

Science Reporter

MARCH 1987 Rs 2



SCORPION POISONING

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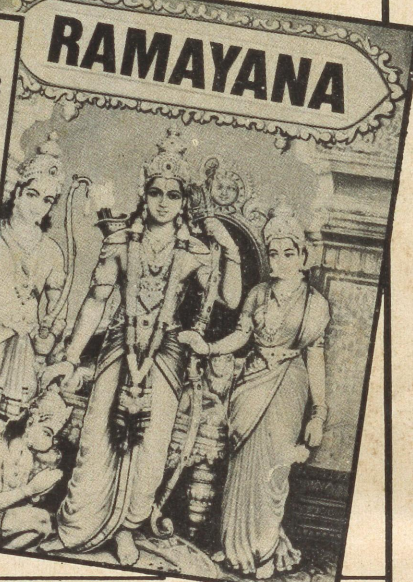
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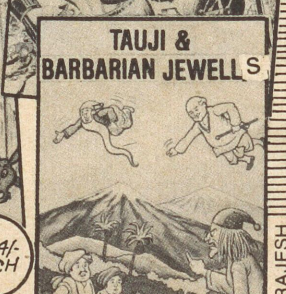
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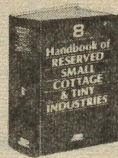
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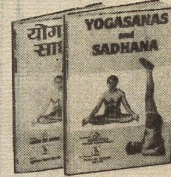
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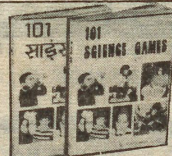
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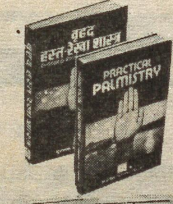


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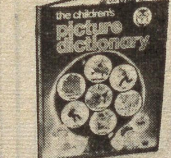


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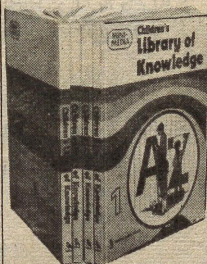
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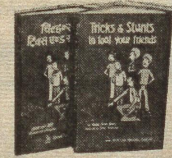
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Science Reporter



Cover: Sand scorpion. The photograph, made at night, illustrates an unusual characteristic of the scorpion cuticle: it fluoresces at night. At maturity the sand scorpion can be upto 8 cm long. (Photo courtesy: Alfred Owczarzak, Oregon State University, USA)

LETTERS

Quality supplement

Sir, Thanks and congratulations for publishing an article on national measurement standards and calibration facilities at NPL as well as giving information about Echelon I, II and III laboratories in *S.R.*, November 1986. This information is useful to many like us, who have to calibrate their instruments.

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Saturn's heat source

Sir, The article **Space Probes to Saturn** by Amalendu Bandyopadhyay (*S.R.*, November 1986) was interesting and informative. The author has nicely covered earth-based studies of Saturn as well as the recent findings from space probes. The beautiful colour photographs of Saturn on the cover page were an added attraction.

The author has rightly pointed out that, like Jupiter, Saturn emits more energy that it receives from the sun. On this aspect, I would like to add that Saturn, with its lower mass, could not have retained enough primordial heat from its formation to be still as warm internally as the excess radio emission implies. Some additional source of heat must be present and its nature is not clear. One suggestion is that differentiation is still going on in the metallic and liquid hydrogen zones, as the heavier helium atoms gradually sink toward the centre of the planet, releasing gravitational energy as they do so. This process is likely at work inside Saturn because it has relatively less helium in its outer layers than Jupiter, consistent with the idea that Saturn's helium has sunk, whereas Jupiter's has not. The probable reason that this has not occurred inside Jupiter is that the interior

of the larger planet is warmer and more turbulent, preventing the helium from quietly sinking toward the centre.

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Saturn's rings

Sir, **Space Probes to Saturn** by Amalendu Bandyopadhyay (*S.R.*, November 1986) was interesting and informative.

I want to add one point about structure of the rings of Saturn which has not been mentioned in the article. Voyager 2 data revealed that another mechanism (which was suspected after the Voyager 1 flyby) was also influencing the structure of the rings. Mathematical calculations show that in any flattened disc system, such as Saturn's rings, small gravitational forces can create a spiral wave pattern, something like the grooves on a phonograph record. The waves take the form of alternating dense and rarefied regions, and the entire spiral pattern rotates about the center of the system. Similar spiral density waves have long been thought responsible for the spiral arm structure of galaxies like our own. The Voyager data have shown that the rings of Saturn are a small-scale model of a spiral galaxy.

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Jelly-fish

Sir, In the article **Fishes that are not fishes** (*S.R.*, Nov. 1986) Nirmal K. Thakur has mentioned that *Physalia* is a jelly-fish. This is absolutely wrong. *Physalia* is a hydrozoan coelenterate commonly known as 'Portuguese man-of-war'.

In fact, jelly-fishes are scyphozoan coelenterates. The most common jelly-

fish is *Aurelia*. Other jelly-fishes are *Cassiopeia*, *Rhizostoma*, *Cyanea*, *Pelagia*, *Charybdaea*, *Lucernaria*. Descriptions of jelly-fishes can be seen in any text-book of non-chordate zoology of graduate standard.

Rajendra Singh
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Biological N₂ fixation

Sir, With reference to the article **Biological and abiological nitrogen fixation** by G.N. Mukherjee (*S.R.*, Nov. 1986), we have the following to add.

Besides the *Rhizobium*-legumes symbiotic association, certain non-leguminous plants are now known where symbiotic N₂ fixation takes place. *Frankia*, an actinomycete, can form nodules in roots of certain non-leguminous plants where it evidently fixes nitrogen symbiotically. These plants are: *Alnus* (Betulaceae); *Casuarina* (Casuarinaceae); *Ceanothus*, *Discaria*, *Trevoa* (Rhamnaceae); *Dryas*, *Cowania*, *Purshia*, *Rubus*, *Cercocarpus* (Rosaceae); *Myrica*, *Comptonia* (Myricaceae) and *Eleagnus*, *Hippophae*, *Shepherdia* (Eleagnaceae).

Rhizobium, has also been reported to form nodules in a non-leguminous plant *Parasponia* (Ulmaceae); a cowpea form of *Rhizobium* is capable of infecting woody, non-leguminous plants of the genus *Trema*. *Azobacter paspali*, a free living bacterium, has been reported to fix N₂ symbiotically in roots of *Paspalum notatum*.

In addition to the symbiotic and free living N₂ fixing bacteria, there is a third category which consists of facultative N₂ fixing forms. They are, for example, *Klebsiella pneumoniae*, *Bacillus polymyxa*, *B. macerans* and *Citrobacter freundii*. Recently, nitrogen fixing (nif) gene from *K. pneumoniae* has been transferred to *E. coli* and the resulting hybrid bacterium

LETTERS

E. coli intermedia, which successfully fixes the N_2 , is categorised as facultative nitrogen fixing bacteria.

Nostoc, a blue green alga, which fixes N_2 in heterocysts, tends to favour more primitive members of the plant kingdom, e.g., lichens, liverworts and pteridophytes for symbiotic associations. The only exception to this is the symbiotic association between Nostoc and *Gunnera* sp., a sub-tropical plant where nodules are formed at the base of the leaves. *Klebsiella* also forms nodules located on the leaves of a tropical plant *Psychotria* sp.

Anabaena sp., a blue green alga, grows in pockets within leaves of a water fern *Azolla*.

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Bose and Saha as science popularisers

Sir, In the 'Book Reviews' section of *S.R.* (August 1986, p. 537) Biman Basu writes, while reviewing two recent collections of older writings of J.C. Bose and M.N. Saha in Bengali for young readers, "few know about their contributions in science popularisation. Both of them wrote in their native tongue Bengali and they wrote mostly for children and young people". Both these statements are partially correct. Like his friend and class-mate Satyendra Nath Bose, Saha was also an ardent supporter of science popularisation, but with a difference. S.N. Bose was doing this for all and sundry through his mother tongue Bengali,

while Saha did not stress on the mother tongue. It was Saha who was instrumental in the founding of Science News Association and its popular journal (with a section devoted to research notes in the form of letters) *Science and Culture* in 1955. Saha wrote profusely for the general public (hundreds of his articles were published in *Science and Culture* and other news papers and magazines). A collection of Saha's popular writings has been published by Orient Longmans, edited by Prof. Shantimoy Chatterjee who compiled and edited Saha's collected research publications (published by CSIR in 1969). Prof. Chatterjee also edited another collection of Saha's popular writings in Bengali *Meghnad Rachana Sankalan*, marketed by Orient Longmans (1966).

Saha's preoccupations with national planning, and with organisations like Indian Association for the Cultivation of Science, Institute of Nuclear Physics, River Research Institute, Calender Reforms Committee, Indian Academy of Science (Allahabad), Asiatic Society, Indian Science Congress, etc., and his participation in parliamentary election (he became a member of the Lok Sabha in 1952) largely inhibited his popular writings. It is not correct to say that Saha did not write anything popular regarding his own researches.

J.C. Bose also wrote popular science for grown-ups in both English and Bengali. However, his popularisation mostly took the form of lectures with demonstrations and in which he excelled. Indeed, his book *Plant Autographs and Their Revelations* published in 1927 was a survey of his own works for intelligent laymen.

In the passing I may mention that almost all the scientists of stature from Bengal wrote for laymen in Bengali. But only one of them wrote regularly for children and juveniles. He was Prof. Sisir Kumar Mitra, F.R.S. It would be worthwhile if someone takes up the task of

collecting his articles and publish them in a book form.

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Calcutta-700074

Gallstones

Sir, In *S.R.*, July 1986 issue P.K. Gogoi has commented on our article entitled, **How gallstones are formed** (*S.R.*, April 1986). His first point is that we have overlooked the importance of pigment bilirubin in the formation of gallstone. In a way we have not given stress on the pigment stone, according to our information, such stones are much less prevalent than cholesterol stones. On page 227 we have mentioned about bilirubin stones without a detailed discussion. Nevertheless, there is scope to discuss details of such stones of the gall bladder.

We agree with Gogoi that supersaturation of cholesterol in bile is not the only mechanism of stone formation. This point has been fairly discussed in our article and we have suggested an alternative stone formation mechanism from the colloid stability point of view. The weakness of the phase rule approach has been discussed in para 2 of page 227. Along with this, the positive roles of micro components have been indicated. In the alternative mechanism (page 228) an entirely different analysis has been presented. Therefore our analysis is not biased in favour of cholesterol supersaturation mechanism inherent in the principle of phase rule.

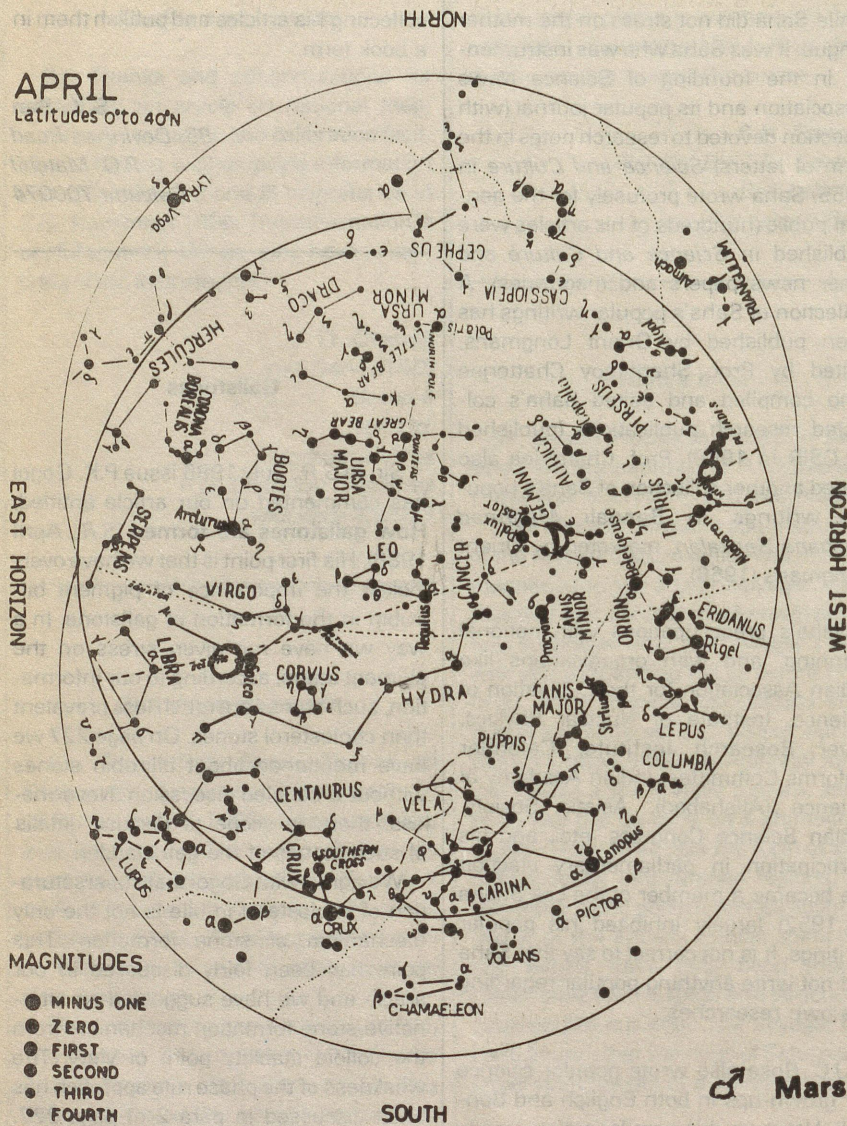
We may add that to support his opinion Gogoi has cited several useful references.

S.P. Moulik
Swapna Das (Pal)
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Calcutta-700032

STARS AND PLANETS

APRIL

Latitudes 0° to 40°N



Planetary positions for April 1987

Date	1st		10th		20th	
	R.A.	Decln	R.A.	Decln	R.A.	Decln
Mercury	23h 02m	8.3S	23h 48m	4.0S	0h 47m	2.6N
Venus	22h 25m	10.8S	23h 06m	7.1S	23h 51m	2.6S
Mars	3h 37m	20.2N	4h 03m	21.6N	4h 31m	22.8N
Jupiter	0h 28m	1.8N	0h 36m	2.6N	0h 44m	3.6N
Saturn	17h 22m	21.6S	17h 22m	21.6S	17h 21m	21.5S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta

The moon

FULL moon occurs on 14th at 8.01 A.M. and new moon occurs on 28th at 7.04 A.M. I.S.T. The moon passes about three degrees north of Mars on 2nd, six and a half degrees south of Saturn on 18th, about a degree north of Venus on 25th, one and a half degrees north of Jupiter on 26th and about three degrees north of Mercury on 27th. The lunar crescent becomes first visible after the new moon on 29th. The moon is at apogee or farthest from the earth on 6th and is at perigee or nearest to it on 18th.

There will be a penumbral eclipse of the moon on 14th. The Moon enters penumbra at 5.50 A.M. and leaves it at 9.48 A.M. I.S.T.

The planets

Mercury (Budha), visible in the morning sky, rises about an hour before sunrise during the first half of the month. Thereafter it becomes too near the sun to be visible. It moves from Aquarius (*Kumbha*) to Aries (*Mesha*) through Pisces (*Mina*). Its visual magnitude is from +0.1 to -0.5.

Venus (Sukra), visible in the morning sky, rises about one and a half hours before sunrise during the month. It moves from Aquarius (*Kumbha*) to Pisces (*Mina*). Its visual magnitude is about -4.0.

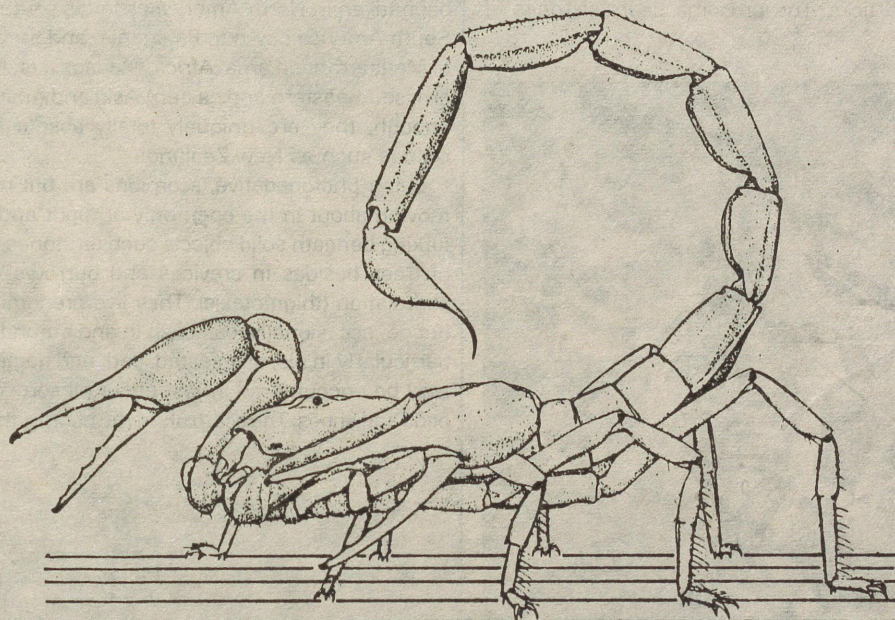
Mars (Mangala), visible in the evening sky, sets about three hours after sunset during the month. It passes about six degrees north of the star Aldebaran (*Rohini*) on 21st. It is in Taurus (*Vrisha*). Its visual magnitude is about +1.6.

Jupiter (Brihaspati), it is too near the sun to be visible during the first half of the month. Thereafter it becomes visible in the morning sky rising about an hour before sunrise during the month. It is in Pisces (*Mina*). Its visual magnitude is about -2.0.

Saturn (Sani), visible in the morning sky, rises about one and a half hours before local midnight during the first half of the month and about two and a half hours before it during the second half. It is in Scorpio (*Vrischika*). Its visual magnitude is about +0.3.

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

Contrary to popular belief, scorpions are not confined to the tropics, and unlike snakes, all scorpions are poisonous. The only effective antidote against scorpion poisoning available at present is the antisera obtained from animals subjected to venom toxins



SCORPION POISONING

R. RAMAMURTHI AND B.S. JANGI

UNLIKE snakes, all scorpions are poisonous; and the pathological condition produced in the human body by the scorpion sting is called scorpionism or, plainly, scorpion poisoning. In some parts of the world, scorpions are indeed fatally injurious and are considered as the public enemy number one; for example, in Arizona, during a twenty-year period, scorpions were responsible for as high as 68% of the deaths due to venomous animals alone. Yet there is such a general ignorance about them! This article is aimed at not only highlighting the scorpion problem at the global level, but also providing some familiarity with the biology of scorpions besides evaluating the scientific and economic potential of their venoms.

What are scorpions?

Scorpions are not insects as popularly believed, for their body is not incised into head, thorax and abdomen, nor do they possess just three pairs of walking legs as insects do. They are clubbed together with spiders, mites, ticks and several other

Dr. B.S. Jangi is the erstwhile editor of the Indian Journal of Experimental Biology and the Indian Journal of Biochemistry and Biophysics; R. Ramamurthi is Professor of Zoology at Sri Venkateswara University, Tirupati.

obscure forms under the class arachnida distinguished by the body, primarily divided into two sections: prosoma or cephalothorax, i.e., head and thorax fused together; and opisthosoma or abdomen. These, one and one, divisions of the arachnid body are either clearly distinct as in scorpions and spiders or entirely fused as in mites and ticks. The prosoma bears six pairs of

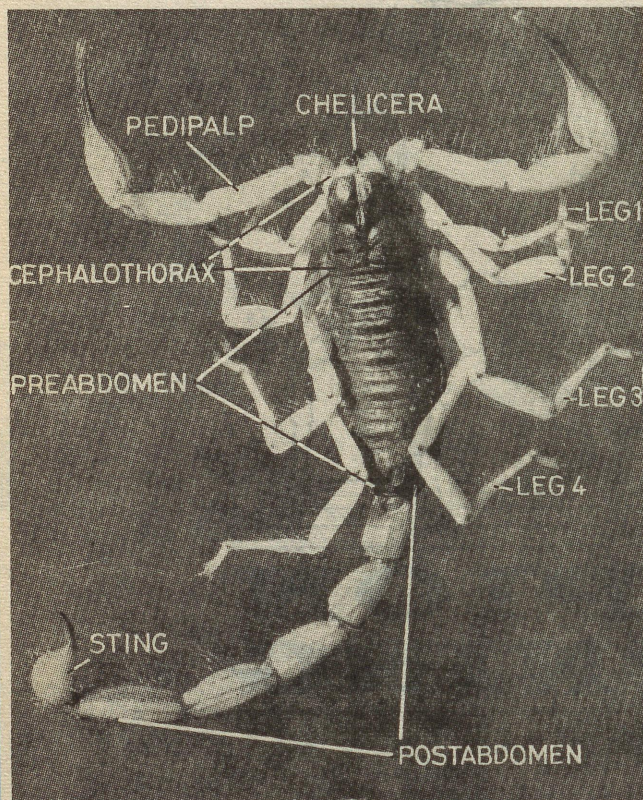


Fig. 1. The black giant hairy scorpion (*Hadrurus*), a North American chactoid, is not deadly but can produce painful, local swelling and inflammation, no worse than the effects of a wasp or bee sting. (Adapted from Stahnke 1956)

appendages, the first two, viz., chelicerae and pedipalps, being the mouth-parts used in feeding, and the following four, the walking legs (Fig. 1). Scorpions belonging to the order Scorpiones are further distinguished by a combination of characters such as pincerlike chelicerae; pincerlike, large-sized pedipalps, the opisthosoma or abdomen differentiated into an anterior, broader mesosoma or preabdomen and a posterior, slender, tail-like metasoma or postabdomen, the latter bearing terminally the vicious sting; and a pair of comblike organs, the pectines, situated underneath on the second preabdominal segment. A few other arachnids, called pseudoscorpions, windscorpions and whipscorpions, are not true scorpions at all!

Where and how do scorpions live?

Scorpions subsist mostly in warm, dry climates and are found practically worldwide; the deserts, in particular, teeming with them. This is possible due to their impervious, waxy integument conferring on them an efficient power of water retention.

Contrary to common belief, scorpions are not confined to tropical and subtropical lands but are represented in cold, temperate zones, too, of both the northern and southern hemispheres, although sparsely. In fact, they are found all over the south of about the 40th parallel of north latitude. Scorpions have thus been taken in North America as far as southern Canada and in South America down to Patagonia, and they inhabit the whole of Mediterranean area, Africa, Madagascar, Middle East, southern, southeastern and eastern Asia and Australia. But curiously enough, they are uniquely totally absent from some Pacific islands such as New Zealand!

Being photonegative, scorpions are but naturally nocturnal, moving about in the open only at night and spending the day lurking beneath solid objects such as stones, logs of wood, bark of trees besides in crevices and burrows, guided by contact stimulation (thigmotaxis). They live predominantly in the wild, but do, occasionally, establish in and around human dwellings, particularly in old, dilapidated, dark and neglected buildings and may be encountered in just about all sorts of places including beds and shoes. The scorpion-in-the-boot-in-the-morning, and old

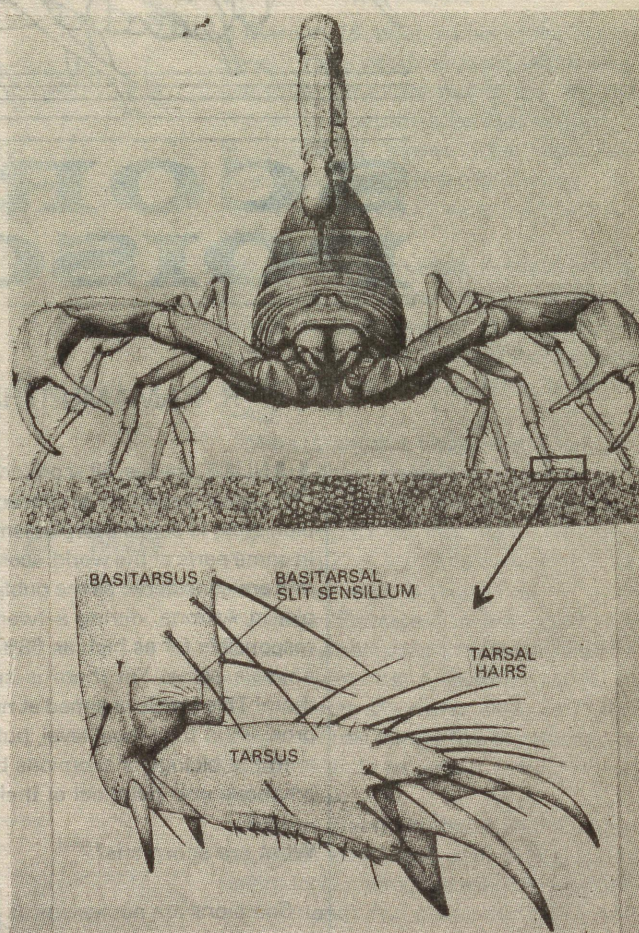


Fig. 2. Frontal view of a scorpion in an upright position on a sandy ground. Sensory hairs and slit-like receptors situated on terminal segments of the leg, resting on and in between sand grains are extra-ordinarily sensitive to movements in the substrate, which helps detection, both of prey and predator. (Adapted from Brownwell, 1981)



Fig. 3. The so-called courtship dance of scorpions, in which the male seizes its mate by pedipalps in a face-to-face position. There is no coitus, only deposition of a packetful of sperms on the ground, to be sucked in by the female

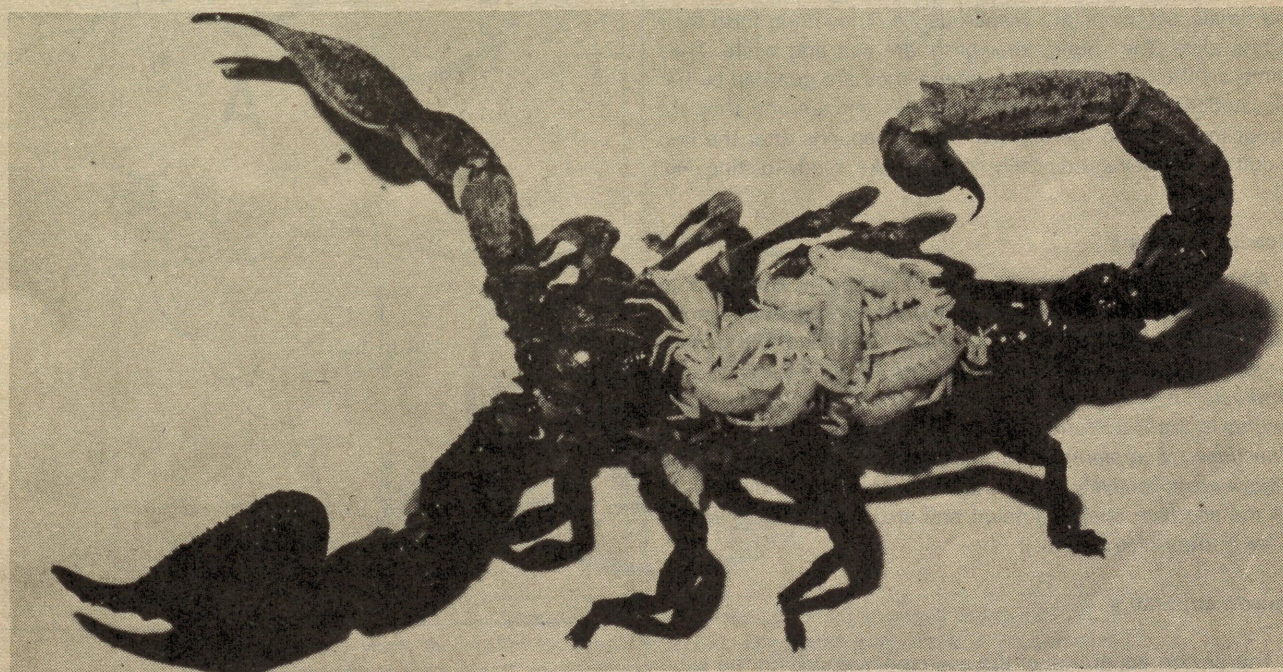


Fig. 4. A mother scorpion (*Heterometrus fulvipes*) carrying the new-born on her back, typically guarded by the elevated tail

tale for most adventure story readers, is thus often quite true! Scorpions may occur in such great abundance in certain regions, called scorpion districts, that often whole towns have been invaded by them!

Scorpions feed chiefly on insects, spiders and centipedes, seizing and crushing their prey by the pedipalps, bringing the poison sting into action only if the captive resists. As the small sized mouth of the scorpion makes the intake of large morsels of solid food impracticable, the victim is cut up by the chelicerae and reduced to pulp by extra-oral digestion before it is finally sucked up in liquid form as in all other arachnids. Scorpions are not real good hunters, for they move relatively slowly, are practically blind and have a poor sense of smell. They would rather prefer to wait for their prey to approach them, detecting it by sensory hairs and slit-like receptors, situated on tarsal segments constituting the terminal part of the leg, which are extraordinarily sensitive to subtle mechanical vibrations of the ground, caused by its movement (Fig. 2). Measurements have shown that scorpions can detect disturbances as far away as 30 cm, and at distances of 10 cm or less, their estimates of target angle and distance are effectually perfect.

Sexual reproduction is the rule in scorpions, excepting *Tityus serrulatus*, a Brazilian species, in which no males occur and the extraordinary female generates its progeny from unfertilized eggs, a mode of propagation named parthenogenesis after *parthenos*, the Greek equivalent of 'virgin girl'. The scorpion maiden is thus not just singly but doubly blessed! In other scorpions, the male, in the act of pairing, seizes the pedipalps of the female by its own (Fig. 3) and then leads her back and forth, in a face-to-face position, in the so-called courtship dance (*promenade a deux*), during which it ejects a closed packet of sperms, the spermatophore, on the ground and pulls the female over it in such a way that she is able to suck it up in her genital opening. Insemination of the female scorpion thus occurs without actual copulation. Unlike the rest of the arachnids but like mammals, scorpions are viviparous, i.e. they bring forth their young alive. The young, after birth, are soft and white. They climb on their mother's back where they are guarded by her elevated (Fig. 4) and remain there under her care until they are about to get along themselves, which happens after the first moult when they are typically scorpion-like, ready to sting (Fig. 5).

