he is perfectly right, but his statement does not bear any great significance.

Many scientists speculate that the value of c might be changing with time extremely slowly so that a detectable change may be observed in a million years' time. In that case, the value of the wavelength of an element's spectral line will differ from that measured today. Should this ever happen, the CGPM will have to consider a new definitin of metre.

Pradip Kumar Datta
Asstt. professor of Physics
Kishnagar Govt. College
Kishnagar (W.B.)

Technique in search of a problem

WHETHER a metal or insulator, it is its surface which has to face the rigors of environment. Of late, the surface of a material has become more important due to the rise in the ratio of surface-to-volume in components, thanks to miniaturisation. Moreover, new applications are observed in industry for materials with a variety of properties which are only skin deep. Surface coatings are not applicable in these cases because, apart from their suitability, adhesion creates problems. In view of these needs, a new technique "Ion implantation", which to date is only a laboratory toy, is on the threshold of commercial applications and also a tool for understanding materials. It is a technique of use not only in high-technology areas but also in day-to-day functioning of small industries.

"Ion implantation" technique is a tool not much different from the one which is used to probe interactions between nucleii. Ions—atoms stripped of electrons—of a particular element are produced. Using electric and magnetic fields these ions are converted into a beam and accelerated to high energies. The ion beam is then allowed to fall on the surface of the target metal or insulator. Either the beam is moved to cover the entire surface of the target or the target itself is moved before the stationary beam. Depending upon their type and energies, ions interact with the atoms or molecules in the upper surface layer of the target and produce changes of immense use in industry. Changes often occur in the upper one-ten millionth of meter layer of the target surface. It is also possible to deposit ions at a predetermined depth in the target.

The biggest advantage of this technique is that it makes possible to deposit thin layers of an element on to the surface of a metal or insulator imparting unique and unusual properties to the latter. Under ordinary circumstances, the element, whether a metal or gas, may or may not even mix with the target metal or insulator! In the initial stages, the technique was widely used in the production of silicon chips, the electronic brains of computers. A silicon chip is made of silicon, a semiconductor, whose electrical properties are varied using ion-implantation technique to produce a variety of suitable electrical circuits. In due course, the technique was applied to metals to improve their wear and tear properties which are confined to the skin of the material. Nitrogen ions were found to improve wearing of steel by a factor of ten. The wearing of a titanium alloy was dramatically increased by a factor of 1000 due to nitrogen ions.

Today, ion implantation technique has been found to change a variety of properties of metals and insulators. A suitable mix of the type of ions and their energies is able to produce these changes. In metals, for instance, in addition to wear, the technique has been able to increase their corrosion-resistance and decrease their coefficient of friction. Metals with such properties are a necessity where their longevity is extremely important, such as, bearings in jet-planes, gyroscopes, hip-joint prostheses, etc. In insulators, the technique has been able to change the refractive index of an optical wave-guide, the magnetic properties of a magnetic bubble memory, the conductivity of polymers, the strength of ceramics, etc. A modified form of the technique is also under test these days because it is more economical. In this case, a vapour of another element is also introduced to the target along with the ion beam.

Dilip M. Salwi

Terrane—a new geological entity

THE upper crust of earth is divided into several plates, each moving with respect to the other at an average speed of five centimeters per year. Wherever plates move away from each other, rifts are formed which lead to new ocean basins; wherever plates collide with each other, a chain of mountains and volcanoes is formed; wherever the plates slide past each other, faults are formed leading to earthquake activities; so on. This is known as the "Plate tectonics" theory, an ingenious yet simple theory which explains more or less all the geological activities of the past and present. The theory however explains only the geological activities over millions of years, like the brief summary of an event. It does not shed light on the details of the event. In recent years, geologists have begun to examine plate tectonics in minute details. Their studies have lead to the discovery of what is known as "Tectono-stratigraphic terrane" or in short simply "Terrane".

A terrane is a crustal block of any shape, size or age or composition which after undergoing any type of geological activity such as lifting, folding, melting or accretion, etc, becomes a part of a plate. In other words, terranes are eroded bits of a plate or bits ejected by a hot spot or volcano, etc, which are refashioned and recycled to produce another plate in the same or some other part of earth. So, the history of origin of a plate is actually the collective history of several terrane bits coming from different parts of earth. India is also considered to be one large terrane which had inched its way up to push the Eurasian plate after severing its ties with the Gondwanaland plate.

Terrane as an entity was discovered in the 70s when a dispute arose over the use of land in Alaska. Geologists found that the theory of plate tectonics cannot be directly applied to the continent because it is not simply of one plate of a particular composition and age but a collage of terranes of differing ages and compositions! To date, the history of a few terranes has been charted. In fact, to trace the history of terranes is today one of the biggest challenges facing geologists (*Scientific American*, November 1985). It is expected to reveal some very interesting aspects of the plate tectonics, dynamics. Terranes would give a slow-motion picture of the growth and movement of plates, shedding light on the periods when geological activity was high and low.

Dilip M. Salwi

Rise in atmospheric carbon dioxide and crop productivity

CARBON dioxide has a dual property of being fairly transparent to solar radiation, but largely opaque to thermal radiation. The first of these characteristics allows sun's rays to penetrate atmosphere and heat earth's surface. Then, when a portion of this absorbed solar radiation is sent back into space as thermal radiation, the second characteristic enables carbon dioxide to intercept a certain fraction of the radiation that would otherwise escape unimpeded to space. This intercepted radiation is absorbed and re-radiated with a portion finding its way back to earth. A consequence of this moderating effect of carbon dioxide on thermal radiant heat loss is that the earth is somewhat warmer than what it would be in the absence of this small, but important component of our atmosphere.

Qualitative aspects of carbon dioxide-climate connection have been well understood for over a century. The first extensive calculations of the magnitude of carbon dioxide effects on climate were made in 1896 which revealed that doubling of carbon dioxide concentration of the atmosphere could elevate average surface air temperature by as much as 8°C.

Over the past two decades, many investigators have calculated the expected change in surface air temperature from an increase in atmospheric carbon dioxide concentration. The standard situation that is studied in this regard is doubling the carbon dioxide concentration from a nominal value of 300 ppm to 600 ppm, since there is good evidence that such a doubling is likely to occur by the middle of the next century. The obtained values ranged from 0.7°C to 9.6°C.

The general circulation models of atmosphere today primarily use radio-active-convective approach solved by numerical techniques on high speed computers. Such methods yield a consensus estimate of about 2°C to 4°C warming for a doubling of carbon dioxide concentration from 300 ppm to 600 ppm. This prediction of global temperature based on carbon dioxide concentration was in complete agreement with atmospheric scientists until 1980 when a storm of protest was raised when the findings of Sherwood B. Idso, Research Physicist of the U.S. Water Conservation Laboratory, Phoenix, Arizona, were published. His findings put the, expected warming due to carbon dioxide concentration doubling at only 0.25° which is about an order of magnitude less than the estimates of the general circulation models. These findings were based on the emperical studies rather than on theoretical model predictions employed earlier by the atmospheric scientists. These findings indicate that the general circulation models of atmosphere for predicting carbon dioxide induced–temperature warming are wholly inadequate. In view of this controversy, an attempt was made in 1983 by Idso to review the carbon dioxide-induced temperature warming based on the existing information on carbon dioxide levels in atmosphere and the atmospheric temperatures from 1860 to 1980. His findings are given below and are found to be revolutionary.

The most recent description of primary carbon dioxide data is that given by C.D. Keeling, a research physicist at Mouna Loa Observatory, Hawaii, U.S.A. in 1982. These data were used by Idso and are given in Fig. 1. The carbon dioxide trend depicted here is the mean of results obtained at Mauna Loa Observatory at Hawaii, U.S.A. and at the South Pole. From this it is evident that the major period of increase has been from mid 1940s to the present. The observed increase in carbon dioxide levels in atmosphere is attributed to industries utilising fossil fuels.

The primary global temperature data used for many years in the climate change debate were those analyzed in 1972 by J.M. Mitchell, Jr., Physicist at the New York Academy of Sciences, U.S.A. As is readily evident from Fig. 2, there was an apparent increase in surface air temperature during 1880 to about mid 1940s. This gave considerable respectability to the hypothesis that the increasing concentration of atmospheric carbon dioxide over that period was responsible for the temperature rise. However the cooling that followed at the same time inspite

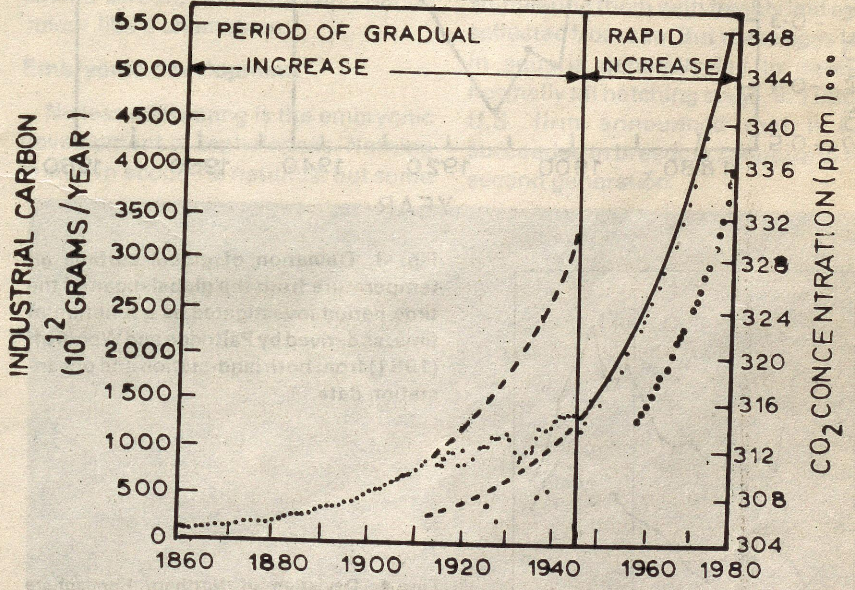


Fig. 1. Global rate of production of industrial CO_2 carbon and the global atmospheric CO_2 concentration as a function of time. The curves through the CO_2 carbon data are exponential fits to the intervals 1860-1914 and 1945-1978. Adapted from Keeling (1982)

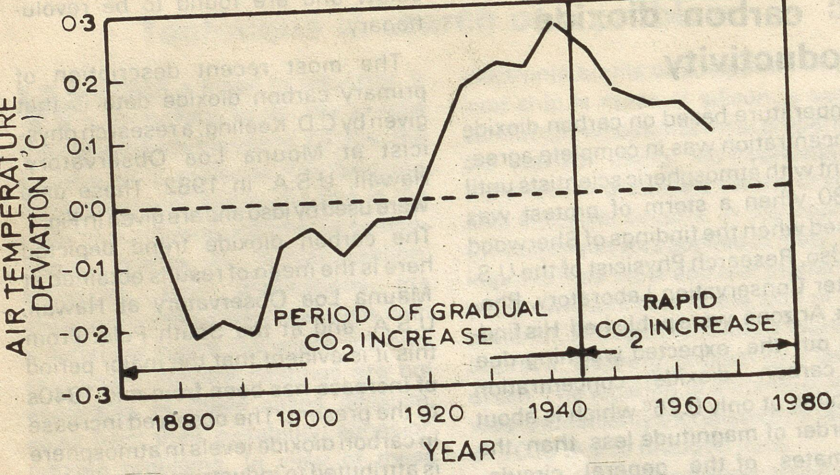


Fig. 2. Deviation of global surface air temperature from the global mean of the period investigated as a function of time, as derived by Mitchell (1961, 1963, 1972) from land-station data

of the more rapid carbon dioxide increase (Fig. 1) did not lend credence to that hypothesis. Thus explanations for this discrepancy were sought in other possible climate change mechanisms such as volcanism and solar radiation viability.

Perhaps the most accurate and representative trends of global surface air temperatures taking into consideration the latitudinal and seasonal variations are found in the most recent contributions made in 1981 by G. Paltridge and S. Woodruff, Atmospheric Scientists at Monsoon Weather Research Station located at Amsterdam, The Netherlands. For ascertaining the global surface air temperatures trends, they took into consideration the sea surface temperature records for the Pacific, Atlantic and Indian Oceans and Mediterranian Sea, since two-thirds of the surface of the earth is ocean. This approach greatly increases the volume and geographical coverage of the surface temperature information and improves the data balance between the northern and the southern hemispheres. Earlier workers made their conclusions from the data obtained from land stations, and the ocean areas of the globe were poorly represented. The data of Paltridge and Woodruff were used by Idso in solving the controversy over the carbon dioxide induced temperature trend, as shown in Fig. 3 reveal a decrease in global temperature of 0.28°C over that period. This is again in contradiction to the theoretical general atmospheric circulation prediction models on carbon dioxide induced warming. Additional data provided by Paltride and Woodruff in Fig. 4 reveal that cooling trend is much more evident in summer than in winter.

From Idso's review and analysis of the existing information of global carbon dioxide and temperature data, the following conclusions can be drawn:

1. There has been a gradual increase in global atmospheric carbon dioxide

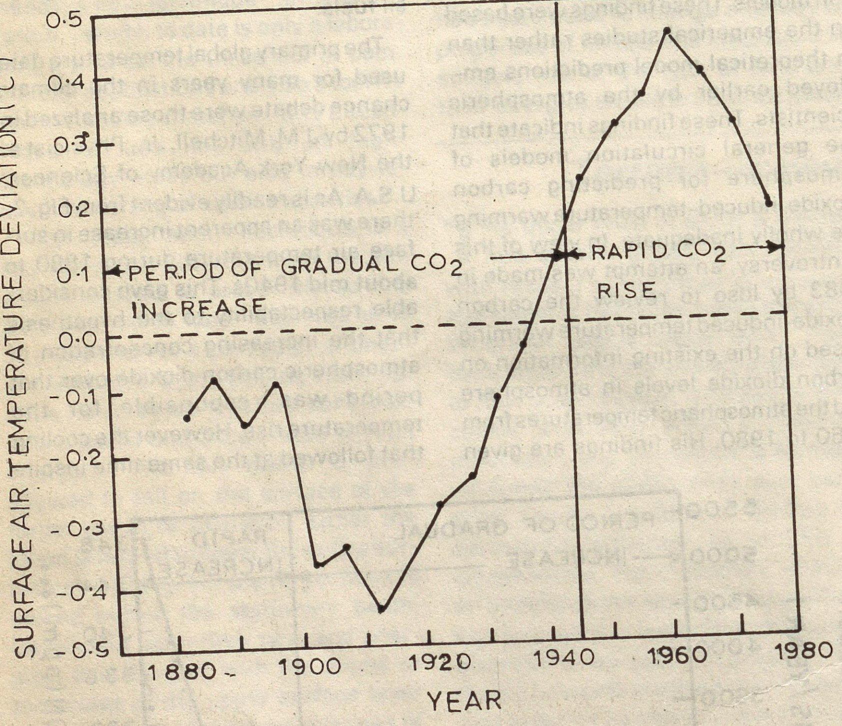


Fig. 3. Deviation of global surface air temperature from the global mean of the time period investigated as a function of time, as derived by Paltridge and Woodruff (1981) from both land-station and ocean-station data

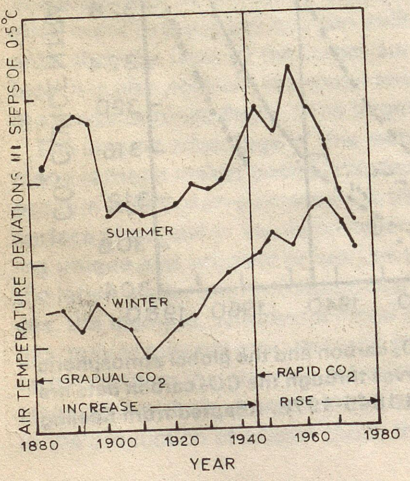


Fig. 4. Deviation of Northern Hemisphere surface air temperature for summer (June-August) and winter (December-February) as a function of time, as derived by Paltridge and Woodruff (1981)

2. There has been a much more rapid rate of increase in atmospheric carbon dioxide concentration from 1945 to the present, i.e., from 316 ppm to 448 ppm.

3. The most recent trend of global surface air temperature during this period of rapid carbon dioxide increase has been downwards, which is in contradiction to the predictions of the most sophisticated general circulational models of the atmosphere in use today.

4. The downward trend in surface air temperature has been more pronounced in northern latitude.

5. The downward trend has been greater in summer than in winter.

6. Theoretical numerical models of the atmosphere are grossly in error to their predictions of future carbon dioxide effects on world climate, as suggested by Idso's emperical model.

In addition to the cooling effect of increasing atmospheric carbon dioxide levels on global temperature, it has a profound positive influence on crop productivity and water use efficiency. These observations were made in 1979 by L.H. Allen, an agricultural scientist working with the U.S. Department of Energy, Washington, D.C. B.A., Kimball, a Soil Scientist at U.S. Water Conservation Laboratory, Phoenix, Arizona in his 400 experiments dealing with economic yields of agricultural crops in 1982 found that doubling the atmospheric carbon dioxide concentration could increase global productivity by 33% and a trippling could boost it by 66%. The doubling of carbon dioxide concentration could also reduce transpiration by 44% due to closure of stomato. When combined with yield increase, this indicates that the water use efficiency may double. Thus the overall effect of carbon dioxide levels in atmosphere is a positive one rather than a negative one, regardless of its effects on projected change in climate. Thus as world population continue to grow, we may desperately need the significant advantage that increased atmospheric carbon dioxide concentrations could bring to the agricultural enterprise in the days and years ahead.

S. Anil Kumar
Asstt. Professor
A.P. Agricultural University
Rajendra Nagar
Hyderabad 500030

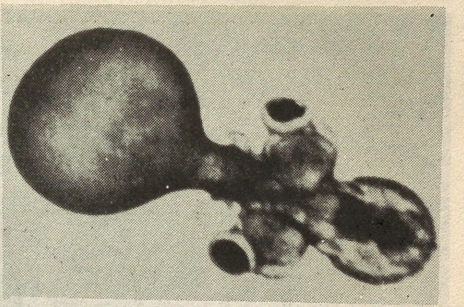
Embryonic development of cephalopods

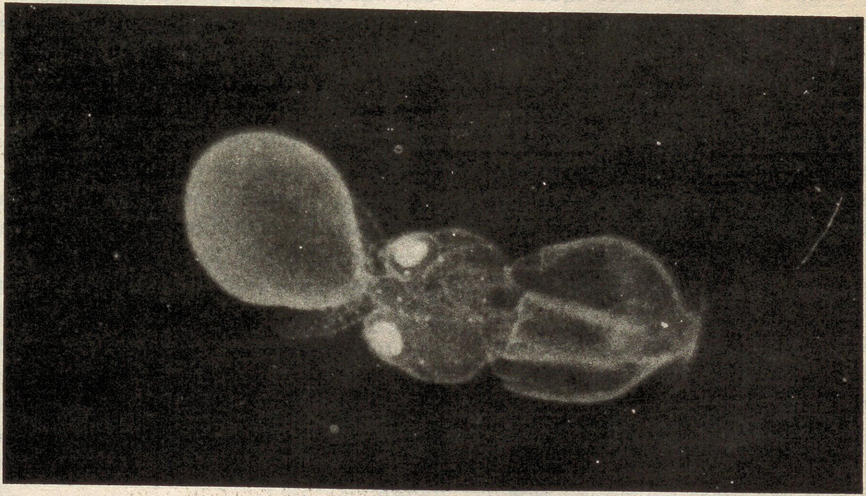
CEPHALOPODS have a long history. Of the living cephalopods octopus, the squid and the sepia are the most well known. Their obscure cousins are the nautilus and argonauts.