Deadly scorpions

Altogether, there are six families of scorpions. But the species causing human death are just a handful and are all among buthoids, representing a single family, Buthidae, the genera largely involved being *Centruroides* and *Tityus* in the New, and *Androctonus*, *Buthacus*, *Buthotus*, *Buthus*, *Leiurus* and *Parabuthus* in the Old World (Figs 6 and 7). The other five families, *Chactidae*, *Scorpionidae*, *Diplocentridae*, *Bothriuridae* and *Vejovidae*, collectively called chactoids, comprise about 60% of all the scorpion species known and are, like buthoids, world-wide in their distribution.

Poison apparatus

The poison apparatus of the scorpion, comprising the sting and associated venom glands (Fig. 8), is borne at the tail end of the animal. The dilated, basal part, called the ampulla or vesicle,

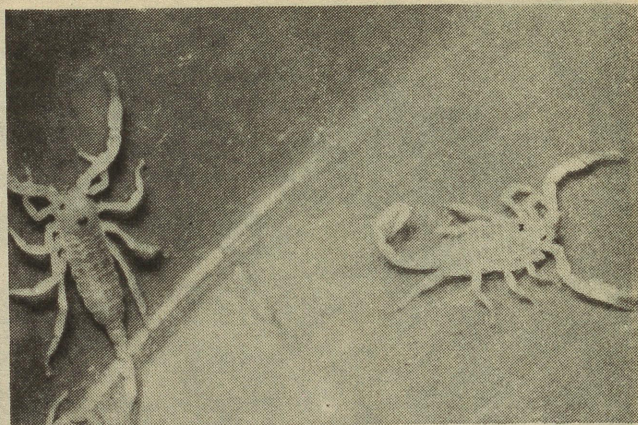


Fig. 5. Two young scorpions (*Heterometrus fulvipes*) which have just deserted their mother after undergoing a moult and are ready for their first strike

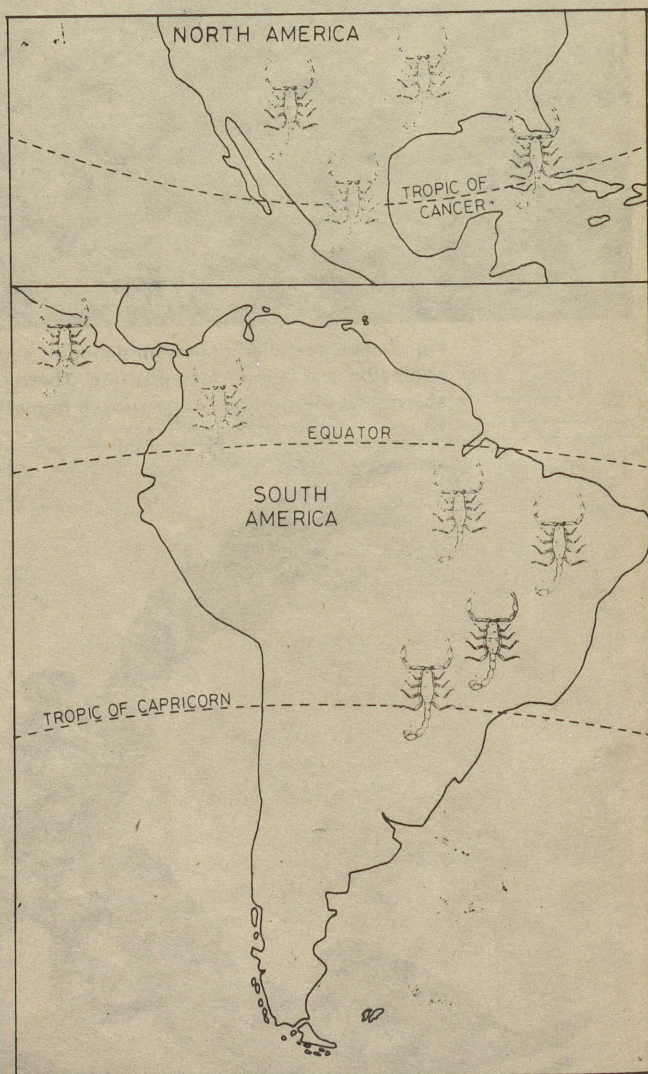


Fig. 6. Geographical distribution of deadly scorpions in the New World

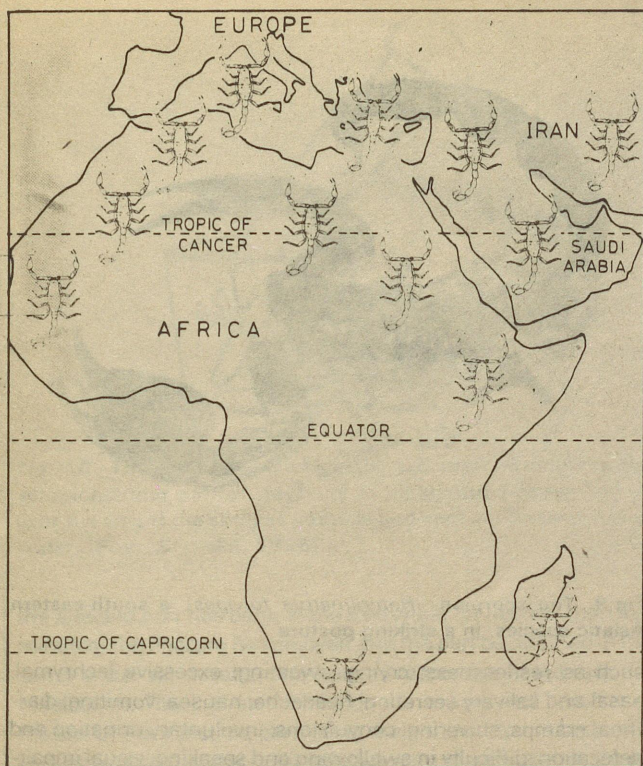


Fig. 7. Geographical distribution of deadly scorpions in the Old World

of the sting contains a pair of saclike venom glands which open individually by tear-shaped apertures, one on each side, near the tip of its curved, spiny, needle-like distal part, the stinger or aculeus, by which the venom is injected into the body of the victim. The sting is movably articulated on the tail and is controlled by a pair each of dorsal (flexor) and ventrolateral (extensor) muscles which originate on the last tail segment and function antagonistically to each other. A venom gland is lined by extensively folded secretory epithelium resting on the basement membrane and is made of a single layer of columnar cells. The vacuolated tips of the cells containing the secretory product are nipped off and break down in the glandular cavity, resulting in the accumulation of the product there (apocrine secretion). The gland is covered along its medial and upper surfaces by a semicircular muscle attached above the gland on the outer wall of the ampulla and below on the lower wall.

Venom

Varying from a clear, transparent to milky, opalescent, viscous fluid, the scorpion venom turns into a whitish gray powder on drying. It consists mostly of protein, the enzymatic part of which is practically nonexistent in buthoids or at best only poorly represented in chactoids, compared to snake venoms which, on the other hand, possess a good lot of tissue-damaging enzymes and thus produce more complex effects.

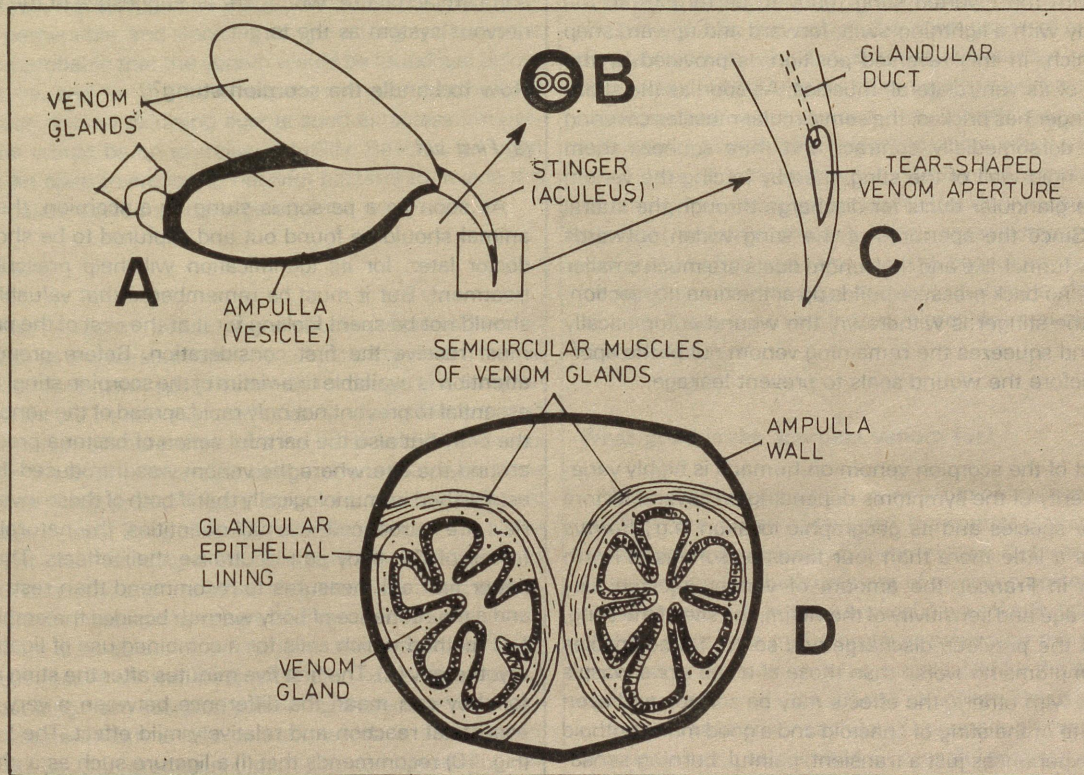


Fig. 8. Poison apparatus of the scorpion, A. Partly dissected sting showing the paired venom glands in the side view, the left having been lifted up to expose the right one, B. A section of the stinger across the venom ducts, C. Magnified view of the terminal part of the stinger, showing a tear-shaped venom aperture and the corresponding glandular duct, D. Cross-section of the stinger showing the finer structure of the venom glands

Several of the snake venom enzymes have been reported from chactoid venoms too, but it is doubtful if the enzymes really exist in the "physiological venom" since the scorpion studies have been based on electrically obtained venoms which, if the current is too strong, would include enzymes more or less resulting from damaged tissue of the sting. Toxicity of the scorpion venom is due primarily to its nonenzymatic protein, mainly in the form of neurotoxins, so far known conclusively from buthoids only, which are low molecular weight polypeptides. It is interesting to note that the toxin content of the buthoid scorpion venom is higher than that of the snake venom. Serotonin, i.e., 5-hydroxy-tryptamine, found in some scorpion venoms in greater amount than in other animal venoms, is a notable nonprotein fraction responsible for elicitation of the notorious painful burning sensation that follows the scorpion sting. Chactoid venoms are generally less dangerous on account of their paucity of toxins, but some forms such as *Heterometrus* are among the largest scorpions and therefore are able to inject considerable doses of the venom, which may produce serious pathological condition, resulting even in death of hypersensitive individuals.

Human envenomation and pathophysiology

The segments of the scorpion tail bend on each other in such a manner that their principal movement is in a vertical plane, most freely in a dorsal direction. That is why the tail can be readily curved up and turned forward over the back of the scorpion, with the inverted sting ready to be thrust into the victim's body with a lightning-swift, forward and upward snap (Fig. 9), which, in this reversed position, is provided by the contraction of its ventrolateral muscles. As soon as the sharp tip of the stinger has pricked, the semicircular muscles covering the glands dorsomedially contract and thus squeeze them against the rigid wall of the sting, thereby forcing the venom through the glandular ducts for discharge through the lateral apertures. Since the apertures of the sting widen outwards more or less funnel-like and the venom ducts are much smaller in diameter, no back pressure builds up at the time of injection, and when the stinger is withdrawn, the wound automatically contracts and squeezes the remaining venom out of the apertures just before the wound seals to prevent leakage.

The effect of the scorpion venom on humans is highly variable, the severity of the symptoms depending on several factors such as the species and its geographic location (e.g., *Buthus occitanus* is a little more than four times poisonous in North Africa than in France), the amount of venom injected, i.e., dosage, the age and sensitivity of the victim, the site of the sting, the time of the previous discharge and so on. Some species produce symptoms no worse than those of a bee's or a wasp's sting while, with others, the effects may be serious and even fatal. The site of the sting of chactoid and a good many buthoid scorpions experiences just a transient, painful, burning sensation resulting from serotonin present in the venom, which may be followed by local swelling, discoloration and mild general effects with no serious danger. But the neurotoxic venoms of some of the buthoid species, notorious killers as they are, produce not only local but also general symptoms of intoxication

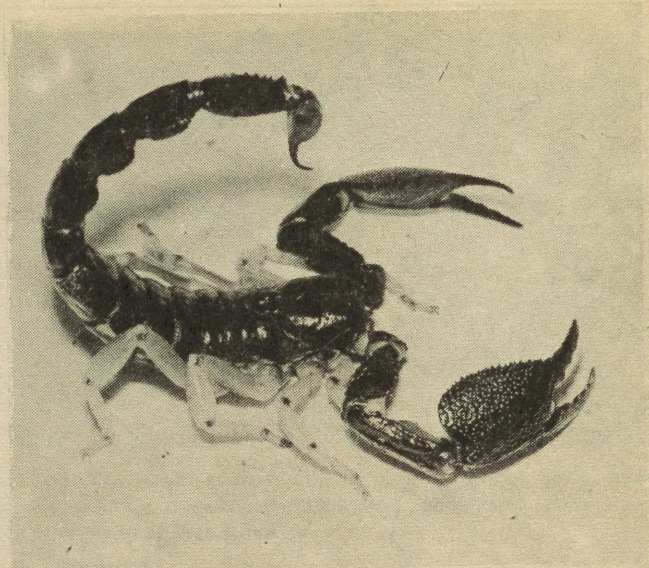


Fig.9. The scorpion, (*Heterometrus fulvipes*), a south-eastern Asiatic species, in a striking posture

such as restlessness; crying; sweating; excessive lachrymal, nasal and salivary secretion; headache; nausea; vomiting; diarrhea; cramps; shivering; convulsions; involuntary urination and defecation; difficulty in swallowing and speaking; visual impairment; initial tachycardia and hypertension leading to bradycardia and hypotension; pulmonary edema; respiratory paralysis; and cardiac failure, which are all suggestive of the autonomic nervous system as the target.

How to handle the scorpion-stung?

(a) First aid

As soon as a person is stung by a scorpion, the attacking animal should be found out and captured to be shown to the doctor later, for its identification will help prescribe correct treatment. But it must be remembered that valuable minutes should not be spent looking for it at the cost of the patient who must receive the first consideration. Before proper medical attention is available to a victim of the scorpion sting, it would be essential to prevent not only rapid spread of the venom through the body but also the harmful action of bacteria present in and around the site where the venom was introduced. It has been established immunologically that if both of these invasive materials are introduced in small quantities, the natural defensive forces of the body can neutralise their effects. There are no better first aid measures to recommend than rest, assurance and a maintenance of body warmth besides the employment of L-C method which calls for a combined use of ligature (L) and cryotherapy (C). The first five minutes after the sting are crucial, for they can mean the difference between a very serious or even fatal reaction and relatively mild effect. The L-C method (Fig. 10) recommends that (i) a ligature such as a shoe lace be placed at once between the site of the sting and the body as near the point of entrance of the venom as possible; (ii) a piece of ice be then applied to the site while preparing a suitable vessel of crushed ice and water; (iii) the affected part of the body well above the ligature be kept in the iced water; and (iv) after

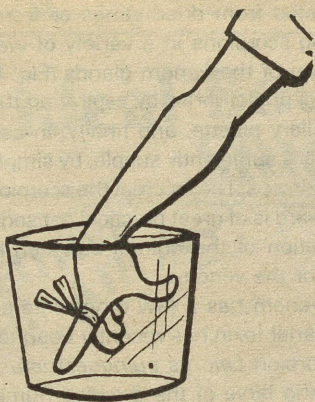


Fig. 10. The manner, in which the L-C method requires the scorpion-stung part of the body to be ligatured above and as near the site of the sting as possible and kept immersed in iced water. (From Stahnke, 1956)

the affected part has been in the iced water for not less than five minutes, the ligature be removed and the part be retained in the same water for at least two hours irrespective of subsequent medication. The L-C method holds the venom and bacteria at the site of the injection, permitting their entry into the body only very slowly so that the body defences can readily destroy them. Removal of venom from the victim's body by cut or incision and suction is of no value in the case of scorpions, for the amount of venom usually injected is minute, the puncture is too small to be generally perceptible, and since the stinger is long and curved, it is highly improbable that the venom would be found just below the puncture, and for this very reason, trying to destroy it by cauterisation and by oxidising agents such as potassium permanganate would be an exercise in futility. Besides, an open wound is an open invitation to harmful bacteria to invade the body and cause additional damage such as gangrene.

(b) Treatment

Antivenin, i.e., serum containing antibodies obtained from an animal such as the horse, previously subjected to venom toxins, is claimed to be the only specific remedy for dangerous scorpion stings and should be administered as early as possible, but in no case an interval of more than two hours should be allowed. Specific antisera for all the truly dangerous buthoid scorpions are available. A full dose of the antiserum, i.e., the one sufficient to neutralise at least 2 mg of the dry scorpion venom, should be employed at once, dividing it into two portions; one-half to be given intravenously, and the other half, intramuscularly or subcutaneously. But despite the progress of serotherapy of envenomation, there is no evidence whatsoever that a specific serum would be effective in the treatment, say, of cardio-vascular failure resulting from scorpion poisoning. In such cases a supportive treatment with a lytic cocktail, which is a mixture of drugs such as chlorpromazine, pethidine and promethazine used to promote artificial hibernation, has given good results. Supportive treatment is certainly necessary if medical intervention is late. And in any case for chactoid stings, for which there is so far no specific treatment by way of serotherapy because of the rarity of serious poisoning by them, the treatment is bound

to be symptomatic. Administration of a combination of sympathetic and parasympathetic drugs would be perfectly logical in view of sympathetico- and parasympatheticomimetic action of neurotoxic venoms such as of scorpions. But this can only help diminish symptoms of poisoning. There is no neutralisation of toxins, nor true repair of lesions caused by them. Following the fact that a scorpion is immune to its own venom, a child envenomed by *Leiurus quinquestriatus*, a deadly species, is on record to have been treated as a last resort with an injection of the scorpion blood itself. Interestingly, the response of the patient was immediate and positive, which shows that the scorpion has the ability to neutralise its own toxins.

(c) Relapse

An important characteristic of scorpion poisoning is that the recovery therefrom may be just apparent, not real, for there may be sudden reappearance of grave respiratory trouble, resulting in death. Therefore close surveillance of the patient must be continued for at least 12 hours after complete disappearance of the symptoms.

Prevention of scorpion poisoning

A quite effective preventive measure against scorpions is descorpionisation, i.e. their destruction, in and around human dwellings, which can be achieved by clearing the premises of accumulations of discarded material under which these creatures seek shelter during the day. Domestic animals such as chickens, ducks and cats make short game of scorpions and thus act as controls. A mixture of insecticides such as DDT, chlordane, lindane and dieldrin, together with pyrethrum, hits scorpions well when spread heavily with a paint-spray gun, resulting in slow but sure death for them when they happen to crawl over the thick residue. Additional measures include refraining from walking barefoot after dark because scorpions are night crawlers; shaking one's shoes, clothing and bedding vigorously before use; and keeping beds away from the wall, for scorpions can manage to crawl up if the surface is not too smooth. There is no vaccine yet to provide immunity to scorpion venom exposure.

What good is the scorpion venom for?

When the intense suffering, economic loss in manhours and medical care are all considered, the control of scorpion poisoning becomes of considerable importance. Commercial antisera or antivenins for the treatment of scorpion poisoning are prepared at several institutes around the world. But the availability of the venom is a major problem governing the production of scorpion antivenins on a large scale. Unlike the snake venom, scorpion venom is very difficult to collect. Thousands of specimens are required for each lot of antivenin, the venom yield per specimen being very limited. Successful scorpion farming is still a far cry, and the laboratory stock needs to be constantly replenished with fresh specimens from the wild. Scorpions can be safely collected with pair of forceps held near the sting (Fig. 11) and can be kept alive in glass containers for months together on a diet of water and insects such as cockroach and house cricket.

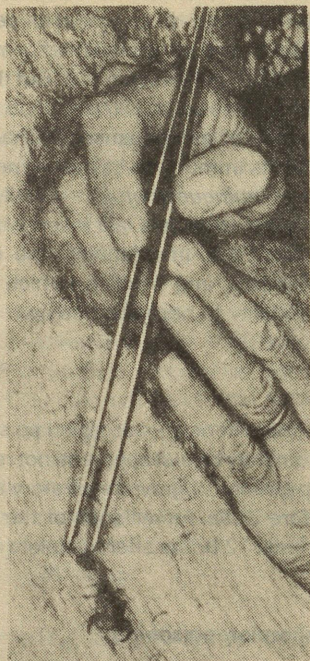


Fig. 11. A specimen of (*Centruroides sculpturatus*), a tiny but one of the deadliest scorpions (hence called midget killer), being held with forceps near the sting, by its collector. The venom spreads rapidly into the body tissues, acting violently on nerves and often causing convulsions, respiratory and cardiac difficulties and even death, particularly in children and hypersensitive adults. (From Zahl, 1968)

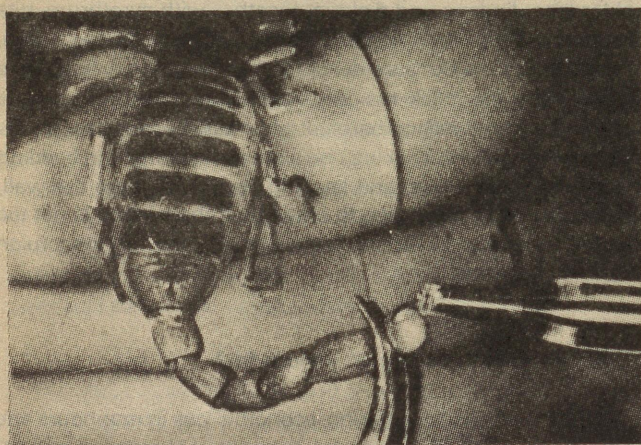


Fig. 12. A scorpion being milked for its venom. A mild shock given with electrified forceps gripping the tail results in ejaculation of the venom which can be taken into a pipette. (From Zahl, 1968)

Toxins are extracted from dried stings or from fresh venom milked from living scorpions in a variety of ways such as by electric stimulation of the venom glands (Fig. 12), by manual excitation of the cephalothorax, by aspirating the tip of the cut stinger by a capillary pipette, and finally, in cases where the cuticle of the sting is sufficiently supple, by simple compression of the sting with forceps. The fact that the scorpion cannot move its stinger downward is of great practical consequence in that it permits manipulation of the animal between human fingers while milking it for the venom.

The scorpion venom has a few other potential uses too. A toxin, called cercarial toxin, has recently been identified in the venom of the scorpion *Leiurus quinquestriatus*, which works against the cercaria larva of the dreaded human blood fluke, *Schistosoma mansoni*, the causative agent of a serious, debilitating disease, called schistosomiasis, bilharziasis or snail fever, which is endemic in Africa, South America and West Indies. Interestingly, the cercarial toxin shows no mammalian toxicity. Treatment of cercariae-infested mice with the toxin has shown very encouraging results. Yet another fraction prepared from the same venom has spermicidal activity and can knock out a significant percentage of motile spermatozoa. Injection of this compound into male albino rats causes a decrease in their prolificity and is thus a promising agent of fertility control. Academically, the worth of the scorpion venom in molecular and evolutionary biology studies has only lately been recognised. As its neurotoxins selectively attack the sodium and potassium ion permeabilities across the nerve cell membrane, thereby interfering with the normal development and propagation of the nerve impulse, the scorpion venom can be employed with great advantage in localising these channels in other cells, and in helping probe the physiological processes in which they play an important role. Moreover, the fact that scorpion venoms show geographical variation, can be of tremendous value to the evolutionary biologist, particularly at the subspecific level.

Further reading

1. Bettini, S., *Arthropod Venoms*, Springer-Verlag, 1978.
2. Brownwell, P.H., Prey Detection by the Sand Scorpion, *Scientific American*. December, 1984.
3. Bucherl, W. and Buckley, E.E, *Venomous Animals and Their Venoms*. Vol. 3, Academic press, 1971.
4. Hebermehe, G.G, *Venomous Animals and Their Toxins*, Spring-Verlag, 1981.
5. Stahnke, H.L, *Scorpions*. Poisonous Animals Research Laboratory, Temper, 1956.
6. Tu, A. *Handbook of Natural Toxins*, Vol. 2, Marcel Dekker, Inc. 1984.
7. Zahl, P.A., Scorpions: Living Fossils of the Sands, *National Geographic*. March, 1968.

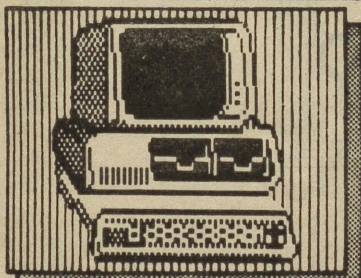
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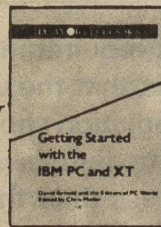
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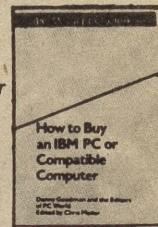
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THE vast and rapid development of high energy nuclear physics has led to the discovery of new radiation detectors. The Cherenkov (also spelled as Cerenkov) radiation detector is one of them. This radiation was first observed by Mme Curie in 1910 as a bluish-white light from transparent materials in the neighbourhood of strong radioactive sources. The first attempts to study this radiation were made by L. Mallet of France in 1926, 28 and 29. He found that many transparent substances always emitted bluish-white light when placed close to radioactive sources and that the emitted radiation has all the wavelengths. However, his observation was later forgotten or ignored and Mallet himself did not pursue the work. P.A. Cherenkov of U.S.S.R. carried out exhaustive experiments during 1934-38, unaware of the earlier work carried out by Mallet, while I.M. Frank and I.G. Tamm of the U.K. proposed a theory for this

(velocity of light in vacuum). So, $v_{\mu} < v < v_0 (= \mu v_{\mu})$, without violating Einstein's principle that no material particle can have a velocity greater than the velocity of light in vacuum. Consider the motion of an electron through a transparent medium like glass. Fig. 1(a) shows a section of the glass in the vicinity of the track AB of this electron, the circles representing the individual atoms composing the glass. Normally, they will be roughly spherical and undistorted in shape. However, in the region close to the passing electron, which at a particular instant in time, for instance, is at the point P, the electric field of the particle distorts the atoms so that the negative charges of the electrons are displaced to one side of the heavier positive charges of the nuclei of these atoms. The medium becomes polarized about the point P. When the electron moves on to another point, say P', the elongated atoms around P return to

WHAT IS CERENKOV RADIATION?

A.V. NARASIMHAM

The important requirement for the emission of Cherenkov radiation is that the velocity of any charged particle emitting the radiation should be greater than the velocity of light in the medium in which the particle travels, while it can still be less than the velocity of light in vacuum

radiation in 1937, and V.L. Ginsburg of Germany gave a quantum theory in 1940. This was henceforth known as "Cherenkov radiation". The photomultiplier tube has been an invaluable tool in the experimental study of this phenomenon. Cherenkov detectors have been found to be highly useful for determination of the velocities of fast charged particles in nuclear and cosmic ray physics. The discovery of anti-proton by English scientist O. Chamberlain in 1955 was carried out using a Cherenkov detector.

Elementary theory

Cherenkov radiation is emitted by charged particles when they pass through a medium with a velocity (v) greater than the velocity of light in that medium (v_{μ}). Even though $v > v_{\mu}$ (where μ is the refractive index of the medium), v can be less than v_0

their normal shape. While the atoms are distorted, they behave like elementary dipoles, with the negative poles pointing away from the track if the passing particle is a negative electron, or vice versa for a positive particle. So, as the particle passes through the medium, each elemental region of the glass along the track will receive a brief electromagnetic pulse. Owing to the complete symmetry of the polarization field surrounding the electron, there will be no resultant field at large distances and therefore no radiation. In this case, there is symmetry both in azimuth and along the axis. Hence the vector sum of all the elemental fields produced at any distant point by the various atomic dipoles vanishes.