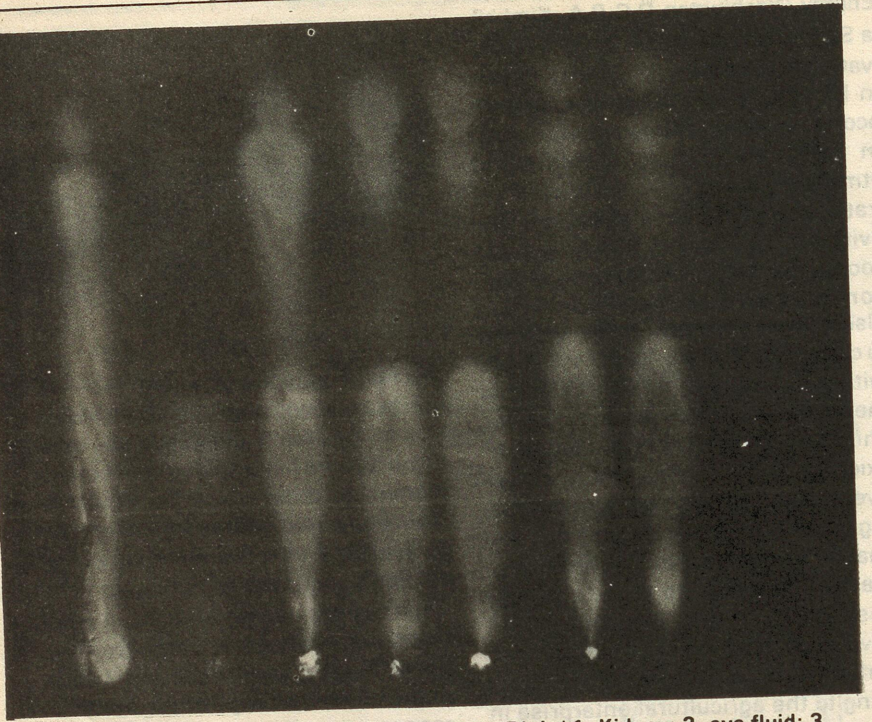
Although most cephalopods are small, the giant pacific octopus *(O. dofleini)* can attain a weight of 45 kg and giant Atlantic squids cast off on shore have measured about 19 m. They are thus the largest invertebrates in the world. Also, the cephalopods have the most well developed brains and eyes in the invertebrate world. Moreover, the octopus has pliant agile arms, suitable for manipulating things, using tools, etc. As early as 1910, intelligence and memory of an octopus that could uncork a bottle and seize crab inside had been scientifically studied. Now brain physiology is being studied at places like Naples. The adult cephalopods have three hearts, 8 to 10 arms, an ink-pot that can spray a smoke screen, and they can change colour like a chameleon.

Embryonic development

No less interesting is the embryonic development of cephalopods. Nothing is known about the nautilus, but some species of octopus, squid and cuttlefish are comparatively easily available and, in the course of the last one century or so, we have gained some information on these subjects. But even now, compared with many other easily available samples, the embryology of cephalopods is a rather virgin field. Cephalopods cannot be bred in laboratory as easily as frogs or fruitflies can be. Eggs of squid, more specifically, of the common *Loligo* of the Mediterranean are easier to handle than those of octopus and cuttle-fish but, on the other hand, the adult *Loligo* are more difficult to maintain, even in aquaria with running sea-water. Some years ago, while at Naples, this author learnt that they could at most be reared for three months or so. More recently, a scientist in Hawaii has succeeded in making the captive *Loligo* lay eggs, by stimulating them with freshly laid eggs collected from sea. But these eggs laid in aquaria generally fail to develop normally till hatching stage. In 1985, a U.S. firm announced that it has succeeded in breeding *Loligo* up to the second generation.


Pulsating yolk


Advanced stage of embryo



Chromatogram of adult loligo tissues. ***(Left to Right)*** **1. Kidney; 2. eye fluid; 3. liver; 4. optical ganglia, 5 & 6. Mantle tissue**

Breeding of cephalopods is a full time project for specialists. Embryologists had to depend on trawling and **fishing for bunches of eggs. This procedure has several limitations. For example** the sea may be rough one day and the eggs collected the next day may be in too advanced a stage of development and so on. Cuttlefish, or at least the common Mediterranean species, *Sepia officinalis,* lay small bunches of large black grapelike eggs (almost the size and shape of grapes) in the aquarium and some of these can be studied. Octopus eggs (1 mm to 20 mm in length) are also available from time to time, but in general there is no continuous supply of cephalopod eggs for the scientists to study. It is no wonder that practically no data on biochemical embryology of cephalopods are available, though physiologists and biochemists have studied adults which can be easily caught.

At Banyuls, South France, the present author tries artificial fertilization of *Loligo*. The process is simple because the adult male carries a well developed Spermatophore, a sac full of tubes like glass capillaries which are packed with sperm. Eggs, can also be obtained easily from mature females (who may also carry spermatophores embedded inside their bodies). On mixing them in sterile sea-water, a success rate of 5%-10% was recorded. Even though the success rate was low, enough material could be obtained for chemical experiments at the earliest stages,—unfertilized, fertilized and early cleavage stages. The eggs died after that stage but with improved techniques, such as washing eggs with sterile sea water before fertilization, and again after fertilization, Marthy at Banyuls obtained considerably more advanced stages. In South France, the right season is from mid February to summer and then again round about September. In Bengal (at Digha, about 150 km from Calcutta) I found only 2 out of 30 squids to carry ripe eggs at the end of June. A month later, the squids vanished. Since then and till the end of September, they have not been caught in fishing nets. The proper season can be determined by collecting specimen, the year round. This small squid is *Loliolus investigatoris.*

The mysterious yolk

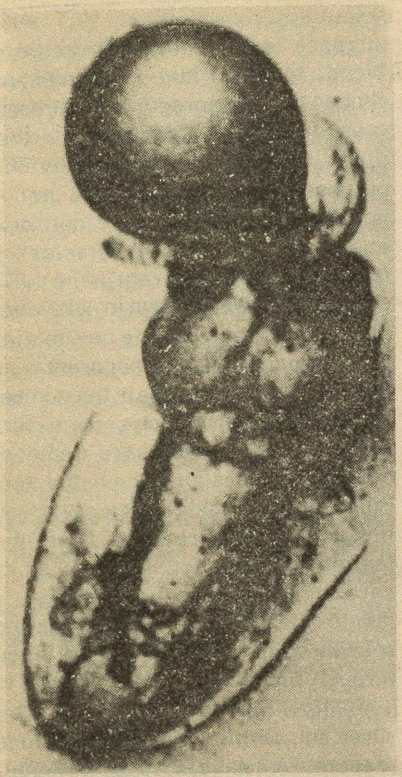
Like cephalopods, birds and fishs have large quantities of extraembryonic yolk. But the well known text book pictures of the two latter embryo types, so familiar to students, are very different from the squid embryo. In these as well as in other cephalopods, the yolk mass is attached to the mouth and pressed far inside the embryo. Millions and millions of years before birds and fishes (both vertebrates) emerged, nature had designed another mechanism for these strange invertebrates.

110 years ago, Ray Lankester was surprised to see the balloon like yolk of the cephalopod embryo pulsating like a heart. It is, in fact, a primitive heart, and to-day while watching and filming it I felt the same shock of wonder as Lankester had experienced so long ago. 5 or 6 heart and heart-like systems are functional, simultaneously, at a certain stage of embryonic development! They pulsate, independently, at different rates.

The amino-acids of yolk and embryo

The amino-acids are the building blocks of proteins. Amino-acids in yolk are expected to be meant for embryonic nutrition. Significance of free amino-acid pools in organisms or tissues thereof is not quite clear.

The present author and H.J. Marthy have now found that unfertilized and fertilized eggs and late stage embryos of the squid have a similar pattern of amino-acids. But before hatching, one particular amino acid, proline, begins to be formed inside the embryo and rapidly increases during the last stage. Proline is naver found in the yolk and Proline is never found in the yolk and advancement. We injected proline into the yolk of early stage embryos and detected that it would soon pass into the embryonic tissues. Formerly it was believed that the inner part of the yolk would contribute to embryonic nutrition at a much later stage when the yolk would be pressed into the embryo. Further light will be shed on the problem of embryonic nutrition of cephalopods with the help of radioactive amino acids



Squid embryo

The mystery of the "stop" signal

Cell division in the cephalopod egg starts from one pole. In due course, the whole yolk mass is covered by these cells. Sometimes a strange phenomenon has been noted. If for any reason, for example, sub-lethal toxic effects are latter withdrawn, cell division is checked and then later takes place again, a partial embryo is formed with the uncovered yolk attached to it.

Comparable doses of glycerol in sterile sea water check mitosis of *Loligo* embryonic cells also. Many more experiments with early stages of *Loligo* embryos, where about half or one third of the egg is still not covered by the cells are indeed necessary but I have already got clear evidence that, at such stages, glycerol inhibits cell division. As the cells "wake up" after some time (which can be well defined) in sea-water, they seem to carry the memory of the "stop" signal. Once the command "stop mitosis" is heard, they do not forget it. Apparently, "stop mitosis" is equivalent to "start differentiation". As the cells wake up, they refrain form covering the remaining part of the yolk and begin to differentiate. Embryos were formed with glass clear uncovered yolk mass attached behind. The embryonic parts, though small and slightly abnormal, were at least so far advanced that even the pink, pigmented eyes were formed.

Perhaps in future this system could be utilized for exploring the mysteries of the stop signal

R.L. Brahmachary
Head, Embryology Unit
Indian Statistical Institute
Calcutta-700035

Osmoregulation in migratory fishes

OSMOREGULATION—the proper maintenance of water and salt balance of the body tissues—in fishes, whether they live in fresh or marine water, is a physiological activity very closely related to their survival. Most fishes are confined to either salt or freshwater and have a limited salinity tolerance (stenohaline), but many fishes can adapt to life in both fresh water and marine conditions (Euryhaline). Marine fishes like Salmon, Hilsa and Lampreys breed in fresh water where their young undergo initial growth and development before returning to the sea (Anadromous migratory fishes). Others like Eels (Anguilla spp.) breed in ocean but subsequently spend a large part of their life in fresh water (Catadromous migratory fishes). As the nature of osmoregulatory problem is quite different in marine and fresh water environments, the ability of these fishes to regulate in both environments during their migration is of much interest

Osmoregulatory problem in marine and freshwater

Marine fishes have lower concentrations of solutes like sodium, potassium, chloride, etc. in their body fluids than that of the surrounding water. As a result, water continuously passes out of the body through gill membranes, lining of the mouth and pharynx, thus fishes face the problem of dehydration. Secondly, as far as quantity of various salts in the body fluids is concerned, problem is exactly opposite, because the marine fishes gain salts by diffusion. Moreover, since they have to drink a lot of water to compensate for the water loss, the problem of salt gain is magnified. As an adaptation marine fishes maintain the body water constant mainly by drinking water, retaining water in the kidney and producing highly concentrated and small quantity of urine. The concentration of salts is maintained by removal of excess salts incorporated in the body through gills and excreting concentrated urine containing a large quantity of salts (Fig. 1).

In freshwater, the problem of osmoregulation is exactly reverse to the marine environment. Fishes have their body fluid concentration higher than that of the surrounding water.

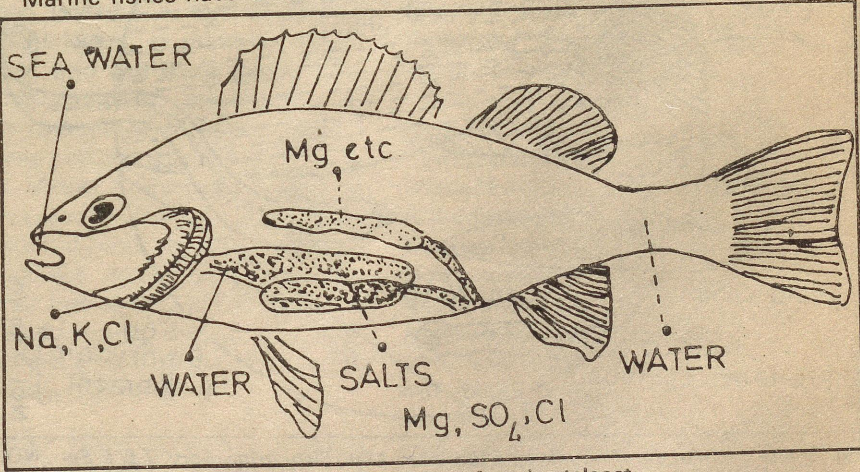


Fig. 1. Osmoregulation of marine teleost

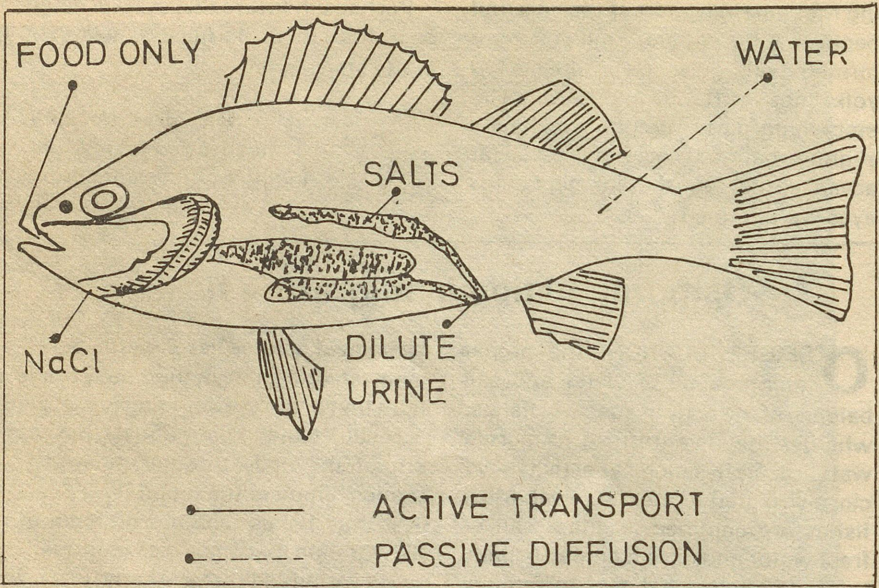


Fig. 2. Osmoregulation of freshwater teleost

Consequently, there is a tendency to lose salt and gain water. Excess of water gained is removed by kidney by excreting copious amount of dilute urine. The salt loss is made good by gills and kidney tubules which are capable of gaining and retaining salts by active absorption. Moreover, body also gains salts from diet (Fig. 2).

Osmoregulation in migratory fishes

Migratory fishes like *eel (Anguilla* spp.) and salmon are considered ideal examples of catadromous and anadromous fishes, respectively. In the life history of the eel, there are three phases *viz,* (a) marine larval phase, (b) freshwater phase, and (c) adult marine phase (Fig. 3). Eels breed in the open sea at a depth of 400 m-500 m. They start their migration in well-fed conditions and bring about various changes in their body before entering into the sea. One of the important, change is an alternation of osmoregulatory mechanisms which leads to an increase in the osmotic pressure of blood to suit marine conditions. Since the osmoregulatory process must function actively, they utilise most of their energy for this purpose. Their downstream migration is strictly passive to conserve energy for the purpose. Preparation for marine life is apparent in the thickening of the layers of skin in eels which helps them survive in the new marine environment. It is also apparent from the appreciable increase in the number of gill tissue cells which secrete chlorides. These cells increase tremendously a few days after the fish enters into seawater, enabling it to resist salt invasion that threatens it in the marine environment. Silver eel, in its catadromous migration, shows a higher rate of intestinal water flux and a lower rate of sodium penetration through the gill than that observed in the yellow eel in freshwater. The silver eel, with its increased aptitude to excrete out salts, successfully regulates salinity. Water loss is compensated for by drinking water. Factors that control the rate of drinking in fish are unknown, perhaps they just feel thirsty. With all these adaptive physiological changes, which are invariably controlled and monitored by endocrine glands eels migrate towards the direction of increasing salinity and successfully spawn in the warmest part of the deeper oceans.

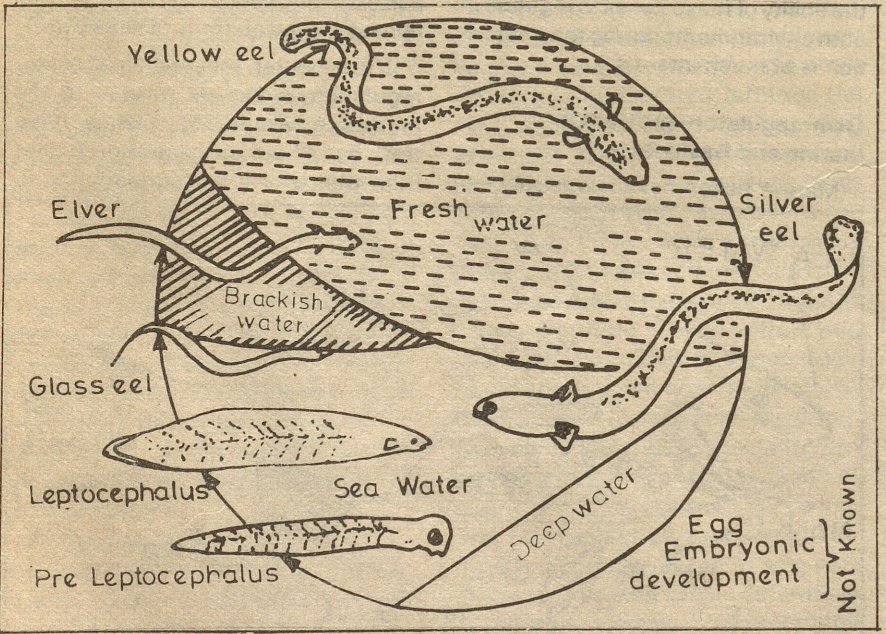


Fig. 3. Life cycle of eel (*Anguilla* sp.) [Source : *Mar. Fish. Infor. Serv. T & E Ser.,* NO. 23:1980]

Salmon depends on two distinct environments for the successful fulfilment of its life history: (i) a marine environment for its main feeding phase during which rapid growth is achieved, and (ii) a freshwater environment in which the reproductive and nursery phases of its life cycle occur. Eggs are laid in gravel beds in lakes or streams, which take about 60 days to hatch depending on the temperature. The fry or alevins grow up to parr. Finally as smolts, the salmon migrate down to the sea for feeding.

A profound modification of the physiological mechanisms of osmoregulation is necessary depending on whether salmon is living in salt or freshwater. This modification appearing at a precise stage of life cycle is one of the determining factors for migration. While approaching coasts to begin its upstream migration, a clear increase in the concentration of salmon's blood occurs, indicating a change in the osmoregulatory mechanism suitable for marine environment.

The young salmon, which is born in freshwater, spends several years in these surroundings and undergoes important morphological, biochemical and physiological modifications before undertaking downstream migration to marine feeding grounds. The 'smolt' develops a more pronounced tolerance to salinity than the 'parr' because of the increase in number of chloride cells in the gills. The activity of two enzymes, namely succinodegydrogenase and salt-linked ATPase associated with chloride cells permits elimination of excess through digestive tract when fish enters the sea. Salmon thus gains hyper capacity to lose chlorine and sodium ions in marine water. Similar to eel, in salmon also, physiological adapations to migration are added by endocrine glands like thyroid, interrenal and pituitary.

The mechanisms involved in osmoregulation during migration are only one aspect of determinism, the others being various external environmental factors. There is still much to understand how exactly fishes manage itself physiologically in different environments during migration and their homing instinct

K.R. Dinesh
Asst. Professor
College of Fisheries
Univ. of Agri. Sciences
Mangalore 577 002

A transmembrane protein of RBC membrane

BIOLOGICAL membranes are made up of lipids and proteins. Lipids form bilayers and act as permeability barriers, while proteins, associating with lipids through hydrophilic or hydrophobic interactions, perform different functions. These proteins can be classified into two groups on the basis of their association with lipid bilayers. Periferal proteins can be extracted from the membrane by using mild conditions such as change in ionic stength. Integral proteins require the use of detergents for their extraction. Those integral proteins which span the whole thickness of a lipid bilayer leaving one end in the cytoplasm and the other in extracellular space are known as transmembrane proteins. They are usually glycoprotein in nature and therefore have been implicated in several important biological functions such as virus binding, cell surface antigenicity, cell recognition, cell communication, cell transformation etc.

Red blood cell (RBC) membrane has been thoroughly studied. Glycoproteins constitute about 10% of the total proteins of RBC membrane. Major sialoglycoprotein (glycoprotein containing sialic acid) of human RBC membrane was named Glycophorin A in 1972. Glycophorin A is the chief constituent making about 70% to 75% of total glycophorins. Transmembrane orientation of Glycophorin A in cell membrane has been studied by several workers using different techniques, such as lactoperoxidase catalyzed iodination. As a transmembrane protein, it can be divided into three portions. One portion is made up of hydrophilic amino acid residues. Second portion, which is present in lipid bilayers, is primarily hydrophobic, and the third portion extending towards cytoplasm is again hydrophilic in nature. Nature of these portions justifies their functions. Middle hydrophobic portion is nicely associated with lipids and other transmembrane proteins through hydrophobic interactions, while the external hydrophilic parts are suitable for electrostatic interactions with polar head groups of lipid bilayers and other polar residues.

Human Glycophorin A is a single polypeptide chain, made of 131 amino acid residues with no disulfide bond. Molecular weight of human Glycophorin A was found to be 29,000 based on sequence data. Glycophorin A from different species show great variations in molecular properties, such as, molecular weigh, chemical compositions, etc. It contains about 40% to 80% carbohydrate which is localized to the segment of protein lying exterior. The sialic acid content in Glycophorin A has been estimated at 21%-24%. This fairly constant level of sialic acid is suggestive of some generalized functions at the cell surface. It has been proposed that decrease in sialic acid content during senescence acts as a trigger for removal of these cells from circulation. Carbohydrates in Glycophorin A include galactose, mannose, fucose, N-acetyl glucosamine and N-acetyl galactosamine. These carbohydrates are linked to Glycophorin A, via O-glycosidic or N-glycosidic linkages. Human Glycophorin A contains 15 O-glycosidic linkages attached as tetrasaccharides to either serine or threonine residues and one complex N-glycosidic linkage which is attached to asparagine residue of Glycophorin A. The acidic nature of protein is evident from higher number of acidic amino acids than that of basic amino acid residues. The molecule is divided into three distinct segments. The first 62 amino acid residues exposed at the cell surface contain all carbohydrates. The segment is also rich in serine or threonine residues. Another one-third of the molecule extent into cytoplasm containing proline residues at regular intervals. Hydrophobic segment which connects these two segments is present in hydrophobic mileu of membrane.

Role of Glycophorin A in transbilayer movement of phospholipids is controversial since in a rare variation of blood En (a-) which lacks Glycophorin A, the distribution of different phospholipids was found normal. Despite uncertainty, several evidences suggest that lipids in immediate vicinity of Glycophorin A behave differently as compared to bulk lipid. Glycophorin A also interacts with itself and with other proteins in the membrane as observed in freeze fractured membranes. Glycophorin A mainly exists in the form of dimers in the membranes, an observation sug-

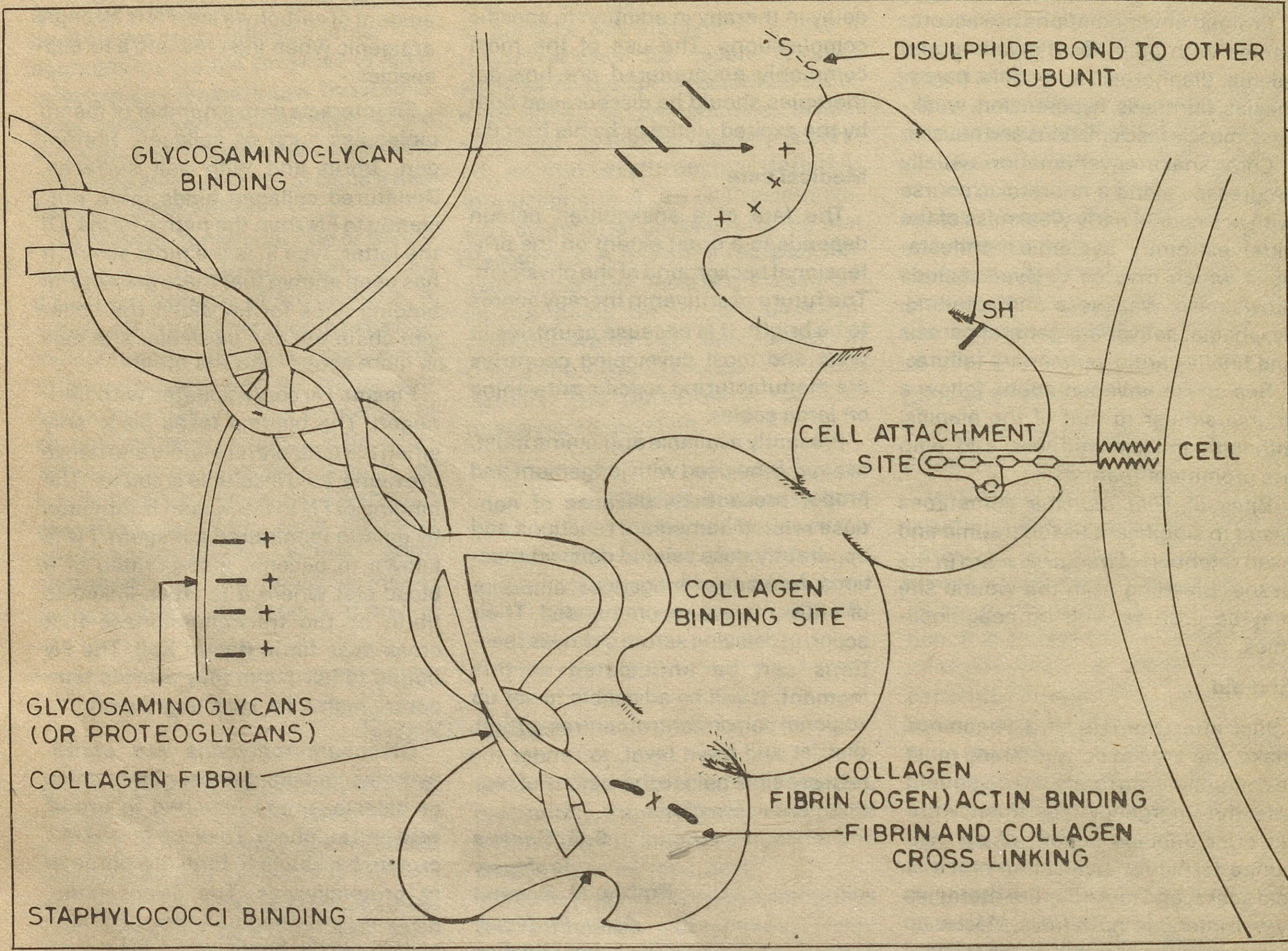


Fig. 1. Model for the structure and interaction of FN. A single subunit of FN is shown (Ruoslathi. E. et al. 1981)

ing. This interaction may play a role in the elimination of insoluble remnants of dead cells, the opsonizing effect of FN. (Opsonins are antibodies and complement enzymes that coat the surface of bacteria and other foreign bodies, making them more susceptible phagocytosis by neutrophils and tissue macrophages).

Structure

Fragmentation studies show that proteolytic fragments with appproximate size of 30,000-40,000 daltons retain the collagen binding property. Other fragments contain cell attachment sites. Other studies show that the fragments that bind to gelatin do not bind to heparin and vice versa. This suggests that the two binding sites must be far from one another (Fig. 1).

A single subunit of FN is composed of domains that have a globular structure and are interspersed by regions of more extended structure. The globular domain contains the binding sites of FN and the extended regions provide sites particularly susceptible to cleavage by proteases (protein splitting enzymes).

Functions

There are several evidences to prove that fibronectins play a role in the attachment of cells to the surrounding matrix *in vivo*. The absence of FN in mitotic cells helps in the expansion and separation of the cells since attachment with neighbouring surface is inhibited. Transformed cells (i.e., cells with changed shape or change of one tissue into another due to various reasons), when treated with FN, reach near normal morphology, presumably due to enhancement of cell attachment and spreading. The FN may be cross-linked either by intermolecular disulphide bonds or by virtue of being a specific substrate for transglutaminase.

Circulating FN cross-linked by factor XIII (a coagulation factor) to fibrinogen on tissue culture surface forms a matrix for cell attachment aiding blood coagulation. This could be a step in wound healing as FN appears in granulation tissue before collagen and disappears as collagen matrix is organised. It has been suggested that the function of the circulating FN could be to opsonize (i.e., to coat, to make it more susceptible) any circulating particles of tissues (collagen binding) or microscopic blood clots (fibrin binding) thus causing their removal by the reticuloendothelial system.

FN is present both outside and within the cell and also on cell surface. Outside the cells FN is present as soluble protein in different body fluids

Table 1. Concentration of fibronectin in different body fluids

*Body fluid**	*Concentration. (Microgram/ml)*
Plasma	300
Amniotic fluid	170
Cerebrospinal fluid	1-3
Urine	About 100
Cultured media of fibroblasts at confluency	Upto 50

*Also been identified in synovial fluid which lubricates the movable joints of the body.

(Table I). FN has also been identified in synovial fluid which lubricates the movable joints of the body. Although FN was first identified in fibroblast it is present in both connective tissue cells and epithelial cells.

FN in diesease

It has been found that fibronectin is absent in tumour cells induced by cancer-producing viruses, and that, on addition of FN, the tumour cells revert to normal growth. The loss of FN is seen not only in cells transformed by cancer-producing virus but also in cells from chemically induced and spontaneously occurring tumours. But exceptions have been reported. Some authors believe that the absence of FN is more likely in metastatic tumours than in primary ones.

Various reasons have been attributed to the absence of FN, viz., decreased synthesis, increased degradation, proteolytic release from receptor sites, altered FN synthesis, altered functions and loss of receptors.

In haemostasis FN has two roles One is interaction with fibrin plasma transglutaminase and secondly promotion of adhesion and spreading of platelets on subendothelial collagen in an injured vessel wall.

Following trauma, surgery, burns, sepsis, etc., there is impairment of reticuloendothelial system with diminished plasma FN. Administration of cryoprecipitate (cryoprecipitate usually refers to precipitate that forms in normal blood plasma which has been subjected to low temperature) to such patients restores plasma FN and improves condition of the patient. Recently, the appearance of FN during initial stage of muscle rejection has been shown which may have a causal relationship to the process of immune defence mechanism.

R.Suresh
1, Venkatraman Street
Srinivasa Ave.
Madras 600 028

Monoclonal antibodies — a technological revolution

IN the field of bio-medical research, few disciplines have experienced such an explosive growth as immunology. The essential function of the immune system is to defend the body against infection. Protection is provided by adaptive immune response evoked as a reaction against an antigen (a foreign protein) which elicits production of antibodies in the host's serum which, in turns combines with the antigen to cause its elimination. The antibodies thus produced are said to be raised against the whole antigen and are multispecific in nature, i.e., they bind with different combining sites on the antigen molecule. For vaccination purpose, highly specific forms of antibodies are required and this led to the devising of technology for production of clones of cells making antibodies which were characterised by their single antibody specificities. This fantastic feat was achieved by two brilliant immunologists, German born Georges F.Koehler and Cesar Milstein of Argentina, who gave the name monoclonal antibodies to these single, specific antibody molecules. In recognition of this outstanding research, these scientists were cited for the prestigious Nobel Award in medicine (1984).

The production of monoclonal antibodies in laboratories requires highly complicated technology alongwith strict germfree working conditions. Contamination of the culture medium in which cell clones are grown leads to the destruction of antibody molecules. The production of monoclonal antibodestruction of antibody molecules. **Production of monoclonal antibo-** phocytes which take active part in production of antibodies. To be more precise, the lymphocytes produced in bone marrow, i.e., B-lymphocytes, are actually the antibody forming cells. These B-cells are selected according to the required specificity and are fused with an appropriate B-cell tumour line. It must be noted that tumour cells have a remarkably fast rate of growth. The cells resulting from the fusion of B-lymphocyte and B-cell tumour line are termed as hybridomas which are selected out in a tissue culture medium, and by successive dilutions, single clones are established. These clones are then grown in the ascitic form in mice resulting in production of high titers of monoclonal antibodies. The characteristic features of the monoclonal antibodies produced by a given hybridoma are that they are identical, having the same immunoglobulin class, the same genetic markers, the same structures and, of course, the same affinities and specificities.

Applications of monoclonal antibodies are wide ranging (Table 1). These single specific antibodies can be used in the separation of different sub-populations of lymphocytes like thymus-produced killer lymphocytes or T-killer cells which take part in cell mediated immunity, T-helper cells which support the antibody making function of B-lymphocytes, and T-suppressor cells which inhibit the antibody production. These cells are identified by different genetic markers present on the surface which are, in

Table 1. Some applications of antibodies

1. In identifications of different lymphocyte subpopulation
2. Diagnosis of lymphoid and myeloid malignancies.
3. Tissue typing
4. Radioimmunoassay
5. Cancer therapy

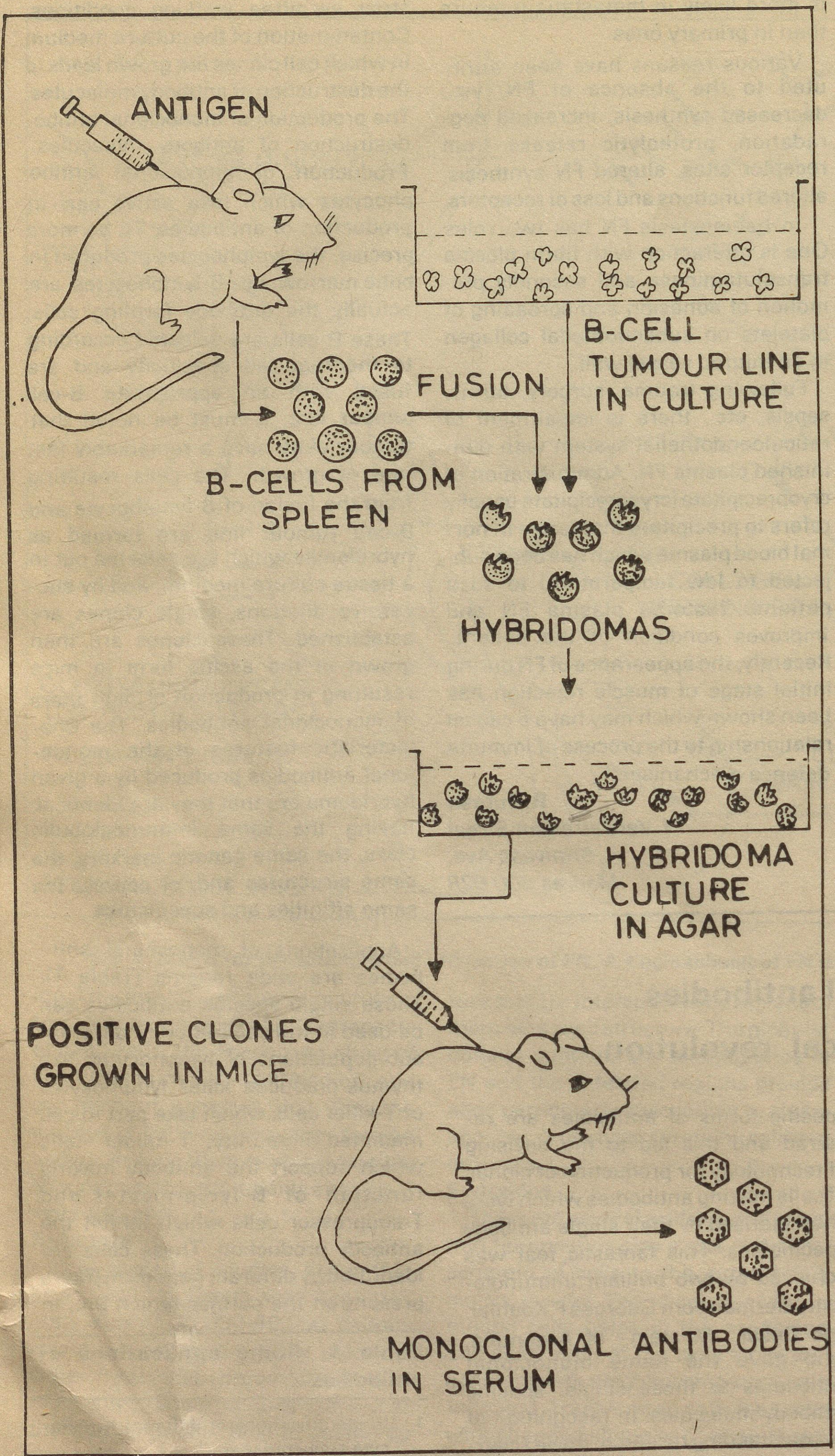


Fig. 1. Diagrammatic representation of the production of monoclonal antibodies

turn, recognized by respective monoclonal antibodies.