If, however, the electron is moving fast, that is, at a speed comparable to that of light in the medium, the picture is quite different (Fig. 1b). In this case, the polarization field is no

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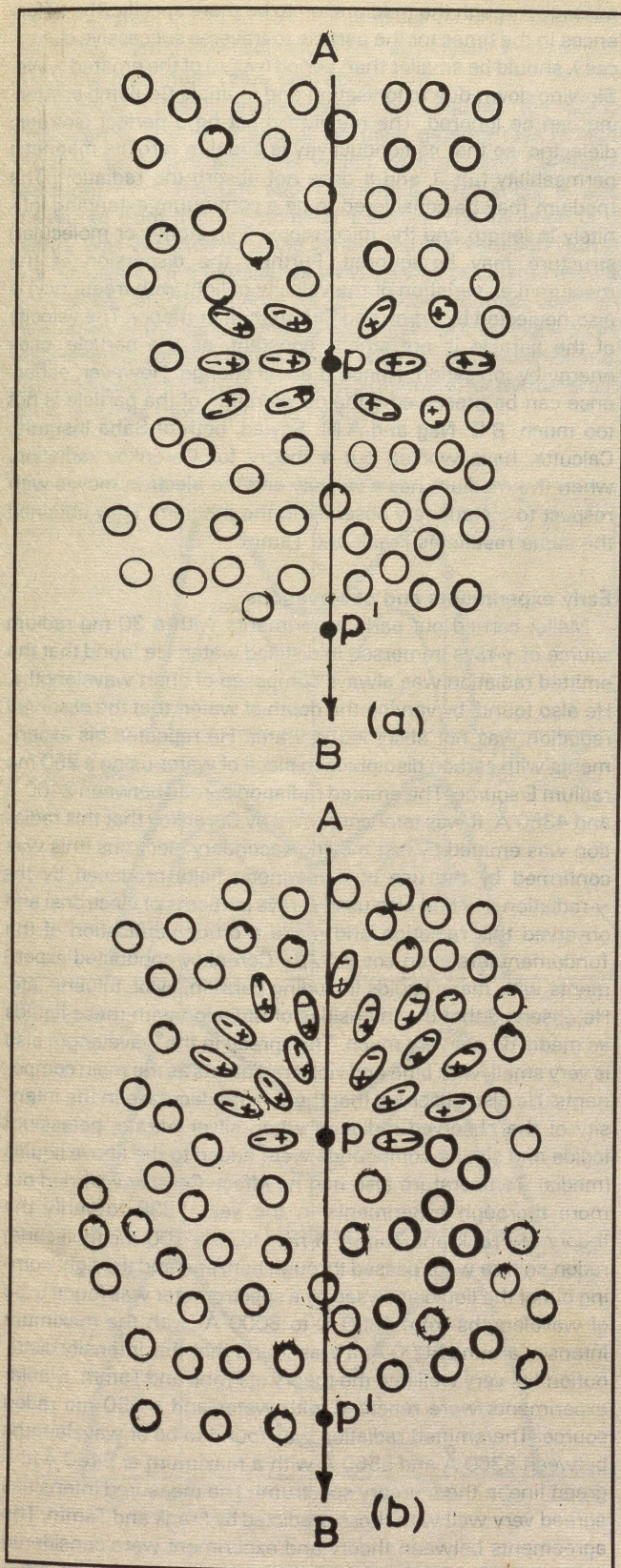


Fig. 1. The polarization set up in a dielectric by the passage of a charged particle, (a) At low velocity, (b) At high velocity

longer completely symmetrical. In the azimuthal plane, symmetry is preserved, but along the axis there is a resultant dipole field which will be present even at large distances from the track of the electron. Such a field will be momentarily set up by the electron at each element along the track, each element radiating a brief electromagnetic pulse. So the speed of the particle is an important parameter that decides the emission characteristics of Cerenkov radiation.

In the general case, i.e., for low velocities, the radiation wavelets from all parts of the track interfere destructively so that, at a distant point, the resultant field intensity is still zero. However, if the velocity of the particle is higher than the phase velocity of the light in the medium, it is possible for the wavelets from all portions of the track to be in phase with one another so that at a distant point of observation there is now a resultant field. It will be understood from the Huygens construction shown in Fig. 2 that this radiation is only observed at a particular angle θ with respect to the track of the particle, namely, that angle at which the wavelets from arbitrary points such as P_1 , P_2 and P_3 on the track AB are coherent and combine to form a plane wave front BC. This coherence takes place when the particle traverses AB at the same time that the light travels from A to C. If the velocity of the particle is βv_0 , where v_0 is the velocity of light in vacuum, and μ the refractive index of the medium, in a time δt , the particle will travel a distance $AB = \beta v_0 \delta t$, and the light a distance $AC = \delta t (v_0/\mu)$,

$$\therefore \cos \theta = 1/\beta\mu \dots (1)$$

which is known as "Cerenkov Relation"

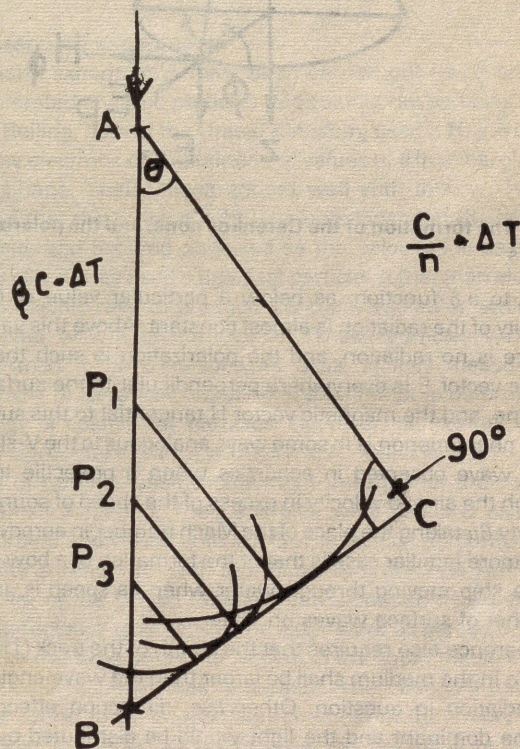


Fig. 2. Huygens construction to illustrate coherence

However, $\cos \theta < 1$. So, $\beta\mu > 1$ or $\beta 1/\mu$ and β_{\min} = the minimum value of $\beta = 1/\mu$, for which $\cos \theta = 1$ or $\theta = 0$ and $v = \beta v_0$ or $\beta = v/v_0$. At this critical velocity, the direction of radiation coincides with that of the particle, and below this threshold velocity, i.e., $v_0 \beta_{\min}$, no radiation takes place for a medium of given refractive index μ , since $\beta\mu$ (or $1/\cos \theta$) cannot be less than unity. For an ultra-relativistic particle for which $\beta = 1$, there is a maximum angle of emission given by $\theta_{\max} = \cos^{-1}(1/\mu)$. The radiation occurs mainly in the visible and near-visible regions of the spectrum for which $\mu > 1$. Emission in the x-ray region is impossible since μ is then less than unity and equation (1) cannot be satisfied.

Fig. 2 has been drawn in one plane only. There is, of course, complete symmetry about the axis of the particle. The light originating from each element of the track is propagated along the surface of a cone with apex is at this element, whose axis coincides with the track, and whose semi-vertical angle is the angle θ (Fig. 3). The distribution in θ of the light intensity approxi-

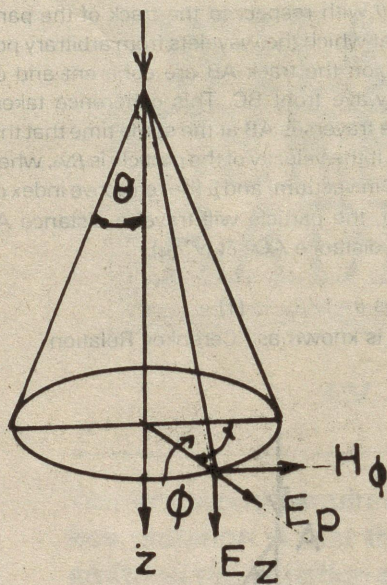


Fig. 3. The formation of the Cerenkov cone, and the polarization vectors

mates to a δ -function, as below a particular value of θ , the intensity of the radiation is almost constant. Above this value of θ , there is no radiation, and the polarization is such that the electric vector E is everywhere perpendicular to the surface of the cone, and the magnetic vector H tangential to this surface.

The phenomenon is in some ways analogous to the V-shaped shock wave observed in acoustics when a projectile travels through the air at a velocity in excess of the speed of sound, the quantity $\beta\mu$ taking the place of the Mach number in aerodynamics. A more familiar case is that of the formation of a bow-wave from a ship moving through water when its speed is greater than that of surface waves on water.

Coherence also requires that the length of the track (1) of the particle in the medium shall be larger than the wavelength λ of the radiation in question. Otherwise, diffraction effects will become dominant and the light would be distributed over an angle $\delta\theta = \lambda/1 \sin \theta$, instead of appearing at only one angle θ in eq. (1). The velocity of the particle must be constant during its

passage through the medium, or, to be more specific, the differences in the times for the particle to traverse successive distances λ should be smaller than period ($=\lambda/v_0$) of the emitted wave. Slowing down due to ionisation and multiple Coulomb scattering can be ignored. The medium must be a perfect isotropic dielectric, so that its conductivity is equal to zero, its magnetic permeability (μ) = 1 and it does not absorb the radiation. The medium may be considered to be a continuum extending infinitely in length and the microscopic (i.e., atomic or molecular) structure may be ignored. Further, the dispersion of the medium (i.e., variation of the velocity of light with frequency) is also neglected by Frank and Tamm in their theory. The velocity of the particle is not strictly constant, as the particle loses energy by ionisation. Hence β and θ change. However, coherence can be preserved if the deceleration of the particle is not too much. B.D. Nag and A.M. Sayied, both of Saha Institute, Calcutta, have worked out a theory for Cerenkov radiation, when the medium has a velocity and the electron moves with respect to a stationary observer in the medium. They obtained the same results as Frank and Tamm.

Early experiments and observations

Mallet carried out early experiments with a 30 mg radium source of γ -rays immersed in distilled water. He found that the emitted radiation was always composed of short wavelengths. He also found, by varying the depth of water, that the observed radiation was not absorbed in water. He repeated his experiments with carbon disulphide in place of water using a 250 mg radium E source. The emitted radiation spread between 2400 Å and 4360 Å. It was later confirmed by Cerenkov that this radiation was emitted by fast moving secondary electrons (this was confirmed by the use of a magnetic field) produced by the γ -radiation. He had also used β -rays (streams of electrons) and observed this radiation and made a crude verification of the fundamental relation $\cos \theta = 1/\beta\mu$. Cerenkov conducted experiments with many liquids including paraffin, xylol, toluene, etc. He observed that the intensities of radiation with these liquids as media do not vary much. The spread in the wavelength also is very small, with blue and violet radiations as the main components. He also observed that there is no decrease in the intensity of the observed radiation when silver nitrate, potassium iodide and similar compounds were added to the above liquids (media). Temperature also had no effect. Cerenkov carried out more thorough experiments in the year 1938 to verify the theory of Frank and Tamm. β -rays from a 100 mc (millicurie) radon source were passed through benzene and the light coming out of the liquid analysed by a spectrometer was found to be of wavelengths from 4300 Å to 6000 Å, with the maximum intensity around 5000 Å. It was found that this intensity distribution fits very well into the theory of Frank and Tamm. Similar experiments were repeated with water and a 150 mc radon source. The emitted radiation was found to be of wavelengths between 5360 Å and 5560 Å with a maximum at 5460 Å (the green line in the mercury spectrum). The measured intensities agreed very well with those predicted by Frank and Tamm. The agreements between theory and experiment were considered to be remarkable. Experiments were carried out with other liquids (as media), including cyclohexane carbon disulphide, carbon tetrachloride and isobutyl alcohol. Their refractive indi-

ces varied from 1.334 to 1.637. The deviation of the observed intensities from theoretical values had an average value of 6%, while the maximum value was about 10%.

Cerenkov used photographic techniques to study dependence of θ on β and μ . He used gamma rays (which produce secondary electrons which, in turn, emit Cerenkov radiation) from Radium and Thorium C. The angle θ was measured from microphotometer tracings. The variation of β with μ was obtained by using various liquids; variation with β (i.e., velocity of the particle, as $\beta = v/v_0$) was calculated from a knowledge of the energy of the γ -ray sources and an evaluation of the corresponding electron velocities. Fig. 4 gives experimental variation of θ with μ in water, C_6H_{12} (cyclohexane), C_6H_6 (benzene) and $C_{11}H_{12}O_2$ (ethyl cinnamate) for two different γ -ray sources thorium C and radium.

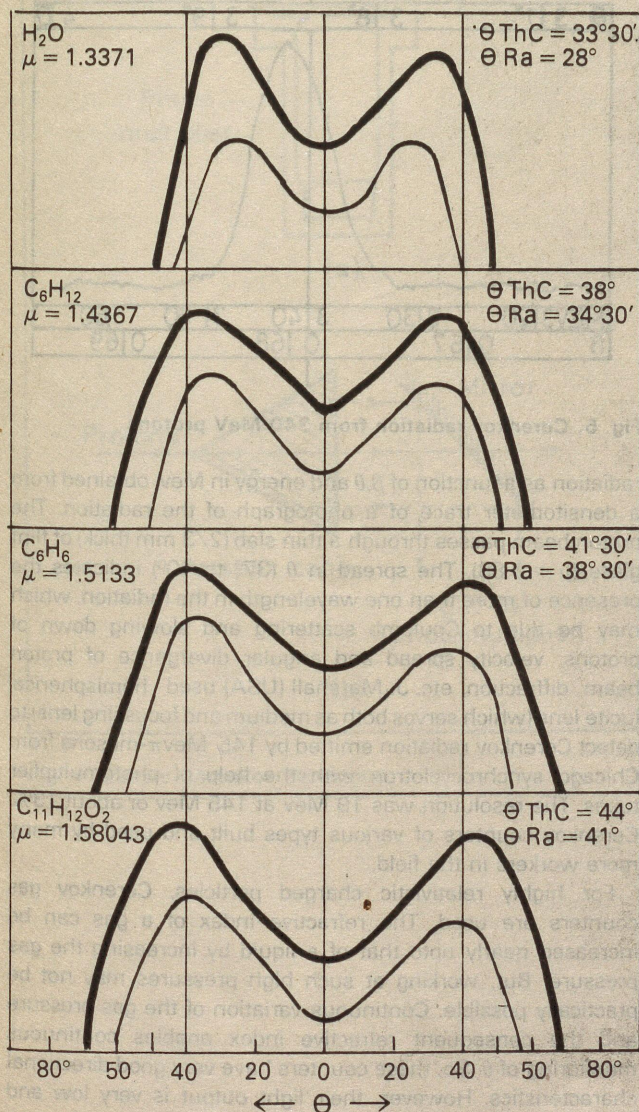


Fig. 4. Variation of θ with μ for two different x-ray sources

Bremsstrahlung vs Cerenkov radiation

Cerenkov radiation may be emitted to a small extent in the infrared region also, but many dielectrics have strong absorption bands in this region. It is difficult to detect this radiation just above the threshold velocity. The radiation is essentially due to the longitudinal polarisation of the medium and differs from another similar and important kind of radiation known as 'Bremsstrahlung'. It may be interesting to draw a few comparisons between the Bremsstrahlung and Cerenkov radiations, as both are associated with high velocity of charged particles. Bremsstrahlung depends upon the mass of the particle more than on its velocity and occurs in the Coulomb field of a screened nucleus. It occurs as a result of a few collisions involving relatively large energy transfer. The intensity of both these radiations is proportional to the square of the charge of the particle. The elemental dipoles causing the emission of Cerenkov radiation do not move, while bremsstrahlung radiation is emitted by the fast-moving accelerated charged particle itself. In bremsstrahlung the particle has an acceleration, while in Cerenkov radiation the particle is expected to move with constant velocity in the medium. There is neither any threshold velocity nor any requirement of coherence in bremsstrahlung radiation. The total energy radiated by an electron in a bremsstrahlung process is much higher than the Cerenkov radiant energy. Bremsstrahlung spreads over a wide range of the spectrum (mostly x- and γ -ray regions) while Cerenkov radiation is confined to the visible region only and cannot appear in the x- or γ -ray regions. The angle of emission of the radiation increases with the velocity of the particle in Cerenkov radiation while it decreases in bremsstrahlung.

Subsequent experiments

Many experiments have been carried out using artificially accelerated charged particles and cosmic ray particles. Collins and Reiling, both of the United Kingdom, used a $10 \mu\text{Å}$ beam of 2 Mev electrons and obtained the values of θ in mica, glass and cellophane. Their values agreed well with theory. They also found that the emitted light was unpolarised at the threshold velocity and became polarized as the velocity increased. J.V. Jelly of U.K. has used single fast particles (other than electrons) from cosmic rays to produce Cerenkov radiation, which was detected with a photomultiplier. These particles were later confirmed to be μ -mesons. P. Bassi of Italy measured the intensity of Cerenkov radiation in an attempt to determine the energy of cosmic ray particles. However, his results were in poor agreement with the theory. C.H. Millar and E.P. Hincks, both of Canada, used cosmic ray μ -mesons for their study of Cerenkov radiation. Their energies were selected using lead absorbers and varied upto 4.2 Gev for which $\beta = 0.9997$. Their results agreed well with the theory of Frank and Tamm. E.H. Belcher of the United Kingdom carried out some experiments using radioactive isotopes. The latter were dispersed uniformly (unlike the experiments of Mallet) in the liquid media in which Cerenkov radiation was generated. The observed intensities were found to be in good agreement with the theory. P.M.S. Blackett of United Kingdom observed Cerenkov radiation in gases, including air. Detection of Cerenkov radiation in gases would be somewhat difficult as their refractive index is very

close to unity. As a result, the intensity would be much lower, the threshold energy would be much higher and the maximum angle of emission would be much smaller. As an example, for air $\mu=1.00029$, $\theta_{\max}=1.3^\circ$, $E_{\min}=21\text{Mev}$ (for electrons), while for water $\mu=1.33$, $\theta_{\max}=41^\circ$ and $E_{\min}=0.26\text{Mev}$ (for electrons). However, many workers detected Cerenkov radiation in air, chloroform vapour and other gases using μ -mesons from cosmic rays.

Cerenkov radiation in the atmosphere was first studied by Blackett. He found that this radiation, produced by cosmic ray particles traversing the atmosphere, gives a small contribution (about 1 in 10000) to the light of the night sky. It was also found that there were momentary light pulses of considerably higher intensity in cosmic-ray-extensive air showers which contain electrons in abundance. The energy of electrons in these and other electron-photon cascade showers can be upto 100 Mev, much higher than the threshold energy for production of Cerenkov radiation. Jelly and W.J. Galbraith (U.K.) carried out extensive experiments in this direction. They found that these light pulses from atmosphere were highly directional and vanished abruptly above a particular angle. They also carried out polarisation experiments and concluded finally that these light pulses were due to Cerenkov radiation. A possible application of the detection of Cerenkov light pulses in atmosphere is the estimation of the electron density in cosmic ray air showers.

The Cerenkov effect can, in principle, be used for the generation of microwaves, as there is no limit to the Cerenkov spectrum on the longwave side, if the medium is free from absorption. Microwaves of low intensity can be generated by Cerenkov effect in ferrites.

Cerenkov counters

An important application of the discovery of Cerenkov radiation is the development of Cerenkov detectors for studies in nuclear and cosmic ray physics—for fast counting of charged particles; for determination of velocity for energy of charged particles moving with ultra high velocities; to discriminating particles with different masses or velocities or energies; and for an accurate determination of their charge and flux. Cerenkov detectors can be used for detection of neutrons also. High energy neutrons liberate protons which emit Cerenkov radiation. Low energy neutrons liberate γ -rays in a reaction. These γ -rays liberate secondary electrons which produce Cerenkov radiation. Cerenkov counters have a wide range of applications and they can be broadly classified into two classes: focussing type, and non-focussing type, depending on their use.

A good medium for a Cerenkov counter should have high refractive index, low absorption and dispersion, low density and low atomic number. Unfortunately, the requirements are not, in general, compatible with one another and some compromises must be made. For instance, a high refractive index (desirable for high light output) is usually associated with high dispersion and poor transmission characteristics, particularly for short wavelengths. Similarly, low density and low atomic number, both of which are desirable for minimum energy loss and scattering, are usually associated with low refractive indices. Glass and some plastic materials have been

found suitable for Cerenkov media. Polymethyl methacrylate (commonly known as perspex), which is easily available and cheap, is found to be a very effective medium. A relativistic particle of unit charge passing through 10cm of glass or perspex gives rise to about 2500 photons of visible light. Lucite is another useful material. Electrons, energetic enough to have appreciable range in lucite ($\beta=1$, $\mu=1.5$, $\theta=48^\circ$), generate 500 photons per cm of path of the coherent Cerenkov radiation. The electron loses about 2 Mev/cm in collisions while only 1 Kev/cm is utilised in the emission of Cerenkov radiation. Polystyrene is also widely used as a Cerenkov medium.

The American scientist, R.L. Mather observed Cerenkov radiation from 340 Mev protons produced in the 184-inch Berkeley cyclotron in 1951. Fig. 5 gives relative intensity of the

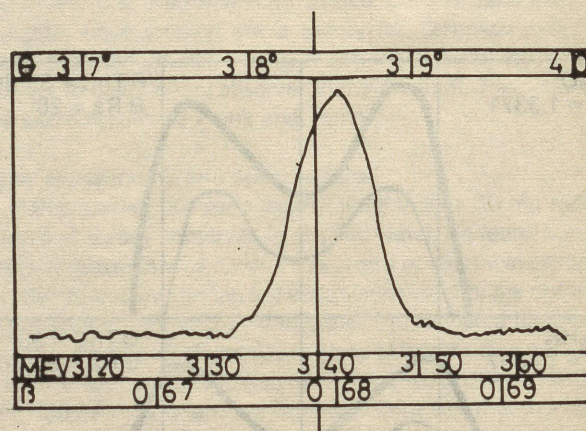


Fig. 5. Cerenkov radiation from 340 MeV protons

radiation as a function of β, θ and energy in Mev, obtained from a densitometer trace of a photograph of the radiation. The proton beam passes through a thin slab (2/3 mm thick) of flint glass ($\mu = 1.88$). The spread in θ (37° to 40°) indicates the presence of more than one wavelength in the radiation, which may be due to Coulomb scattering and slowing down of protons, velocity spread and angular divergence of proton beam, diffraction, etc. J. Marshall (USA) used hemispherical lucite lens (which serves both as medium and focussing lens) to detect Cerenkov radiation emitted by 145 Mev π -mesons from Chicago synchrocyclotron with the help of photomultiplier tubes. The resolution was 19 Mev at 145 Mev or about 13%. Cerenkov counters of various types built and used by many more workers in the field.

For highly relativistic charged particles, Cerenkov gas counters are used. The refractive index of a gas can be increased nearly upto that of a liquid by increasing the gas pressure. But, working at such high pressures may not be practically possible. Continuous variation of the gas pressure and the consequent refractive index enables continuous monitoring of θ . So, these counters have very good directional characteristics. However, their light output is very low and special efforts have to be made to increase sensitivity to detection. Critical temperature and pressure are important parameters that decide the choice of the gas, which has to be compressed greatly to achieve the required value of μ . The

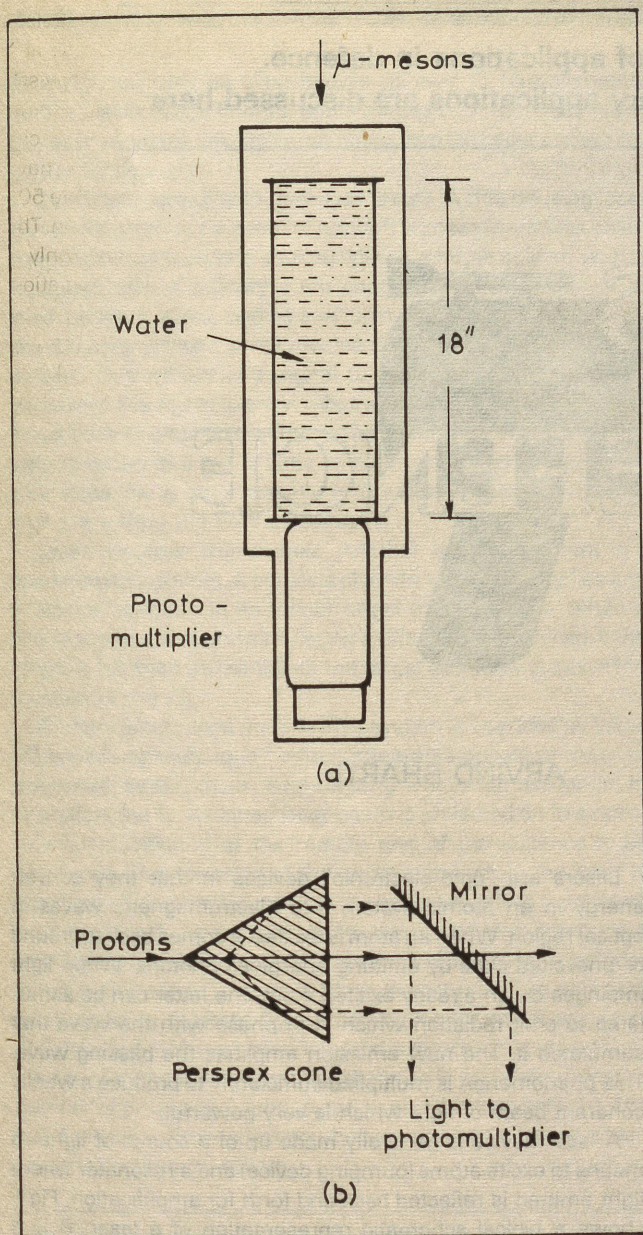


Fig. 6. Simple Cerenkov detectors

most useful gases are air, nitrogen, helium, argon, methane, freon and carbon dioxide. The threshold energies for fundamental particles to be detected by these counters are: electrons: 10 Mev - 60 Mev, μ and π mesons: 2 Mev - 17 Mev, protons: 20 Gev - 110 Gev, α -particles: 80 Gev - 450 Gev. The dimensions of a counter are decided by the path-length required for a certain amount of light output.

Cerenkov effect can be used for preparation of standard light sources as the intensity and spectral distribution of Cerenkov radiation can be evaluated with a knowledge of other parameters of the experiment. Cerenkov radiation has been observed by many workers in linear accelerators, as the velocity of charged particles in these linear accelerators is of the order of velocity of light, and the intensity may be quite appreciable. Cerenkov radiation has also been observed from water-moderated reactors of about 100 kW. In fact, many photographs of the Cerenkov light in water surrounding the core of the swimming pool reactor at Harwell, U.K., were taken. This radiation is emitted mainly by secondary electrons (mostly Compton-scattered) produced by absorption of γ -rays emitted from the reactor core. These γ -rays are generated in the fission process or in (n, γ) reactions or by the decay of activated core material. It is estimated that the Cerenkov output is about 10^{18} photons/sec from a 100 kW water-moderated reactor core. The intensity of the Cerenkov radiation can be used to determine the amount of fission products. V.I. Veksler of USSR proposed the concept of an inverse Cerenkov effect. The essential idea is that a medium, for example, an electron gas, moves very fast with respect to stationary heavy ions in the medium, conveying energy to the ions. This is an application of Cerenkov effect in a moving medium. Cerenkov radiation can be used to monitor the strength of a radioactive source, which can be immersed in the medium, as the intensity of the radiation can be related to the activity of the source.

Further reading

1. Mallet, L.C.R., *Acad Sci (Paris)*, 183(1926) 274; 187(1928) 222; 188 (1929) 445.
2. Cerenkov, P.A., *Dokl. Akad. Nauk, SSSR*, 2(1934) 451; 3(1936) 413; 14(1937) 101, 105; 20(1938) 651; 21(1938) 116319; *Physical Review*, (1937) 52, 378.
3. Frank, I.M., *Dokl. Akad. Nauk, SSSR*, 14(1937) 109; 42(1944) 341; *IZV Akad Nauk Fiz*, 6 (1942) 33.
4. Tamm, I.G., *Zh, fis, SSSR*, 1(1939) 439.

Lasers have a large number of applications in defence.
Some of their most interesting military applications are discussed here

LASERS IN DEFENCE

ARVIND BHARTI

LASER is an acronym for "Light amplification by stimulated emission of Radiation". A simple definition for a laser can be "A light-emitting body with feed-back for amplifying the emitted light". Laser produces an intense beam of a very pure single colour. Although Albert Einstein had recognised the possibility of stimulated emission in 1917, the first laser device was built by an American, T.H. Maiman only in 1960.

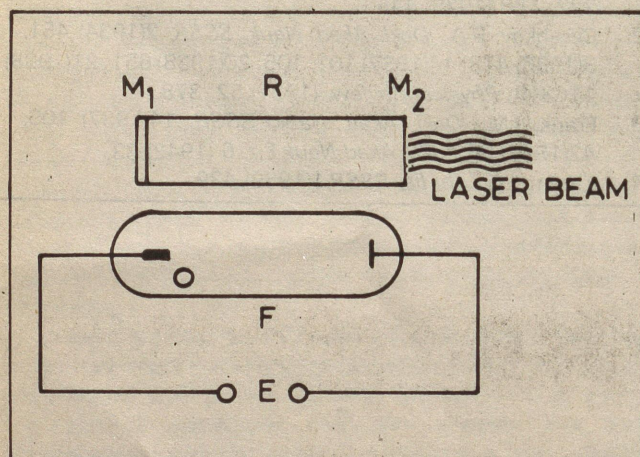


Fig. 1. A typical laser (schematic)

Lasers are "opto-electronic" devices in that they convert energy in an atomic system into electromagnetic waves in optical region. When an atom is excited, it comes back to ground or unexcited state by emitting energy as photons. When light impinges on an already excited atom, the latter can be stimulated to emit radiation which is in phase with the wave that stimulated it. The new emission amplifies the passing wave. This phenomenon is multiplied sufficiently to produce a wholly coherent beam of light which is very powerful.

A laser device is generally made up of a source of light—a means to excite atoms (pumping device) and a resonator where light emitted is reflected back and forth for amplification. Fig.1 shows a typical schematic representation of a laser. R is a resonator tube, mirror M₁ is fully silvered and mirror M₂ partially, so that light is amplified to a threshold value before it comes out as a pulse. F is a flashlamp or pumping device and E is electrical power source.

Laser frequency depends upon the choice of material system and laser action can be obtained at all visible colours as well as infrared and ultraviolet wavelengths. Being essentially electromagnetic radiation, a laser beam can be reflected, refracted, polarised and split by means of beam splitters.

Military applications

The military applications of lasers are varied and numerous. Some of the most interesting applications are mentioned here. They cover both destructive (as weapon) and non-destructive (detection and communication) aspects of laser systems.

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Broadly, they can be classified as follows: (i) Miscellaneous such as laser range finders, battle games with harmless laser; (ii) Laser weapons; (iii) Laser guidance; and (iv) Laser communication for defence.

Battlefield games with harmless lasers. A rifle housing laser generator produces a beam of pencil thickness (harmless beam from a gallium arsenide source). When a target soldier, who is equipped with a military outfit containing silicon sensors (in their helmets, arms, bodies and legs) receives the laser beam, the sensors activate a microwave antenna in helmet of each soldier. This transmits a signal to a central computer which processes the signal to show whether the soldier was 'hit' in the head, body or limb, so that he can be eliminated. When a soldier gets exposed in a mock battle in his most vulnerable part, his rifle stops firing automatically with an audio alarm. He is carried away from the field as casualty.

Laser marksmanship trainer. Another laser equipment is a marksmanship trainer. It consists of a rifle, target assemblies and a scoring console. In an indoor target training range, when a rifle is triggered, sound simulating a rifle shot is produced. If the target is hit, then the sensor in the target assembly displays the location of the hit.

Artillery laser range finders. This system is operated by using "Q-switching technique" which generates pulses of several-megawatt peak power, each lasting a few nanoseconds. In operation, the Q-switched laser beam is projected on to a retro-reflector positioned at the remote end of the distance to be measured. The counting of the pulse starts when the laser is triggered off and continues until the beam returns to the system from the target. As the laser beam leaves the laser aperture, a small portion of the laser energy is sampled by a silicon photodetector which starts a mega-hertz pulse counter. The returning laser signal is detected by a photo multiplier and is amplified and then fed to the counter. When the returned signal reaches the counter, the latter stops. The distance is calculated from the number of pulses, the pulse duration and the speed of light. The present range finders employ helium-neon gas lasers which are less costly than others.

The equipment can be made compact and portable by using Ni-Cd rechargeable batteries. Some of these finders are used in tracking rockets, aircraft and missiles. These finders can lock with the moving target so that a continuous surveillance on the position and distance of the target is possible. Laser range finders are standard equipment in many types of military hardware. Artillery range finders using Nd-YAG lasers are mounted on tanks, and the information received by the range finder is transmitted to a centrally located computer. This type of range finders can find out the position of a target (5 Km to 8 Km away) within tenths of a centimeter. The present trend is to use space as an operational environment with satellites as headquarters for information processing. The advantage of such a system is the ability of laser beam to propagate in space without significant loss in energy.

Colidar

A successful colidar (coherence light detection and ranging) or laser radar is reported to have been developed recently in the US. Based on the range finder principle, laser radars are very useful for detection at short distances and low altitudes where conventional microwave radars cannot work. So, colidars and microwave radars can be combined to cover a wide range, from very close to quite far. As the laser beam locks on to the target, very precise information regarding velocity and position of moving target can be achieved. Accuracy claimed for a colidar is 35 cm from 80 Km in position and 25mm/s in velocity. The colidar is portable because both transmission and receiving devices are fitted in one assembly.

Laser weapons

Several laser weapons have been devised. They include laser rifles, laser handguns, target-penetrating high power laser, free electron lasers and high power laser equipment.

Laser rifle. In a laser rifle, the laser rods are individually activated by flash lamps which receive high voltage pulsed current from a bank of capacitors contained in the stock of the

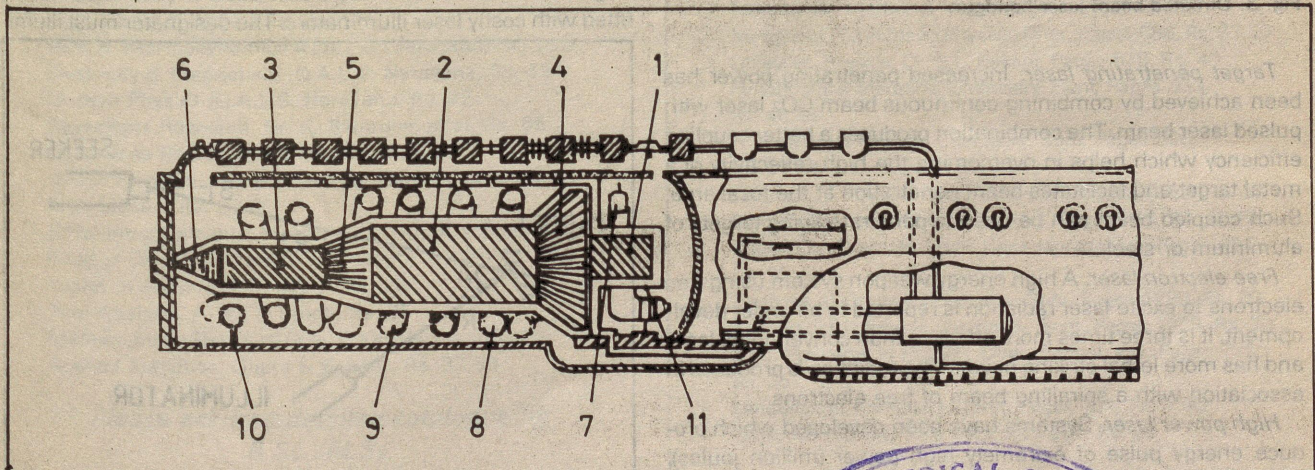
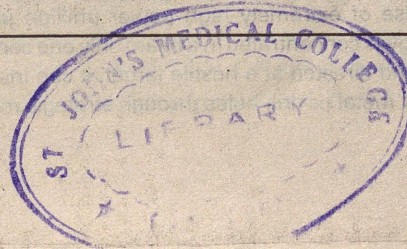


Fig. 2. Directed-beam laser rifle



rifle. The capacitors are energised by a self-charging battery network. A vibrator mechanism converts low voltage direct current to a pulsating high voltage current for energising the flash lamps.

Fig. 2 shows sectional diagram of a laser rifle (forward half) in which laser generation set is located. Generator consists of three ruby or Nd-YAG rods designated 1, 2, 3 which are disposed alternately between fibre optic cones 4, 5 and 6. The fibre optic cones amplify the laser beam by condensing the beam before transmitting it to the next laser rod. The laser rods are excited to emission by flash lamps 7, 8, 9 and 10. Flash lamps and laser rods are separated by the fibre optic cones. There is glass envelope 11 through which a cooling fluid circulates to cool the lasing elements. When the laser triggering mechanism is actuated, this fluid is supplied from a compressed fluid reservoir within the system. The range of a laser rifle is about 200 meters.

Laser handgun. Fig. 3 shows the schematic cross-section of a typical laser handgun. Its range and power are both less than those of laser rifles, but it has sufficient power to incapacitate a person from 20 odd meters. Both laser rifle and handgun were first patented by an American Arthur M. Muncheyan.

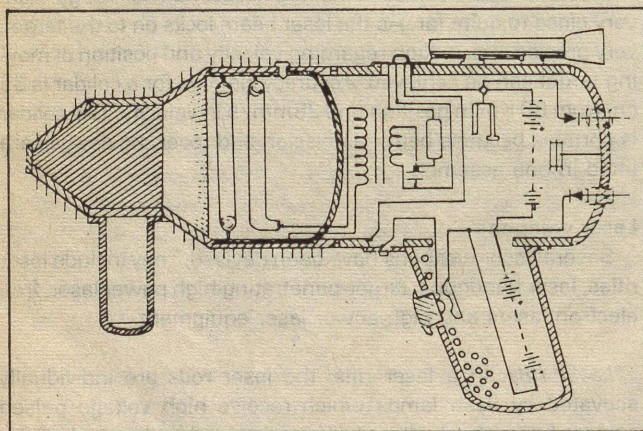


Fig. 3. Directed-beam laser handgun

Target penetrating laser. Increased penetrating power has been achieved by combining continuous beam CO₂ laser with pulsed laser beam. The combination produces a better coupling efficiency which helps in overcoming the high reflectivity of a metal target and facilitates beam penetration at the focal area. Such coupled beam can be used to penetrate flying targets of aluminium or steel.

Free electron laser. A high energy weapon system using free electrons to excite laser radiation is reported to be under development. It is three times more effective than conventional laser and has more lethal striking power. The radiation is produced in association with a spiralling beam of free electrons.

High power laser. Systems have been developed which produce energy pulse of extremely high power (million joules). When such energy is concentrated in a beam only one centimeter in diameter and directed at a hostile target, it can instantly cut large areas of metal or drill holes through strategic mecha-

nisms to deactivate or destroy them. The system could produce energy equivalent of nuclear fission and could be made use of in triggering an H-bomb without a thermonuclear device.

Laser guidance

Applications of the laser to guide a missile or smart bomb are characterised by some attractive features. In comparison to their microwave counterparts, angular resolution of laser systems are an order of magnitude higher with much smaller aperture/antenna. In a laser system, the target can completely intercept the beam and so return a stronger signal, avoiding the waste of transmitted power. Further unlike radar signals laser signals are very difficult to detect. So, generally laser systems are immune to conventional electronic counter measures (ECM). Laser systems can be normally harmonized with weapons sight and systems.

These advantages have led to successful development of laser guidance systems for bombs, missiles and projectiles.

Active command guidance. In an active guidance system, a transmitter is fitted in the missile itself and the receiver guides the missile onto the radiation reflected from the target. An active laser sector incorporates a small Nd-YAG laser in the nose of the missile and pulsed energy is directed towards the target by a system of gimbal mounted optics. The return energy is collected and concentrated on a four quadrant silicon detector which provides directional information to the guidance processor. In air-to-air application, the system tracks the body of an aircraft. This yields enhanced terminal accuracy. As it is a self-contained system, the pilot can launch the missile and move away.

The pulsed mode of operation and narrow field of view can be exploited through proper signal processing to give high degree of immunity to counter measures and to provide high degree of resistance to background noise.

Semi-active terminal guidance. This is the most widely used form of laser guidance. The target is illuminated by a laser designator either located on ground or on board an aircraft. The missile homes on to the scattered laser radiation from the target. This has an advantage that each missile need not be fitted with costly laser illuminators. The designator must illumi-

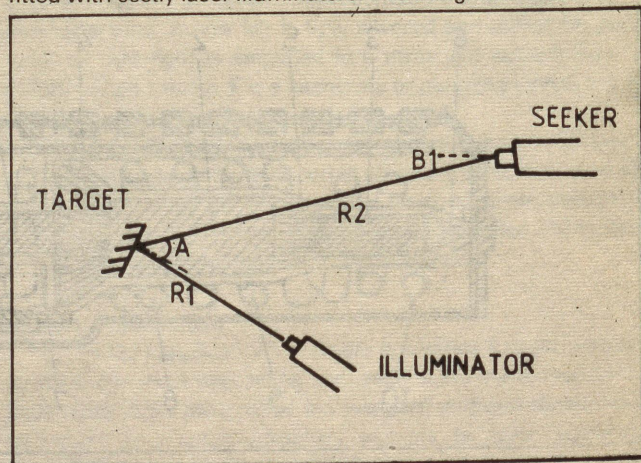


Fig. 4. Semi-active guidance system (schematic)

nate the target throughout the flight of missile or bomb.

Passive system. In passive laser guidance, the missile or a smart bomb can home on radiation emitted by the target. As such laser designator sources can become easy targets for a passive guidance system. Aircraft which is being tracked by a laser beam riding missile guidance system, can release passive laser-guided missile to home on the object emitting the laser beam, and thus destroy the missile on its flight before it hits the aircraft.

Beam riding. In a guidance system a beam radiation is directed at the target and the missile centres itself on the beam. Practically, zero inertia beam deflection techniques have made fast scanning type laser system attractive and reliable. In a typical surface-to-air application, the tracking laser can easily lock on to a low flying target. The missile rides the beam that has followed the target leading to a highly reliable overall system.

Laser communication

The high coherence and directionality of laser beams make laser communication between several locations at one time possible. The band-width of laser is so wide (10^{13} Hz to 10^{15} Hz) that ten million separate communication lines can be carried at the same time. The transmitted beam is many orders of magnitude narrower than radio frequency waves. So it can be conveniently used for short range terrestrial paths, closed pipe

system, and in space. Further, as green colour laser can travel in water (over a limited distance), it is possible to communicate under sea with a satellite.

Further readings

1. Einstein, Albert, on the Quantum theory of Radiation (Reprinted in *The Old Quantum theory*, Elmsford N.Y. Pergamon, 1967 pp. 167-183).
2. Brown Ronald (*Lasers A survey of their performance and applications*), London Business books limited, 1969, pp. 67-68.
3. *Encyclopedia Britania*, Vol. 10, p.686, 15th edition, 1981.
4. VonAllen, Martin R. (*Coupling of Laser Radiation to Metals and Semi-Conductors*), (in Physical Process in Laser-Materials Interactions, Editor. M. Prertoliti) NATO, Advanced Study Institute Series B: Physics, Vol. 84, pp. 49-75, Plenum Press, New York.
5. Mukunda Rao, M. and Sirohi, R.S., *Laser Technology and Applications* (Pub. COASTED), 1984 pp. 11-44.
6. *Lasers and Applications*, Vol. 4, No.10 (1985), pp. 6-11.
7. *Ibid*, Vol. 10, No.6 (1986), p.22.
8. *Ibid*, Vol. 10, No.7 (1986), pp. 5-16.
9. NATO's Defence FOFA, but still nuclear Karl-Heinz-Kamp, International Defence Review 7, 1986, pp.901-902.
10. Muncheryan H.M., *Laser Technology*, Howard. W. Sons & Co. Inc., USA, 1979. pp.221-222.

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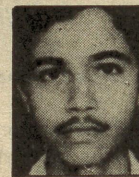
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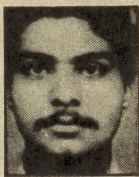
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Learning by instinct

"INSTINCT" and "learning" are two different approaches to explain behaviour in the animal world. Instinct is animalistic in origin in the sense genes, units of heredity, guide behaviour. It is something which is inherent in man and animals. On the other hand, learning, which involves conscious decision-taking, is what the prevailing environment moulds the behaviour of a living being to assist in its fight for survival. Egotist that man is, he has always been believing that he is the only animal which has the capacity to learn. Instinct was therefore condescendingly referred to as "animal instinct". Whether to search for food or save itself from a predator, it was supposed that the "lower" animals always resort to instinct. These conclusions were however based on superficial observations because ethology, the study of animal behaviour in the wild, needs enormous time and patience. It is only in the last decade or so that scientists have been seriously studying the behaviour of animals, birds and insects not only in the wild but also under the controlled conditions of laboratories. Their studies have now revealed that instinct or learning does not work in isolation and independent of each other; they mutually reinforce each other (*Scientific American*, January '87). Instinct alone takes an animal, bird or insect nowhere in its fight for survival. After all, there are several factors changing in an environment due to climate, weather and season. The living being has to learn by instinct in order to adapt itself to the environment for survival.

The biggest flaw in the previous experiments on animals under laboratory conditions (the subject being called "Behavioural psychology") was that an animal, bird or insect was supposed to learn all that it was conditioned to learn. Experiments of the last decade or so have however shown that an animal would only learn something if it has an instinct (a result of evolution) for it. For instance, pigeons could be conditioned to peck at a spot for reward but if they were conditioned to jump for it they could not do so. Again, rats readily learnt to press a bar for food but they could not do so to avoid shock; instead, they could learn to jump to avoid shock. Moreover, rats were found to be sensitive to odour because in normal course their survival depends upon not eating dangerous foods. Pigeons, on the other hand, were found to be sensitive to the colour of seeds for similar reasons. Recent experiments have shown that pigeons learn to use their beak to identify novel seeds as food and rats their sense of odour for novel foods. In short, there is something that an animal learns by instinct. Instinct and learning interplay to mould the behaviour of a living being to suit environment.

Experiments have further shown that animals do exhibit other characteristics of learning which we consider our prerogatives. For instance, just as we keep in our memory the location of our homes, a honey bee has been found to memorise the source of nectar. It keeps in its memory the source of nectar in the following hierarchical order—the odour of nectar, the colour of flower that contains nectar, the shape of the flower, the time at which the flower opens, so on. Like we categorise things into abstract groups, for instance, table, chair, lamp, etc. are categorised as "furniture", pigeons have been found to categorise trees. On occasions, they have been found to confuse a telephone pole or a TV antenna for a tree, just as a human infant would. Similarly, birds have been observed to be born with a basic song which they improvise upon on listening to their

parents and neighbours and produce a song with a stamp of their own individuality required in proclaiming their territorial rights. This is not unlike a human infant who is born with a recognition for few sounds. It is in the company of parents and relatives that he begins to improvise upon and enrich his vocabulary to acquire a language. All these aforementioned examples are sufficient to indicate that the boundary between instinct and learning has blurred and a new behavioural unity between animals and man has emerged.

Dilip M. Salwi

Farmers on the sea-floor!

YES, there are farmers on the sea-floor! This is not from a Science fiction novel which describes an ancient civilization existing underneath the oceans and seas. This is the finding of two geologists of the U.S. Geological Survey, C. Hans Nelson and Kirk R. Johnson (*Scientific American*, February 1987). According to these geologists, California grey whales and Pacific walrus are those farmers tilling the sea-floor in their search for food. In the process, these creatures are digging out not only nutrients from the sea-floor as food for other small marine beings but also mud which is ecologically harmful to marine beings dwelling there. In fact, these creatures are digging out more mud than what a river (in this case Yakon river) is releasing into the sea. In other words, the creatures are inadvertently maintaining an ecological balance which would be threatened with the fall in their population. Nature's exquisite ways of performing a balanced functioning are manifold—and here is one!

Unusual pits and furrows on the sea-floor came to the notice of C. Hans Nelson when he was using sound waves to survey the sea-floor of the Bering Sea for any evidence of geologic hazards to offshore oil platforms and pipelines. Sure that those markings could not be the result of some geological activity, his first suspicions naturally fell on California grey whales which visit that part of the sea because for several centuries now whalers and scientists have observed the presence of mud in the stomach and plume of whales. Further studies showed that those whales go down to the sea-floor to excavate their favourite food, the bottom-dwelling crustacean amphipod. They have been observed to create a series of pits before they surface. Long sinuous furrows on the sea-floor have been attributed to the local walrus because broken clams, their favourite food, have been found near them. Otherwise, the furrows could as well have been the markings of keels of ships and submarines.

When whales bite sediments on the sea-floor for amphipods, they release into the water not only mud covering the sandy floor but also nutrients and juvenile amphipods. Nutrients are food to plankton which itself becomes food to amphipods. Moreover, amphipods thrive in disturbed habitats—the pits created by whales. They are also averse to the presence of mud. In short, by searching for food on the sea-floor, whales create

favourable conditions for juvenile amphipods to grow and become food for them in the next season! It is like growing one's own food by tilling the land!

Dilip M. Salwi

Winged bean—A versatile plant

In developing countries, cultivation of legumes is the best and quickest way of augmenting production of food proteins. The whole human population depends upon 20 food plant species only. This is a dangerously small number to depend upon to feed the world. Biologists are now digging into nature's genetic stockpile of lesser known plants. Increased supplies of vegetable proteins by members of the Fabaceae are being explored.

One plant with potential to enrich deficient diets with protein of high quality is the winged bean (*Psophocarpus tetragonolobus* L.) DC. Its sprouts, shoots and leaves have the highest vitamin A recorded in a tropical plant. This is an important discovery, for in many developing countries, thousands of young children go blind every year due to vitamin A deficiency. Flowers of the plant, when fried, make a sweet dish with the appearance and texture of mushrooms. Young pods which are one of the six different foods supplied by this plant, make a succulent green vegetable that is eaten raw, steamed, boiled, fried or pickled to make a crisp, chewy delicacy. Seeds virtually duplicate soyabeans in composition and nutritional value. They are rich in protein, oil, minerals, vitamins and essential aminoacids. Because of the presence of certain antinutritive factors, mature winged bean seeds must first be cooked before consumption, a phenomenon common to several leguminous seeds. The tubers, like small carrots, have four times the protein content of potatoes and have a delicious, nutty flavour when cooked. Winged bean seeds are used for various purposes around the world (Table 1). The chopped plant is also used as green manure, cover, and forage and as a restorative crop because of exceptional nodulation.

Agronomy

The winged bean is a climbing herb which reaches upto a

Table 1

Oil	— Thailand and Ghana
Flour	— Asia, Africa and USA
White milk	— Thailand
A nutritious weaning gruel	— Ghana, Czechoslovakia
Coffee substitute	— Indonesia
Effective pest control agent against Bruchid beetles which attack stored legumes	— Indonesia



Winged bean

height of 3 m-4 m. Leaves are alternate, pulvinate, and trifoliate. Flowers are large and showy and the range of colours vary from near white to deep purple. The pods are four-cornered, with wings at each corner. Pod colours range from green—the most common colour—to pink, red or purple. Wings may be wavy, serrated or lobed. Individual pods contain from 5 to 20 seeds. The seeds, shiny and globular, range in weight from 0.04 g to 0.64 g.

The winged bean can develop large numbers of nitrogen-fixing root nodules, often exceeding the number formed on other legumes. Excellent nodulation without any need for inoculation appears to take place wherever the crop has been grown. The roots enlarge to form tubers of the size of small carrots. Their firm, ivory white flesh has a pleasant nutty flavour when cooked.

Environmental requirements

The winged bean has traditionally been cultivated between latitudes of 20°N and 10°S. For good growth the plant requires ample and well-distributed moisture. It is traditionally cultivated in areas with annual rainfall in the range 700 mm-4,000 mm. It thrives in hot, humid areas with 2,500 mm or more of annual rainfall. It grows well in soils with low organic matter and in sandy loam or heavy clay. It does not do well in very alkaline or very acid soils. Its 'ideal' pH limits are given as between 5.5 and 4.3. Like many other legumes, the winged bean is susceptible to aluminium toxicity on acid soils. It withstands high temperature but almost never survives frost. Continuous day temperatures higher than 32°C or lower than 18°C inhibit flowering.

Cultivation

Winged beans are grown mainly in small plots, subsistence or backyard gardens, the edges of fields, and against fences or walls. Best results can be obtained when the crop is planted during May-June. In India, and in many other tropical countries, the onset of rainy season is preferred for raising this crop. In many countries spacing of about one meter between rows and

25 cm-70 cm between plant is recommended. Seeds are planted at a depth of 2 cm-3 cm. In the first month of cultivation, weeds must be controlled. Staking the crop increases yield.

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Methanogenic bacteria—a unique biological group

METHANOGENIC bacteria are a unique type of microorganisms which produce methane. They are perhaps the strictest anaerobes known, requiring not only oxygen-free conditions but also a reducing potential less than -330 mv. Methane production plays a key role in the anerobic decomposition of organic matter. By consuming the fermentative products of higher trophic levels, they are essential animals, rumen of animals, sanitary land fills, hot springs and wet wood of living trees.

The first observation of methane production is credited to the Italian Physicist Alesandro Volta in 1776 and was named as

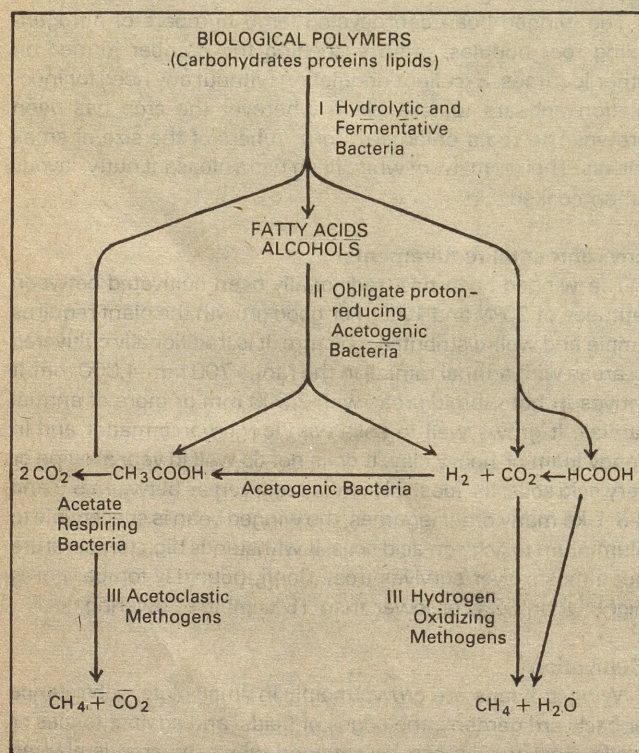


Fig. 1. Flow diagram for anaerobic decomposition of organic matter

“marsh gas” or “combustible air”. The identity of this as equivalent to the synthetic illuminating gas, methane, was made in 1806. It was Bechamp, a student of Pasteur, who provided the evidence in 1868 that the methanogenesis was a microbial process carried out by a microscopic living “ferment”. Since the work of Bechamp, numerous studies on methanogenesis have led to a clearly defined bacterial origin of methane.

The microbial production of methane is now known to involve three stages or groups of bacteria. The first stage involves the breakdown of polymers (cellulose, etc.) to organic acids and alcohols by hydrolytic fermentative bacteria (These bacteria are mostly anaerobes). These compounds are converted to acetate, H₂ and CO₂ by the second group of bacteria which are normally called the H₂ producing acetogenic bacteria. The third stage involves the conversion of acetate and H₂ plus CO₂ to methane by methanogens (Fig. 1).

Nutritional requirements and metabolism

The methanogenic bacteria have enormous biosynthetic abilities and have simple nutritional requirements. They grow autotrophically in mineral salt media containing CO₂ as a carbon source and H₂ as an energy source, except *Methanothrix* and *Methanococcoides*. Many of these autotrophs also utilise formate, a one carbon compound, as the carbon source. *Methanothrix* utilises acetate, a two carbon compound, and *Methanococcoides* utilizes methylamine and methanol. A thermophilic strain of *Methanosarcina* utilises acetate, methylamines and methanol. Thus the methanogens are either autotrophs or utilise simple organic compounds such as format, acetate, methylamine, etc. and occupy the terminal position in anaerobic food chain.

The methanogens are metabolically unique. The known bacteria CO₂ fixation pathways, the Calvin cycle, the serine pathway, or the hexulose pathway are not present in them. The mechanism of methane formation is equally unique in the microbial world and involves several novel coenzymes. Today, seven coenzymes and factors that are not found in any other group of bacteria have been identified in methanogens. Many of the coenzymes unique to methanogens are present in greater abundance than the typical vitamins. These coenzymes are: (1) Coenzyme M, (2) Coenzyme F₄₂₀, (3) Coenzyme F₄₃₀, (4) Methanopterin and Formaldehyde Activating Factor (FAF), (5) Component B, (6) Methanofuran or carbon dioxide Reducing Factor, and (7) Corrinoids.

Cell wall composition

The chemical composition of the cell wall of methanogenic bacteria is unlike other prokaryotes. They lack typical bacterial peptidoglycan muramic acid. Pseudomurin is found in the members of the order methanobacterials, which contain L-talosaminuronic acid instead of muramic acid of eubacteria, and exhibit different types of linkages and amino acid sequences (Fig. 3). The main cell wall component of *Methanosarcina* consists of a heteropolysaccharide containing glucosamine, neutral sugars and uronic acid, and lack typical N-acetyl glucosamine and D-glutamic acid of typical bacterial cell wall. All

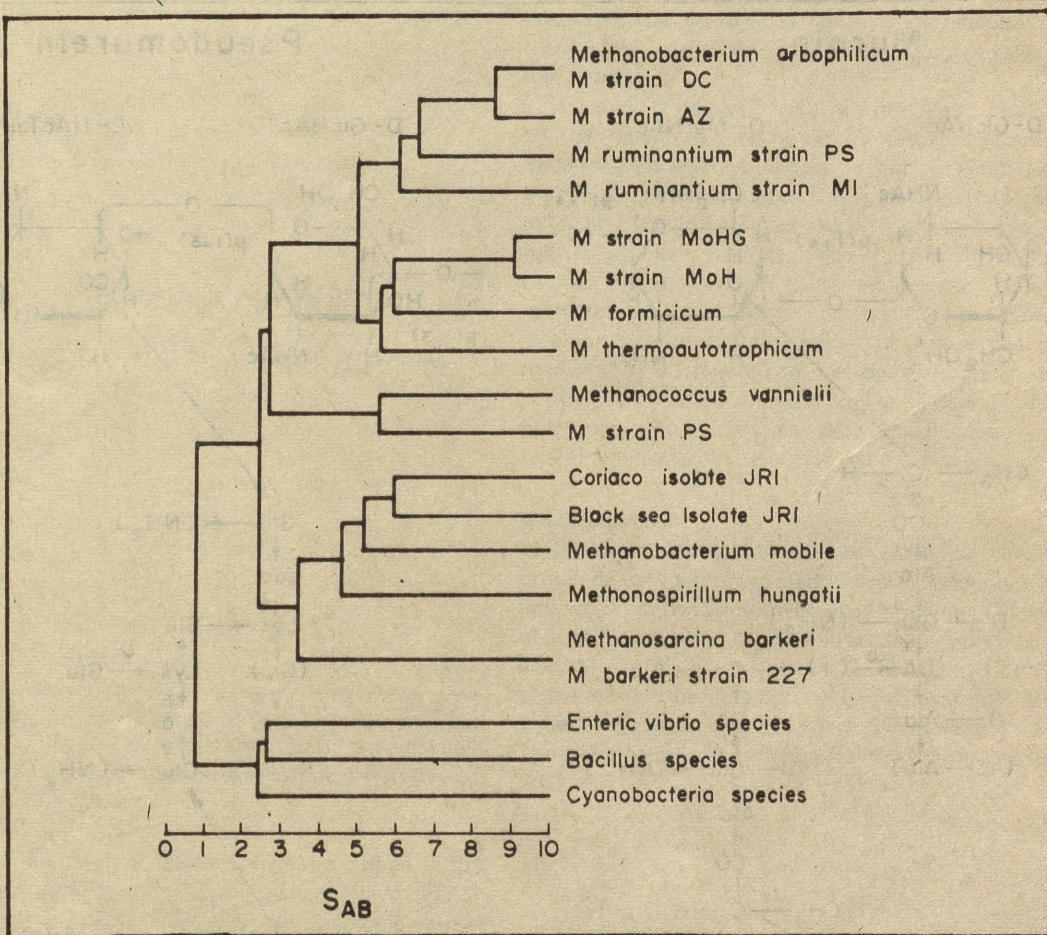


Fig. 2. Dendrogram of the phylogenetic relationships of methanogens and typical bacteria based on 16S RNA analysis

other methanogenic bacteria contain protein subunits in their cell wall composition. This makes them insensitive towards antibiotics such as penicillin, cephalosporin and vancomycin.