Monoclonal antibodies are finding use in the diagnosis of myeloid and lymphoid malignancies in the body. Radioimmunoassay, a technique used in the detection of low concentrations of antigens, is being improvised by the use of single specific antibodies. Certain clinical operations like tissue typing and sero typing of micro-organism are benefiting from the use of monoclonal antibodies and recently their potentialities are being utilised for cancer therapy. The anti-tumour specific antibodies are raised against the tumour and then these antibodies are coupled with cytotoxic agents which on body administration reach the specific tumour and destroy it without harming the normal tissues. This is the 'magic bullet' therapy. The biochemical basis of development and differentiation has become amenable to analysis by use of monoclonal antibodies. The steps involved in development and maturation of sperm cells as well as mouse embryos have been investigated using specific monoclonal antibodies.

Recently, parasite immunologists have realised the potentialities of monoclonal antibodies and research in this direction is accelerating at a tremendous rate. D.S. Rowe, a W.H.O. scientist at Geneva, Switzerland, has discussed in detail applications of monoclonal antibody technology in immunoparasitology. In the case of malaria, the malarial parasite has been cultured *in vitro* to obtain large quantities of parasitic antigens which are later purified and used as vaccines. This is being supplemented by using monoclonal antibodies in immunosorbent columns. Passive immunization of mice against the blood fluke *Schistosoma mansoni* is being tried by M.A. Smith and his colleagues at Welcome Research Laboratories, Kent.

Given above are a few applications of monoclonal antibodies, but their other wide spectrum potentialities are being rapidly recognized by scientists. In near future an era of further advancements would usher in this modern field of bio-medical science.

Deepak Bhatnagar
S.S. Lal
Shashi Kiran
Deptt. of Zoology
Institute of Advanced Studies,
Meerut University, Meerut (U.P.)

Phalaropes—birds with changed sex behaviour

THE word phalarope has its origin in Greek word phalaropus, meaning coot - foots (Gk : *Phalis*— coot, *ropus* — foot). The phalarope is a shore-bird belonging to order Charadriiformes and represented by three species, viz., *Phalaropus fulicarius, P. lobatus* or *Lobipes lobatus* and *Steganopus tricolor*. These three species are commonly known as red phalarope, northern or gray phalarope and Wilson's phalarope (after an American naturalist, Alexander Wilson) respectively.

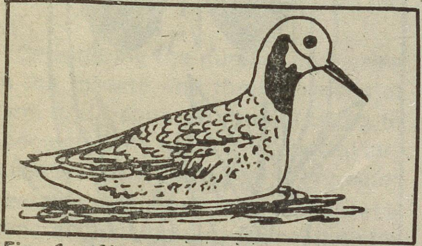


Fig. 1. Northern female phalarope *(Lobipes lobatus)* in summer breeding plumage

Habit and habitat

Gray phalarope, *P. lobatus*, is found in Peru, Argentina, north-west Africa, southern Arabia and Indonesia (Fig. 1). It breeds in sub-arctic regions of eastern and western hemisphere. *P. fulicarius*, the red phalarope, is distributed near the east and west coast of South America and west coast of Africa (Fig. 2). The breeding place of this species is arctic zone in both eastern and western hemisphere. Wilson's phalarope, *Steganopus tricolor*, is restricted to America (Fig. 3 a and b). It enjoys its breeding ground from great lakes westward across the Prarie provinces of Canada into British Columbia and further south over a large area of the western U.S.A.

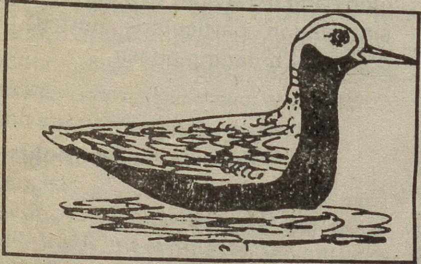


Fig. 2. Red female phalarope *(Phalaropus fulicarius)* with breeding plumage

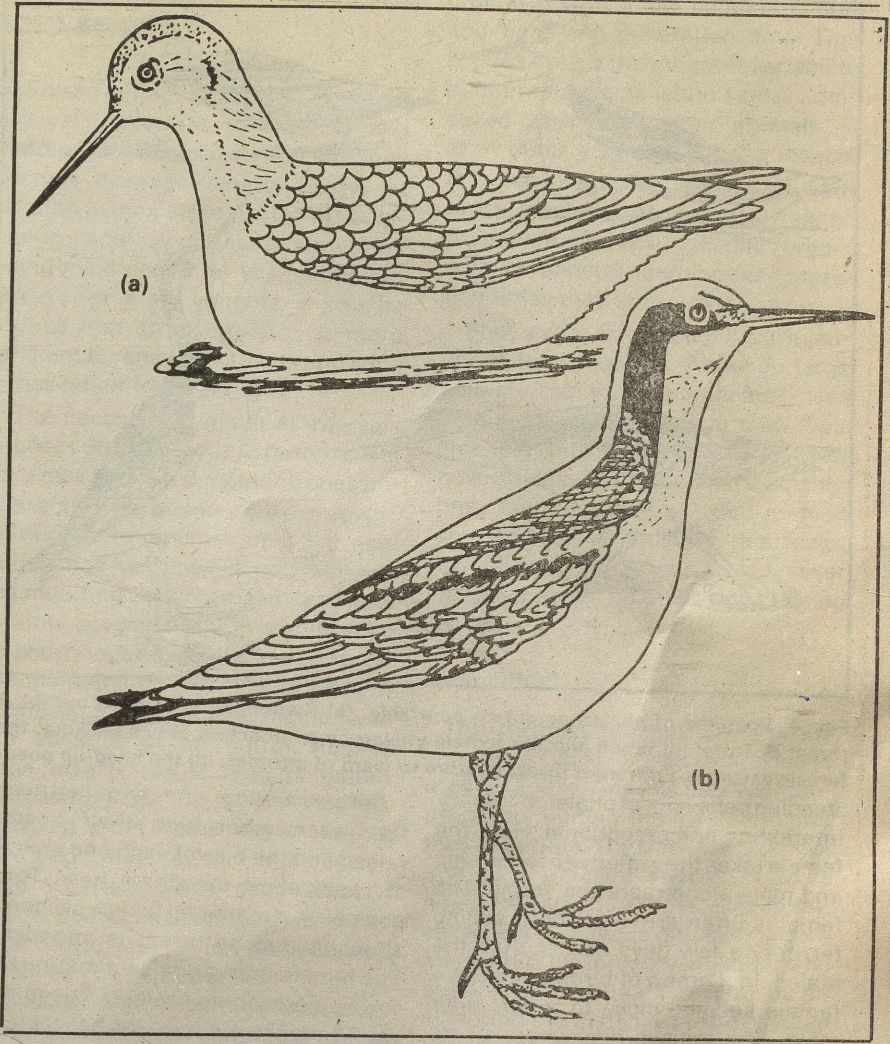


Fig. 3. Wilson's phalarope *(Steganopustricolor)* (a) male; (b) female

Phalarope, as a shore-bird, is an excellent swimmer. In shallow waters where the other shore-birds wade phalarope swims. While floating high in water it looks as if it were made of cork. Most of the time it sleeps a float during swimming except the breeding period. It feeds on crustaceans, small fishes as well as marine planktons. It daintly picks up bits of food from the surface of water in the manner of surface feeding by ducks. At times, it rotates like a top and dabs, at water for food. Wilson's phalaropes have been observed spinning as fast as one revolution per second and every time spearing water with their beaks.

Morphological characteristics

The phalarope resembles sand pipers in shape but its neck is somewhat longer than the latter which makes it appear more graceful. It measures about 18 cm-25 cm in length and stands at 10 cm-14 cm high. The female is comparatively larger than the male in all species with an average weight of 68 gm for female and 48 gm for male. Its bill is slender, short and straight with a well defined groove near the base of the nostril. The legs are very peculiar in having either lobes or stripes of skin edging their toes. The anterior toes are bordered throughout by a web and are divided into lobes like that of coots and grebes. All phalaropes possess a dull winter plumage—gray above and white below, in both the sexes. During breeding period, plumage colouration is somehow changed to more colourful in males than females (Fig. 3).

Courtship and breeding behaviour

In the whole avian kingdom the

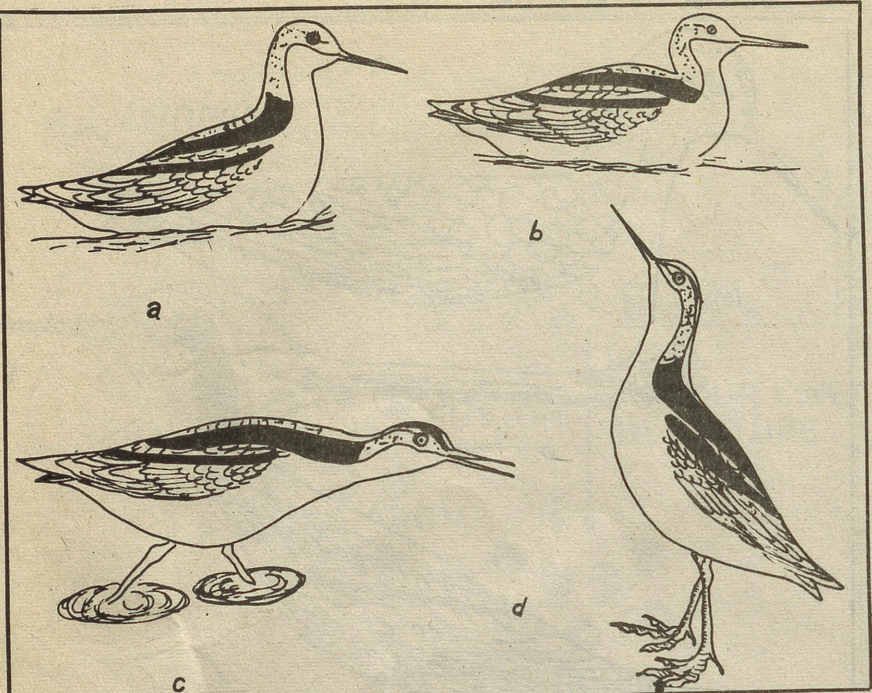


Fig. 4. Postures of phalarope during courtship. (a) Swimming with head up; (b) A threat posture; (c) When another female phalarope approaches. While walking, the female assumes a different threat posture to ward of intruder; (d) the head-up pose

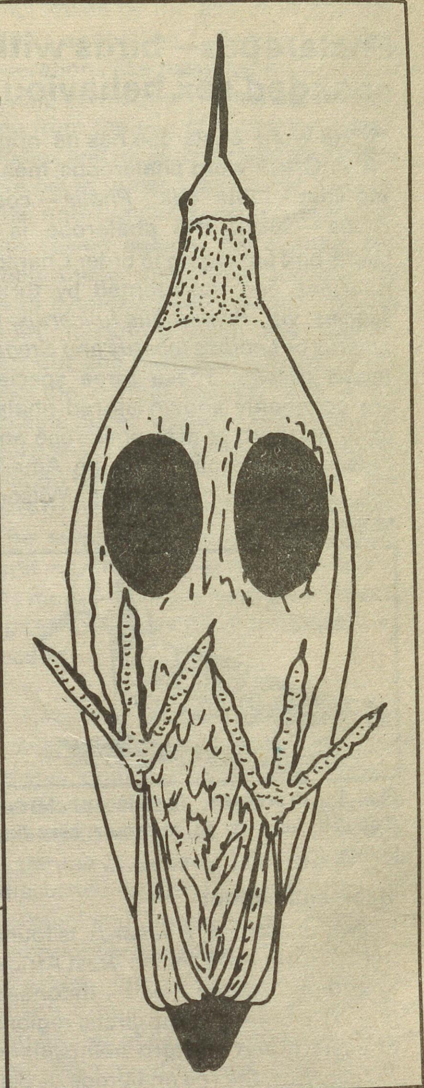


Fig. 5. Appearance of brood patches on the abdomen of the male phalarope before the period of incubation

breeding behaviour of phalarope is very interesting and exceptional. Here the female takes the initiative in courtship and male alone rears the young. The females often arrive at the breeding territory a few days earlier than the males. In a group of birds one sees a female keeping close to a particular male. She follows him wherever he moves. If any other female tries to infiltrate and woo her companion, she would lower her head and pull it inward till it is scarcely visible. This, of course, is a threat gesture. It sets a stage for a forward lunge. The thretening female swims purposefully towards the intruder with her head down. On reaching close to her rival, she flies at her with her extended neck and dangling legs. Usually the threatened female retreats. Fights are rare, for normally the intruding females give up the attempt and fly away from the claimed territory.

Females are highly choosy or selective for their partner. They choose particular males and ward off other females by threat and if necessary by attack. Thus the male bird becomes accustomed to the company of a particular female and later projects his sexual display towards her (Fig. 4).

Before mating, the two partners face each other with their heads raised and the bills of each one aimed at a point above the others' head. This position is maintained for few seconds showing that no threat is intended. The female then signals for mating by taking a crouching position. The male raises up like a miniature helicopter, hovers over the female's back and mating follows. The raised beak display seems to be a prelude only to the first mating between two individuals, but when they are closer and familiar the practice is discontinued.

Soon after the eggs are laid, the female bird leaves the breeding ground and the male starts incubating the eggs for 21 days. Shortly before the incubation period, the male bird sheds feathers from a particular part of the abdomen forming two oval bare patches. Gradually the bareskin thickens and becomes engorged with blood. This "brood patch" (Fig. 5) enables the male to keep eggs and youngs warm.

Hormones play a vital role in the bird's behaviour. There is as much testosterone in the ovary of the female as in the testes of the male. Evidently, the brilliant plumage of the female phalarope is due to the high production of androgen by ovaries. Moreover, it is only the female hormone in the male which initiates a brood patch for incubating eggs. Thus, although the males and females are generally distinguished morphologically, their physiology and behaviour exhibit the opposite action particularly during the course of breeding phase.

Prafulla Kumar Mohanty
Lecturer
P.G. Department of Zoology
Utkal University, Vani Vihar
Bhubaneswar-751004

Why are insects small ?

INSECTS range in size from small parasitoid wasps 0.18 mm in length to stick insects in some of which the body length exceeds 30 cm. The smallest insects are considerably smaller than the largest protozoa, and the largest far exceed in size the smallest members of each of the classes of vertebrates. As for weight, some insects are lighter than the nucleus of a large protozoan, but it seems that the heaviest living insects weigh not more than 100g. The heaviest invertebrate known is the giant squid (*Architeuthis,* 3,000 kg) and the heaviest arthropod, a spider crab (30 kg).

Considering the number of species in the Insecta and their diversity of form and habitat, it is interesting to speculate why at least in special circumstances they do not achieve greater sizes. It is not unreasonable to expect a general tendency during evolution for the upper and lower ends of the size range of an animal group to increase or to decrease to values at which the benefits of larger or smaller sizes respectively are offset by their inherent disadvantages. It is possibly easier to set the lower size limit as being that which is sufficient to accommodate the numer and diversity of cells—certainly many thousands—necessary to provide for the degree of structural and physiological complexity required by an insect. But what about the upper end size range of insects, and what advantages and disadvantages would accrue if some insects were much bigger than their present forms? It is of interest to examine biological and physical factors that seem relevant to the problem.

The effects of physical factors such as gravity, surface-to-volume ratio and oxygen diffusion vary according to the size of the animal. In particular, it would appear that physical problems associated with the insect exoskeleton tend strongly to limit body size.

Exoskeleton

A comparatively inextensible exoskeleton, such as that of the most arthropods, confers both advantages and disadvantages. Tubular structures are very resistant to twisting and bending, but above a certain size they become disproportionately heavy in relation to their strength. On the engineering analogy of tubular structures being most useful for scaffolding but girders for great weights, it can be argued that an exoskeleton is more efficient for smaller animals and solid bones better for larger ones.

The necessity to moult at intervals exposes all arthropods to hazards. Not only may they die if moulting does not go exactly well, but they are extremely vulnerable to enemies until the new cuticle has hardened. A problem during moulting of terrestrial insects that mounts progressively in significance as body size and weight increases, is the maintenance of shape of the soft tissues immediately after moulting. In the absence of structural support large insects would tend to flatten increasingly as the size increases. Hanging from some object during moulting may offset this factor upto a certain size, but after a critical point has been reached problems due to gravity may prove insuperable during moulting.

Another feature of the insect exoskeleton which may contribute to size limitation is the remarkably efficient water proofing mechanism. This has undoubtedly been of major importance in the evolutionary success of the insects. It may however contribute to the limitation of their size, as it severely restricts the extent to which the body can be cooled by evaporation. Under hot conditions, internal temperatures of active insects may build up until they are nearer to critical limits. Consideration of surface-volume ratios would therefore suggest that smaller insects would be less exposed to this risk.

Body size

Where there is a need to adapt to rapidly changing conditions, an organism with a large population size and a short generation time provides far greater opportunities for evolutionary forces to operate rapidly than does an organism with a low population size and/or a long generation time. This applies even if the inherent variability in both organisms is the same. Compared with most other animals — even other arthropods— the insects are advantageously placed in both these respects. Body size is related to generation time; smaller organisms in general have shorter generation times than larger organisms.

Body size is also related to the quantity of food required. Although large animals require proportionately less food per unit body weight than their smaller relatives, a large animal must nevertheless eat more than a smaller one. Since there are times of food shortage for all animals, this factor would seem to favour smaller over larger animals, all other things being equal.

Respiration

The tracheal (trachea are the air conveying tubes for respiration) mode of respiration in insects may well contribute to limiting the maximum size they can attain. The tracheal system of insects is efficient enough to serve larger insects than those exist today, especially if gaseous diffusion is supplemented by forced ventilation and there is an adequate system of air sacs, and the distances to be covered by diffusion via tracheae and tracheoles are not too large. Nevertheless, there are features of large insects which seem to indicate that respiration may be a factor limiting size. Thus large, active insects, such as dragonflies and butterflies, tend to have their bulk reduced by their bodies being long and slender, and large bulky beetles, such as the 20 cm cerambycid, *Titanus giganteus* (Linnaeus) tend to be very sluggish. the insect's respiratory system thus serves small species admirably at all levels of activity, but is relatively less effective in llarge forms. In contrast with this are large spiders and scorpions whose respiratory system consists of booklungs supplying oxygen to the tissues via the respiratory blood pigment, haemocyanin. These organisms are capable of short bursts of violent activity, but must then rest for several minutes when fresh oxygen is stored in the haemocyanin.

The efficiency of the insect tracheal system has virtually eliminated a function that blood has in many other organisms, namely, the transport of respiratory gases. Thus the circulatory system has not become elaborate, and this may be an additional factor limiting body size.

Overall, it is probable that the essential features of the anatomy and physiology of modern insects, which serve them so well, operate at their best only in organisms of rather small size.

Pushpinder J. Rup
Deptt. of Biology
Guru Nanak Dev Univ.
Amritsar 143 005

Seaweeds as medicine

THE term 'seaweeds' in the present article is confined to marine macroscopic algae only. Marine macroscopic algae, besides being a good source of food, have many important uses such as fertilizer, etc., but their medicinal value is no less important.