Cell membrane

Cell membrane lipids are perhaps the most invariant and unique aspect of the methanogenic bacteria. Unlike the straight chain fattyacids and fattyacid ester glycerol lipids that are characteristic of eubacteria and eukaryotes, methanogenic bacteria contain isoprenoid and isopranyl glycerol ether lipids (Fig. 4). These and other facts suggest important differences in the construction of membrane superstructure in methanogens which challenge a number of basic concepts of membrane biochemistry.

Methanogenesis

Methanogenesis occurs in anaerobic enrichments at temperatures from about 0°C to 100°C. Low temperature (Psychrophilic) methane producing bacteria have not been isolated. Most known methanogens are mesophilic (require moderate temperature of 21°C-45°C). Five thermophiles (which require

higher temperature) having an optimum between 50°C and 80°C have been isolated. More recently, active bacterial methanogenesis at 100 + 2°C and in certain samples at 300°C have been observed in enrichment water samples collected from submarine hydrothermal vents and they contained cells that exhibited blue-green autofluorescence, a typical character of methanogenic bacteria (Baross *et al.*, 1982 and Winfrey, 1984). This is one of the most amazing discoveries about these unique bacteria. This revolutionary observation destroys all current concepts on the upper temperature limits of life and future studies on these extreme ultrathermophilic methanogens and their associates may lead to new information on the nature of the life itself.

The archaebacteria

Thus the methanogens with their rRNA oligonucleotide sequencing, novel catabolic and anabolic pathways, deviation in protein synthesis at both transcription and translation levels from typical bacteria and typical eukaryotes, and their unique lipid and wall structure have resulted in their classification as a third primary kingdom—the Archaebacteria. In addition to

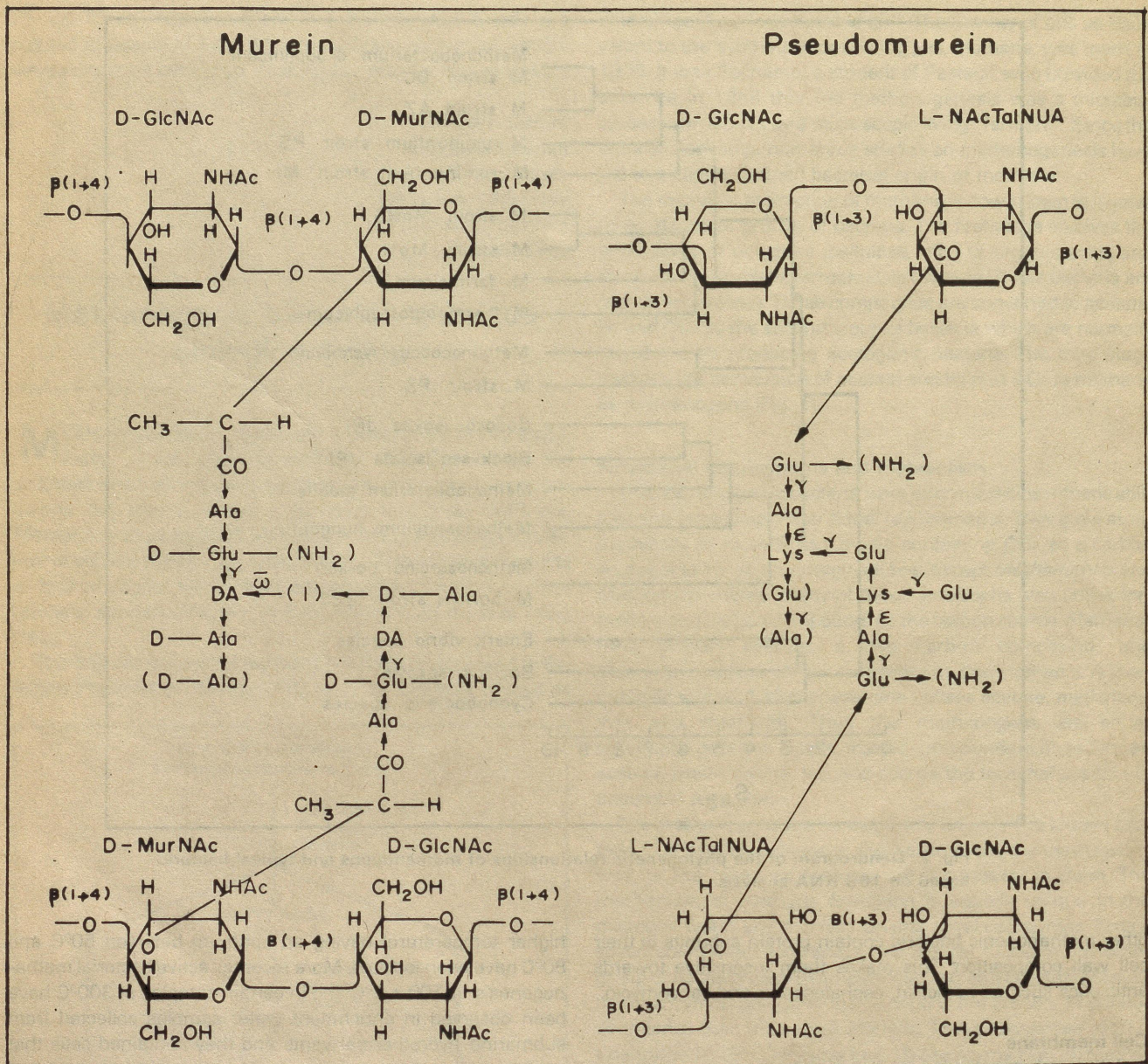


Fig. 3. Comparison of the primary structure of the murein (peptidoglycan) of eubacteria and the pseudomurein of the methanobacteria

methanogens, the other archaeobacterial types are the so-called extreme halophiles (salt lovers) and extreme, thermophiles (heat lovers). These two groups thrive in drastic living conditions. The halophiles (*Halobacterium*) thrive in the Great Salt Lake, in the Dead Sea, and in salt evaporation facilities, where they can carry on a unique version of photosynthesis. Instead of usual chlorophyll, the halophiles use a pigment called bacteriorhodopsin to harness the sun's energy. Some inhabitants of deep-sea volcanic vents flourish in temperature about 104°C—the water is kept from boiling by the extreme pressure of the ocean depths. And then there are thermoacidophiles (*Sulfolobus* and *Thermoplasma*) that live under even harsher condi-

tions. The thermoproteales are the most recently discovered group of extremely thermophilic organisms, isolated mainly from volcanic walls. The best studied Archibacteria are methanogenic bacteria.

Thus the methanogens are unique in the microbial world. Their importance in the anaerobic decomposition of organic matter and carbon cycling, and their potential use in the production of valuable energy source, methane, make them a fascinating and valuable group of bacteria to study. In the last one decade numerous advances in our understanding of methanogens, methanogenic habitats and methanogenic process have been made. The knowledge gained in the methanogenic inter-

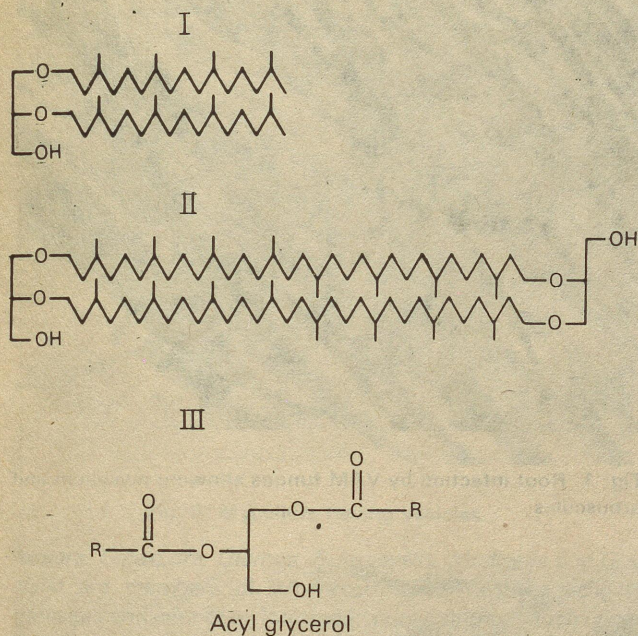


Fig. 4. Structures of C_{20} diphityanyl glycerol diether (I) and C_{40} dibiphyanyl diglycerol tetraether (II) found in the polar lipid fraction of methanogens (III) structure of ester linked fatty acid commonly found in eubacteria

actions and interspecies H_2 transfer reactions helped in the modern designs for anaerobic digesters that have greatly increased the speed and efficiency of anaerobic waste treatment.

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Deodar and its uses

BOTANICALLY known as *Cedrus deodara* (Roxb.) Loud, the Family *Pinaceae* occurs naturally throughout the western Himalayas—from Afghanistan to Garhwal—at elevations ranging from 1,200 m to 3,000 m above sea level. It is most common at 1,800 m to 2,600 m. The deodar belt varies in different localities. It is usually higher on the southern slopes than on the northern slopes. The plant occurs in nature on mountainous country with slopes varying from moderate to precipitous, as well as on level ground on river valleys at suitable elevations.

The luxuriant deodar forests are found where rainfall varies from 100 cm to 175 cm. They however fail to grow where rainfall is high as in eastern Himalayas. The growth rate is high if soil is fairly porous and fertile. In southern Indian slopes, growth is usually poor. In Mussorie, the life-cycle of *Cedrus*

deodara is completed in 18 months after initiation of cones. But the duration of the cycle may vary according to altitude, locality and season.

The wood of deodar is durable due to presence of an essential oil—the reason why it is rarely attacked by white ants and fungi. Because of its lasting qualities, the ancient Egyptians employed it for making mummy cases. It was also used to keep insects out of the ancient tombs. Deodar wood is primarily used for making railway sleepers, wagons, packing cases, spars, floor boards, ceilings, framework and doors, etc. Deodar timber is recommended as a substitute for teak and sal wood. Many tribes and local inhabitants of nearby areas use the wood of deodar as a medicine. It is reported to possess diaphoretic, diuretic and carminative properties, and is said to be useful in fevers, piles, pulmonary and urinary disorders. The bark is astringent and useful against fevers, diarrhoea and dysentery.

Cedarwood oil

On steam distillation saw dust of deodar yields a reddish brown oil with a characteristic balsamic odour due to the presence of *p*-methyl-3-tetrahydroacetophenone (8%-10%). Esters of butyric, isobutyric, hexoic and an unidentified crystalline acid (m.p. 110°) are present in the oil. On an average 2.5-3.0 per cent of the oil can be obtained by steam distillation process. The residue can be used as fuel which burns without a sooty flame. The essential oil can also be obtained from stems (8%-14%) of the tree.



Fig. 1. Cedarwood plant in Himalayas

Large quantities of cedarwood (deodar) oil are used in India in perfumery for scenting soaps, in room sprays, as disinfectants and allied products. It is also widely employed as a tissue-clearing agent in animal and plant histological works and in oil immersion lens studies. Commercial potentialities of the Himalayan cedarwood oil prompted the drug industry of Kashmir to undertake its large scale production.

Recently, Central Institute of Medicinal and Aromatic Plants, Lucknow, has identified the insecticidal principal of cedarwood oil. It has been found to be a repellent agent against economically important insect pests, including pulse beetle, rice lesser grain borer and fruit fly *Drosophila melanogaster*, which destroy food crops. It is effective against mosquitoes, houseflies and cockroaches.

The advantage of cedarwood oil is that it is non-toxic to mammals and is easily available. It has a pleasant odour and is cheaper than other natural insecticides, it can also protect warm clothes and carpets from moths, termites and ants. There is a wide scope for the utilization of this oil as a substitute for conventional insecticidal spray fluids.

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Vesicular – arbuscular mycorrhizae—a source of increasing agricultural crop production

It is well known that the soil surrounding plant roots is a zone of intense microbial activity. Majority of saprophytic soil-inhabiting microbes in the rhizosphere interact with plants. These microorganisms obtain their nutrients from the host without damaging the function of the root tissues. Under certain circumstances, the root infection is considered to be highly advantageous to the host. S.D. Garret, Cambridge University, U.K. in the year 1956 suggested that such symbiotic relationships show the highest level of parasitic specialisation.

The plant roots are known to be intimately associated with specific soil fungi called 'Mycorrhizae' (fungus roots) Nearly all economic species of plants of agricultural importance form mycorrhizae as natural components of root systems. Mycorrhizal fungi assimilate nutrients from soil for their own needs and in addition translocate them in different forms to host roots.

Mycorrhizae are often classified into three kinds, ectotrophic, endotrophic and ectendotrophic. Ectotrophic mycorrhizae are those in which the fungus completely encloses the rootlet in a sheath or mantle of tissue formed of compact hyphal cells and penetrates only between the cells of the root cortex. This kind of association is found in many forest trees. In endotrophic

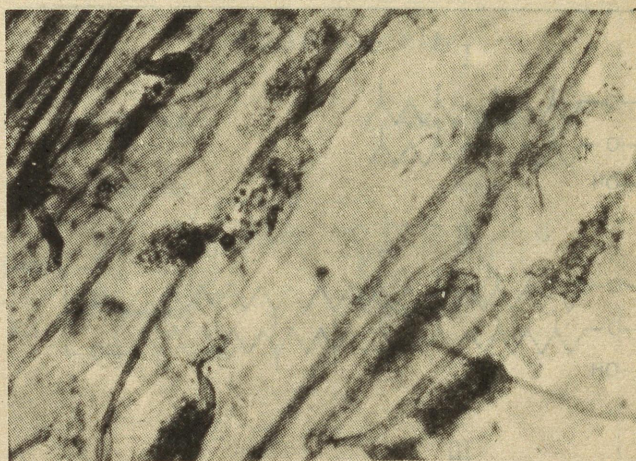


Fig. 1. Root infection by VAM fungus showing mycelium and arbuscules

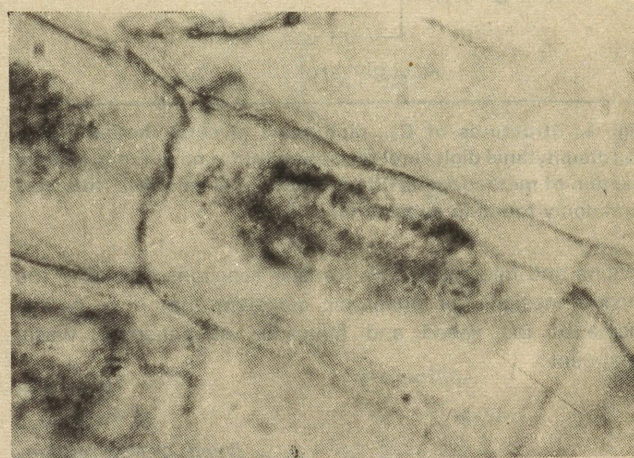


Fig. 2. Arbuscule in cell

mycorrhizae the fungus does not form an external mantle but lives within the root. The hyphae in the soil contact directly with hyphae running between and within the cells of the host. Most of these fungi are found in almost all families of angiosperms. In ectendotrophic mycorrhizae the fungus behaves in a similar manner to that of the ectotrophic type, but has both inter and intracellular hyphae.

The endomycorrhizae are further divided into two groups: (1) those produced by septate fungi, and (2) those produced by non-septate fungi. The latter type is called phycomycetous or vesicular-arbuscular mycorrhizae (VAM) which are of practical significance in agriculture since they occur in a large number of crops except in rice growing in flooded conditions. The fungi possess arbuscules (little tree-like hyphal branching) and vesicles (ovate or spherical structures) in the mycelium which function either as food storage organs or they may develop into thick walled chlamyospores which may function as reproductive structures.

The fungi belonging to the family endogonaceae like *Acau-*

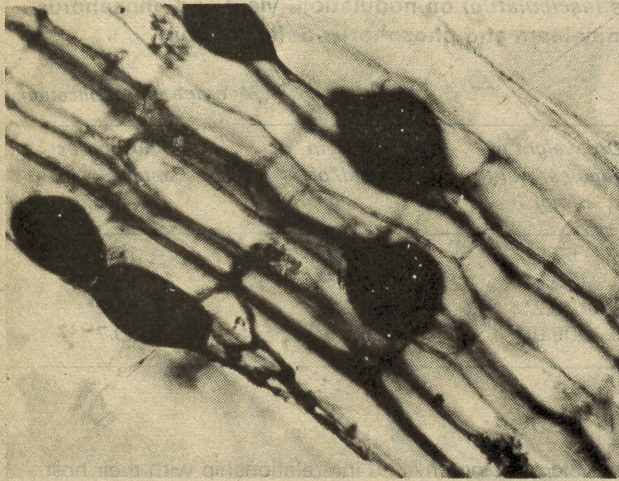


Fig. 3. Mycelium having vesicles

Ilospora, *Gigaspora*, *Glomus*, *Sclercoystis*, *Modicella* and *Glaiziella* are members of VA-mycorrhizae. They are obligate parasites and cannot be isolated in pure cultures. Much of our acquired knowledge of VAM has been obtained by using pot cultures consisting of single fungal species maintained on the root of living host plants grown in sterilized or partially sterilized soil. The process of wet-sieving and decanting, a technique commonly used by nematologists to extract nematode cysts and larvae from soil, can be successfully employed to extract VAM spores from soil also. By carefully extracting spores of various VAM fungi and using them to inoculate plants in sterilized or partially sterilized soil, one would be able to maintain different species of VAM fungi.

These fungi have a wide spectrum of host ranges. They can be multiplied by using host plants like maize, clovers, cowpea, soybean, onion, barley, sorghum, millets, several grasses, etc., in pots containing sterilized soil and finely washed river sand mixture (1:1) after inoculating the top layer of pots with sufficient quantities of VAM inoculum (usually consisting of mycelia and spores).

There is now considerable evidence that mycorrhizal association are of importance to plant nutrition, especially in nutrient-deficient soils. Inoculating the host plant with VAM fungi specific for a compatible host-soil-fungus combination can lead to more economical use of costly phosphatic fertilizers and better exploitation of inexpensive fertilizer sources. Improved

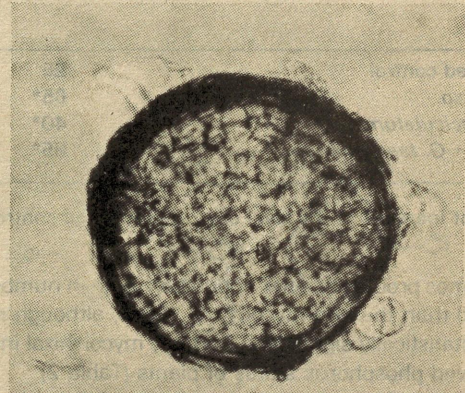


Fig. 4. Enlarged spore of *glomus fasciculatum*

inoculation techniques have been developed in the last decade and significant responses have been obtained following a variety of inoculation methods. The results of various findings revealed that the mycorrhizal plants possess a greater ability to absorb phosphorus from soil than the control (non-mycorrhizal) plants. At the Indian Agricultural Research Institute, New Delhi, a series of potted experiments were conducted by using unsterilized soil (pH 7.3) with different non-leguminous and leguminous plants to study the response of VAM inoculation on the performance of host plants. The top layer of soil in pots is inoculated with soil+sand (1:1)-based culture of VAM containing the root segments previously infected with VAM fungus, hyphal fragments and spores of the fungus at the rate of 100g-150g of inoculum per 10 kg soil. The results in Table 1 indicate that the simple soil inoculation with VAM increased the yield (dry matter and grain) and phosphorus content in plants in almost all trials. It is also noteworthy to point out that mycor-

Table 1. Response of millets to inoculation with *Azospirillum brasilense* and *Glomus fasciculatum*

(Average of 4 replications)

Treatment	Finger millet (<i>Eleusine coracana</i>)		Italian millet (<i>Setaria italica</i>)		Kodo millet (<i>Paspalum scrobiculatum</i>)	
	1	2	1	2	1	2
Uninoculated control	12.5	5.5	10.8	4.2	8.7	3.6
<i>Azospirillum brasilense</i>	15.5*	7.2*	13.5*	6.8*	10.2*	5.5*
<i>Glomus fasciculatum</i>	14.2	6.8*	12.8*	6.5*	9.2	4.8*
<i>A. brasilense</i> + <i>G. fasciculatum</i>	16.4*	7.5*	13.8*	7.2*	11.8*	6.2*

1: Dry matter yield (g/pot); 2: Grain yield (g/pot)-each pot had 4 plants in case of finger millet and 10 plants in case of Italian millet and Kodo millet

* Significant increase at 5% level over uninoculated control

Table 2. Dual inoculation with *Rhizobium* sp. and *Glomus fasciculatum* on nodulation, yield and phosphorus uptake of cowpea (*Vigna unguiculata*) in a sandy-loam and phosphorus-deficient soil

(Average of 4 replications)

Treatment	Number of nodules/plant	Dry weight of nodules/plant (mg)	Grain yield/plant (g)	Phosphorus uptake/plant (mg)
Uninoculated control	25	57.5	2.7	13.5
<i>Rhizobium</i> sp.	65*	150.5*	4.5*	18.5*
<i>Glomus fasciculatum</i>	40*	100.2*	3.2	25.2*
<i>Rhizobium</i> + <i>G. fasciculatum</i>	85*	205.0*	4.9*	30.7*

* Significant increase at 5% level over uninoculated control.

rhizal legumes produced better nodulation (both in number and dry weight) than the non-mycorrhizal plants, although results were not statistically significant. Further, mycorrhizal inoculation improved phosphorus status of plants (Table 2).

Phosphorus is known to increase nitrogen fixation by different diazotrophs (nitrogen fixers). To establish associative effects of VAM and diazotrophs, studies were carried out by growing plants in unsterilized soil inoculated with VAM culture and appropriate nitrogen-fixer (*Rhizobium* in case of legumes, and *Azospirillum brasilense* in case of cereals). It is interesting to point out that seed inoculation with appropriate nitrogen fixer in conjunction with soil inoculation with VAM fungus resulted in better performance of hosts than the simple individual inoculation treatments (Tables). This suggests that by establishing a higher population of VAM fungus, one would be able to derive benefits of phosphorus savings. This in turn results in better exploitation of nitrogen fixation, particularly in legumes.

These preliminary but encouraging results have prompted us to test the efficacy of VAM inoculation on barley and legume (pigeonpea) crops under field conditions. Seeds were treated with appropriate diazotrophs, i.e., *Rhizobium* sp. In case of pigeonpea and *Azospirillum brasilense* in case of barley. The results pointed out that the dual inoculation with both the endosymbionts namely, *Rhizobium/A. brasilense*, and VAM fungus resulted in more dry matter content and grain yield than from that of individual organisms namely, VAM alone or *Rhizobium/A. brasilense* alone. VA-mycorrhizal inoculation produced increased phosphorus uptake in plants as compared to the uninoculated control.

VA-mycorrhizal associations are also known to offer resistance to certain plant diseases and soil moisture stress conditions to some extent. However, difficulties in the production of large quantities of VAM fungi have limited their commercial application. They cannot be grown *in vitro*. Very little information is available on procedures to maximize the yield of mycorrhizal inoculum in pot cultures. One has to devise ways and means of increasing mycorrhizal inoculum production by adopting different methods of inoculation, improving the host-fungus relationship, soil conditions etc. Laboratory culture of VAM fungi could enable development of technology for commercial production of inoculum and could facilitate research on their

physiology, taxonomy and interrelationship with their host.

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Biochemical mode of action of some pesticides

THERE are many organic and inorganic compounds which exert toxic action on insect pests, they are called pesticides. The pesticide molecules interfere with vital processes of insects, leading to their death. They are known to inhibit enzyme activity in insects. Pesticides can be natural (e.g., pyrethrins, rotenones, etc.) or they can be prepared synthetically (e.g., DDT; HCH; organophosphates etc.).

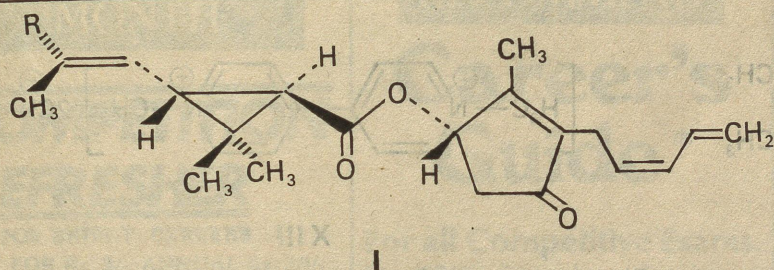
Below are given some of the examples of pesticides which illustrate different modes of their biochemical action.

Pyrethrins

The naturally occurring pyrethrins produce disturbance to the axonic nerve impulse conduction (in insects). This results in rapid knockdown and paralysis. Such a physiological action has been interpreted as due to depolarising effect produced by pyrethrins. This causes an imbalance of the normal sodium and potassium ions across the nerve membrane.

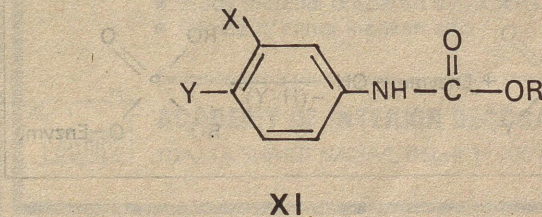
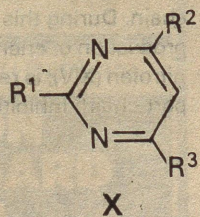
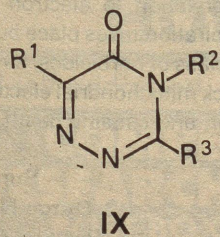
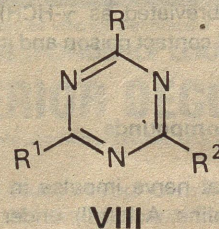
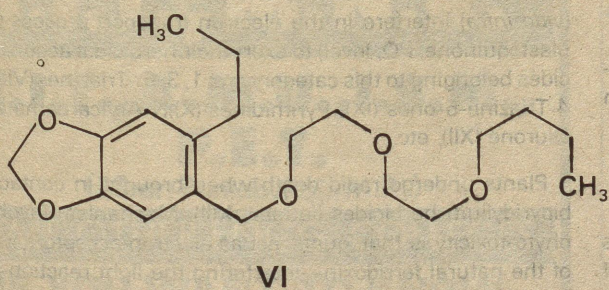
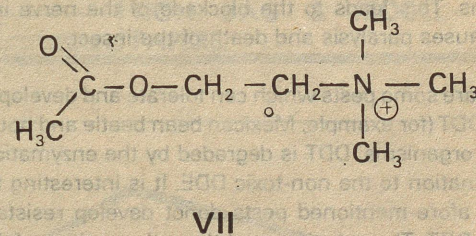
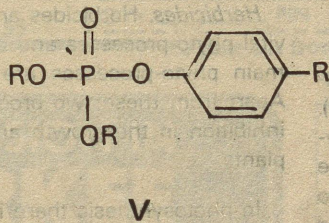
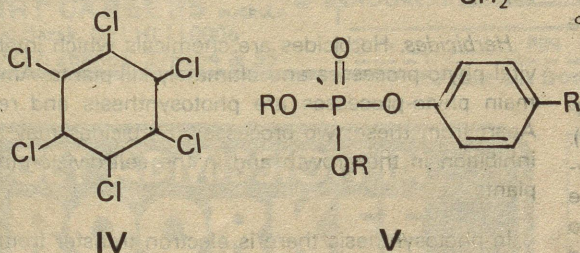
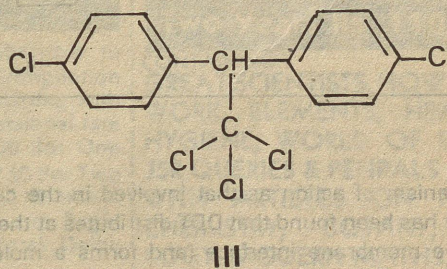
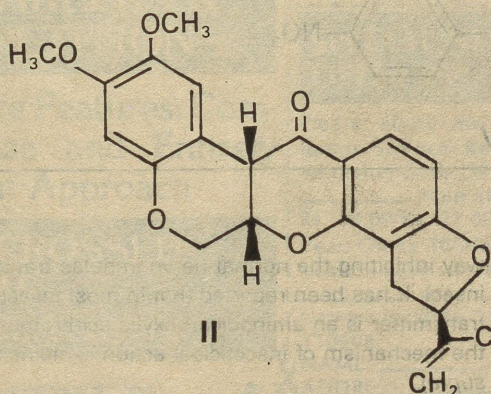
It is interesting however to note that some insects recover from the initial knockdown effect and paralysis (produced by pyrethrins) due to the built-in detoxification caused by microsomal oxidases. There are a number of compounds called 'Synergists' which are capable of either delaying or inhibiting detoxification processes involved within the insect. The synergist, for example, piperonyl butoxide (VI) is incorporated with pyrethrins to ensure a lethal action on the target organism.

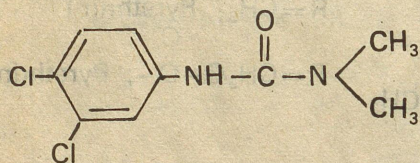
DDT. The poisoning of pests by DDT follows somewhat the



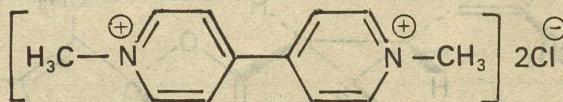
R = CH₃; Pyrethrin I

R = CH₃O-C(=O)-; Pyrethrin II.

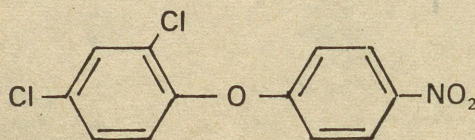




XII



XIII



XIV

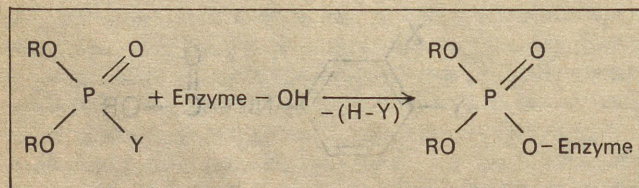
same mechanism of action as that involved in the case of pyrethrins. It has been found that DDT distributes at the lipid-protein nerve membrane interface (and forms a molecular complex with the over-laying protein layer) in such a way as to produce an imbalance in the transport of sodium and potassium ions. This leads to the blockade of the nerve impulse which causes paralysis and death of the insect.

There are some pests which can tolerate and develop resistance to DDT (for example, Mexican bean beetle and house fly). In these organisms, DDT is degraded by the enzymatic dehydrochlorination to the non-toxic DDE. It is interesting to note that the afore-mentioned pests do not develop resistance to *o*-chloro-DDT. The substituent at the ortho position of the said pesticides is capable of sterically blocking the enzymatic dehydrochlorination.

Lindane. Lindane (abbreviated as γ -HCH) has been described as a stomach and contact poison and its mode of action is similar to DDT.

Organo-phosphorous compounds

It has been found that nerve impulse in some insects is transmitted by acetylcholine, Ach (VII), under the influence of



enzyme acetylcholine esterase. The insecticidal organophosphorus compounds block the active site of the enzyme, in this

way inhibiting the normal nerve impulse transmission in the insect. It has been reported that in most insects the chemical transmitter is an aminodicarboxylic acid rather than Ach, but the mechanism of insecticidal action remains the same (*vide supra*).

Herbicides. Herbicides are chemicals which interfere with vital phyto-processes and ultimately kill plants. Amongst the main phyto-processes are photosynthesis and respiration. Apart from these two processes, herbicides may also exert inhibition in the growth and in the cell division (mitosis) in plants.

In photosynthesis there is electron transfer from water to photosystem (*via* various electron acceptors). During this process ADP is converted into energy rich ATP. The herbicides (*vide infra*) interfere in the electron transport process (at the plastoquinone, PQ, level) to exert their herbicidal action. Herbicides belonging to this category are: 1, 3, 5-Triazines (VIII); 1, 2, 4-Triazine-5-ones (IX), Pyrimidines (X); N-Arylcarbamates (XI), Diurone (XII), etc.

Plants undergo rapid death when brought in contact with bipyridylum herbicides ('quats'; XIII). Mechanism involved in phyto-toxicity is that 'quats' act as electron acceptors in place of the natural ferridoxin—interfering the light reaction-I.

Herbicides like dinitrophenols, halophenols, etc., prevent coupling of oxidative phosphorylation to electron transport chain. During this process, respiration takes place but without production α energy. Another class of herbicides, for example, nitrofen (XIV), is reported to block mitochondrial electron transport chain, inhibiting respiration and causing death of plants.

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74th Indian Science Congress

RESOURCES and Human Well-being: Inputs from Science and Technology" was the focal theme of the 74th Indian Science Congress which was held in the campus of Central College, Bangalore from 3 to 8 January. More than 3000 delegates, among them top scientists, research scholars and students attended the session organised under the auspices of Bangalore University. Among the foreign delegates was a nine-member team from the American Association for the Advancement of Science led by its president Dr. Lawrence Bogorad. Other foreign delegates came from Australia, Bangladesh, Burma, Canada, Cuba, Federal Republic of Germany, Hungary, Italy, Jordan, Malaysia, Nepal, Poland, Sri Lanka, the United Kingdom, and Viet Nam. Prime Minister Rajiv Gandhi delivered the valedictory address.

Delivering her presidential address at the inaugural function on 3 January, the General President of the session Prof. Archana Sharma spoke of the need to reorient the approach to planning to make the best use of our material and human resources. "Generalised policies and large-scale planning", she said, "is not suitable for a country of India's diversity unless inputs from science and technology are evolved in a manner that they satisfy the specific requirements of individual sub-populations."

Defining resource as "a means for satisfying human and social needs at a given space and time", she pointed out that basically human needs are simple—the primary physical components required to sustain life and health. But human wants are diverse and variable and perhaps unlimited in scope. "The way to counteract the human failing of increasing demands for individual rather than collective consumption," she said, "is to revive human values of compassion and fellowship; to invoke the consciousness in each individual of the need for sharing of available resources and of conservation for common and long-term good." For long-term development, scientific and technological aims should be to make more efficient resource use with high productivity, protect environment and employ sustainable methods with renewable components, she pointed out.

Referring to the various technology missions identified by the government as time bound programmes to solve specific problems such as supply of drinking water to problem villages, control of major diseases by immunoprophylaxis, improvement of cattle herd through embryo transfer technology and others, Prof. Sharma pointed out that they cut across disciplines and agencies to focus on the solution of the existing problems. For successful implementation, these result-oriented projects would require periodic reorganisation in specific areas and close interaction between the policy-makers, scientists and ultimate users. But more important, she said, they would require a drastic change in the work ethics—greater competence in public sectors and social responsibility in private ones.

At the inaugural function, 15 young scientists received the

annual INSA Awards from Dr. A.S. Paintal, President of Indian National Science Academy.

The sectional presidential addresses covered a wide range of topics—from "Mathematics and Human Well-being" by Prof. (Mrs) A.R. Singal in the section of Mathematics to "Human Adaptations in the Thar Desert" by Prof. V.N. Misra in the section of Anthropology & Archaeology. The topic of the presidential address by Prof. J.P. Tandon in the section of Chemistry was more academic, viz, "Newer Trends in the Chemistry of Schiff Base and Allied Derivatives". In the Section of Botany Prof. K.S. Bilgrami spoke on "Fungal Toxins: Their Biological Effects and Ecological Significance".

The two-day plenary session on the Focal Theme on 4-5 January in the Senate Hall drew a large audience. The session began with the summation of the AAAA-ISCA Seminar by the AAAS President Dr. Bogorad. The seminar, he said, had selected four broad areas for cooperation. They were (i) Beyond the Green Revolution, (ii) Soil-food-water, (iii) Bio-technology, and (iv) Computers in Schools. Delegates from Bangladesh, Nepal and the Philippines presented status reports on the focal theme outlining action taken in their respective countries.

The speakers on second day's plenary session included Dr. A.P. Mitra, Director-General, CSIR, Dr. Maheshwar Dayal Secretary, Department of Non-Conventional Energy Sources and Dr. C.R. Rao of the Indian Council of Agricultural Research.

Dr. Mitra spoke about the various activities of CSIR Labs which have a bearing on the focal theme. Reclamation and development of wastelands, water desalination, the Ganga Action Plan, exploration for sea-bed minerals, and Antarctica expeditions were a few of the major projects, which had a large component of input from CSIR.

The main thrust of Dr. Maheshwar Dayal's talk was on renewable energy systems such as biomass, solar energy, wind generators, etc. He said solar photovoltaic powder was cheaper than diesel-based and coal-based power transmitted over long distances. He disclosed that a pilot plant for the production of thin-film amorphous silicon for solar cells is to be set up during the 7th Plan. A 22-kW solar power station is already in operation in Andhra Pradesh and a 30 MW plant has been designed. 400 villages in Mizoram, Ladakh and other remote areas have already been electrified using solar energy, Dr. Dayal said.

Dr. C.R. Rao spoke about the major research activities of ICAR which have helped maintain the per capita food availability in India despite large population increase. Use of hybrid varieties of food crops, better crop management and expansion of irrigation facilities have led to a three-fold increase in food production in the last 30 years and today India has become a food exporter.

An interesting illustrated talk on "Studies of the Unusual Solids and Computer Simulation" was delivered by Prof. C.N.R. Rao, past President of INSA. He spoke about strange organometallic and inorganic solids which had crystal-like regular struc-

ture but were not true crystals. Formed as a result of "intergrowth phenomenon", these solids had unusual properties and could be tailor-made. Prof. Rao also narrated how accurate prediction of properties of organic compounds could be made by computer simulation. He said unfortunately not much research is being done in these areas in the country at present. India, he said, "needs a lot of young researchers in the field of inorganic solid-state chemistry".

The seventh G.P. Chatterjee Award Lecture on "Science, Joy and Freedom" delivered by Prof. Yash Pal, Chairman, University Grants Commission covered a wide spectrum. He spoke about the dangers of unrestricted import of technology, the nuclear threat to mankind, spirituality, and about the need to reform the education system.

The valedictory address by the Prime Minister, Mr. Rajiv Gandhi mainly concerned the state of Indian science. He believed that "too much red-tape, bureaucratic delays and tolerance of irrelevance and mediocrity" was the main cause of our remaining poor despite having a large scientific community. He laid great emphasis on the need to eliminate mediocrity from all fields of science and technology, repeating the point again and again.

He said, whenever we start talking of science, of moving ahead faster, "those that feel threatened are the mediocre, the weak". It is in keeping the status-quo, in keeping mediocrity alive that we stifle excellence. There are vested interests, mainly political groups, who have got themselves entrenched in keeping a status quo, in keeping things as they are in the rural areas, in the towns, in our universities, in colleges and sometimes even in our scientific institutions. We must have the will

to break this vested interest and weed out the mediocrity.

Another constraint pointed out by the Prime Minister was that of resources for scientific research. Recalling the Indian Nobel Laureate C.V. Raman's prophetic words "there is only one solution for India's economic problems and that is science, more science and still more science", Mr. Gandhi pointed out that India today spends less than one per cent of its GNP on science. Industry invested almost nothing in real R & D. This ratio, he said, must change.

The Prime Minister also spoke of our archaic school system that encouraged learning by rote rather than helping children develop a questioning mind. "We are taught that the teacher is always right and told never to question the teacher. Precisely the opposite of what a scientific mind must demand". The new education policy, he said, is aimed at removing this contradiction.

As in the previous years, the 74th session of the Indian Science Congress has also drawn up specific recommendations for presentation to the government. This year's recommendations cover seven priority areas, namely Health, Energy, Land, Water, Agriculture and Climate, and Family Welfare.

A welcome feature of the Indian Science Congress sessions in recent years has been the large participation of young scientists. This has been mainly due to the encouragement ISCA provides in the form of annual cash awards and travel grants for presentation of papers by young scientists at the session. Each award carries a certificate and Rs. 3,000 in cash. The Prime Minister Mr. Rajiv Gandhi gave away this year's ISCA Awards to 19 young scientists.

S.S. Bhatnagar Awards—1985 & 1986

NINETEEN scientists/technologists have been awarded Shanti Swarup Bhatnagar Prizes in science and technology for the years 1985 and 1986. Their names, disciplinewise, are as under:

Recipients for 1985

Physical Sciences

1. Prof. Narendra Kumar, Indian Institute of Science, Bangalore
2. Prof. Kehar Singh, Indian Institute of Technology, Delhi

Biological Sciences

1. Prof. M. Vijayan, Indian Institute of Science, Bangalore
2. Dr. C.M. Gupta, Central Drug Research Institute, Lucknow

Engineering Sciences

1. Prof. P. Ramachandra Rao, Banaras Hindu University, Varanasi

Medical Sciences

- Dr. D.K. Ganguly, Indian Institute of Chemical Biology, Calcutta

Mathematical Sciences

1. Prof. S.K. Malik, Panjab University, Chandigarh
2. Prof. R. Parthasarathy, Tata Institute of Fundamental Research, Bombay

Earth Sciences

1. Dr. R.N. Singh, National Geophysical Research Institute, Hyderabad

Recipients for 1986

Physical Sciences

1. Prof. P.K. Kaw, Physical Research Laboratory, Ahmedabad

Chemical Sciences

1. Prof. P. Balaram, Indian Institute of Science, Bangalore

Biological Sciences

1. Prof. Madhav Gadgil, Indian Institute of Science, Bangalore

Engineering Sciences

1. Prof. M.L. Munjal, Indian Institute of Science, Bangalore

NEWS AND NOTES

Medical Sciences

1. Dr. S.S. Agarwal, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow
2. Dr. Pradeep Seth, All India Institute of Medical Sciences, New Delhi

Mathematical Sciences

1. Prof. T. Parthasarathy, Indian Statistical Institute, New Delhi
2. Prof. U.B. Tewari, Indian Institute of Technology, Kanpur

Earth Sciences

1. Prof. A.K. Gupta, University of Allahabad
2. Dr. K. Mallick, National Geophysical Research Institute, Hyderabad

The Shanti Swarup Bhatnagar Prize for science and technology was instituted in 1957 by the Council of Scientific & Industrial Research in memory of its first Director, the late Dr. S.S. Bhatnagar. The Prize is given for outstanding research contributions made primarily in India. Only scientists and technologists below 45 years of age are eligible for consideration. The value of the award is Rs. 20,000/- each with a scroll.

Information on Nickel

NICKEL Development Institute, Canada and Zinc Development Association, London have formed a joint collaboration to provide technical information on Nickel and its applications to industries in India and neighbouring countries from now on. The information needs will be serviced by Indian Lead Zinc Information Centre, the Indian Branch of Zinc Develop-

ment Association, London. For details contact:

*Indian Lead Zinc Information Centre
B-6/7, Shopping Centre
Safdarjung Enclave
New Delhi-110029*

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The magnetic way to painless brain stimulation

EVER since the work of Galvani and Volta in the 1770s it has been known that nerves and muscles can be stimulated by electric currents. Indeed the whole neuromuscular system of the body is an intricate electrical signalling network.

Sensory nerves transmit impulses from the extremities of the body to the brain and central nervous system to pass on information such as temperature, force, pressure, texture and vibration. Motor nerves transmit signals in the opposite direction, from the brain to the muscles, to control bodily movement.

Electrical stimulation is a widespread and standard clinical tool for the investigation of disorders of the nervous system. Perhaps its most common application is to measure the speed at which signals travel along nerves.

If a nerve is stimulated, by applying a brief pulse of current via surface electrodes such as strips of metal or conducting rubber in contact with the skin, or needles inserted into the body, impulses will travel along the particular nerve. These impulses, known as action potentials, may be detected further along the nerve using similar electrodes connected to recording amplifiers, and the transit time or latency from stimulating to recording site can be measured.

Disease of the nervous system in general slow down the conduction velocity of the nerves, which can be up to 80 m/s in normal subjects, and so can be detected by such measurements.

While conventional electrical stimulation provides a valuable clinical tool in many applications, it does have some limitations. In particular, it is difficult to stimulate deep structures using surface electrodes without causing considerable pain, and the human brain is also virtually inaccessible because the high electrical resistance of the skull makes it difficult to pass current from the scalp to the brain.

The ability to stimulate the human brain would allow the measurement of transit times through the central motor pathways of the brain and spine, and it is known that these pathways are seriously affected in diseases such as multiple sclerosis.

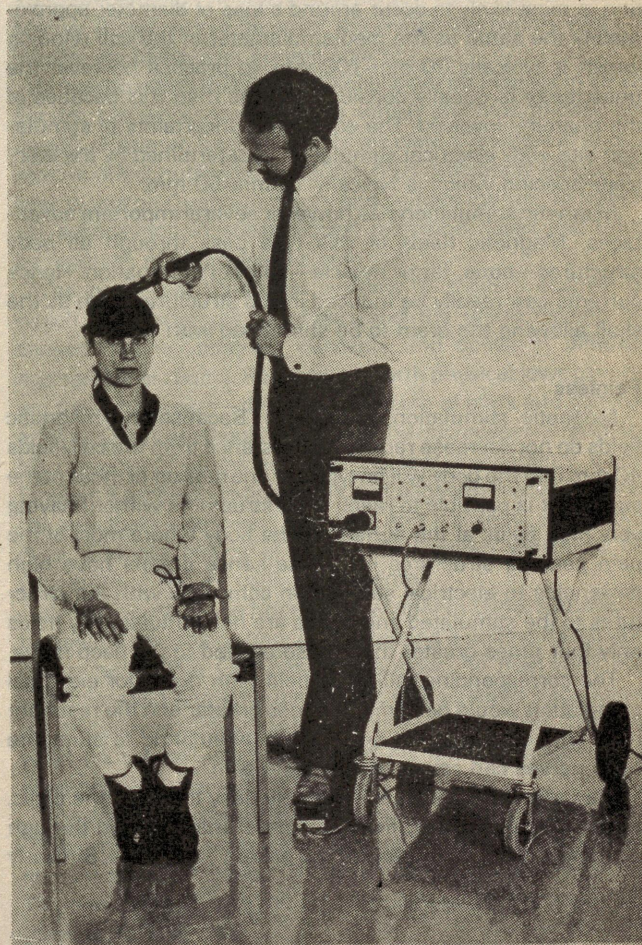
Research started in 1975 in the Department of Medical Physics and Clinical Engineering at Sheffield University, northern England, into a novel method of stimulating human nerves using pulsed magnetic fields.

The stimulation of superficial nerves was reported in 1982, and in 1985 the first magnetic stimulation of the human brain and deep nerves throughout the body was described (*Lancet*, 1, 1106, 1985).

Practical technique

Magnetic stimulation is now a practical clinical technique and the stimulators are to be manufactured in Britain by a private firm under licence from Sheffield University.

The basic concept of magnetic stimulation is simple. By



The prototype magnetic stimulator in use

passing a brief duration (typically several hundred microseconds) very high amplitude pulse of current through a coil a corresponding pulse of magnetic field is produced. By the basic laws of electromagnetism this pulse of magnetic field will induce electrical currents in any conductor through which it passes, including the human body.

If the induced currents are of sufficient amplitude and duration they will stimulate nerves by exactly the same mechanism as if the currents had been applied via electrodes in contact with the body.

Magnetic stimulation has advantages and disadvantages compared to conventional electrical stimulation. Its disadvantages are twofold.

First, the equipment is relatively bulky and costly because of the high current, high voltage technology involved. Commercial versions will be considerably smaller than the prototype but will still weigh 10 to 20 kilograms and initially be limited to

one stimulus every three seconds. The equivalent technology for electrical stimulators is very simple and they can be made both small and lightweight.

Second, the precise site under the stimulating coil at which the nerve is stimulated is not well defined. In theory, stimulation is most likely to occur around a loop of diameter approximately the same as the median diameter of the coil winding which is typically 70 mm-100 mm. In practice however the uncertainty is usually considerably less than this because of the anatomy involved. The equivalent uncertainty of stimulation site with electrical stimulation is determined by the electrode spacing which is typically 10 mm-50 mm.

Magnetic stimulation has however several important advantages. Magnetic fields of this type pass through all body structures—bone, fat or muscle—without attenuation. Hence currents can readily be induced inside structures such as the skull allowing the brain to be stimulated with ease.

Painless

Magnetic stimulation is painless. Because the magnetic fields do not decrease rapidly with distance from the coil (fields 40 mm into the body will be typically one quarter of those at the surface) it is possible to reach deep structures without having very high fields at the surface of the body where most of the pain sensing structures lie. These sense organs have high thresholds to electrical stimulation compared with the structures to the stimulated and hence are not stimulated by fields only four times greater than those applied to the deep nerve.

The corresponding fall-off in field with depth for electrical stimulation would be some 30 times greater and the resultant high surface fields that occur while attempting to stimulate deep nerves can cause considerable pain.

Magnetic stimulation is extremely easy to use in the clinic. Because the magnetic fields will pass unattenuated through clothing it is not necessary for the patient to undress. Similarly

it is not necessary to make electrical contact with the patient, as has to be done with conventional stimulation.

Indeed it is not even necessary to make mechanical contact with the patient. Stimulation can be achieved with the coil held some tens of millimetres away from the skin, a feature which may be valuable in the assessment of seriously damaged areas of tissue such as head injuries.

Clinical applications

The first clinical study (*Lancet*, 1, 1325, 1986) carried out using magnetic stimulation has shown the ease with which slowing of nerve conduction within the brain and spine of patients having multiple sclerosis can be detected and that, as would be expected, no slowing occurs in patients having motor neurone disease.

Evidence is beginning to accumulate that slowing which has not yet caused clinical symptoms can be detected. Because of the lack of discomfort associated with magnetic stimulation of the brain it is now possible, for the first time, to carry out repeated measurements on patients to quantify the effectiveness of new therapies for central nervous system disorders.

Other applications at present under investigation include the monitoring of central pathways during surgery to detect damage before it becomes irreversible and the assessment of deep and previously inaccessible peripheral nerves.

At present six magnetic stimulators, all constructed by Sheffield University, are in clinical use in England and the United States of America.

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IT PAYS TO
ADVERTISE IN
SCIENCE REPORTER

Albert Einstein

"I may have made one great mistake in my life", said Einstein to Linus Pauling, "When I signed the letter to the President recommending that atom bombs be made, but there was some justification—the danger that Germans would make them". Earlier in the summer of 1939, he had written to the then U.S. President, F.D. Roosevelt, warning him that German scientists might have discovered a way of setting up nuclear chain-reactions in uranium. In a way this letter was prologue to the 'Manhattan Project' and thus its author, who was also the author of the famous equation $E=mc^2$ became the reluctant father of the atomic age.

When on August 6, 1945 at 8 A.M., his secretary Helen Dukas broke the news of bomb-explosion on Hiroshima, with infinite sadness, the scientist murmured: "Oh Weh!" (Alas!)

Born on March 14, 1879 at Ulm (Germany), Einstein studied at Swiss Federal Institute of Technology, Zurich, and became a clerk in Patents Office at Bern. Later, he became Director of the Kaiser Wilhelm Institute for Physics in Berlin. He taught at Prague and lectured throughout Europe. "As a man without roots anywhere.....I myself have wandered continually hither and yon—a stranger every where"—Einstein addressed these words to his friend Max Born in 1920. Einstein, then 41, had indeed been a man without roots. When Hitler became chancellor of Germany in 1933, Einstein was spending a term as visiting professor at Caltech in America.

Einstein wrote his first paper on Relativity in 1905. Announcing that there was no such thing as 'absolute rest', he laid down the following two general principles or axioms:

- (i) It is impossible to detect uniform motion through ether.
- (ii) In all forms of wave motion, the velocity of propagation of the wave is independent of the velocity of the source.

In developing his 'General Theory of Relativity' which appeared in 1915, Einstein looked for an appropriate mathematical theory to deal with the structure of physical space and he found in Riemann's abstract system the conceptual tool he needed. Mathematical certainty of knowledge can be attained only at the price of analyticity and thus of complete lack of factual content. This insight may be summarized in Einstein's words:

"As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality". As Rutherford knocked out matter, Einstein knocked out space and time. Einstein's general theory of relativity has one of its basic hypotheses such a minimal principle: that in our space time world, however complicated its geometry be, light rays and bodies upon which no force acts move along shortest lines.

Addressing in Paris at the Sorbonne, Einstein remarked: "If my theory of relativity is proven successful, Germany will claim me as a German and France will declare that I am a citizen of the world. Should my theory prove untrue France will say that I am a German and Germany will declare that I am a Jew.

It is ironical that Germany, where Einstein did much of his finest work, expressed its appreciation of its efforts by driving him into exile.

Einstein resigned his post at Kaiser Institute and renounced German citizenship. The United States received him and in 1933 he came to Princeton, New Jersey. He bought a house in Mercer Street where he spent the remaining twenty years of his life. He never saw Europe again.

It may be noted that he won Nobel prize for Physics in 1922, not for his works on Relativity which are monumental triumphs of human intellect but for his classic analysis of photo-electric effect published in 1905 which profoundly influenced later works on Quantum theory and pointed the way to technical applications in spectroscopy, television, laser and other by-products of photo-electric cell.

The two great theoretical systems of modern science by which man attempts to understand the world beyond his senses rest on different concepts and speak in different mathematical idioms. Relativity set forth physical laws governing the *macrocosm*—the outer universe of stars and galaxies and the Quantum theory deals with the *microcosm*—the invisible universe of atoms and their nuclear components. It was Einstein's ambition to bridge the gulf between the two theoretical structures—between the great and the small and to produce a single edifice of cosmic law within which all the pageantry of Nature could be discerned.

Wolfgang Pauli, the Nobel prize winner in 1945, summed up his feeling regarding chances of attaining a unified field theory by saying: "What God has put asunder, no man shall ever join". Einstein knew he had swum into scientific back-water, yet he believed with all his heart and soul in casualty. That was what he meant when he uttered his famous remark: "God does not play dice with the world".

Einstein was constantly besieged by requests for lectures. "The only way to escape the personal corruption of praise is to go on working," he said "One is tempted to stop and listen to it. The only thing to do is to turn away and go on working. Work, there is nothing else."

Says Helen Dukas, "All he needed was a pencil and paper and his head".

Einstein loved to explain little things of nature in a simple and beautiful way.

"I have no special gift—I am only passionately curious", said Einstein, "My religion consists of an humble admiration of illimitable superior spirit who reveals himself in the slight details we are able to perceive with our frail and feeble minds. God is subtle, but he is not malicious".

When offered presidentship of Israel, he wrote to Prime minister D. Ben Gurion, "All my life I have dealt with objective matters and hence I lack both, the natural aptitude and the experience to deal properly with people and to exercise official functions. For these reasons alone, I should be unsuited to fulfill the duties of that high office, even if advancing age was not making increasing in-roads on my strength".

He died in Princeton Hospital on April 18, 1955, shortly after mid-night.

Einstein would be recognised, as Max Born observed "as one of the greatest theoretical physicists of all time, even if he had not written a single line of Relativity."

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Biological filters and air-lift pumps for aquaria

MAINTAINING the quality of water in aquarium tanks is indispensable for growing ornamental fish. Excreta of fish and unused food materials often lower the oxygen content of water in tanks. Unless water is changed at least once in two days in aquarium tanks, optimal survival of fish cannot be expected. Home aquarists are therefore forced to make alternative arrangements for changing water in tanks when they are not at home for a longer time. Biological filters and air-lift pumps are nowadays used in aquaria to help aerate and maintain the quality of water. These modern devices are simple in design, low in cost, easy to maintain and efficient.

Biological filter (Fig.1) consists of suitably cut and perforated asbestos sheet (or fibre glass or acrylic plate) which is fixed at about 10 cm above the bottom of aquarium tank using rubber corks as supports at its four corners. This sheet fits tightly in the tank and serves as a false-bottom. Above the plate, washed gravels are spread uniformly for a thickness of about 5 cm.

Water in an aquarium is liable to contamination especially with ammonia due to the metabolic activities of fish. When the ammonia-laden water passes through the gravel bed, it is activated by aerobic nitrifying bacteria such as *Nitrosomonas* and *Nitrobacter* present in it. The *Nitrosomonas* oxidises ammonia into nitrite, which is further converted into nitrate by *Nitrobacter*. The ammonia-free water so formed occupies the bottom of the tank, i.e., below the false-bottom and is subsequently air-lifted to the surface.

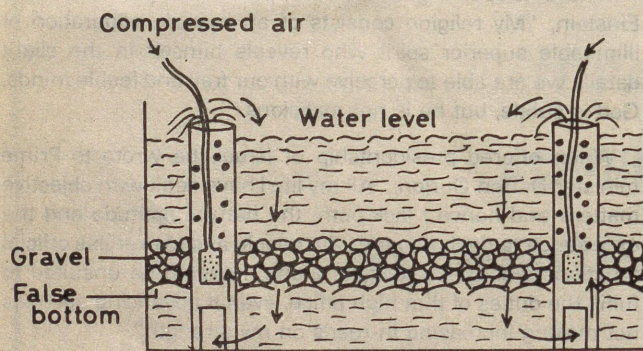


Fig. 1. Biological filter

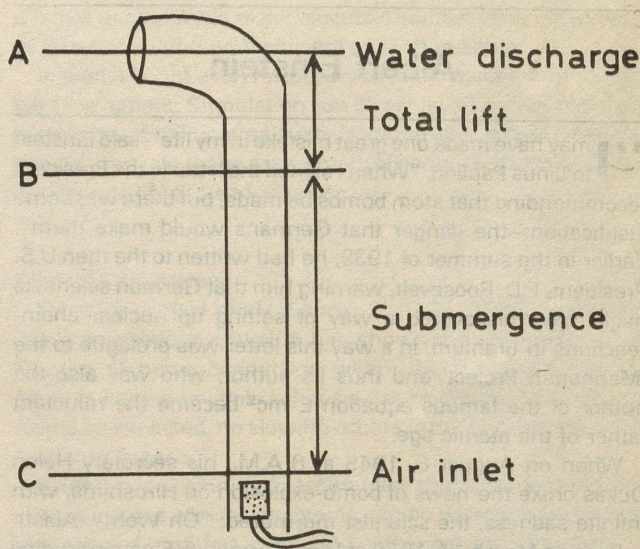


Fig. 2. Air lift

Air-lift (Fig.2) is a vertical pipe made of PVC or fibre glass. Its diameter and length vary with the size of an aquarium tank. The top and bottom of the pipe are open. The bottom edge of the tube has three rectangular slits cut out at equidistant points on it. In an aquarium tank, the pipe is held in holes of the false-bottom in such a way that the mouth of the tube is at about 1 cm above the water level. An air-stone connected to an aerator or compressor through a polythene tube is kept inside the pipe.

It is known that when a pipe is held vertically in water the level of water inside and outside the pipe is equal. When air is injected at the lower end of the pipe, it rises up and forms bubbles. It produces a mixture of air and water which is lighter than water alone. The air-water mixture inside the pipe is therefore lighter than the water outside the pipe and so the prevailing equality of water levels is disturbed. Heavier water from underneath the filter plate moves into the lower end of the pipe. As long as air is injected into water, the air-water mixture is spitted out at the top of the pipe. The length of the lift pipe held below affects the efficiency of an air-lift. An air-lift works less effectively when the volume of the injected air exceeds the capacity of the lift pipe.