The use of seaweeds, particularly the 'kelps' such as *Laminaria, Ascophyllum, Macrocystis, Fucus, Eisenia,* etc., all belonging to Phaeophyta, dates back to 300 B.C. Chinese and Japanese made extensive use of them in the treatment of goiter and obesity because of high iodine content of seaweeds. Iodine is an important constituent of the thyroid hormone and finds a place in the chemotherapy of thyroids. A large number of seaweeds belonging to green and red algae such as *Codium fragile, Codium dichotoma, Grateloupia divaricata, Alsidium, Durvillea* and *Corallina officinalis. Digenea simplex* have long been used in Japanese folk medicine as killers of worms. It yields kaenic acid (2-carboxy 3-carbonymethyl-4-pyrrolidine) a highly priced chemical, whose price is well above Rs. 96.0 per kg and is very effective in the treatment of round worm *Ascaris lumbricoides,* whip worm *Trichuris trichura* and the tape worm *Taenia* spp. Kaenic acid mixed with santonine (a drug obtained from the young flower heads of *Artemisia cine, A. vulgaris, A. maritima* and *A. nilgarica* of family *Compositae)* is marketed as a syrup and is used in the treatment of ascariasis, where the intestinal worm *Ascaris* affects the bowel and may even spread to the stomach, liver and lungs in case of round worm. The drug is also effective in eradicating intestinal infection by whip worm (Trichuriasis) and infection with *Enterobius vermicularis* or with other oxyurids (Oxyuriasis). It is also available in tablet and powdered form in combination with piperazine adipate.

The highly sulphated derivative of polysaccharide laminarin is extracted from *Laminaria* species. *Delesseria sanguinea* has antiblood coagulant property, and according to Kraul (1938), as quoted by J. Tokida (1954) of Faculty of Fisheries, Hokkaido University, Japan, and H. Elsner (1938) and his associates of University Centre of Medicine, Berlin, is even superior to heparin. The sulphated laminarin derivatives could be effectively used as antilipemic agent, i.e., in lowering fatty substances like cholesterol in the blood stream while minimising the risk of the side effects of anticoagulant action. Further researches may lead to its effective use against deposition of fats in the lumen of blood vessels.

Ascorbic acid (vitamin C) is an almost universal component of many seaweeds. Its quantity in *Dictyopteris divaricata,* a brown alga, is 3.01 mg/g Six species of *Dictyopteris,* viz., *D. membranacea* (Okha Port), *D. woodwardii* (Okha Port, Malwan and Krusadai Islands), *D. australis* (Okha Port, Dwaraka), *D. acrostichoides* (Okha Port, Bombay), *D. Muelleri* (Tuticorin) and *D. delicatula* (Cape Comorin, Tuticorin, Pamban and Laccadive-Maldive Islands) occur in India and a survey of their vitamin C content may provide useful data. Laver *(Porphyra)* is also very rich in vitamin C and was extensively eaten by English sailors as antiscorbutic agent to prevent scurvy on long voyages. Seaweeds are also a good source of vitamin B_1, B_{12}, riboflavin, niacin, pantothenic acid, folic acid and vitamin E.

The phycocolloides of seaweeds such as *Chondrus, Gracilaria, Pterocladia* and *Gelidium* have laxative properties and are thus used in the treatment of constipation, stomach aches and ulcers. The main use of agar in pharmaceutical industry is in coating the capsule of medicines, particularly those where it is necessary that the medicine be released slowly in the stomach (time release capsule). South East Asian countries use species of *Acetabularia* (green alga) as curative of gallstone in kidney. *Chondrus* extracts in cosmetic preparation keep skin healthy and free from skin infections and retard natural aging phenomena. *Ulva* species are used in the treatment of burn in some African countries as well as in Japan. *Laminaria* stipes (cylindrical stalk like portion of the thallus in between holdfast and blade) are used in cervical dilation, to open wounds and in inducing abortion.

No potent commercially utilizable antibiotic of seaweed origin is in the market but the search is going on. 3-thiopanes has anti-bacterial properties and has been isolated from *Chondrus californica. Dasya pedicillata* var. *stanfordiana* produces a moderate antimicrobial agent p-hydroxybenzaldehyde. Tetrabromo heptanone from *Bonnemaisonia hamifora* with a wide spectrum of activity against a large number of organisms has been reported from *Laurencia filiformis* and *L. pacifica.* From *Laminaria angustata* a basic amino acid 'laminine' has been isolated which like choline lowers blood pressure. An antitumor compound, tecotrienol (LX), has been isolated from *Sargassum tortile.*

The potentiality of seaweeds as a source of medicine has not yet been fully investigated and there is a vast scope of research in this field. It is likely that in the decades to come many more useful medicines from marine algae will be discovered.

Madhu Changoiwala
Centre of Advanced Study
Deptt. of Botany
University of Calcutta, Calcutta 700019

NEWS & NOTES

Menace of mental illness in India

THE ICMR Centre for Advanced Research on Community Mental Health at the National Institute of Mental Health and Neuro Sciences (NIMHANS), Bangalore, has recently brought out a manual entitled *Manual of Mental Health for Multipurpose Workers*. The manual is written in a layman's language. It touches all aspects of mental health. A total of six to seven million Indians are afflicted with mental illnesses and about ten times that number of mild illnesses. Most of the mentally ill persons are in rural India.

The mental health care facilities available for such a large number in our country are meagre. There are only 42 mental hospitals in the country with about 20,000 beds. More than 50 per cent of the beds are occupied by chronic patients. There is only one psychiatrist for one million people in India as against 50-150 in developed countries.

Mental illness

Mental illness is caused by a variety of reasons. Both biological and environmental (home and social) factors play significant roles. However, more than one factor causes manifestation of an illness. Hereditary factors alone are not responsible for mental illnesses.

Several abnormal changes in bodily and mental functions are seen during a mental illness. Abnormal body functions include (i) disturbed sleep; (ii) less appetite and food intake; (iii) more bowel and bladder movements; and (iv) little sexual desire. Changes in mental functions include (i) peculiar and bizarre behavior; (ii) irrelevent and ununderstandable talk; (iii) exhibition of excessive and/or inappropriate emotions; (iv) poor perception, memory, intelligence and judgement; (v) alteration in the level of consciousness. A patient's individual and social activities are altogether disturbed.

Types of mental illness

Psychosis and neurosis are the two most common types of mental illness. Others include epilepsy, mental retardation and childhood behavioral problems.

Psychosis is a sever type of mental illness in which the patient talks and behaves abnormally because of the severely disturbed function of the body and mind. He loses touch with reality and therefore neglects his needs and does not work. He is not aware of his illness. Sometimes it can be associated with diabetes, high blood pressure, tuberculosis and other diseases affecting the brain.

Neurosis, on the other hand, is a mild type of illness. Unlike psychosis, the patient is in touch with reality but his mental functions are disturbed causing discomfort to him. He is aware of his symptoms and seeks help.

Epilepsy and mental retardation are other conditions related to brain. Epilepsy is marked by attacks in which the patient loses consiousness, falls down and has rhythmic movements of the limbs. Children and young adults are more often affected. Sometimes people, especially children and young women, get attacks which resemble and epileptic attack. This is known as hysterical fit.

Available treatments

Several types of treatments are available. They are drugs (tablets, injections and capsules), ECT (shock treatment) and psychotherapy (psychological help). Co-operation, help, love and affection, support and encouragement act as a catalyst in relieving mental illness.

N.C. Jain
Division of Publication & Information
Indian Council of Medical Research,
Ansari Nagar
New Delhi-110 029

Plants for arid lands–Ask SEPASAT!

AIMING to collect and preserve knowledge on the local uses of plants in their native areas which are being lost as traditional customs collapse, the SEPASAT (Survey of Economic Plants for Arid and Semi-Arid Tropics) Unit of Royal Botanic Gardens, Kew (UK), has been collating information on about 6,000 plants from the dry regions that have been reported to be useful but have not been commercially exploited on a large scale. G.E. Wickens, Head of the Economics and Conservation section of SEPASAT, recently announced through one of its Newsletters, that the long-awaited output programme is now working in anticipation of the types of questions that SEPASAT is likely to be asked. The SEPASAT Databank comprises information held both on computer and in paper files, on filling cards and in a small library of books and articles. The information is mainly compiled by scanning certain classical works in botany as well as the current botanical and agricultural books and journals taken by the library at Kew. It presents data on useful plants of the dry tropical areas that receive less than, 800 mm rainfall per year. Plant uses cited in the botanical, agricultural and ethnobotanical literature have been recorded. Major crop plants are reported to be excluded as they are already adequately covered by existing information systems. But wild relatives of major crop species, as they are of enormous importance in plant breeding for the production of new cultivars that can tolerate diseases and adverse environmental conditions like drought and salinity, are included. Besides, information regarding correct scientific name of a plant species including synonyms, life form, habit, life span, toxicity and environmental requirements like soil pH, salinity, moisture, altitude, frost tolerance, rainfall range, etc., has also been mentioned. In short, SEPASAT can operate as an enquiry unit.

(Continued on p. 269)

MEDICAL NOTES

Advantages of dietary fibre

NUTRITIONISTS have been concerned about the requirements of degestible carbohydrates, proteins fats, vitamins and minerals to plan adequate well-balanced diets. But besides starch and other digestible carbohydrates in the food, there are a large number of indigestible fibrous or viscous polysaccharides called fibre or roughage. Importance of these fibrous materials in the diet has been and still is overlooked. None of the dietary fibres is nutritive, but their presence in diet is necessary for proper digestion and elimination of wastes.

Interest in dietary fibre first grew in 1969 when it was found that cancer and other diseases of the large intestine, common in the West, were rarely seen in tropical Africa. It was suggested that high intakes of dietary fibre protected Africans against these diseases. Interest was further aroused in 1971 by a report that patients with diverticulitis of the colon, previously treated with bland, low-fibre diets, improved greatly when given high-fibre diets. Evidence also came that dietary fibre might reduce the risk of coronary heart disease, obesity, diabetes and other common disorders besides disorders of the large bowel. It was found that the contraction of muscular walls of digestive organs is stimulated by fibres, counteracting the tendency to constipation.

Types of dietary fibre

Plants synthesise a wide range of substances—from simple sugars to several carbohydrate polymers. Among them, starch is almost entirely digested and absorbed from the upper small intestine in animals, while fibrous or viscous polysaccharides that give plants their structure and form are not digested in the mammalian small intestine. In man, they pass unchanged into the colon where they are fermented to a variable extent. These polysaccharides, the indigestible components of plant cell-walls, makeup dietary fibre. The structure of plant cell-wall varies from plant to plant and is also affected by the growing conditions and age. Therefore, their chemical composition also differs. Though quantitatively different for different plants, the macromolecular components of cell-wall consist of fibrillar polysaccharides (mainly cellulose), matrix polysaccharides (pectic substances, hemicellulose and glycoproteins) and encrusting substances (mainly lignin). Physical attributes of fibres in plant cell-walls determine the shape and so the function of the plant and also the effects of dietary fibre on digestion and absorption. The proportion of water-soluble and insoluble fibre, fibre chemistry, particle size and the extent to which the cellular and pore structure of the fibre is affected by processing and cooking, all affect digestion and absorption.

Chemistry of fibre

Cellulose is a polymer of glucose linked by β—(1→4) bonds with molecular formula $(C_6H_{10}O_5)_n$. The cellulose molecule is not planar but has a screw-axis, each glucose unit being at right angles to the previous one. The long chain of glucose units is held together by hydrogen bonding, so cellulose has a three-dimensional structure. This produces strong fibres with great rigidity and tensile strength. Generally cellulose molecule consists of about 10,000 glucose units. Hemicelluloses are branched polymers of pentose and hexose sugars (i.e., xylose, arabinose, mannose, galactose and their uronic acid derivatives). Proportions depend on the plant source. Lignins are polymers of aromatic alcohols; they encrust cellulose and hemicelluloses during secondary thickening.

Pectins are a complex mixture of colloidal polysaccharides; they are partly esterified rhamnogalacturonans with an α—(1→4)—linked D-galacturonan chain interspersed with L-rhamnopyranosyl residues with side-chains which include D-glucuronic and galacturonic acid. Some acidic groups are methylated. Some pectin is extractable from plant tissue by means of aqueous chelating agents, but 20%-30% is closely bound to other cell-wall constituents, especially cellulose. Pectins readily hold water in an interconnecting network.

Gums are water-soluble viscous polysaccharides of 10,000-30,000 units, mainly glucose, galactose, mannose, arabinose, rhamnose and their uronic acids which may be methoxylated and acetylated. Gums commonly used in the food industry are gum arabica, tragacanth, karaya gum, carob gum and guar gum which are obtained as exudates from stems or seeds of tropical and semitropical trees and shrubs.

Mucilages are polysaccharides from seeds and seaweeds used in small amounts in the food industry as thickening and stabillising agents by virtue of their water-holding and viscous properties. The mucilages of some seeds (e.g., isabgol husks) are bulk laxatives made up of highly branched arabinoxylans. Alginic acid from seaweed is a polymer of (1→4)-linked β—D-mannuronic acid or of (1→4)-linked α—L—guluronic acid or a mixture. There are also poly-

Table 1. Effect on taecal weight of added dietary fibre (J.H. Cummings et al., 1978)

Fibre content of diet (g)/day	*Source of added fibre*	*Mean faecal weight (g/day)*
22	fruit, vegetables, creals	95
60	+ bran	197
61	+ cabbage	143
67	+ carrot	189
88	+ apple	203

saccharides containing fucose in seaweed mucilages. The mucilages may be sulphated to a variable degree.

Dietary sources

Vegetables, particularly the leafy ones, fruits, condiments and spices are good sources of fibre. Wholemeal bread provides as much as 8.5 g fibre per 100 g. Brown and white bread provide 5.1 g/100 g and 2.7 g/100 g respectively. Potatoes and other root vegetables provide 1/100 g-2.5 g/100 g, leafy vegetables 2.5 g/100 g - 3.5 g/100 g and fruits upto 3 g/100 g. Calculations from dietary surveys show that average intake of dietary fibre in Europe and North America is about 25 g/day, in Africa, especially in maize-eating communities, intakes range from 50 g/day to 150 g/day. In Asia where rice is the staple diet, the fibre content of diets is in the range of 40 g/day to 80 g/day. There are also large variations in fibre intake between vegetarians and non-vegetarians. For example, vegetarians in India take upto 120 g/day while in non-vegetarians intake is only 10-20 g/day or less. There also exists a clearcut socioeconomic differention. People in the higher intake is only 10g-20g/day or less. There also exists a clearcut socioecomic differentiation. People in higher amounts of leafy vegetables or root vegetables, and so their fibre intake is small. People of low income group, on the other hand, consume high amounts of fibre through leafy and root vegetables in their daily diet. The traditional diets of the Masai tribes in East Arfica and of Eskimos do not contain any fibre.

Fate of dietary fibre

Fibre in the diet may slow down the passage of food in the mouth and stomach and so help promote a sensation of satiety. Also by delaying entry of food into the small intestine it modifies the rate of absorption of nutrients. Dietary fibres slow down movement in the jejunum (the middle portion of the small intestine) by increasing the viscosity of its contents; in this way they may delay absorption of glucose and other nutrients. Virtually the whole of the dietary fibre in food enters caecum unchanged. Lignin and most of the cellulose (50%-90%) pass out in the faeces unaltered. The remaining cellulose and most of the hemicellulose and pectins (72%-97%) are broken down by bacterial fermentation in colon. Energy liberated by fermentation is used by colonic bacterial population for growth. Some of the pentoses and volatile short-chain fatty acids formed are absorbed and metabolised. The gases formed (hydrogen, methane or both) are excreted as flatus. The amount of hydrogen in the expired air reflects the amount of fermentation taking place. Quantity and nature of dietary fibre may determine bacterial flora of colon. The bacterial mass in colon contributes to the total metabolism of the body, like liver and other organs, but its effects are small and importance uncertain.

Benefits of dietary fibre

Constipation. A high intake of fibrous diet prevents constipation. Dietary fibre is the most effective long-term means of increasing faecal output. When subjects on low-fibre diets are given supplements of high-fibre foods, faecal weight increases. A greater intake of dietary fibre leads to a larger faecal mass in one of the two ways. If the extra fibre comes from wheat bran, the predictable increase in stool weight is a function of the water-holding capacity of the bran. This capacity depends on particle size and is reduced by cooking so that more cooked bran is required to produce the same stool bulking effect. If the extra fibre comes from fruits and vegetables, the effect is less predictable. There is a slight rise in stool weight as a result of increased bacterial proliferation during fermentation of fibre. Results of a study made by J.H. Cummings and associates in the United States (1978) have shown that daily faecal weight increases when subjects on low fibre diets are given supplements of high-fibre foods (Table 1). Faecal output varies with the source of supplement. The best supplement is coarse wheat bran but isabgol is also highly effective and much more palatable and acceptable to the elderly.

Diverticular disease. Colonic diverticula is a condition frequently found in aged persons. It is usually a symptomless condition, but often leads to spasmodic pain in the abdomen that is relieved on passing a pelleted or ribboned stool. A high-fibre diet is effective in reducing the condition. Coarse wheat bran (15 g/day-30 g/day) reduces both pressure and symptoms. The benefit of cereal bran is, however, realised only after several weeks of intake.

Obesity. While there is no evidençe that fibre has a direct effect in promoting satiety, high-fibre diets seem more likely to produce appropriate sensations of satiety because the greater bulk of the food leads to more chewing and slower passage through stomach. Orthodox reducing diets are all rich in fibre. Supplement of dietary fibre with a very low energy diet is desirable to reduce obesity. The recently published Royal College of Physicians' report on Obesity, London, UK (1983) advises men to take fibre, low fat and low sugar diet during slimming or in the treatment of overweight or obesity.

Hypocholesterolaemia. Hypocholesterolaemic effect of dietary fibre has received much attention because there is a strong relationship between the level of serum cholesterol and development of atherosclerosis and myocardial infarction (heart attack). It is reported that dietary fibre increases faecal output of bile acids and reduces serum cholesterol. But some workers have shown inconsistent and often contradictory results.

Diabetes. Diabetes may be controlled by using high-fibre diet and at present high carbohydrate, high-fibre diets are widely used in the treatment of the disease. Diets consisting of less animal fat, less sugar and more of the complex carbohydrates are now recommended for diabetic patients. A high-fibre diet, because of its greater bulk and viscosity, may pass more slowly through the small intestine and thereby delay absorption of glucose which may reduce the risk of developing diabetes.

Untoward effects

Dietary fibres upto 180 g/day do not produce any serious adverse effect on health. But anyone changing suddenly

(Continued on p. 271)

SCIENCE FOR THE YOUNG

Incendiaries

INCENDIARIES are mixtures of chemical substances which are used for the destruction of materials and property by fire.

The use of fire as a weapon for destruction is as old as mankind. The *Mahabharata* mentions about the conspiracy hatched by Duryodhan to burn the Pandavas in the "Wax Palace" constructed from highly combustible materials like lac, oil and jute. It is known to all how Hanuman reduced prosperous and mighty city of Lanka to ashes. The Bible relates how Samson affixed lighted torches to the tails of foxes and released them in the corn fields of Philistines and to the action of water on naphtha and burnt lime.