An air-lift pump with in-built biological filter unit (Fig. 3) is composed of two dissimilar cylindrical plastic tubes, which open at both ends. The smaller tube (diameter, 2.5 cm and length, 30 cm) is held firmly inside the larger one (diameter 7.5 cm and length, 32 cm) with the help of three acrylic plastic struts. The upper opening of the inner tube is about 2 cm lower than that of the outer. The entire unit stands on three plastic legs on the floor of the aquarium. The space between the inner and outer tube is filled with gravels and the water level in the aquarium is maintained at a level slightly lower than the upper end of the inner tube. An air-stone is kept at the base of the

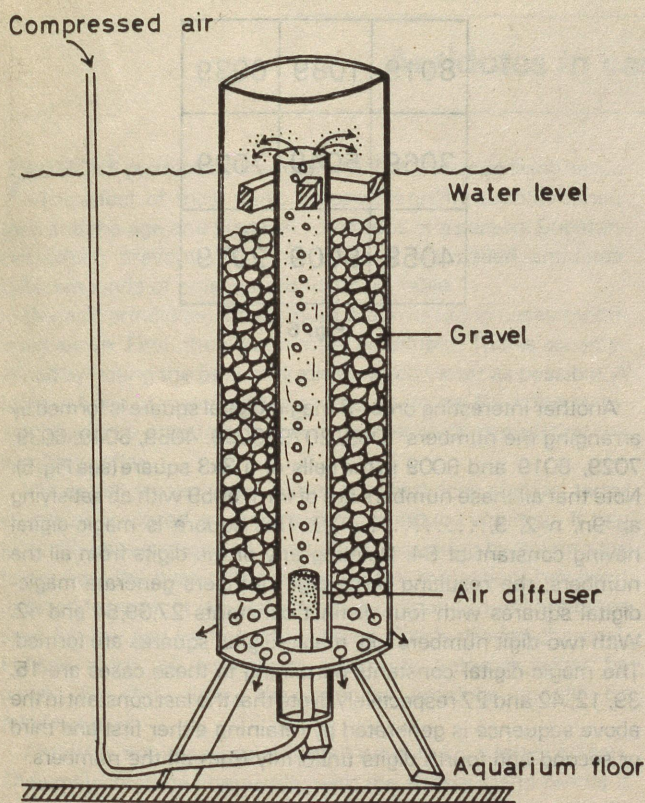


Fig. 3. Air-lift pump with in-built biological filter unit

inner tube. The upward displacement of air forces the water to spill over into the outer tube. The gravel bed of the latter serves as a biological filter.

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Science quiz

- (1) The monsoon causes rains over several regions of India during the period from June to September.
- (2) is the world's largest coffee producing country.
- (3) To see his life-size image a man 2 metres tall must use a plane mirror of minimum height metre.
- (4) invented natural logarithms.
- (5) The total number of bones in an adult human body is
- (6) Domestic electrical fittings are connected in
- (7) June 5, is the date on which World Day is observed.

- (8) A number which cannot be divided exactly except by itself and the integer 1 is called a number.
- (9) The escape velocity with respect to the earth is km/sec.
- (10) Direct trunk dialling by subscribers was first introduced in India between and in 1960.
- (11) For a given perimeter a has the maximum area.
- (12) The Central Drug Research Institute is located at
- (13) To minimise eddy current losses, the core of a transformer must have a electrical resistance.
- (14) Our heart normally beats about times per minute.
- (15) is the location of a heavy water project in Tamil Nadu.
- (16) Potassium is one of the chemicals required to make the head of a match-stick.
- (17) When compared to platinum and lead wires, human hair withstands a stress.
- (18) The first nuclear fission reactor was built up by
- (19) The British physicist, Dennis Gabor did pioneering work on
- (20) The most abundant element in the sun is
- (21) The walls of a dam are broader at the bottom to withstand the higher
- (22) The IST corresponding to 5.30 a.m. GMT is
- (23) Water has maximum density at
- (24) On the earth the weight of a body is a maximum at the
- (25) The number of sunspots becomes a maximum once in years.

Magic-digital squares

A magic square of order-3 constructed by 9 and its multiples shows interesting properties. This square is not only magic in the conventional sense but also retains its magic instinct when sums of the digits of its elements are taken (Fig. 1). By taking the sum of the digits of the elements, the magic constant comes out to be 27. Such a square may be called magic-digital square and the corresponding constant may be called magic-digital constant. Shown in Figs 2 and 3 are some other examples of magic-digital squares. The magic-digital constants of these squares are 15 and 18 respectively.

Magic-digital squares of Figs 2 and 3 may be generalised. In fact any 3×3 square starting with the element n or $n+1$ (where

72	09	54
27	45	63
36	81	18

Fig. 1

17	10	15
12	14	16
13	18	11

Fig. 2

8019	1089	6039
3069	5049	7029
4059	9009	2079

Fig. 5

18	11	16
13	15	17
14	19	12

Fig. 3

8712	1089	6534
3267	5445	7623
4356	9801	2178

Fig. 4

$n=0,1,2,\dots,9$) with a common difference 1 between the consecutive elements will be magic-digital.

Incidentally, the order-3 square formed by 1089 and its multiples is also magic-digital, the magic-digital constant of this square being 54 (Fig. 4). Taking the first three or the last three digits of the numbers the magic-digital constant of the squares so formed is 39 in each case. Deleting the second or third digit uniformly from all the numbers, the resulting squares again are magic digital each having magic-digital constant of 42. If the first two or the last two digits of the numbers be only retained, then the magic-digital squares so formed have each a magic-digital constant of 27. Retaining the middle two digits only generates a square having magic-digital constant of 24. Deleting the middle two digits again leads to a magic-digital square of constant 30. Retaining either first and third digits or second and fourth digits also generates squares each having magic-digital constant of 27. If the first or the last digit of the numbers only be retained it leads to squares having magic-digital constant of 15 in each case. Taking either of the middle two digits, squares with magic-digital constant of 12 are formed.

Another interesting order-3 magic-digital square is formed by arranging the numbers 1089, 2079, 3069, 4059, 5049, 6039, 7029, 8019 and 9009 in the cells of a 3x3 square (see Fig. 5). Note that all these numbers are of form $a0b9$ with ab satisfying $ab=9n$, $n=2, 3, \dots, 10$. This square is magic-digital having constant of 54. Deleting any of the digits from all the numbers, the resulting three-digit numbers generate magic-digital squares with four distinct constants 27, 39, 54 and 42. With two-digit numbers too, magic-digital squares are formed. The magic-digital constants pertaining to these cases are 15, 39, 12, 42 and 27 respectively. Note that the last constant in the above sequence is generated by retaining either first and third or second and fourth digits uniformly from all the numbers.

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Answers to science quiz

- (1) South-West, (2) Brazil, (3) One, (4) John Napier, (5) 206, (6) Parallel, (7) Environment, (8) Prime, (9) 11.6, (10) Kanpur, Lucknow, (11) Circle, (12) Lucknow, (13) High, (14) Seventy, (15) Tuticorin, (16) Chlorate, (17) Greater, (18) Enrico Fermi, (19) Holography, (20) Hydrogen, (21) Pressure, (22) 11 a.m. (23) 4°C, (24) Poles, (25) Eleven

Ref. S.R. Jan. 1987, Pp. 57-58, *Malaria control through community participation*; photographs are by courtesy. The Director, VCRC, Pondicherry.

Antidotes in case of poisoning

POISONS produce deleterious or lethal effects on living tissue. The effect of most poisons depends on the quantity consumed and the age and physical conditions of a person. Substances which prevent action of poisons are called antidotes. Different kinds of poisons are listed in Table 1.

General principles of treatment are involved in cases mentioned above. First, the poison must be diluted. This is accomplished by letting the patient drink as much water as possible. A large volume of water also promotes vomiting. Next, the stomach should be emptied. This is usually done by stimulating the vomiting reflex.

Warm salt water, soapy water of substances such as tartar emetic or prepared mustard will often induce vomiting. If this fails, the patient may gag himself into vomiting by holding his finger past the base of the tongue. After the patient has been induced to vomit, it is helpful to give milk or general antidotes such as raw egg whites and olive oil. Finely divided charcoal, Fuller's earth, or aluminium hydroxide antacids might be given. By this time, the specific antidote should be administered.

Antidotes act in several different ways to counteract poison. They may combine chemically with the substance to render it harmless, as in the case of soda with an acid or vinegar with lye; they act physically to coat the mucous membranes with a protective layer, as in the case of olive oil, or milk, or the poisonous substance may be adsorbed on the surface of finely divided particles, as in the case of charcoal or Fuller's earth. Egg albumin (egg white) combines with many substances and is coagulated by them, making expulsion of the poison more effective. Some antidotes act physiologically to produce the opposite effect from the original poison.

Another way in the treatment of poisons is to eliminate it from the systemic circulation. However, as with ethyl alcohol, methyl alcohol, ether, benzene and acetone, the elimination may be aided by breathing deeply in order to expel the substance with the exhaled air. Drinking as much fluid as possible will aid in excretion through kidneys. The use of saline catheters (e.g., Epsom salts, sodium sulfate, sodium phosphate) may aid in the elimination of some poisons from blood by way of the liver, bile and digestive system.

The emergency treatment of poisoned persons is aimed principally at keeping the patient alive until the poison is eliminated or neutralized. In the case of carbon monoxide, hydrogen cyanide and any other poison that has been breathed, artificial respiration must be administered. Shock is often the cause of death in poison cases; this may be prevented by warmth and stimulants such as strong coffee or tea. When possible, the patient should be kept conscious as an aid to eliminate poison by vomiting or other means.

If sleep-producing drugs have been taken, such as opium or morphine, it is best to keep the patient awake by giving strong coffee. In instances of strychnine poisoning, any stimulants

Table 1. Different kinds of poisons

(i) Corrosives	like strong acids and alkalis which cause the local destruction of tissue.
(ii) Irritants	produce congestion of the organ when they come in contact with them.
(iii) Neurotoxins	include narcotics, barbiturates, alcohols and anaesthetics.
(iv) Hemotoxins	are carbon monoxide and hydrogen cyanide. They combine with blood and prevent oxygen from forming hemoglobin.
(v) Hepatotoxins	which have the effect on liver cells.
(iv) Nephrotoxins	which have injurious effects on nephrons, i.e., the basic unit of the kidney.

should be avoided and the patient should be kept as quiet as possible.

In emergency treatment of poisoning:

- dilute the poison by inducing the patient to drink a large amount of water.
- bring about repeated vomiting by giving large amounts of soapsuds, warm salts, soda or mustard water.
- gag the patient by tickling the back of the throat with the finger.
- keep up the vomiting until the fluid that is vomited is clear as when it was swallowed.
- give artificial respiration if breathing ceases.
- use the universal antidote.
- call a physician immediately.

Universal antidote

Two parts of burned, powdered toast + one part of milk of magnesia + one part of strong tea.

The burned powdered toast is a source of carbon, the milk of magnesia is a source of magnesium oxide and the strong tea is a source of tannic acid. The carbon absorbs poisons, magnesium oxide has a soothing effect on mucous membranes of the stomach and a laxative action that tends to neutralize poisons, and tannic acid tends to neutralize caustic alkaline substances.

A.K. Rattan

H.K. Mangat

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**PRAGATI PRAKASHAN
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A bird colony can be an info center

HONEYCOMB is the best example of a nature's information center, where honey bees obtain information from each other on the location and quality of flowers. But as yet no other non-human vertebrate had been found to have an information center to exchange information on the location and quality of food. However, recently, a Princeton zoologist Charles R. Brown has reported in *Science* (October 3, 1986) the first such information center in bird kingdom. He has found that cliff swallows use their nesting colony to exchange information on their food. Cliff swallow (*Hirundo pyrrhonota*) is a small migratory bird which builds its nests in western North America. Its nest is of the shape of gourd and made of mud, which is hung from the edge of a cliff or canyon and even bridges and highway culverts. A colony of cliff swallows contain one nest to some thousands. Its food is flying insects which it catches exclusively while flying in the air.

Brown conducted his studies in Nebraska, U.S.A., from May to August for three years. He studied 167 colonies consisting of more than 50,000 nests, all of which were present in open areas so that the birds could be observed directly using binoculars. Brown found that the insects, which swallows eat, form dense patches for 20 to 30 minutes due to convection currents.

As and when a swallow (or several swallows) returned to its nest carrying an insect in its beak or with a bulging stomach, it was followed by its neighbours as soon as it left the colony to have more food. Brown found that, apart from this direct visual sign of the availability of food, the distant neighbours also determined the success of a swallow by its direct and rapid mode of flight to the source of food. One interesting question that occurs here is, why does a swallow allow others to follow it because, after all, its own chance of gathering food then becomes less? Brown found no conflict of interest among swallows because the answer is very simple. The patch of insects disintegrates very fast and so the most has to be made out of it. A swallow has therefore neither the time to deceive its followers nor the need because there is enough for every body.

Who first discovers a patch of insects in a colony? It can be any one of its resident swallows. There is no regular leader or follower. However, as 20 per cent of the time every cliff swallow is on its own, such a loner is often the one responsible for discovering a new patch of insects. Some further studies remain to be conducted. For instance, what is the effect of the size of a colony on the efficiency of its information center?

Dilip M. Salvi

Good-bye, winter

*The days that used to lie curled up,
numbed by the penetrating frost,
bit by bit stretch out their limbs,
now that winter's past.*

—Sri Dharanidhara

WINTER offers many jobs. Sitting in the sun, chatting by a fire, eating or sipping something hot—these at once come to mind. Where snow falls, people have sports like skiing and ice-skating. And for the fop a new wardrobe opens, of bright, stylish woollens.

But no less are the season's rigours. In fact, they seem to weigh more than the joys. In the colder lands they certainly do. To those who cannot keep themselves warm, winter is not just cold: it is wilfully cruel. For that reason it is often pictured as a witch or a demon.

Other living things also feel the nip of winter. Flowers fade.

Leaves fall from the trees. Many plants die out. Birds fly in millions to warmer places. Herds of animals migrate. Those which cannot, go into winter sleep. Or they prepare to go through the cold months in other ways.

Melancholy days are come, says William Cullen Bryant. Almost always the sky is gray. It is so depressing. One turns to the glow of fire. It is at once cheering. But one cannot sit or read or work by the fire for too long.

Outside it is misty and gray yet. One's mind goes back to the days of sunshine and warmth. It yearns for them. A nature lover calls this yearning spring fever.

When does it begin? Spring fever, "respecting no clock or calendar, no living man, nor his wife, nor his children, may find its victims any time after the winter solstice, which is but a few days before Christmas."

One counts the days which must pass before winter ends. And when it ends, there is a feeling of relief, of joy and mirth. It is

OF LEAVES AND FEATHERS

good-bye not only to the "melancholy" days but also to chill, sore throat, numb fingers and several aches and pains.

Poets have sung of it. Story-tellers have spun yarns about it. Some customs also centre round it. This has been so everywhere and in every age.

The Bible tells how the people felt glad when the winter's cold and rain ended. It is in the Song of Solomon:

For, lo, the winter is past, the rain is over and gone, the flowers appear on the earth, the time of the singing of birds is come, and the voice of the turtle is heard in our land.

In one of his odes the Roman poet, Horace, celebrates the coming of spring. In other words, the passing of the freezing cold:

*Melts winter now, his bitter frosts
in spring's sweet change expire...
No longer beasts in stalls delight,
not ploughman by the fire.*

North of Italy is colder Germany. Here the coming of spring is no mere end of the cold days. It is freedom from the grip of ice, the start of a season of hope. Says the hero of Goethe's play, Faust:

*Released from ice are brook and river
By the quickening of the gracious spring;
The colours of hope to the valley cling,
And weak old winter himself must shiver.*

Central heating may keep the rooms warm. But it cannot stop sleet and snow. To the Germans the end of winter is still a big event. Bells ring in the springtime. Then Boogg, the effigy of winter, is burnt amidst cheers in a public place.

Hungary too has similar rite to show in the spring. In New Mexico the effigy of Old Man Gloom goes up in flames.

Russian winter is much harsher. In one of their tales a witch, Polar night, stands for the northern cold. She lives in an icy palace, gray and bleak. The hag wants to kill Robin Redbreast. For she knows when the bird sings, it will be spring.

So she catches Robin Redbreast and takes it to her far-off palace. But a girl frees the bird. As it sings, the sun shines brighter and brighter. The woods turn green, the little streams gurgle and the witch's icy palace melts.

Have you read the Song of Hiawatha? The long poem tells of

another very harsh winter. It is in North America.

*O the long and dreary winter!
O the cold and cruel winter!
Ever thicker, thicker, thicker,
Froze the ice on lake and river;
Ever deeper, deeper, deeper
Fell the snow over the landscape,
Fell the covering snow and drifted
Through the forest, round the village.*

The bitter cold brings with it other troubles. Food is scarce. There is sickness in the wigwams of the Red Indians. Many people perish.

Then the miskodeed is in bloom. It is the first flower of springtime. With it the winter passes, so does the time of trouble. Joy and hope return:

*Came the Spring with all its splendour,
All its birds and all its blossoms,
All its flowers and leaves and grasses.*

Our winter—in the north—is not long. But for a spell or two of biting cold, it is mild. Also, it is bracing. Some of our food crops grow at this time. Fruits and kitchen greens are abundant. And the countryside flows with sugarcane juice.

In some of our old stories winter appears as an old man. He has a white beard but ruddy cheeks. About his shoulders is thrown a shawl of homespun wool. No frown marks his brow, nor sourness his looks. His manner is kindly and genial.

One supposes that people relish the cold days. The more so because they come after much heat and a lot of rain. And we are no doubt more active then than in summer or the monsoon.

No. Most of us are soon fed up with winter. Getting up on a cold morning calls for some courage. So does washing and bathing with cold water. A little exposure may mean a cold or cough or pain in the body. One has all the time to try to keep oneself warm.

But many people cannot afford it. Hence the longing for spring, even though the long hot days will be at its heels.

At last it is Basant Panchami. The festival day may be cold. But it holds out a promise. A simple, rhythmic saying spells it out: Aya Basant, pala udant—Come the spring festival, away flies cold.

O.P. Bhagat

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Plasmids to control chemical pollutants

SOIL microorganisms metabolize a variety of natural and synthetic organic substances and recycle them. This process is referred to as catabolism or degradation. Such communities of microorganisms can be employed effectively in cleaning up of the residues of our industrial units.

A few of the microorganisms have evolved additional and highly efficient system for responding to the appearance of a variety of xenobiotics. The genes encoding for the catabolism of these unusual substances are located on small extra-chromosomal pieces of DNA, called plasmids (mini-chromosomes), first recognized in 1952 by Joshua Lederberg in the U.S. Plasmids are autonomus self-replicating units and co-exist with the host chromosome. A plasmid normally exists in a highly twisted or supercoiled configuration (Fig. 1). When the catabolic capacities are located on a plasmid, the latter is termed a degradative or catabolic plasmid. We prefer to all it 'dissimilatory' plasmid.

Dissimilatory plasmids

The first report that the degradative pathway is plasmid specified was made by A.M. Chakraborty, an Indian scientist settled in U.S. in 1972, who obtained evidence for the degradation of salicylate in *Pseudomonas putida*. Since then reports on the involvement of plasmids in the degradation of camphor, naphthalene, octane, toluene, 3-chlorobenzoate and others (Table 1)

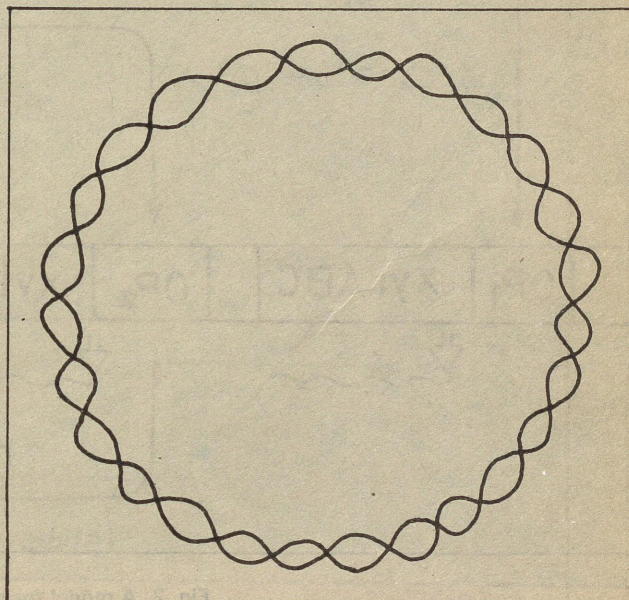


Fig. 1. Supercoiled configuration of plasmid DNA

Table 1

S. No.	Organism	Substrate utilized	Plasmid designation
1	<i>Pseudomonas putida</i>	Salicylate	SAL
2	<i>P. putida</i>	Octane	OCT
3	<i>P. putida</i>	Naphthalene	NAH
4	<i>P. putida</i>	Camphor	CAM
5	<i>P. putida</i>	Toluene and Xylenes	TOL
6	<i>Pseudomonas</i> sp.	2,4-D	—
7	<i>P. convexa</i>	Nicotine	NIC
8	<i>P. putida</i>	3, 5-Xylenol	pRA500
9	<i>P. putida</i>	3-Chlorobenzoate	pAC25
10	<i>Alcaligenes eutrophus</i>		
	<i>A. paradoxus</i>	2, 4-D	pJP1
11	<i>Arthrobacter oxidans</i>	Nicotine	NIC
12	<i>Pseudomonas diminuta</i>	Parathion	pCMS 1
13	<i>Pseudomonas fluorescens</i>	Ethyl benzene	pEB
14	<i>P. fluorescens</i>	Styrene	pEG
15	<i>Beijerinckia</i> sp.	Biphenyls	pKG2
16	<i>Pseudomonas putida</i>	1,2,4-Trimethyl benzene	pTMB
17	<i>Alcaligenes eutrophus</i>	Toluene	pRA1000
18	<i>Pseudomonas solanacearum</i>	Catechin	pAMB1
19	<i>P. putida</i>	Salicylate-Toluene	pKF439
20	<i>Acinetobacter</i> sp.		
	<i>Alcaligenes</i> sp.	4-Chlorobiphenyl	pSS50

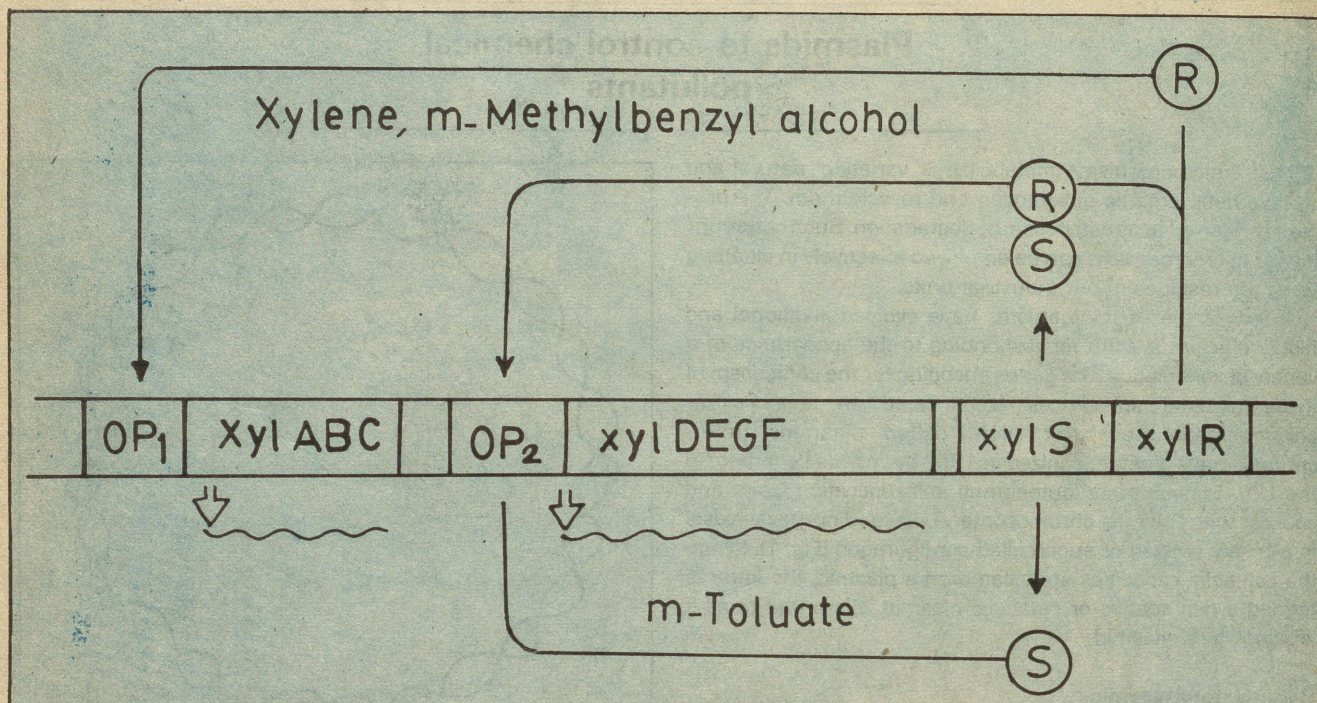


Fig. 2. A model for the positive regulation

have appeared. The best studied among the dissimilatory plasmid is the TOL plasmid specifying the toluene-xylene pathway. A model for the regulation of the enzymes has been proposed (Fig. 2). The genes have also been cloned on to *E. coli* but were expressed poorly.

Most of the dissimilatory plasmids are self-transmissible and are large in size, referred to as megaplasmids. Most degradative pathways in bacteria are inducible. This ensures that the organism does not synthesize the enzymes unless the substrate is present, thereby preventing unnecessary bio-synthetic activity.

It appears that all dissimilatory plasmids described so far carry the genes of peripheral pathway. The final aromatic substrates are further metabolized and channelled into Kreb's cycle (Fig. 3).

Establishment of plasmid encoded degradation

The evidence for plasmid involvement in degradation rests on two lines: genetic and physical.

Genetic evidences. The plasmid-borne characters are unstable and strains cured (by elimination of the plasmid) of the particular phenotype arise spontaneously but at low frequency. The frequency of such spontaneous curing is increased by treating the wild type cells, with ethidium bromide, acridine orange, mitomycin C, or exposing them to ultraviolet light and temperature shock. To ensure that the host has been cured of the plasmid, additional checks are necessary. For example, there should be no detectable reversion of the cured type to wild type and no detectable levels of the plasmid coded enzyme under conditions which should induce them.

The second genetic criterion is to demonstrate the transferability from host to recipient. When a plasmid can be transferred through conjugation, it is called conjugative plasmid.

Physical evidences. Definitive identification ultimately depends upon demonstration by physical means (get electrophoresis, electron microscopy) that the wild type strains carry a plasmid and the cured type do not carry.

Work on dissimilatory plasmids in India

In India, work on the genetic aspects of degradation has been initiated by the authors. Evidence for the involvement of plasmid in the dissimilation of catechin has been demonstrated. Catechin, which is a recalcitrant structural unit of condensed tannin, was degraded by *Pseudomonas solanacearum* to phloroglucinol carboxylic acid and protocatechuic acid. These intermediates were further degraded to central metabolites, hydroxyquinol, protocatechuic acid and catechol (Fig. 4). The enzymes of catechin degradation have been found to be inducible and plasmid dependent.

Strain construction

Strains with improved degradation rates or with a broad range of degradative ability can be constructed by gene manipulation technique (Fig. 6). Such an approach requires extensive knowledge of the biochemistry of the pathway under investigation. By gene cloning techniques, a large part of a particular pathway can be introduced into novel strains. A.M. Chakraborty used this approach to produce a bacterium called multipasmid *Pseudomonas* (MPP). This strain is effective in degrading oil.

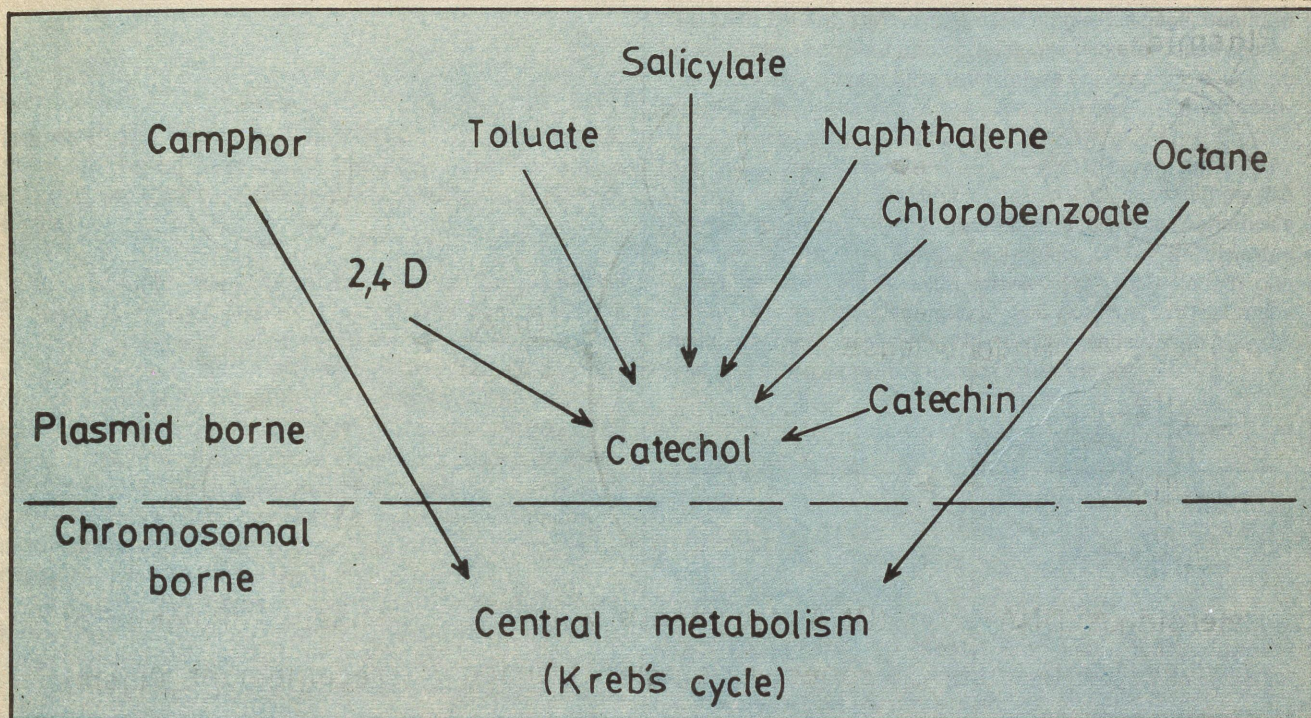


Fig. 3. Plasmid borne dissimilatory pathways of aromatic substances

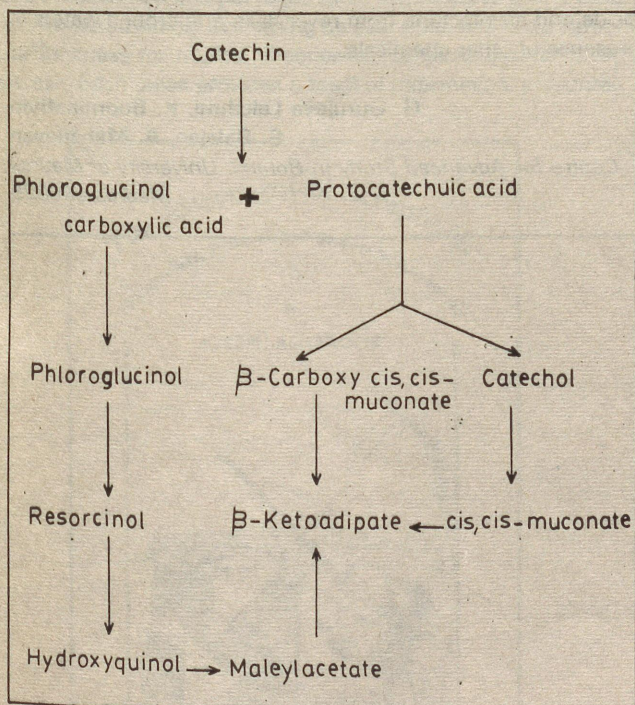


Fig. 4. Dissimilatory pathway of catechin by *Pseudomonas solanacearum*

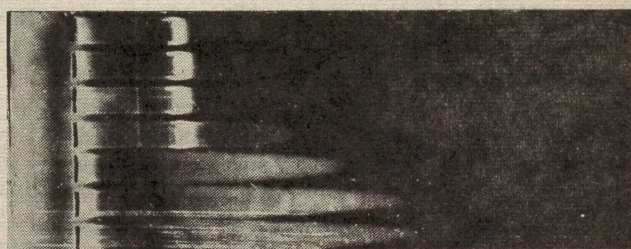


Fig. 5. Plasmid DNA separated on Agarose Gel Electrophoresis, from cured (lane 1-3) and wild (lane 4-7) strains of *Pseudomonas solanacearum* lane 1 starts from Top

However, the use of this strain in removing oil slick is restricted because,

(1) Crude oil essentially comprises straight chain alkanes which are readily degraded by other bacteria. The oil fraction has a very low percentage of aromatic substances such as toluene, naphthalene, etc.