Growth of icendiaries

There are innumerable instances in history where incendiary devices have been used. The Chinese used incendiaries which were attached to birds and animals. In India tar coated rags were thrown at fortified forts by catapults and oil poured from forts on attackers below, to drive them off. The Greeks used an early incendiary mixture called 'Greek Fire' to defeat the Arab fleet by blowing it from pipes mounted on ships. With the advent of gunpowder in the thirteenth century, the use of short range incendiary devices declined and the enemy could be engaged at a distance by the rocket which carried an incendiary projectile.

By World War II, the major powers had developed incendiaries into important weapons of strategic warfare. Large scale incendiary attacks broke the will of the Axis even before the advent of the atom bomb. In the closing stages of World War II, the Japanese launched several thousand baloons carrying incendiary devices towards North America to carry the war into the American territory. Although such a concept appears preposterous, some baloons did cross the Pacific Ocean covering thousands of kilometers and caused damage to life and property. As of today, incendiaries have not only been used in large quantities in all major conflicts, but have found other civil uses also.

Types of icendiaries

The ancient incendiary formulation "Greek Fire" was a crude mixture of saltpetre with combustibles like volcanic dust, animal fat, etc. However, modern incendiaries are very efficient agents and burn with a powerful exothermic reaction.

The incendiary agents can be divided into two main types —those that require an igniter for their functioning (non-pyrophoric) and those that burn spontaneously in air (pyrophoric). In the former type are grouped the metal incendiaries, the oil incendiaries and the mixture of oil and metal incendiaries.

Metal incendiaries include various metals like magnesium aluminium, magnesium-aluminium alloys, thermite, etc. Metals when raised to the temperature of ignition melt and produce very high temperature. The scattered metal pieces or the flowing burning metal ignite the surrounding combustibles. Fire fighting is difficult because the burning metal reacts with water and carbon tetrachloride (CTC) tc form toxic gaseous products. Table I gives the heat c combustion of a few metals.

Thermite comprises a mixture of powdered aluminium (27%) and iron oxide (73%) or other metal oxide. When it is ignited, it liberates a large amount of heat, the reaction is depicted as:—

$Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe \quad \Delta H = 800$ calories per gram.

Under favourable conditions, the thermite reaction produces temperature around 2000 °C and thin sheets of metal can be perforated by hot molten metal.

Gasoline, kerosene, blends of hydrocarbons, readily inflammable liquids and thickened hydrocarbons are included amongst oil incendiaries. Hydrocarbons release large amounts of energy when ignited in air, heat of combustion of gasoline is 10,400 calories per gram. Molotov Cocktail is an incendiary device utilising hydrocarbon. In 1952 Louis Fieser used a mixture of aluminium soaps from naphthenic acid and fatty acids of coconut oil to gel gasoline into a sticky mass called napalm. Today napalm is a general name for thickened oil incendiary and several new thickeners and additives are in use. Even though napalm is a very good, all-purpose incendiary, it has very little penetration.

Oil and metal incendiaries are mixtures of metals (like magnesium, magnesium oxide) with oxidisers and hydrocarbons. As these formulations contain both metals and oxidisers, condensed phase reaction products are obtained and the resulting heat flux conducted to target is increased.

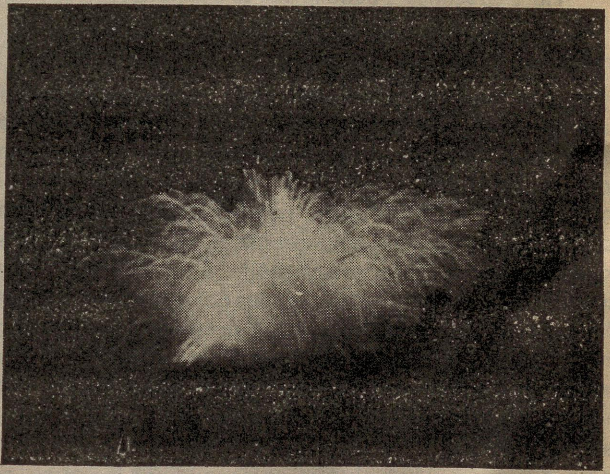


Fig. 1. Incendiary on initiation

Pyrophoric incendiaries are capable of igniting spontaneously in air and do not require any ignition device. White phosphorus, zirconium, titanium, triethyl aluminium, etc., are spontaneously inflammable.

Requirements of incendiary formulations

The incendiary mixture should have either a very high temperature of combustion or a persistent flame effect. The rate of heat released by incendiary mixture depends on factors like:—

(a) Decomposition temperature; (b) Particle size. It controls surface to volume ratio of incendiary agent; and (c) Oxidising agent blended with combustible materials (It increases rate of heat evolution).

The incendiary must be capable of heating the target (fuel) until its ignition temperature is reached. The normal ignition temperature varies from 200 °C—440 °C, and to be effective the incendiary could generate at least four times the heat to raise the temperature to this point. Fig. 1 shows the incendiary at the time of initiation while Fig. 2 shows the secondary burning of the combustibles.

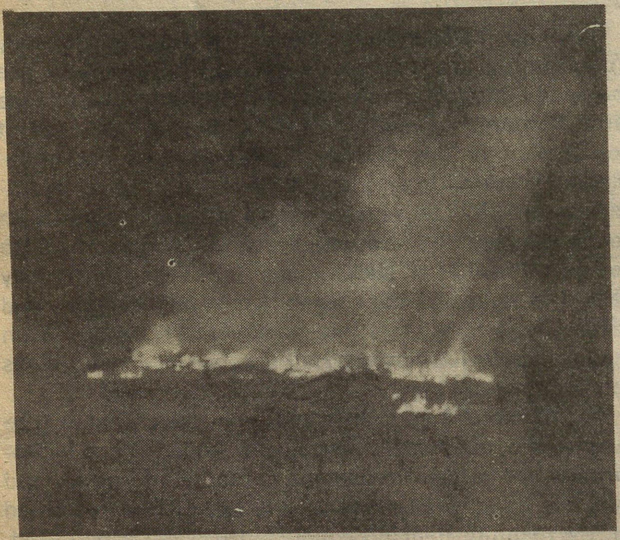


Fig. 2. Secondary burning due to incendiary

Present and future developments

Major effort is being expended in the development of superior napalm with greater stability and low temperature applications. New hydrocarbon gelling agents have been synthesised aluminium 2-ethyl hexanoate, aluminium di and tristearate, aluminium palmitate and aluminium octanoate are potential gelling agents. Pyrophoric metals like zirconium, titanium, misch metal, depleted uranium as incendiary components of projectiles have been the subject of intense study. New pyrophoric compounds are being investigated. When spontaneous inflammable liquids like triethyl aluminium and diethyl aluminium chloride are thickened using polyisobutylene, the resulting product is called thickened pyrophoric agent (TPA). This material is being currently used abroad as incendiary because of advantages like long shelf life and prepackaging ability

Peaceful uses

The thermite process can be used for producing molten iron or steel for welding and repairing a wide range of items.

Table 1. Heat of combustion of some metals

Sl No	Metal	Heats of combustion (calories/gm)
1.	Aluminium	7000
2.	Beryllium	15000
3.	Magnesium	6000
4.	Silicon	7200
5.	Titanium	4600
	Zirconium	2800

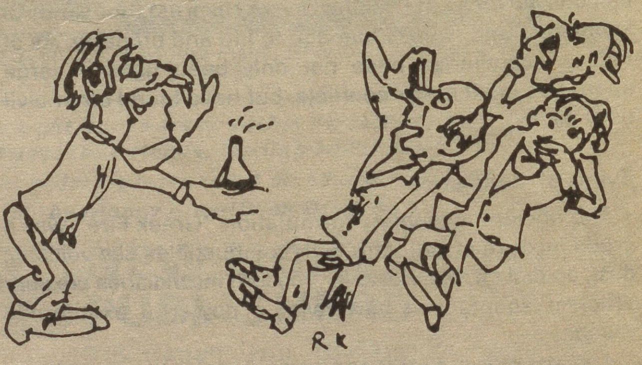
Some examples are repairing heavy machine parts, rail weldings, forgings and large pump housings. A very large tonnage of a number of carbon free metals and alloys are being made by a variation of this method in countries where there is a shortage of hydrothermal power, as the process utilizes the energy of a chemical reaction and is very rapid. Chromium, vanadium, manganese, molybdenum, zirconium, boron-titanium and a number of manganese-copper, manganese-zinc, ferro-titanium alloys are being produced. Slow burning thermite in a cartridge form has been used for heating cans of food in expeditions.

Amarjit Singh
P.K.Mishra
Explosives Res.& Dev.Lab
Pashan, Pune-21

Chemistry quiz through cartoons

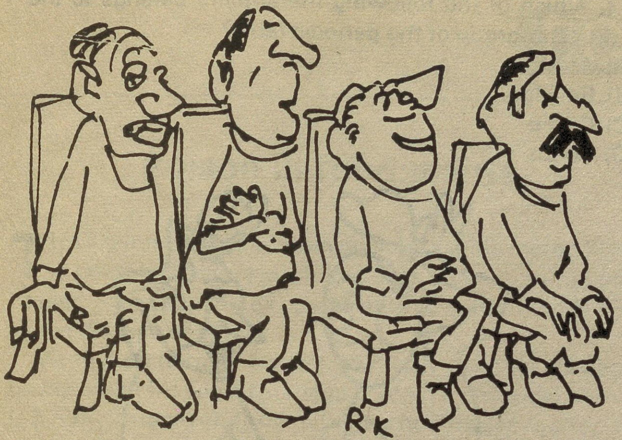
1. The compound having the most offensive odour is

(A) aniline (B) carbylamine
(C) chloroform (D) hydrogen sulphide

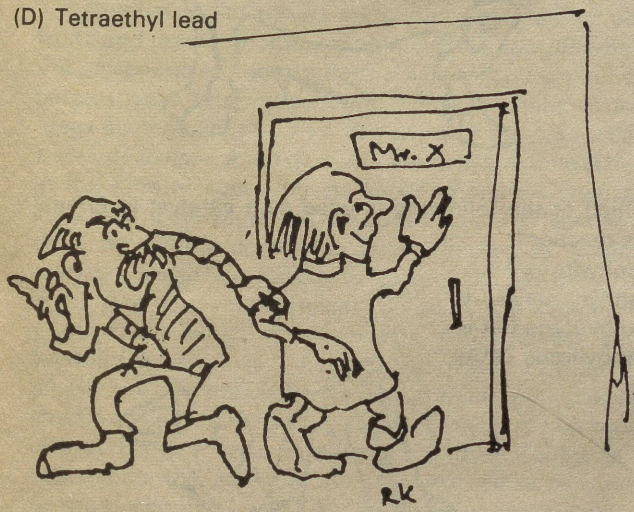


2. Which of the following is an odd amongst others?

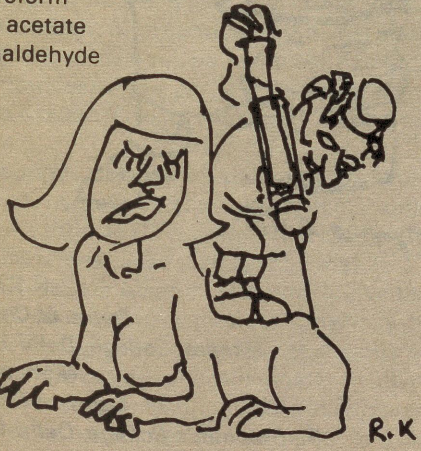
(A) $CH_3.CH_3$
(B) $CH_3.CH_2CH_3$
(C) $CH_3.CH{=}CH_3$
(D) $CH_3.CH_2CH_2CH_3$



3. Which of the following is used as an anti-knock compound?
(A) 1, 2-Dibromoethane
(B) n-Heptane
(C) iso-Octane
(D) Tetraethyl lead



4. Which of the following compounds is used as an anaesthetic?
(A) Acetylene
(B) Chloroform
(C) Ethyl acetate
(D) Formaldehyde

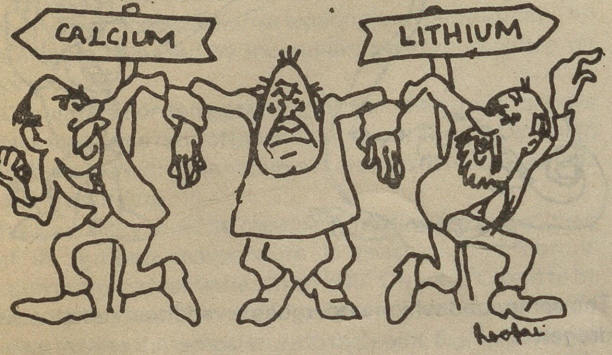


5. Which of the following is fire-resistant?
(A) Asbestos
(B) Dolomite
(C) Gypsum
(D) Soda glass

6. The compound which undergoes an addition reaction with hydrogen is
(A) C_2H_2
(B) C_2H_6
(C) C_3H_8
(D) C_4H_{10}

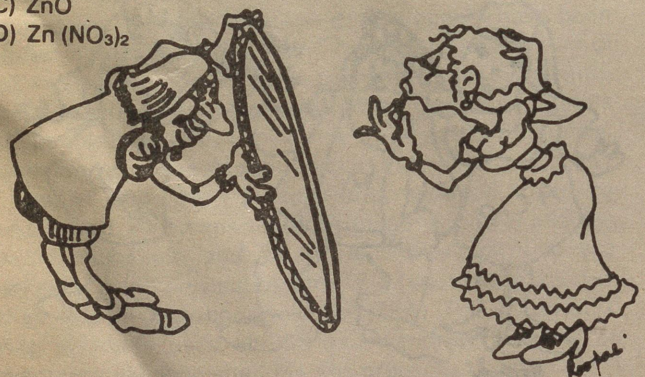
7. Which of the following metals reacts with both acid and alkali solutions?
(A) Aluminium
(B) Copper
(C) Iron
(D) Magnesium

8. Which of the following elements reacts the way calcium and lithium do?
(A) Al
(B) Fe
(C) Mg
(D) Zn

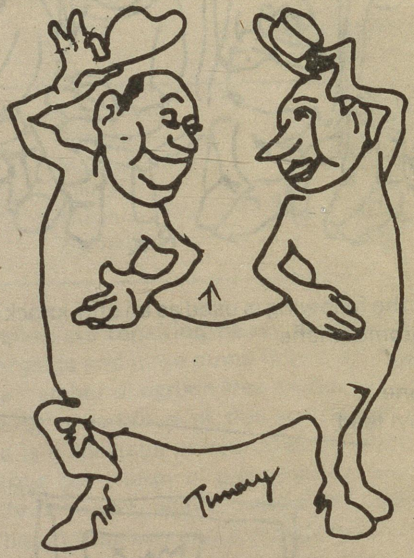


9. Which of the following metals has the highest density?
(A) Ag
(B) Al
(C) Mg
(D) Zn

10. Which of the following compounds is used for silvering of mirrors?
(A) AgBr
(B) $AgNO_3$
(C) ZnO
(D) $Zn(NO_3)_2$



11. Which of the following metal-pairs belongs to the same sub-group of the periodic table?
(A) Al-Mg
(B) Be-Mg
(C) Cu-Fe
(D) Fe-Zn



12. Which of the following is used as a catalyst in Friedel-Crafts reaction?
(A) Anhydrous $AlCl_3$
(B) Anhydrous $AuCl_3$
(C) Anhydrous $CaCl_2$
(D) Anhydrous $ZnCl_2$

R.K. Trikha
Deptt. of Chemistry
Hansraj College, Delhi 110 007
Mohan Katyal
Deptt. of Chemistry
St. Stephen's College, Delhi 110 007

Poison in food plants

THAT our food may contain poisons seems incredible. It is believed that natural foods are safer than the processed ones, but some constituents of natural foods may cause disease or death.

Many members of *Cruciferae* family such as cobbage, turnip, mustard seed, rutabaga contain a chemical named L-5 vinylthioxazolidone which encourages goiter by preventing the thyroid gland from using iodine present in normal diet. It inhibits formation of thyroid hormone. These plants can cause goiter to develop when consumed in large quantities. Soyabeans and red scales of groundnut, if consumed in plenty, are found to produce goiter.

A number of species of the genus *Solanum* including fruits and tubers of ordinary potato *(Solanum tuberosum)* are poisonous as they contain a highly toxic solanine. In potato tubers, solanine accumulation is maximum in green areas such as 'sun burned' spots which are produced on exposure to light. A dangerous amount of solanine is found at the time of sprouting, so spoiled potatoes should be discarded. When potatoes are boiled, solanine leaches out or is potentially destroyed. Green berries of *Solanum nigrum* are also harmful due to solanine but, when ripe, the amount of its toxin decreases. Solanine is a saponin like glycoalkaloid which on hydrolysis yields sugars and a saponin-like alkaloid. It has an irritant effect on mucous membrane of alimentary tract and on absorption into blood stream brings about haemolysis of red cells. It also causes stimulation of central nervous system followed by depression and even paralysis of respiratory and motor centres. About 30 mg/100 gm body wt. is needed for poisoning to occur.

Spinach *(Spinacia oleracea)* is perhaps the commonest herbage vegetable. However, a large amount of spinach in diet leads to a low level of calcium and prevents absorption of needed calcium. Oxalic acid present in spinach combines with calcium in the blood and forms insoluble calcium oxalate crystals. Man cannot excrete this salt and hence its formation is considered pathological. Extracellular urinary calculi (stones) often partly or entirely are composed of calcium oxalate. Lack of calcium in blood however results in coma.

Compounds capable of yielding free hydrocyanic acid (HCN) on hydrolysis are surprisingly common in food plants. As little as 0.06 gm of HCN may cause death of a man. The largest dose tolerated by man is 0.15 gm. Lima bean *(Phaseolus lunatus)* is a widely planted pulse food crop but some of its varieties, expecially those having coloured seeds, are occasionally poisonous and contain a cynogenic glycoside phaseolunatin. In some countries restrictions are placed on the sale of coloured variants of these beans. Varieties with white seeds seldom contain harmful quantities of glycoside. Proper cooking destroys the glycoside entirely. Yield of HCN from Bengal gram, *arhar*, peas and kidney bean *(Phaseolus vulgaris)* is negligible. Seeds of apples, cherries, peach, apricot and some varieties of almond have a high concentration of hydrocyanic acid. **Some other cyanide producing plants are maize,** sorghum, sugarbeet and lettuce.

Crippling disease, especially in different parts of M.P., is associated with the consumption of Khesari dal *(Lathyrus sativus)*. The principal causative factors of this disease have been identified as B-N-oxalylamino-L-alanine and a glycoside of diamino propionitrile. The intake of freshly cooked broad beans *(Vicia faba)* have caused haemolytic anaemia in some persons. Djenkol bean *(Pithecelobium lobatum)* causes kidney failure because of the presence of toxic amino acid, djenkolic acid.

Recently even components of substances (such as spices) generally regarded as safe have been reported to pose special problems. Some other antinutritional factors are phytic acid in rice grain, flatulence (feeling of discomfort caused by accumulation of gas in the alimentary canal) causing factors in legumes (Bengal gram, soyabean, lima beans and kidney beans), antivitamin factors in kidney bean and soyabean, and potential carcinogenic factors in black pepper.

It has been estimated that by the age of 50 years, every man has eaten 10 tons dry wt. of food. Even though the concentration of poisons is generally low, their cumulative intake could be sufficient to cause problems. Much experimentation is necessary before one can make definitive statements on health hazards caused by naturally occurring chemical compounds in our food plants.

Jasbir Kaur
Deptt. of Botany
PAU, Ludhiana-141004

NEWS AND NOTES *(Continued from p. 261)*

SEPASAT can provide a list of information of all the useful plants in the dry, tropical zones which obviously include some parts of India.

The information from the SEPASAT Databank is free of charge to national and international non-profit making organisations. However, neither SEPASAT nor Kew can be held responsible, for any adverse reactions that may arise from the use of plant included in the SEPASAT Databank.

Onkar J. Chakre
Wealth of India-
Monographs, PID (CSIR)
New Delhi-110012.

ENVIRONMENT

Acid rain and its effects on fish and wildlife

ACID rain usually refers to any precipitation having a pH of less than that of normal rain water, which is presumed to be around 5.6. In simpler terms pH is a quantitative expression for acidity or alkalinity of a solution, i.e., concentration of hydrogen or hydroxyl ions. Theoretically pH is defined as the negative logarithm of hydrogen ion concentration in grams per litre. Since pH scale is logarithmic there is a tenfold difference between adjacent numbers. For example, water at pH 3 is 10 times more acidic than water at pH 4, and 100 times more acidic than water at pH 5.

Normal rain water is weakly acidic because atmospheric CO_2 combines with rainwater to form weak carbonic acid. Acid rain is the result of a series of complex reactions in which sulfur and nitrogen oxides combine with rain water to form sulfuric and nitric acids, which are much stronger acids than naturally occurring carbonic acid.

Substantial amounts of sulfur and nitrogen oxides are released to the atmosphere by several natural processes and industrial activities. Natural phenomena such as volcanoes, forest fires, lightning and the decomposition of organic matter release large quantities of these oxides into the atmosphere. Human related activities such as fossil-fuel burning and transportation release large amounts of these oxides. This is more so in heavily industrialized and urbanized areas, where emissions of sulfur and nitrogen oxides into the atmosphere is estimated of being more than 10 times greater from human activities than from natural sources. In the U.S. alone about 2/3 of the land area receives acid precipitation. Scientists believe that wind currents and storm tracks transport air borne pollutants from the area of origin to elsewhere. This fact has led to several international controversies also.

Most if not all areas are susceptible to acid rain. The buffering capacity of water or soil determines its susceptibility. In general, the lower the buffering capacity of a soil or water, the greater its sensitivity to acid rain. Surface waters with low calcium carbonate levels (10 mg/l or less) are considered potentially sensitive to acid rain

The acidification of any freshwater system is a slow and gradual process, which remains subtle and undetected until damage has occurred. However, in the ecosystem several noticeable changes occur, and they may serve as indicators of zooplankton and other fish food items may show a aquatic organisms may serve as indicators. The production of zooplankton and other fish food items may show a decline. Fish species also differ considerably in their tolerance to low pH. Decline in larval fish number may be an early evidence of acidification, because early life stages are more sensitive to low pH than older fish of the same species. Identification of lakes and streams undergoing early stages of acidification is also chemically possible. Excess sulphate concentrations, reduced alkalinity and increased aluminum concentrations can provide signals before marked pH decreases occur.

Acid rain has several effects on fish and fishery resources. Fishes after spawning or overwintering are particularly more sensitive to low pH. Fishes well established in lakes and streams that have acceptable pH levels may be subjected to severe stress following heavy summer rains or spring snowmelt, with its accumulated acidity. In temperate waters fishes trapped in surface layers of frozen streams or small lakes are particularly susceptible during the first major thaw.

Fish kills are a common feature in highly acidified waters. The process of acidification may force the fishes to move out of the area. At sublethal levels, fishes may fail to reproduce as they suffer stress. The population may become gradually extinct because of negligible recruitment of young fish to replace older ones as they die. Continuous chronic exposure to acidified waters can also result in reduced growth rates, impairment to body organs, and a decrease in resistance to environmental stress and diseases. Fish populations may decline because of mortality brought about indirectly. Fishes in acidified waters may die of accumulation of heavy metals. Shortage of the preferred food items of the fish may also play a role in the decline of fish population. Eventually, the physiological stress caused by acid conditions leads to gradual extinction of the fish species.

Acid rain affects wildlife, but not as apparently as fishes. Nevertheless many direct and indirect effects of acid rain on productivity and survival of wildlife populations have been documented. Acid rain can directly affect eggs and tadpoles of frogs and salmanders that breed in small forest ponds. It is even postulated that acid rain can indirectly affect animals at the top of the food chain because of bioaccumulation and biomagnification of metals through food chain. Wildlife is also affected indirectly by the loss and alternation of food and habitat resources. Considerable damage to plant communities is also reported. As plants and wildlife are directly related any effect on the former will be disadvantageous to the latter.

Major effects of acid rain cannot be abated without managing the source of pollution. However, some measures may be taken locally to counter acidification of streams, lakes and ponds. Addition of calcium carbonate or calcium oxide to acidified waters (liming) is one of the common practices for raising the pH of these waters. As a management measure acidified waters may be stocked with hatchery-raised hardy fish species. This replenishes the stock that would otherwise decline.

(Continued on page 273)

SCIENCE IN INDUSTRY

Fire retardant for tents

To reduce fire hazards in tents/shamianas, the Central Building Research Institute (CBRI), Roorkee, has developed a chemical treatment which would make the canvas of tents/shamianas retard fire.

The CBRI process consists of treating the canvas with a suspension of a finely divided antimony compound and a halogenated co-polymer alongwith glow retardant and plasticizer in an organic solvent. The canvas, after treatment, is dried at 60°C for about an hour and hot pressed. A chemical loading 45%-70% add-on is adequate to bring about an effective fire retardancy.

Specimens of treated canvas when tested as per BS 3119 (by fixing vertically, igniting with Bunsen burner and exposing for 12 seconds) did not catch flame after the removal of the burner.

Untreated specimens caught fire immediately and burnt completely within 12 seconds. The tensile strength of the treated fire retardant canvas was found to be enhanced by 18%-20% in both warp and weft directions. The cost of the treatment works out to be about Rs 20/m^2.

Rice flake production

THE Central Food Technological Research Institute (CFTRI), Mysore, has made improvements in the traditional rice flake-making technology, which result in increased production and improvement in quality of the product.

In the traditional technique, flaked rice is made by first soaking paddy overnight in warm water, and then roasting it with hot sand in a *bhatti* for a few minutes. The roasted paddy is then passed repeatedly through an edge runner mill having a single idle roller for removing the husk and bran layers and flattening the kernel simultaneously. This method gives only 61%-62% yield mainly because of the severe action of the edge runner, which not only chips away the edges of the rice flakes but also causes a high percentage of breakage.

CFTRI's studies have shown that the yield of flakes can be increased by 1%-2% by optimization of the soaking and roasting steps and the precise control of the preflaking resting time. By providing an additional idle roller to the traditional edge runner, flaking time can be reduced and the yield can be further increased to about 65%.

Further improvements are possible by separating the dehusking and debranning operations from the flaking operation. One method which gives about 68% yield is to dehusk and debran roasted paddy by passing it through the edge runner mill for a short period and then flaking it in a heavy duty roller flaker such as is normally used for making corn flakes.

Another method, which can be employed as a continuous process, gives an yield of almost 70%. It consists of roasting soaked paddy in a continuous gram roaster, followed by dehusking in a paddy sheller, and a gentle polishing in a rice polisher. The polished rice is then flaked in the roller flaker.

Flakes produced by the continuous process are brighter, more chewy, and also puff better than the traditionally processed products when heated in oil.

Polymer/rubber-bitumen blends

BITUMEN used in a bituminous surfacing mix should be able to resist plastic deformation at high road temperature and brittle cracking at low road temperature. Commercially available penetration-grade bitumens used at many sites in the country are not able to satisfy both the requirements, resulting in premature failure of bituminous surfacing. The fatigue life of a bitumen mix can be increased by making it somewhat more resilient. The Central Road Research Institute (CRRI), New Delhi, had carried out laboratory studies with a view to modify temperature-viscosity characteristics of bitumen and to improve resiliency characteristics of bituminous mixes by incorporation of polymers in small quantities (2%-10%) in bitumen. The various polymers studied included polythylene, styrene-butadiene-styrene block copolymer, ethyl-vinyl acetate copolymer, ethyl-vinyl acetate and natural rubber latex.

The incorporation of polymers resulted in an increase in the viscosity values of bitumen at high temperatures leading to an improvement in stability and fatigue characteristics of the bituminous mixes.

Answers to chemistry quiz

1. B, 2. C, 3. D, 4. B, 5. A, 6. A, 7. A, 8. C, 9. A. 10. B, 11. B, 12. A

ENVIRONMENT *(Continued from page 272)*

Control of fossil-fuel emissions, enforcement of emission standards and augmenting laboratory research and field monitoring are needed to solve the acid rain problem. Acid rain and its effects will not go away overnight. Increasing public awareness of the problem is the first step toward finding some solution.

C.V. Mohan
Astt. Professor
Univ. of Agricultural Sciences
College of Fisheries
Mangalore-575002

OF LEAVES AND FEATHERS

April's gay apparel

APRIL poses a question. Has summer begun? Many people feel that it has. For the air loses that nice touch it had in March. Coolers are switched on and the demand for ice goes up.

But spring's work is not finished yet. The silk-cotton has blossomed. So have the mango and the kachnar and the palas. And the new leaves of the jamun, mulberry and shesham are still quite fresh and green. Many other trees have, however, yet to leaf and flower.

The peepul sheds its old leaves. On the branches sprout what look like pink and brownish bits of silk. Amidst them are numerous dull green beads, which will ripen into reddish fruit.

Is the pongam sick? All its leaves have yellowed and shrivelled. They cover the tree like a loose, dead skin.

No, the tree is not sick or pestilence-stricken. It is renewing its youth, as it were. As the old leaves go, new ones take their place. Pastel green to begin with, they get a deeper hue in a few days. And among them peep forth small, white flowers, with a dash of pink or violet.

The coral tree is in bloom. Its branches are leafless. For that reason the scarlet flowers look more prominent. You'd say the tree is a many-armed goddess, bearing a lamp in each hand.

For soft splendour look at the jacaranda. So profuse are its blue flowers that hardly any leaves can be seen. The tree seems to be rising like a large flame which is as bewitching as it is soothing.

Much of the neem's old foliage is gone. What remains is all yellow. Softly and slowly the leaves fall all day long. Under the tree and around it the ground seems to be strewn with flakes of gold.

In a fork, amid the long, bare branches of that tree is a nest. It seems to be a messy pile of twigs, with one or two hempen threads hanging. Near it sits a dove. Now and then it coos. Is it asking intruders to keep off?

Above its deep, drowsy-sounding call comes a cheerful voice. It is the warbling of a bulbul. The small brownish bird, black-crested and red-vented, perches on a top branch. It repeats its musical call. Soon it flies to another branch —then off to another tree.

Gulmohur in bloom

Quite many sparrows have built their nests of straw and twigs and threads. Some others are still looking — or fighting — for nesting sites. Niche, shelf, corner, cavity, even an uncared for box or basket—any of these will do.

As the days pass, more and more leaves come forth. The neem too breaks into brownish shoots. The mango carries its old green leaves and also some new ones, of a shiny coppery shade. And a feathery lace of leaflets runs along the thin gulmohur branches.

Meanwhile, the first melons and water-melons arrive. Also loquats and falsas. And the supply of mangoes from the South increases.

If you like flamboyant colours, gulmohur is the tree for you. You cannot miss its red and gold blooms. They greet you from the roadside. They wave at you from a house garden. They stand in front of you on a traffic island.

Amidst all these colours are the splashes of bougainvilleas. White, yellow, purple, brick-red, crimson—you will see all these tints and many more. On the walls, over the arches, up any support they run wild—or is it run riot?

The April sky has its own shades. As the sun sets, the rags of clouds are dyed orange and gold. Dusk makes them dark gray, then light gray, until they melt into the night.

It is cool at this time. Near a courtyard the air is strangely sweet.

Is it perfume from a dress
That makes me so digress?

No. It is the fragrance of that flowering shrub, lady of the night. A breeze wafts it all around. Add moonlight, and you have romance.

Days pass. The sun grows brighter. The blue of the sky turns hazy. Mornings may be cool. But by noon the loo begins, and it blows all through the afternoon.

It is a sly wind. It finds way everywhere, even into rooms. Eyes grow heavy, the mouth feels dry. It takes the glossy look off the leaves. Birds seek shady places. Dogs pant, their tongues sticking out. Buffaloes sit indolently in muddy pools.

Is it the end of April's glory? The month has yet to spring a surprise, its most pleasant surprise. The amaltas, which looked shabby all these days, is a different sight.

New leaves clothe it. And all its branches are hung over with clusters of soft, yellow flowers — flowers of purest gold.

Note: The trees and shrubs are as seen in Delhi. Their leafing and flowering days differ from place to place. Even in Delhi the timing is not strictly the same every year. It may vary from one to two weeks according to the weather.

Kachnar (*Bauhinia variegata*)
Palas (*Butea frondosa*)
Jamun (*Eugenia jambolana*)
Shisham (*Dalbergia sissoo*)
Peepul (*Ficus religiosa*)
Neem (*Azadirachta indica*)
Pongam (*Pongamia glabra*)
Gulmohur (*Poinciana regia*)
Amaltas (*Cassia fistula*)

O.P. Bhagat
New Delhi 110 015

MEDICAL NOTES *(Continued from p. 263)*

from a low-fibre to a high-fibre diet is liable to get diarrhoea and also abdominal discomfort from increased gas production in the colon. In practice, these symptoms are only temporary and disappear when high-fibre diet is continued. But if they persist, the fibre content of the diet needs to be reduced. Large intakes of high-fibre foods lead to higher excretion of minerals and in some circumstances this may be followed by mineral deficiency. Rickets and osteomalacia are common in West Asia, Pakistan and India which may be attributed to diets in which 70% or more of the energy comes from wholemeal bread or *chapattis*. There is, however, evidence that development of these diseases are largly due to the mineral deficiency in the diet rather than its fibre content. In some under-developing countries, delayed puberty and anaemia have been attributed to zinc deficiency, arising from poor absorption of the mineral from a diet containing large amount of coarse, unleavened bread. But recent studies have shown that dietary fibre does not affect mineral metabolism. Potentially much more important is an increased risk of iron-deficiency anaemia which is probably due to heavy menstrual losses. Fibre content upto 100 g/day in the diet can improve the health without any hazards.

B. Mandal
Lecturer in Chemistry
B.N. Mahavidyalaya Itachuna, Hooghly (W.B.)

LETTERS *(Continued from page 204)*

15,000 km by means of some ducted propagation.

S.K. Gurtu
ISSA, Metcalfe House,
Delhi-110 054

Sundarbans tigers

Sir, I was pleased to read the article Sundarbans tigers—why are they man-eaters? by Kalyan Chakrabarti (*S.R.*, August, 1985). The article is informative and the author has successfully tried to explain the reasons why tigers become man-eaters. I would like to add some more information about their habit of man-eating. I think it is a behavioural change that has been developed due to the disturbance in the ecosystem of that region.

The number of fresh water sources near their hide-outs has either gone down or been disturbed. So, they are forced to move out to quench their thirst. For this, they have to travel long distances where there is an increased chance to meet humans. Now once the beast gets the taste of human flesh, it certainly follows the same trail where it can easily get humans.

The second ecological reason for their man-eating habit may be the fall in the population of their favourite prey animal, e.i., wild boar. When the beast does not get its prey animal, it moves longer distances in search of its prey. During this long march, it happens to meet the poor men who are mostly honey collectors, fishermen, shell collectors, wood cutters etc.

M.J. Moonis
Department of Zoology
A.M.U.
Aligarh-202 001.

Science quiz

Sir, In **Science quiz** by V.B. Chimkod (*S.R.*, February 1986), one of the questions was: Which is the fastest flying bird? The answer was Swift. But this is not correct. Actually the fastest flyng bird is the Peregrine falcon. According to bird encyclopedias, it is a large bird 38 cm-48 cm long; the female being larger than the male. The speed of a peregrine's swoop according to recent estimates shows that it may exceed 400 kmph. According to *Reader's Digest Great Illustrated Dictionary*, the bird Swift, achieves speeds upto only 112 kmph.

S. Prakash
Vellalar Street
Mutharasanallur
Tiruchi
Tamilnadu-620 101

Fortified salt

Sir, This is with reference to my article 'Fortified common salt to combat anemia' published in *S.R.*, Jan. 1986. Since many readers have requested for more information on the topic, I have a brief list of references.

1. *Nutritional anemias*, Tech. Rep. Ser. 503: WHO, Geneva.
2. *Am. J. Clin, Nutr.*, 28: 1395-1401, 1975.
3. *Am. J. Clin. Nutr.*, 31: 1112-1114, 1978.
4. *Ind. J. Med. Res.*, 68: 58-69, 1978.
5. *Br. J. Nutr.*, 43: 45-51, 1980.
6. *Am. J. Clin. Nutr.*, 35: 1442-1451, 1982

Jamuna Prakash
Lecturer
Department of Home Science
Manasa Gangotri
Mysore-570 006

BOOK-REVIEWS

☐

THE NIGHT SKY *by* Ian Ridpath, *Collins Gem Guide* (Available from: *Rupa & Co,* 3831, Pataudi House Road, Daryaganj, New Delhi-110002), Pp. 240, Rs. 35.50

FOR a city-dweller, the night sky is of least interest because, apart from so many distractions (or attractions?) of the city life, it is the least seen in his daily life due to his way of life. Moreover, due to the prevailing smoke and dust in a city, the night sky also does not attract his attention as much as it should. See the night sky after a heavy rainfall and one would be amazed to find himself missing so much of it. It would appear as if the entire circular dome of the night sky embedded with millions of twinkling stars, some bright and some dim, had come closer to earth! It is an awe-inspiring and bewitching sight. The night sky is bound to lure him away from earthly distractions forever in his life! Nature in its most elemental beauty can produce such effects on an impressionable mind. But here is a marvellously produced book which would certainly inspire a city-dweller, if not make him a total convert to celestial charm, to peep out of his windows or climb up to a roof-top to observe the night sky in all its splendour. It is popularisation of astronomy at its best.

The entire sphere of the night sky is divided into 88 groups of stars, known as "Constellations". These constellations are of varying sizes and shapes with 88 different names of objects, both animate and inanimate, found on earth. Leaving aside the unknown reasons behind their arbitrary-looking groupings of stars and their names, most of the constellations, if not all, are an amazing spectacle to behold. It is fun to spot them and then examine in details their structure. In the process, one discovers a large number of stars, some famous and some not very famous. And if one has a pair of binoculars or a telescope at hand, one can examine stars further and discover not only variable stars, giants, dwarfs, etc., but also nebulae, clusters, galaxies, etc., which look like stars to naked eye.