(2) The MPP would be in competition with other marine bacteria in their own habitat. Further, it requires an exogenous supply of nitrogen source for growth.

As nitrogen source will limit the activity of microorganisms in cleaning up areas polluted with xenobiotics, we believe that free living nitrogen fixing microorganisms are ideal to remove xenobiotics. Studies on this aspect using *Azotobacter* sp. are under way in our laboratory.

Exploitation of genetically engineered microorganisms in the environment requires careful planning. Dump sites usually con-

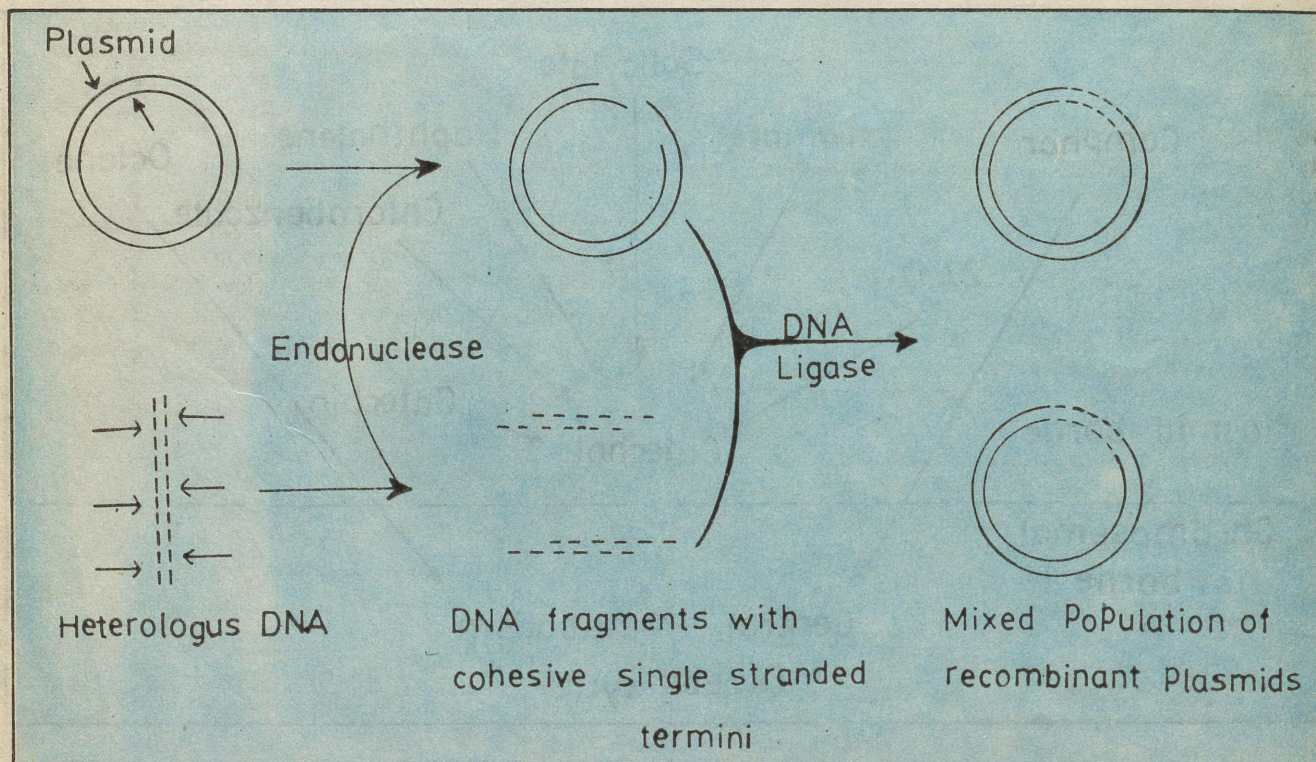


Fig. 6. Method for the *in vitro* construction of hybrid plasmid molecules containing fragments of heterologues DNA

tain many chemicals in high concentrations, and sites contaminated with a single chemical may contain other easily assimilable carbon sources that may be utilized preferentially over the toxic chemicals. However, J.J. Pignatello and his associates at Grey Fresh Water Biological Institute, University of Minnesota, U.S.A. in 1983 demonstrated the effectiveness of a pentachlorophenol degrading *Flavobacterium* sp. in removing pentachlorophenol, a powerful biocide mostly used by the wood

preserving industry but also used as herbicide, algicide, molluscicide and disinfectant, from river, lake and ground waters in presence of other chemicals.

G. Gurujeya Lakshmi, K. Boominathan
S. Balajee, A. Mahadevan

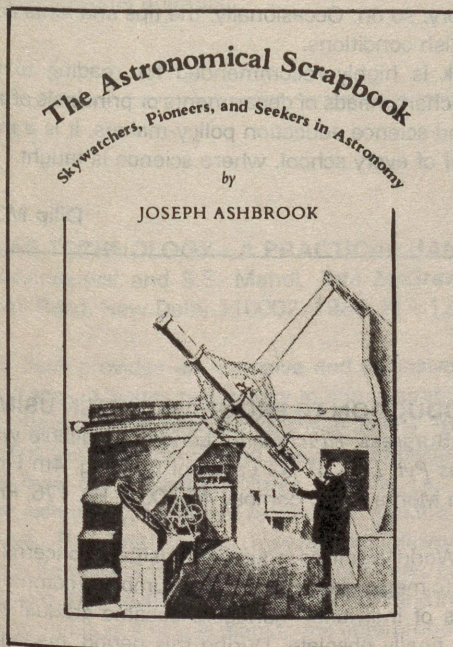
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BOOK REVIEWS

THE ASTRONOMICAL SCRAPBOOK by Joseph Ashbrook, Sky Publishing Corporation, 49, Bay State Road, Cambridge, Mass. 02238, U.S.A. and Cambridge University Press, Pp. 468, \$ 19.95

JOSEPH Ashbrook's column 'Astronomical Scrapbook' first appeared in *Sky & Telescope* magazine in August 1954. It continued to appear almost regularly for 26 years till his untimely death in August 1980. By then Ashbrook had been the magazine's editor for 16 years. The present volume is a collection of 91 of Ashbrook's best of the lot, brought together in 83 updated chapters by the magazine's present editor Leif Robinson. The articles are grouped into seven sections each broadly concerned with a specific aspect of astronomy such as astronomers' life-sketches, telescopes and techniques, studies of the moon, stars and stellar systems, and so on.

The most striking feature of the anthology is the vast range of its coverage and its vintage flavour. Based mainly on material culled from the "crumbling and forgotten literature" at Harvard Observatory's library, Ashbrook's pieces bring out little-known, fascinating episodes from the history of astronomy. They tell us about forgotten geniuses and crackpots, great telescopes and their makers, astronomical hoaxes and scandals, and about astronomical curiosities. Each article, as the extensive 'Notes and References' appended at the end show, has been meticulously researched and put together by Ashbrook who, it is said, "remembered almost everything he ever read, and had a particular fondness for misfits, ill-conceived projects, and far-away places." Each piece provides a feast of information, presented



with such finesse that there is not a single dull page. Beautiful old woodcuts and rare photographs are used for illustration.

Some of the chapter titles themselves are irresistible—Tycho Brahe's nose; Harvester of the skies; The Sadler-Smyth scandal; Darkness at noon; An alleged satellite of Venus; Comets true and false; A hole in the sky—would surely attract any curious reader, and Ashbrook does not disappoint him. No wonder, for more than a quarter of a century, Ashbrook's column was the first thing that readers of *Sky & Telescope* turned to when each issue arrived. Now collected in one volume, Ashbrook's "little gems" will no doubt enthrall many thousands more, especially the younger readers who may not have had the opportunity to read them earlier.

Biman Basu

NATURE STUDY by Martyn Bramwell, *Piccolo Factbook* (Available from: Rupa & Co, 3831, Pataudi House Road, Daryaganj, New Delhi-110002), Pp. 80, Rs. 22.65

THE other day when this reviewer met some bird-watchers, all of them emphasised the point that bird-watching as a hobby should be cultivated in schools (*S.R.*, December '86). A teacher should take children to gardens, parks and forests to acquaint them with bird-life, among other things. But, the question is, how many of our school teachers have interest in bird-life? There is, in fact, a need to cultivate their interest in this subject! Besides, if a parent thinks of acquainting his child with bird-life, he too is at a loss to do so because he himself lacks the know-how. In this context, the book under review is a ready guide to watch not only birds but also plants, insects, trees and animals. Whether it is a bird or insect or tree, all are a part of the same ecosystem and their activities are inter-related. So, one comes to know about it by watching the activities of the other. In short, one becomes acquainted with the working of nature and the problems of nature conservation. This knowledge is needed in abundance among our children and even adults in the time to come when challenges posed by nature are likely to threaten our existence on earth.

After a brief introduction to the subject, the book begins with the kind of preparations required, such as, what to wear, the kind of baits to be made, and notes to be written about the living world. Then it goes over to tips on how to conduct studies on birds, insects, small animals, a habitat such as of a park, etc. Some easy-to-make equipment needed for such studies are also given with clear-cut illustrations. Often the type of experiments one can pursue further are hinted at. At places, instructions and warnings are given in bold types so that animals are not unnecessarily harmed or some chemicals do not cause harm to the experimenter. At the end of the book, there is a chapter each on how to keep one's collection of specimens,

BOOK REVIEWS

where to look for signs of pollution and what should one do to further the cause of nature conservation. Indeed, by performing experiments and studies mentioned in this small book, any body would be hooked on to nature study for ever.

This reviewer only wishes such a book had been available to him during his childhood. It would have been fun watching a caterpillar metamorphose into a butterfly, marking the territory of a bird, catching and studying insects, testing leaves for photo-synthetic activity, keeping a collection of spider nets, building a nesting box, and so on. This fully illustrated and multi-coloured book is packed with fun and knowledge for every curious youngster and adult.

Dilip M. Salwi



ASE SCIENCE TEACHER'S HANDBOOK Edited by John Nellist and Brian Nicholl, *Hutchinson* (Available from: *B.I. Publications Pvt. Ltd.*, Promotion Department, 54, Janpath, New Delhi-110001), Pp. 298, £11.95

"WE aim... to teach students that science is essentially a process of discovery. We then put so much into the syllabus for students to 'discover' that we end up 'telling' them instead", says Ken Dobson while discussing "How is science taught and learnt?" in the book under review. Indeed, in these few words, the writer has presented the situation especially prevailing in most of our schools. There are however places in our country where if a student dares to ask a teacher a question or explain something further, the latter asks him whether he wants to pass or not! In any case, the book under review is a useful compendium on all aspects of science teaching, giving at one place all that an effective teacher and efficient school-manager should know. Going through the book, this reviewer felt the backwardness of our teaching methods judging it of course from his school days, about two decades ago. Nevertheless, in view of the rapidly changing economic, social and industrial changes in the country, the book is suitable for even the most modern school in the country which needs to review its mode of working from time to time. Of course, by "modern" the reviewer does not mean modern in architecture; the school building could as well be a beautiful monument!

Some points mentioned in this well researched and lucidly written book need to be highlighted here. Science as a subject has several dimensions, namely, contents, processes, context, science-education, and meta-science. While planning a syllabus or curriculum for teaching science, all these dimensions should be given proper emphasis so that a student gets a balanced view of it. Questions, say, in mathematics, should not only be put within the limited purview of the subject but also in related subjects and day-to-day life so that a student grasps the power and significance of what he is learning in the class. A teacher should not think, "I teach, therefore the students

learn". Teaching does not indicate that students are learning. It is a teacher's duty to ensure that students are learning and not simply attending his lectures. Emphasis should not be laid simply on the presentation of a subject and the controlling of a class; a teacher should observe how students are responding to his lessons. Efforts should be made to understand students, their inherent motivations and their problems so that whether they have really understood a thing or not could be ascertained. It has been observed that students often respond to teaching in two ways: one, to satisfy the teacher so that they obtain good marks, whether they are convinced by what they have read or not; and the other, what they themselves believe in owing to cultural and other reasons. Wrong notions harboured in the minds of students could be elicited only when a teacher takes pains to do so. A teacher should also praise the good qualities of a student first before telling him about his deficiencies and the ways to improve himself. While assigning numbers to students, the criterion should not simply be to give highest marks only to correct answers, however untidily they have been written. Separate marks should be given for tidiness, hand-writing and other aspects. In short, the book gives all kinds of ideas for the creation of a balanced science student.

After a general introduction written by the Editors, the book contains six chapters, each written by an expert in the field. The chapters range from a balanced syllabus, evaluation of students, how students learn, to organisation of science teaching, management of laboratories and procurement of equipment. Every chapter begins with a brief resume in points about what it has to offer. Box items concerning projects which teachers could take up intersperse the text. The last, seventh chapter of the book is regarding "special problems" such as why girls do not take science, how to maintain safety in laboratory, how to teach science to students with different cultural or religious backgrounds, how to select books for the library and equipment for laboratory, so on. Occasionally, the tips and hints are relevant to British conditions.

The book is highly recommended for reading to all our science teachers, heads of departments or principals of science schools, and science education policy-makers. It is a must on library shelf of every school, where science is taught.

Dilip M. Salwi



AN INTRODUCTION TO PROGRAM DESIGN USING JSP by Rod S. Burgess, *Hutchinson*, London (Available with: *B.I. Publications Pvt. Ltd.*, 61-63 Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay 400 001). Pp. 176, Price not quoted

AFTER World War II, as industrial/business concerns expanded into mega-sizes, the rule-of-thumb and commonsense approaches of individual managers became gradually inadequate and finally obsolete. During this period 'management'

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graduated from an art to a science and grew from strength to strength. Enter the cheap computers, and management science embraced these machines with open arms. By this time, systems analysis had become the main tool of management science. Under the canopy of systems analysis stands, among others, program design.

Although the title of the book gives the last two words, 'Using JSP', in much smaller type than the rest, JSP is what it is all about. Michael Jackson (not to be confused with the pop-star of the same name) developed what is called the Jackson Structured Programming (JSP), which is now considered one of the best program design techniques.

The parameters and limitations of the book are truthfully stated in the Preface: "This text concentrates on the basics of the JSP design method, leaving the detailed treatment of the more difficult features such as inversion and backtracking, and applications such as on-line and data base programs, to a more advance text."

The sequential order in which the nine chapters of the book are arranged is excellent. As a result, the reader is taken from the introduction to program design and the fundamentals of JSP to the intricate applications of the JSP design method in one smooth ride.

A good number of examples are given in each chapter to make the concepts easily understandable. The 'exercises' which follow each chapter and their solutions given at the end of the book are the other useful aspects of the book.

The subject needs a large number of flowcharts and they are visualized and printed in a really professional manner. Although computer languages like BASIC and COBOL are used wherever needed, by and large the book elucidates "a program design method which is programming language independent."

To sum up *Program Design* can be unreservedly recommended not only to students of systems analysis but also to practising systems analysts.

S.K. Nag



BIOGAS TECHNOLOGY—A PRACTICAL HANDBOOK by K.C. Khandelwal and S.S. Mahdi, *Tata McGraw-Hill*, 12/4, Asaf Ali Road, New Delhi-110002, 1986, XI + 128.

THE book provides an intensive and extensive information package on biogas technology to administrators, planners, researchers, village level workers and users. The guidelines regarding the construction and operation of biogas plant given in the book are divided into three sections, i.e., utilization of biogas technology, hardware technology, and the national programme. The first section covers the following chapters, namely, Benefits of biogas, Utilisation of biogas, and Utilisation of Manure. This section highlights the direct and indirect multifarious benefits of a biogas plant to the entrepreneur, namely, a

clean fuel, richer manure, elimination of drudgery from a rural women's daily work, and as a renewable source of energy for running diesel/petrol engines and village industries. Besides, these are social and environmental benefits. The digested slurry produced after the recycling of dung in a biogas plant is a hidden source of micro-nutrients to the soil. The quantity and quality of slurry is higher than that generated at a farm-yard and can be used as a manure to crops or fish ponds. There are about 38 industries engaged in the manufacture of biogas appliances throughout the country and so the promotion of biogas plants in the country will enhance employment opportunities.

The second section deals with hardware technology which contains the following chapters, viz., Technology of biogas, Selection of a model and size, Installation of a biogas unit, Gas distribution pipeline and operation and maintenance. This section deals with the floating gas holder type plant (also known as KVIC plant) fixed dome type (also known as janta biogas plant) Ganesh Model and Pragati Model. The comparison of advantages and disadvantages of a floating gas holder and fixed dome type of plants is clearly tabulated separately. The floating gas holder type and fixed dome type are found in the ratio of 5:4 in the country. Ganesh model is similar to floating gas holder type plant but its cost is lower by 30-40 per cent than the latter design. In its construction, low cost material is used. Pragati Model combines the merits of both the floating gas holder type and fixed dome type plants. For the selection of the model and the size of the plant the factors considered are technical, climatic, geographical and economic. The common problems encountered while installing and operating biogas units and their remedies are also listed separately.

The third section covers the national programme for biogas. It contains the following chapters, namely, National project for biogas development, Institutional finance, Guidelines for promoters and turn-key supervisors and safety. This section highlights the past performance and the future projections of biogas technology in the country. With the availability of 1,000 million tonnes of cattle waste annually, it is estimated that 16-22 million small biogas units can be operated in the country, assuming that 75% of the total cattle waste is available for biogas production. Considering the vast Indian potential for biogas plants the Government of India launched a National Project of Biogas Development (NPBD) in the Sixth Five Year Plan. About 5,00,000 households are currently benefiting from biogas plants. The target of 15 lakh biogas plants is proposed for the Seventh Five Year Plan period (1985-90). The Oriental Fire and General Insurance Company Ltd. has also started a insurance scheme for biogas plants which covers damages caused to the plants due to natural calamities, fire, flood, riots, explosions, etc.

At the end of the book about 54 specifications of different designs of biogas plants are mentioned in the annexure to the book, which will serve as a handy reference to its users. If this book is translated into regional languages, it would cater to the needs of the people who are using biogas technology.

P.R. Bose

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PERSPECTIVES IN PLANT VIROLOGY, VOL. 1, edited by B.M. Gupta, B.P. Singh, H.N. Verma and K.M. Srivastava, *Print House (India)*, 5, Taj Bahadur Sapru Marg, Lucknow, Pp. 322, Rs. 350.00

VIRUSES are very small (smaller than bacteria) living organisms and submicroscopic obligate parasites, which chemically consist of nucleoproteins. They could be transmitted to healthy plants even through the sap extracted from infected plants. Though virus was first discovered in tobacco in 1892 as Tobacco Mosaic Virus (TMV), plant virology has recently emerged as a full-fledged discipline. Besides plant virologists, this area has also generated interest among molecular biologists and genetic engineers. Research findings published in a large number of periodicals devoted to plant virology, plant pathology and allied subjects have practically made it impossible for a reader to acquaint himself with all aspects of phytovirology.

The volume under review is an attempt to pool available information on all aspects of plant virology through review articles. Spread over to twelve chapters it contains review articles from reputed plant virologists. The volume includes chapters on various aspects of plant viruses—infesting potato, tomato, citrus and cucurbitaceous plants. It also contains recent and up-to-date information on viroids, gemini-viruses, plant-virus-inhibitors, seed and pollen-borne viruses, potato seed certification, role of tissue culture, and quarantine in the management of viral diseases. Up-to-date references have been given at the end of each chapter, while a subject index has been given at the end of the book.

In spite of poor photographs and some proof mistakes, the volume would hopefully be of use to researchers and to all those interested in plant virology.

Tapan Mukherjee

SCIENCE AND TECHNOLOGY PERSPECTIVES, Oxford & IBM Publishing Co., 66, Janpath, New Delhi-110001, Pp.140, Rs. 90.00 (Hardbound).

HERE is a collection of invited lectures given by eminent scientists, technologists, managers and communicators as a part of the Silver Jubilee Celebrations of the Indian Institute of Technology, New Delhi. This trend is welcome from two angles: first, through the lectures our young engineers and scientists are exposed to the realities in our scientific organisations and the country on the whole and also potential subjects of research and, secondly, through the lectures now available in book form a wider audience is further exposed to what these eminent

persons have to say. Of course, somebody would say that we Indians are good at lecturing and it is time we start working! Indeed, often, lectures delivered by our eminent persons are high sounding, repetitive, shallow and full of double-talk. Nevertheless, some lectures are worth preservation in print so that they could be read for all time to come.

In the collection under review, there is one such lecture which needs to be read by every one. Given by the well known communicator and environmentalist Anil Aggarwal, his lecture gives some interesting and some gloomy insights into the fuel-wood crisis that threaten to engulf our country in near future. He says that ours is one of those few countries in which people at large are dependent upon wood for cooking purposes, while it is becoming increasingly scarce and costly due to massive deforestation in progress all over the country to meet the demands of cities. Quoting several cases, he claims that rural people in various parts of the country are not even able to earn their living because the wood that they use, for instance, to build their boats had become highly costly due to wrong conservation policies. He claims that unless and until people work in unity and form voluntary organisations to protect their forests the fuel-wood crisis is likely to haunt the countryside for a long time to come. His lecture makes a city-bred aware of things he or she had not thought of before. Management researcher Pradip N.Khandawalla's lively lecture on the prevailing creativity in our society reflects upon its dearth in our organisations and their heads. He gives a number of ways of how to develop creativity and how it could be implemented in our day-to-day life and research.

Management consultant R.P.Billimoria's lecture is on management in private companies and industries. Apart from mentioning in brief the usual practices followed in them, he has highlighted one interesting thing. He claims that our Board of Directors are often defunct bodies which conduct their tasks in a ritualistic manner leading to non-productivity and chaos. This is, in fact, more true about our scientific organisations and institutes than private companies about which he talks. Another stimulating lecture is by K.P.P.Nambiar, Head of the Indian Telephone Industries, in which he has not only highlighted the major reasons why our electronic industry failed to deliver the goods but also given a good account of his own experiences as the Director of Keltron. He claims that only political will, a group of dedicated workers, removal of inept and corrupt people from positions of authority, and maximum communication between different rungs of an organisation are required for achieving success in any field of endeavour.

There is also a lecture on the potentials of biotechnology in the country by P.M.Bhargava, the well known biochemist. Perhaps, he is lobbying for people's support to this field of research which holds considerable promise in a vast country like ours because this is the pet theme of all of his lectures! A newcomer to this field would however appreciate his interesting lecture. One fails to understand why Manfredo Macloti was asked to give a lecture on science and technology in Europe because its contents have no relevance either to Indian situation or engineers. Moreover, it is full of cut and dry facts. H.E.Hoelscher's

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lecture on science and technology is disjointed. One begins to wonder where he is leading the reader to. The U.G.C. Chairman Yash Pal's lecture on control, meandering and streaming in management is, true to the topic, a meandering overview of management as practiced in our scientific organisations. According to him, oral messages, contacts, so on, work effectively to get things done in our prestigious organisations! The lecture on medical education in the country mentions a large number of discrepancies and lacunae in the system but does not offer concrete suggestions to remove them.

On the whole, the collection is fine and should find place on the shelf of every library.

Dilip M. Salwi



MUTAGENESIS: BASIC AND APPLIED edited by A.B. Prasad, *Print House*, 5, Tej Bhadur Sapru Marg, Lucknow, Pp. 288, Rs. 295.00

MUTAGENS are agents which alter the genetic material of an organism. Their discovery in 1927 by H.J. Muller is of considerable importance not only to investigate the structure and functions of genetic material but also to generate novel variants in economic plants. Even though the physical mutagens are non-specific and lead to chromosomal damages, they have been more commonly employed in inducing genetic change. Chemical mutagens, on the other hand, cause more precise alterations in the DNA molecule. The applicability of induced mutations have been restrained because of: (i) the tedious biochemical screening of a large number of mutants; sometimes, more desirable mutant lines are lost for the inavailability of rapid biochemical analysis; (ii) the raising of numerous offsprings of mutant lines, which is labour-intensive and demands more space and finance; and (iii) the restricted utility of mutagens, as the same mutagen produces similar phenotypic changes time and again. In spite of these bottlenecks, mutagens have proved to be indispensable for conducting genetical and breeding studies.

The present book on mutagenesis primarily covers the proceedings of the XV International Congress of Genetics, Satellite symposium held at Darbhanga (India). The book deals with interesting topics in plant, animal and human systems. There are in all 22 chapters which have been inappropriately divided into three sections. The first six chapters comprise the first section on fundamental aspects such as alterations in chromosome structure, centromere separation and aneuploidy, DNA repair defect, nitrofurans-induced DNA damage, etc. The second section deals with the role of mutagens in generating variation in crop plants. These plants with new traits can either be cultivated directly or utilized in hybridization programmes. Experiments involving cereals, pulses and oilseed crops have

been dealt with. The next seven chapters are included in the last section—chemical mutagenesis—which covers the alterations of the material induced by chemical agents such as metallic salts, anti-tuberculosis drugs, pesticides, etc.

The chapters cover the original research work conducted by mutageneticists. The book also contains six review papers. The results obtained by the research workers have been well presented and effectively discussed in light of the available literature. The scope of the book is narrow as it will cater to a limited section of investigators only. The review chapters, on the other hand, will have a wider acceptability as post-graduate students will also find them useful. The methodology provided for the experiments performed will benefit researchers, especially beginners in this field.

The editing of the book is poor. Large number of mistakes have been omitted by the editor. It is heavily priced and is therefore beyond the reach of an individual buyer.

B. Subramaniam

Books Received

1. **THE WISDOM OF SCIENCE** by Hanbury Brown, *Cambridge University Press*, (1986), 139, Munirka Enclave, New Delhi-110067 Pp. 194, £ 6.95
2. **EXPLORING THE NIGHT SKY WITH BINOCULARS** by Patrick Moore, *Cambridge University Press* (1986) (address as above) Pp. 204, £ 11.95
3. **CHEMICAL ANALYSIS** by Kenneth A. Rubinson, *Little Brown & Co.* (1987), (Indian distributors: *B.I. Publications Pvt. Ltd.*, 61-63, Lakshmi Building, 4th Floor, Sir Phirozshah Mehta Road, Bombay 400001), Pp. 924, \$ 45.00
4. **DEFENCE RESEARCH AND DEVELOPMENT: Products, Processes, Technologies**, *Department of Defence Research & Development* (1986), Ministry of Defence, New Delhi, Pp. 168, price not stated.
5. **INTO THE HEART OF THE MIND** by Frank Rose, *Wiley Eastern Limited* (1986), 4835/24, Ansari Road, Daryaganj, New Delhi-110002, Pp. 210, Rs. 26.50
6. **WINNERS AND THEIR ESSAYS—ALL INDIA ESSAY COMPETITION ON WASTELAND DEVELOPMENT FOR SCHOOL STUDENTS**, *Society for Promotion of Wastelands Development*, Shriram Bharatiya Kala Kendra, 1, Copernicus Marg, New Delhi-110001, Pp. 173, price not stated.
7. **A MANUAL OF FRESH-WATER AQUA CULTURE** by R. Santhanam, N. Sukumaran and P. Nagarajan, *Oxford & I B H Publishing Co.*, 66, Janpath, New Delhi-110001, Pp. 193, Rs. 60.00
8. **THERMODYNAMICS AND STATISTICAL PHYSICS** by S.L. Kakani, *Sultan Chand & Sons*, 23, Daryaganj, New Delhi-110002, Pp. 362 + Appendix, Rs. 30.00
9. **ILLUSTRATING BBC-BASIC** by Douald Alcock, *Cambridge University Press* (1986), 139, Munirka Enclave, New Delhi-110057, Pp. 184, £ 6.95

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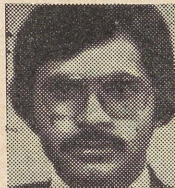
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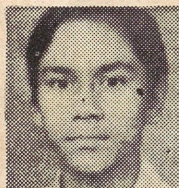


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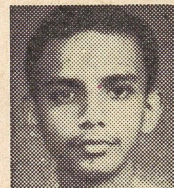
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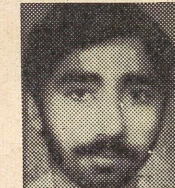
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