Night sky-watching is a hobby which is entertaining and educative. It can also give one a thrill of discovery. The book under review gives a brief introduction to the subject in the beginning. Then it gives a series of maps which gives the positions of all constellations with respect to each other. Maps of the constellations follow in alphabetical order on the right hand side pages. Their details appear on the left hand side pages. The types of stars and their positions with respect to the Milky Way, ecliptic, etc., are also clearly given in the maps. The biggest advantage of this book over so many others available in the market is that it is of pocket size and quick to refer to. Standing in cold of the night atop a roof with a pair of binoculars or a telescope in one hand and a torch in another to refer to a book, it is a blessing. The price of the book should not deter any stargazer from buying it because its beautiful and clear maps, compact information and handy size make it worth possessing.

Dilip M. Salwi

☐

SCIENCE IN INDIA—50 YEARS OF THE ACADEMY
Edited *by* C.N.R. Rao and H.Y. Mohan Ram, *Indian National Science Academy,* Bahadur Shah Zafar Marg New Delhi-110002, Pp. 142, Rs. 110

MORE than 50 years ago, the Indian Science Congress Association passed a resolution to form an all India body of scientists with the objective to promote growth of science in the country and to harness scientific knowledge for national welfare. Thus came into being the National Institute of Sciences of India with its headquarters at the Asiatic Society of India building in Calcutta. But with the Independence of India, as all major scientific policy-making activities began to shift to the capital of India, the institute was shifted to New Delhi in 1951. About twenty years later, the name of the institute was also changed to the Indian National Science Academy. Today, it is one of the pioneering scientific bodies in the country with its aims and aspirations continuing to take into its fold most, if not all, the science-related aspects of the changing Indian milieu. It celebrated its silver jubilee with much enthusiasm and sobriety only the last year. On the eve of that occasion, the book under review was released. It is a very well produced reference book which gives a brief idea of how science and technology developed in the country, especially in the last 50 years. With its beautiful, glossy jacket, excellent photos and sketches, attractive layout and easy style of text, it is perhaps one of the best books ever brought out by any science institute or academy in the country. It is a sure buy for anybody who wants to keep a tab on science in the country, although for obvious reasons it is expensive.

The book starts from the very beginning of the civilization in the Indian sub-continent, highlighting sketchily the significant contributions of ancient Indians in various fields of science and technology. It then goes on to the major contributions made by Indians or Europeans who lived in India to various aspects of science to date. In the process, it also traces the history of various pioneering institutes and organisations in the country. Thereafter, the book switches over to the current status of science development in the country, whose growth could be traced to the blueprint that Pandit Jawahar Lal Nehru made soon after the Independence. It gives briefly, one by one, how a particular organisation came into being and its present structure, with an introductory overall picture of the scientific and technological developments in the country since Independence. In the last, the book gives a brief idea of the Academy itself, its history, its organisational structure and its activities, past and present. It also gives a list of its Fellows and photographs of the past Presidents.

One thing this reviewer could not however understand. Why has the title of the book "Science in India" been clubbed with "50 years of the Academy"? It gives the impression that the book is about developments in science in the country which could be directly attributed to the Academy during its last 50 years of existence.

Dilip M. Salwi

DEMON IN THE SKULL (a revised version of A Plague of Pythons) *by* Frederik Pohl, *Penguin Books* (Available with: *Penguin Overseas Ltd.*, 706, Eros Apts, Nehru Place, New Delhi-110 019) Pp. 171, £. 1.95.

WHAT is Science Fiction? It is a question which is usually answered with differing opinions. Science fiction is, to put it very simply, a story woven around a novel scientific idea. It varies from hard core science stories to pure fantasy. In many of the present day science fiction books, the scientific idea is either too simplistic or is just a ploy to go under the name of science fiction. Some of them have a formula mixture of horror, violence and sex. Fortunately, the book under review does not belong to such a category.

The backdrop for this story is a partially destroyed world of the post-war period. The author must have conveniently imagined a limited nuclear war! Chandler is an electronics engineer working in an antibiotics plant in California. He commits a rape and murder of a co-working girl, of course, under possession. He is exiled and branded a 'Hoaxer,! Koitska, a Russian, plans to control the minds of the people with the help of a master transmitter and thus rules the whole world. Long live the much written about idea of the 'ultimate world domination'! He commands an executive committee under him, called the Exec, whose members wear a coronet which gives them extraordinary power to control and kill their subjects by migrating into their minds. Chandler, a witness to this horror, hates the ways of the Exec. His services as an electronics engineer are used by Koitska in constructing a duplicate of the master transmitter. The author has vaguely proposed a submillimeter radiation principle underlying this mind control business.

Chandler finds a friend in Rosalie Pan, an ex-singing star and a powerful member of the Exec. She helps him become a member of the Exec. Chandler gradually began to think like an executive. At the end he gets a chance to overpower a dying Koitska and dons his coronet. Now our hero takes revenge, trying to kill all the Exec members, one by one. Having tasted the power, he reconsiders his earlier decision of destroying all the installations and retains his coronet.

At first the story moves very slowly and without a direction and as the title of the book suggests it looks like a ghost story. However, thankfully, the book has nothing to do with demons and pythons. Fantasy also demands an element of convincibility, which the story is found to be lacking. The most interesting part of the story is at the end when the till-now-oppressed man suddenly becomes the oppressor and rationalises his act. The human weakness for falling pray to power is showed effectively. The story is based on the dictum—'power corrupts and absolute power corrupts absolutely'. The book, of course, is good reading material blended with a few unconvincing and unearthly characters.

K. Rajagopal

GENETICS *by* P.K. Gupta, *Rastogi Publications,* Shivaji Road, Meerut-250002, Pp. 659, Rs. 49.50.

THE science of genetics has made tremendous strides in recent years. The last three decades have witnessed some of the most exciting discoveries in this field. Almost every week some new findings are being published in reputed journals. For such a subject to understand, students need to have a good text book. The book under review has fulfilled this lasting demand to a greater extent.

About half the chapters out of a total of 33 cover basic and fundamental aspects starting from Mendels laws of inheritance, physical basis of heredity, linkages and crossing over in chromosomes, structural and numerical changes in chromosomes, to the determination of sex and sex-linked, sex influenced and sex limited traits. Cytoplasmic inheritance, and mutations at phenotypic, biochemical and molecular level are appropriately dealt with. A full chapter is devoted to plasmids and transposons. Since the discovery of structure of nucleic acids in 1953 by Watson and Crick, the whole concept of gene has changed and attracted attention of geneticists, biochemists and molecular biologists alike. The fine structure of gene, its chemistry, and the chromatin structure has been covered in detail. The expression of genes vis-a-vis protein synthesis and its regulation in both prokaryotes and eukaryotes, and the genetic code form the subject matter of a few chapters. The artificial synthesis of gene has opened up new avenues for research and has led to the formation of subjects like genetic engineering and biotechnology. The application of genetic tools for the welfare of human race, particularly in medical science and in agriculture for the improvement of crops has been summed up well.

At the end of each chapter problems are given to ascertain whether the basic concept has been understood or not. Good illustrations are given at proper places. Important references for more details are given at the end. The language of the book is easy to understand, but at few places it is rather complicated and needs simplification. There are obviously some printing errors here and there. Overall, the book is well written for honours and post graduate classes. It is reasonably priced.

K.Y. Kavathekar

A TEXTBOOK OF PHYSICAL CHEMISTRY *by* A.S. Negi and S.C. Anand, *Wiley Eastern Limited,* 4654/21 Daryaganj, New Delhi 110 002, 1985, Pp. vii+961. Rs. 50.00

A large number of books are available on physical chemistry but only a few provide students the latest trends and developments on various topics of the subject in a simple manner. The authors have brought out an uptodate textbook for degree students of Indian universities incorporating all the changes made recently in their syllabus. The book has been divided into twentyfive chapters appended with subject index, values of fundamental constants, and some useful mathematical relations.

Kinetic molecular theory of gases, studies of dilute solutions, electro-chemical laws, quantum mechanics, chemical kinetics and molecular spectroscopy are discussed in sufficient details. Illustrations diagrams, tables, experimental techniques and solved examples have been employed to explain the fundamentals of the subject. General and objective type problems with their answers are given at the end of each chapter to test the understanding and grasp of the concepts discussed. S.I. (International System of Units) units are used throughout the text. The authors with over a decade of experience of teaching physical chemistry at University of Delhi have been able to present a coherent and adequate coverage of various topics strictly in line with the syllabi of Indian universities. The presentation is logical, lucid and comprehensive delineating the latest trends and developments with emphasis on theroetical and conceptual approach.

The book is useful for students and teachers as well. A chapter on chromatographic techniques should be added in the next edition of the book.

S.D. Panwar

ESSENTIALS OF PLANT TECHNIQUE *by* J.N. Dwivedi and R.B. Singh, *Scientific Publishers,* Jodhpur, 1985, Pp. 176, Rs. 75.

THE wide range of techniques evolved by scientists has played a significant role in rapid and an indepth understanding of the structures and functions of diverse and fascinating life forms. During the preparation of a biological system for observation, the final result depends on every step through which the object has been processed. So it is essential to process the material with absolute precision. Simultaneously, it is also important to understand the principles underlying each step. A book on techniques has to fulfil the above two demands besides covering modifications of the techniques published from time to time.

The book 'Essentials of Plant Technique' (should be techniques) attempts to provide several methodologies for study of plant systems. It meets the syllabus requirements of post-graduate students of some universities. There are twelve chapters with a brief list of selected bibliography. The chapters include killing and fixation, stains and staining procedure, sectioning, whole mounts, squashing, herbarium development, culturing, fossil study and chromatography, and two general chapters one each on glasswares and solutions. Some of the chapters such as stains and dyes, staining procedure, culture technique, and chromatography are well written. They will act as a ready information for pursuing practical. Also their theory has been satisfactorily discussed. A chapter on study of fossils is interesting.

Most of the techniques discussed in the present book are commonly followed by under and post-graduate students of many universities. The treatment of the chapters has been slightly lopsided. Microtechniques comprise half the total number of chapters. Some more chapters such as polyacrylamide gel electrophoresis, DNA isolation, determination of protein and amino acid content, chromosome banding techniques, estimation of nuclear DNA could have made the book more interesting, wider in approach besides disseminating knowledge on some topical techniques. In the 'bulky' plant collection kit, one of the most important instrument-hand lens-has been lost! It is a surprise to see some figures such as hot plate (p. 46), petridishes and other glass wares (p. 71), pressure cooker (p. 104), hack saw (p. 138), in a book meant for post-graduate students. The left half of the 'rocking microtome' (p. 41) looks like a fossilized human skull. The other figures such as perforated plant press (p. 76), collection pick, knives (p. 77), hatchet (p. 78), etc., are poorly drawn. For inoculations under sterile conditions, at present 'laminar flow' is commonly used in place of the obsolete 'inoculation hood box' (p. 111), Words have been misspelt at several places. In a book written for post-graduate students it is astonishing to find a chapter on glasswares which are well known even to higher secondary school students. The book is priced high and so will be out of the reach of students.

Overall, the book will be helpful to both under and post-graduate students.

B. Subramaniam

HOPS IN INDIA *by* S.K. Bakshi and C.K. Atal, *Regional Research Laboratory,* Council of Scientific and Industrial Research, Jammu-Tawi, 1985. Pp. 76. Price not mentioned.

BEER is a popular drink the world over. Its characteristic taste is mainly due to hop *(Humulus lupulus* Linn.). Hop is the dried inflorescence of female plants. Apart from being a preservative, it is used for flavouring malt beverages. Though hop was cultivated in India in distant past, owing to lack of proper knowledge about its cultural practices hop-growing came to a premature end. Hop is now being imported into India to cater to the needs of Indian breweries.

The Regional Research Laboratory, Jammu, took up detailed study on hops on scientific lines. But the information lay scattered in the form of research papers, handouts, newspaper communications, etc. Hence the present book. The book is divided into 11 chapters, viz., Introduction, Botanical features, World Hop scenario, Hop culture, Performance of exotic varieties, Breeding, Pests and diseases, Harvesting, Chemical constituents, Hop research at RRL (Kashmir) and Structural organisation of hop industry.

The brief introduction which gives historical account of hops in the world and in India is followed by botanical features. It gives information on taxonomy and morphology of the plant. Here it is mentioned that the genus *Humulus* consists of two distinct species *(H. lupulus* and *H. japonicus)* whereas a third species *(H. yunnanensis)* is also mentioned. This should have been ascertained. According to the International Code of Botanical Nomenclature, the names of cultivars have to be given in roman type and within single quotes, e.g., 'Comet'; whereas throughout the book they are given both in italics or roman. This should have been standardized. The chapter on World Hop scenario gives a good account of area and production in hop-producing countries, varieties under cultivation and marketing systems prevailing in the world. Various statistical tables provide substantial data on different aspects of hops. Here New Zealand figures, perhaps quite inadvertently, in northern hemisphere. The chapter on hop culture provides detailed information in easily understanding style on various agro-technological requirements for raising a successful crop, including trellis work, propagation, fertilizer requirement, irrigation, etc. The authors have paid attention to minute requirements and so this chapter will specially be useful to hop growers.

Ninety five per cent of the hop in India is under a single variety 'Late Cluster'. The authors are aware of the dangers of such monoculture and so have given a good account of new genotypes evolved by RRL, Jammu. Control measures for diseases should have been covered little more elaborately. Post-harvest processing is adequately covered. A brief review of chemical constituents is given. The economics of production and marketing are also discussed. Suggestions for future development of hops industry in India are also included. Of the three appendices, one on calender of monthly operations in a hop yard should prove very useful to growers. The book ends with a list of references cited.

As the authors claim, and rightly so, the book is first of its kind in India and will prove very useful to all those interested in different aspects of hops.

N.R. Mankad

☐

PLANET OF THE APES *by* Pierre Boulle, *Penguin Books* (available with: *Penguin Overseas Ltd.,* 706, Eros Apartment, 56, Nehru Place, New Delhi-110019), Pp. 174, £ 1.95.

CAN the planet earth after several hundred years be ruled by gorillas, chimpanzees and orang-outangs? What will happen if one day some eccentric scientist decides to induce sudden mutation in the Great Apes so that they finally emerge as the master race? Such an appalling scourge can be menacing for the human race. This is probably the message which the author wants to convey through the science fiction novel under review.

The story starts with a couple, Jinn and Phyllis, wandering in space in their spaceship just to pass their leisure time. Their space vessel is propelled by the pressure of light radiation received from three suns that their solar system contains. Then, suddenly, the young couple comes across a bottle containing a message. The message is in the form of a manuscript that carries full account of an adventure undertaken by the writer of the message Ulysse Merou, a journalist by profession. He was accompanied by Professor Antelle, a scientist and leader of the expedition, a bright young physician Arthur Levian and Hector the chimpanzee. The expedition was aimed at a distant star Betelgeuse or Alpha Orionis situated three hundred lightyears away from earth. Finally, they could safe land on the planet which they gave the name Soror in view of its striking resemblance with earth. The planet contained everything: oceans, mountains, forests, cultivated fields, towns and,of course, inhabitants. However, *Homo sapiens* in this planet were nothing but naked animals resembling human beings in appearance.

The master race on this planet were the Apes. They dressed like men and hunted humans for their sport! The humans were used by Apes for their bizarre experiments. Ulysse Merou was also captured by Apes. However, he was delighted to see Nova, a girl, who was also put in captivity in a cage near to his own. Towards this savage and barbarian girl, Ulysse developed some sort of affection. The novel goes on to describe in blood-curdling and horrifying details the atrocities incurred on humans by Apes. The plight of Ulysse could have been no better had it not been the cooperation extended to him by the she-monkey Zira and her finance Cornelius whose sympathy he was able to win. In fact, they ultimately came to Ulysse's rescue.

P.K.Mukherjee

Books Received

1. **ORGANIC CHEMISTRY VOLUME I** *by* S.M.Mukherji, S.P.Singh and R.P.Kapoor, *Wiley Eastern Limited, 4835/24 Ansari Road, Daryaganj, New Delhi-110 002, Pp 1404, Rs. 73.50.*

2. ***ORGANIC CHEMISTRY VOLUME II*** *by* S.M.Mukherji, S.P.Singh and R.P.Kapoor, *Wiley Eastern Limited, 4835/24 Ansari Road, Daryaganj, New Delhi-110 002, Pp 1404, Rs. 73.50.*

5. **BTEC STUDY GUIDE FOR MICROPROCESSOR APPRECIATION LEVEL III** (available with: *B.I.Publications Pvt. Ltd.*, Promotion Department, 61-63 Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp 111, Price not given.

3. ***MICROWORLDS ADVENTURES WITH LOGO*** *by* sichard Noss, Clare Smallman and Michael Thorne (available from: *B.I.Publications Pvt. Ltd.*, Promotion Department, 61-63 Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp 104, Price not mentioned.

4. **APPLIED MATHEMATICS FOR ADVANCED LEVEL** *by* W.E.Williams and A.Waltham (available from: *B.I.Publications Pvt. Ltd.*, Promotion Department, 61-63 Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp 345, £ 6.95.

6. **STEP-BY-STEP PROGRAMMING COMMODORE 64 GRAPHICS** *by* Phil Cornes (available with: *B.I.Publications Pvt. Ltd.*, Promotion Department, 61-63 Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp 64, £ 5.95

7. **YOU START BIOLOGY** *by* Chris James & Kevin Wall (available with: *B.I.Publications Pvt. Ltd.*, Promotion Department, 61-63 Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp 122, Price not mentioned.

8. **MOSSES, FERNS, CONIFERS AND FLOWERING PLANTS** *by* Ruth N.Miller (available from: *B.I.Publications Pvt. Ltd.*, Promotion Department, 61-63 Lakshami Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay-400 001), Pp 134, Price not mentioned.

9. **COMPUTER EDUCATION FOR YOU**, *Cad Systems Pvt. Ltd.*, 21 B Guresaday Road, Calcutta-700 019, Pp 72, Rs. 5.

TO OUR CONTRIBUTORS

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

SUBSCRIPTION FORM

To
The Editor
SCIENCE REPORTER
Publications & Information Directorate
Hillside Road
New Delhi-110012

Please enter/renew my subscription to SCIENCE REPORTER for one year. I am sending Rs. 10.00 by M.O No. .... dated .... marked payable to **Editor-in-Chief, PID,** New Delhi-110012.

Name (In capitals) ....

Full address (in capital) ....

....

Pin ....

Signature

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

It takes about four weeks to commence the supply of *Science Reporter* to fresh subscribers.
Please correspond in case you do not receive your copy after four weeks.

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

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

Printed and published by S.P. Ambasta, Publications & Information Directorate (CSIR). Hill Side Road, New Delhi-110012. & Printed at Indian Printing Works, New Delhi-110055.